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Jack Jeffrey

Hawai‘i Volcanoes National Park

Draft Plan / Environmental Impact Statement for Protecting and Restoring Native Ecosystems by Managing Non-Native Ungulates

October 2011

National Park Service
U.S. Department of the Interior

UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
DRAFT PLAN / ENVIRONMENTAL IMPACT STATEMENT FOR PROTECTING AND RESTORING NATIVE ECOSYSTEMS BY MANAGING NON-NATIVE UNGULATES

Hawai‘i Volcanoes National Park, Hawai‘i County, Hawai‘i

Non-native ungulates were first introduced to the Hawaiian Islands over 1,000 years ago when Polynesians brought domestic pigs to the islands. In the late 18th century, goats, European pigs, sheep, and cattle were introduced as a food source, and eventually some animals became feral (wild). Other non-native ungulates, such as the mouflon sheep that were introduced in the 1950s, were brought as game animals. Axis deer were brought to the Hawaiian Islands from India in late 1867 as a gift to Kamehameha V. Populations of these herbivores flourished because of the mild climate, an abundant food source, and a lack of predators.

Because the ecosystems of the Hawaiian Islands evolved over millions of years in the absence of large mammalian herbivores, they are particularly vulnerable to the effects of non-native ungulates. This is because unlike continental systems that evolved with ungulates, much of the native flora lacks defenses to browsing such as stinging hairs, repellent odors, or thorns. Non-native ungulates cause loss of vegetation, wildlife habitat degradation, and population decline for native Hawaiian species. Non-native ungulates impact native species through browsing, stripping bark, and altering habitat by trampling, soil erosion, digging (pigs), and inhibiting the regeneration of native species. Non-native ungulates increase soil disturbance and encourage the spread of non-native plants. Non-native ungulates detract from the natural conditions that contribute to the wilderness character of the park through the loss of native species and damage to the ecological integrity of the area. Non-native ungulates also have the potential to damage cultural resources, which include archeological sites, cultural landscapes, and ethnographic resources.

The detrimental impacts of non-native ungulates in Hawai‘i were recognized before the park’s establishment in 1916. In 1903, the Hawai‘i Territorial Government Board of Agriculture and Forestry established a forest reserve system to protect remaining watersheds and forests on the islands. In 1910, a Noxious Animal Eradication Program was established, and through 1958 an aggressive campaign to eliminate feral cattle, goats, and pigs was carried out by the Territorial Government that included animal control (1927–1931) within Hawai‘i Volcanoes. Park-led efforts began in 1932 and continue to the present.

This draft plan/EIS analyzes the no-action alternative and four action alternatives for managing non-native ungulates to protect and restore native ecosystems. Under alternative A (no action), existing management practices would be followed and no new management actions would be implemented beyond those available when the non-native ungulate management planning process started. Methods under this current management would be lethal, and would include the use of fencing, and the use of volunteers in direct reduction with firearms. Under alternative B, all aspects of the current management program would be retained, including the use of fencing and volunteers. However, as with all action alternatives, management would be guided by a comprehensive systematic parkwide management plan, which would include a defined population objective of zero or as low as practicable in managed areas, and a systematic progression of management phases, monitoring, and considerations for the use of management tools. Under alternative C, the park would investigate the expansion and enhancement of existing lethal removal techniques, and qualified volunteers would not be used in any ungulate management actions. All elements under alternative C would be implemented with the goal of providing the most efficient and cost-effective methods of ungulate management. Under alternative D, management would rely primarily on lethal techniques similar to alternative C, but non-lethal techniques such as relocation could also be considered. Qualified volunteers could be used for a variety of management actions, including ground shooting. To provide the full range of alternatives, alternative E would involve the same management techniques as alternative D, and although qualified volunteers would be used, they would not participate in ground shooting.

The NPS will accept comments on the plan/EIS from the public for 60 days from the date the Environmental Protection Agency publishes the Notice of Availability in the Federal Register. Mail comments to the name and address below or post online at http://parkplanning.nps.gov/havo. Our practice is to make comments available for public review. Before including your address, phone number, email address, or other personal identifying information in your comment, you should be aware that your entire comment—including your personal identifying information—may be made publicly available at any time. While you may ask us in your comments to withhold your personal identifying information from public review, we cannot guarantee that we will be able to do so. Submissions from organizations or businesses and from individuals identifying themselves as representatives or officials of organizations or businesses will always be made available for public review in their entirety. For more information, or to submit written comments, contact:

Superintendent, Hawai`i Volcanoes National Park
RE: Protecting & Restoring Native Ecosystems by
Managing Non-Native Ungulates Plan/EIS
P.O. Box 52
Hawaii National Park, HI 96718-0052

National Park Service
U.S. Department of the Interior

Hawai‘i Volcanoes National Park
Hawai‘i County, Hawai‘i

HAWAI‘I VOLCANOES NATIONAL PARK

PROTECTING AND RESTORING NATIVE ECOSYSTEMS BY MANAGING NON-NATIVE UNGULATES
DRAFT PLAN / ENVIRONMENTAL IMPACT STATEMENT

October 2011

EXECUTIVE SUMMARY

PURPOSE OF AND NEED FOR ACTION

Non-native ungulates, or mammals with hooves, are an issue of concern in Hawai‘i because of their detrimental effects on native plant and animal diversity and ecosystems. The unique ecosystems of the Hawaiian Islands evolved without large mammalian herbivores and are particularly vulnerable to the impacts of non-native ungulates. Goats, pigs, sheep, mouflon sheep, deer and cattle, all of which are non-native ungulates, destroy habitat, inhibit native forest regeneration and cause local extinctions of vulnerable species. Non-native ungulates detract from the natural conditions that contribute to the wilderness character of the park through the loss of native species and damage to the ecological integrity of the area. Non-native ungulates also have the potential to damage cultural resources at the park, which include archeological sites, cultural landscapes, and ethnographic resources.

The purpose of this Draft Plan/Environmental Impact Statement for Protecting and Restoring Native Ecosystems by Managing Non-native Ungulates (plan/EIS) at Hawai‘i Volcanoes National Park (Hawai‘i Volcanoes or the park) is to develop a comprehensive and systematic framework for managing non-native ungulates that supports long-term ecosystem protection; supports natural ecosystem recovery and provides desirable conditions for active ecosystem restoration; and supports protection and preservation of cultural resources. A plan/EIS is needed to address the impacts of non-native ungulates, which include loss of native ecosystems, especially native plant and animal communities; loss of sensitive native species, including state- and federally listed species; deterioration of wilderness character; and loss of irreplaceable cultural resources. The park’s most recent plan for non-native ungulate control was written over 30 years ago. The new plan/EIS will provide a parkwide framework to systematically guide non-native ungulate management activities over the next decades that considers the recently acquired Kahuku unit; new invasive species challenges; and current National Park Service (NPS) policy and guidance.

This document has been prepared in accordance with the *National Environmental Policy Act of 1969*, as amended, which requires a range of reasonable alternatives be developed and the potential impacts resulting from these alternatives be analyzed. Five alternatives are presented: the no-action alternative (continue existing non-native ungulate management program), and four action alternatives, including the preferred alternative. The document also describes the environment that would be affected by the alternatives and the environmental consequences of implementing any of the alternatives.

PARK PURPOSE AND SIGNIFICANCE

The purpose and significance of Hawai’i Volcanoes National Park are based on the park’s management documents, which provide the general direction for each alternative. The purpose and significance are stated below to provide the reader with adequate background when examining the summary of the alternatives and the environmental consequences.

The following park purpose statement was developed for the *Hawai‘i Volcanoes National Park General Management Plan*, which is currently being developed:

> Hawai‘i Volcanoes National Park protects, studies, and provides access to Kīlauea and Mauna Loa, two of the world’s most active volcanoes; and perpetuates endemic Hawaiian ecosystems and the traditional Hawaiian culture connected to these landscapes (NPS n.d.a).

Park significance statements capture the essence of the park's importance to the nation's natural and cultural heritage. Understanding park significance helps managers make decisions that preserve the resources and values necessary to the park's purpose. The following significance statements were developed for the *Hawai'i Volcanoes National Park General Management Plan*, which is currently being developed:

- Hawai'i Volcanoes National Park protects and interprets the largest and most continuously active shield volcanoes in the United States, and provides the best physical evidence of island building processes that continue to form the 2,000-mile-long Hawaiian Archipelago.
- Hawai'i Volcanoes National Park's active volcanoes serve as a living laboratory for scientific investigations that began over a century ago and continue to advance global understanding of volcanic processes.
- Hawai'i Volcanoes National Park protects, restores and studies unique and diverse ecosystems and endemic species that are the result of over 30 million years of evolution on an active volcanic landscape, wide climate variation, and the extreme isolation of the Hawaiian Islands.
- Hawai'i Volcanoes National Park encompasses the largest and most ecologically diverse wilderness in the Pacific Islands.
- Hawai'i Volcanoes National Park embraces the Native Hawaiian spiritual significance of this landscape and interprets related cultural traditions.
- Hawai'i Volcanoes National Park encompasses sites, structures, objects and landscapes that document over 600 years of human life and activities on an active volcanic landscape.
- Hawai'i Volcanoes National Park provides access to two of the most active volcanoes in the world and an opportunity to understand and appreciate the distinctive geology and natural and cultural adaptations to the land (NPS n.d.a).

OBJECTIVE IN TAKING ACTION

Objectives are "what must be achieved to a large degree for the action to be considered a success" (Director's Order 12 [NPS 2001a]). All alternatives selected for detailed analysis must meet all objectives to a large degree and resolve the purpose of and need for action. Objectives for managing non-native ungulate populations at Hawai'i Volcanoes must be grounded in the park's enabling legislation, purpose, significance, and mission goals, and must be compatible with direction and guidance provided by the park's strategic plan, the 1974 natural resources management plan, the 1975 master plan, the 1986 natural resource management plan, and the 1999 resource management plan (NPS 1974, 1975a, 1986, 1999a), and other management guidance. Any plan the park develops must be consistent with the laws, policies, and regulations that guide the NPS. The following objectives relate to the management of non-native ungulates at Hawai'i Volcanoes.

Objectives are "what must be achieved to a large degree for the action to be considered a success" (Director's Order 12 [NPS 2001a]). All alternatives selected for detailed analysis must meet all objectives to a large degree and resolve the purpose of and need for action.

MANAGEMENT METHODOLOGY

- Develop or refine informed, scientifically based methods for management of non-native ungulate populations to allow for the protection and recovery of park resources.

VEGETATION

- Protect native plant communities and assist with their natural recovery from impacts of non-native ungulates.
- Provide desirable conditions for active restoration of native plant communities degraded by non-native ungulate activity to a native state.

NATIVE WILDLIFE AND WILDLIFE HABITAT

- Protect native wildlife and wildlife habitat and assist with their natural recovery from impacts of non-native ungulates.

RARE, UNIQUE, THREATENED, OR ENDANGERED SPECIES

- Protect endangered, threatened, and rare plant and animal species and assist with their natural recovery from impacts of non-native ungulates.

CULTURAL/HISTORIC RESOURCES

- Prevent impacts to archeological resources, historic structures, cultural landscapes, and ethnographic resources from non-native ungulate activity.

WILDERNESS

- Using the minimum tools necessary to meet minimum requirements per the *Wilderness Act*, limit the impacts of non-native ungulates, as well as management actions, on wilderness areas located within the park.
- Assist in the recovery of natural conditions that have been impacted, or may be impacted, by non-native ungulates.
- Determine the minimum requirements to restore wilderness character in areas impacted by non-native ungulates.

SOILS

- Minimize the impacts of non-native ungulates on soil erosion and disturbance.

VISITOR USE AND EXPERIENCE

- Provide visitors with the opportunity to experience native ecosystems and cultural landscapes that have not been impacted by non-native ungulate activity.
- Enhance visitor awareness and understanding of non-native ungulate management actions and why they are necessary for the protection of park resources.
- Minimize limitations to visitor access as a result of non-native ungulate management activities.

PARK MANAGEMENT AND OPERATIONS

- Minimize long-term impacts (in terms of reduced staff time and resources) to programs at the park incurred by continued monitoring and management of non-native ungulates.

COORDINATION AND OUTREACH

- Coordinate with neighboring land managers implementing non-native ungulate management actions beneficial to the protection of park resources.
- Coordinate with other stakeholders regarding non-native ungulate management and the protection of park resources.
- Enhance public awareness and understanding of the impacts of non-native ungulates and the need for management to protect and restore park resources.

NON-NATIVE UNGULATES AT HAWAI'I VOLCANOES NATIONAL PARK

At Hawaiʻi Volcanoes, non-native ungulate management measures were first implemented in a concentrated manner beginning in 1927, when the Territorial Government conducted goat removal as part of a regional effort to protect Hawaiʻi's watershed. Between 1927 and 1931, these efforts resulted in the removal of 17,389 goats from the park. Efforts by the Territorial Government ceased after 1931. The NPS took over control efforts and relied on private hunters to remove non-native ungulates in the park on a permit basis between 1932 and 1934. These efforts proved to be ineffective in reducing animal numbers and were subsequently discontinued. After 1934, virtually no control of non-native goats or other non-native species occurred at the park until 1938, when the Civilian Conservation Corps used organized drives to remove the animals from the park. These drives were supplemented with boundary and internal fencing. Although successful in removing large numbers of non-native ungulates from the park, Civilian Conservation Corps efforts were suspended in 1941 due to World War II and fences deteriorated (NPS 1972).

Starting in 1944, the NPS hired private companies for goat control. These companies would round up goats from the park and then sell them at a profit. This method continued until 1955, when it was discontinued due to lack of effectiveness. Starting in 1955 and lasting until 1970, the NPS relied exclusively on park staff to eliminate non-native ungulates within the park. During this time, more than 30,000 goats were removed from the park through a variety of techniques such as organized hunts and drives. However, a lack of steady funding and inadequate fencing did not allow for a level of sustained management that would reduce the population. In 1970, the park had over 14,000 goats residing within its boundary (NPS 1972).

Along with feral goat eradication efforts, attempts to control feral pigs were carried out in the park. Approximately 7,000 pigs were eliminated from the older part of the park from 1930 to 1971 (Katahira et al. 1993). These efforts were not successful in eliminating pigs, largely due to the inability of NPS employees to carry out sustained reduction efforts and prevent reentry of pigs into ungulate-control areas.

During this period of feral ungulate control, domestic cattle from the adjoining ranches would wander and graze within the park. The most impacted areas included Mauna Loa and portions of Kīlauea. Although authorized grazing was discontinued in 1948, a small number of stray cattle (both domestic and feral) remained until the early 1970's (Tunison et al. 1995). A small population of feral sheep was eliminated when the NPS assumed ownership of ʻĀinahou Ranch in the early 1970s (Harry, pers. comm. n.d.).

In the 1970s, the NPS changed management strategies to include a systematic approach of direct reduction and fencing, including the use of volunteers in management efforts. The strategy included the use of boundary and internal fences to isolate populations, removal of individuals at greater rates than they can be replenished by reproduction and ingress, boundary fence inspection and maintenance, and monitoring and removal to prevent population increases (NPS 1974, 1986, 1993, 1997a, 1997b, 1999b, 2001b). Since the approach was adopted, NPS staff have eliminated nearly all goats below 9,000 foot elevation (excluding the Kahuku Unit) and pigs from approximately 40,000 acres of interior fenced units or pig control units. Ingress of feral ungulates (goats, mouflon sheep, pigs and cattle) into managed units has occurred at very low, manageable rates since the 1970s. In Kahuku, large numbers of mouflon sheep are present along with feral pigs and a few feral goats and cattle. Several hundred feral sheep occur in the remote north corner of Kahuku. Between 2004 and 2006, approximately 1,900 mouflon sheep were removed from Kahuku along with construction of fence segments along the park boundary; however, populations remain high in many areas (estimated at 1,797 ± 688 by December 2006) due to an annual population increase estimated between 21.1 and 33.1 percent (Stephens et al. 2008; USGS 2006a).

ALTERNATIVES CONSIDERED

The alternatives considered include a "no-action" alternative plus four action alternatives—including the preferred alternative—that were developed by an interdisciplinary planning team and through feedback from the public, other agencies, and the scientific community during the planning process. The four action alternatives would meet, to a large degree, the non-native ungulate management objectives for Hawai'i Volcanoes National Park and the purpose of and need for action.

The alternatives considered include a "no-action" alternative plus four action alternatives—including the preferred alternative—that were developed by an interdisciplinary planning team and through feedback from the public, other agencies, and the scientific community during the planning process.

Under alternative A (no action), the NPS would continue current non-native ungulate practices, which are informed by the 1974 resources management plan/EIS and subsequent amendments (NPS 1974, 1986, 1999a), and other management decisions. Management techniques would be lethal and would include the use of fencing. Qualified volunteers would continue to be used to assist with certain ground shooting activities, and could be used for certain other non-native ungulate management activities. The population-level objective would be zero (or as low as practicable) in existing management units in the park. However, no population objective and fencing strategy would be defined for future areas in a comprehensive parkwide plan.

Under alternative B, the NPS would implement a comprehensive, systematic management plan that would use lethal techniques and would include the use of fencing. Alternative B would include a systematic progression of management phases, monitoring, and considerations for the use of management tools, with a defined population objective of zero non-native ungulates or as low as practicable in managed areas. Qualified volunteers would be used to assist with ground shooting operations, and could be used for certain other non-native ungulate management activities.

Under alternative C, the NPS would implement a comprehensive, systematic management plan using the most efficient and cost-effective methods of non-native ungulate management. Management techniques would be lethal and would include the use of fencing. Alternative C would include a systematic progression of management phases, monitoring, and considerations for the use of management tools, with a defined population objective of zero non-native ungulates or as low as practicable in managed areas. Volunteers would not be used in any capacity associated with non-native ungulate management.

Under alternative D, the NPS would implement a comprehensive, systematic management plan providing maximum management flexibility. In addition to fencing, management tools would rely primarily on lethal techniques, but non-lethal techniques such as relocation could also be considered. Alternative D would include a systematic progression of management phases, monitoring, and considerations for the use of management tools, with a defined population objective of zero non-native ungulates or as low as practicable in managed areas. Qualified volunteers would be used to assist with ground shooting operations, and could be used for certain other non-native ungulate management activities.

Under alternative E, the NPS would implement a comprehensive systematic management plan that includes fencing, relies primarily on lethal techniques, but also considers non-lethal techniques such as relocation. Alternative E would include a systematic progression of management phases, monitoring, and considerations for the use of management tools, with a defined population objective of zero non-native ungulates or as low as practicable in managed areas. To provide the full range of alternatives, alternative E would involve the same management techniques as alternative D, and although qualified volunteers would be used, they would not participate in ground shooting.

PREFERRED ALTERNATIVE

The Council on Environmental Quality (CEQ) regulations for implementing National Environmental Policy Act (NEPA) (40 CFR 1502.14[e]) require that an agency identify its preferred alternative or alternatives in draft and final EIS documents. The preferred alternative is that alternative “which the agency believes would fulfill its statutory mission and responsibilities, giving consideration to economic, environmental, technical and other factors” (46 FR 18026, Q4a).

The preferred alternative is that alternative “which the agency believes would fulfill its statutory mission and responsibilities, giving consideration to economic, environmental, technical and other factors” (46 FR 18026, Q4a).

The NPS has identified alternative D, Comprehensive Management Plan that Maximizes Flexibility by Expanding Lethal and Non-Lethal Removal Techniques, as its preferred alternative. In identifying its preferred alternative, the NPS considered factors such as the extent to which alternatives meet plan objectives, environmental consequences, anticipated effort associated with implementation, degree of management flexibility, and costs.

Among all alternatives evaluated, alternative D provides the greatest flexibility of management techniques, including options for use of non-lethal actions, within the context of a comprehensive, systematic management plan. By incorporating the use of qualified volunteers to assist in management activities, alternative D provides the NPS with opportunities to increase awareness of non-native ungulate issues and engage the surrounding community and general public in stewardship of park resources. Although alternative D would be expected to involve some increase over other alternatives in time needed to achieve the population-level objective, this would not prevent the NPS from fully meeting its non-native ungulate management objectives. Although alternative D would likely include some additional costs and administrative oversight over other alternatives, these factors would likewise not be expected to prevent the NPS from fully meeting its non-native ungulate management objectives.

ENVIRONMENTAL CONSEQUENCES

The summary of environmental consequences considers the actions being proposed and the cumulative impacts from occurrences inside and outside the park. The potential environmental consequences of the actions are addressed for: vegetation; native wildlife and wildlife habitat; rare, unique, threatened, or endangered species; cultural/historic resources (archeological resources, cultural landscapes, ethnographic resources); wilderness; soils; soundscapes; land management adjacent to the park; socioeconomics; visitor use and experience; visitor and employee safety; and park management and operations. The following table is a summary of environmental consequences.

	Alternative A: No Action (Continue Existing Non-native Ungulate Management Activities)	Alternative B: Comprehensive Management Plan that Uses Lethal Removal Techniques	Alternative C: Comprehensive Management Plan that Maximizes Efficiency by Expanding Lethal Removal Techniques and Discontinuing the Use of Volunteers	Alternative D: Comprehensive Management Plan that Maximizes Flexibility of Management Techniques	Alternative E: Comprehensive Management Plan that Increases Flexibility of Management Techniques While Limiting the Use of Volunteers
Vegetation	Under alternative A, short- and long-term negligible to minor adverse impacts would result from the implementation of ground-based management actions. In areas of the park already considered ungulate free, alternative A would produce negligible adverse impacts because the frequency and duration of management actions in these areas would be minimal; and long-term beneficial impacts on vegetation would result from the continuation of animal exclusion. Long-term beneficial impacts would be unlikely for Kahuku and areas currently unmanaged (e.g., portions of ʻŌlaʻa), where no established population-level objective or fencing strategy has been identified in a comprehensive and systematic plan. The effects of alternative A, when combined with impacts of past, present, and reasonably foreseeable future actions on vegetation, would have short- and long-term minor to moderate adverse cumulative impacts on vegetation. Long-term beneficial cumulative impacts would be less certain under alternative A, because implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.	Under alternative B, short- and long-term negligible to minor adverse impacts on vegetation would result from the implementation of ground-based management actions. In areas of the park already managed for ungulates, alternative B would produce negligible adverse impacts because the frequency and duration of management actions in these areas would be minimal. Long-term beneficial impacts to vegetation would be fully realized under this alternative because the comprehensive, systematic approach described in chapter 2, "Elements Common to All Action Alternatives," would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time. The effects of alternative B, when combined with impacts of past, present, and reasonably foreseeable future actions on vegetation, would have short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts.	Same as alternative B, plus: Potential for reaching desired conditions sooner by relying exclusively on lethal removals conducted by NPS and other professionals.	Same as alternative B, except: Use of volunteers for ground shooting in additional areas and use of relocation could reduce efficiency and delay achieving desired conditions.	Same as alternative B, except: Use of relocation could reduce efficiency and delay achieving desired conditions.
Native Wildlife and Wildlife Habitat	Under alternative A, short-term minor to moderate adverse impacts would result from the implementation of monitoring and management actions. In the older section of the park, long-term beneficial impacts to native wildlife and wildlife habitat would result from the continuation of animal exclusion in managed units. However, long-term beneficial impacts to native wildlife and wildlife habitat would be unlikely for areas currently unmanaged (e.g., portions of Kahuku and ʻŌlaʻa), for which no established population-level objective and fencing strategy has been identified. The effects of alternative A, when combined with impacts of past, present, and reasonably foreseeable future actions on native wildlife and wildlife habitat, would have short- and long-term minor to moderate adverse cumulative impacts on vegetation. Long-term beneficial cumulative impacts would be less likely under alternative A, because implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.	Under alternative B, short-term minor to moderate adverse impacts would result from the implementation of monitoring and management actions. Long-term beneficial impacts to native wildlife and wildlife habitat would be fully realized under this alternative because the comprehensive, systematic approach described in chapter 2, "Elements Common to All Action Alternatives," would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time. The effects of alternative B, when combined with impacts of past, present, and reasonably foreseeable future actions on wildlife and wildlife habitat, would have short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts.	Same as alternative B, plus: Potential for reaching desired conditions sooner by relying exclusively on lethal removals conducted by NPS and other professionals.	Same as alternative B, except: Use of volunteers for ground shooting in additional areas and use of relocation could reduce efficiency and delay achieving desired conditions.	Same as alternative B, except: Use of relocation could reduce efficiency and delay achieving desired conditions.

	Alternative A: No Action (Continue Existing Non-native Ungulate Management Activities)	Alternative B: Comprehensive Management Plan that Uses Lethal Removal Techniques	Alternative C: Comprehensive Management Plan that Maximizes Efficiency by Expanding Lethal Removal Techniques and Discontinuing the Use of Volunteers	Alternative D: Comprehensive Management Plan that Maximizes Flexibility of Management Techniques	Alternative E: Comprehensive Management Plan that Increases Flexibility of Management Techniques While Limiting the Use of Volunteers
Rare, Unique, Threatened, or Endangered Species	Under alternative A, short-term minor to moderate, and long-term minor adverse impacts on rare, unique, threatened, or endangered species and their habitat would result from the implementation of non-native ungulate management actions. In the older section of the park, long-term beneficial impacts would result from the continuation of animal exclusion in managed units, with moderate to major beneficial impacts on federally listed species. However, long-term beneficial impacts would be unlikely for Kahuku and areas currently unmanaged (e.g., portions of ‘Ōla‘a), for which no established population-level objective and fencing strategy has been identified. The effects of alternative A, when combined with impacts of past, present, and reasonably foreseeable future actions on rare, unique, threatened, or endangered species, would have short- and long-term minor to moderate adverse cumulative impacts on vegetation. Long-term beneficial cumulative impacts, including moderate to major beneficial impacts on federally listed species, would be less likely under alternative A, because management would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities and implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.	Under alternative B, short-term minor to moderate, and long-term minor adverse impacts on rare, unique, threatened, or endangered species and their habitat would result from the implementation of monitoring and management actions. Long-term beneficial impacts would be fully realized under this alternative, with moderate to major beneficial impacts on federally listed species because the comprehensive, systematic approach described in chapter 2, “Elements Common to All Action Alternatives,” would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time. The effects of alternative B, when combined with impacts of past, present, and reasonably foreseeable future actions, would have short- to long-term minor to moderate adverse and long-term beneficial and cumulative impacts, with moderate to major beneficial cumulative impacts on federally listed species.	Same as alternative B, plus: Potential for reaching desired conditions sooner by relying exclusively on lethal removals conducted by NPS and other professionals.	Same as alternative B, except: Use of volunteers for ground shooting in additional areas and use of relocation could reduce efficiency and delay achieving desired conditions.	Same as alternative B, except: Use of relocation could reduce efficiency and delay achieving desired conditions.
Cultural/Historic Resources: Archeological Resources	Under alternative A, long-term negligible to minor adverse impacts on archeological sites and associated viewsheds would result from the implementation of management actions. In the older section of the park, long-term minor to moderate beneficial impacts would result from the continuation of animal exclusion in managed units. However, long-term benefits would be unlikely for Kahuku and areas currently unmanaged (e.g., portions of ‘Ōla‘a), for which no established population-level objective and fencing strategy has been identified in a comprehensive and systematic plan. The effects of alternative A, when combined with impacts of past, present, and reasonably foreseeable future actions on archeological resources, would have long-term minor to moderate adverse cumulative impacts on archeological resources. Long-term beneficial cumulative impacts would be less likely under alternative A, because implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.	Under alternative B, long-term negligible to minor adverse impacts on archeological sites and associated viewsheds would result from the implementation of management actions. Long-term minor to moderate beneficial impacts to archeological resources would be fully realized under this alternative because the comprehensive, systematic approach described in chapter 2, “Elements Common to All Action Alternatives,” would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time. The effects of alternative B, when combined with impacts of past, present, and reasonably foreseeable future actions on archeological resources, would have long-term minor to moderate adverse and long-term moderate beneficial cumulative impacts.	Same as alternative B, plus: Potential for reaching desired conditions sooner by relying exclusively on lethal removals conducted by NPS and other professionals.	Same as alternative B, except: Use of volunteers for ground shooting in additional areas and use of relocation could reduce efficiency and delay achieving desired conditions.	Same as alternative B, except: Use of relocation could reduce efficiency and delay achieving desired conditions.

	Alternative A: No Action (Continue Existing Non-native Ungulate Management Activities)	Alternative B: Comprehensive Management Plan that Uses Lethal Removal Techniques	Alternative C: Comprehensive Management Plan that Maximizes Efficiency by Expanding Lethal Removal Techniques and Discontinuing the Use of Volunteers	Alternative D: Comprehensive Management Plan that Maximizes Flexibility of Management Techniques	Alternative E: Comprehensive Management Plan that Increases Flexibility of Management Techniques While Limiting the Use of Volunteers
Cultural/Historic Resources: Cultural Landscapes	Under alternative A, long-term minor adverse impacts on cultural landscapes would result from implementation of management actions. Designed landscapes would be less impacted than either historic vernacular landscapes or ethnographic landscapes. In the older section of the park, long-term minor beneficial impacts on cultural landscapes would result from the continuation of animal exclusion in managed units. However, long-term benefits would be unlikely for cultural landscapes still inhabited by non-native ungulates, for which no established population-level objective and fencing strategy has been identified in a comprehensive and systematic plan. The effects of alternative A, when combined with impacts of past, present, and reasonably foreseeable future actions on cultural landscapes, would have long-term minor adverse cumulative impacts on cultural resources. Long-term beneficial cumulative impacts would be less certain under alternative A, because implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.	Under alternative B, long-term minor adverse impacts to cultural landscapes would result from the implementation of management actions. Designed landscapes would be less impacted than either historic vernacular landscapes or ethnographic landscapes. Long-term minor beneficial impacts to cultural landscapes would be fully realized under this alternative because the comprehensive, systematic approach described in chapter 2, "Elements Common to All Action Alternatives," would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time. The effects of alternative B, when combined with impacts of past, present, and reasonably foreseeable future actions on cultural landscapes, would have long-term minor adverse and long-term minor beneficial cumulative impacts.	Same as alternative B, plus: Potential for reaching desired conditions sooner by relying exclusively on lethal removals conducted by NPS and other professionals.	Same as alternative B, except: Use of volunteers for ground shooting in additional areas and use of relocation could reduce efficiency and delay achieving desired conditions.	Same as alternative B, except: Use of relocation could reduce efficiency and delay achieving desired conditions.
Cultural/Historic Resources: Ethnographic Resources	Under alternative A, short-term minor adverse impacts on ethnographic resources would result from the implementation of management actions. In the older section of the park, long-term moderate to major beneficial impacts would result from the continuation of animal exclusion in managed units. However, long-term beneficial impacts would be unlikely for Kahuku and areas currently unmanaged (e.g., portions of ʻŌlaʻa), for which no established population-level objective and fencing strategy has been identified in a comprehensive and systematic plan. The effects of alternative A, when combined with impacts of past, present, and reasonably foreseeable future actions on ethnographic resources, would have short- and long-term minor adverse cumulative impacts. Long-term beneficial cumulative impacts would be less likely under alternative A, because implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.	Under alternative B, short-term minor adverse impacts on ethnographic resources would result from the implementation of management actions. Long-term moderate to major beneficial impacts would be fully realized under this alternative because the comprehensive, systematic approach described in chapter 2, "Elements Common to All Action Alternatives," would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time. The effects of alternative B, when combined with impacts of past, present, and reasonably foreseeable future actions on ethnographic resources, would have short- and long-term minor adverse and long-term moderate to major beneficial cumulative impacts.	Same as alternative B, plus: Potential for reaching desired conditions sooner by relying exclusively on lethal removals conducted by NPS and other professionals.	Same as alternative B, except: Use of volunteers for ground shooting in additional areas and use of relocation could reduce efficiency and delay achieving desired conditions.	Same as alternative B, except: Use of relocation could reduce efficiency and delay achieving desired conditions.

	Alternative A: No Action (Continue Existing Non-native Ungulate Management Activities)	Alternative B: Comprehensive Management Plan that Uses Lethal Removal Techniques	Alternative C: Comprehensive Management Plan that Maximizes Efficiency by Expanding Lethal Removal Techniques and Discontinuing the Use of Volunteers	Alternative D: Comprehensive Management Plan that Maximizes Flexibility of Management Techniques	Alternative E: Comprehensive Management Plan that Increases Flexibility of Management Techniques While Limiting the Use of Volunteers
Wilderness	Under alternative A, short- and long-term minor to moderate adverse impacts to wilderness would result from fences, helicopter work and ground activities related to removal efforts and fence construction and maintenance. In the older section of the park, long-term beneficial impacts on wilderness through the recovery of natural conditions would result from the continuation of animal exclusion in managed units. Long-term beneficial impacts would be unlikely for the Kahuku unit and areas currently unmanaged (e.g., portions of ‘Ōla‘a), where no established population-level objective or fencing strategy has been identified in a comprehensive and systematic plan. The effects of alternative A, when combined with impacts of past, present, and reasonably foreseeable future actions on wilderness, would have short- and long-term minor to moderate adverse cumulative impacts. Long-term beneficial cumulative impacts would be less likely under alternative A, because non-native ungulate management would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities and implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.	Under alternative B, short- and long-term minor to moderate impacts on wilderness would result from fences, helicopter work and ground activities related to removal efforts and fence construction and maintenance. Long-term beneficial impacts to wilderness would be fully realized under this alternative because the comprehensive, systematic approach described in chapter 2, “Elements Common to All Action Alternatives,” would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time. The effects of alternative B, when combined with impacts of past, present, and reasonably foreseeable future actions on wilderness, would have sort- and long-term minor to moderate adverse and long-term beneficial cumulative impacts.	Same as alternative B, plus: Potential for reaching desired conditions sooner by relying exclusively on lethal removals conducted by NPS and other professionals.	Same as alternative B, except: Use of volunteers for ground shooting in additional areas and use of relocation could reduce efficiency and delay achieving desired conditions.	Same as alternative B, except: Use of relocation could reduce efficiency and delay achieving desired conditions.
Soils	Under alternative A, short-term, localized negligible adverse impacts to soils would result from ground-based management actions. In the older section of the park, long-term beneficial impacts on soil would result from the continuation of animal exclusion in current management units. Long-term beneficial impacts would be unlikely for Kahuku and portions of ‘Ōla‘a, where no established population-level objective or fencing strategy has been identified in a comprehensive and systematic plan The effects of alternative A, when combined with impacts of past, present, and reasonably foreseeable future actions on soil, would have short- and long-term minor to moderate adverse cumulative impacts. Long-term beneficial cumulative impacts would be less likely under alternative A, because implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.	Under alternative B, short-term, localized negligible adverse impacts to soils would result from ground-based management actions. Long-term beneficial impacts to soils would be fully realized under this alternative because the comprehensive, systematic approach described in chapter 2, “Elements Common to All Action Alternatives,” would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time. The effects of alternative B, when combined with impacts of past, present, and reasonably foreseeable future actions on soil, would have short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts.	Same as alternative B, plus: Potential for reaching desired conditions sooner by relying exclusively on lethal removals conducted by NPS and other professionals.	Same as alternative B, except: Use of volunteers for ground shooting in additional areas and use of relocation could reduce efficiency and delay achieving desired conditions.	Same as alternative B, except: Use of relocation could reduce efficiency and delay achieving desired conditions.

	Alternative A: No Action (Continue Existing Non-native Ungulate Management Activities)	Alternative B: Comprehensive Management Plan that Uses Lethal Removal Techniques	Alternative C: Comprehensive Management Plan that Maximizes Efficiency by Expanding Lethal Removal Techniques and Discontinuing the Use of Volunteers	Alternative D: Comprehensive Management Plan that Maximizes Flexibility of Management Techniques	Alternative E: Comprehensive Management Plan that Increases Flexibility of Management Techniques While Limiting the Use of Volunteers
Soundscapes	Under alternative A, there would be short-term moderate adverse impacts to soundscapes would result from ground-based and aerial management actions. In the older section of the park, long-term beneficial impacts on soundscapes would result through the continuation of ungulate exclusion in current management units. Long-term beneficial impacts would be unlikely for the Kahuku unit and areas currently unmanaged (e.g., portions of ʻŌlaʻa), where no established population-level objective or fencing strategy has been identified in a comprehensive and systematic plan. The effects of alternative A, when combined with impacts of past, present, and reasonably foreseeable actions on soundscapes, would have short-term moderate adverse cumulative impacts. Long-term beneficial cumulative impacts would be less likely under alternative A, because implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.	Under alternative B, short-term moderate adverse impacts to soundscapes would result from the use of firearms, vehicles, helicopters, and fence maintenance equipment. Long-term beneficial impacts to soundscapes would be fully realized under this alternative because the comprehensive, systematic approach described in chapter 2, "Elements Common to All Action Alternatives," would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time. The effects of alternative B, when combined with impacts of past, present, and reasonably foreseeable actions on soundscapes, would have short-term moderate adverse and long-term beneficial cumulative impacts.	Same as alternative B, plus: Potential for reaching desired conditions sooner by relying exclusively on lethal removals conducted by NPS and other professionals.	Same as alternative B, except: Use of volunteers for ground shooting in additional areas and use of relocation could reduce efficiency and delay achieving desired conditions.	Same as alternative B, except: Use of relocation could reduce efficiency and delay achieving desired conditions.
Land Management Adjacent to the Park	Alternative A would result in short- and long-term negligible to moderate adverse and beneficial impacts on land management adjacent to current park management units. Where existing boundary fences occur, impacts of removal efforts on non-native ungulate populations outside the park would be negligible. However, impacts of any future removal efforts would be uncertain in areas currently unmanaged and for which no population objective or fencing strategy has been identified (e.g., portions of ʻŌlaʻa and Kahuku). The long-term minor to moderate adverse and beneficial impacts of past, present, and reasonably foreseeable future actions on land management adjacent to the park, when combined with the impacts of implementing alternative A, would have long-term minor to moderate adverse and beneficial cumulative impacts on land management adjacent to the park.	Alternative B would result in short- and long-term negligible to minor adverse and beneficial impacts on land management adjacent to the park. Proposed new boundary fences, would minimize impacts of removal efforts conducted inside the park on populations outside the park. The long-term minor to moderate adverse and beneficial impacts of past, present, and reasonably foreseeable future actions on land management adjacent to the park, when combined with the impacts of implementing alternative B, would have long-term, minor to moderate adverse and beneficial cumulative impacts on land management adjacent to the park.	Same as alternative B, plus: Potential for reaching desired conditions sooner by relying exclusively on lethal removals conducted by NPS and other professionals.	Same as alternative B, except: Use of volunteers for ground shooting in additional areas and use of relocation could reduce efficiency and delay achieving desired conditions.	Same as alternative B, except: Use of relocation could reduce efficiency and delay achieving desired conditions.

	Alternative A: No Action (Continue Existing Non-native Ungulate Management Activities)	Alternative B: Comprehensive Management Plan that Uses Lethal Removal Techniques	Alternative C: Comprehensive Management Plan that Maximizes Efficiency by Expanding Lethal Removal Techniques and Discontinuing the Use of Volunteers	Alternative D: Comprehensive Management Plan that Maximizes Flexibility of Management Techniques	Alternative E: Comprehensive Management Plan that Increases Flexibility of Management Techniques While Limiting the Use of Volunteers
Socioeconomics	Under alternative A, non-native ungulate management program would have beneficial impacts on local communities as a result of park payroll and spending on non-native ungulate control, fencing, and related supplies. Impacts to non-market social values would be minor, short-term, and adverse during control activities. There would be no measurable effect on park visitation and recreation spending. Long-term beneficial impacts to non-market social values through the restoration of native species and communities would be less likely for the Kahuku unit and areas currently unmanaged (e.g., portions of ‘Ōla‘a), where no established population-level objective, or fencing strategy, or management implementation has been identified in a comprehensive and systematic plan. The effects of alternative A, when combined with the impacts of past, present, and reasonably foreseeable future actions on socioeconomic resources, would have short-and long-term minor adverse impacts and long-term beneficial impacts on socioeconomic resources. Long-term beneficial cumulative impacts would be less likely under alternative A, because implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.	Under alternative B, non-native ungulate management program would have beneficial impacts on local communities as a result of park payroll and spending on non-native ungulate control, fencing, and related supplies. Impacts to non-market social values would be minor, short-term, and adverse during control activities. There would be no measurable effect on park visitation and recreation spending. Long-term beneficial impacts to non-market social values through the restoration of native species and communities would be fully realized under alternative B because the comprehensive, systematic approach described in chapter 2, “Elements Common to All Action Alternatives,” would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time. The impacts of past, present, and reasonably foreseeable future actions on socioeconomic resources, when combined with the impacts of implementing alternative B, would have short- and long- term minor adverse and long-term beneficial cumulative impacts.	Same as alternative B, plus: Potential for reaching desired conditions sooner by relying exclusively on lethal removals conducted by NPS and other professionals. Impacts on participants in the volunteer program are expected to be minor, as substitute hunting opportunities are available.	Same as alternative B, except: Use of volunteers for ground shooting in additional areas and use of relocation could reduce efficiency and delay achieving desired conditions. Some beneficial impacts to social values would be gained among individuals who prefer non-lethal relocation approaches over lethal methods. Conversely, the additional resources needed to implement non-lethal methods (e.g., capture and relocation of animals) may delay the NPS in reaching desired conditions and result in more reduction efforts, which would contribute to adverse impacts to social values.	Same as alternative D, except: Impacts on participants in the volunteer program are expected to be minor, as substitute hunting opportunities are available.
Visitor Use and Experience	Under alternative A, short- and long-term minor adverse affects on visitor use and experience would result from temporary closures and disruptions caused by ungulate control measures and fence construction and repair, and the long-term presence of fences. In the older section of the park, long-term beneficial impacts to the visitor experience resulting from the recovery of native vegetation and wildlife habitat would continue in managed units. Long-term beneficial impacts would be less likely for the Kahuku unit and areas currently unmanaged (e.g., portions of ‘Ōla‘a), where no established population-level objective, or fencing strategy, or management implementation has been identified in a comprehensive and systematic plan. The effects of alternative A, when combined with impacts of past, present, and reasonably foreseeable future actions on visitor use and experience, would have short- and long-term minor adverse cumulative impacts. Long-term beneficial cumulative impacts would be less likely under alternative A, because implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.	Under alternative B, short- and long-term minor adverse affects on visitor use and experience would result from temporary closures and disruptions caused by ungulate control measures and fence construction and repair, and the long-term presence of fences. Long-term beneficial impacts to visitor use and experience would be fully realized under this alternative because the comprehensive, systematic approach described in chapter 2, “Elements Common to All Action Alternatives,” would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time. The effects of alternative B, when combined with impacts of past, present, and reasonably foreseeable future actions on visitor use and experience, would have short- and long-term minor adverse cumulative and long-term beneficial impacts.	Same as alternative B, plus: Potential for reaching desired conditions sooner by relying exclusively on lethal removals conducted by NPS and other professionals.	Same as alternative B, except: Use of volunteers for ground shooting in additional areas and use of relocation could reduce efficiency and delay achieving desired conditions.	Same as alternative B, except: Use of relocation could reduce efficiency and delay achieving desired conditions.

	Alternative A: No Action (Continue Existing Non-native Ungulate Management Activities)	Alternative B: Comprehensive Management Plan that Uses Lethal Removal Techniques	Alternative C: Comprehensive Management Plan that Maximizes Efficiency by Expanding Lethal Removal Techniques and Discontinuing the Use of Volunteers	Alternative D: Comprehensive Management Plan that Maximizes Flexibility of Management Techniques	Alternative E: Comprehensive Management Plan that Increases Flexibility of Management Techniques While Limiting the Use of Volunteers
Visitor and Employee Safety	Under alternative A, short- and long-term minor to moderate adverse impacts on visitor and employee safety would result from implementation of management actions. In the older section of the park, long-term beneficial impacts to visitor and employee safety would continue in managed units. Long-term beneficial impacts would be unlikely for the Kahuku unit and areas currently unmanaged (e.g., portions of ʻŌlaʻa), where no established population-level objective or fencing strategy has been identified in a comprehensive and systematic plan. In these areas, animals could potentially remain on the landscape indefinitely, increasing exposure of employees and visitors to safety risks associated with ungulate management activities. The effects of alternative A, when combined with impacts of past, present, and reasonably foreseeable future actions on visitor and employee safety, would have short- and long-term minor to moderate adverse cumulative impacts.	Under alternative B, short- and long-term minor to moderate adverse impacts on visitor and employee safety would result from implementation of management actions. Long-term beneficial impacts to visitor and employee safety would be fully realized under this alternative. The effects of alternative B, when combined with impacts of past, present, and reasonably foreseeable future actions on visitor and employee safety, would have short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts.	Same as alternative B, plus: Potential for reaching desired conditions sooner by relying exclusively on lethal removals conducted by NPS and other professionals.	Same as alternative B, except: Use of volunteers for ground shooting in additional areas and use of relocation could reduce efficiency and delay achieving desired conditions.	Same as alternative B, except: Use of relocation could reduce efficiency and delay achieving desired conditions.
Park Management and Operations	Alternative A would result in long-term moderate adverse impacts on the Natural Resources Division and short- and long-term negligible to minor adverse impacts on other divisions. There could be increased costs associated with alternative A, because management would not have a comprehensive plan to guide implementation. There would be less likelihood that the NPS would progress through management phases, monitor, and apply management tools consistently (and effectively) as staff and institutional knowledge change over time. The greatest uncertainty would be for Kahuku and areas currently unmanaged (e.g., portions of ʻŌlaʻa), for which no established population-level objective and fencing strategy has been identified. The effects of alternative A, when combined with impacts of past, present, and reasonably foreseeable future actions on park management and operations, would have long-term moderate adverse cumulative impacts.	Alternative B would result in long-term moderate adverse impacts to the Natural Resources Division and short- and long-term negligible to minor adverse impacts to other park divisions. Compared to alternative A, there would be increased cost efficiency associated with alternative B, because ungulate management would be guided by the fencing strategy, population objective, and comprehensive and systematic approach described in chapter 2, "Elements Common to All Action Alternatives." The effects of alternative B, when combined with impacts of past, present, and reasonably foreseeable future actions on park management and operations, would have long-term moderate adverse cumulative impacts.	Same as alternative B, plus: There would be cost efficiency gained through the discontinuation of volunteers in ground shooting efforts.	Same as alternative B, except: Use of volunteers for ground shooting in additional areas and use of relocation could reduce efficiency and delay achieving desired conditions.	Same as alternative B, except: Use of relocation could reduce efficiency and delay achieving desired conditions.

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Acronyms

ACETA	aerial capture, eradication, and tagging of animals
AGL	Above ground level
APHIS	Animal and Plant Health Inspection Service
ASM	American Society of Mammalogists
ATMP	air tour management plan
CEQ	Council on Environmental Quality
CESU	Cooperative Ecosystem Studies Unit
CFR	Code of Federal Regulations
dBA	A-weighted decibel
DLNR	Department of Land and Natural Resources
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FR	Federal Register
GMP	general management plan
GPS	global positioning system
HDOA	Hawai‘i Department of Agriculture
HEAR	Hawai‘i Ecosystems at Risk Project
IAMC	Interagency Aviation Management Council
LFO	Level flyover
NEPA	National Environmental Policy Act
NHT	National Historic Trail
NPS	National Park Service
NRCS	Natural Resources Conservation Service
PEPC	Planning, Environment, and Public Comment
PIERC	Pacific Islands Ecosystem Research Center
plan/EIS	*Draft Plan / Environmental Impact Statement for Protecting and Restoring Native Ecosystems by Managing Non-native Ungulates*
SEA	Special Ecological Area
TMA	Three Mountain Alliance
TNC	The Nature Conservancy
USC	United States Code
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WUI	wildland/urban interface

Chapter 1 Purpose of and Need for Action

CHAPTER 1: PURPOSE OF AND NEED FOR ACTION

This *Draft Plan / Environmental Impact Statement for Protecting and Restoring Native Ecosystems by Managing Non-native Ungulates* (plan/EIS) *at Hawai'i Volcanoes National Park* (Hawai'i Volcanoes or the park) analyzes the impacts that could result from continuation of current management activities (the no-action alternative), as well as the impacts that could result from four action alternatives.

This chapter describes the reasons the National Park Service (NPS) is taking action at this time to evaluate a range of alternatives and management actions for the protection and restoration of native ecosystems by managing non-native ungulates (mammals with hooves). Specifically, this chapter includes

- impacts associated with non-native ungulates at the park;
- history of non-native ungulates at the park;
- history of non-native ungulate management at the park;
- statements of the purpose and need for taking action, as well as specific objectives;
- background information about the park;
- a discussion of issues and impact topics identified during the scoping process and considered in preparation of the plan/EIS, as well as issues dismissed from further analysis; and
- related laws, policies, plans, and other constraints.

Hawai'i Volcanoes is located on the Island of Hawai'i (figure 1). The park boundary originally included 35,865 acres (including Haleakalā on the Island of Maui, which is now a separate national park system unit) and was expanded through the years to 333,000 acres. The most recent of these expansions was the acquisition of the Kahuku Unit, adding 116,000 acres to the park. The study area for the plan/EIS is Hawai'i Volcanoes (figure 2). Special attention will be given to areas of the park where non-native ungulate populations are known to exist. For example, the recently acquired Kahuku Unit has large concentrations of non-native feral (wild) ungulates, specifically mouflon sheep (*Ovis musimon*), pigs (*Sus scrofa*), sheep (*Ovis aries*), and small numbers of feral cattle (*Bos taurus*) and goats (*Capra hircus*). Also, feral pigs continue to impact areas of 'Ōla'a and Kīlauea units.

Upon conclusion of the plan/EIS and decision-making process, one of the alternatives, or a combination of actions from multiple alternatives, will become the plan for protecting and restoring native ecosystems by managing non-native ungulates. This plan will guide future actions for a period of approximately 15-20 years or until conditions necessitate revising the plan.

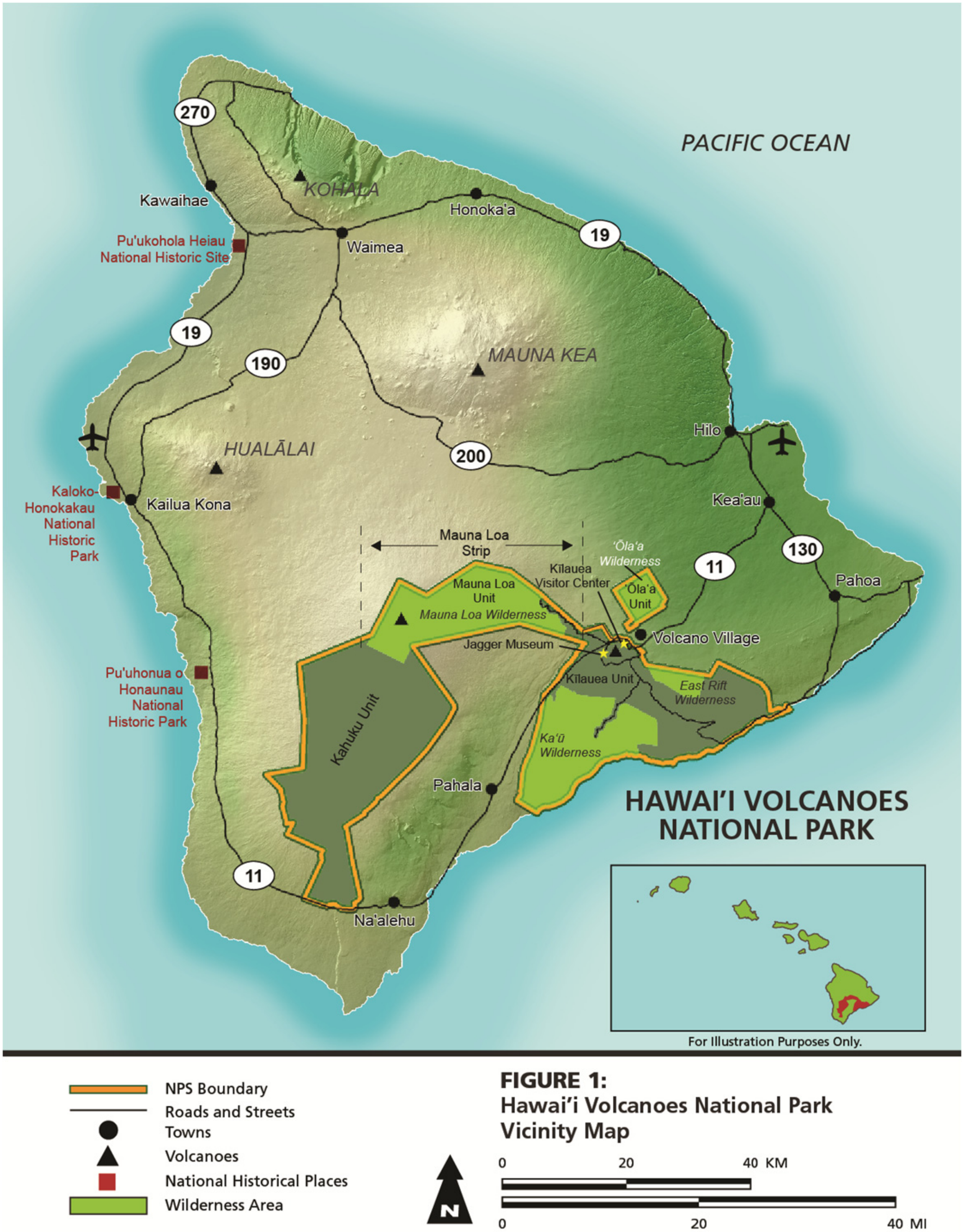
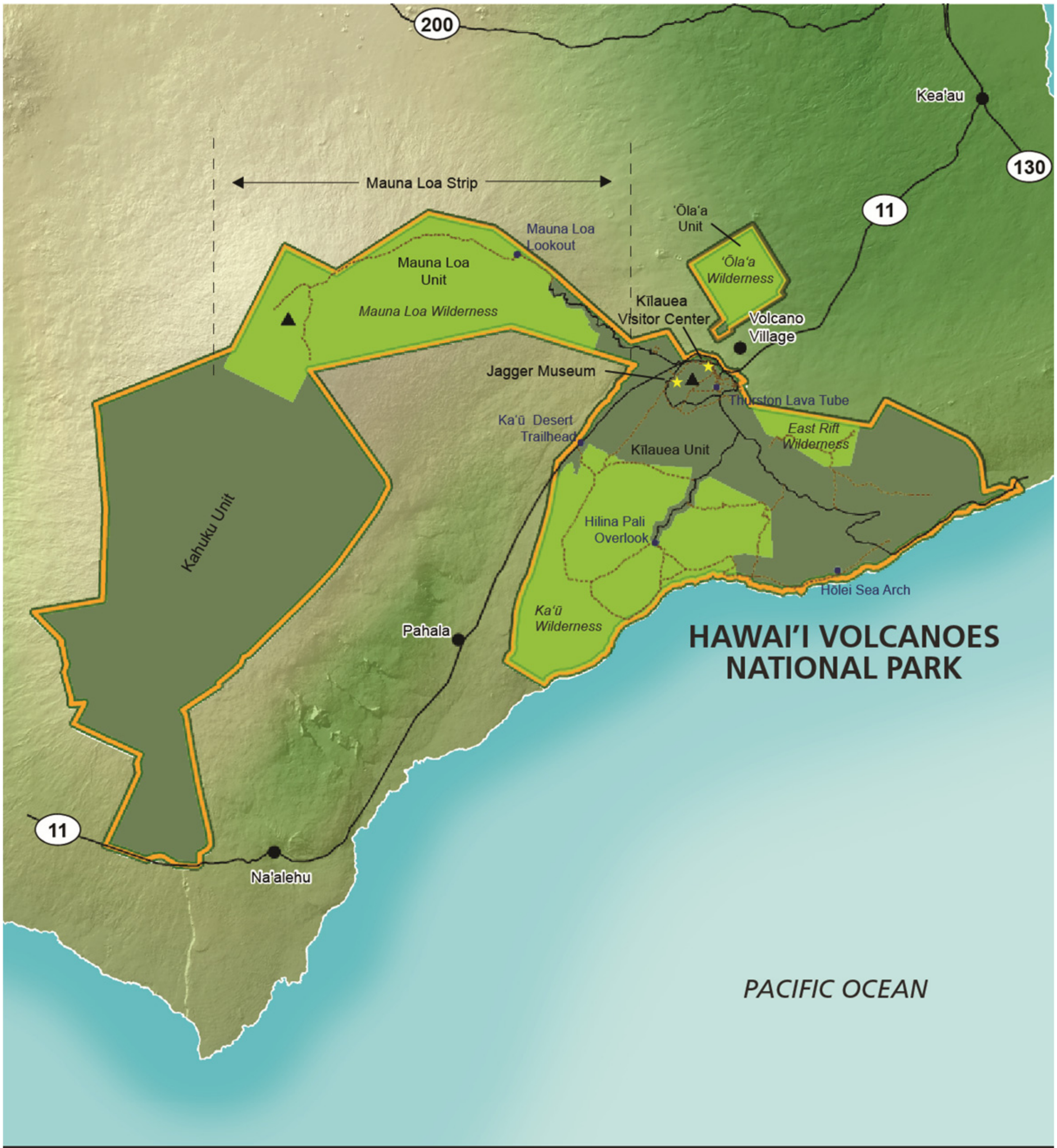


FIGURE 1:
Hawai'i Volcanoes National Park
Vicinity Map



NPS Boundary
Roads and Streets
Towns
Volcanoes
Wilderness Area
Overlook
Trails

FIGURE 2:
Hawai'i Volcanoes National Park Study Area Map

N
0 3 6 9 12 Miles

For Illustration Purposes Only.

IMPACTS ASSOCIATED WITH NON-NATIVE UNGULATES AT HAWAI‘I VOLCANOES NATIONAL PARK

Non-native species are those that do not naturally occur in the ecosystem and were introduced by humans, accidentally or incidentally, into the environment from elsewhere. Because the ecosystems of the Hawaiian Islands evolved over millions of years in the absence of large mammalian herbivores, they are particularly vulnerable to the effects of non-native ungulates. This is because unlike continental systems that evolved with ungulates, much of the native flora lacks defenses against browsing such as stinging hairs, repellent odors, or thorns. Non-native ungulates cause loss of vegetation, wildlife habitat degradation, and population decline for native Hawaiian species. Non-native ungulates impact native species through browsing (Scowcroft 1983), stripping bark (Scowcroft and Sakai 1983), and altering habitat by trampling (Spatz and Mueller-Dombois 1973; Drake and Pratt 2001; Busby et al. 2010), soil erosion (Stone and Loope 1987; Vitousek et al. 1987), digging (feral pigs) (Ralph and Maxwell 1984; Loope et al. 1991), and inhibiting the regeneration of native species (Scowcroft and Giffin 1983; Loope and Scowcroft 1985). Non-native ungulates increase soil disturbance and encourage the spread of non-native plants (NPS 2007a; Spatz and Mueller-Dombois 1975; Aplet et al. 1991; LaRosa 1992). Non-native ungulates detract from the natural conditions that contribute to the wilderness character of the park through the loss of native species and damage to the ecological integrity of the area.

For example, feral pigs preferentially browse or uproot some native plants such as tree ferns (*Cibotium* spp.), native mints, and native shrubs. Feral pigs facilitate the establishment of non-native plants by damaging the native vegetation, opening the tree fern canopy (allowing more light to penetrate the understory), disturbing soil, and dispersing non-native and invasive weed seeds. Goats heavily browse vegetation and prefer palatable native plants that lack defenses against non-native ungulates. Mouflon sheep prefer a valuable plant community dominated by the native trees koa (*Acacia koa*), māmane (*Sophora chrysophylla*), and shrubs ‘ā ‘ali‘i (*Dodonaea viscosa*). Feral sheep have contributed to the decline in populations of the māmane, an endemic leguminous tree that occurs in the subalpine woodland ecosystem, by stripping the bark off the trees, which facilitates damage from insects and other disease-causing organisms. They also appear to prefer native perennial grasses to non-native species (Scowcroft and Conrad 1992). In old growth forests, both domestic and feral cattle destroy native understory plants, leading to species loss and facilitating invasive weeds. While large canopy trees often persist for some time despite this disturbance, natural regeneration of canopy species is suppressed, and forest integrity declines dramatically (USFWS 2007).

Feral sheep have contributed to the decline in populations of the māmane, an endemic leguminous tree that occurs in the subalpine woodland ecosystem, by stripping the bark off the trees, which facilitates damage from insects and other disease-causing organisms.

In addition to direct ecosystem impacts, loss of vegetation and soil disturbance caused by trampling, digging, and rooting can increase soil erosion and deterioration of watersheds (Cuddihy and Stone 1990). Loss of native soil macroinvertebrates has been associated with pig disturbance (Vtorov 1993). Through their rooting and wallowing habits, feral pigs create unnatural pockets of standing water, including troughs created in fallen tree fern trunks, which are favorable breeding places for *Culex* mosquitoes. These mosquitoes can transmit avian malaria and avian pox, two main factors of loss of native forest birds (NPS 1999a; USGS 2005a). This is an issue particularly in young rainforests on Kīlauea and Mauna Loa where soils are porous and there are few natural sources of standing water.

The potential impacts of non-native ungulates are recognized as significant threats in several U.S. Fish and Wildlife Service (USFWS) recovery plans for listed species (USFWS 1996a, 1996b, 1997, 1999b, 2003, 2004, 2006a, 2008a). In the park, this was evidenced in the mid-1990s when several mouflon sheep breached a boundary fence and preferentially browsed on populations of the federally listed endangered Mauna Loa silversword (*Argyroxiphium kauense*) and threatened Hawaiian catchfly (*Silene hawaiiensis*) (NPS 1999a; Belfield and Pratt 2002). Outside the park, feral sheep have also been found to be a substantial factor in the decline of the Mauna Kea silversword (Welsh 2002). Predation of eggs and goslings of the federally listed endangered nēnē or Hawaiian goose (*Branta sandvicensis*) has been attributed to feral pigs (USFWS 2004).

Non-native ungulates also have the potential to affect cultural resources at the park, which include archeological sites, cultural landscapes, and ethnographic resources. Ground disturbance caused by trampling, digging, and rooting could impact archeological sites. Trampling affects surface and subsurface (cave) features and built structures that can be knocked down (Moniz-Nakamura pers. comm.). Non-native ungulates that use caves may damage fragile artifacts. Alterations in the ecosystem of an area could impact the characteristics that contribute to its designation as a cultural landscape. Traditional uses and ethnographic resources, could be impacted by the loss of native plant and animal communities important to the culture of native peoples.

People who visit Hawai‘i Volcanoes to see natural ecosystems may be affected by the degradation and modification of native habitat and the effects of non-native ungulates on native species.

HISTORY OF NON-NATIVE UNGULATE SPECIES AT HAWAI‘I VOLCANOES NATIONAL PARK

Non-native ungulates were first introduced to the Hawaiian Islands over 1,000 years ago when Polynesians brought domestic pigs to the islands. In the late 18th century, goats, European pigs, sheep, and cattle were introduced as a food source, and eventually some animals became feral (wild). Other non-native ungulates, such as the mouflon sheep that were introduced in the 1950s, were brought as game animals. Axis deer (*Axis axis*) were brought to the Hawaiian Islands from India in late 1867 as a gift to Kamehameha V. Populations of these herbivores flourished because of the mild climate, an abundant food source, and a lack of predators. These animals are described in more detail below.

FERAL PIG

Polynesians introduced domestic pigs to the Island of Hawai‘i over 1,000 years ago. European pigs introduced to the Hawaiian Islands in the late 18th century became feral and interbred, and largely replaced the smaller Polynesian pigs. Animals eventually moved further away from human settlements and moved upland, where their numbers have multiplied. Outside of managed units, pigs occupy a wide range of habitats in the park, with higher concentrations of animals in mesic and wet forest than in dry lowland environments.

Example of Hollowed Out Tree Ferns by Feral Pigs at Kahuku

FERAL GOAT

Captain Cook introduced domestic goats to the Hawaiian Islands in 1778 and Captain George Vancouver brought additional animals in 1793 (NPS 1972). By the 1850s, large populations of feral goats had established on the Island of Hawaiʻi. In 1970, the goat population at Hawaiʻi Volcanoes was estimated at more than 14,000 animals in spite of removal efforts from 1916 to 1970. However, the goat population in the park has been virtually eliminated since the implementation of a systematic approach to goat control in 1970 (NPS 1999a). Today there are only a few individual goats in Kahuku.

FERAL SHEEP

Captain Colnett, who reached the Island of Hawaiʻi by 1793, introduced sheep to the Hawaiian Islands. By 1822, feral sheep were well established on Mauna Kea. By 1960, populations were estimated at 8,000 animals on the Island of Hawaiʻi (HDLNR 1975). In the park, several hundred sheep occupy the remote north corner of Kahuku.

FERAL CATTLE

Historically, domestic cattle impacted several areas of the park. On Mauna Loa, animals from the adjoining cattle ranches were allowed to freely graze in koa ʻōhiʻa forest, inflicting much damage on the native forest and a number of rare plant species, until the practice was discontinued in 1948 (Morris 1967). Other areas where cattle grazing occurred include Kahuku and ʻĀinahou. These commercial cattle ranches were established prior to park acquisition. Today, all domestic animals have been removed and feral cattle occur mainly on forested state lands and occasionally wander into the adjacent Kahuku Unit of the park.

MOUFLON SHEEP

Mouflon sheep were introduced to the Island of Hawai‘i in 1957, where they were crossbred with feral sheep already on the island to create a hybrid animal. Hybrid animals were released on Mauna Kea as part of a game management program, in addition to a population of purebred mouflon sheep that were released on the island in 1962. During the next 4 years, additional introductions of the species were made, resulting in a total release of 46 rams and 48 ewes. By spring of 1979, this introduced population grew to an estimated 525 animals (HDLNR 1979). At the Kahuku Ranch, a newly acquired unit of Hawai‘i Volcanoes, records indicate that eight mouflon sheep were brought to the site in 1968, and an additional three animals were brought to the site in 1974 from the Honolulu Zoo. The Kahuku population numbered several hundred in 1986, and more recent surveys estimated the mouflon sheep population was 2,586 ± 705 in November 2004; however, NPS management actions resulted in a decline by 30 percent to 1,797 ± 688 by December 2006 (Stephens et al. 2008).

Mouflon Sheep at Kahuku

AXIS DEER

Axis deer were brought to the Hawaiian Islands from India in late 1867 as a gift to Kamehameha V, and were released on Moloka‘i in early 1868. Some axis deer were subsequently moved to O‘ahu before 1898, to Lana‘i in 1904, and to Maui in 1959 (Hawai‘i Conservation Alliance 2007). Recent sightings of individuals have been reported on the Island of Hawai‘i. No animals have been confirmed in the park.

HISTORY OF NON-NATIVE UNGULATE MANAGEMENT AT HAWAI'I VOLCANOES NATIONAL PARK

The detrimental impacts of non-native ungulates in Hawai'i were recognized before establishment of the park in 1916. In 1903, the Hawai'i Territorial Government Board of Agriculture and Forestry established a forest reserve system to protect remaining watersheds and forests on the islands. In 1910, a Noxious Animal Eradication Program was established, and through 1958 an aggressive campaign to eliminate feral cattle, goats, and pigs was carried out by the Territorial Government that included animal control (1927–1931) within Hawai'i Volcanoes. Park-led efforts began in 1932 and continue to the present. The following summarizes non-native ungulate management at Hawai'i Volcanoes.

NON-NATIVE UNGULATE CONTROL FROM 1916 TO 1970S

At Hawai'i Volcanoes, non-native ungulate management measures were first implemented in a concentrated manner beginning in 1927, when the Territorial Government conducted goat removal as part of a regional effort to protect Hawai'i's watershed. Between 1927 and 1931, these efforts resulted in the removal of 17,389 goats from the park. Efforts by the Territorial Government ceased after 1931. The NPS took over control efforts and relied on private hunters to remove non-native ungulates in the park on a permit basis between 1932 and 1934. These efforts proved to be ineffective in reducing animal numbers and were subsequently discontinued. After 1934, virtually no control of non-native goats or other non-native species occurred at the park until 1938, when the Civilian Conservation Corps used organized drives to remove the animals from the park. These drives were supplemented with boundary and internal fencing. Although successful in removing large numbers of non-native ungulates from the park, Civilian Conservation Corps efforts were suspended in 1941 due to World War II and fences deteriorated (NPS 1972).

Starting in 1944, the NPS hired private companies for goat control. These companies would round up goats from the park and then sell them at a profit. This method continued until 1955, when it was discontinued due to lack of effectiveness. Starting in 1955 and lasting until 1970, the NPS relied exclusively on park staff to eliminate non-native ungulates within the park. During this time, more than 30,000 goats were removed from the park through a variety of techniques such as organized hunts and drives. However, a lack of steady funding and inadequate fencing did not allow for a level of sustained management that would reduce the population. In 1970, the park had over 14,000 goats residing within its boundary (NPS 1972).

Along with feral goat eradication efforts, attempts to control feral pigs were carried out in the park. Approximately 7,000 pigs were eliminated from the older part of the park from 1930 to 1971 (Katahira et al. 1993). These efforts were not successful in eliminating pigs, largely due to the inability of NPS employees to carry out sustained reduction efforts and prevent reentry of pigs into ungulate-control areas.

During this period of feral ungulate control, domestic cattle from the adjoining ranches would wander and graze within the park. The most impacted areas included Mauna Loa and portions of Kīlauea. Although authorized grazing was discontinued in 1948, a small number of stray cattle (both domestic and feral) remained in the park until the early 1970s (Tunison et al. 1995). A small population of feral sheep was eliminated when the NPS assumed ownership of 'Āinahou Ranch in the early 1970s (Harry, pers. comm. n.d.).

NON-NATIVE UNGULATE CONTROL FROM 1970S TO PRESENT

In the 1970s, the NPS changed management strategies to include a systematic approach of direct reduction and fencing, including the use of volunteers in management efforts. The strategy included the use of boundary and internal fences to isolate populations, removal of individuals at greater rates than they can be replenished by reproduction and ingress, boundary fence inspection and maintenance, and monitoring and removal to prevent population increases (NPS 1974, 1986, 1993, 1997a, 1997b, 1999b, 2001b). Since the approach was adopted, NPS staff have eliminated nearly all goats below 9,000 feet in elevation (excluding the Kahuku Unit) and pigs from approximately 40,000 acres of interior fenced units or pig control units. Ingress of feral ungulates (goats, mouflon sheep, pigs and cattle) into managed units has occurred at very low, manageable rates since the 1970s. In Kahuku, large numbers of mouflon sheep are present along with feral pigs and a few feral goats and cattle. Several hundred feral sheep are in the remote north corner of Kahuku. Between 2004 and 2006, approximately 1,900 mouflon sheep were removed from Kahuku along with construction of fence segments along the park boundary; however, populations remain high in many areas (estimated at 1,797 ± 688 by December 2006) due to an annual population increase estimated between 21.1 and 33.1 percent (Stephens et al. 2008; USGS 2006a).

Examples of Boundary Fence at Kahuku

Examples of Boundary Fence and Koa Forest Recovery Following Ungulate Removal on Kahuku (left photo) and Mauna Loa (right photo)

PURPOSE OF AND NEED FOR ACTION

Purpose is a broad statement of goals that the National Park Service intends to fulfill by taking action. Need answers to the question, "Why is action being taken at this time?" Objectives are what must be achieved to a large degree for the action to be considered a success.

The purpose of this plan/EIS is to develop a comprehensive and systematic framework for managing non-native ungulates that supports long-term ecosystem protection; supports natural ecosystem recovery and provides desirable conditions for active ecosystem restoration; and supports protection and preservation of cultural resources. A plan/EIS is needed to address the impacts of non-native ungulates, which include loss of native ecosystems, especially native plant and animal communities; loss of sensitive native species, including state- and federally listed species; and loss of irreplaceable cultural resources. The park's most recent plan for non-native ungulate control was written over 30 years ago. The new plan/EIS will provide a parkwide framework to systematically guide non-native ungulate management activities over the next decades that considers the recently acquired Kahuku Unit; new invasive species challenges, especially those presented by mouflon sheep; and current NPS policy and guidance.

OBJECTIVES IN TAKING ACTION

Objectives are "what must be achieved to a large degree for the action to be considered a success" (Director's Order 12 [NPS 2001a]). All alternatives selected for detailed analysis must meet all objectives to a large degree and resolve the purpose of and need for action. Objectives for managing non-native ungulate populations at Hawai‘i Volcanoes must be grounded in the park's enabling legislation, purpose, significance, and mission goals, and must be compatible with direction and guidance provided in the park's strategic plan, the 1974 natural resources management plan, the 1975 master plan, the 1986 natural resource management plan, and the 1999 resource management plan (NPS 1974, 1975a, 1986, 1999a), and other management guidance. Any plan the park develops must be consistent with the laws, policies, and regulations that guide the NPS. The following objectives relate to the management of non-native ungulates at Hawai‘i Volcanoes.

MANAGEMENT METHODOLOGY

- Develop or refine informed, scientifically based methods for management of non-native ungulate populations to allow for the protection and recovery of park resources.

VEGETATION

- Protect native plant communities and assist with their natural recovery from impacts of non-native ungulates.
- Provide desirable conditions for active restoration of native plant communities degraded by non-native ungulate activity to a native state.

NATIVE WILDLIFE AND WILDLIFE HABITAT

- Protect native wildlife and wildlife habitat and assist with their natural recovery from impacts of non-native ungulates.

RARE, UNIQUE, THREATENED, OR ENDANGERED SPECIES

- Protect endangered, threatened, and rare plant and animal species and assist with their natural recovery from impacts of non-native ungulates.

CULTURAL/HISTORIC RESOURCES

- Prevent impacts to archeological resources, historic structures, cultural landscapes, and ethnographic resources from non-native ungulate activity.

WILDERNESS

- Using the minimum tools necessary to meet minimum requirements per the *Wilderness Act*, limit the impacts of non-native ungulates, as well as management actions, on wilderness areas located within the park.
- Assist in the recovery of natural conditions that have been impacted, or may be impacted, by non-native ungulates.
- Determine the minimum requirements to restore wilderness character in areas impacted by non-native ungulates.

SOILS

- Minimize the impacts of non-native ungulates on soil erosion and disturbance.

VISITOR USE AND EXPERIENCE

- Provide visitors with the opportunity to experience native ecosystems and cultural landscapes that have not been impacted by non-native ungulate activity.
- Enhance visitor awareness and understanding of non-native ungulate management actions and why they are necessary for the protection of park resources.
- Minimize limitations to visitor access as a result of non-native ungulate management activities.

PARK MANAGEMENT AND OPERATIONS

- Minimize long-term impacts (in terms of reduced staff time and resources) to programs at the park incurred by continued monitoring and management of non-native ungulates.

COORDINATION AND OUTREACH

- Coordinate with neighboring land managers implementing non-native ungulate management actions beneficial to the protection of park resources.
- Coordinate with other stakeholders regarding non-native ungulate management and the protection of park resources.
- Enhance public awareness and understanding of the impacts of non-native ungulates and the need for management to protect and restore park resources.

PARK BACKGROUND

Hawai‘i Volcanoes National Park, located on the Island of Hawai‘i, was established by Congress on August 1, 1916. The park extends from sea level to 13,677 feet (4,169 meters) and is home to two of the world’s most active volcanoes, Kīlauea (4,000 feet (1,219 meters) high) and Mauna Loa (13,677 feet (4,169 meters) high). Kīlauea has been in nearly continuous eruption since 1983; Mauna Loa last erupted in 1984. The park encompasses over 10 percent of the land on the Island of Hawai‘i, including the summits and most of the southwest and east rift zones of Kīlauea and portions of the southwest and northeast rift zones of Mauna Loa (NPS n.d.b, 2004a, 2009e). These two volcanoes are primary features of the park, and the principal reason for its establishment by Congress as a unit of the national park system (NPS 2006a).

Hawai‘i Volcanoes stretches over several ecosystems from the summit of Mauna Loa to where lava from Kīlauea meets the Pacific Ocean (NPS 2004a). The park’s various environments (coastal dry lowland, mid-elevation seasonally dry, montane rain forest, montane seasonally dry, subalpine, and alpine) harbor distinct plant and animal communities (Mueller-Dombois and Fosberg 1974). More than 90 percent of the native Hawaiian flowering plants and animals are endemic to the Hawaiian Archipelago; in other words, unique (found naturally nowhere else) to the Hawaiian Islands. This level of endemism is unsurpassed in the world and is the product of over 30 million years of evolution in a remote island setting. Included among the endemic species are many rare plants and animals. Approximately 30 percent of all federally listed threatened and endangered species are found in the Hawaiian Islands (USFWS 2011). Hawai‘i Volcanoes provides habitat for over 50 federally listed endangered, threatened, and candidate plants and animals (including species historically at the park and non-resident species). The international biosphere reserve designation, conferred in 1980, recognizes the park’s long-term commitment to scientific study, monitoring, and protection of the range of unique tropical forests and woodlands. The world heritage designation, conferred in 1987, is based on the “ongoing geologic processes of volcanism, of endemic and native biota and human interrelationships with the lands” (UNESCO 1987).

HAWAI‘I VOLCANOES NATIONAL PARK ENABLING LEGISLATION

Congress established Hawai‘i National Park (later to become Hawai‘i Volcanoes National Park) on August 1, 1916, declaring:

> The tracts of land on the Island of Hawai‘i and the Island of Maui, in the Territory of Hawai‘i … shall be perpetually dedicated and set apart as a public park or pleasuring ground for the benefit and enjoyment of the people of the United States … [and provide for] … the preservation from injury of all timber, birds, mineral deposits, and natural curiosities or wonders within said park, and their retention in their natural condition as nearly as possible.

This plan/EIS is expected to fulfill the enabling legislation through the active restoration of the native ecosystem through the removal of non-native ungulates, which will assist in returning the park’s ecosystem to its natural condition.

The enabling legislation of the park has been modified throughout the years, both to establish the national parks on the islands of Hawai‘i and Maui as separate parks and to expand the boundary of Hawai‘i Volcanoes. The following amendments were made to the enabling legislation:

- Act of 1920: Authorized the governor of the Territory of Hawai‘i to acquire privately owned lands and rights-of-way within the boundaries of Hawai‘i National Park.
- Act of 1922: Added additional lands to the park, specifically those lands of the Ka‘ū Desert and Kapāpala.
- Act of 1928: Modified the park boundary on the Island of Hawai‘i.
- Act of 1930: Stated that the United States had sole and exclusive jurisdiction over Hawai‘i National Park and further defined the purpose of the park and the activities allowed or prohibited. Specifically, the act stated:

  > All hunting or the killing, wounding, or capturing at any time of any wild bird or animal, except dangerous animals when it is necessary to prevent them from destroying human lives or inflicting personal injury, is prohibited within the limits of said park … That the Secretary of the Interior shall make and publish such general rules and regulations as he may deem necessary and proper for the management and care of the park and for the protection of the property therein, especially for the preservation from injury or spoliation of all timber, natural curiosities, or wonderful objects within said park, and for the protection of animals and birds in the park from capture or destruction, and to prevent their being frightened or driven from the park.

- Act of 1938: Added additional lands, known as the Kalapana extension, to Hawai‘i National Park.
- Act of 1959: Formed part of the legislation for the admission of Hawai‘i to the Union, approved March 18, 1959.
- Act of 1961: Separated the parks on Maui and Hawai‘i, officially establishing the park on the Island of Hawai‘i as “Hawai‘i Volcanoes National Park.”
- Act of 1978: Added 269 acres to Hawai‘i Volcanoes National Park.
- Act of 2000: Eliminated restrictions on the acquisition of certain lands contiguous to Hawai‘i Volcanoes National Park.

PURPOSE AND SIGNIFICANCE OF HAWAI‘I VOLCANOES NATIONAL PARK

Purpose

The following park purpose statement was developed for the *Hawai‘i Volcanoes National Park General Management Plan*, which is currently being developed:

> Hawai‘i Volcanoes National Park protects, studies, and provides access to Kīlauea and Mauna Loa, two of the world’s most active volcanoes; and perpetuates endemic Hawaiian ecosystems and the traditional Hawaiian culture connected to these landscapes (NPS n.d.a).

Significance

Park significance statements capture the essence of the park's importance to the nation's natural and cultural heritage. Understanding park significance helps managers make decisions that preserve the resources and values necessary to the park's purpose. The following significance statements were developed for the *Hawai'i Volcanoes National Park General Management Plan*, which is currently being developed:

- Hawai'i Volcanoes National Park protects and interprets the largest and most continuously active shield volcanoes in the United States, and provides the best physical evidence of island building processes that continue to form the 2,000-mile-long Hawaiian Archipelago.
- Hawai'i Volcanoes National Park's active volcanoes serve as a living laboratory for scientific investigations that began over a century ago and continue to advance global understanding of volcanic processes.
- Hawai'i Volcanoes National Park protects, restores, and studies unique and diverse ecosystems and endemic species that are the result of over 30 million years of evolution on an active volcanic landscape, wide climate variation, and the extreme isolation of the Hawaiian Islands.
- Hawai'i Volcanoes National Park encompasses the largest and most ecologically diverse wilderness in the Pacific Islands.
- Hawai'i Volcanoes National Park embraces the Native Hawaiian spiritual significance of this landscape and interprets related cultural traditions.
- Hawai'i Volcanoes National Park encompasses sites, structures, objects, and landscapes that document over 600 years of human life and activities on an active volcanic landscape.
- Hawai'i Volcanoes National Park provides access to two of the most active volcanoes in the world and an opportunity to understand and appreciate the distinctive geology and natural and cultural adaptations to the land (NPS n.d.a).

ISSUES AND IMPACT TOPICS

National Environmental Policy Act (NEPA) regulations require an "early and open process for determining the scope of issues to be addressed and for identifying the significant issues related to a proposed action" (40 CFR 1501.7). Issues are problems, opportunities, and concerns regarding the current and potential future management strategies for managing non-native ungulates and impacts of management actions that are included in this plan/EIS. The issues were identified by the NPS, the public, and other interested parties through the scoping process (for additional information, see "Chapter 5: Consultation and Coordination"). The impact topics are a more refined set of concerns analyzed for each of the management alternatives. The impact topics were derived from issues and in "Chapter 4: Environmental Consequences," the impact topics were used to examine the extent to which a resource would be affected by the actions of a particular alternative.

The issues were identified by the NPS, the public, and other interested parties through the scoping process (for additional information, see "Chapter 5: Consultation and Coordination").

VEGETATION

Hawai‘i Volcanoes National Park is home to a wide diversity of vegetation types including rain forests, subalpine shrublands, dryland forests, and sparsely vegetated lava flow communities, among others. A spectrum of tropical environments ranging from persistently or seasonally wet to dry, account for the floral diversity found in the park. The diversity can also be attributed to the varied elevations in the park (sea level to 13,677 feet (4,169 meters)) and volcanic activity, which results in a mosaic of successional stages throughout the park (UNEP 1995).These environments support unique flora, including many rare species. Thirty-six plant species listed as threatened, endangered, or candidate species under the *Endangered Species Act* (ESA) are located in the park and its vicinity, while 69 plant species are identified as species of special concern or rare (NPS 2006f). The activities of non-native ungulates can impact the structure and function of these unique vegetative communities by altering the succession of the ecosystem. For example, feral goats have impacted dry and mesic park environments, extending from sea level to the alpine zone, by destroying trees and shrubs and preventing regeneration of many native plant species (UNEP 1995). Impacts from other non-native ungulates include direct reduction of vegetation from browsing or rooting up plants. Many of the impacts on vegetation from non-native ungulates occurred prior to park acquisition and continued into current times. The park has been addressing these impacts by removing non-native ungulates and restoring vegetation. Non-native ungulate removal has the potential to change fire regimes in the park by changing fuel loads (because of increasing vegetation) and altering microclimate conditions as a result of less or no grazing. This could also affect vegetation.

Issue Statement. Non-native ungulates impact native vegetation by foraging on, digging up, and trampling native vegetation. However, the removal of non-native ungulates could also affect vegetation by changing the fire regime in the park.

Non-native ungulate activity, such as browsing, trampling, and seed dispersal through animal waste, has the potential to increase the number and type of non-native plant species within the park. As the number of non-native plant species increases, the native plant species within the park encounter increased competition and are adversely affected. Beneficial impacts would result from the removal of non-native species from the ecosystem, as directed in the NPS *Management Policies 2006* (NPS 2006b). Conversely, as vegetation increases, new non-native plant species may invade following ungulate removal.

Issue Statement. Non-native ungulate activities can promote non-native plant species through habitat alteration and seed dispersal. An increase in non-native plant species could have a negative impact on the park’s native plant communities. Conversely, new non-native plant species may invade following ungulate removal.

NATIVE WILDLIFE AND WILDLIFE HABITAT

Hawai‘i Volcanoes is home to a unique assemblage of native wildlife. The Hawaiian hoary bat (*Lasiurus cinereus semotus*) is the only native land mammal in the park and in the Hawaiian Islands. Most of the endemic bird species are rare or endangered (UNEP 1995). The park is also home to endemic invertebrates (including two federally endangered *Drosophila*), which are key contributors to island biodiversity. Non-native ungulate species have been identified as a primary factor in the success of invasive species (any species that has moved into an area and reproduced so aggressively that it has replaced some of the original species) and the loss of native biodiversity. Destruction of native vegetation by non-native ungulates has contributed to the decline and loss of wildlife habitat. One example of how non-native ungulates have impacted native species includes the creation of conditions that promote malaria among native forest bird species.

Issue Statement. Non-native ungulate activity reduces habitat and forage availability through browsing, trampling, bark stripping, and seed dispersal, and can also lead to the spread of disease among bird species. While all wildlife species could be impacted, there could be disproportionate impacts to the native bird communities from the presence of non-native ungulates.

Past non-native ungulate management actions at the park have included the use of vehicles, helicopters, firearms, and dogs. The noise created from these actions is short term, lasting only for the duration of the management action. The noise from these actions has the potential to create short-term localized disturbances to all animal species in the park.

Issue Statement. Native wildlife in Hawai‘i Volcanoes may be impacted by non-native ungulate management activities, such as the visual intrusion and noise produced from humans, vehicles, firearms, helicopters, fences, and machinery (for fence construction), and by the trampling and clearing of vegetation.

RARE, UNIQUE, THREATENED, OR ENDANGERED SPECIES

More than 90 percent of the native flowering plant and animal species are considered unique and are endemic to the Hawaiian Islands. Many of these species are also listed as state- or federally threatened or endangered. Approximately 30 percent of the federally listed threatened and endangered species in the United States can be found on the Hawaiian Islands. Hawai‘i Volcanoes provides habitat for over 50 species that are listed as threatened, endangered, or candidate. These include 35 plant and 19 animal species that are present or were historically documented in the park. An additional 69 plant and 13 animal species are identified as species of concern or rare. Some of these species, including some recently extirpated species, are the federally endangered ‘ākepa (honeycreeper, *Loxops coccineus*), ‘akiapōlā‘au (*Hemignathus munroi*), ‘alauahio (Hawai‘i creeper, *Oreomystis mana*), nēnē (Hawaiian goose, *Branta sandvicensis*), ‘ua‘u (Hawaiian petrel, *Pterodroma sandwichensis*), ‘io (Hawaiian hawk, *Buteo solitarius*), ‘ō‘ū (honeycreeper, *Psittirostra psittacea*—historically found in the park), ‘a‘o (Newell’s shearwater, *Puffinus auricularis newelli*—historically found in the park), ‘alalā (Hawaiian crow, *Corvus hawaiiensis*—historically found in the park), and the ‘ōpe‘ape‘a (Hawaiian hoary bat).

Overall, non-native ungulate species have been identified as a primary factor in the success of invasive species and the loss of native biodiversity, including the loss of threatened and endangered species. Many of the USFWS recovery plans for endangered species identify the removal of non-native ungulates as essential for the protection of these species and their habitat. One example of how non-native ungulates have impacted these species includes the creation of conditions that promote malaria among native bird species. There are also direct impacts to threatened and endangered species, such as herbivory of silverswords by goats and mouflon sheep. Management activities may also cause impacts, such as potential wildlife (e.g., petrel and Hawaiian hoary bat) striking fences for managing non-native ungulate populations. These occurrences can be mitigated through fence design and use of flagging, which is currently implemented at the park.

Issue Statement. Rare, unique, threatened, or endangered species within Hawai‘i Volcanoes are impacted by non-native ungulate populations and their related activities (e.g., trampling, direct herbivory, and seed dispersal) through direct predation, herbivory, habitat destruction, or other direct and indirect impacts, such as creating conditions that breed diseases detrimental to the native wildlife populations.

Issue Statement. Rare, unique, threatened, or endangered species within Hawai‘i Volcanoes may be impacted by non-native ungulate management activities that disturb the soundscape, such as the use of vehicles, firearms, or helicopters. Other disturbances could result from human activity in the area during a management practices.

Due to its unique ecosystems, Hawai‘i Volcanoes was designated as a biosphere reserve (areas of terrestrial and coastal/marine ecosystems or a combination thereof, which are internationally recognized) in 1980 and a world heritage site (places that are of outstanding universal value to humanity and should be protected for future generations to appreciate and enjoy) in 1987. Hawai‘i Volcanoes is a unique example of island-building through ongoing volcanic processes, and represents the most recent activity in the formation of the Hawaiian Islands. The park contains significant areas of nearly intact subalpine and alpine ecosystems and unique assemblages of native subtropical rain forest, mesic forest, and dryland biota, providing an example of succession following dynamic volcanic activity, as well as providing habitat for listed threatened and endangered endemic species. Further, the park is on the Nature Conservancy’s (TNC’s) list of globally imperiled areas (UNESCO 1987). The presence and abundance of threatened and endangered species in part contributes to the park’s listing by these organizations. The presence of non-native ungulates impacts the native and threatened and endangered populations that contribute to these listings through direct and indirect impacts such as browsing, trampling, rooting, bark stripping, predation, depredation, and facilitation of non-native plants as competitors.

Issue Statement. Rare, unique, threatened, or endangered species in Hawai‘i Volcanoes contribute to the park’s designation as a biosphere reserve and world heritage site. Any decline in these species resulting from the presence and activities of non-native ungulates could impact the characteristics of the park that make it eligible for these listings.

CULTURAL/HISTORIC RESOURCES

The extent of cultural resources at Hawai‘i Volcanoes documents nearly 600 years of human activity and includes a range of resources from indigenous island cultural adaptations to a unique lava landscape (Tuggle and Tomonari-Tuggle 2008). Cultural resources in the park include archeological resources, cultural landscapes, ethnographic resources, and historic structures. Although some data is needed to determine the extent of impacts that non-native ungulate management activities could have on cultural landscapes and historic resources, potential impacts on archeological resources could occur from digging, rooting, trampling, or other ground-disturbing activities. Ground disturbance could also occur during management actions if fencing is used, potentially impacting these resources. Traditional uses by native populations still occur today, including ceremonial activities. Non-native ungulates could have both beneficial and adverse impacts on activities of native populations. The presence of non-native ungulates impacts native vegetation and wildlife that native populations use to continue traditional practices. Hawaiian plants and animals were held in special regard by native populations who believed they represented the physical forms of their ancestral deities (Burrows et al. 2007). Consequently the damage to native species and habitat caused by non-native ungulates remaining on the landscape could result in adverse impacts. Management of non-native ungulates may also result in short-term adverse impacts, as areas where these traditional uses occur may close temporarily for management activities. Additional impacts could result from noise associated with management activities that occur in or near areas that are considered sacred. Removing non-native ungulates could also cause regeneration of vegetation that may cover archeological/ethnographic resources (such as petroglyphs).

Issue Statement. Non-native ungulates could impact cultural resources through ground disturbance (e.g., from digging and rooting) and by damaging the native plants and animals traditionally valued by native populations. Management activities also have the potential to cause adverse impacts (such as those from the installation of fencing and from temporary site closures in the park). However, more information is needed to determine the potential impacts on cultural landscapes and historic structures.

Though not an ancient traditional use, hunting has become a component of contemporary practice (Burrows et al. 2007). Impacts of non-native ungulate management actions on recreational and subsistence hunters in the park are expected to be low as there is no history of legal hunting for recreational or subsistence purposes in the park. Prior to park acquisition, the general public was not allowed to hunt in Kahuku; hunting was limited to ranch employees and occasional recreational hunters who paid private guides. Park management actions may influence animal populations and indirectly affect hunting opportunities outside the park.

Issue Statement. Hunting is a local contemporary practice and management of non-native ungulates in the park could impact surrounding animal populations outside the park.

WILDERNESS

In 1978, areas of Hawai‘i Volcanoes were designated by Congress as wilderness. The park contains 123,100 legislated acres in four management units that fall under this designation. These areas preserve diverse segments of Hawai‘i in an undeveloped state. Units within the wilderness area are the Mauna Loa Unit on the southwest-facing slope and summit of Mauna Loa above 5,000 feet (1,254 meters) in elevation; the Ka‘ū Desert Unit, encompassing the Ka‘ū Desert below 3,000 feet (914 meters) in elevation; the ‘Ōla‘a Unit, including the ‘Ōla‘a rain forest; and the East Rift Unit in the upper East Rift Zone. As recognized in the 1975 *Final Environmental Statement for the Proposed Wilderness Areas* (NPS 1975b), management of non-native ungulates requires entry into these wilderness areas and has impacts such as noise from management activities (firearms, helicopters, vehicles, people) and trampling of vegetation. Other potential impacts include the visual intrusion from control installations, such as traps, snares, and solar power panels.

Issue Statement. The management of non-native ungulates could impact wilderness areas through additional noise and disturbance during management activities.

Issue Statement. Removing non-native ungulates will assist in the recovery of natural conditions in wilderness.

SOILS

Because the geology of the area is a result of the volcanic history of the island, soils at Hawai‘i Volcanoes are generally shallow, although deeper soils occur on older substrates on Mauna Loa. In addition, the primarily rainy climate at the park creates an increased likelihood for soil erosion. Park staff noted that the overabundance of non-native ungulates has led to soil erosion and disturbance in dry, mesic communities in the past (Baker and Reeser 1972). Furthermore, evidence indicates that non-native ungulates contribute to erosion and water runoff that feeds into intermittent streams that flow below the park into the Ka‘ū Forest Reserve during heavy rains. This disturbance results from digging by feral pigs or general disturbance related to non-native ungulates, such as grazing by large numbers of goats and sheep. Control of these non-native species could result in beneficial impacts through a reduction of soil disturbance and erosion.

Issue Statement. Non-native ungulate populations lead to soil disturbance and erosion, which can impact the soils that support native vegetation and wildlife.

SOUNDSCAPES

Elements of non-native ungulate management strategies discussed during internal scoping include the use of vehicles, helicopters, and firearms. Noise resulting from management activities could affect park visitors and wildlife. These potential impacts would be of short duration, lasting only the length of the management activity. Current sources of ambient noise in the park where management actions would occur include minimal visitor use, as well as air tours in the area. Acoustical data on helicopter noise was collected for the air tour management plan (ATMP). For the ATMP, the park was divided into acoustic sampling areas and ambient noise levels were measured. Throughout the park, the noise level does not exceed 55 decibels (except near roadways); the maximum in many places is as low as 35 decibels. Typical measures of noise are a soft whisper (30 decibels) or conversational speech (65 decibels). Many areas of the park fall within these levels and could be impacted by non-native ungulate management activities. The impact of soundscapes could carry over to other resource areas such as threatened and endangered species, adjoining land uses, and visitor use, and may be discussed under those impact topics.

Issue Statement. Certain non-native ungulate management activities such as the use of vehicles, helicopters, or firearms may cause temporary disturbance to park soundscapes for both visitors and wildlife.

LAND MANAGEMENT ADJACENT TO THE PARK

The lands surrounding Hawai‘i Volcanoes contain numerous stakeholder interests, including federal, state, local, and private landholders. Some of these interests include homeowners who support non-native ungulate management because they view the native plant and animal communities at the park as an asset to their land value, and others who may value the presence of non-native ungulates as a game animal. These values are considered in this plan/EIS. Actions by neighboring landowners that may impact the park, such as keeping non-native ungulates as domestic livestock, are also considered. These animals have the potential to cross onto park lands and become feral, potentially impacting the park’s wildlife and vegetation, as discussed above. The plan/EIS also considers management actions with the potential for animals to relocate outside of the park, transferring their impacts to neighboring land uses, both private and governmental. The park also has numerous partnerships and other relationships with surrounding landowners that complement park conservation efforts. Plans from other agencies considered in the development of this plan/EIS include those being implemented by members of the Three Mountain Alliance (TMA) (e.g., USFWS, TNC, Department of Land and Natural Resources (DLNR), and Kamehameha Schools) in areas surrounding the park. Planned activities by the state were taken into account, including state watershed, game, and non-native ungulate management plans for the Natural Areas Reserve System, Forest Reserves, and Game Management Areas.

Issue Statement. The management of non-native ungulates in the park could impact surrounding lands and conflict with the land use plans of adjoining lands. Non-native ungulate management could relocate the population to adjacent lands. The actions of adjoining landowners may also impact the number of non-native ungulates in the park, introducing (through accidental release) or removing (through other management programs) these species.

SOCIOECONOMICS

Non-native ungulate management actions in the park would not be expected to create employment or impact property values. Potential impacts to socioeconomics include purchasing management supplies from island businesses and impacts on the businesses that serve tourists if management actions increase or decrease park visitation. In fiscal year 2007 total spending associated with Hawai‘i Volcanoes National Park was estimated to be $114 million, of which $109 million was spent by nonlocal visitors. The total labor income generated by this spending was almost $43 million and the gross regional product was over $67 million. This economic activity supported 2,199 jobs in the local economy (Stynes 2008).

Issue Statement. Proposed non-native ungulate management activities may impact local businesses through the amount of supplies purchased. Local businesses related to tourism would also be impacted if management actions change the level of park visitation.

VISITOR USE AND EXPERIENCE

Many people visit Hawai‘i Volcanoes to enjoy the natural areas and experience an environment that cannot be found anywhere else. The park is traditionally an area of high visitor use on the Island of Hawai‘i and received an average of 1.375 million visitors annually between 1998 and 2007 (NPS 2009b). If the number of visitors increases, the number of facilities (e.g., restrooms and parking areas) to accommodate the use may also need to increase. Future park visitation may also be influenced by the new Kahuku Unit of the park, which would provide new visitor opportunities when funding is available.

The use at Hawai‘i Volcanoes is mainly day use, with visitation centering on the Crater Rim Drive and Chain of Craters Road. Visitation opportunities at Hawai‘i Volcanoes include viewing and understanding volcanic processes; seeing the park’s natural and cultural resources; practicing traditional cultural activities; and experiencing the relative solitude of the park’s backcountry (NPS 2004b). Other visitor use activities dependent on the environment include bird-watching and nature photography. Currently, unmanaged non-native ungulate populations are altering these natural communities, which are a large component of the visitor experience at the park. Direct impacts include trampling, browsing, preying on, or otherwise disturbing native plants and animals. Other impacts are indirect, such as the impact that feral pigs have on bird species by promoting the establishment of standing water, which breeds mosquitoes. Management of non-native ungulates would be expected to have beneficial impacts on visitor use and experience, because the threat to native ecosystems from these non-native species would be addressed. Addressing this threat would help to continue and reestablish some of the natural features that attract visitors. Active restoration of native ecosystems could also be possible.

Issue Statement. The natural ecosystems in the park are an important component of the visitor experience. The impact to these ecosystems from non-native ungulates through habitat destruction and modification, which cause declines in native species, could adversely impact visitor use and experience.

The variety of visitor uses at Hawai‘i Volcanoes may be impacted by non-native ungulate management activities because these activities may require closing areas of the park for short periods. Although these impacts would be short term, many people only visit the park a single time because of the time and travel involved to reach the site. Visitors who are only at the park for 1 day may not be able to have their desired visitor experience while management activities are being conducted.

Issue Statement. Proposed non-native ungulate management activities may require certain areas of the park to be closed to the general public during management activities, which may affect visitor use and experience.

VISITOR AND EMPLOYEE SAFETY

Visitor and employee concerns related to safety include the use of firearms by volunteers and park staff during removal actions, and visitors encountering management actions while in the park. A danger may also be posed by physically encountering non-native ungulates while in the park.

Issue Statement. Impacts to health and safety of the public and park employees could occur during management actions (especially those actions that use firearms) and through interactions between humans and wildlife.

PARK MANAGEMENT AND OPERATIONS

The operating budget of Hawai'i Volcanoes for fiscal year 2008 was approximately $6,740,143; this supports 84 employees responsible for the management of 333,000 acres of land (NPS n.d.b; Yoshida 2009b). The implementation of a non-native ungulate management plan would require park staff to plan and carry out management actions. These actions could impact park staff by redirecting them from other activities in the park to conduct non-native ungulate management actions. Park operations were also an issue considered in the development of alternatives because the *Antideficiency Act* does not allow federal agencies to commit to expenditures for which there is no funding.

Issue Statement. Non-native ungulate management activities could impact park management and operations by redirecting park operations from other activities to the management of non-native ungulates.

ISSUES DISMISSED FROM FURTHER CONSIDERATION

The following impact topics and issues were removed from detailed consideration in the plan/EIS.

Geohazards. A geohazard is an event related to geological features and processes that cause loss of life and severe damage to property and the natural and built environment, such as an earthquake or rockslide. Although the volcanoes in the park are considered geohazards, the activity from these volcanoes would not be impacted by management of non-native ungulates.

Air Quality. Potential sources of air quality emissions from the implementation of a non-native ungulate management plan include the use of vehicles and helicopters to carry out the prescribed management activities. Since Hawai'i is designated as in attainment with all six Environmental Protection Agency (EPA) criteria pollutants, it was determined that the increase in air emissions from these activities would be minimal and short term, resulting in only negligible impacts on the regional air quality.

Greenhouse Gas Emissions and Climate Change. There is strong evidence linking global climate change to human activities, especially greenhouse gas emissions associated with the burning of fossil fuels (IPCC 2007). Some of the activities associated with non-native ungulate management may result in fossil fuel consumption, such as the use of helicopters for aerial shooting. Some specialized activities, such as direct reduction and trapping, may require vehicular travel to assist in carrying out management activities. However, greenhouse gas emissions associated with the plan would be negligible in comparison to park-related, local, and regional greenhouse gas emissions. Furthermore, the implementation of any of the action alternatives could result in beneficial impacts to local greenhouse gas levels because the restoration of native plant species would act as a "sink" for greenhouse gases. Therefore, the issue of the contribution of non-native ungulate management activities to climate change through greenhouse gas emissions was dismissed from further analysis.

Streamflow Characteristics. The management of non-native ungulates would not occur in any areas or involve management actions that would potentially impact streamflow. There are no permanent streams in the park. Minimal surface waters, including a small number of temporary streams that occur during heavy rain events, are located in or adjacent to the park; therefore, the possibility that this resource would be impacted by management activities would be negligible.

Water Quality or Quantity. The management of non-native ungulates would not occur in any area or involve management actions that would potentially impact water quality or quantity. Minimal surface waters, including a small number of temporary streams that occur during heavy rain events, are located in or adjacent to the park; therefore, the possibility that this resource would be impacted by management activities would be negligible. Please refer to the "Marine and Estuarine Resources" section below for more information about anchialine pools.

Floodplains and Wetlands. There are no designated floodplains in the park that would be impacted by management of non-native ungulates. In Kahuku, vegetation mapping surveys in the 1970s and in 2005 failed to locate significant bogs in the area. The park has some small semi-bog areas in wet forests in ʻŌlaʻa that could be affected by management activities, particularly the management of feral pigs. However, these adverse impacts would be negligible, with possible minor beneficial impacts.

Marine and Estuarine Resources. The boundary of Hawaiʻi Volcanoes National Park includes the shoreline and associated habitats along the Pacific Ocean. Within the park, brackish anchialine pools along the shoreline serve as the only habitat for certain species. None of the actions proposed in this plan would affect the shoreline, estuaries, or marine environments of the park because past management of non-native ungulates has excluded animals directly upslope from these areas. In addition, it is not anticipated that upstream water quality or quantity would be measurably affected by the proposed actions; therefore downstream impacts would be negligible.

- Because impacts on marine and estuarine habitats would not likely be measurable, impacts on species inhabiting these environments are not anticipated. Of particular concern in these environs are federally listed threatened and endangered species. These include the Hawaiian monk seal (*Monachus schauinslandi*), green sea turtle (*Chelonia mydas*), hawksbill sea turtle (*Eretmochelys imbricate*), and an candidate endangered endemic shrimp (*Metabetaeus lohena*).
- The Hawaiian monk seal is endangered throughout its range, with critical habitat designated in the Northwest Hawaiian Islands (a remote archipelago of small islands, largely protected as a marine reserve). Within the park, Hawaiian monk seals have been observed to haul out and bask along the shoreline. Because the use of the park by this species is limited, and because the marine and shoreline habitats of the park would not be affected under the proposed actions, the Hawaiian monk seal is not carried forward for analysis.
- Green sea turtles are most commonly found in fairly shallow waters (except when migrating) inside reefs, bays, and inlets. They prefer lagoons and shoals with an abundance of marine grass and algae, and require open beaches with a sloping platform and minimal disturbance for nesting (USFWS 2009i). The green sea turtle may forage offshore and occasionally haul out to bask on the park's beaches, but there are no known nesting sites at the park. Because the use of the park by this species is limited to basking on the shoreline, and because the marine and shoreline habitats of the park would not be affected under the proposed actions, the green sea turtle is not carried forward for analysis.
- Hawksbill turtles occur along the shoreline and surrounding waters of the island (NPS 2009i). They are typically found feeding in the vicinity of rock or reef habitats in shallow tropical waters with little turbidity (NMFS and USFWS 1998). Preferred nesting habitat includes low-energy sandy beaches under the cover of woody vegetation (NMFS and USFWS 1998). Hawksbill nests are monitored and protected at ʻĀpua Point, Halapē, and Keauhou in the park. Because the marine and shoreline habitats of the park would not be affected under the proposed actions, the hawksbill sea turtle is not carried forward for analysis.
- The brackish-water shrimp is known to occur in low- to high-salinity anchialine pools. Anchialine pools are rare, localized brackish waters along coastal lava flows that are subject to tidal

fluctuations but are not openly connected to the ocean (USFWS 2009c; USGS 2005b). Recent surveys (2004–2009) for *Metabetaeus* in Hawai‘i’s national parks have documented that it is widespread in this unique habitat type. Current studies indicate that adults are sensitive to increases in pool salinity (Foote 2009b). Because none of the proposed actions would affect water quantity, quality, or salinity in the shoreside anchialine pools, this species is not carried forward for analysis.

Unique or Essential Fish Habitat. The boundary of Hawai‘i Volcanoes National Park includes the shoreline and associated habitats along the Pacific Ocean, but does not extend into the marine environment. Therefore, no unique or essential fish habitat is designated at Hawai‘i Volcanoes. Because this habitat does not occur in the park, and because impacts on upstream water quality and quantity are not likely to be measurable, no impacts on nearby unique or essential fish habitat would be anticipated. Therefore, this topic is not carried forward for analysis.

Non-native Wildlife other than Ungulates. According to the Hawai‘i Ecosystems at Risk Project (HEAR) (2010), the invasion of Hawai‘i by non-native mammals, birds, snakes, and insects is the single greatest threat to Hawai‘i’s economy and natural environment, and to the health and lifestyle of Hawai‘i’s people. These species have been introduced to the state either intentionally or by accident over hundreds of years. Within the park, there are a variety of non-native animals, including rats, mongooses, coqui frogs, and yellowjacket wasps, to mention a few. The presence of these species adversely affects native wildlife and vegetation across Hawai‘i. Populations of these “other” non-native wildlife will be managed, as appropriate, under separate plans.

Museum Collections. Non-native ungulate management at Hawai‘i Volcanoes would mainly occur in the undeveloped areas of the park and would not impact the park’s museum collections. Archeological items that could be included in the museum collection in the future are considered under the cultural/historical resources impact topic.

Historic Structures. The park contains a number of historic districts and structures listed or eligible for listing on the National Register of Historic Places (National Register). These properties include the Summit Rest House and the Mauna Loa Observatory Shelter. Although there are historic structures listed or eligible for listing on the National Register of Historic Places in the park, there would be negligible impacts on these structures from implementing non-native ungulate management. Prehistoric archeological structures, such as shrines, are addressed under the “cultural/historical resources” impact topic.

Energy Resources and Resource Conservation. Non-native ungulate management would not be expected to affect energy resources or resource conservation related to energy in the park.

Environmental Justice. The purpose of environmental justice is to ensure that (1) all people are treated fairly with respect to the development and enforcement of protective environmental laws, regulations, and policies; and (2) potentially affected community residents are meaningfully involved in the decisions that will affect their environment and/or their health. Conversely, allegations of environmental injustice refer to situations in which these social justice goals have not been met, indicating a perceived disproportionate exposure to environmental harms and risks. Examples of such risks may include health concerns (such as those associated with indoor and outdoor air quality issues and water quality issues), impacts on livelihood and subsistence, and other impacts on human health and prosperity.

Environmental justice is associated with Executive Order 12898, which was published on February 11, 1994. This executive order requires all federal agencies to incorporate environmental justice into their mission by “identifying and addressing … disproportionately high and adverse human health or environmental effects of [their] programs, policies and activities on minority and low-income populations in the United States" (Executive Order 12898, 59 FR 7629 [1994]). The broad goal of Executive Order 12898 is then tempered in section 6-609 by the caution that "this order is intended only to improve the internal management of the executive branch and is not intended to create any right enforceable against the United States."

The EPA defines a community with potential environmental justice populations as one that has a greater percentage of minority or low-income populations than does an identified reference community. Minority populations are those populations having (1) 50 percent minority population in the affected area (EPA 1998); or (2) a significantly greater minority population than the reference area. There are no specific thresholds provided for low-income or poverty populations. For the purposes of this study, it is assumed that if the study area minority and/or poverty status populations encompass more than 10 percentage points higher than those of the reference area, there is likely an environmental justice population of concern.

Although the Big Island/Hawai‘i County was initially targeted as the study area, it was determined that further refinement was necessary to better understand the potential environmental justice populations living closer to the park. As a result, minority and poverty data was collected for Census Bureau block groups including and surrounding the park. This data was compared with environmental justice data from the Big Island/Hawai‘i County, Hawai‘i, and the nation. Figure 3 illustrates all Census Bureau block groups on the Big Island, the park boundary, and Census Bureau block groups encompassing and adjacent to the park (the study area).

In general, there are more White and Native Hawaiian and Pacific Islander populations and fewer Asian populations in the study area compared to the island as a whole. Table 1 shows that the percentage of Native Hawaiians and Pacific Islanders in Tract 213, Block Group 1 (in bold), in the westernmost part of the study area, is more than 10 percent higher than that of the island and the state.

Table 2 shows that the block groups encompassing and adjacent to the park have low-income populations, four of which (in bold) have poverty percentages that are 10 percentage points higher than those of the Big Island and of the state. Poverty rates in Tract 210.02, Block Group 4, are more than 10 percent higher than those of the state and 9 percent higher than poverty rates on the Big Island.

As these tables indicate, there are potential environmental justice populations of concern in the study area. The primary concern for these populations would be potential impacts to subsistence use as a result of achieving the desired conditions (removing all ungulates from the park). However, hunting and subsistence hunting is only allowed in units of the national park system under specific authorization by statute or regulation, per section 4.4.3 of NPS *Management Policies 2006* (NPS 2006b). There is no such authorization in the statutes for Hawai‘i Volcanoes National Park. Under prior ownership, Kahuku was off limits to hunting by the general public (Avery 2009). Additionally, it is assumed that removal of non-native ungulates in the park would minimally impact the populations available for hunting on adjacent forest and state game reserves adjacent to Kahuku and other sections of the park. This is partly a result of ongoing boundary fence construction, which limits non-native ungulate movement between the park and adjacent lands. Therefore, park management actions would not impact environmental justice populations if they are using these surrounding areas for subsistence hunting purposes. As a result, the park ungulate management actions analyzed in this plan/EIS would have minimal to no impacts on environmental justice populations, and this impact topic was not carried forward for further analysis.

FIGURE 3:
Environmental Justice Study Area

TABLE 1: ENVIRONMENTAL JUSTICE INFORMATION FOR MINORITY POPULATIONS

Block Group	Total Population	White	Black	American Indian / Alaskan Native	Asian	Native Hawaiian and Other Pacific Islander	Some Other Race	Two or More Races	Hispanic or Latino
USA	281,421,906	80.00%	12.80%	1.00%	4.40%	0.20%	0.16%	1.60%	15.10%
Hawaiʻi	1,211,537	29.10%	2.90%	0.50%	39.90%	8.90%	0.15%	18.60%	8.20%
Hawaiʻi County	148,677	37.80%	0.90%	0.70%	24.20%	10.80%	0.19%	25.70%	11.00%
Aggregate of Block Groups	14,312	42.57%	0.71%	0.84%	14.95%	12.49%	0.96%	27.49%	8.83%
Tract 210.02, BlkGrp 3	3,367	33.65%	0.92%	0.00%	17.76%	13.25%	0.77%	33.65%	15.06%
Tract 210.02, BlkGrp 4	1,564	44.25%	0.00%	1.28%	6.33%	14.32%	1.53%	32.29%	9.53%
Tract 211.00, BlkGrp 4	2,460	53.86%	1.14%	0.77%	16.38%	8.94%	1.42%	17.48%	7.56%
Tract 212.00, BlkGrp 1	1,626	14.21%	0.00%	0.43%	42.44%	7.38%	0.49%	35.06%	7.07%
Tract 212.00, BlkGrp 2	3,179	55.21%	1.13%	1.70%	7.90%	9.15%	1.10%	23.81%	8.08%
Tract 213.00, BlkGrp 1	2,116	45.18%	0.33%	0.95%	4.68%	***22.97%**	0.43%	25.47%	2.36%

Source: U.S. Census Bureau 2009a.

*The percentage of Native Hawaiians and Pacific Islanders in this tract, in the westernmost part of the study area, is more than 10 percent higher than that of the island and the state.

TABLE 2: ENVIRONMENTAL JUSTICE INFORMATION FOR POVERTY-STATUS POPULATIONS

Block Group	Total Population	% In Poverty
USA	281,421,906	13.30%
Hawai‘i	1,211,537	9.10%
Hawai‘i County	148,677	13.40%
Aggregate of Block Groups	14,312	23.62%
Tract 210.02, BlkGrp 3	3,367	***26.50%**
Tract 210.02, BlkGrp 4	1,564	22.57%
Tract 211.00, BlkGrp 4	2,460	***24.99%**
Tract 212.00, BlkGrp 1	1,626	***24.09%**
Tract 212.00, BlkGrp 2	3,179	***24.78%**
Tract 213.00, BlkGrp 1	2,116	16.45%

Source: U.S. Census Bureau 2009a.

* These four block groups have poverty percentages that are 10 percentage points higher than those of the Big Island and of the state.

Prime or Unique Farmland Soils. Prime farmland soils are protected under the *Farmland Protection Policy Act* of 1981. Prime farmland is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops. The land must also be available for these uses: cropland, pasture land, forestland, or other land, but not water or urban built-up land. Prime farmland has the soil quality, growing season, and moisture supply needed to economically produce sustained high yields of crops when treated and managed, including water management, according to acceptable farming methods (USDA-NRCS 2009b). Prime farmland does not include land already in or committed to urban development or water storage; land used or designated for commercial, industrial, or residential purposes is, therefore, categorically excluded from consideration. A 1973 soil survey conducted for the Island of Hawai‘i, which included Hawai‘i Volcanoes National Park, identified some soils in Hawai‘i Volcanoes that could be classified as prime or unique farmland soils. They are as follows (USDA-NRCS 2009c):

- Alapai hydrous silty clay loam consociation
- Mauna‘iu-‘Akelelu complex
- Ha‘a-Ke‘amoku complex
- Ki medial loam consociation
- Manu medial silt loam consociation

However, areas containing these soils are not currently in active production, nor does the potential exist for them to be converted or developed, thereby precluding their potential use as productive areas in the future. As a result, prime and unique farmlands are not carried forward for further analysis.

RELATED LAWS, POLICIES, PLANS, AND CONSTRAINTS

The following laws, policies, and plans by the NPS, Hawaiʻi, or agencies with neighboring land or relevant management authority are described in this section to show the framework this plan/EIS will need to operate under and the goals and policies that will be considered. It should be noted that Hawaiʻi Volcanoes National Park has exclusive jurisdiction, and Hawaiʻi does not have authority on park lands.

NATIONAL PARK SERVICE ORGANIC ACT AND MANAGEMENT POLICIES

By enacting the *Organic Act* of 1916, Congress directed the U.S. Department of the Interior and the NPS to manage units "to conserve the scenery and the natural and historic objects and wildlife therein and to provide for the enjoyment of the same in such a manner and by such a means as will leave them unimpaired for the enjoyment of future generations" (16 USC 1). The *Redwood National Park Expansion Act* of 1978 reiterates this mandate by stating that the NPS must conduct its actions in a manner that will ensure no "derogation of the values and purposes for which these various areas have been established, except as may have been or shall be directly and specifically provided by Congress" (16 USC 1a-1).

Despite these mandates, the *Organic Act* and its amendments afford the NPS latitude when making resource decisions. Because conservation remains predominant, the NPS seeks to avoid or to minimize adverse impacts on park resources and values. However, the *Organic Act* does give the Secretary of the Interior discretion to provide "for the destruction of such animal and of such plant life as may be detrimental to the use of any of said parks, monuments, or reservations" (16 USC 3), and the NPS *Management Policies 2006* (NPS 2006b) give the NPS discretion to allow negative impacts when necessary (section 1.4.3). This was upheld in *New Mexico State Game Commission v. Udall*, 410 F.2d 1197 (10th Cir 1969), when the 10th Circuit Court of Appeals determined that "(t)he obvious purpose of this language is to require the Secretary to determine when it is necessary to destroy animals which, for any reason, may be detrimental to the use of the park."

Because conservation remains predominant, the NPS seeks to avoid or to minimize adverse impacts on park resources and values. The Organic Act does give the Secretary of the Interior discretion to provide "for the destruction of such animal and of such plant life as may be detrimental to the use of any of said parks, monuments, or reservations" (16 USC 3), and the NPS Management Policies 2006 (NPS 2006b) give the NPS discretion to allow negative impacts when necessary.

While some actions and activities can cause impacts, the NPS cannot allow an adverse impact that constitutes resource impairment (NPS 2006b, section 1.4.3). The *Organic Act* prohibits actions that impair park resources unless a law directly and specifically allows for such actions (16 USC 1a-1). An action constitutes an impairment when its effects "harm the integrity of park resources or values, including the opportunities that otherwise would be present for the enjoyment of those resources or values" (NPS 2006b, section 1.4.5). To determine impairment, the NPS must evaluate "the particular resources and values that would be affected; the severity, duration, and timing of the impact; the direct and indirect effects of the impact; and the cumulative effects of the impact in question and other impacts" (NPS 2006b, section 1.4.5).

The NPS *Management Policies 2006* (NPS 2006b) have added the standard of "unacceptable impacts" to park decision making. The evaluation of unacceptable impacts addresses the concept that, while an impact may not reach the level of impairment, it would still not be acceptable within a park's particular environment. Section 1.4.7.1 states that unacceptable impacts are those that, individually or cumulatively, would

- be inconsistent with the park's purpose or values, or
- impede the attainment of a park's desired future conditions for natural and cultural resources as identified through the park's planning process, or
- create an unsafe or unhealthful environment for visitors or employees, or
- diminish opportunities for current or future generations to enjoy, learn about, or be inspired by park resources or values, or
- unreasonably interfere with:
  - park programs or activities, or
  - an appropriate use, or
  - the atmosphere of peace and tranquility, or the natural soundscape maintained in wilderness and natural, historic, or commemorative locations within the park,
  - NPS concessioner or contractor operations or services.

Also applicable to the management of non-native ungulates is "Section 4.4.4, Management of Exotic Species." This section of the NPS *Management Policies 2006*, specifically "Section 4.4.4.2, Removal of Exotic Species Already Present," states:

> All exotic plant and animal species that are not maintained to meet an identified park purpose will be managed—up to and including eradication—if (1) control is prudent and feasible, and (2) the exotic species

- interferes with natural processes and the perpetuation of natural features, native species or natural habitats, or
- disrupts the genetic integrity of native species, or
- disrupts the accurate presentation of a cultural landscape, or
- damages cultural resources, or
- substantially hampers the management of park or adjacent lands, or
- poses a public health hazard as advised by the U.S. Public Health Service (which includes the Centers for Disease Control and the NPS public health program), or
- creates a hazard to public safety.

These policies place a high priority on non-native species that have, or potentially could have, a substantial impact on park resources, and that can reasonably be expected to be successfully controlled. If non-native species cannot be successfully eliminated, NPS policy directs that managers seek to contain these species to prevent further spread or resource damage.

OTHER NATIONAL PARK SERVICE AND FEDERAL LAWS, REGULATIONS, AND POLICIES

The NPS is governed by laws, regulations, and other policies before, during, and following any management action related to the development of a NEPA document.

Redwood Amendment to the General Authorities Act

Reasserting the systemwide standard of protection established by congress in the original *Organic Act*, the *Redwood Amendment* states:

> The authorization of activities shall be construed and the protection, management, and administration of these areas shall be conducted in light of the high public value and integrity of the National Park System and shall not be exercised in derogation of the values and purposes for which these various areas have been established, except as may have been or shall be directly and specifically provided by Congress (P.L. 95-250, 16 USC 1a-1).

Congress intended the *Redwood Amendment* to reiterate the provisions of the *Organic Act*, not to create a substantively different management standard. Although the *Organic Act* and the *General Authorities Act*, as amended by the Redwood Amendment, use different words ("unimpaired" and "derogation") to describe what the NPS must avoid, they define a single standard for the management of the national park system—not two different standards. For simplicity, the NPS *Management Policies 2006* uses the word "impairment," not both statutory phrases, to refer to that single standard (NPS 2006b).

National Environmental Policy Act of 1969, as Amended

NEPA section 102(2)(c) requires that an environmental impact statement (EIS) be prepared for proposed major federal actions that may significantly affect the quality of the human environment.

Endangered Species Act of 1973, as Amended

The ESA requires all federal agencies to consult with the Secretary of the Interior on all projects and proposals having potential impact on federally endangered or threatened plants and animals.

Federal Noxious Weed Act of 1975

The *Federal Noxious Weed Act* (7 USC 2801–2814, January 3, 1975, as amended 1988 and 1994) provides for the control and management of non-native weeds that injure or have the potential to injure the interests of agriculture and commerce, wildlife resources, or the public health.

National Historic Preservation Act of 1966, as Amended

Section 106 of the *National Historic Preservation Act* requires federal agencies to consider the effects of their undertakings on properties listed on or potentially eligible for listing on the National Register of Historic Places. All actions affecting the park's cultural resources must comply with this legislation.

Wilderness Act of 1964

With the signing of the *Wilderness Act* by President Lyndon B. Johnson on September 3, 1964, the National Wilderness Preservation System was established to "secure for the American people of present and future generations the benefits of an enduring resource of wilderness."

The *Wilderness Act* states, "In order to assure that an increasing population, accompanied by expanding settlement and growing mechanization, does not occupy and modify all areas within the United States and its possessions, leaving no lands designated for preservation and protection in their natural condition, it is hereby declared to be the policy of the Congress to secure for the American people of present and future generations the benefits of an enduring resource of wilderness." Although there is great similarity between the NPS *Organic Act* and the *Wilderness Act*, Congress applied the *Wilderness Act* to the NPS to strengthen its protective capabilities.

Under the *Wilderness Act*, the park must apply the "minimum requirement" concept to all management activities that affect the wilderness resource and character at Hawai'i Volcanoes. "Minimum requirement" is a documented process the NPS uses to determine the appropriateness of all actions affecting wilderness. This concept is intended to minimize impacts on wilderness values and resources. Managers may authorize (using a documented process) the generally prohibited activities or uses listed in section 4(c) of the *Wilderness Act*, if deemed necessary to meet the minimum requirements for the administration of the area as wilderness and where those methods are determined to be the "minimum tool" for the project.

National Parks and Recreation Act of 1978

Public Law 95-625, passed November 10, 1978, designated 123,100 acres of land in Hawai'i Volcanoes as wilderness. This act required that areas designated as wilderness shall be administered by the Secretary of the Interior in accordance with the applicable provisions of the *Wilderness Act*, as described above.

Antideficiency Act

The *Antideficiency Act* prohibits federal managers from making or authorizing expenditures in excess of the amount available to them from appropriations or other funds, unless authorized by law. Based on this, the plan/EIS created must be able to be implemented using expected funding sources.

Title 36, Code of Federal Regulations

Title 36 provides the regulations "for the proper use, management, government, and protection of persons, property, and natural and cultural resources within areas under the jurisdiction of the National Park Service" (36 CFR 1.1[a]).

Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-income Populations"

The NPS must address, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities, including planning projects, on minority populations and low-income populations.

Executive Order 13112, "Invasive Species"

This executive order requires the NPS to prevent the introduction of invasive species and provide for their control and to minimize the economic, ecological, and human health impacts that invasive species cause.

Executive Order 13186, "Responsibilities of Federal Agencies to Protect Migratory Birds"

Executive Order 13186 was established on the premise that migratory birds contribute to biological diversity, bring enjoyment to millions of Americans, and are of great ecological and economic value to this county and other countries. Under this order, federal agencies taking actions that have, or are likely to have, a measurable negative effect on the migratory bird population are directed to develop and implement a memorandum of understanding with the USFWS that promotes the conservation of migratory bird populations. This executive order also requires that the environmental analysis of federal actions required by NPS or other established environmental review processes evaluate the effects of the action and agency plans on migratory birds, with an emphasis on species of concern.

Director's Order 77: Natural Resources Management Guideline (1991)

The *Natural Resources Management Guideline* (NPS 1991) provides guidance to park managers for all planned and ongoing natural resource management activities. Managers must follow all federal laws, regulations, and policies. This document provides the guidance for park management to design, implement, and evaluate a comprehensive natural resource management program.

Director's Order 41: Wilderness Preservation and Management (1999)

The purpose of Director's Order 41 (NPS 1999c) is to provide accountability, consistency, and continuity to the NPS wilderness management program, and to otherwise guide servicewide efforts in meeting the letter and spirit of the 1964 *Wilderness Act*.

Director's Order 28: Cultural Resource Management (1998)

This director's order sets forth the guidelines for management of cultural resources, including cultural landscapes, archeological resources, historic and prehistoric structures, museum objects, and ethnographic resources (NPS 1998). This order calls for the NPS to protect and manage cultural resources in its custody through effective research, planning, and stewardship in accordance with the policies and principals contained in the NPS *Management Policies 2006* (NPS 2006b).

Animal Welfare Act, as Amended (7 USC 2131–2159)

The *Animal Welfare Act* requires that minimum standards of care and treatment be provided for certain animals bred for commercial sale, used in research, transported commercially, or exhibited to the public. Individuals who operate facilities in these categories must provide their animals with adequate care and treatment in the areas of housing, handling, sanitation, nutrition, water, veterinary care, and protection from extreme weather and temperatures. Although federal requirements establish acceptable standards, they are not ideal. Regulated businesses are encouraged to exceed the specified minimum standards. Non-native ungulate management alternatives with a research component would be regulated by this act.

National Parks Omnibus Management Act of 1998

The *National Parks Omnibus Management Act* of 1998 (16 USC 5901 et seq.) underscores NEPA in that both are fundamental to NPS park management decisions. Both acts provide direction for articulating and connecting the ultimate resource management decision to the analysis of impacts using appropriate technical and scientific information. Both also recognize that such data may not be readily available and provide options for resource impact analysis in this case.

The *National Parks Omnibus Management Act* of 1998 directs the NPS to obtain scientific and technical information for analysis. The NPS handbook for Director's Order 12 states that if "such information cannot be obtained due to excessive cost or technical impossibility, the proposed alternative for decision will be modified to eliminate the action causing the unknown or uncertain impact or other alternatives will be selected" (NPS 2001a).

RELATIONSHIP TO HAWAI'I VOLCANOES NATIONAL PARK PLANNING DOCUMENTS

The purpose, need, and objectives for the plan/EIS should be consistent with park planning documents. These documents include the Hawai'i Volcanoes National Park Natural Resources Management Plan Final Environmental Statement (NPS 1974), Statement for Management: Hawai'i Volcanoes National Park (NPS 1985), Final Environmental Statement for the Proposed Wilderness Areas at Hawaii Volcanoes National Park (NPS 1975b), Kahuku: An Interim Operating Plan (NPS 2006a), the General Management Plan/EIS (NPS n.d.a), and various cultural and natural resource management documents described below.

Hawai'i Volcanoes National Park Natural Resources Management Plan Final Environmental Statement (1974)

This natural resource management plan was prepared to provide direction to the park on biological research; propagating rare and endangered plant and animal species; reintroducing rare species into their former ranges; protecting rare, endemic biota from depredation by species introduced by modern man; and providing avenues for public knowledge of these unique Hawaiian ecosystems. It is consistent with the objectives of the park master plan (see discussion below) and includes specific information relative to the control of feral goats and pigs (NPS 1974).

The plan proposes reducing and controlling goat numbers and distribution to allow endangered Hawaiian plants to survive and become reestablished through the following actions: reconstructing and maintaining existing boundary and drift fences; constructing and maintaining drift and exclosure fences; removing goats using means that allow deputized citizens to assist in management actions, where effective; and removing goats through drives and roundups, as well as through direct reduction using trained goat dogs, conducted by NPS personnel (NPS 1974).

Similarly, the plan proposes reducing and controlling pig numbers and distribution to minimize effects on native Hawaiian vegetation. The plan includes actions such as removing pigs using means that allow deputized citizens to assist in management actions, where effective; direct reduction conducted by NPS personnel; and research on pig population control measures (NPS 1974).

Hawai'i Volcanoes National Park Master Plan (1975)

The 1975 master plan addresses the issue of non-native animals in the park, and acknowledges that they are destroying some of the native vegetation and damaging other native animal species habitats. The plan addresses the role of future research in discovering new management methods for non-native ungulates that would provide greater options to control non-native animal populations. Past management efforts under this plan, specifically goat control programs using drives, NPS staff and local citizen participation, and drift fences, were successful in protecting portions of the park. This plan addresses further management of non-native ungulates in the park, proposing to fence an additional 40,000 acres (NPS 1975a).

Final Environmental Statement for the Proposed Wilderness Areas at Hawaii Volcanoes National Park (1975)

In relation to non-native ungulates, specifically feral pigs and goats, this document addresses the impact of non-native species in the park, indicating that feral pigs can be found in all four park units. Impacts of feral pigs addressed in the EIS include damage to native vegetation and the introduction of non-native plant species by disturbance of soils and native plant cover. Feral goats occupying the drier coastal and mountain sections of the park were also identified as needing management control. The following possible management measures for feral pigs and goats were identified: drives, roundups, and direct shooting by deputized citizens or park personnel. Other management measures included in the EIS were construction of fences and use of power tools and helicopter. The planning document acknowledges that the maintenance of native plant and bird populations is almost entirely dependent on the control of feral goats and pigs (NPS 1975b).

Statement for Management: Hawai‘i Volcanoes National Park (1985)

The *Statement for Management: Hawai‘i Volcanoes National Park* states, “regulations shall provide for the preservation from injury of all timber, birds, mineral deposits, and natural curiosities or wonders within said park, and their retention in their natural condition as nearly as possible.” It also states, “the purpose of Hawai‘i Volcanoes National Park is to conserve the volcanic features, endemic Hawaiian ecosystems, Hawaiian cultural and archeological remains, and inherent scenic values for visitor enjoyment and appreciation and for their scientific and historic values.” This document identifies the presence of non-native ungulates in the park as a major management issue, stating: “Establishing and maintaining effective control of feral animals, especially pigs, requires a substantial investment in boundary surveys, fencing, and applied research. About 4,000 feral pigs are causing irreversible damage to park forest lands, which is essential habitat for six endangered birds.” The park is further directed to “protect the park’s remnant Hawaiian ecosystems, including endangered species, from further depredation and competition by those non-native animals and plants introduced by modern people” (NPS 1985). These mandates and directives from the statement for management were taken into consideration during the development of this plan/EIS for protecting park resources from non-native ungulate impacts.

Hawai‘i Volcanoes National Park Resource Management Plan (1999)

The natural resource goals of the resource management plan state that a primary goal is to restore the park’s ecosystems through the removal of key non-native species, followed by natural recovery, and to expand restoration efforts currently focused on localized areas to a parkwide scale. The plan describes the status of non-native vertebrates on the island and how they contribute to the destruction of native flora and fauna. It also provides strategies and key actions for non-native animal control, with extensive descriptions concerning each mammal species (NPS 1999a). This document is the main resource management planning document at the park, and its goals were considered in the development of this plan/EIS for protecting park resources from non-native ungulate impacts.

Hawai‘i Volcanoes National Park Fire Management Plan (2005)

The purpose of this plan is to develop and improve the park’s fire management program to protect human life, property, and cultural resources, and to maintain or restore natural resources. This plan will facilitate the implementation of current national fire plan direction. Portions of the growing community of Volcano on the park’s boundary are threatened by fire starting in the park; park resources are threatened by fire starting in the community. In addition, the acquisition of the 116,000-acre Kahuku Ranch in 2003 posed a new wildland/urban interface (WUI) issue with the adjacent community of Hawaiian Ocean View Estates (NPS 2005a).

Under the new plan, wildland and prescribed fire are used whenever appropriate as tools to achieve resource management objectives. A naturally ignited wildland fire may be managed to accomplish resource management goals, depending on the fire management unit where it occurs. Initial suppression action will be taken to minimize cost and damages and to prevent the escape of any wildland fire. The intensity of response may range from aggressive suppression action to monitoring with minimal on-the-ground actions. Guidelines for determining specific strategies are described in the fire management plan. All human-caused fires will receive a suppression response commensurate with values to be protected, firefighter and public safety, and cost efficiency (NPS 2005a).

Prescribed fires, classified as those ignited by managers to accomplish resource management objectives, generally have three main objectives: (1) wildland fire hazard reduction; (2) reintroduction of fire as an ecological process; and (3) other resource benefits. Prescribed fire may be used in support of ecosystem management to maintain or restore plant communities or cycle nutrients, reduce or remove exotic plants, and for a variety of other resource management objectives (NPS 2005a).

Kahuku: An Interim Operating Plan (2006)

The interim operating plan directs the management and public use of the Kahuku District, an 116,000-acre addition to Hawaiʻi Volcanoes. This document provides guidance for managing this section of the park using established procedures and policies until an updated general management plan (GMP) is completed. Non-native ungulate control is addressed in the “natural resources” section, which describes efforts to recover approximately 6,500 acres of koa forest through the control of non-native ungulates and construction of a 10-mile fence along the park boundary bordering Kīpāhoehoe and Manukā Natural area Reserves, Kona Hema Preserve, Yee Hop Ranch, and other landholdings (NPS 2006a).

A second component of non-native ungulate management requires the construction of ungulate-resistant fences along portions of the park boundary and at strategic internal locations. Due to the success of the first 10 miles of fencing, two 8-mile fence segments were constructed and funding for additional fencing has been requested. Although the entire Kahuku plan would be considered in the development of this plan/EIS, additional management actions called for in the interim operating plan that would be applicable to the non-native ungulate management planning process include constructing small fenced exclosures to protect populations of rare plants at risk of extirpation from ungulates; monitoring vegetation in plant communities impacted by ungulates; and conducting experiments to evaluate recovery of vegetation following exclusion of animals and identify additional measures to restore native plant diversity in small fenced exclosures (NPS 2006a).

General Management Plan/EIS (Ongoing)

In the spring of 2009, the park began the process of drafting a new GMP/EIS. The plan will answer the question: “What kind of place do we want this park to be?” It will serve as a guidebook for the next 15 to 20 years to help managers make decisions about how to best protect natural and cultural resources, the appropriate levels and types of uses, the facilities that should be developed, and how people should access the park.

It has been more than 30 years since the park’s previous master plan was completed. Since that time, the park has experienced increased visitation, advances in knowledge about ecological and cultural resources, and numerous volcanic eruptions with the resultant loss of buildings and roadways. In 2003, the park grew by 116,000 acres with the acquisition of Kahuku on the southwest slope of Mauna Loa Volcano.

The park’s general management planning effort will develop a strategic vision for the entire park. This presents an opportunity to position the park as an environmental leader in creating climate-friendly and sustainable park operations, including reducing the park's carbon footprint. It is also very likely that the GMP/EIS will address desired conditions and management actions pertaining to non-native ungulates in the park. It is expected that the GMP/EIS planning process will be completed in 2014.

NON-NATIVE UNGULATE MANAGEMENT BY OTHER FEDERAL, STATE, AND LOCAL AGENCIES/ENTITIES IN THE REGION

Hawaiʻi Volcanoes is surrounded by other federal, state, and privately held land, as shown in figure 4. The agencies and organizations that own these lands include the USFWS, the Hawaiʻi, Kamehameha Schools, and TNC. Each of these entities has different mandates, and further details about management of the land in the vicinity of the park is provided in "Chapter 3: Affected Environment."

These entities, along with the park, Kulani Correctional Facility (State Department of Public Safety), U.S. Geological Survey (USGS) Biological Resource Division, U.S. Forest Service (USFS), and U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), are part of the TMA (formerly ʻŌlaʻa–Kīlauea Partnership). This alliance, the largest cooperative land management effort focused on watershed protection in Hawaiʻi, seeks to manage invasive species and protect native species across land ownership boundaries. Regarding non-native ungulates specifically, the TMA seeks to eliminate and/or reduce damage in high-priority native ecosystems and watersheds while providing for increased hunting opportunities in designated areas (TMA 2007).

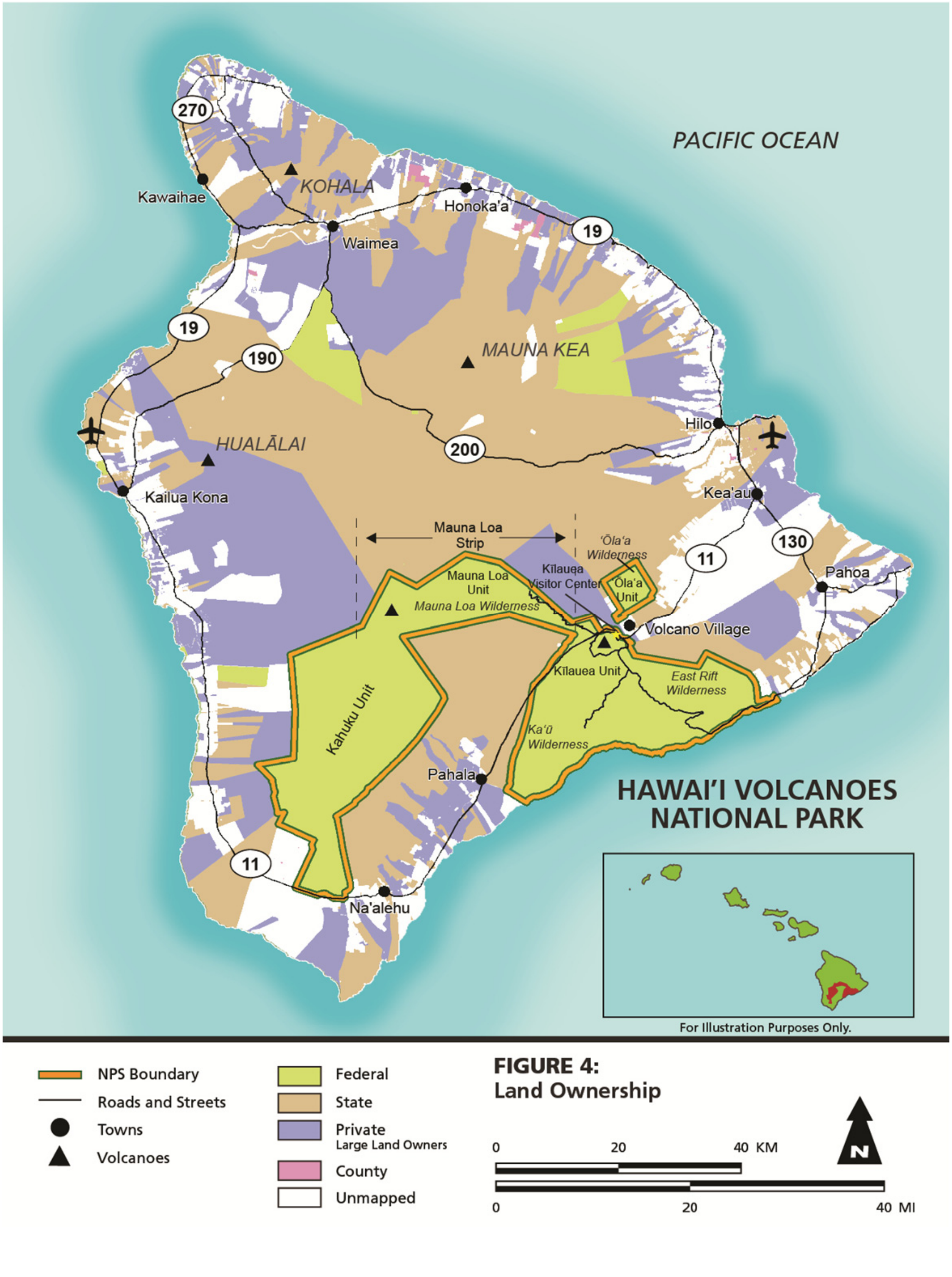
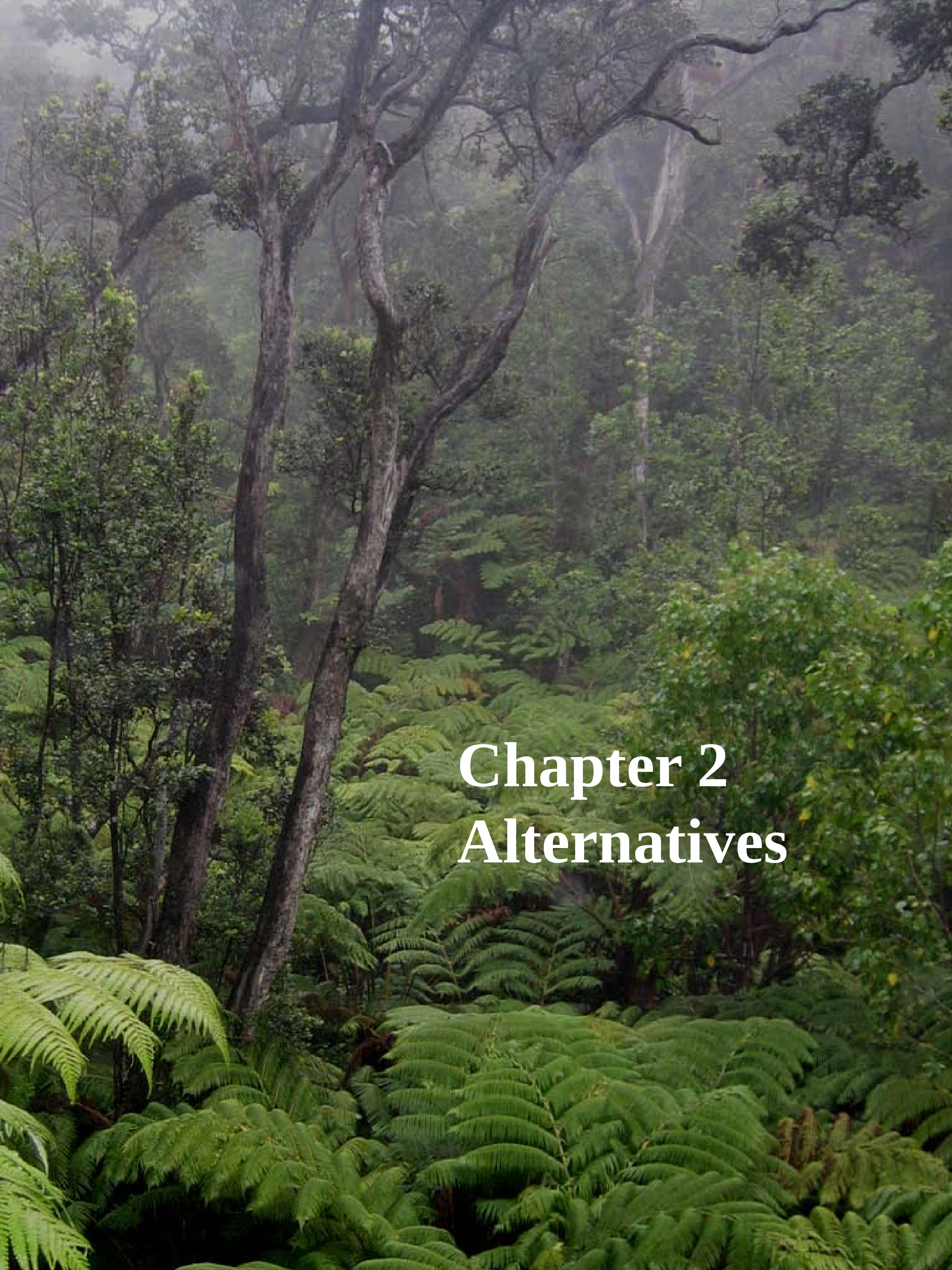


FIGURE 4:
Land Ownership



Chapter 2
Alternatives

CHAPTER 2: ALTERNATIVES

INTRODUCTION

This chapter describes the various actions that could be implemented to protect and restore native ecosystems by managing non-native ungulates at Hawai‘i Volcanoes. This includes a description of the “no-action” alternative (alternative A), which is the continuation of current non-native ungulate management activities. NEPA regulations require consideration of the no-action alternative and a range of reasonable alternatives.

The interdisciplinary NPS planning team developed the action alternatives (alternatives B through E) discussed in this chapter, taking into consideration feedback from the public and the science team (see “Chapter 5: Consultation and Coordination”). Action alternatives retained for detailed analysis must meet, to a large degree, the purpose of and need for action and the management objectives described in chapter 1.

Chapter 2 describes the alternatives in detail, including elements common to all alternatives and elements common to all action alternatives, and provides an overview of the alternatives in table form. The remainder of the chapter addresses how alternatives meet objectives, alternatives that were considered but eliminated from detailed analysis, and consistency with the purposes of NEPA.

OVERVIEW OF ALTERNATIVES

As required by NEPA, the alternatives described in this chapter represent a full spectrum of options for protecting and restoring native ecosystems by managing non-native ungulates at Hawai‘i Volcanoes. As a result of the alternatives development process, four action alternatives were selected for detailed analysis. Table 3 shows a summary of actions proposed under each alternative.

ELEMENTS COMMON TO ALL ALTERNATIVES

Many actions related to non-native ungulate management in the park would be common to all alternatives, including the no-action alternative (alternative A) and the four action alternatives (alternatives B through E). Implementation of any action described below would be subject to available funding.

References to the “old” section of the park refer to the 217,000 acres acquired prior to the Kahuku addition. Current management of the “old” section of the park would continue under all alternatives. This area includes the Kīlauea, ‘Ōla‘a, and Mauna Loa units of the park that extends from the coast to the Mauna Loa summit. With the exception of feral pigs, management actions have essentially eliminated non-native ungulates below 9,000 feet (2,743 meters) in elevation. Above 9,000 feet (2,743 meters) are occasional mouflon sheep, hybrid mouflon sheep, and possibly goats. Feral pigs are excluded from interior fenced units protecting approximately 40,000 acres of subalpine, montane, and selected lowland communities. In remaining areas, feral pigs are typically at low densities in dry to arid environments, and reach higher densities in seasonally dry to wet environments in the Kīlauea and ‘Ōla‘a units.

MANAGEMENT TOOLS

Direct Reduction with Firearms—Ground Shooting

This tool involves using firearms from the ground for the lethal removal of non-native ungulates. Personnel involved, which would include NPS staff, would have the appropriate skills and proficiencies in the use of firearms and protecting public safety, including experience in the use of firearms for the removal of wildlife. In the past, university cooperators have assisted the park with direct reduction efforts; however, they are not being used currently.

Individuals, as necessary, would be involved with direct reduction activities, including the field activities directly related to reduction efforts (shooting, field dressing, data collection, carcass handling). Individuals could work simultaneously in different areas of the park, depending on the target species. Each member's role would be identified during a pre-reduction meeting and could include any of the actions noted above. Individuals would generally access an area on foot or by vehicle. The individuals would locate groups of non-native ungulates to facilitate reduction activities for a targeted species, although non-native ungulates located by chance would also be considered for removal as long as it would not adversely affect the removal of the target species. Consideration would be given to the choice of firearm, ammunition, and shot placement to ensure the humaneness of the action. Non-native ungulates injured during the operation would be dispatched as quickly as possible to minimize suffering.

As part of direct reduction activities, trained dogs could be used to locate and flush sheep, goats, or mouflon sheep to facilitate direct reduction from the ground. These dogs could also be used to locate and immobilize non-native ungulates, such as feral pigs, during implementation of direct reduction with firearms. They would not be used in known breeding/molting areas of the nēnē to minimize the potential for unintended impacts on this federally listed species. This method could also be used in combination with tools such as telemetry (described below).

To increase the efficiency of removal activities, park staff would also make use of the tendency for some non-native ungulates, such as feral cattle, feral sheep, feral goats, and mouflon sheep, to form larger social groups. Staff would capture an individual non-native ungulate, place a telemetry collar on it, release it, and track it back to the larger group. Once the larger group is identified, ground shooting would be implemented.

Direct Reduction with Firearms—Aerial Shooting

Direct reduction with firearms would also occur from helicopters. As with ground shooting, personnel involved would have the appropriate training, certifications, skills, and proficiencies in helicopter operations, firearms, and safety.

This method is most effective in open areas where skilled shooters are able to take animals in vegetation openings. Trained dogs and/or ground crews would be used in combination with aerial shooters to help spot non-native ungulates and/or flush them into open areas. This method could also be used in combination with telemetry, as described for ground shooting.

TABLE 3: SUMMARY OF ALTERNATIVE ELEMENTS

Management Activity	Alternative A: No Action (Continue Existing Non-native Ungulate Management Activities)	Alternative B: Comprehensive Management Plan that Uses Lethal Removal Techniques	Alternative C: Comprehensive Management Plan that Maximizes Efficiency by Expanding Lethal Removal Techniques and Discontinuing the Use of Volunteers	Alternative D: Comprehensive Management Plan that Maximizes Flexibility of Management Techniques	Alternative E: Comprehensive Management Plan that Increases Flexibility of Management Techniques While Limiting the Use of Volunteers
General description of the alternative	Under alternative A, the NPS would continue current non-native ungulate practices, which are informed by the 1974 resources management plan/EIS and subsequent amendments (NPS 1974, 1986, 1999a), and other management decisions. Management techniques would be lethal. Qualified volunteers would continue to be used to assist with certain ground shooting activities, and could be used for certain other non-native ungulate management activities.	Under alternative B, the NPS would implement a comprehensive, systematic management plan that would use lethal techniques. Alternative B would include a systematic progression of management phases, monitoring, and considerations for the use of management tools. Qualified volunteers would be used to assist with ground shooting operations, and could be used for certain other non-native ungulate management activities.	Under alternative C, the NPS would implement a comprehensive, systematic management plan utilizing the most efficient and cost-effective methods of non-native ungulate management. Management techniques would be lethal. Alternative C would include a systematic progression of management phases, monitoring, and considerations for the use of management tools. Volunteers would not be used in any capacity associated with non-native ungulate management.	Under alternative D, the NPS would implement a comprehensive, systematic management plan providing maximum management flexibility. Management tools would be primarily lethal, but non-lethal techniques could be considered, such as relocation. Alternative D would include a systematic progression of management phases, monitoring, and considerations for the use of management tools. Qualified volunteers would be used to assist with ground shooting operations, and could be used for certain other non-native ungulate management activities.	Under alternative E, the NPS would implement a comprehensive, systematic management plan that relies primarily on lethal techniques, but non-lethal techniques could be considered such as relocation. Alternative E would include a systematic progression of management phases, monitoring, and considerations for the use of management tools. To provide a full range of alternatives, qualified volunteers would not be used for ground shooting activities. Volunteers could be used for certain other non-native ungulate management activities.
Population-level objective	Has been described in different ways for the older section of the park, but for practical purposes is zero non-native ungulates (or as low as practicable). No established population-level objective for Kahuku, but past experience and current scientific knowledge suggest a practical goal of zero non-native ungulates (or as low as practicable).	Zero non-native ungulates, or as low as practicable in managed areas, recognizing the possibility of remnant populations and ingress animals.	Same as alternative B.	Same as alternative B.	Same as alternative B.
Direct reduction with firearms—ground shooting	Lethal removal of non-native ungulates using firearms from the ground. All actions related to direct reduction with firearms from the ground would be included, such as shooting, data collection, and carcass handling. Direct reduction with firearms—ground shooting—could also include the following elements: • Could be used in combination with dogs; however, dogs would not be used in nēnē habitat until trained to avoid the nēnē. • Could be used in combination with telemetry.	Same as alternative A.	Same as alternative A, plus: • Ground-shooting activities could be expanded by use of bait stations to attract larger groups of non-native ungulates for removal. • Consider inducing estrus in captive female non-native ungulates to lure other non-native ungulates. • Consider use of cracker shells (shotgun shells that when discharged make a loud noise to startle animals) to flush animals into open areas. • Consider use of infrared technologies to locate non-native ungulates, which could also facilitate lethal removal by aerial shooting.	Same as alternative C.	Same as alternative C.

Management Activity	Alternative A: No Action (Continue Existing Non-native Ungulate Management Activities)	Alternative B: Comprehensive Management Plan that Uses Lethal Removal Techniques	Alternative C: Comprehensive Management Plan that Maximizes Efficiency by Expanding Lethal Removal Techniques and Discontinuing the Use of Volunteers	Alternative D: Comprehensive Management Plan that Maximizes Flexibility of Management Techniques	Alternative E: Comprehensive Management Plan that Increases Flexibility of Management Techniques While Limiting the Use of Volunteers
Direct reduction with firearms—aerial shooting	Lethal removal of non-native ungulates using firearms from the air. This activity would occur in open-canopy areas where skilled shooters are able to take animals that appear in vegetation openings. Choice of firearm, ammunition, and shot placement are all factors in the humaneness and success of using aerial shooting that would be considered. Personnel would have the appropriate skills, proficiencies, training, and certifications in helicopter operation and in the use of firearms for the removal of wildlife. Direct reduction with firearms—aerial shooting—could also include the following elements: • Could be used in combination with dogs; however, dogs would not be used in nēnē habitat until trained to avoid the nēnē. • Could be used in combination with telemetry.	Same as alternative A.	Same as alternative A, plus: • Aerial shooting activities could be expanded by use of bait stations to attract larger groups of non-native ungulates for removal. • Consider inducing estrus in captive female non-native ungulates to lure other non-native ungulates. • Consider use of cracker shells (shotgun shells that when discharged make a loud noise to startle animals) to flush animals into open areas. • Consider use of infrared technologies to locate non-native ungulates, which could also facilitate lethal removal by aerial shooting.	Same as alternative C.	Same as alternative C.
Snaring	Snaring would be used exclusively for the removal of feral pigs under one or more of the following conditions: • Populations are at remnant levels. • Densities are low. • Terrain is rugged. • Location is remote. • Pigs have become accustomed to other removal techniques. Using this method, a cable snare would be placed in areas where pigs are most likely to travel, or approximately one snare per acre. Snares would be mapped and marked with global positioning system (GPS) technology. Units with snares would be well signed to limit potential safety issues.	Same as alternative A.	Same as alternative A, plus: • Explore the use of snares for other non-native ungulates in addition to feral pigs. • Explore the use of snares in combination with telemetry devices that would alert park staff when snares have been tripped.	Same as alternative C.	Same as alternative C.
Baiting and trapping	Baiting and trapping would include trapping pigs, mouflon sheep, and feral cattle and dispatching the animals in or near the traps. This tool would be used wherever feasible.	Same as alternative A.	Same as alternative A, plus: Explore expanding the use of this method for lethal removal of other non-native ungulates as well.	Same as alternative C.	Same as alternative C.

Management Activity	Alternative A: No Action (Continue Existing Non-native Ungulate Management Activities)	Alternative B: Comprehensive Management Plan that Uses Lethal Removal Techniques	Alternative C: Comprehensive Management Plan that Maximizes Efficiency by Expanding Lethal Removal Techniques and Discontinuing the Use of Volunteers	Alternative D: Comprehensive Management Plan that Maximizes Flexibility of Management Techniques	Alternative E: Comprehensive Management Plan that Increases Flexibility of Management Techniques While Limiting the Use of Volunteers
Relocation	Relocation would not be used.	Same as alternative A.	Same as alternative A.	Park staff would investigate the possibility of capturing non-native ungulates and relocating them to other lands by either: • Driving the non-native ungulates onto adjacent lands where they could be hunted; or • Capturing non-native ungulates, using radio-collaring and traps or non-lethal snares, and transporting them to another location. All relocation activities would require willing recipients and would be carried out in close cooperation with the state. When considering areas to relocate animals, the NPS would avoid sites where undesirable impacts to the environment could occur. All necessary permits would be obtained. Prior to transporting animals to other locations, any necessary disease testing would be conducted.	Same as alternative D.
Fencing	The NPS would continue retrofitting boundary fences from 4-foot fences to 6-foot fences in areas vulnerable to mouflon sheep ingress in the older section of the park. The NPS would continue to use interior fencing to delineate managed non-native ungulate removal areas and exclude non-native ungulates from sensitive resource areas, including restoration plots, in the older section of the park. Past experience and consideration of current scientific knowledge indicate that boundary fencing would be necessary in Kahuku. However, under alternative A implementation of a comprehensive boundary fence would be uncertain.	Same as alternative A, plus: • complete a boundary fence for the Kahuku Unit, • establish a boundary fence for unmanaged portions of the ʻŌlaʻa rainforest, In addition, localized internal fencing could be constructed to assist in the control of non-native ungulates as needed. Boundary fences could be established on the east end of Kīlauea if active lava flow ceased and ingress occurred. The actual sequence of fencing would be based on conditions on the ground as the implementation of other parts of the plan occurs. Design of fencing could be modified based on new information and future experimentation to exclude multiple non-native ungulate species.	Same as alternative B.	Same as alternative B.	Same as alternative B.

Management Activity	Alternative A: No Action (Continue Existing Non-native Ungulate Management Activities)	Alternative B: Comprehensive Management Plan that Uses Lethal Removal Techniques	Alternative C: Comprehensive Management Plan that Maximizes Efficiency by Expanding Lethal Removal Techniques and Discontinuing the Use of Volunteers	Alternative D: Comprehensive Management Plan that Maximizes Flexibility of Management Techniques	Alternative E: Comprehensive Management Plan that Increases Flexibility of Management Techniques While Limiting the Use of Volunteers
Use of qualified volunteers	Qualified volunteers would be used for direct reduction with firearms during the reduction phase in more accessible areas of Kahuku (e.g., areas below 5,000 ft in elevation). The following would be required of potential qualified volunteers: • Completing a registration form • Obtaining a Hunter Education Certificate or card • Presenting registration of the firearm to be used and a Hawaiʻi hunting license • Providing their own transportation • Being able to spend a minimum of 8 hours hiking over rough terrain A minimum of one NPS staff member would directly supervise and escort every two volunteers and these staff members would direct volunteers as to which animals should be removed. Volunteers would be allowed to keep the meat or other parts from any animal they kill (inconsistent with current NPS practice). Qualified volunteers could also be used for other non-native ungulate management activities, including fence construction and maintenance, monitoring, baiting, trapping, and relocation. These qualified volunteers would need to demonstrate proficiency appropriate to their proposed involvement.	Same as alternative A, except: • For consistency with current NPS practice, volunteers would not be allowed to keep any part of the animal, including the meat. • The NPS would work to promote increased volunteer engagement in the full spectrum of non-native ungulate management activities open to volunteer participation (e.g., fence construction and maintenance, monitoring, etc.).	Volunteers would not be used in any capacity associated with non-native ungulate management.	Same as alternative B, plus: • Volunteers could be used for ground shooting activities in additional management phases and areas where safe and practicable.	Same as alternative B, except: • Volunteers would not be used for any ground shooting activities.
Carcass disposal	Carcasses of animals would generally be left in place, unless volunteers choose to keep the meat or other parts of the animal. Carcasses may be relocated from kill sites if they are located in sensitive areas, such as next to a road, trail, or cultural site.	Same as alternative A. However, volunteers would not be able to keep the meat. The NPS would investigate opportunities to salvage and donate meat when practicable, following all applicable NPS guidelines.	Carcasses of animals would generally be left in place. Carcasses may be relocated from kill sites if they are located in sensitive areas, such as next to a road, trail, or cultural site.	Same as alternative B.	Same as alternative B.

Helicopter and firearms use would comply with all relevant regulations, policies, and plans (see the “Employee and Visitor Health and Safety” section in “Chapter 4: Environmental Consequences”), and would be consistent with the Interagency Aviation Management Council’s (IAMC) *Interagency Helicopter Operations Guide* (IAMC 2006) and the *Aerial Capture, Eradication, and Tagging of Animals Handbook* (Department of the Interior Departmental Manual 351 [DM 2–351 DM 3]). Only qualified personnel would participate in helicopter operations. Compliance with all relevant NPS directives related to firearms use in parks, as well as federal firearm laws administered by the Bureau of Alcohol, Tobacco, and Firearms, would be required. The NPS would continue to pursue safe and effective non-toxic alternatives to the use of lead bullets. Firearm noise suppressors would be considered at the discretion of the NPS.

Snaring

Snaring would be used for the removal of feral pigs. This technique would be used primarily to remove remnant pigs, when densities are low, in rugged terrain or remote sites, and/or to remove pigs that have become accustomed to other removal techniques and learned to avoid them. This technique involves placing a cable snare in areas where pigs are most likely to travel, including trails, ridgetops, and fence lines. Cable snares consist of a loop of steel cable fastened to a secured or heavy object and situated to catch an animal it passes through the narrow opening, ultimately killing the animal. The snares would be well marked, mapped with GPS coordinates, heavily flagged, and sometimes baited. Prior consultation with NPS subject experts and the park botanist would be conducted to determine the type of snare, placement, and bait selection to avoid potential impacts to nēnē and other native sensitive species in the area. Fenced management units with snares would be well signposted, which would limit potential safety issues.

Baiting and Trapping

Baiting and trapping would be used for lethal removal of feral pigs, mouflon sheep, and feral cattle. Traps would be used to capture the animals, which would then be dispatched in or near the trap. This method would be used in fenced and unfenced areas; the latter typically during the breeding and nesting season of the endangered nēnē where nests or goslings need to be protected from predatory pigs. Prior consultation with NPS subject experts and the park botanist is conducted to determine the type of trap, placement and bait selection to avoid potential impacts to nēnē and other native sensitive species in the area.

Fencing

In the older section of the park, the NPS would continue to repair boundary fences (see figure 5). In areas where there is potential for mouflon sheep to breach fences, the NPS would continue to retrofit boundary fences from 4-foot to 6-foot fences. The NPS would also continue to use interior fencing (39 to 72 inches in height, depending on the non-native ungulates in the area) to delineate managed non-native pig removal areas and exclude non-native ungulates from sensitive resource areas, including restoration plots. Fenced management units typically range from several hundred acres in size to several thousand acres. Smaller fenced units (e.g., several acres) are typically constructed for the protection of highly sensitive resources (e.g., endangered silverswords and nēnē) or to evaluate recovery as a prelude to establishment of larger, fenced managed units.

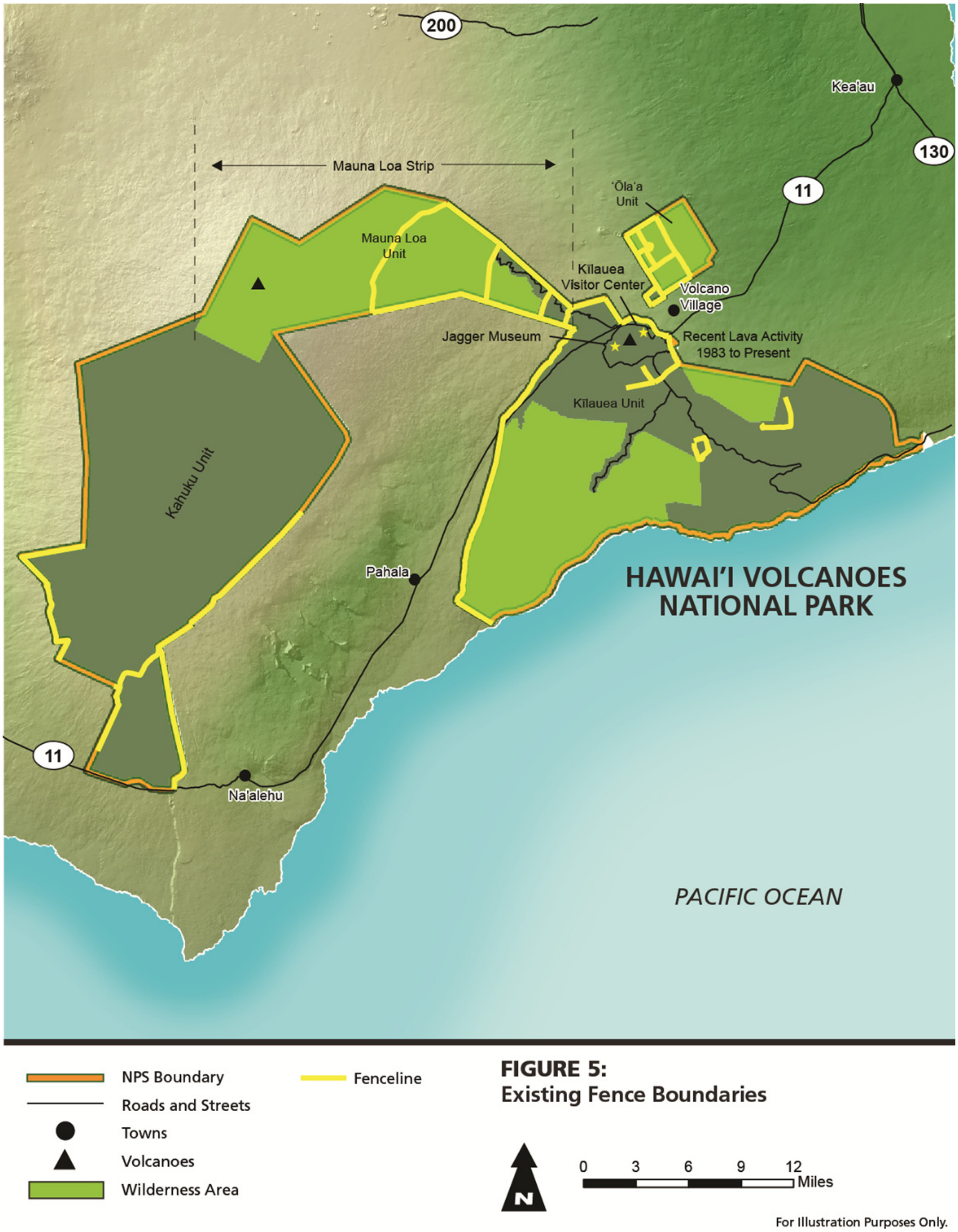


FIGURE 5:
Existing Fence Boundaries

Although fencing for the Kahuku Unit would be part of any alternative, the type, amount, location, and priority of fencing would vary between the no-action and the action alternatives (see discussion in “Elements Common to All Action Alternatives” and “Alternative A”). Based on past experience and research, any fencing would be at least 6 feet (2 meters) high and would be designed to keep multiple non-native ungulate species outside the park boundary. Any fencing would be modified, as necessary, to minimize impacts on other wildlife (e.g., using white vinyl strips or flagging to make the fence more visible to petrels) and address any changes in fencing technology (e.g., fence design, remote cameras to monitor breaches, etc.).

Carcass Handling and Disposal

Carcasses of animals would generally be left in place. Carcasses may be relocated from kill sites if they are located in sensitive areas, such as next to a road, trail, or cultural site.

HUMANE MANAGEMENT ACTIONS

The NPS would adhere to guidelines from the American Society of Mammalogists (ASM n.d.) and the American Veterinary Medical Association (AVMA 2007) to ensure that management actions are conducted as humanely as possible to minimize non-native ungulate suffering. When using direct reduction with firearms, consideration would be given to the choice of firearm, ammunition, and shot placement to ensure the humaneness of the action.

WEED AND FIRE MANAGEMENT PROGRAMS

The NPS would continue to implement the weed control program (NPS 1999a) and the fire management plan that are already in use at the park (NPS 2005a). For information regarding weed control in the park, refer to the “Vegetation” section in chapter 3. The fire management plan is described in detail in chapter 1.

THREATENED OR ENDANGERED PLANT AND ANIMAL SPECIES

The NPS would continue to coordinate with the USFWS to ensure that potential environmental impacts on listed species are adequately considered and, as needed, identify appropriate mitigation measures to avoid impacts on listed species in the area. See appendix A for letters detailing consultation efforts conducted to date for this plan/EIS.

CULTURAL RESOURCES

The NPS would continue to coordinate with the State Historic Preservation Officer to ensure compliance with all pertinent laws and regulations, and, if necessary, will seek a Memorandum of Agreement to cover the management actions of the preferred alternative. Archeological surveys would be conducted prior to the construction of fences, and fences would be realigned, if necessary, to avoid impacts to archeological resources and to minimize disturbance to the cultural viewshed. See appendix A for letters detailing consultation efforts conducted to date for this plan/EIS.

MINIMUM REQUIREMENTS AND MINIMUM TOOLS FOR MANAGEMENT ACTIONS IN WILDERNESS AREAS

Pursuant to the *Wilderness Act*, the park’s manager must apply the “minimum requirement” concept to all management activities that affect the wilderness resource and character at the park. Minimum requirement is a documented process the NPS uses to determine the appropriateness of all actions affecting wilderness. This concept is intended to minimize impacts on wilderness values and resources. Using this process, managers may authorize the generally prohibited activities or uses listed in section 4(c) of the *Wilderness Act* if deemed necessary to meet the minimum requirements for the administration of the area as wilderness, and where those methods are determined to be the "minimum tool" for the project.

In accordance with NPS policy, a minimum requirements analysis must be completed before a management action can be taken in designated wilderness areas. NPS *Management Policies 2006* states that the purpose of a minimum requirements analysis is to determine (1) whether the proposed management action is appropriate or necessary for administration of the area as wilderness and does not cause a significant impact on wilderness resources and character; and (2) the techniques and types of equipment needed to ensure that impacts on wilderness resources and character are minimized (NPS 2006b, section 6.3.5).

In addition, Director's Order 41: *Wilderness Preservation and Management* sets forth guidance for applying the minimum requirement concept to protect wilderness and for the overall management, interpretation, and uses of wilderness. With regard to natural resource management in wilderness, it reaffirms management policies and states, "Management intervention should only be undertaken to the extent necessary to correct past mistakes, the impacts of human use, and the influences originating outside of wilderness boundaries" (NPS 1999c).

Management intervention to ensure the survival of endemic communities of plants and animals at risk from human introduced non-native ungulates was determined to be a minimum requirement for the administration of wilderness areas in the Final Environmental Statement for the Proposed Wilderness Areas at Hawai‘i Volcanoes National Park (NPS 1975b). Specific actions identified were construction of fences, use of power tools to assist with fence construction, and the use of helicopters to exclude non-native goats and pigs for the protection of park resources. Subsequent environmental assessments (NPS 1997a, 1997b, 1999b) re-affirmed the need to construct fences and conduct non-native ungulate control measures in wilderness units.

The current minimum requirements decision guide template (see appendix B) is used by each of the agencies to assist wilderness managers in making appropriate decisions for wilderness management. The minimum requirements analysis provides a method of determining the necessity of an action in wilderness areas and how to minimize impacts, but does not bind an agency to take a particular action.

Under all alternatives, the NPS would implement management activities to remove non-native ungulates from areas that include designated wilderness and areas currently being evaluated for wilderness eligibility (e.g., upper elevation portions of the Kahuku Unit). Although the *Wilderness Act* implies that management actions that manipulate natural processes in wilderness conflict with wilderness values, managing populations of non-native ungulates is not expressly prohibited in the act. As noted previously, section 4(c) of the *Wilderness Act* notes that agencies may engage in management actions that may otherwise be prohibited in wilderness provided they are necessary "to meet the minimum requirements for the administration of the area."

The results of the minimum requirements analysis determined that management of non-native ungulate populations in wilderness is necessary to meet the minimum requirements for the administration of wilderness areas in the park (see appendix B). Managing populations of non-native ungulates, as proposed under all alternatives, would perpetuate or assist recovery of the natural conditions that contribute to the character of the wilderness at Hawai‘i Volcanoes National Park. Specific actions (fence construction, the use of power tools and helicopter) identified in the alternatives are considered the minimum tools necessary to meet these requirements (see appendix B).

MINIMIZATION OF DISTURBANCE TO PUBLIC

To the extent feasible, efforts would be made to minimize safety concerns and disturbances to the public, such as scheduling non-native ungulate management activities during periods of lower visitor use (e.g., early morning). However, the NPS would determine if specific areas of the park would also need to be temporarily closed during non-native ungulate management activities. The public would be appropriately notified of these closures.

At the time of this writing (summer 2011), Kahuku is open to the public on weekends. Because areas currently open to the public overlap with the areas where volunteers conduct animal reduction activities, the park closes these areas the first Saturday of every month to safely conduct the reduction activities. Closures are not typically needed in the ‘Ōla‘a, Kīlauea, and Mauna Loa sections of the park, which are primarily in the maintenance phase and require minimal removal efforts (see discussion of “Frequency and Duration of Management Actions” under “Elements Common to All Action Alternatives” for more details). Although these sections of the park are open to the public, visitation is typically rare away from roads and trails. As a result, closures in these areas typically involve notifying the front desk, dispatchers, researchers, and other park staff of plans to conduct removal activities in these areas, in addition to placing signs on fences and/or gates to notify visitors. Removal activities are also generally conducted in the early morning to minimize impacts on visitors.

EDUCATION

Under all alternatives, NPS staff would continue to provide information in the visitor center, on nature walks, and in evening programs about NPS efforts to perpetuate endemic plants and animals and about issues related to non-native ungulates. Programs in local communities would be conducted as opportunities arise.

FORMAL PARTNERSHIPS

As described in “Chapter 1: Purpose of and Need for Action,” the NPS is part of the TMA (formerly the ‘Ōla‘a-Kīlauea Partnership), a cooperative land management effort for over 1 million acres of land on the Island of Hawai‘i (see the “Non-native Ungulate Management by Other Federal, State, and Local Agencies in the Region” section). Under all alternatives, the NPS would continue to collaborate with existing partners as well as increase participation in partnerships with neighboring landowners to implement non-native ungulate management actions beneficial to the protection of park resources.

USE OF BEST AVAILABLE SCIENCE

As described in chapter 1, “Research Summary,” the NPS has relied on scientific research to develop and implement effective strategies for non-native ungulate management in the park. Under all alternatives, the NPS would continue to rely on the best available science to implement non-native ungulate management. This includes working with scientists and technical experts with a background in non-native ungulates to evaluate and refine current control methods, and develop new methods to address multiple non-native ungulate species.

Under all alternatives, the NPS would continue to rely on the best available science to implement non-native ungulate management. This includes working with scientists and technical experts with a background in non-native ungulates to evaluate and refine current control methods, and develop new methods to address multiple non-native ungulate species.

ELEMENTS COMMON TO ALL ACTION ALTERNATIVES

The following elements would be common to all action alternatives. Some of the actions listed under "Elements Common to All Action Alternatives" may be implemented under alternative A, the no-action alternative. However, they would not be part of a comprehensive, systematic management plan under alternative A and therefore would not be considered common to all alternatives.

NON-NATIVE UNGULATE POPULATION-LEVEL OBJECTIVE

The *Organic Act* of 1916 and NPS *Management Policies 2006* (NPS 2006b) require that the NPS manage resources in natural conditions (described as the condition of resources that would be present in the absence of human dominance over the landscape) to prevent the need for restoration and leave them unimpaired for the enjoyment of future generations. The NPS *Management Policies 2006* acknowledges that park units are parts of much larger ecosystems and that management of resources should occur within this context. In addition, NPS *Management Policies 2006* states that non-native species will not be allowed to displace native species if this displacement can be prevented (NPS 2006b).

To meet these requirements and to attain objectives for protecting natural resources and supporting their natural recovery, the NPS concluded that the population-level objective for all action alternatives would be zero non-native ungulates, or as low as practicable in managed areas, recognizing the possibility of remnant populations and ingress animals. Although removal of non-native ungulates alone would not result in comprehensive ecosystem protection and restoration, it would not be possible to achieve success with non-native ungulates on the landscape.

To meet these requirements and to attain objectives for protecting natural resources and supporting their natural recovery, the NPS concluded that the population-level objective for all action alternatives would be zero non-native ungulates, or as low as practicable in managed areas, recognizing the possibility of remnant populations and ingress animals.

MANAGEMENT PHASES

Non-native ungulate management under a comprehensive, systematic plan would be divided into four phases:

1. **Initial assessment**. This phase occurs prior to initiation of control work, and includes monitoring to estimate initial abundance levels and distribution and to determine the amount of resources that will be necessary to manage non-native ungulates in prescribed areas.
2. **Reduction**. This first phase of control work typically begins at or near maximum population density, and usually after ingress has been controlled by fences. The goal of this phase is to reduce the population as much as possible in a short period of time, thereby reducing population recruitment and curtailing excessive ecosystem damage.
3. **Post-reduction**. This phase occurs when remnant levels of non-native ungulates have been achieved and the animals often become more difficult to detect, monitor, and manage.
4. **Maintenance**. The goal of this phase is to prevent ingress to management units in which non-native ungulates targeted for control have been fully removed and to carry out follow-up removal of ingress animals.

FREQUENCY AND DURATION OF MANAGEMENT ACTIONS

Information regarding the frequency and duration of management actions in this plan/EIS is based on ungulate management actions conducted between fiscal year (FY) 2003 and FY 2009 (NPS 2005b, 2006c, 2007c, 2010b). Actual frequency and/or duration during the implementation of any action alternative would depend on conditions at the time of implementation.

Reduction and Post-reduction Phases

Frequency and duration of the reduction/post-reduction phases for mouflon sheep, pigs, and goats in Kahuku have been estimated based on reduction efforts in the west (approximately 12,600 acres) and mauka (approximately 8,900 acres) Kahuku units (FY 2003–FY 2009). During this phase, the annual number of full-day removal efforts using ground shooting averaged 20 and varied between 8 and 28. The annual number of helicopter-assisted (herding and/or aerial shooting) reduction/post-reduction efforts for mouflon sheep and goats averaged 7 and varied between 0 and 19, typically increasing to 2 to 3 times a month as animals became more wary of ground-pursuit methods. Aerial shooting generally lasts 1.5 to 2 hours, while ground shooting can last up to 10 hours per day. The reduction phase would typically take place over a period of 6 to 36 months, depending on the size of the unit, whether the unit is expanded, and availability of funding. For the purposes of the analysis, it is assumed that reduction/post-reduction would continue at a similar pace for the foreseeable future, resulting in about 20 removal efforts per year within a unit. Up to one-third of the removal efforts would include helicopter assistance. Frequency and duration of the reduction/post-reduction phases in remaining unmanaged areas in ‘Ōla‘a have been based on feral pig control efforts in the new unit of the ‘Ōla‘a area from FY 2005 to FY 2007. Staff conducted an average of 24 full-day removal efforts using ground shooting with dogs and snaring during this period. A similar intensity of effort per acre would be assumed for remaining unmanaged areas. The number of removal efforts would decrease over the life of the plan as non-native ungulates are removed and excluded from an area and the NPS moves into the maintenance phase.

Maintenance Phase

Information on the frequency and duration of management actions during the maintenance phase is based on efforts conducted in non-native ungulate control units in the Kīlauea, Mauna Loa, and ‘Ōla‘a sections of the park. Because non-native ungulate populations targeted for control have generally been excluded and removed in these areas, management actions are focused on removing ingress animals. The frequency of maintenance activities varies based on the number of non-native ungulates that breach an area in any given year. Between October 2004 and September 2009, the average annual number of animals removed from all management units in the maintenance phase was one goat, one mouflon sheep, zero cattle, and twelve pigs. This resulted in the park conducting an average of approximately fifteen removal efforts per year. During that period, four efforts (three involving goats and one involving mouflon sheep) were helicopter assisted (i.e., aerial shooting). Aerial operations last no more than a couple of hours. The remaining removal efforts were conducted using snaring, trapping, and/or ground shooting. These operations generally last 6 to 8 hours. Removal efforts typically begin at first light to minimize impacts on visitors and to maximize effectiveness. For the purposes of this analysis, it is assumed that maintenance efforts would continue at a similar level for the foreseeable future, resulting in about 5 to 25 removal efforts per year across all units in the maintenance phase. Approximately one-third of these efforts per year would require helicopter assistance. As the NPS shifts from reduction to maintenance in the Kahuku section of the park, the number of maintenance efforts parkwide would likely increase.

In mid-elevation, seasonally dry nēnē habitat on Kīlauea, baiting and live trapping would be the primary tool for removing feral pigs from the vicinity of nests and goslings. These localized activities would be conducted annually and limited to the breeding season (October through March).

MONITORING

A formalized monitoring system, as described in appendix C, would be part of all action alternatives. The information gained through monitoring would inform the use of management tools and the progression through the four management phases described above.

When ungulates such as mouflon sheep are abundant and inhabit relatively open environments, particularly during the initial assessment phase, systematic aerial surveys are an effective means of assessing population levels. However, although feral pigs inhabit a wide range of sparse, open, and dense vegetation communities, they are the most problematic ungulate to assess during all management phases, especially in dense vegetation. Therefore, ground-based systematic monitoring techniques are often used when feral pigs are at high population levels. Monthly perimeter inspections of fences are the primary means of assessing the integrity of management units during the maintenance phase.

Systematic monitoring techniques are less effective for all species at low population levels because ungulates may congregate in small numbers away from original monitoring locations. Adaptive strategies and combinations of multiple techniques may be necessary to monitor small numbers of non-native ungulates remaining in management units. Occasionally, some monitoring techniques may be used out of sequence or during other phases of non-native ungulate management as needed.

CONDITIONS OF USE FOR MANAGEMENT TOOLS

Due to the harsh environment and remoteness of some areas in Hawai‘i Volcanoes, there are challenges to managing non-native ungulates. For example, in parts of the park where fences are exposed to substantial rainfall and washouts, volcanic fumes, or sea spray, they can deteriorate quickly, requiring more frequent maintenance to help prevent ingress. Management must be adapted to address densely vegetated forests, difficult terrain, or remote areas of the park. Some methods used in these areas include aerial shooting of animals such as mouflon sheep in remote and difficult terrain, using snares that trap and kill pigs, and using dogs to seek out and flush mouflon sheep in the dense forests. Natural barriers, primarily earth cracks, can preclude the use of certain management techniques and block access to animals such as pigs, because of the possibility that park staff or dogs would fall into the cracks (NPS 1999a, 2006b). Areas that are hard to access require intensive efforts that consume valuable staff time, and control of remnant individual animals is difficult in these locations.

Several studies to test efficacy of control methods and evaluate recovery of the vegetation following animal removal have been conducted in the park (Baldwin and Fagerlund 1943; Cuddihy 1984; Hone and Stone 1989; Katahira 1980; Katahira et al. 1993; Loh and Tunison 1999; Pratt et al. 1999; Spatz and Mueller-Dombois 1975; Stone et al. 1992; Tunison et al. 1994; Tunison et al. 1995). Current studies are focused on evaluating the population growth and developing control techniques for mouflon sheep (Stephens et al. 2008; USGS 2006a.) and monitoring recovery of koa forest following mouflon sheep reduction in Kahuku (Loh et al. 2005). Also, the park has established several small experimental exclosures to evaluate vegetation changes and develop methods to facilitate koa–‘ōhi’a forest recovery in former cattle-grazed pasture in Kahuku (NPS 2006i). Similar studies have taken place at Haleakalā National Park (Anderson and Stone 1993; Diong 1981, 1982; Stone et al. 1991) and in Hakalau Forest National Wildlife Refuge (Hess et al. 2006). A study by Loope et al. (1991) documented the recovery of a bog disturbed by feral pig damage after a fence was constructed around it. Throughout the next 6 years, the area’s vegetation was assessed annually to evaluate progress as recovery occurred.

Based on past research and experience, and in consideration of input from the public and the science team, the NPS has identified considerations for implementing the management tools under the action alternatives. These considerations include target species for particular management techniques and conditions under which management tools are most warranted (see table 4).

TABLE 4: CONSIDERATIONS FOR IMPLEMENTING MANAGEMENT TOOLS

	Management Tools							
	Direct Reduction with Firearms—Ground Shooting	Direct Reduction with Firearms—Aerial Shooting	Snaring		Baiting and Trapping		Relocation	
	All Action Alternatives	All Action Alternatives and Other Non-Native Ungulates	Alternative B	Alternatives C-E	Alternative B	Alternatives C-E	Alternatives B, C	Alternatives D, E
Species	Sheep, goats, pigs, mouflon sheep, deer, and feral cattle	Sheep, goats, mouflon sheep, pigs, deer and feral cattle	Pigs	Pigs and other non-native ungulates	Pigs, mouflon sheep, and feral cattle	Pigs, mouflon sheep, feral cattle, and other non-native ungulates	Domestic cattle (returned to ranchers); not used for feral animals	Sheep, mouflon sheep, pigs, deer, domestic cattle (returned to ranchers), and other non-native ungulates
Population levels	All	All	Generally low density	Same as alternative B	All	Same as alternative B	Low density (ingress domestic cattle)	All
Environment	Wherever effective and safe	Wherever effective and safe; in general, beneficial in open-canopy areas, remote areas	In general, rugged terrain (cracks, lava tubes that present safety risks to dogs and staff); remote sites; also along trails that lead to traps (used if baiting not successful)	Wherever effective and safe	Wherever effective and safe	Wherever effective and safe	Wherever effective and safe	Wherever effective and safe
Other factors	Could be used in combination with dogs	Could be used in combination with dogs	Would be used when pigs have become accustomed to other techniques	Same as alternative B, plus: Could be used for other non-native ungulates	Would include use in nēnē habitat for pigs; can be used at any time during removals when effective	Same as alternative B	Park would work with ranchers to relocate domestic cattle back to their ranches	Same as alternatives B and C, plus: Would require willing recipients for other ungulates; and all necessary permissions, environmental review, and permits; would avoid relocating animals to sites where undesirable impacts to the environment could occur

Notes: Use of any tool is subject to available funding. Relocation could involve either driving to adjacent lands or capturing animals and transporting them to other areas; both require willing recipients and close coordination with pertinent agencies.

FENCING

As described in "Elements Common to All Alternatives," the NPS would continue to repair and retrofit boundary fences around the older section of the park and construct localized interior fences to manage and exclude non-native ungulates.

Under all action alternatives, the NPS would

- complete a boundary fence for the Kahuku Unit;
- construct a boundary fence for unmanaged portions of the ʻŌlaʻa rainforest (figure 6).

In the Kahuku Unit, the boundary fence would extend upslope for several miles into sparsely vegetated lava fields before terminating at the 11,000 foot elevation where potential for animal ingress would be low. In addition, localized internal fencing could be constructed to assist in the control of non-native ungulates, if needed. Also, boundary fences could be established on the east end of Kīlauea if active lava flow ceased and ingress of feral goats or other ungulates occurred in significant numbers.

The actual sequence of fencing would be based on conditions on the ground while other parts of the plan are being implemented. Design of fencing would be as described in "Elements Common to All Alternatives," but could be modified based on new information and future experimentation to exclude multiple non-native ungulate species.

MINIMIZING IMPACTS TO SPECIAL STATUS PLANT AND ANIMAL SPECIES

After informal consultation with the USFWS, the following measures were identified to minimize potential impacts to endangered species and habitat associated with ungulate removal, fence repair, replacement and construction:

- Ungulate removal efforts could take place year round depending on where and when animals are detected and may include actions conducted during critical periods for sensitive species. Trap placement and bait selection is done in consultation with NPS subject experts and the park botanist to avoid potential impacts to nēnē and other sensitive native plant and animal species in the area. The use of dogs to assist with locating animals would be avoided in known areas where nēnē or other ground nesting sensitive native species occur. Low-flying helicopter work would be minimized in sensitive wildlife habitat during critical periods. However, if control actions are required (e.g., due to animal ingress), park staff will confer with the appropriate wildlife biologist to determine if sensitive species are in the area, and depending on the determination, consult with USFWS prior to implementation of control actions. Personnel involved in removal efforts will follow sanitation protocols for inspecting and cleaning equipment, personal gear, and vehicles to reduce the risk of bringing non-native plants and animals into an area.

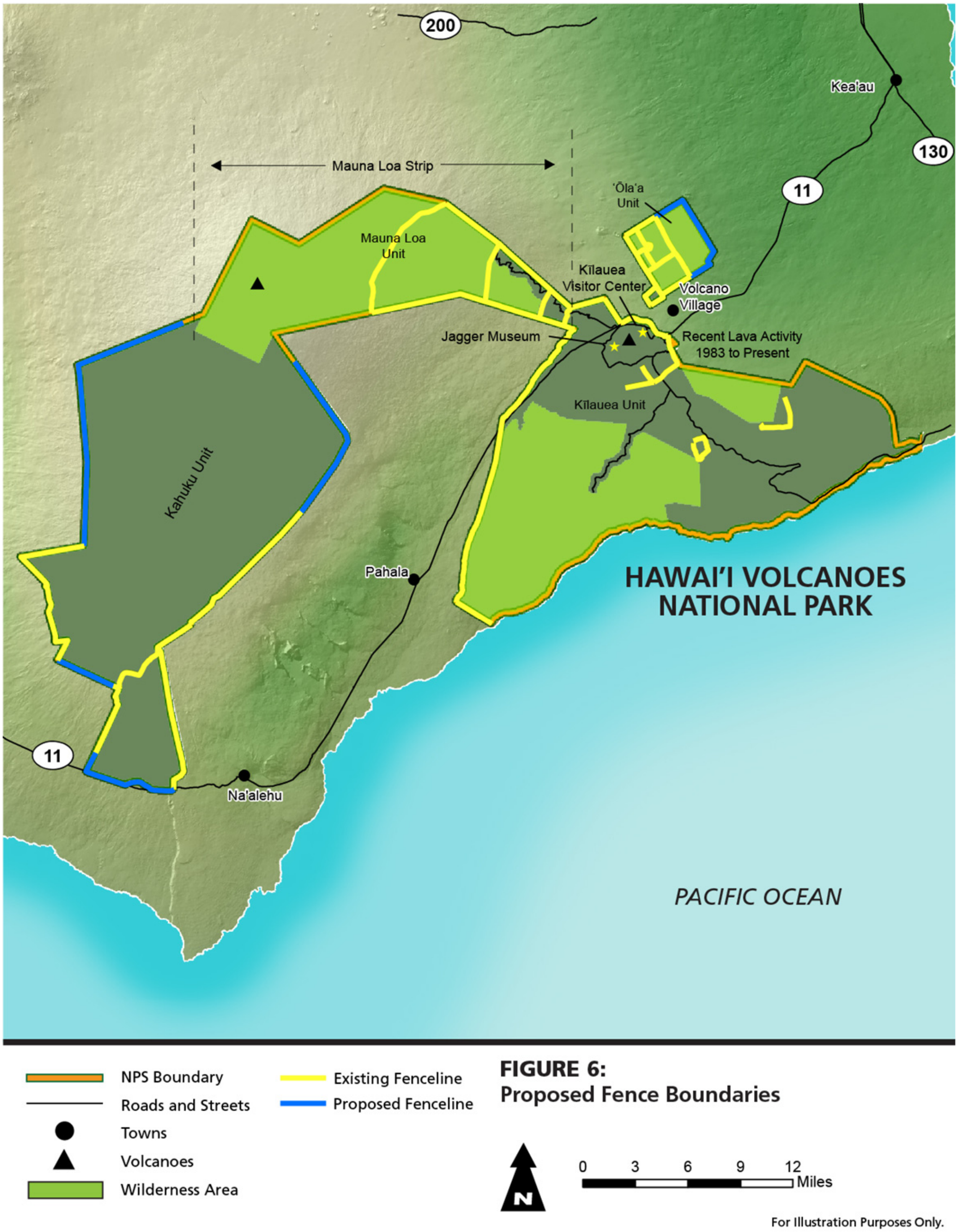


FIGURE 6:
Proposed Fence Boundaries

- Botanical surveys conducted prior to fence corridor clearing would mark all listed and rare plant species in the area, including helicopter staging areas. Fence alignment and helicopter staging areas would be adjusted so that no endangered or rare species observed in the vicinity of the fence line would be affected by the proposed project (at least 15 feet (4.6 meters) away from listed plants per comments received from USFWS). Impacts to native vegetation associated with fence corridor clearing would be limited to a 4-foot corridor. Plant removal would be limited to common understory vegetation, brush, and small trees less than 6 inches in diameter. Vehicles would stay on existing roads and trails. If off-road use is needed, routes would be surveyed and listed plants would be clearly marked with flagging or tape. Park staff familiar with the native plants in the area would supervise workers within fenced units. All listed species along fence construction corridors would be clearly marked with flagging or tape.
- In areas where Hawaiian petrel and Newell's shearwater occur or fly over, to reduce the risk of fence strikes, white vinyl strips, flagging, or similar material would be attached to the top strand of the fence that protrudes above the canopy. In addition to strips on the top strand of the fence, strips would be attached along the middle of the fence where the fence is found on open or sparsely vegetated lava flows. Fence alignment would be adjusted to at least 30 feet (9.1 meters) away from seabird colonies. If improved marking strategies emerge they could be used in place of the current practice. Fence alignment would be adjusted to avoid impacts on seabird colonies.
- All park sanitation protocols for inspecting and cleaning personnel clothing, boots, and gear; project equipment; vehicles; and construction material would be followed to reduce the risk of bringing non-native plants, insects and coqui frogs into the area. For a minimum of 1 year after completion of the project, worksites would be inspected and treated to remove non-native species that may have entered the area.
- In endangered forest bird habitat, fence alignment would be adjusted to avoid cutting large trees. The proposed specifications for vegetation clearing (described above) limits removal to trees less than 6 inches in diameter. This would protect ‘ōhi‘a (*Metrosideros polymorpha*) or koa trees with a diameter of 3 feet (1 meter) or greater, which are preferred nesting habitat for ‘ākepa. To the extent practical, construction activities and helicopter transport of fence materials would be scheduled before or after the peak breeding season for endangered forest birds (February through July). If an endangered forest bird or active nest is detected in or near the project area during construction, the NPS would halt construction activity and not resume until coordination with the USFWS has occurred.
- In Hawaiian hawk habitat, to the extent practical, helicopter transport of fence materials and construction activities would be scheduled before or after the breeding and nesting seasons (March through September). For construction during the breeding season, a nest search of the area proposed for fence corridor construction and surrounding environs would be conducted by the park biologist or a qualified alternate immediately prior to the onset of construction to ensure that no nests are in the vicinity. If an active nest is detected during construction, construction activity would be halted and will not resume until coordination with the USFWS has occurred.
- Trained NPS staff would evaluate helicopter staging areas prior to transport of material to drop sites, and sites may be relocated, if needed, to reduce impacts to nēnē. If nēnē are observed during construction activity along the fence line, appropriate NPS staff would be contacted to evaluate the situation, and the construction would be suspended until the birds move on of their own accord or coordination with the USFWS occurs.
- In order to reduce potential disturbance to Hawaiian hoary bats, no tree (>15-feet tall) removal or trimming would occur when lactating or non-volant bats are present (May through August, ≤5,000-feet in elevation). Additionally, no barbed wire would be used in new fence construction

in order to minimize potential bat entanglement. Where potential entanglement may occur (e.g., in open areas), barbed wire would be removed from existing fences.

- To protect potential host plants and habitat for the picture-wing fly (*Drosophila heteroneura*, *Drosophila mulli*), impacts on native vegetation associated with fence corridor clearing would be limited to a 4-foot corridor. Plant removal would be limited to common understory vegetation, brush, and small trees less than 6 inches in diameter, and avoid removal of important host plants (e.g., *Clermontia* spp., *Cyanea* spp. *Trematlobelia* spp., *Pritchardia* spp.).

In addition, the proposed project would incorporate the following measures to avoid impacts from humans and vehicles when construction or eradication efforts take place in the vicinity of listed plants:

- Vehicles would stay on existing roads and trails. If off-road use is needed, routes would be surveyed and listed plants would be clearly marked with flagging or tape.
- Park staff familiar with the native plants in the area would supervise workers within fenced units.
- All listed species along fence construction corridors would be clearly marked with flagging or tape.

USE OF BEST AVAILABLE SCIENCE

As described in "Elements Common to All Alternatives," the NPS would continue to rely on scientific research to develop and implement effective strategies for non-native ungulate management in the park. As described in the State of Hawai‘i DLNR technical report entitled *Review of Methods and Approach for Control of Non-native Ungulates in Hawai‘i*, non-native ungulate control programs require "an up-to-date evaluation of the full range of tools available, management flexibility in the choice of methods and approach deployed, and an integrated approach that uses multiple methods and approaches" (HDLNR 2007). The Department of Interior Secretarial Order 3305 underscores the need for peer review to ensure the validity of the science used in decision making. Recognizing these needs, the NPS convened a science team, consisting of scientists and technical experts with a background in non-native ungulates that reviewed the efficacy of available management methods including, but not limited to, those considered by the state ("Chapter 5: Consultation and Coordination"). These discussions were considered by the NPS planning team when formulating the action alternatives. In addition, management actions would generally be used as described later in this chapter, but the NPS could explore the potential to expand their use as new information becomes available regarding their effectiveness.

The Department of Interior Secretarial Order 3305 underscores the need for peer review to ensure the validity of the science used in decision making. Recognizing these needs, the NPS convened a science team, consisting of scientists and technical experts with a background in non-native ungulates that reviewed the efficacy of available management methods including, but not limited to, those considered by the state.

FORMAL PARTNERSHIPS

As described in "Elements Common to All Alternatives," the NPS would continue to collaborate with existing partners as well as increase participation in partnerships with neighboring landowners to implement non-native ungulate management actions beneficial to the protection of park resources. Under all action alternatives, the comprehensive plan would provide a framework for communication, coordination and collaborations among park partners and community stakeholders.

ALTERNATIVE A: NO ACTION (CONTINUE EXISTING NON-NATIVE UNGULATE MANAGEMENT ACTIVITIES)

The Council on Environmental Quality (CEQ) requires that the alternatives analyzed in an EIS "include the alternative of no action" (40 CFR 1502.14[d]). The no-action alternative "sets a baseline of existing impact continued into the future against which to compare impacts of action alternatives" (NPS 2001a, Section 2.7). Under alternative A, the NPS would continue current non-native ungulate management practices and not implement any new activities beyond those used when the non-native ungulate management planning process started.

In the older section of the park, the NPS has managed non-native ungulates for decades pursuant to a variety of plans and other management decisions (See "History of Non-native Ungulate Management at Hawai'i Volcanoes National Park" in chapter 1). Although described in different ways, the NPS has for all practical purposes operated with a population-level objective of zero non-native ungulates (or as low as practicable) in the older section of the park. As described under "Elements Common to All Alternatives," with the exception of feral pigs, management actions have essentially eliminated non-native ungulates below 9,000 feet (2,743 meters) in elevation. Feral pigs are excluded from interior fenced units protecting approximately 40,000 acres of subalpine, montane, and selected lowland communities. Under alternative A, the NPS would continue to use lethal management techniques in the older section of the park as described in "Elements Common to All Alternatives" and would conduct monitoring activities similar to those described in appendix C to inform management tool selection. The NPS would continue to repair, retrofit, and install fencing in the older section of the park as described in "Elements Common to All Alternatives."

In the Kahuku Unit, interim actions taken since the acquisition of the unit would continue under alternative A. However, unlike the older section of the park, there would not be an established population-level objective for the unit, although past experience and consideration of current scientific knowledge suggest a practical goal of eliminating non-native ungulates. Under alternative A, the NPS would continue to use lethal management techniques in Kahuku as described in "Elements Common to All Alternatives" and would conduct monitoring activities similar to those described in appendix C to inform management tool selection. Past experience and consideration of current scientific knowledge indicate that boundary fencing would be necessary in the Kahuku Unit to support non-native ungulate management efforts. However, because it is not currently part of any approved management plan for the park, implementation of a comprehensive boundary fence in Kahuku would be uncertain under alternative A.

Under alternative A, the implementation of non-native ungulate management would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities. Because alternative A does not incorporate the comprehensive, systematic approach described in "Elements Common to All Action Alternatives," it would be uncertain whether the NPS would progress through management phases, monitor, and apply management tools consistently as staff and institutional knowledge change over time. The greatest uncertainty would be for Kahuku and areas currently unmanaged (e.g., portions of 'Ōla'a), for which no established population-level objective and fencing strategy has been identified.

MANAGEMENT TOOLS

Under alternative A, available management tools and use would be as described be in "Elements Common to All Alternatives."

QUALIFIED VOLUNTEERS

Under alternative A, qualified volunteers could be used to assist with ground shooting in more accessible areas of Kahuku where animal densities are high. Volunteers would not be used in less accessible areas where individuals are at remnant levels, or if other safety concerns are present.

To be eligible, qualified volunteers would be required to fill out a registration form and meet specific criteria, including

- obtaining a Hunter Education Certificate or card;
- presenting registration of the firearm to be used and a Hawai‘i hunting license;
- providing their own transportation; and
- being able to spend a minimum of 8 hours hiking over rough terrain.

Qualified volunteers would be used to assist with ground shooting approximately once or twice a month. NPS staff would formulate a plan for each removal effort to ensure that control work is done in priority areas and that potential safety concerns and conflicts with other park visitors are addressed. A minimum of one park staff member would be present to directly supervise and escort every two volunteers. Once in the field, park staff would direct volunteers as to which animals should be removed, ensuring that each individual understands the effort is for the purposes of resource management, and not for the experience of a “fair chase.” Volunteers could also assist with spotting and handling the carcasses. NPS staff would collect data consisting of names of volunteers; date, area, and time, of removal activities; and species, sex, age, and herd size of animals removed. Volunteers would be allowed to keep the meat and other parts from any animal they kill (which is inconsistent with current NPS practice).

The primary purpose of volunteer participation would be to increase awareness of non-native ungulate issues and engage the surrounding community and general public in stewardship of park resources. Although volunteers have been used in other activities related to ungulate management (e.g., fence building, monitoring, baiting), based on past volunteer involvement, the majority of volunteer interest would continue to be in participation with ground shooting efforts. Any qualified volunteer who meets the requirements for participation would become part of a pool of available personnel who may supplement NPS management teams. In addition, all qualified volunteers would be directly supervised in the field by NPS personnel during any non-native ungulate management actions.

CARCASS HANDLING AND DISPOSAL

Carcasses would generally be left in place, unless volunteers choose to keep the meat or other parts of the animal. Carcasses may be relocated from kill sites if they are in sensitive areas, such as next to a road, trail or cultural site.

ALTERNATIVE B: COMPREHENSIVE MANAGEMENT PLAN THAT USES LETHAL REMOVAL TECHNIQUES

Under alternative B, the NPS would implement a comprehensive, systematic management plan that would use lethal removal techniques. The population-level objective would be zero, or as low as practicable in managed areas, recognizing the possibility of remnant populations and ingress animals. Management phases, monitoring, conditions of use for management tools, and fencing priorities would be as described in “Elements Common to All Action Alternatives.” Qualified volunteers could be used for certain ground shooting activities and other non-native ungulate management activities.

MANAGEMENT TOOLS

Under alternative B, the NPS would use the management tools described in "Elements Common to All Alternatives." The use of management tools would be as described in that section and in "Considerations for Implementing Management Tools" (table 4).

QUALIFIED VOLUNTEERS

The use of qualified volunteers would be as described for alternative A. However, for consistency with current NPS practice concerning the use of qualified volunteers, they would not be allowed to keep any part of the animal, including the meat. Additionally, the NPS would work to promote increased volunteer engagement in the full spectrum of non-native ungulate management activities open to volunteer participation (e.g., fence construction and maintenance, monitoring, etc.). The primary purpose of the NPS's use of qualified volunteers would be to increase awareness of non-native ungulate issues and engage the surrounding community and general public in stewardship of park resources.

CARCASS HANDLING AND DISPOSAL

As described in "Elements Common to All Alternatives," carcasses of animals would generally be left in place. In addition, the NPS would investigate opportunities to salvage and donate meat when practicable, following all applicable NPS guidelines.

ALTERNATIVE C: COMPREHENSIVE MANAGEMENT PLAN THAT MAXIMIZES EFFICIENCY BY EXPANDING LETHAL REMOVAL TECHNIQUES AND DISCONTINUING THE USE OF VOLUNTEERS

Under alternative C, the NPS would implement a comprehensive, systematic management plan utilizing the most efficient and cost-effective methods of non-native ungulate management. Management techniques would be lethal. The population-level objective would be zero, or as low as practicable in managed areas, recognizing the possibility of remnant populations and ingress animals. Management phases, monitoring, conditions of use for management tools, and fencing priorities would be as described in "Elements Common to All Action Alternatives." Volunteers would not be used in any capacity associated with non-native ungulate management.

MANAGEMENT TOOLS

Under alternative C, the NPS would use the management tools described in "Elements Common to All Alternatives." Alternative C would also expand the application of management tools as described below. Table 4, "Considerations for Implementing Management Tools," summarizes the general conditions that the NPS would consider when determining which tools to use in implementing management actions.

Direct Reduction with Firearms—Ground and Aerial Shooting

Under alternative C, activities associated with ground shooting could be expanded by using bait stations to attract larger groups of non-native ungulates for removal. The park would also consider luring non-native ungulates into larger groups by inducing estrus in captive females. Studies have shown that inducing estrus may increase the efficiency of telemetry devices, as more males would seek out these animals than they would non-estrus females (Campbell et al. 2006). This process would involve trapping a limited number (for example, two) of female animals. Under the guidance of the NPS veterinarian and conducted by the certified park practitioner, these animals would be collared, held in an approximately 1-acre enclosure, sedated, and given estrogen implants. The implant would be injected in the area of the non-native ungulate's ear using a specially designed implantation device. The treated ungulate would be ear tagged or collared to identify the treated animal as a precautionary measure in the event that the ungulate escapes from the enclosure. Once implanted, the females would continuously be in estrus, which would be used as a lure for the male non-native ungulates. When lured, the male non-native ungulates would be lethally removed and the injected females would be collected and used for other removal operations. Each dose of the estrogen implants would last approximately 200 days, after which time the female non-native ungulates would need to be re-injected (Elanco Animal Health 2002). To potentially facilitate removals during aerial shooting, the use of cracker shells (shotgun shells that when discharged make a loud noise to startle animals) to flush animals into open areas, as well as infrared technologies to locate non-native ungulates, could be investigated. Infrared technology could be used with aerial shooting to locate non-native ungulates for lethal removal using devices that remotely detect body heat emitted from the animals. Use of infrared technology would be limited to daybreak because of safety issues associated with night helicopter operations and because there is a very narrow window before the ground heats up and heat from other sources (e.g., warm rocks) begins to confuse the infrared signals.

Snaring

Snaring could be expanded by using other types of snares for additional non-native ungulate species wherever effective and safe. The NPS would also explore using snares in combination with telemetry devices that would alert park staff when snares have been tripped.

Baiting and Trapping

The NPS would investigate the expanded use of baiting and trapping for lethal removal of sheep and axis deer (if they are discovered in the park) in addition to pigs, mouflon sheep, and feral cattle.

QUALIFIED VOLUNTEERS

Under alternative C, qualified volunteers would not be used for any non-native ungulate management activities, including but not limited to, non-native ungulate monitoring, lethal and non-lethal removal actions, and fencing. Elimination of the use of qualified volunteers would be aimed at increasing efficiency of management actions. NPS use of volunteers for non-native ungulate management activities requires additional NPS staff time for program administration, recruitment, training, and directing field efforts. Additionally, data indicate that NPS staff are more efficient at conducting lethal removal activities than volunteers. For example, data from the NPS and USGS (Stephens et al. 2008) show that NPS staff participants in the closely directed volunteer program at Kahuku were more efficient at removing mouflon sheep (5.2 per day) than qualified volunteers (4.6 per day) between March 2004 and February 2007, despite the fact that the volunteers had the advantage of taking the first shot. The greater efficiency of NPS staff is further demonstrated by a comparison of a staff-only removal effort in July 2009 (70 non-native ungulates removed in 1 day) versus a staff/volunteer effort conducted in September 2009 (47 non-native ungulates removed in 1 day). Based on past participation, discontinuing the use of volunteers in other activities related to ungulate management (fence building, monitoring, baiting) would not noticeably affect the ungulate program, as volunteer interest in these activities has been infrequent and focused on the more accessible areas of the park, which limits the efficiency gained by using volunteers.

CARCASS HANDLING AND DISPOSAL

As described in "Elements Common to All Alternatives," carcasses of animals would generally be left in place.

ALTERNATIVE D: COMPREHENSIVE MANAGEMENT PLAN THAT MAXIMIZES FLEXIBILITY OF MANAGEMENT TECHNIQUES

Under alternative D, the NPS would implement a comprehensive, systematic management plan providing maximum management flexibility. Management tools would rely primarily on lethal techniques, but non-lethal techniques such as relocation could also be considered. The population-level objective would be zero, or as low as practicable in managed areas, recognizing the possibility of remnant populations and ingress animals. Management phases, monitoring, conditions of use for management tools, and fencing priorities would be as described in “Elements Common to All Action Alternatives.” Qualified volunteers could be used for ground shooting and other non-native ungulate management activities.

MANAGEMENT TOOLS

Under alternative D, the NPS would rely primarily on management tools as described for alternative C. Additionally, the NPS could use non-lethal management tools as described below. “Table 4: Considerations for Implementing Management Tools,” summarizes the general conditions that the NPS would consider when determining which tools to use in implementing management actions.

Relocation

The NPS would investigate the possibility of relocating non-native ungulates, such as feral sheep, mouflon sheep and pigs, to other lands (in addition to domestic cattle being returned to ranchers). This could occur through one of two ways:

- Driving the non-native ungulates onto adjacent lands
- Capturing non-native ungulates using telemetry and traps, or non-lethal snares, and transporting them to another location

All potential relocation activities would require willing recipients and would be carried out in close cooperation with the state. When considering areas to relocate animals, the NPS would avoid sites where undesirable impacts to the environment could occur (e.g., rare native plants and animals, critical habitat, soils, cultural resources etc.). Any necessary permissions and permits would be obtained prior to relocation activities. Prior to transporting animals to other locations, any necessary disease testing required by the state would be conducted.

Relocation to adjacent lands would include the use of a helicopter, with a few staff on the ground, to drive the non-native ungulates along the boundary fence line to a temporary “wing” fence. The wing fence would open and lead the animals into a holding pen. From the holding pen, the non-native ungulates would be transferred to adjacent lands. These operations would last less than a day, usually only a few hours at a time. Where caught close to roads, animals could also be transported by vehicle to nearby locations.

QUALIFIED VOLUNTEERS

The use of qualified volunteers would be as described for alternative B. In addition, qualified volunteers could be used for ground shooting activities in additional management phases and areas where safe and practicable.

CARCASS HANDLING AND DISPOSAL

Carcass handling and disposal would be as described for alternative B.

ALTERNATIVE E: COMPREHENSIVE MANAGEMENT PLAN THAT INCREASES OF MANAGEMENT TECHNIQUES WHILE LIMITING THE USE OF VOLUNTEERS

Under alternative E, the NPS would implement a comprehensive, systematic management plan that relies primarily on lethal techniques, but also considers non-lethal techniques such as relocation as described under alternative D. The population-level objective would be zero, or as low as practicable in managed areas, recognizing the possibility of remnant populations and ingress animals. Management phases, monitoring, conditions of use for management tools, and fencing priorities would be as described in "Elements Common to All Action Alternatives." To provide a full range of alternatives, qualified volunteers would not be used for ground shooting activities. Volunteers could be used for other non-native ungulate management activities.

MANAGEMENT TOOLS

Under alternative E, the NPS would use management tools as described for alternative D. "Table 4: Considerations for Implementing Management Tools," summarizes the general conditions that the NPS would consider when determining which tools to use in implementing management actions.

QUALIFIED VOLUNTEERS

The use of qualified volunteers would be as described for alternative B, except that volunteers would not be used for any ground shooting activities.

CARCASS HANDLING AND DISPOSAL

Carcass handling and disposal would be as described for alternative B.

HOW ALTERNATIVES MEET OBJECTIVES

As stated in chapter 1, all action alternatives (B–E) selected for analysis must meet all objectives to a large degree. The action alternatives must also address the stated purpose of taking action and resolve the need for action; therefore, the alternatives were individually assessed in light of how well they would meet the objectives of this plan/EIS, which are stated in "Chapter 1: Purpose of and Need for Action." This process is the foundation for determining the agency-preferred alternative. Alternatives that did not meet the objectives were not analyzed further (see the "Alternatives Eliminated from Further Consideration" section in this chapter).

Table 5 compares how each of the alternatives described in this chapter would meet the plan objectives. Table 6 summarizes the effects of each alternative on each impact topic, as described in "Chapter 4: Environmental Consequences."

TABLE 5: HOW ALTERNATIVES MEET OBJECTIVES

Objective	Alternative A: No Action (Continue Existing Non-native Ungulate Management Activities)	Alternative B: Comprehensive Management Plan that Uses Lethal Removal Techniques	Alternative C: Comprehensive Management Plan that Maximizes Efficiency by Expanding Lethal Removal Techniques and Discontinuing the Use of Volunteers	Alternative D: Comprehensive Management Plan that Maximizes Flexibility of Management Techniques	Alternative E: Comprehensive Management Plan that Increases Flexibility of Management Techniques While Limiting the Use of Volunteers
Management Methodology					
Develop informed, scientifically based methods for management of non-native ungulate populations to allow for the protection and recovery of park resources.	There would be no comprehensive parkwide plan to guide management over the next 25 years in a way that would ensure that informed, science-based methods would continue to be implemented.	Management actions were developed considering input from a science team. A comprehensive, systematic plan provides for continuous monitoring of the results of management actions and adjustments of management actions as needed, ensuring implementation of informed, science-based methods over time.	Same as alternative B.	Same as alternative B.	Same as alternative B.
Vegetation					
Protect native plant communities and assist with their natural recovery from impacts of non-native ungulates.	In existing fenced units, desired conditions for vegetation would result from the continuation of animal exclusion. Potential for reaching desired conditions would be unlikely for areas currently unmanaged (e.g., portions of ʻŌlaʻa and Kahuku), where no established population-level objective or fencing strategy has been identified in a comprehensive and systematic plan. Also there would be less likelihood that the NPS would progress through management phases, monitor, and apply management tools consistently as staff and institutional knowledge change over time.	Population objectives and fencing strategy identified in a comprehensive, systematic management plan would provide greater certainty that desired conditions would be achieved and that non-native ungulate management would protect and assist with the natural recovery of native plant communities.	Same as alternative B, plus: Potential for reaching desired conditions sooner by relying exclusively on lethal removals conducted by NPS and other professionals.	Same as alternative B, except: Use of volunteers for ground shooting in additional areas and use of relocation could reduce efficiency and delay achieving desired conditions.	Same as alternative B, except: Use of relocation could reduce efficiency and delay achieving desired conditions.
Provide desirable conditions for active restoration of native plant communities degraded by non-native ungulate activity to a native state.	In existing fenced units, management actions would continue to help provide opportunities for active restoration of native plant communities. However, lack of a comprehensive, systematic plan would reduce the likelihood that actions would be applied consistently and achieve the conditions necessary to support such efforts parkwide over time.	Population objectives and fencing strategy identified in a comprehensive, systematic management plan would provide greater certainty that desired conditions would be achieved and that non-native ungulate management would provide opportunities for active restoration of native plant communities.	Same as alternative B, plus: Potential for reaching desired conditions sooner by relying exclusively on lethal removals conducted by NPS and other professionals.	Same as alternative B, except: Use of volunteers for ground shooting in additional areas and use of relocation could reduce efficiency and delay achieving desired conditions.	Same as alternative B, except: Use of relocation could reduce efficiency and delay achieving desired conditions.
Native Wildlife and Wildlife Habitat					
Protect native wildlife and wildlife habitat and assist with their natural recovery from impacts of non-native ungulates.	In existing fenced units, management actions would continue to help protect native wildlife and wildlife habitat and provide opportunities for natural recovery. Potential for reaching desired conditions would be unlikely for areas currently unmanaged (e.g., portions of ʻŌlaʻa and Kahuku), where no established population-level objective or fencing strategy has been identified. The lack of a comprehensive, systematic plan would reduce the likelihood that actions would be applied consistently and support natural recovery parkwide over time.	Population objectives and fencing strategy identified in a comprehensive, systematic management plan would provide greater certainty that desired conditions would be achieved and that non-native ungulate management would protect and assist with the natural recovery of native wildlife and wildlife habitat.	Same as alternative B, plus: Potential for reaching desired conditions sooner by relying exclusively on lethal removals conducted by NPS and other professionals.	Same as alternative B, except: Use of volunteers for ground shooting in additional areas and use of relocation could reduce efficiency and delay achieving desired conditions.	Same as alternative B, except: Use of relocation could reduce efficiency and delay achieving desired conditions.

Objective	Alternative A: No Action (Continue Existing Non-native Ungulate Management Activities)	Alternative B: Comprehensive Management Plan that Uses Lethal Removal Techniques	Alternative C: Comprehensive Management Plan that Maximizes Efficiency by Expanding Lethal Removal Techniques and Discontinuing the Use of Volunteers	Alternative D: Comprehensive Management Plan that Maximizes Flexibility of Management Techniques	Alternative E: Comprehensive Management Plan that Increases Flexibility of Management Techniques While Limiting the Use of Volunteers
Rare, Unique, Threatened, or Endangered Species					
Protect endangered, threatened, and rare plant and animal species and assist with their recovery from impacts of non-native ungulates.	In existing fenced units, management actions would continue to help protect endangered, threatened, and rare plant and animal species, while providing opportunities for both natural and active recovery. Potential for reaching desired conditions would be unlikely for areas currently unmanaged (e.g., portions of ʻŌlaʻa and Kahuku), where no established population-level objective or fencing strategy has been identified. The lack of a comprehensive, systematic plan would reduce the likelihood that actions would be applied consistently and support recovery parkwide over time.	Population objectives and fencing strategy identified in a comprehensive, systematic management plan would provide greater certainty that desired conditions would be achieved and that non-native ungulate management would protect and assist with the recovery of endangered, threatened, and rare plant and animal species.	Same as alternative B, plus: Potential for reaching desired conditions sooner by relying exclusively on lethal removals conducted by NPS and other professionals.	Same as alternative B, except: Use of volunteers for ground shooting in additional areas and use of relocation could reduce efficiency and delay achieving desired conditions.	Same as alternative B, except: Use of relocation could reduce efficiency and delay achieving desired conditions.
Cultural/Historic Resources					
Prevent impacts on archeological resources, historic structures, cultural landscapes, and ethnographic resources from non-native ungulate activity and management.	In existing fenced units, management actions would continue to help prevent impacts on cultural resources from non-native ungulate activity. However, lack of a comprehensive, systematic plan would reduce the likelihood that actions would be applied consistently and prevent impacts parkwide over time.	Population objectives and fencing strategy identified in a comprehensive, systematic management plan would provide greater certainty that actions would continue to be implemented in a manner that would reduce the potential for adverse impacts on cultural resources and that desired conditions necessary to protect these resources would be achieved.	Same as alternative B, plus: Potential for reaching desired conditions sooner by relying exclusively on lethal removals conducted by NPS and other professionals.	Same as alternative B, except: Use of volunteers for ground shooting in additional areas and use of relocation could reduce efficiency and delay achieving desired conditions.	Same as alternative B, except: Use of relocation could reduce efficiency and delay achieving desired conditions.
Wilderness					
Restore natural conditions and perpetuate natural processes in wilderness (including areas managed for wilderness values).	In existing fenced units, management actions would continue to help restore natural conditions and perpetuate natural processes in wilderness. However, lack of a comprehensive, systematic plan would reduce the likelihood that actions would be applied consistently and support restoration over time.	Population objectives and fencing strategy identified in a comprehensive, systematic management plan would provide greater certainty that desired conditions would be achieved and that non-native ungulate management would help restore natural conditions and perpetuate natural processes in wilderness.	Same as alternative B, plus: Potential for reaching desired conditions sooner by relying exclusively on lethal removals conducted by NPS and other professionals.	Same as alternative B, except: Use of volunteers for ground shooting in additional areas and use of relocation could reduce efficiency and delay achieving desired conditions.	Same as alternative B, except: Use of relocation could reduce efficiency and delay achieving desired conditions.
Limit the impacts of non-native ungulate management actions needed to protect wilderness resources and values through the use of the minimum requirements/tools decision process.	Existing analysis of minimum tools would continue to be done on a case-by-case basis (primarily for fencing), but not as part of a comprehensive, systematic plan.	A comprehensive, systematic evaluation for all non-native ungulate management actions would ensure that minimum tools are used to meet the minimum requirements for managing wilderness at the park.	Same as alternative B.	Same as alternative B.	Same as alternative B.
Soils					
Minimize impacts on soils through increased soil erosion and disturbance caused by non-native ungulates	In existing fenced units, management actions would continue to help minimize soil erosion and disturbance. However, lack of a comprehensive, systematic plan would reduce the likelihood that actions would be applied consistently and minimize impacts parkwide over time.	Population objectives and fencing strategy identified in a comprehensive, systematic management plan would provide greater certainty that desired conditions would be achieved and that soil erosion and disturbance would be minimized.	Same as alternative B, plus: Potential for reaching desired conditions sooner by relying exclusively on lethal removals conducted by NPS and other professionals.	Same as alternative B, except: Use of volunteers for ground shooting in additional areas and use of relocation could reduce efficiency and delay achieving desired conditions.	Same as alternative B, except: Use of relocation could reduce efficiency and delay achieving desired conditions.

Objective	Alternative A: No Action (Continue Existing Non-native Ungulate Management Activities)	Alternative B: Comprehensive Management Plan that Uses Lethal Removal Techniques	Alternative C: Comprehensive Management Plan that Maximizes Efficiency by Expanding Lethal Removal Techniques and Discontinuing the Use of Volunteers	Alternative D: Comprehensive Management Plan that Maximizes Flexibility of Management Techniques	Alternative E: Comprehensive Management Plan that Increases Flexibility of Management Techniques While Limiting the Use of Volunteers
Visitor Use and Experience					
Provide visitors with the opportunity to experience native ecosystems and cultural resources that are protected from the impacts of non-native ungulates.	In existing fenced units, management actions would continue to help provide visitors with the opportunity to experience native ecosystems and cultural resources that are protected from the impacts of non-native ungulates. However, lack of a comprehensive, systematic plan would reduce the likelihood that actions would be applied consistently and support the objective parkwide over time.	Population objectives and fencing strategy identified in a comprehensive, systematic management plan would provide greater certainty that visitors would experience native ecosystems and cultural resources that are protected from the impacts of non-native ungulates.	Same as alternative B, plus: Potential for reaching desired conditions sooner by relying exclusively on lethal removals conducted by NPS and other professionals.	Same as alternative B, except: Use of volunteers for ground shooting in additional areas and use of relocation could reduce efficiency and delay achieving desired conditions.	Same as alternative B, except: Use of relocation could reduce efficiency and delay achieving desired conditions.
Enhance visitor awareness and understanding of non-native ungulate management actions and why they are necessary for the protection of park resources.	Existing interpretive programs would enhance visitor awareness and understanding of non-native ungulate management actions and why they are necessary for the protection of park resources, but not as part of a comprehensive, systematic plan.	A comprehensive, systematic management plan would provide a framework for the development of interpretive programs aimed at enhancing visitor awareness and understanding of non-native ungulate management actions and why they are necessary for the protection of park resources.	Same as alternative B.	Same as alternative B.	Same as alternative B.
Minimize limitations to visitor access as a result of non-native ungulate management activities.	Management actions as currently implemented would minimize impacts on visitor access, but not as part of comprehensive, systematic plan.	A comprehensive, systematic management plan would provide greater certainty that the reduction phase would be completed sooner, which would minimize closures that affect visitor access.	Same as alternative B, plus: Potential for completing the reduction phase sooner by relying exclusively on lethal removals conducted by NPS and other professionals, which would minimize closures that affect visitor access.	Same as alternative B, except: Use of volunteers for ground shooting in additional areas and use of relocation could reduce efficiency and prolong the reduction phase, requiring more closures.	Same as alternative B, except: Use of relocation could reduce efficiency and prolong reduction actions, requiring more closures.
Park Management and Operations					
Minimize long-term impacts, in terms of reduced staff time and resources, to programs at the park caused by continued monitoring and management of non-native ungulates.	There would be no comprehensive, systematic plan to guide non-native ungulate management parkwide over the next 25 years in a way that would minimize impacts on park management and operations.	A comprehensive, systematic management plan would provide greater certainty that the more intensive reduction phase would be completed sooner, minimizing long-term impacts on park management and operations. Administration of the volunteer program would require additional oversight, which would contribute to long-term impacts on park management and operations.	Same as alternative B, plus: Potential for completing the reduction phase sooner by relying exclusively on lethal removals conducted by NPS and other professionals, which would minimize long-term impacts on park management and operations.	Same as alternative B, except: Use of volunteers for ground shooting in additional areas and use of relocation could reduce efficiency and prolong long-term impacts on park management and operations.	Same as alternative B, except: Use of relocation could reduce efficiency and prolong long-term impacts on park management and operations.
Coordination and Outreach					
Coordinate with neighboring land managers implementing non-native ungulate management actions beneficial to the protection of park resources.	Existing communication, coordination efforts, and partnerships would enhance protection of park resources, but not as part of a comprehensive, systematic plan.	A comprehensive, systematic management plan would provide a framework for communication, coordination, and collaboration among partners that would benefit protection of park resources.	Same as alternative B.	Same as alternative B.	Same as alternative B.
Coordinate with other stakeholders regarding non-native ungulate management and the protection of park resources.	Existing communication and coordination efforts with other stakeholders would continue, but not as part of a comprehensive, systematic plan.	A comprehensive, systematic management plan would provide a framework for communication and coordination with other stakeholders.	Same as alternative B, except: Eliminating the use of volunteers for non-native ungulate management would decrease opportunities for stakeholder participation.	Same as alternative B.	Same as alternative B, except: Eliminating the use of volunteers for ground shooting activities would decrease opportunities for stakeholder participation.

Objective	Alternative A: No Action (Continue Existing Non-native Ungulate Management Activities)	Alternative B: Comprehensive Management Plan that Uses Lethal Removal Techniques	Alternative C: Comprehensive Management Plan that Maximizes Efficiency by Expanding Lethal Removal Techniques and Discontinuing the Use of Volunteers	Alternative D: Comprehensive Management Plan that Maximizes Flexibility of Management Techniques	Alternative E: Comprehensive Management Plan that Increases Flexibility of Management Techniques While Limiting the Use of Volunteers
Enhance public awareness and understanding of the impacts of non-native ungulates and the need for management to protect and restore park resources.	Existing interpretive and outreach programs would continue to enhance public awareness and understanding of non-native ungulate management actions and why they are necessary for the protection of park resources. Use of volunteers would also provide additional opportunities for enhancing public awareness. However, these efforts would not be part of a comprehensive, systematic plan.	A comprehensive, systematic management plan would provide the framework for interpretive and outreach programs that would enhance public awareness and understanding of non-native ungulate management actions and why they are necessary for the protection of park resources. Use of volunteers would provide additional opportunities for enhancing public awareness.	Same as alternative B, except: Eliminating the use of volunteers would decrease opportunities for enhancing public awareness through participation in non-native ungulate management.	Same as alternative B.	Same as alternative B, except: Eliminating the use of volunteers for ground shooting activities would decrease opportunities for stakeholder participation.

TABLE 6: SUMMARY OF ENVIRONMENTAL CONSEQUENCES

	Alternative A: No Action (Continue Existing Non-native Ungulate Management Activities)	Alternative B: Comprehensive Management Plan that Uses Lethal Removal Techniques	Alternative C: Comprehensive Management Plan that Maximizes Efficiency by Expanding Lethal Removal Techniques and Discontinuing the Use of Volunteers	Alternative D: Comprehensive Management Plan that Maximizes Flexibility of Management Techniques	Alternative E: Comprehensive Management Plan that Increases Flexibility of Management Techniques While Limiting the Use of Volunteers
Vegetation	Under alternative A, short- and long-term negligible to minor adverse impacts would result from the implementation of ground-based management actions. In areas of the park already considered ungulate free, alternative A would produce negligible adverse impacts because the frequency and duration of management actions in these areas would be minimal; and long-term beneficial impacts on vegetation would result from the continuation of animal exclusion. Long-term beneficial impacts would be unlikely for Kahuku and areas currently unmanaged (e.g., portions of ʻŌlaʻa), where no established population-level objective or fencing strategy has been identified in a comprehensive and systematic plan. The effects of alternative A, when combined with impacts of past, present, and reasonably foreseeable future actions on vegetation, would have short- and long-term minor to moderate adverse cumulative impacts on vegetation. Long-term beneficial cumulative impacts would be less certain under alternative A, because implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.	Under alternative B, short- and long-term negligible to minor adverse impacts on vegetation would result from the implementation of ground-based management actions. In areas of the park already managed for ungulates, alternative B would produce negligible adverse impacts because the frequency and duration of management actions in these areas would be minimal. Long-term beneficial impacts to vegetation would be fully realized under this alternative because the comprehensive, systematic approach described in chapter 2, “Elements Common to All Action Alternatives,” would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time. The effects of alternative B, when combined with impacts of past, present, and reasonably foreseeable future actions on vegetation, would have short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts.	Same as alternative B, plus: Potential for reaching desired conditions sooner by relying exclusively on lethal removals conducted by NPS and other professionals.	Same as alternative B, except: Use of volunteers for ground shooting in additional areas and use of relocation could reduce efficiency and delay achieving desired conditions.	Same as alternative B, except: Use of relocation could reduce efficiency and delay achieving desired conditions.
Native Wildlife and Wildlife Habitat	Under alternative A, short-term minor to moderate adverse impacts would result from the implementation of monitoring and management actions. In the older section of the park, long-term beneficial impacts to native wildlife and wildlife habitat would result from the continuation of animal exclusion in managed units. However, long-term beneficial impacts to native wildlife and wildlife habitat would be unlikely for areas currently unmanaged (e.g., portions of Kahuku and ʻŌlaʻa), for which no established population-level objective and fencing strategy has been identified. The effects of alternative A, when combined with impacts of past, present, and reasonably foreseeable future actions on native wildlife and wildlife habitat, would have short- and long-term minor to moderate adverse cumulative impacts on vegetation. Long-term beneficial cumulative impacts would be less likely under alternative A, because implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.	Under alternative B, short-term minor to moderate adverse impacts would result from the implementation of monitoring and management actions. Long-term beneficial impacts to native wildlife and wildlife habitat would be fully realized under this alternative because the comprehensive, systematic approach described in chapter 2, “Elements Common to All Action Alternatives,” would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time. The effects of alternative B, when combined with impacts of past, present, and reasonably foreseeable future actions on wildlife and wildlife habitat, would have short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts.	Same as alternative B, plus: Potential for reaching desired conditions sooner by relying exclusively on lethal removals conducted by NPS and other professionals.	Same as alternative B, except: Use of volunteers for ground shooting in additional areas and use of relocation could reduce efficiency and delay achieving desired conditions.	Same as alternative B, except: Use of relocation could reduce efficiency and delay achieving desired conditions.

	Alternative A: No Action (Continue Existing Non-native Ungulate Management Activities)	Alternative B: Comprehensive Management Plan that Uses Lethal Removal Techniques	Alternative C: Comprehensive Management Plan that Maximizes Efficiency by Expanding Lethal Removal Techniques and Discontinuing the Use of Volunteers	Alternative D: Comprehensive Management Plan that Maximizes Flexibility of Management Techniques	Alternative E: Comprehensive Management Plan that Increases Flexibility of Management Techniques While Limiting the Use of Volunteers
Rare, Unique, Threatened, or Endangered Species	Under alternative A, short-term minor to moderate, and long-term minor adverse impacts on rare, unique, threatened, or endangered species and their habitat would result from the implementation of non-native ungulate management actions. In the older section of the park, long-term beneficial impacts would result from the continuation of animal exclusion in managed units, with moderate to major beneficial impacts on federally listed species. However, long-term beneficial impacts would be unlikely for Kahuku and areas currently unmanaged (e.g., portions of ‘Ōla‘a), for which no established population-level objective and fencing strategy has been identified. The effects of alternative A, when combined with impacts of past, present, and reasonably foreseeable future actions on rare, unique, threatened, or endangered species, would have short- and long-term minor to moderate adverse cumulative impacts on vegetation. Long-term beneficial cumulative impacts, including moderate to major beneficial impacts on federally listed species, would be less likely under alternative A, because management would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities and implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.	Under alternative B, short-term minor to moderate, and long-term minor adverse impacts on rare, unique, threatened, or endangered species and their habitat would result from the implementation of monitoring and management actions. Long-term beneficial impacts would be fully realized under this alternative, with moderate to major beneficial impacts on federally listed species because the comprehensive, systematic approach described in chapter 2, “Elements Common to All Action Alternatives,” would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time. The effects of alternative B, when combined with impacts of past, present, and reasonably foreseeable future actions, would have short- to long-term minor to moderate adverse and long-term beneficial and cumulative impacts, with moderate to major beneficial cumulative impacts on federally listed species.	Same as alternative B, plus: Potential for reaching desired conditions sooner by relying exclusively on lethal removals conducted by NPS and other professionals.	Same as alternative B, except: Use of volunteers for ground shooting in additional areas and use of relocation could reduce efficiency and delay achieving desired conditions.	Same as alternative B, except: Use of relocation could reduce efficiency and delay achieving desired conditions.
Cultural/Historic Resources: Archeological Resources	Under alternative A, long-term negligible to minor adverse impacts on archeological sites and associated viewsheds would result from the implementation of management actions. In the older section of the park, long-term minor to moderate beneficial impacts would result from the continuation of animal exclusion in managed units. However, long-term benefits would be unlikely for Kahuku and areas currently unmanaged (e.g., portions of ‘Ōla‘a), for which no established population-level objective and fencing strategy has been identified in a comprehensive and systematic plan. The effects of alternative A, when combined with impacts of past, present, and reasonably foreseeable future actions on archeological resources, would have long-term minor to moderate adverse cumulative impacts on archeological resources. Long-term beneficial cumulative impacts would be less likely under alternative A, because implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.	Under alternative B, long-term negligible to minor adverse impacts on archeological sites and associated viewsheds would result from the implementation of management actions. Long-term minor to moderate beneficial impacts to archeological resources would be fully realized under this alternative because the comprehensive, systematic approach described in chapter 2, “Elements Common to All Action Alternatives,” would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time. The effects of alternative B, when combined with impacts of past, present, and reasonably foreseeable future actions on archeological resources, would have long-term minor to moderate adverse and long-term moderate beneficial cumulative impacts.	Same as alternative B, plus: Potential for reaching desired conditions sooner by relying exclusively on lethal removals conducted by NPS and other professionals.	Same as alternative B, except: Use of volunteers for ground shooting in additional areas and use of relocation could reduce efficiency and delay achieving desired conditions.	Same as alternative B, except: Use of relocation could reduce efficiency and delay achieving desired conditions.

	Alternative A: No Action (Continue Existing Non-native Ungulate Management Activities)	Alternative B: Comprehensive Management Plan that Uses Lethal Removal Techniques	Alternative C: Comprehensive Management Plan that Maximizes Efficiency by Expanding Lethal Removal Techniques and Discontinuing the Use of Volunteers	Alternative D: Comprehensive Management Plan that Maximizes Flexibility of Management Techniques	Alternative E: Comprehensive Management Plan that Increases Flexibility of Management Techniques While Limiting the Use of Volunteers
Cultural/Historic Resources: Cultural Landscapes	Under alternative A, long-term minor adverse impacts on cultural landscapes would result from implementation of management actions. Designed landscapes would be less impacted than either historic vernacular landscapes or ethnographic landscapes. In the older section of the park, long-term minor beneficial impacts on cultural landscapes would result from the continuation of animal exclusion in managed units. However, long-term benefits would be unlikely for cultural landscapes still inhabited by non-native ungulates, for which no established population-level objective and fencing strategy has been identified in a comprehensive and systematic plan. The effects of alternative A, when combined with impacts of past, present, and reasonably foreseeable future actions on cultural landscapes, would have long-term minor adverse cumulative impacts on cultural resources. Long-term beneficial cumulative impacts would be less certain under alternative A, because implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.	Under alternative B, long-term minor adverse impacts to cultural landscapes would result from the implementation of management actions. Designed landscapes would be less impacted than either historic vernacular landscapes or ethnographic landscapes. Long-term minor beneficial impacts to cultural landscapes would be fully realized under this alternative because the comprehensive, systematic approach described in chapter 2, "Elements Common to All Action Alternatives," would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time. The effects of alternative B, when combined with impacts of past, present, and reasonably foreseeable future actions on cultural landscapes, would have long-term minor adverse and long-term minor beneficial cumulative impacts.	Same as alternative B, plus: Potential for reaching desired conditions sooner by relying exclusively on lethal removals conducted by NPS and other professionals.	Same as alternative B, except: Use of volunteers for ground shooting in additional areas and use of relocation could reduce efficiency and delay achieving desired conditions.	Same as alternative B, except: Use of relocation could reduce efficiency and delay achieving desired conditions.
Cultural/Historic Resources: Ethnographic Resources	Under alternative A, short-term minor adverse impacts on ethnographic resources would result from the implementation of management actions. In the older section of the park, long-term moderate to major beneficial impacts would result from the continuation of animal exclusion in managed units. However, long-term beneficial impacts would be unlikely for Kahuku and areas currently unmanaged (e.g., portions of ʻŌlaʻa), for which no established population-level objective and fencing strategy has been identified in a comprehensive and systematic plan. The effects of alternative A, when combined with impacts of past, present, and reasonably foreseeable future actions on ethnographic resources, would have short- and long-term minor adverse cumulative impacts. Long-term beneficial cumulative impacts would be less likely under alternative A, because implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.	Under alternative B, short-term minor adverse impacts on ethnographic resources would result from the implementation of management actions. Long-term moderate to major beneficial impacts would be fully realized under this alternative because the comprehensive, systematic approach described in chapter 2, "Elements Common to All Action Alternatives," would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time. The effects of alternative B, when combined with impacts of past, present, and reasonably foreseeable future actions on ethnographic resources, would have short- and long-term minor adverse and long-term moderate to major beneficial cumulative impacts.	Same as alternative B, plus: Potential for reaching desired conditions sooner by relying exclusively on lethal removals conducted by NPS and other professionals.	Same as alternative B, except: Use of volunteers for ground shooting in additional areas and use of relocation could reduce efficiency and delay achieving desired conditions.	Same as alternative B, except: Use of relocation could reduce efficiency and delay achieving desired conditions.

	Alternative A: No Action (Continue Existing Non-native Ungulate Management Activities)	Alternative B: Comprehensive Management Plan that Uses Lethal Removal Techniques	Alternative C: Comprehensive Management Plan that Maximizes Efficiency by Expanding Lethal Removal Techniques and Discontinuing the Use of Volunteers	Alternative D: Comprehensive Management Plan that Maximizes Flexibility of Management Techniques	Alternative E: Comprehensive Management Plan that Increases Flexibility of Management Techniques While Limiting the Use of Volunteers
Wilderness	Under alternative A, short- and long-term minor to moderate adverse impacts to wilderness would result from fences, helicopter work and ground activities related to removal efforts and fence construction and maintenance. In the older section of the park, long-term beneficial impacts on wilderness through the recovery of natural conditions would result from the continuation of animal exclusion in managed units. Long-term beneficial impacts would be unlikely for the Kahuku unit and areas currently unmanaged (e.g., portions of ‘Ōla‘a), where no established population-level objective or fencing strategy has been identified in a comprehensive and systematic plan. The effects of alternative A, when combined with impacts of past, present, and reasonably foreseeable future actions on wilderness, would have short- and long-term minor to moderate adverse cumulative impacts. Long-term beneficial cumulative impacts would be less likely under alternative A, because non-native ungulate management would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities and implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.	Under alternative B, short- and long-term minor to moderate impacts on wilderness would result from fences, helicopter work and ground activities related to removal efforts and fence construction and maintenance. Long-term beneficial impacts to wilderness would be fully realized under this alternative because the comprehensive, systematic approach described in “Elements Common to All Action Alternatives” would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time. The effects of alternative B, when combined with impacts of past, present, and reasonably foreseeable future actions on wilderness, would have sort- and long-term minor to moderate adverse and long-term beneficial cumulative impacts.	Same as alternative B, plus: Potential for reaching desired conditions sooner by relying exclusively on lethal removals conducted by NPS and other professionals.	Same as alternative B, except: Use of volunteers for ground shooting in additional areas and use of relocation could reduce efficiency and delay achieving desired conditions.	Same as alternative B, except: Use of relocation could reduce efficiency and delay achieving desired conditions.
Soils	Under alternative A, short-term, localized negligible adverse impacts to soils would result from ground-based management actions. In the older section of the park, long-term beneficial impacts on soil would result from the continuation of animal exclusion in current management units. Long-term beneficial impacts would be unlikely for Kahuku and portions of ‘Ōla‘a, where no established population-level objective or fencing strategy has been identified in a comprehensive and systematic plan. The effects of alternative A, when combined with impacts of past, present, and reasonably foreseeable future actions on soil, would have short- and long-term minor to moderate adverse cumulative impacts. Long-term beneficial cumulative impacts would be less likely under alternative A, because implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.	Under alternative B, short-term, localized negligible adverse impacts to soils would result from ground-based management actions. Long-term beneficial impacts to soils would be fully realized under this alternative because the comprehensive, systematic approach described in “Elements Common to All Action Alternatives” would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time. The effects of alternative B, when combined with impacts of past, present, and reasonably foreseeable future actions on soil, would have short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts.	Same as alternative B, plus: Potential for reaching desired conditions sooner by relying exclusively on lethal removals conducted by NPS and other professionals.	Same as alternative B, except: Use of volunteers for ground shooting in additional areas and use of relocation could reduce efficiency and delay achieving desired conditions.	Same as alternative B, except: Use of relocation could reduce efficiency and delay achieving desired conditions.

	Alternative A: No Action (Continue Existing Non-native Ungulate Management Activities)	Alternative B: Comprehensive Management Plan that Uses Lethal Removal Techniques	Alternative C: Comprehensive Management Plan that Maximizes Efficiency by Expanding Lethal Removal Techniques and Discontinuing the Use of Volunteers	Alternative D: Comprehensive Management Plan that Maximizes Flexibility of Management Techniques	Alternative E: Comprehensive Management Plan that Increases Flexibility of Management Techniques While Limiting the Use of Volunteers
Soundscapes	Under alternative A, there would be short-term moderate adverse impacts to soundscapes would result from ground-based and aerial management actions. In the older section of the park, long-term beneficial impacts on soundscapes would result through the continuation of ungulate exclusion in current management units. Long-term beneficial impacts would be unlikely for the Kahuku unit and areas currently unmanaged (e.g., portions of ‘Ōla‘a), where no established population-level objective or fencing strategy has been identified in a comprehensive and systematic plan. The effects of alternative A, when combined with impacts of past, present, and reasonably foreseeable actions on soundscapes, would have short-term moderate adverse cumulative impacts. Long-term beneficial cumulative impacts would be less likely under alternative A, because implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.	Under alternative B, short-term moderate adverse impacts to soundscapes would result from the use of firearms, vehicles, helicopters, and fence maintenance equipment. Long-term beneficial impacts to soundscapes would be fully realized under this alternative because the comprehensive, systematic approach described in “Elements Common to All Action Alternatives” would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time. The effects of alternative B, when combined with impacts of past, present, and reasonably foreseeable actions on soundscapes, would have short-term moderate adverse and long-term beneficial cumulative impacts.	Same as alternative B, plus: Potential for reaching desired conditions sooner by relying exclusively on lethal removals conducted by NPS and other professionals.	Same as alternative B, except: Use of volunteers for ground shooting in additional areas and use of relocation could reduce efficiency and delay achieving desired conditions.	Same as alternative B, except: Use of relocation could reduce efficiency and delay achieving desired conditions.
Land Management Adjacent to the Park	Alternative A would result in short- and long-term negligible to moderate adverse and beneficial impacts on land management adjacent to current park management units. Where existing boundary fences occur, impacts of removal efforts on non-native ungulate populations outside the park would be negligible. However, impacts of any future removal efforts would be uncertain in areas currently unmanaged and for which no population objective or fencing strategy has been identified (e.g., portions of ‘Ōla‘a and Kahuku). The long-term minor to moderate adverse and beneficial impacts of past, present, and reasonably foreseeable future actions on land management adjacent to the park, when combined with the impacts of implementing alternative A, would have long-term minor to moderate adverse and beneficial cumulative impacts on land management adjacent to the park.	Alternative B would result in short- and long-term negligible to minor adverse and beneficial impacts on land management adjacent to the park. Proposed new boundary fences, would minimize impacts of removal efforts conducted inside the park on populations outside the park. The long-term minor to moderate adverse and beneficial impacts of past, present, and reasonably foreseeable future actions on land management adjacent to the park, when combined with the impacts of implementing alternative B, would have long-term, minor to moderate adverse and beneficial cumulative impacts on land management adjacent to the park.	Same as alternative B, plus: Potential for reaching desired conditions sooner by relying exclusively on lethal removals conducted by NPS and other professionals.	Same as alternative B, except: Use of volunteers for ground shooting in additional areas and use of relocation could reduce efficiency and delay achieving desired conditions.	Same as alternative B, except: Use of relocation could reduce efficiency and delay achieving desired conditions.

	Alternative A: No Action (Continue Existing Non-native Ungulate Management Activities)	Alternative B: Comprehensive Management Plan that Uses Lethal Removal Techniques	Alternative C: Comprehensive Management Plan that Maximizes Efficiency by Expanding Lethal Removal Techniques and Discontinuing the Use of Volunteers	Alternative D: Comprehensive Management Plan that Maximizes Flexibility of Management Techniques	Alternative E: Comprehensive Management Plan that Increases Flexibility of Management Techniques While Limiting the Use of Volunteers
Socioeconomics	Under alternative A, non-native ungulate management program would have beneficial impacts on local communities as a result of park payroll and spending on non-native ungulate control, fencing, and related supplies. Impacts to non-market social values would be minor, short-term, and adverse during control activities. There would be no measurable effect on park visitation and recreation spending. Long-term beneficial impacts to non-market social values through the restoration of native species and communities would be less likely for the Kahuku unit and areas currently unmanaged (e.g., portions of ‘Ōla‘a), where no established population-level objective, or fencing strategy, or management implementation has been identified in a comprehensive and systematic plan. The effects of alternative A, when combined with the impacts of past, present, and reasonably foreseeable future actions on socioeconomic resources, would have short-and long-term minor adverse impacts and long-term beneficial impacts on socioeconomic resources. Long-term beneficial cumulative impacts would be less likely under alternative A, because implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.	Under alternative B, non-native ungulate management program would have beneficial impacts on local communities as a result of park payroll and spending on non-native ungulate control, fencing, and related supplies. Impacts to non-market social values would be minor, short-term, and adverse during control activities. There would be no measurable effect on park visitation and recreation spending. Long-term beneficial impacts to non-market social values through the restoration of native species and communities would be fully realized under alternative B because the comprehensive, systematic approach described in “Elements Common to All Action Alternatives” would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time. The impacts of past, present, and reasonably foreseeable future actions on socioeconomic resources, when combined with the impacts of implementing alternative B, would have short- and long- term minor adverse and long-term beneficial cumulative impacts.	Same as alternative B, plus: Potential for reaching desired conditions sooner by relying exclusively on lethal removals conducted by NPS and other professionals. Impacts on participants in the volunteer program are expected to be minor, as substitute hunting opportunities are available.	Same as alternative B, except: Use of volunteers for ground shooting in additional areas and use of relocation could reduce efficiency and delay achieving desired conditions. Some beneficial impacts to social values would be gained among individuals who prefer non-lethal relocation approaches over lethal methods. Conversely, the additional resources needed to implement non-lethal methods (e.g., capture and relocation of animals) may delay the NPS in reaching desired conditions and result in more reduction efforts, which would contribute to adverse impacts to social values.	Same as alternative D, except: Impacts on participants in the volunteer program are expected to be minor, as substitute hunting opportunities are available.
Visitor Use and Experience	Under alternative A, short- and long-term minor adverse affects on visitor use and experience would result from temporary closures and disruptions caused by ungulate control measures and fence construction and repair, and the long-term presence of fences. In the older section of the park, long-term beneficial impacts to the visitor experience resulting from the recovery of native vegetation and wildlife habitat would continue in managed units. Long-term beneficial impacts would be less likely for the Kahuku unit and areas currently unmanaged (e.g., portions of ‘Ōla‘a), where no established population-level objective, or fencing strategy, or management implementation has been identified in a comprehensive and systematic plan. The effects of alternative A, when combined with impacts of past, present, and reasonably foreseeable future actions on visitor use and experience, would have short- and long-term minor adverse cumulative impacts. Long-term beneficial cumulative impacts would be less likely under alternative A, because implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.	Under alternative B, short- and long-term minor adverse affects on visitor use and experience would result from temporary closures and disruptions caused by ungulate control measures and fence construction and repair, and the long-term presence of fences. Long-term beneficial impacts to visitor use and experience would be fully realized under this alternative because the comprehensive, systematic approach described in “Elements Common to All Action Alternatives” would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time. The effects of alternative B, when combined with impacts of past, present, and reasonably foreseeable future actions on visitor use and experience, would have short- and long-term minor adverse cumulative and long-term beneficial impacts.	Same as alternative B, plus: Potential for reaching desired conditions sooner by relying exclusively on lethal removals conducted by NPS and other professionals.	Same as alternative B, except: Use of volunteers for ground shooting in additional areas and use of relocation could reduce efficiency and delay achieving desired conditions.	Same as alternative B, except: Use of relocation could reduce efficiency and delay achieving desired conditions.

	Alternative A: No Action (Continue Existing Non-native Ungulate Management Activities)	Alternative B: Comprehensive Management Plan that Uses Lethal Removal Techniques	Alternative C: Comprehensive Management Plan that Maximizes Efficiency by Expanding Lethal Removal Techniques and Discontinuing the Use of Volunteers	Alternative D: Comprehensive Management Plan that Maximizes Flexibility of Management Techniques	Alternative E: Comprehensive Management Plan that Increases Flexibility of Management Techniques While Limiting the Use of Volunteers
Visitor and Employee Safety	Under alternative A, short- and long-term minor to moderate adverse impacts on visitor and employee safety would result from implementation of management actions. In the older section of the park, long-term beneficial impacts to visitor and employee safety would continue in managed units. Long-term beneficial impacts would be unlikely for the Kahuku unit and areas currently unmanaged (e.g., portions of ʻŌlaʻa), where no established population-level objective or fencing strategy has been identified in a comprehensive and systematic plan. In these areas, animals could potentially remain on the landscape indefinitely, increasing exposure of employees and visitors to safety risks associated with ungulate management activities. The effects of alternative A, when combined with impacts of past, present, and reasonably foreseeable future actions on visitor and employee safety, would have short- and long-term minor to moderate adverse cumulative impacts.	Under alternative B, short- and long-term minor to moderate adverse impacts on visitor and employee safety would result from implementation of management actions. Long-term beneficial impacts to visitor and employee safety would be fully realized under this alternative. The effects of alternative B, when combined with impacts of past, present, and reasonably foreseeable future actions on visitor and employee safety, would have short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts.	Same as alternative B, plus: Potential for reaching desired conditions sooner by relying exclusively on lethal removals conducted by NPS and other professionals.	Same as alternative B, except: Use of volunteers for ground shooting in additional areas and use of relocation could reduce efficiency and delay achieving desired conditions.	Same as alternative B, except: Use of relocation could reduce efficiency and delay achieving desired conditions.
Park Management and Operations	Alternative A would result in long-term moderate adverse impacts on the Natural Resources Division and short- and long-term negligible to minor adverse impacts on other divisions. There could be increased costs associated with alternative A, because management would not have a comprehensive plan to guide implementation. There would be less likelihood that the NPS would progress through management phases, monitor, and apply management tools consistently (and effectively) as staff and institutional knowledge change over time. The greatest uncertainty would be for Kahuku and areas currently unmanaged (e.g., portions of ʻŌlaʻa), for which no established population-level objective and fencing strategy has been identified. The effects of alternative A, when combined with impacts of past, present, and reasonably foreseeable future actions on park management and operations, would have long-term moderate adverse cumulative impacts.	Alternative B would result in long-term moderate adverse impacts to the Natural Resources Division and short- and long-term negligible to minor adverse impacts to other park divisions. Compared to alternative A, there would be increased cost efficiency associated with alternative B, because ungulate management would be guided by the fencing strategy, population objective, and comprehensive and systematic approach described in chapter 2, “Elements Common to All Action Alternatives.” The effects of alternative B, when combined with impacts of past, present, and reasonably foreseeable future actions on park management and operations, would have long-term moderate adverse cumulative impacts.	Same as alternative B, plus: There would be cost efficiency gained through the discontinuation of volunteers in ground shooting efforts.	Same as alternative B, except: Use of volunteers for ground shooting in additional areas and use of relocation could reduce efficiency and delay achieving desired conditions.	Same as alternative B, except: Use of relocation could reduce efficiency and delay achieving desired conditions.

PREFERRED ALTERNATIVE

The CEQ regulations for implementing NEPA (40 CFR 1502.14[e]) require that an agency identify its preferred alternative or alternatives in draft and final EIS documents. The preferred alternative is that alternative "which the agency believes would fulfill its statutory mission and responsibilities, giving consideration to economic, environmental, technical and other factors" (46 FR 18026, Q4a).

The NPS has identified alternative D, Comprehensive Management Plan that Maximizes Flexibility of Management Techniques, as its preferred alternative. In identifying its preferred alternative, the NPS considered factors such as the extent to which alternatives meet plan objectives (see table 5), environmental consequences, anticipated effort associated with implementation, degree of management flexibility, and costs.

Among all alternatives evaluated, alternative D provides the greatest flexibility of management techniques, including options for use of non-lethal actions, within the context of a comprehensive, systematic management plan. By incorporating the use of qualified volunteers to assist in management activities, alternative D provides the NPS with opportunities to increase awareness of non-native ungulate issues and engage the surrounding community and general public in stewardship of park resources. Although alternative D would be expected to involve some increase over other alternatives in the time needed to achieve the population-level objective, this would not prevent the NPS from fully meeting its non-native ungulate management objectives. Although alternative D would likely include some additional costs and administrative oversight over other alternatives, these factors would likewise not be expected to prevent the NPS from fully meeting its non-native ungulate management objectives.

The NPS will consider comments on this draft plan/EIS and may modify or adjust the preferred alternative accordingly. Any modifications or adjustments will be disclosed in the published final plan/EIS. A Record of Decision will follow the final plan/EIS and will be made available to the public.

ALTERNATIVES ELIMINATED FROM FURTHER CONSIDERATION

A number of additional alternatives addressing non-native ungulate management in the park were developed based on the results of internal and external scoping, including public and agency scoping. The following section discusses those alternatives considered and dismissed, and explains why each was eliminated from further study.

HUNTING IN THE PARK

A management action using unsupervised, licensed sportsmen was proposed repeatedly during park-sponsored public scoping efforts. It was not carried forward for further analysis because it would essentially be a public hunt, which would be inconsistent with existing laws, policies, regulations, and case law regarding public hunts in units of the national park system and with long-standing basic policy objectives for national park system units where hunting is not authorized. Because public hunting was not carried forward, all elements suggested related to public hunting, such as creating a licensing system or concession service for hunting, were also not considered.

The likelihood that the NPS would change its long-standing servicewide policies and regulations regarding hunting in parks is remote and speculative. Throughout the years, the NPS has taken differing approaches to wildlife management, but has maintained a strict policy of not allowing hunting in park units of the national park system where it is not congressionally authorized. In 1970, Congress passed the *General Authorities Act* and in 1978 the "Redwood Amendment," which clarified and reiterated that the single purpose of the NPS *Organic Act* is conservation. While the *Organic Act* gives the Secretary of the Interior the authority to destroy plants or animals for the purposes of preventing detriment to park resources, it does not give the Secretary authority to permit the destruction of animals for recreational purposes. In 1984, after careful consideration of congressional intent with respect to hunting in national parks, the NPS promulgated a rule that allows public hunting in national park areas only where “specifically mandated by Federal statutory law” (36 CFR 2.2). The NPS reaffirmed this approach in the NPS *Management Policies 2006* (NPS 2006b). At this time, the agency intends to exhaust all other possible alternatives before it attempts to change its governing laws, regulations, or policies, due to concerns that such actions may have negative impacts on the visitors and resources of this and other parks in the national park system.

Although the use of private individuals as qualified volunteers to assist with lethal removals was retained in some alternatives (see details under the alternatives), the use of qualified volunteers does not constitute hunting because the lethal removal of non-native ungulates described in the alternatives is an administrative activity that would be conducted in accordance with an approved resource management plan and under the direct supervision of NPS staff. In contrast to hunting, removal activities that would involve qualified volunteers would not be recreational in nature, would not involve personal taking of meat or other portions of the animal, and would not be bound by the principles of fair chase.

SINGLE LETHAL METHOD AS A STAND-ALONE ALTERNATIVE

Because multiple non-native ungulate species occur at the park, a variety of tools are needed based on target species, the stage of the removal process, and other factors, such as terrain, which can influence the effectiveness of certain techniques. This is affirmed by the state’s review of available management methods (HDLNR 2007). As a result, the NPS planning team felt that multiple management methods would be needed to meet the purpose, need, and objectives of the plan/EIS. Having multiple lethal removal methods available would allow management in remote areas of the park, and would allow the park staff to adjust selected actions as population numbers decrease or as animals become more accustomed to management activities. For these reasons, a single lethal method alternative was dismissed from the plan/EIS.

FERTILITY CONTROL

Park staff considered the role fertility control could play in the range of alternatives, including as a stand-alone alternative to meet the park’s desired conditions for zero non-native ungulates. Based on science team discussions, this option would result in a slow, nominal population decline that would not remove non-native ungulates from the ecosystem within the lifetime of this plan. As a result, impacts from non-native ungulates would continue and this option would not meet the purpose, need, and objectives of this plan/EIS. Therefore, fertility control was dismissed from further consideration as a stand-alone alternative.

This method was considered in combination with relocation or driving non-native ungulates to adjacent lands, but concerns over driving chemically treated animals to adjacent lands where they could be hunted and consumed made it impractical. The NPS planning team also considered the use of fertility control to slow non-native ungulate population growth so fewer animals would need to be removed by other means over the life of this plan/EIS. There are several obstacles to administering such an agent. Delivery by injection would require non-native ungulates to be captured, injected, marked, released, and recaptured for a booster shot (HDLNR 2007). Both the NPS planning team and the science team noted that the level of effort required to implement this option would be better spent removing the non-native ungulates to eliminate the impacts associated with their presence on the landscape.

As a result, the NPS planning team discussed the potential for delivering a fertility-control agent orally, as recommended by the state (HDLNR 2007). Originally, this was considered a feasible option, so the NPS planning team outlined other criteria that the fertility-control agent would have to meet, as follows:

1. **Oral delivery**. The agent would have to be delivered remotely through bait that would be unpalatable to nontarget animals. This would minimize the dangers and stress for the animals and people involved, unintended impacts on native wildlife, and associated costs.
2. **Multiyear effectiveness**. Given the expense of treating animals, a chemical agent would need to be effective (at least 85 percent) for at least 3 to 5 years, which is also consistent with the time frame for removing non-native ungulates from control units.
3. **Single-treatment effectiveness**. The agent must effectively control fertility for the life of the animal with a single dose, and must not require a booster. A single-dose treatment would minimize the effort to treat large numbers of non-native ungulates.
4. **At least 85 percent effectiveness**. Considering the variability in biological response and the difficulty and expense of applying chemical contraceptives to a free-roaming wildlife population, the lowest acceptable level of effectiveness would be 85 percent.
5. **Use limited to fenced control units**. Because of concerns about their being hunted and consumed, a population of non-native ungulates would be fenced away from sensitive resources and fertility-control agents would be administered to them. Over time, as animals in the fenced population die, they would not be replaced by new births, reducing the population. The availability of resources within the fenced area would also contribute to a decline in the population, as the resources become more limited. This method was deemed impractical in combination with relocation or driving non-native ungulates to adjacent lands, as there are concerns about the human consumption of chemically treated animals.
6. **Appropriate approvals and certifications**. Ideally, the agent should have regulatory approval for use in the specific non-native ungulate being targeted. Alternatively, the agent could be a drug approved for use in other ungulate species and available for those in the park. Finally, an agent could be used experimentally if the responsible regulatory agency (U.S. Food and Drug Administration or EPA) approved an investigational new animal drug exemption or experimental use permit. This exemption requires specialized authorizations under a drug research project. All agents would need to be certified as safe for use in the specific ungulate species by the prescribing veterinarian.
7. **Withdrawal period**. Any fertility-control agent used must have a zero-day withdrawal period (the amount of time following treatment after which an ungulate would be considered drug free and fit for consumption) to allow consumption of the meat if the animal is killed by a hunter immediately after being treated.
8. **Safety for treated animals**. The agent must have no long-term effects on treated non-native ungulates other than effective fertility control. This would include the absence of toxic short-term reactions or debilitating long-term effects that would increase morbidity or mortality in the population. The agent must not affect pregnant animals or their fetuses, or result in any genetic mutations that would be passed on to subsequent generations of non-native ungulates if the fertility control is not successful.
9. **No substantial behavioral effects**. The fertility-control agent must not result in substantial behavioral effects, such as changes in breeding behavior. It is the park's goal to avoid substantial changes that would adversely affect wildlife behavior, visitor experience, and/or the health and safety of the public.

10. **Safety for nontarget animals**. A fertility-control agent should have no adverse effects (e.g., toxicity, changes in fertility, genetic mutations) on nontarget animals.

Consultation with NPS experts in wildlife fertility control indicated that an agent that meets these criteria is currently unavailable, and it is highly unlikely such an agent would be developed during the life of this plan/EIS. It is possible that an agent that meets some of these criteria would be developed, but even that is not expected. There is not a lot of research on oral delivery of reproductive-control agents, and none has dealt with applications in free-ranging ungulate populations. This research is being conducted with steroid hormones (progesterone) that must be mixed with palatable bait and fed to animals on a daily basis. In other words, if one treatment is missed, the non-native ungulate could be impregnated. While this approach might be feasible in feedlots for domestic livestock, the NPS would have serious difficulty ensuring adequate uptake to maintain infertility in the free-ranging non-native ungulate populations at the park. Even if used in fenced control units, these areas could encompass thousands of acres, and the same difficulties would exist. There are also concerns in the scientific community about putting such steroids into the environment and the potential for impacts on nontarget species. Research has been conducted since 2000 to formulate a nonsteroid alternative for oral delivery, but the lack of success makes it a remote possibility that such an agent would be available during the life of this plan/EIS.

Because fertility control administered by injection would result in environmental impacts that could be avoided using other methods, and because oral delivery of fertility-control agents is not technically feasible and could not be implemented if chosen, the use of this technology in combination with other management techniques was dismissed from further consideration.

Toxins and Poisons

Under this alternative, poison would be mixed with food sources such as grains to kill non-native ungulates. Death from poisoning is not immediate, and health concerns resulting from people potentially hunting and eating poisoned non-native ungulates that have wandered out of the park could be an issue. In addition, nontarget native wildlife, including native birds of prey, domestic wildlife, or roaming pets could eat a tainted carcass or the poison itself. Further, there are no toxicants that are currently registered for use on ungulates in the United States (HDLNR 2007), and such a toxicant is not expected to become available during the life of this plan/EIS. Therefore, this alternative was dismissed.

Biological Control

Under this alternative, parasites or disease could be introduced to reduce the non-native ungulate population. Infecting a population of animals with a disease-causing organism has the potential to be highly effective in reducing the number of animals. However, as noted by the science team and the state of Hawaiʻi's technical report (HDLNR 2007), even the low likelihood of infecting domestic livestock or humans makes this technique impractical in most locations. It is not currently practiced or recommended for any of Hawaiʻi's feral non-native ungulate species and appears to hold little promise for safe use in the near future. There are presently no known disease organisms that could be safely introduced without threat to domestic livestock and animals managed for hunting. In addition, death from such methods would not be immediate or humane (HDLNR 2007). Health concerns about people potentially hunting and eating diseased animals that have wandered out of the park could be an issue. Introducing a large predator capable of taking non-native ungulates would require introduction of another non-native species (such an animal does not occur in Hawaiʻi), which would not be consistent with NPS policies. Thus, the use of biological control as a management method was not considered further in this plan/EIS.

BOUNTIES

This was not considered a viable option based on issues cited in the state's technical report on non-native ungulate management in Hawai'i, which states: "Bounties have been found to be generally ineffective in animal management, and have actually resulted in increases in the target species in many cases. Problems include fraud (such as bringing in evidence of kills from animals outside the target area), deliberate release of breeding animals, or purposely leaving some animals behind to provide future income" (HDLNR 2007). Further, the prohibition on public hunting in the park would make offering bounties an infeasible way to achieve population reduction in the park. Because this method is not recommended by the state and has proven ineffective in the past, it was not carried forward for analysis in this plan/EIS.

NO CONTROL

Under this concept, the park would not take any further control measures for non-native ungulates. This lack of action would not meet the purpose, need, and objectives for the plan/EIS, as impacts from non-native ungulates on park resources, such as removal of native vegetation, destruction of habitat for native species, and damage to cultural resources, would continue. Therefore, this alternative was dismissed from further consideration.

RAISING GOATS FOR FOOD

The concept of raising goats for food was raised during public scoping. This concept was dismissed from analysis because it equates to maintaining a managed herd, which would not meet the purpose, need, and objectives for the plan/EIS. Although providing food sources for goats could decrease browsing pressure on vegetation resources at the park, increasing food sources would increase goat health and reproduction, leading to a growing goat population. In the long term this would compound problems associated with high goat numbers (see "Chapter 1: Purpose of and Need for Action"). For these reasons, this alternative was dismissed from the plan/EIS.

PROVIDING ACCESS THROUGH KAHUKU FOR HUNTING OR OTHER RECREATIONAL ACTIVITIES

During scoping, the public raised questions regarding the park's ability to provide access through Kahuku to reach state lands for hunting. Access was also requested for other recreational activities, such as bicycling, hiking, and bird-watching. Questions related to access in various areas of the park are outside the scope of this plan/EIS and will be revisited in the ongoing process to develop a GMP for Hawai'i Volcanoes National Park. Therefore, this alternative was dismissed from further consideration in this plan/EIS.

CONSISTENCY WITH SECTION 101(B) OF THE NATIONAL ENVIRONMENTAL POLICY ACT

NEPA requires an analysis of how each alternative meets or achieves the purposes of the act, as stated in section 101(b). Each alternative analyzed in a NEPA document must be assessed as to how it meets the following purposes:

1. fulfill the responsibilities of each generation as trustee of the environment for succeeding generations;

2. assure 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 (42 USC 4331).

ALTERNATIVE A: NO ACTION (CONTINUE EXISTING NON-NATIVE UNGULATE MANAGEMENT ACTIVITIES)

Alternative A would meet the purpose of NEPA in that the NPS would continue current management of non-native ungulates, thereby supporting the protection and recovery of native plant and animal species, and the protection of cultural resources, for the enjoyment of current and future generations. However, under alternative A, the implementation of non-native ungulate management would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities. As a result, consistent application of management tools over time would be uncertain, meaning that the extent to which alternative A meets the purposes of NEPA would be considered less than under the action alternatives.

ALTERNATIVE B: COMPREHENSIVE MANAGEMENT PLAN THAT USES LETHAL REMOVAL TECHNIQUES

Alternative B would meet the purpose in NEPA in that the NPS would implement a comprehensive, systematic plan to manage non-native ungulates, thereby supporting the protection and recovery of native plant and animal species, and the protection of cultural resources, for the enjoyment of current and future generations. The comprehensive, systematic approach to management would help to ensure consistent and successful application of management tools over time, meaning that alternative B would meet the purposes of NEPA to a greater extent than alternative A.

ALTERNATIVE C: COMPREHENSIVE MANAGEMENT PLAN THAT MAXIMIZES EFFICIENCY BY EXPANDING LETHAL REMOVAL TECHNIQUES AND DISCONTINUING THE USE OF VOLUNTEERS

Alternative C would meet the purpose in NEPA in that the NPS would implement a comprehensive, systematic plan to manage non-native ungulates, thereby supporting the protection and recovery of native plant and animal species, and the protection of cultural resources, for the enjoyment of current and future generations. The comprehensive, systematic approach to management would help to ensure consistent and successful application of management tools over time, meaning that alternative C would meet the purposes of NEPA to a greater extent than alternative A and to a similar extent as alternative B.

Alternative D: Comprehensive Management Plan that Maximizes Flexibility of Management Techniques

Alternative D would meet the purpose in NEPA in that the NPS would implement a comprehensive, systematic plan to manage non-native ungulates, thereby supporting the protection and recovery of native plant and animal species, and the protection of cultural resources, for the enjoyment of current and future generations. The comprehensive, systematic approach to management would help to ensure consistent and successful application of management tools over time, meaning that alternative D would meet the purposes of NEPA to a greater extent than alternative A and to a similar extent as alternatives B and C.

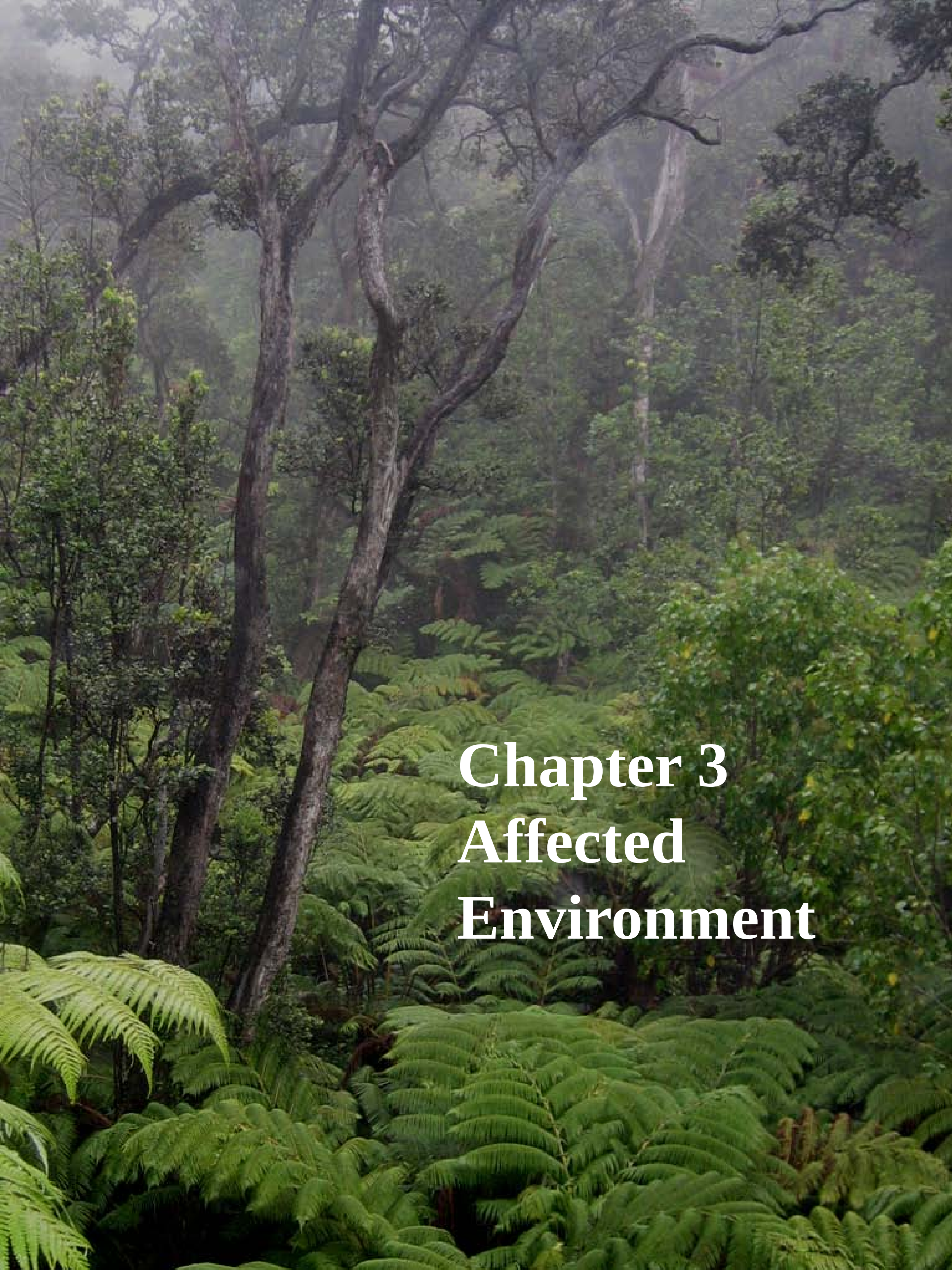
Alternative E: Comprehensive Management Plan that Increases Flexibility of Management Techniques While Limiting the Use of Volunteers

Alternative E would meet the purpose in NEPA in that the NPS would implement a comprehensive, systematic plan to manage non-native ungulates, thereby supporting the protection and recovery of native plant and animal species, and the protection of cultural resources, for the enjoyment of current and future generations. The comprehensive, systematic approach to management would help to ensure consistent and successful application of management tools over time, meaning that alternative E would meet the purposes of NEPA to a greater extent than alternative A and to a similar extent as alternatives B, C, and D.

ENVIRONMENTALLY PREFERRED ALTERNATIVE

The NPS is required to identify the environmentally preferred alternative in its NEPA documents for public review and comment. Guidance from the CEQ states that the environmentally preferred alternative is “the alternative that causes the least damage to the biological and physical environment; it also means the alternative which best protects, preserves, and enhances historic, cultural, and natural resources” (40 CFR 1500–1508). The CEQ NEPA regulations also indicate that the environmentally preferable alternative is the one that “will promote the national environmental policy as expressed in NEPA’s Section 101” (46 FR 18026, Q6a).

The NPS has identified alternative C (Comprehensive Management Plan that Maximizes Efficiency by Expanding Lethal Removal Techniques and Discontinuing the Use of Volunteers) as the environmentally preferred alternative. Among all alternatives considered, alternative C provides for the most expedient and efficient management of non-native ungulates by relying exclusively on lethal removal techniques and through eliminating the use of volunteers in non-native ungulate management activities. As a result, the NPS would be expected to achieve its population-level objective more quickly under alternative C than under any other alternative. As such, alternative C would most quickly reduce the continued impacts of non-native ungulates on natural and cultural resources in the park. Furthermore, the focus of alternative C on expedient and efficient management would be expected to result in fewer management actions over the life of the plan, resulting in fewer management-related environmental impacts than under other alternatives.



Chapter 3 Affected Environment

CHAPTER 3: AFFECTED ENVIRONMENT

GENERAL PROJECT SETTING

The Island of Hawaiʻi is the youngest island in the Hawaiian Island chain, which is located approximately 2,390 miles west of California and is considered the most geographically remote high island chain in the world. The Hawaiian Islands formed as undersea volcanoes that erupted and built mountains that rose from the sea floor, with the Island of Hawaiʻi first emerging 430,000 years ago (Juvik and Juvik 1998).

Today, Hawaiʻi Volcanoes National Park encompasses two active volcanoes: Mauna Loa and Kīlauea. Mauna Loa erupts every 20 years on average and features two active rift zones (areas associated with the rise and eruption of magma) that create fissures, cinder and spatter cones, lava flows, and faults; Kīlauea, which has erupted from the Puʻu ʻŌʻō, Kupaianaha and Thanksgiving Eve Breakout vents on the eastern side of the park since 1983, has added approximately 212 acres to the island's southern shore (as of January 2007), and is among the world's most active volcanoes. As with all Hawaiian Island volcanoes, Mauna Loa and Kīlauea release basaltic lavas that are high in silica and low in sodium and potassium (NPCA 2008; Ziegler 2002).

The geographic isolation and geologic history of the island, combined with a wide range of climates (described below), have resulted in a wide variety of vegetation and habitat types, ranging from coastal lowlands to alpine environments and from wet forests to xeric systems. These are described in more detail in the "Vegetation" section of this chapter. Almost all of the native terrestrial flowering plants and animals are unique to the Hawaiian Islands and play important roles in the traditional culture of Native Hawaiians (NPCA 2008; Ziegler 2002).

The geographic isolation and geologic history of the island, combined with a wide range of climates (described below), have resulted in a wide variety of vegetation and habitat types, ranging from coastal lowlands to alpine environments and from wet forests to xeric systems.

In general, the park climate is characterized by a two-season year, by mild and fairly uniform temperature conditions everywhere except at high elevations, and by marked geographic differences in rainfall. Climate data has been recorded at the park headquarters (around 4,000 feet (1,219 meters) above sea level) since 1949 and shows that temperatures range from an average minimum of 59°F to a maximum of 67°F in winter, and from 63°F to 71°F in summer. Average annual temperature from 1949 to 2006 was about 61°F. The highest recorded temperature was 89°F in December of 2000, while the lowest was 34°F in January of 1978 (WRCC n.d., 2006). It is important to note that temperature and precipitation vary by exposure to trade wind showers and elevation, which ranges from sea level to 13,677 feet (4,169 meters) at the summit of Mauna Loa. For example, temperatures at the summit of Kīlauea can be 12 to 15 degrees cooler than coastal lowlands, and mean temperatures in alpine areas on Mauna Loa—which include elevations of about 8,500 feet to the 13,677 foot summit (2,591 to 4,169 meters) and can experience snowfall—range from 43°F to 48°F (NPS 2007c, 2008a). In addition, wet forests in the park average 90 to 140 inches of rain per year, while precipitation in coastal lowlands averages from 20 to 60 inches (NPS 2007c).

VEGETATION

As described previously, vegetation in the park varies with the climate, elevation and topographic exposure (exposed or sheltered from trade wind showers). The fire management plan (NPS 2005a) for Hawaiʻi Volcanoes National Park identifies seven environmental zones, adapted from vegetation maps created by Mueller-Dombois and Fosberg (1974), each with different plant communities: alpine/aeolian, subalpine, mesic/wet forest, montane seasonal, mid-elevation seasonal, coastal lowland, and Kahuku pasture/mesic forest. The plant communities supported in these zones (shown on figure 7) are home to more than 400 native species of vascular plants, as well as 600 non-native vascular plant species. These plant communities are described in the following sections, which include discussions of climatic and geographic factors that affect their composition, as well as the highly invasive non-native species present that threaten park ecosystems and the fire environment. These descriptions are followed by a summary of the influence that non-native ungulates have on plant communities.

ALPINE/AEOLIAN

The upper portions of the Mauna Loa and Kahuku units are in this zone, which varies in elevation from 8,500 feet to the 13,677-foot summit of Mauna Loa (2,591 to 4,169 meters). This zone experiences average temperatures ranging from 43°F to 48°F and rainfall from 20 to 28 inches, with frequent nightly frost in the winter months. Most of the alpine zone is characterized by nearly barren lava flows with sparse, low, vegetation consisting of small patches of stunted native shrubs, mostly pūkiawe (*Leptecophylla tameiameiae*) and ʻōhelo (*Vaccinium reticulatum*). Grasses, sedges, lichens, and mosses comprise the rest of the plant life (NPS 2005a). This zone also contains isolated kīpuka, which are large and small areas untouched by recent lava flows that are "islands" of plant and animal life surrounding by a "sea" of lava (NPCA 2008; NPS 2005a). There is very little or no vegetation in the areas above 11,000 foot elevation. Within this zone, no fires have been documented; and there is essentially no wildfire potential. Most of the alpine zone is still exposed to occasional mouflon sheep and feral goats.

SUBALPINE

This zone extends from 6,500 to 8,500 feet (1,981 to 2,591 meters) (and higher). The average annual temperature ranges from 49°F to 54°F, with occasional winter frost. In the Mauna Loa Unit, rainfall averages are from 30 to 40 inches per year (summers are dry and most precipitation is in the winter). Low-lying clouds cause fog-drip from trees and shrubs, which contributes to precipitation. The climate of the Kahuku subalpine environment is decidedly moister, with nearly daily cloud cover and light precipitation on the southeast slope, upslope of the Kaʻū and Kapāpala forest reserves (Doty and Mueller-Dombois 1966).

In the Mauna Loa Unit, much of the subalpine vegetation is concentrated in two major kīpuka on older pāhoehoe lava flows. Sparsely vegetated lava flows dominate many areas of this zone. The most widespread plant community in the subalpine is ʻōhiʻa (*Metrosideros polymorpha*) scrub, with an understory of open native shrubs and grasses. Scrub is characterized by scattered, short, ʻōhiʻa with native shrub and grasses. ʻŌhelo, pūkiawe, and ʻaʻaliʻi (*Dodonaea viscosa*) are the most abundant native shrubs, while the most abundant grass is the native bunchgrass *Deschampsia nubigena*. Vegetation on the extensive, younger ʻaʻā flows consists of scattered and very scattered native ʻōhiʻa trees and native shrubs. In the Mauna Loa Unit, where ungulates have been removed, native plants dominate the vegetation, māmane (*Sophora chrysophylla*) is regenerating, and recovery of rare plants (including the endangered Mauna Loa silversword [*Argyroxiphium kauense*]) through active restoration has begun. (NPS 2005a). Vegetation is similar in Kahuku, but four decades of browsing by mouflon sheep has reduced native species abundance and diversity (Benitez et al. 2008; NPS 2005a).

The potential for large or intense wildfires in the subalpine is low. Patches of vegetation with closely spaced shrubs and grasses are small and discontinuous. Vegetation is sparse and low growing, with low fuel loadings. Young lava flows dissect subalpine fuel beds creating a natural barrier to firespread.

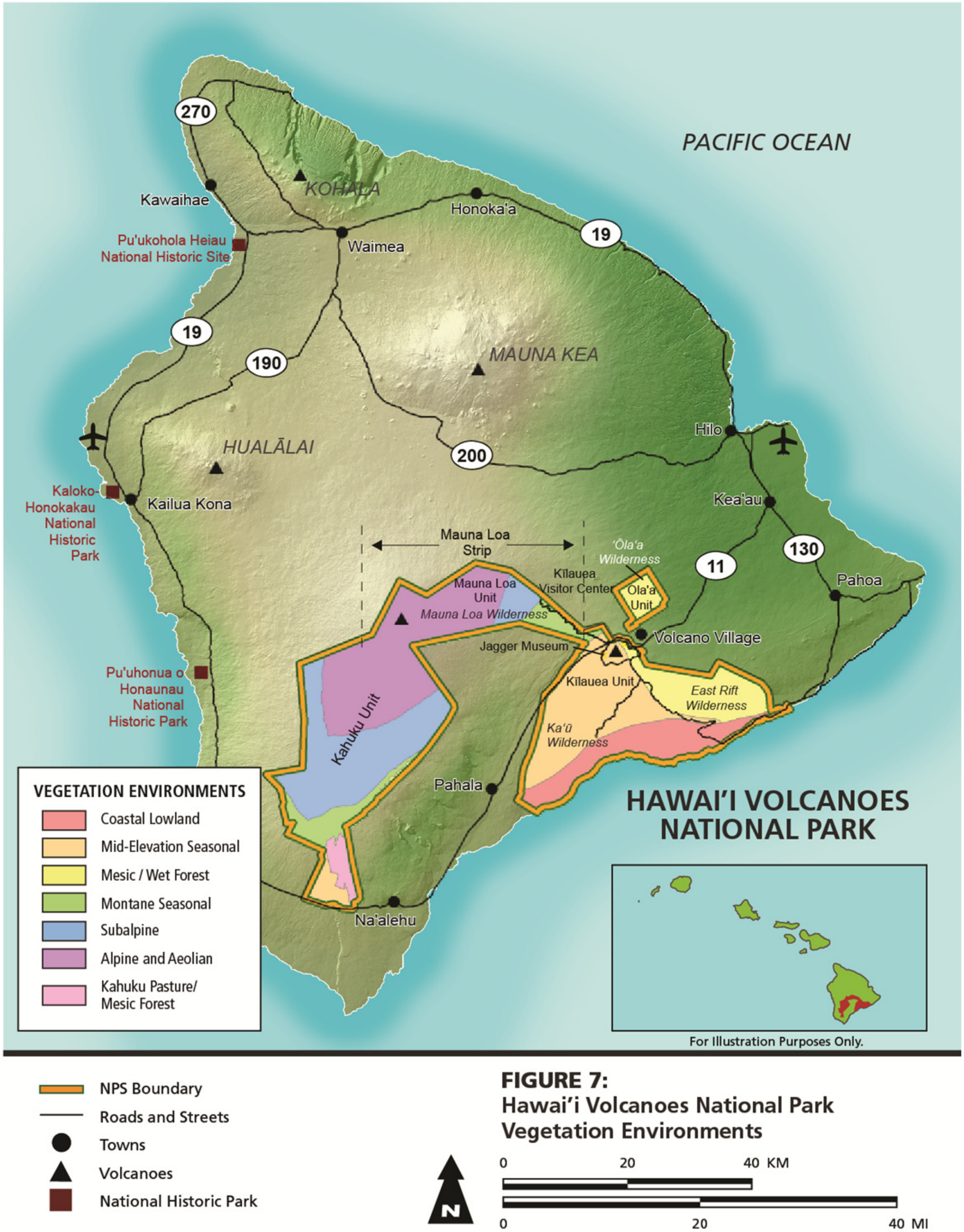


FIGURE 7:
Hawai'i Volcanoes National Park Vegetation Environments

MONTANE SEASONAL

In the Mauna Loa unit, the montane seasonal zone occurs between 4,000 and 6,700 feet (1,219 to 2,042 meters) and is dry during the summer, with variations in annual rainfall depending on elevation (60 inches per year at 4,000 feet (1,219 meters) in elevation and 40 inches per year at 6,000 feet (1,829 meters) in elevation). In Kahuku, the area at 5,000 to 6,000 feet (1,524 to 1,829 meters) on the southwest-facing slope can also be characterized as montane seasonal. This zone in Kahuku is wet in the summer, and is characterized by frequent afternoon cloud buildup and low-lying fog (NPS 2005a).

In the Mauna Loa Unit, most of the montane seasonal environment is densely vegetated and found on 750- to 4,000-year-old lava flows, although several massive, more recent (late prehistoric or historic) ʻaʻā flows also penetrate this zone. The vegetation of this zone varies considerably with soil depth and substrate age. For example, the most diverse and well-developed forests occur at Kīpuka Kī and Kīpuka Puaulu—the most biologically rich site in the park—which are islands of ash soil more 1,500 to 3,000 years old on the lower east end of the Mauna Loa Unit (4,000 to 4,400 feet (1,219 to 1,341 meters) in elevation). Although included in the montane seasonal fire management unit, these kīpukas support a rare mesic forest community characterized by mānele (*Sapindus saponaria*) / koa (*Acacia koa*) / ʻōhiʻa forest community, as well as several threatened, endangered, or candidate species, or species of concern (discussed later in this chapter) (NPS 2005a).

Above 5,000 feet (1,524 meters) elevation, most soils are shallow, discontinuous ash deposits over weathered pāhoehoe. Where deeper soils occur, koa dominates the forest and contains an understory comprised of native shrubs pūkiawe and ʻaʻaliʻi, sedges, and a mixture of alien meadowrice grass and native grasses. At lower elevations koa forest understory is dominated by alien pasture grasses, a legacy of 150 years of cattle grazing. Across elevations within this zone, small stands of shrubland and grassland persist on shallow soils. The shrublands are dominated by native shrubs pūkiawe and ʻaʻaliʻi with a continuous understory of mixed alien and native grasses at lower elevations and native bunchgrasses above 5,000 foot elevation. Grasslands are generally small and are dominated by alien grasses at lower elevation and native bunch grasses at upper elevation.

Vegetation in the montane seasonal zone in Kahuku is dominated by closed stands of ʻōhiʻa forest with a native shrub, fern, and mixed native-alien grass understory. Koa may or may not be a component in these forests. Koa is more prevalent on the west side of Kahuku (above TNC Kona Hema Preserve). This area was impacted by cattle and logging and much of the native understory has been replaced by nonnative kikuyu and meadowrice grass. Since non-native ungulate removal efforts were initiated, vigorous recruitment of young koa has occurred.

Across the Kahuku and Mauna Loa units, ʻaʻā flows are characterized by open to sparse ʻōhiʻa woodlands with a sparse native shrub understory in many areas. Other areas consist of very scattered native shrubs (grass is never abundant) (NPS 2005a).

Historically, wildfires have been rare in this zone. Only one large wildfire has been observed on the Mauna Loa Unit. In 1975, a fire swept through 2,000 acres of koa forest, shrublands and grasslands from an adjacent ranch. In spite of abundant fuel, there has been no wildfires since then. Part of this may be due to vigorous fire prevention, closing the Mauna Loa Strip Road in very high and extreme fire danger. Fire history of Kahuku is not known in detail. A wildfire starting in adjacent ranchlands penetrated a stand of ʻōhiʻa and koa in 1993. Recovery of koa and other species following wildfire has been inhibited by browsing of mouflon sheep, while ʻōhiʻa and naio (*Myoporum sandwicense*), plants ignored by sheep, are recovering rapidly after fire by resprouting. Fire may have played an important role in the evolution of portions of the montane seasonal zone on the Mauna Loa Unit (Mueller-Dombois 1981). This is suggested by the fact that there are continuous fine fuels in the form of native grasses and shrubs and that many of the dominant plant species, including koa, ‘a‘ali‘i, and native grasses recover rapidly from fire by resprouting (in the absence of ungulates). On the other hand, the montane seasonal communities are at a highly dynamic stage of development. The suite of species on Mauna Loa Unit that responded positively to release from herbivores may share characteristics common to fire-adapted species. Historical fire is not known from the unique, species-rich Kīpuka Kī and Kīpuka Puaulu. The fire tolerance of the many woody species in these mesic forest kīpuka, including the numerous rare species, is not known.

MESIC/WET FOREST

Mesic and wet forests grade into each other along the sharp rainfall gradients that characterize the park. Almost all wet forests, which include areas with approximately 90 to 140 or more inches per year, are found on the eastern edge of the park, which receives nearly daily trade-wind rains. These forests are found in four locations: on the eastern rim of the summit caldera of Kīlauea Volcano, along the East Rift of Kīlauea above approximately 2,300 feet (701 meters) in elevation, in ‘Ōla‘a Forest (a 10,000-acre part of the park east of the community of Volcano), and in Kahuku on the eastern edge of the pastures and upslope of Ka‘ū and Kapāpala forest reserves between 3,000 and 5,000 feet (914 and 1,524 meters) in elevation (NPS 2005a).

Mesic/Wet Forest Habitat – Hawaii Volcanoes National Park
Source: National Park Service

Wet forests at Hawai‘i Volcanoes National Park are characterized by two major plant associations: tree fern (*Cibotium glaucum*) and uluhe fern (*Dicranopteris linearis*) forests. Tree fern forests are multi-layered, dominated by ‘ōhi‘a and tree ferns, and are best developed on the older, deep ash soils of ‘Ōla‘a Forest and some areas of the East Rift. Most of the wet forest in ‘Ōla‘a is dominated by a dense canopy of tree fern, often co-mingled or slightly overtopped by open stands of other native trees. The relatively young substrates of volcanically active areas at Kīlauea summit and the East Rift support closed canopy stands of ‘ōhi‘a, with a subcanopy of other native trees and tree ferns. Ground cover is dense and consists of a high diversity of native ferns, as well as native shrubs and herbaceous plants (NPS 2005a).

Uluhe fern forests are found at the summit of Kīlauea and along the East Rift, and are characteristic of early successional communities that occur on younger lava flows and in secondary successional communities following ‘ōhi‘a dieback. Uluhe is a dense matted fern that grows 3 to 20 feet (1 to 6 meters) tall and suppresses all vegetation, native and non-native. As a result, species diversity is lower in uluhe forests when compared to tree fern forests (NPS 2005a).

Mesic forests, which receive approximately 60 to 90 inches of rain per year, are found primarily east of Chain of Craters Road and west of wet forests, mākai (oceanside) of wet forest in the southeastern section of the park, and upslope of Kaʻū and Kapāpala forest reserves in Kahuku. These forests are dominated by closed to open stands of ʻōhiʻa and koa forest with highly variable understory vegetation. In Kahuku, the understory consists of tree ferns and native trees or shrubs. East of Chain of Craters Road, the understory is similar, but many areas have dense stands of introduced faya tree (*Morella faya*) or native uluhe fern. The understory of mesic forest in the lower East Rift of Kīlauea is dominated by continuous swards of introduced swordfern (*Nephrolepis* sp.) (NPS 2005a).

Wildfire is uncommon in most mesic and wet forest in the park. In wet forest, fires have typically occurred in uluhe after rainless periods of several weeks and when the dead fronds and leaf litter dries out. Only the mesic forest stands in the lower East Rift have had a recent history of fire. In these stands, the dense native understory has been replaced by invasive swordfern which carries wildfire readily under dry, windy conditions.

Mid-elevation Seasonal

This zone is found between approximately 1,000 and 4,000 feet (305 and 1,219 meters) in elevation in the leeward part of the park. As a result, it is sheltered from daily trade-wind rains and precipitation varies from 20 to 60 inches per year. Vegetation of the mid-elevation seasonal environment varies with substrate and rainfall. For example, younger flows, or deep cinder with little ash-soil development, typically support sparse native shrubs, primarily pūkiawe and ʻaʻaliʻi, and scattered, short ʻōhiʻa. Flows with deeper ash support dry ʻōhiʻa woodland. However, this plant community has been altered by the introduction of non-native plants and fire. In many areas, the understory is dominated by non-native bush beardgrass (*Schizachyrium condensatum*), broomsedge (*Andropogon virginicus*), and molasses grass (*Melinis minutiflora*), which form a nearly continuous matrix between the open layers of native shrubs. In Kahuku, where mouflon sheep and other ungulates remain on the landscape, a similar open to sparse woodland structure with an understory dominated by tall non-native grasses bush beardgrass, broomsedge and barbed wire grass (*Cymbopogon refractus*) prevails. The non-native shrub Christmasberry (*Schinus terebinthifolius*) is also present and dominates portions of this zone. Other areas of the park (not including Kahuku) have been invaded by the non-native faya tree, which has become a codominant with ʻōhiʻa in some areas and displaced it in others. In addition, the majority of dry ʻōhiʻa woodlands on Kīlauea have burned in the last 40 years, creating savannas of scattered ʻōhiʻa and native shrubs with abundant non-native grass (NPS 2005a).

Wildfire has been most prevalent in the mid-elevation seasonal environment of the park. Invasion of fire-adapted non-native broomsedge and bush beardgrass was noted in the mid 1960s (Doty and Mueller-Dombois 1966), despite the presence of large numbers of feral goats in the area. Apparently, the grasses were not a preferred forage for goats (Baker and Reeser 1972), and instead grew abundantly thereby facilitating the spread of large wildfires. Nearly two-thirds of the mid-elevation seasonal environment (excluding young lava flows) have been affected by wildfire over the last 40 years. After fire, grasses out-compete native woody plants and increase in cover and fuel loading (Hughes et al. 1991; D'Antonio et al. 2000). Burned sites are then predisposed to more severe fires in the future compared to adjacent unburned woodlands because of increased fuel loadings and because wind speeds are substantially greater in the more open post-fire savannas (Freifelder 1998). Over the last ten years, the park has conducted several large scale planting projects in burn areas with the goal of restoring native plant diversity and vegetation structure in affected areas (Loh et al. 2007; McDaniel et al. 2008). The park has adapted its native plant restoration efforts to this new fire regime by focusing recovery efforts on native species that are more fire-tolerant (Loh et al. 2007; Loh, et al. 2009). Among the fire-tolerant native species are many that are considered highly palatable to goats (e.g., naio, māmane, ʻiliahi [*Santalum paniculatum*], koʻokoʻolau [*Bidens hawaiiensis*]) and could not be restored without first excluding these animals from the area. In Kahuku, where mouflon sheep and other feral ungulates remain on the landscape, species favored by ungulates as forage such as māmane and ʻiliahi are uncommon.

COASTAL LOWLAND

The coastal lowland environment lies below the mid-elevation seasonal environment and includes the immediate shoreline, the coastal plain upland of the large fault scarps or pali (cliffs/ridges), and the faces of the pali. Typically warm and dry, rainfall varies from less than 20 inches per year in the western part of the park to about 60 inches per year along the eastern boundary. These dry conditions, combined with the relatively young age of the substrate, limit the development of vegetation in this zone (NPS 2005a).

A narrow band of coastal strand vegetation is found along parts of the immediate shoreline. Vegetation varies from naupaka (*Scaevola taccada*) dominated scrub to sparse salt-tolerant herbs. The endangered grass *Ischaemum byrone*, the endangered loulu palm (*Pritchardia affinis*), and the species of concern, *Portulaca villosa* grows in a number of locations where planted. The endangered shrub ʻōhai (*Sesbania tomentosa*) grows in some coastal strand sites. Interior, the coastal lowlands are now largely dominated by grasses. The wetter, eastern portions have the remains of a coastal shrubland, modified by fire. Prior to fire this community was dominated by tall ʻākia (*Wikstroemia sandwicensis*) shrubs, along with other native shrubs including ʻa'ali'i and ʻūlei. Alien broomsedge and bush beardgrass, along with native pili grass (*Heteropogon contortus*), formed a matrix between the shrubs and permitted wildfires to spread. Most of the ʻākia shrublands burned in the Pu'u ʻŌ'ō eruptions that started in 1983 and only persist in small pockets. The remainder has since been buried by lava or converted to low open shrubland with scattered ʻa'ali'i and ʻūlei, with broomsedge, bush beardgrass, and pili grass growing between the shrubs. The drier, western portion of the coastal lowlands are dominated by alien grasslands with patches of alien shrubs. The dominant grasses are alien Natal redtop (*Melinis repens*), thatching grass (*Hyparrhenia rufa*), molasses grass (*Melinis minutiflora*), bush beardgrass, and broomsedge. Native pili grass, a fire-adapted species, is an important component of the grasslands in some areas. The coastal lowlands also contain small scattered stands of dry and mesic forests on the faces of the pali. Younger flows are dominated by open stands of ʻōhi'a, while older flows support stands of native tree lama (*Diospyros sandwicensis*) with an understory of the shrub alahe'e (*Psydrax odorata*). A number of threatened, endangered, candidate species, including kauila (*Alphitonia ponderosa*), hala pepe (*Pleomele hawaiiensis*), ʻahakea (*Bobea timonioides*), and ʻohe makai (*Reynoldsia sandwicensis*) occur in lama forest. Lama forest in the park have been greatly reduced in the last 30 years by lava flows so that just a few patches remain (NPS 2005a).

Fire is generally not a major concern in the coastal strand, except for the upper fringe of the strand in some areas. Where grass fuels are present, they tend to be low growing and scattered. Further inland, wildfire has become relatively frequent over the last 30 years. Feral goats were removed in the early 1970s. Although this allowed for some recovery and prevented further loss of pili and other native plant species from damage by herbivores, tall, perennial, fire-promoting grasses quickly replaced low growing grasses adapted to grazing pressure. Within remaining dry and mesic forest, grass fuels are common only in the smaller lama forest patches. However, fire may carry in alien sword fern and lantana during extreme fire conditions.

KAHUKU PASTURE/MESIC FOREST

This zone encompasses 7,200 acres of former cattle pasture containing remnants of mesic forest located on the lower east end of the Kahuku Unit on the south slope of Mauna Loa, extending from 2,500 feet in elevation to 5,000 feet in elevation (762 to 1,524 meters in elevation). The area extends east to mesic forest (60 to 80 inches of rain per year) and to the west lies adjacent to seasonally dry ʻōhiʻa woodlands (40 to 60 inches of rain per year) (NPS 2005a).

Vegetation is generally characterized by abundant alien grasses and an open canopy of ʻōhiʻa or ʻōhiʻa-koa. Fragments of native forest are scattered across this area and become increasingly abundant on the east end of the park boundary that lies adjacent to the state Kaʻū Forest Reserve. Vegetation surveys conducted in 2007, identified a number of rare plants remaining in forest fragments and as individuals in the pasture, including the only ʻohe (*Tetraplasandra hawaiensis*) and olonā (*Touchardia latifolia*) individuals found in the Kahuku Unit and several endangered species discovered in a pit crater and ravine (Benitez et al. 2008). Until recently, domestic cattle along with mouflon sheep and pigs damaged remaining forest fragments and suppressed establishment of many native seedlings. Domestic cattle were removed in 2010. Experiments in four 10-acre fenced exclosure units are evaluating methods for restoring native forest following exclusion of all ungulates.

There is very little documented fire history for this area. The last reported wildfire was in 2005, when a human-caused fire swept across several acres of Kikuyu grass (*Pennisetum clandestinum*).

INFLUENCE OF NON-NATIVE UNGULATES

Non-native ungulates have caused extensive damage to individual plants and altered plant communities in the park. These impacts have occurred across the different vegetation environments everywhere ungulates have been found. Because much of the endemic vegetation of Hawaiʻi evolved over millions of years in the absence of large mammalian herbivores they are particularly vulnerable to the effects of non-native ungulates.

On the Island of Hawaiʻi, feral goats, sheep, pigs, cattle and domestic cattle destroy native vegetation through trampling and feeding, leading to species loss (Baker and Reeser 1972; Scowcroft and Conrad 1992; Stone and Loope 1987). In forests, large-canopy trees often persist for some time despite this disturbance, but natural regeneration of canopy species is suppressed, and forest integrity declines dramatically. Also, as vegetation is removed conditions are created for the establishment of non-native plants that contribute further to the decline of native plant communities (Jacobi 1981; Merlin and Juvik 1992). Rare plant species, due to their low numbers, are particularly at risk for local extirpation or extinction (USFWS 1996a, 1996b, 1999). Feral pigs are a major modifier of Hawaiian wet forest. Pigs selectively seek out certain native plant species for food including hāpuʻu tree ferns, other understory ferns, ʻieʻie (*Freycineatia arborea*), and lobeliads (Diong 1982; Stone and Loop 1987). The destruction of hāpuʻu, a major component of wet forest on the Island of Hawaiʻi, is a particular concern as the fibrous trunk serves as nurse logs for native seedlings. Pigs create conditions for the spread of highly disruptive invasive weeds by opening up habitat as well as transporting propagules in their hair and feces (Aplet et al. 1991; Diong 1982; LaRosa 1992). Also, by removing vegetation, pigs increase erosion and nutrient losses which in turn may limit the potential for vegetation recovery.

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Many of these impacts along with the subsequent response of vegetation following release from ungulate pressure have been documented within the park. These include damage by feral goats in the parks dry and seasonally dry environments on Kīlauea (Baker and Reeser 1972); feral pigs in wet forest in ʻŌlaʻa and Kīlauea's East Rift (Katahira 1980; Cooray and Mueller-Dombois 1981; Taylor and Stone 1986; Aplet et al. 1991; Loh and Tunison 1999); effects of multiple ungulates in montane seasonal habitat on Mauna Loa (Spatz and Mueller Dombois 1973; Tunison et al. 1994); and koa regeneration following mouflon sheep control in montane seasonal habitat at Kahuku (Loh et al. 2005; HDLNR 2005c).

In the subalpine where ungulates have been removed, native plants dominate the vegetation, māmane is regenerating, and recovery of rare plants (including the endangered Mauna Loa silversword) through active restoration has begun. Species diversity is lower in the Kahuku subalpine zone, where animals remain (NPS 2005a; Benitez et al. 2008).

Where ungulates have been removed from portions of mesic and wet communities on Kīlauea and 'Ōla'a, native understory species and tree seedlings are recovering and managers are implementing recovery efforts for rare, threatened, and endangered species (Loh and Tunison 1999; Pratt et al. 1999; Pratt et al. 2009). Outside of fenced units, native understory vegetation continues to deteriorate (Cole et al. in press). The impact on native understory vegetation is noticeable in portions of Kahuku where impacts by feral mouflon sheep, pigs and cattle have removed much of the vegetation understory.

In the montane seasonal zone of the Mauna Loa Unit, koa forest rapidly expanded into shrublands and grasslands following removal of ungulates in the 1970s (Tunison et al. 1994; Tunison et al. 1995). However, at lower elevations, the understory below the koa canopy is dominated by non-native pasture grasses, a legacy of decades of cattle grazing. In Kahuku, past cattle grazing and continued presence of mouflon sheep and pigs continue to impact this zone by damaging mature plants and seedlings. However, in former koa forest where animal numbers have been reduced to remnant levels, rapid regeneration of koa by root sprout and seedlings has occurred (Loh et al. 2005; HDLNR 2005c). Seedling regeneration by other native trees and shrubs (e.g., ‘a‘ali‘i, māmane, akala [*Rubus hawaiiensis*] and naio) is limited by the scarcity of mature individuals remaining in the area.

In the mid-elevation seasonally dry zone of Kīlauea, removal of feral goats prevented further loss of native species through browsing, and allowed for the reintroduction of rare plants by park managers. However, the invasion of fire-adapted non-native broomsedge and bush beardgrass, which began in the 1960s while ungulates were present and continued following animal removal, has increased fire frequency and size, resulting in the loss of fire-sensitive native plants (Tunison et al. 2001). Park staff have modified native plant restoration efforts to this new fire regime by focusing recovery efforts on native species that are fire-tolerant (Loh et al. 2007; Loh et al. 2009). Among these fire-tolerant native plants are many species that are considered highly palatable to goats (e.g., naio, māmane, ‘iliahi [*Santalum paniculatum*], ko‘oko‘olau [*Bidens hawaiiensis*]) and could not be restored without first excluding these animals from the area. In Kahuku, where mouflon sheep and other ungulates remain on the landscape, many of these species are uncommon.

In the coastal lowlands of Kīlauea, high concentrations of feral goats left many areas denuded of vegetation and heavily eroded (Baker and Reeser 1972). Following the removal of goats in the 1970s, vegetation in the coastal lowlands has been characterized by recovering coastal strand vegetation, remnant dry shrubland and forest and native pili grasslands to the east, and invasion of tall non-native fire-adapted grasses to the west (Tunison et al. 2001). Since the removal of goats, park managers have begun restoration efforts for rare plants (Pratt et al. 2009); and conducted several small research burns to evaluate the use of prescribe fire to perpetuate fire-tolerant native species (many of which were vulnerable to herbivores) in pili grasslands (Tunison et al. 2001).

NON-NATIVE PLANTS

Over half of the 950 vascular plant species found at Hawai‘i Volcanoes National Park are non-native, and more than 100 species are considered highly disruptive to native ecosystems (Smith 1985). The more disruptive species reduce native plant diversity and abundance and cause the local extinction of

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species. Some non-native species such as faya tree (*Morella faya*), fountain grass (*Pennisetum setaceum*), and strawberry guava (*Psidium cattleianum*) are able to completely replace native plant communities and form monospecific stands.

About 50 of the non-native plants in the park are locally distributed, making it feasible to contain or eliminate their populations. For more widespread species, management is focused on excluding them from high priority management areas called Special Ecological Areas (SEAs). Fountain grass is among the few widespread species that is removed parkwide. Fountain grass is a highly aggressive fire-promoting non-native species occurring at very low densities over 100,000 acres of the drier sections of the park. One of the few non-native species that can colonize young lava flows, if left unchecked it would convert barren lava flows to non-native grass savannas, increase fire potential, prevent the natural succession of native shrubland and forest, and greatly alter the visual landscapes of the park. Biannually, managers search for and remove all fountain grass plants from the park.

Non-native Fountain Grass
Source: NPS - http://www.nps.gov/plants/alien/fact/pese1.htm.

See the "Cumulative Impact Scenario" section in chapter 4 for more information on non-native plant control in the park.

VEGETATION AND THE ROLE OF CLIMATE CHANGE

Results of documented temperature changes in Hawai‘i show a fairly rapid rise in surface temperature over the past 30 years, with more rapid warming occurring at higher elevations (Giambelluca et al. 2008). Stronger warming trends, especially at higher elevations, can have severe ecological impacts in Hawai‘i, including consequences on water resources and native biodiversity (Giambelluca et al. 2008).

The two key climatic features of Hawaiian montane forests are the northeast trade winds and the associated trade-wind inversion, which influence humidity and precipitation, and as a result influence the distribution of plant communities. Studies show that both local temperature and the elevation of the trade-wind inversion, which averages 1,900 meters, have responded substantially to past climate changes (Benning et al. 2002). If the frequency of occurrence or the height of the trade-wind inversion are affected by climate warming, it will have substantial effects on precipitation throughout Hawai‘i, but especially on the upper mountain slopes. Trends in rainfall (lower rainfall) and recent changes in the trade-wind inversion suggest warming may result in drier conditions, which would result in severe impacts on the highly vulnerable ecosystems found in areas above the mean inversion height (Giambelluca and Luke n.d.). Increased variability of rainfall coupled with potential for drought could have profound impacts on cloud forest. For example, results from a study of successional vegetation on lava flows at Mauna Loa suggest that severe drought is a likely mechanism causing or reinforcing a shift from dominance by woody species to dominance by herbaceous species (Loope and Giambelluca 1998).

As a result of global climate change, changes in the occurrence or height of the trade-wind inversion, carbon dioxide, temperature, water availability, nutrient availability, and cloud cover can all affect the resistance of plants and trees to introduced herbivores. For example, increased carbon dioxide can reduce leaf nitrogen, and herbivores will respond with either decreased growth or increased consumption. Herbivores and pathogens can alter the species composition and size structure of forests, which can in turn affect ecosystem processes such as evapotranspiration (loss of water from the soil by evaporation and transpiration from plants), carbon dioxide flux (change in the output and intake of carbon dioxide), and heat transfer, thereby creating feedbacks to climate (Ayres and Lombardero 2000). Anthropogenic climate change and shifts in the trade-wind inversion (changing patterns of cloud cover, rainfall, and humidity) can both interact with past land-use changes and biological invasions to drive several of the remaining native species of Hawai‘i to extinction (Benning et al. 2002). In general, invasion by a single species combined with warming trends can alter the composition and dynamics of an entire ecosystem (Simberloff 2000; Vitousek et al. 1997).

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NATIVE WILDLIFE AND WILDLIFE HABITAT

Hawai‘i Volcanoes National Park protects a unique diversity of wildlife and habitat. The majority of the native wildlife in Hawai‘i is endemic (found nowhere else on earth) (NPCA 2008). This section focuses on the native terrestrial wildlife species, including mammals, birds, invertebrates, and reptiles in the park that could be affected by ungulate management and by the expected results of the proposed alternatives.

MAMMALS

The Hawaiian hoary bat (*Lasiurus cinereus semotus*) is the only native land mammal in the park and in the Hawaiian Islands. Known in Hawai‘i as ‘ōpe‘ape‘a, the nonmigrant Hawaiian hoary bat occurs over a wide range of elevations (primarily from sea level to 7,500 feet [2,288 meters]). Data regarding the habitat and population status of this species are very limited, but available documentation suggests that the ‘ōpe‘ape‘a appears to be most numerous in native dry to mesic forests, and is often associated with native forest edges (Pratt et al. 2009; USFWS 2009a). The Hawaiian hoary bat was first listed as federally endangered in 1970 and continues to hold that status (USFWS 2009a). More information regarding this species is provided in the “Rare, Unique, Threatened, or Endangered Species” section of this chapter.

Hawaiian Hoary Bat
Source: National Park Service

The only native marine mammal associated with Hawai‘i Volcanoes National Park is the Hawaiian monk seal (*Monachus schauinslandi*), or ‘īlio-holo-i-ka-uaua. This mammal is also federally listed as endangered, and can be observed occasionally swimming offshore or resting at remote beaches in the park. Because neither this species nor its habitat would be affected by non-native ungulate management actions, it is not analyzed further in this document.

The other 12 mammals in Hawai‘i Volcanoes National Park are all non-native (NPCA 2008).

BIRDS

Many bird species survive in and depend on the habitat provided within the park boundaries, from the seacoast to the alpine/aeolian (NPS 2006h). Of the 87 species of birds present in the park, 41 are non-native (NPCA 2008).

‘i‘iwi
Photo credit © Jack Jeffrey

Hawaiian forest birds are an important component in native Hawaiian rainforests, carrying out vital ecosystem processes such as seed dispersal, pollination, and nutrient cycling (USGS 2005a). Of the 23 surviving endemic Hawaiian songbird species, those living in the park include 6 Hawaiian honeycreepers: ‘apapane (*Himatione sanguinea*), ‘amakihi (*Hemignathus virens virens*), ‘i‘iwi (*Vestiaria coccinea*), ‘ākepa (*Loxops coccineus*), ‘akiapōlā‘au (*Hemignathus munroi*), and the Hawai‘i creeper (*Oreomystis mana*) (NPCA 2008; NPS 2006g). In general, Hawaiian honeycreepers are now restricted to koa and ‘ōhi‘a forests at high elevations, generally above 4,000 feet (1,219 meters), while some rare species of Hawaiian honeycreepers are restricted to forests above 5,000 feet (1,525 meters). ‘Apapane, ‘amakihi, ‘i‘iwi, ‘akiapōlā‘au, and the Hawai‘i creeper all rely on tall ‘ōhi‘a trees for nesting habitat. The ‘ākepa generally nest in tree hollows, rather than on tall branches like other Hawaiian honeycreepers (Pratt et al. 2009). The latter three species are all listed as federally endangered, and are further addressed in the “Rare, Unique, Threatened, or Endangered Species” section of this chapter. Hawaiian honeycreepers, once abundant in the park and the Hawaiian Islands, have experienced drastic reductions in population size since the arrival of Europeans. Factors contributing to their demise include loss of forest habitat, introduction of small mammals and predators, and various avian diseases such as mosquito-transmitted diseases (USGS 2006c).

The pueo, or Hawaiian short-eared owl (*Asio flammeus sandwichensis*), is another bird species endemic to Hawai‘i. This species can be found on the island from sea level to 8,000 feet (2,450 meters). While the pueo occupies a variety of habitats, including dry and wet forests, shrublands, grasslands, and montane parklands, many bird species in the park are dependent on food resources from the forest understory and midcanopy (NPS 2009j; HDLNR 2005a). The native thrush, ‘ōma‘o (*Mayadestes obscurus*), spends much time midcanopy eating fruits of subcanopy trees, including kāwa‘u (*Ilex anomala*), kōlea (*Myrsine* spp.), and ‘olapa (*Cheirodendron trigynum*) (NPS 2009j; USGS 2006b). Ōma‘o is the most common of the Hawaiian thrushes and occurs mainly in native ‘ōhi‘a and koa forests above 3,280 feet (1,000 meters). This species prefers forests with a closed canopy 80 to 130 feet (25 to 40 meters) in height, with many fruiting trees in the understory (Audubon 2007). ‘Oma‘o also occur and breed in alpine habitat on Mauna Loa. These birds may be a distinct population from forest ‘Oma‘o (Hawaii Audubon Society 2005). The Hawai‘i ‘elepaio (*Chasiempis sandwichensis*), or flycatcher, is an insect feeder that occurs in a variety of forest habitat, including dry to mesic koa forest on Mauna Loa and ‘ōhi‘a wet forest in ‘Ōla‘a and Kīlauea (Stone and Pratt 2007).

Three additional endangered species of endemic Hawaiian birds found in the park include the nēnē (Hawaiian goose, *Branta sandvicensis*), ʻuaʻu (Hawaiian petrel, *Pterodroma sandwichensis*), and ʻio (Hawaiian hawk, *Buteo solitarius*) (NPS 2008b). Habitat for the nēnē is highly variable, and ranges from sparsely vegetated lava flows to scrubland to open grasslands (NPS 2009j). Uaʻu nesting habitat is quite variable statewide, ranging from heavily vegetated, forested slopes on Lanai and Kauai to subalpine and alpine environments on Maui and Hawaiʻi (Simons and Hodges 1998). In the park, the species nests in pits, cracks and lava tubes within sparsely-vegetated, weathered pahoehoe lava flows on Mauna Loa (Hu et al. 2001). The ʻio prefers native and non-native forests, grasslands, and cane fields, and generally nests in native ʻōhiʻa trees (USFWS 1984). These species are described further in the "Rare, Unique, Threatened, or Endangered Species" section of this chapter.

Three additional endangered species of endemic Hawaiian birds found in the park include the nēnē (Hawaiian goose, Branta sandvicensis), ʻuaʻu (Hawaiian petrel, Pterodroma sandwichensis), and ʻio (Hawaiian hawk, Buteo solitarius) (NPS 2008b).

INVERTEBRATES

Approximately 98 percent of the native invertebrates documented in the park are endemic to Hawaiʻi (NPS 2003a). The majority of these invertebrates are dependent on the health of the native plant populations, which they use for food and shelter (NPCA 2008).

Among the more than 1,100 documented native invertebrate species in the park, there are only two native butterflies: the Kamehameha butterfly (*Vanessa tameamea*), which is Hawaiʻi's state insect, and the Blackburn's blue (*Udara blackburni*). Māmaki is the preferred host plant for the Kamehameha butterfly, while koa and ʻāʻaliʻi are favored by Blackburn's butterfly (HDLNR 2009). Other native invertebrates include 200 species of moths; over 150 beetles (order Coleoptera) that include the colorful koa bug (*Plagithmysius varians*); approximately 150 species of bees and wasps (order Hymenoptera); and a number of hoppers, scales and insects (order Hemiptera), true bugs (order Heteroptera), nerve-winged insects (order Neuoptera), crickets and katydids (order Orthoptera), damseflies and dragonflies (order Odonata), spiders (order Araneae), thrips (order Thysanoptera), and book and bark lice (order Psocoptera). The endemic picture wing fly (family Drosophilidae), of which there are approximately 90 species documented in the park, is among the most studied endemic invertebrate groups and an example of island-hopping speciation (Stone and Pratt 2007).

Other native invertebrates present in the park include the giant Hawaiian darner (*Anax strenuus*), the largest native Hawaiian insect and largest dragonfly in the United States; Hawaiian cave tree crickets (*Thaumatogryllus cavicola*), which live on the ceilings of lava tubes; several carnivorous caterpillars, including *Hyposmocoma molluscivora*, which was discovered in 2003 and is remarkable for its ability to spin webs similar to spiders; and the happy-face spider (*Theridion grallator*), which occurs under plant leaves awaiting its prey (NPCA 2008; Rubinoff and Haines 2006; HDLNR 2009; UNEP-WCMC 2007). Among the terrestrial mollusks or pūpū, the small Hawaiian tree snails (subfamily Achatinellinae) are the most commonly encountered in the park.

REPTILES AND AMPHIBIANS

There are no land-dwelling reptiles and amphibians native to the Island of Hawaiʻi, but two species of sea turtle use the park's shore: the hawksbill sea turtle (*Eretmochelys imbricata*) and the green sea turtle (*Chelonia mydas*). Because these species would not be affected by non-native ungulate management actions, they are not discussed further in this document.

WILDLIFE AND ROLE OF CLIMATE CHANGE

In addition to the factors associated with vegetation (described in the "Vegetation" section of this chapter), which would also affect wildlife habitat, climate change has implications unique to wildlife in Hawai‘i. For example, the biogeographic ranges of species like mosquitoes are set by climate, and changes in climate, including seasonal changes in temperature and rainfall, could lead to a change in ranges and newly established populations (Atkinson and LaPointe 2009; Giambelluca et al. 2008). Accelerated warming at higher elevations may have substantial impacts on Hawai‘i's native endangered and threatened bird species by allowing disease-carrying mosquitoes to reach the high-elevation forests in which the birds find refuge (Giambelluca et al. 2008). Hawaiian honeycreepers, for example, have been eliminated from low- and mid-elevation forests largely due to introduced predators and diseases (Benning et al. 2002). The trade-wind inversion, as described in the "Vegetation" section of this chapter, is likely to have a substantial role in determining the upper extent of forest bird habitat in the Hawaiian Islands. If the trade-wind inversion and its effects on rainfall prevent expansion of forest bird habitat into higher elevations, remaining high-elevation forest bird populations may be squeezed between expanding disease transmission from lower elevations and the upper limits of suitable habitat. These changes would likely drive remaining populations of honeycreepers to extinction (Atkinson and LaPointe 2009). This process could be accelerated by the presence of feral pigs and other non-native ungulates, which can create larval mosquito habitat in otherwise well-drained forests like those in the park, where there are few natural standing water sources (Atkinson and LaPointe 2009; NPS 2009e).

These conclusions are further supported by landscape analyses of three high-elevation forest refuges (Hawai‘i, Maui, and Kaua‘i), which show that climate change is likely to combine with past land-use changes and biological invasions to drive several of the remaining populations of Hawaiian honeycreepers to extinction, especially on the islands of Hawai‘i and Kaua‘i (Benning et al. 2002).

Native Wildlife and Noise

In addition to its effect on humans, noise can adversely affect wildlife communities in parks by interrupting important communication networks for survival and reproduction between insects, birds, and mammals. For example, certain wildlife communications may signify mating calls, danger from predators, and territorial claims (NPS 2009c).

RARE, UNIQUE, THREATENED, OR ENDANGERED SPECIES

FEDERALLY LISTED SPECIES

Under the ESA of 1973, the NPS has the responsibility to address impacts to federally listed threatened and endangered species. The terms "threatened" and "endangered" describe the official federal status of certain species in the park as defined by the ESA. The term "candidate" is used officially by the USFWS when describing those species for which the USFWS has on file sufficient information on biological vulnerability and threats to support issuance of a "proposed rule to list," but issuance of the proposed listing rule is precluded by higher listing priorities. While listing actions of higher priorities go forward, the USFWS works with several private and government agencies to carry out conservation actions for these species to possibly eliminate the need for listing.

The ESA also requires the designation of "critical habitat" for listed species when "prudent and determinable." Critical habitat includes geographic areas that contain the physical or biological features that are essential to the conservation of the species and may need special management or protection, even if the area is not occupied by the species at the time of listing. Critical habitat designations affect only federal agency actions or federally funded or permitted activities. The ESA requires that such actions avoid “destruction” or “adverse modification” of designated critical habitat (USFWS 2009b).

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As of 2010, 437 plant and animal taxa in Hawai‘i were listed as endangered or threatened by the USFWS, or approximately 30 percent of all such plants and animals listed for the entire United States (USFWS 2010). Based on a review of lists provided by the USFWS (Leonard 2009) and additional information on species in the park provided by NPS staff (NPS 2009j), 35 plants are listed as threatened, endangered, or candidate species under the ESA in the park and its vicinity (NPS 2009e). The park is also home to 13 endangered, 2 threatened, and 3 candidate animal species, including birds, insects, mammals, and reptiles. However, only the endangered, threatened, and candidate species and their habitat that would likely be affected due to non-native ungulate management actions are analyzed and are shown in table 7. These include species historically found in the park (e.g., ‘ō‘ū [*Psittirostra psittacea*] and a‘e [*Zanthoxylum hawaiiense*]) as well as reintroduced and outplanted individuals, the latter a federally listed species translocated to a park unit outside its historic range (NPS 2007d) (e.g., koki‘o [*Kokia drynarioides*]) (NPS 2009j).

TABLE 7: ENDANGERED, THREATENED, AND CANDIDATE SPECIES OF HAWAI‘I VOLCANOES NATIONAL PARK AND ITS SURROUNDING AREAS THAT COULD BE IMPACTED AS A RESULT OF NON-NATIVE UNGULATE MANAGEMENT ACTIONS

Common Names	Scientific Name	Federal Status
Mammals		
Hawaiian hoary bat	*Lasiurus cinereus* ssp. *semotus*	Endangered
Birds		
Nēnē, Hawaiian goose	*Branta sandvicensis*	Endangered
‘Io, Hawaiian hawk	*Buteo solitarius*	Endangered
‘Akiapōlā‘au	*Hemignathus munroi*	Endangered
‘Ākepa, honeycreeper	*Loxops coccineus coccineus*	Endangered
Hawai‘i creeper	*Oreomystis mana*	Endangered
‘Ō‘ū	*Psittirostra psittacea*	Endangered
‘Ua‘u, Hawaiian petrel	*Pterodroma sandwichensis*	Endangered
‘A‘o, Newell’s shearwater	*Puffinus auricularis newelli*	Threatened
‘Akē ‘akē, band-rumped storm petrel	*Oceanodroma castro*	Candidate
Insects		
Pomace fly, hammerhead picture-wing[1]	*Drosophila heteroneura*	Endangered
Flying earwig Hawaiian damselfly	*Megalagrion nesiotes*	Endangered
Pomace fly, Mull’s picture-wing	*Drosophila mulli*	Threatened
Pomace fly, pāpala picture-wing	*Drosophila digressa*	Candidate
Plants		
Palai lā‘au, Pendant Kihi fern	*Adenophorus periens*	Endangered
Ka‘ū, Mauna Loa silversword[1]	*Argyroxiphium kauense*	Endangered
no common name	*Asplenium peruvianum* var. *insulare (A.*	Endangered

Common Names	Scientific Name	Federal Status
	fragile var. *insulare)*	
ʻŌhā wai, Lindsey's ʻōhā	*Clermontia lindseyana*	Endangered
ʻŌhā wai, Pele's ʻōhā	*Clermontia peleana peleana*	Endangered
Hāhā[2]	*Cyanea hamatiflora* ssp. *carlsonii*	Endangered
Hāhā, haʻiwale, kanawao keʻokeʻo[3,4]	*Cyanea shipmanii*	Endangered
Hāhā, haʻiwale, kanawao keʻokeʻo[1]	*Cyanea stictophylla*	Endangered
Haʻiwale[1]	*Cyrtandra giffardii*	Endangered
Haʻiwale	*Cyrtandra tintinnabula*	Endangered
Hau kuahiwi[1]	*Hibiscadelphus giffardianus*	Endangered
Hilo ischaemum[1]	*Ischaemum byrone*	Endangered
Kokiʻo[3]	*Kokia drynarioides*	Endangered
Alani, Zahlbruckner's pelea[1]	*Melicope zahlbruckneri*	Endangered
Maʻaloa	*Neraudia ovata*	Endangered
ʻAiea	*Nothocestrum breviflorum*	Endangered
Hōlei	*Ochrosia kilaueaensis*	Endangered
Kīponapona[4]	*Phyllostegia racemosa*	Endangered
Laukahi kuahiwi[1]	*Plantago hawaiensis*	Endangered
Hawaiʻi hala pepe[1]	*Pleomele hawaiiensis*	Endangered
Poʻe, ʻihi mākole[1]	*Portulaca sclerocarpa*	Endangered
Loulu	*Pritchardia affinis*	Endangered
ʻŌhai[1]	*Sesbania tomentosa*	Endangered
ʻĀnunu; white-bur cucumber[1]	*Sicyos alba*	Endangered
no common name	*Spermolepis hawaiiensis*	Endangered
no common name	*Stenogyne angustifolia*	Endangered
Aʻe, Hawaiʻi pricklyash	*Zanthoxylum hawaiiense*	Endangered
ʻAhinahina, Haleakalā silversword, Hawaiian catchfly[3]	*Argyroxiphium sandwicense* ssp. *macrocephalum*	Threatened
Sheriff's catchfly[1]	*Silene hawaiiensis*	Threatened
ʻAkū	*Cyanea tritomantha*	Candidate
ʻOhe	*Joinvillea ascendens* ssp. *ascendens*	Candidate
Holei[3]	*Ochrosia haleakalae*	Candidate
Many-flowered phyllostegia	*Phyllostegia floribunda*	Candidate
Makou, large-flower native buttercup	*Ranunculus hawaiensis*	Candidate
ʻĀnunu, large-leaved ʻānunu, largeleaf bur-cucumber	*Sicyos macrophyllus*	Candidate

Source: Leonard 2009; NPS 2009j.

[1]Species has designated critical habitat in and adjacent to Hawaiʻi Volcanoes National Park.

[2]Species has critical habitat in and adjacent to the park, but species is not known to occur there.

[3]Outplanted species.

[4]Species located adjacent to the park, but natural populations not known to occur in Hawaiʻi Volcanoes National Park.

Mammals

Endangered

Hawaiian hoary bat (*Lasiurus cinereus* ssp. *semotus*). The Hawaiian hoary bat is an endemic subspecies of the hoary bat, a medium-sized, nocturnal, insectivorous bat with brown and gray, white-tinged fur. Hoary bats are solitary and roost among foliage in trees. The Hawaiian hoary bat has been observed foraging in a variety of both open and more vegetated habits, including over open water and near the edges of native forests. The Hawaiian hoary bat is widely distributed on the Island of Hawai‘i and in the park; it is most frequently observed between sea level and 7,500 feet (2,286 meters) (USFWS 1998b). The breeding season for this species typically occurs from April to August when bats seem to shift into the lowlands of the island (Fraser et al. 2007). The largest populations of the Hawaiian hoary bat are thought to occur on Kaua‘i and Hawai‘i. Population numbers are not fully known; however, the bat is believed to have declined in number over the last 100 years (USFWS 1998b). Threats to the Hawaiian hoary bat include habitat destruction (elimination of roosting sites and vegetation supporting invertebrate food sources) and possibly direct and indirect effects of pesticides, introduced insects, and disease (USFWS 1998b; Fraser et al. 2007).

Birds

Endangered

Hawaiian goose; nēnē (*Branta sandvicensis*). The Hawaiian goose has a black head and nape, buff cheeks and neck with black furrows and is heavily barred above and lighter underneath (NPS 2009e). Habitat for this species is highly variable, and ranges from sparsely vegetated lava flows to scrubland to open grasslands from sea level to approximately 7,000 feet in elevation. At the park, nēnē typically nest on lava flows concealed in patchy vegetation; however, nest site selection varies widely across the state. The nesting season is primarily from October through March. Hatchlings are particularly vulnerable to nutritional inadequacies and severe weather; goslings of all ages are vulnerable to predation prior to fledging. During the non-breeding season, the Hawai‘i Volcanoes National Park nēnē flock typically moves to higher elevations in search of seasonally available forage (including berries) and a wetter climate, as lower-elevation breeding areas often dry out during summer months (NPS 2009e).

Hawaiian goose; nēnē
Source: National Park Service

The total population of Hawaiian geese in the park is small (approximately 200 birds), but it is increasing due to successful breeding seasons as a result of habitat management and predator control. In 2006 and 2007, 40 and 30 fledglings were produced, respectively. In previous years the average count was approximately 15 (NPCA 2008). Threats include predation of adults, goslings and eggs by non-native predators (mongooses, cats, dogs, rats, and pigs), habitat loss, poor quality of some remaining habitat, and vehicle collisions (Pratt et al. 2009).

Hawaiian hawk; ʻio (*Buteo solitarius*). The Hawaiian hawk is small and broad-winged with dark or light plumage. Habitat includes most native and non-native forests (including papaya, guava, and macadamia orchards), grasslands, and cane fields. The Hawaiian hawk is more abundant in windward than in leeward forests, avoids dry scrub areas, and prefers either open savanna or denser rain forest (Audubon 2007; USFWS 1984). Nesting occurs March through September, and eggs are typically laid in late April and early May. Clutch size generally varies from one to three eggs (USFWS 1984). Nesting occurs in the high branches of trees of various kinds and heights, ranging from 32 to 78 feet (10 to 24 meters). In a recent survey, native ʻōhiʻa trees were selected 80 percent of the time (Audubon 2007). The Hawaiian hawk can be found anywhere from near sea level to 8,500 feet (2,590 meters) (USFWS 1984). In the park, individuals are regularly sighted in mesic and wet forest on Kīlauea summit and lower Mauna Loa. In a recent survey of Kahuku unit, birds occurred in mesic and wet koa ʻōhiʻa forest, ʻōhiʻa–māmane–naio subalpine woodland, and open pasture with remnant stands of native forest (Tweed et al. 2007). Threats include destruction or disturbance of nesting habitat, predation, avian diseases, and extensive modification and reduction of native forest habitat (USFWS 1984).

ʻAkiapōlāʻau (*Hemignathus munroi*). The ʻakiapōlāʻau is a medium-sized (5.5 inches [14 centimeters]), stocky, short-tailed, yellow-green (males) or green (females) Hawaiian honeycreeper with a long, sickle-shaped upper mandible and a short, straight lower mandible. All recent observations of this species have been in montane mesic and wet forest dominated by koa and ʻōhiʻa or in subalpine dry forest dominated by māmane and naio. ʻAkiapolaʻau often join mixed-species foraging flocks, possibly to enhance predator detection. Historically, this species was much more common and widespread than it is today, being found in native forest island-wide. Now critical to the ʻakiapolaʻau are forests at higher elevations where mosquitoes are absent or occur only seasonally. ʻAkiapōlāʻau can be found breeding during any month of the year; however, breeding and molting occur primarily from February to July. Nests are most often found in the branches of tall ʻōhiʻa trees (USFWS 2006a).

In the park, ʻakiapōlāʻau, has been detected within the boundaries of Kahuku above Kaʻū Forest Reserve between 5,000 and 6,400 feet (1,525 and 1,950 meters) (Tweed et al. 2007). Detections were made within the boundaries of Kahuku above Kaʻū Forest Reserve (Tweed et al. 2007). Threats to this species include habitat loss and degradation, predation, introduced diseases, and introduction of non-native species. This species is particularly vulnerable to these threats and slow to recover due to its low reproductive rate (USFWS 2006a).

ʻĀkepa (*Loxops coccineus coccineus*). The Hawaiʻi ʻākepa is a red-orange (males) or grayish green (females), 4-inch songbird with an asymmetrical bill. Highest densities of ʻākepa are found in old growth forests with large, canopy-emergent ʻōhiʻa or koa trees. Foraging occurs primarily among ʻōhiʻa leaves, and occasionally among koa leaves and seedpods. Large ʻōhiʻa trees are particularly important to ʻākepa, because they provide both nest sites and the preferred foraging substrate, whereas large koa trees provide primarily cavities (USFWS 2006a). ʻĀkepa are believed to nest exclusively in tree cavities (Tweed et al. 2007). The ʻākepa has a clearly defined breeding season, with nest-building from early March to late May, egg-laying from mid-March to late May, hatching in late March to early June, and fledging from the beginning of April to the end of June (USFWS 2006a).

In the park, ‘ākepa have been detected within the boundaries of Kahuku in subalpine woodland with scattered `ōhi`a trees above the Ka‘ū Forest Reserve. Although suitable nesting trees do not occur in the subalpine woodland in the park, potential nesting trees do occur downslope in mature montane forest (Tweed et al. 2007). The historical range of this species once included much of the island, but ‘ākepa have been extirpated from lower elevations (below 4,300 feet [1,300 meters]), presumably because of the distribution of introduced mosquitoes that transmit avian malaria and avian pox (USFWS 2006a). Additional threats include habitat loss and degradation, introduced predators, and competitors.

Hawai‘i creeper (*Oreomystis mana*). The Hawai‘i creeper is an olive-green to gray honeycreeper with a white chin and throat. Hawai‘i creepers travel in family groups and are most common in mesic and wet forests above 5,000 feet (1,500 meters). The species prefers undisturbed, old-growth forests with large, canopy-emergent ‘ōhi‘a or koa trees, and foraging primarily takes place on the branches, trunks, and foliage of these live trees. Nests have been found from January to August, but peak breeding for this species occurs from February to May. Most Hawai‘i creepers build open cup nests (with a small percentage being cavity nests) at midcanopy at approximately 43 feet (13 meters) in height. The reproductive potential for the Hawai‘i creeper appears to be low due to its small clutch size (usually two eggs), relatively long developmental period, and limited breeding areas (USFWS 2006a). In the park, honeycreepers occur in Kahuku above the Ka‘ū Forest Reserve. All observations of this species in Kahuku have occurred in forest habitat between 5,000 and 6,400 feet (1,525 and 1,950 meters) (Tweed et al. 2007). Threats include modification and loss of habitat, avian diseases, competition with introduced birds, and predation by introduced mammals (USFWS 2006a).

‘Ō‘ū (*Psittirostra psittacea*). ‘Ō‘ū is a heavy-bodied, 7-inch Hawaiian honeycreeper with a thick hooked bill. The upper and lower parts of this bird are varying shades of olive-green, with a bright yellow head distinguishing the male and an olive-green head distinguishing the female. ‘Ō‘ū are historically known from a wide range of forest habitats, extending from sea level to alpine areas; however, ‘ō‘ū are now confined to mid-elevation (3,000 to 5,000 feet [914 to 1,524 meters]) mesic and wet ‘ōhi‘a forests with 47 to 98 inches (1,200 to 2,500 millimeters) annual rainfall. A peak in nesting has been suggested during April and May, but nesting of the ‘ō‘ū has never been described and little is known of its breeding habits (USFWS 2006a).

Historically, this species was found on the islands of Kaua‘i, O‘ahu, Moloka‘i, Lana‘i, Maui, and Hawai‘i, but the last verified sighting was in 1989 on Kaua‘i. In the park, ‘ō‘ū are thought to be extirpated, and may be extinct on the Island of Hawai‘i. A few ‘ō‘ū were noted in ‘Ōla‘a Forest and near Nāhuku (Thurston Lava Tube) in 1959-1961, but none were detected at Makaopuhi and Nāpau. Later detections in the Park were in ‘Ōla‘a Forest in 1975 and 1978, southeast of park headquarters in 1977, and in the eastern lowland forests (Kalapana area) in 1979. The last confirmed sighting of ‘ō‘ū in the park was in ‘Ōla‘a Forest in 1987 (Pratt et al. 2009).

Threats include modification and loss of habitat, avian diseases, and predation. Introduced ungulates have caused forest degradation by reducing or eliminating forest habitat and food resources, and have created mosquito breeding sites, all of which threaten ‘ō‘ū and other forest birds (USFWS 2006a). Although a widespread and adaptable species, the ‘ō‘ū may have been particularly susceptible because it favored lower elevations, where these threats were (and continue to be) more severe (Pratt et al. 2009).

Hawaiian petrel; ‘ua‘u
Source: National Park Service

Hawaiian petrel; ‘ua‘u (*Pterodroma sandwichensis*). The Hawaiian petrel is a seabird that ranges thousands of miles over the central tropical Pacific and nests only on the Hawaiian Islands (Audubon 2007). The ‘ua‘u averages 16 inches (40 centimeters) in length, and has dark gray upperparts with a white forehead and underparts. When ‘ua‘u are not at open sea, their nesting habitat includes bare rock, talus slopes, or the edges of lava flow (USFWS 1983). In the park, Hawaiian petrels nest in colonies primarily above 8,000 feet (2,440 meters) elevation on Mauna Loa at several sites. At the Kahuku Unit on the western slope of Mauna Loa, nesting may extend down to 5,500 feet (1,680 meters) elevation (Pratt et al. 2009). ‘Ua‘u are long-lived and lay only a single egg per year, making this species very susceptible to population declines. During their nesting season ‘ua‘u return to the same nesting burrows every year, entering and exiting their burrows only at night (Audubon 2007). In the park, nesting season begins typically in April and extends through November. Monitoring for nesting activity is not comprehensive, but approximately 30 to 60 active nests are estimated annually for the Mauna Loa Unit. Nesting activity occurs at Kahuku, but the number of nests is unknown (NPS 2009e). Young birds, identified by traces of natal down, occasionally are found in November on roads or near lighted buildings. These individuals were on their nocturnal fledging journey to the sea and collided with some obstruction or became disoriented by artificial lighting. Once at sea, Hawaiian petrels are rarely sighted from shore. The primary threat is predation by introduced feral cats and mongooses (Pratt et al. 2009). Habitat destruction by feral ungulates, and disorientation by artificial lights are additional limiting factors for this species.

Threatened

Newell’s shearwater; ‘a‘o (*Puffinus auricularis newelli*). Ranging from 12 to 14 inches (30 to 36 centimeters) in length, this small to medium-sized seabird has black upperparts, which sharply contrast with its white undersides (USFWS 1983). Newell’s shearwater is a highly pelagic species that forages over deep water east and south of Hawai‘i (Audubon 2007; NESH Working Group 2005). Colonies are typically located in areas of open native forest dominated by ‘ōhi‘a with a dense understory of uluhe fern (NESH Working Group 2005). Newell’s shearwater typically requires an open, downhill flight path to get airborne and thus favors ridge crests or embankments for its nesting habitat (USFWS 1983). Nesting, in which a single egg is laid, occurs from April through November (NESH Working Group 2005). Nests can be found in burrows or deep crevices of high-elevation forests (Audubon 2007). Pushed to extremes to avoid predation by pigs, mongooses, and cats, the birds now nest almost entirely on slopes that exceed 65 degrees (Audubon 2007; NESH Working Group 2005). This species was documented nesting at Makaopuhi Crater in the park, but the site was overrun by lava in 1972 (USFWS 1994b). In summer 2005, researchers were unable to document nesting by ‘a‘o in the park, though numerous incidental auditory detections by park staff in 2003 and 2005, and five predated carcasses discovered over the years suggest that this species still occurs in the park (Swift and Burt-Toland 2009). Threats include nest depredation by introduced predators, collision with powerlines, disorientation by artificial lights, and degradation of habitat by feral ungulates (Audubon 2007; NESH Working Group 2005).

Candidate

Band-rumped storm petrel; ʻakeʻake (*Oceanodroma castro*). This small seabird is a dark sooty-brown with a distinctive white band across the rump. Listed as endangered by Hawaiʻi, the species is uncommon in Hawaiʻi, seen only during the breeding season of April through November (Hawaiʻi Audubon Society 2005). Breeding habitats are not known, but breeding is suspected on Hawaiʻi, Kauaʻi, and possibly Maui. In the park, high-elevation (greater than 8,000 feet [2,438 meters]) nesting is suspected on Mauna Loa. However, while birds have been identified in the area and at least two predated carcasses recovered, nest sites have not been documented. The band-rumped storm petrel is threatened by introduced predators as well as disorienting artificial lights and powerlines (NPS 2009e; Pratt et al. 2009).

Insects

Endangered

Pomace fly; hammerhead picture-wing (*Drosophila heteroneura*). Hammerhead picture-wing is the proposed common name for this species. The picture-wing *Drosophila* have been referred to as the “birds of paradise” of the insect world, due to their relatively large size (0.17 to 0.25 inches [4.32 to 6.35 millimeters]), colorful wing patterns, and the territorial behaviors and elaborate courtship displays of males (USFWS 2006b). This species breeds predominantly in *Clermontia* spp. (ʻōhā) and other lobelioids. Breeding normally occurs year-round, but egg laying and larval development increase following the rainy season as the availability of decaying matter, which the flies feed on, increases in response to the heavy rains (USFWS 2008b). Hammerhead picture-wing is considered to be endemic to the Island of Hawaiʻi where, historically, it was known to be relatively widely distributed between 3,400 and 6,000 feet (1,036 and 1,829 meters) above sea level. Its historical range in the park includes Kahuku, in addition to ʻŌlaʻa and Thurston (USFWS 2006b). In the 1930s, visitors to the park were directed to montane mesic forest kīpuka to see one of the species’ major host plants, *Clermontia hawaiiensis*. These mesic kīpuka were used as cattle paddocks as recently as the 1940s and *Clermontia hawaiiensis* was no longer present in the kīpuka in the early 1970s. The absence of host plants in many areas of the park can likewise be directly attributed to ungulate activity (Foote, pers. comm., 2009b). There are three documented extant populations: private land at Hualālai Volcano where it was last observed in 1993; a site at approximately 4,436 feet (1,352 meters) above sea level near a host plant species, *Clermontia clermontioides*, last observed in 1998; and at the Kona Unit of the Hakalau Forest National Wildlife Refuge, last observed in 2001 (USFWS 2006b).

The historical distribution of the hammerhead picture-wing in the park was probably limited by decreased forest cover or loss of suitable food material as a result of past and current feral ungulate activity. In addition, fire and the resulting invasion of fire-adapted non-native plants threaten habitat of this species in dry to mesic grassland, shrubland, and forests on the island (USFWS 2008b). Critical habitat for this species has been designated on 4,582 acres on Hawaiʻi, 687 acres of which are located in the park. The primary constituent elements for Hammerhead picture-wing are as follows:

1. Mesic to wet, montane, ʻōhiʻa and koa forest between the elevations of 2,980 to 5,755 feet (908 to 1,754 meters).
2. The larval stage host plants *Cheirodendron trigynum* ssp. *trigynum*, *Clermontia clermontioides*, *C. clermontioides* ssp. *rockiana*, *C. hawaiiensis*, *C. kohalae*, *C. lindseyana* (endangered), *C. montis-loa*, *C. parviflora*, *C. peleana* (endangered), *C. pyrularia* (endangered), and *Delissea parviflora*, which exhibit one or more life stages (from seedlings to senescent individuals) (USFWS 2008b).

Flying earwig Hawaiian damselfly (*Megalagrion nesiotes*). This endangered insect is a large and elongated damselfly, endemic to Hawai‘i. Males are up to 5 centimeters long and have a silvery blue-grey color. Females are predominantly brownish in color and are more rarely seen. In the late 19th century, the flying earwig Hawaiian damselfly was observed from Hā‘ao Springs in Ka‘ū Forest Reserve below the southeast boundary of Kahuku Unit to Kīlauea and the region of the park in Puna District. The species is currently known to occur in streambanks in moist to wet montane forest from about 1,000 to 3,000 feet (300 to 900 meters) elevation on East Maui. Most recent observations come from dense banks of uluhe fern mats (*Dicranopteris linearis*). Its habits suggest that its immatures may inhabit damp fern litter, similar to a related species (*Megalagrion oahuense*) on the Island of O‘ahu (Pratt et al. 2009). Extensive tracts of uluhe fern habitat in the park have not yet been surveyed for this damselfly. Without such surveys, it is premature to state that the species is extirpated from the Island of Hawai‘i and the park (Foote, pers. comm., 2009b). This species was last observed on East Maui in 2005. There is evidence of long-term decline in streamflow in this region of east Maui, and the combination of drought and stream diversions over the last decade may have led to this damselfly’s extinction. More recently, the uluhe fern banks formerly occupied by this species have become overtopped by a non-native weed (Koster’s curse, *Clidemia hirta*) (Pratt et al. 2009). Other threats to this species include agriculture/urban development and habitat modification by non-native ungulates (74 FR 32490–32510).

The flying earwig Hawaiian damselfly was listed as federally endangered by the USFWS in June 2010. Although the USFWS finds that designation of critical habitat is prudent for the species, it is unable to identify the physical and biological features that are considered essential to the conservation of the species (i.e., primary constituent elements). Therefore, the USFWS finds that critical habitat for the flying earwig Hawaiian damselfly is not determinable at this time, and the agency intends to continue gathering information regarding the essential life history requirements of the species to facilitate identification of essential features and areas (75 FR 35990-36012).

Threatened

Pomace fly; Mull’s picture-wing (*Drosophila mulli*). The proposed common name for *Drosophila mulli* is Mull’s picture-wing. This species has very few markings on its thorax and wings, compared to most other picture-wings. Similar to Hammerhead picture-wing, this species is restricted to the Island of Hawai‘i. *D. mulli* has only been observed on or under the native loulu palm (*Pritcharida beccariana*). The loulu palm is identified as the host plant for this species (USFWS 2006b). Plants are found in ‘Ōla‘a Unit in the park and in the adjacent State-owned forest at Ōla‘a Forest Reserve and in upper Waiakea Reserve. USFWS has identified at least two separate populations of the fly based on collections from *Pritchardia* located in the State-owned upper Waiakea Reserve and ‘Ōla‘a Forest Reserve. Rats and non-native beetles are both unchecked seed predators of the palm, and no fencing or rat control has been implemented in the state reserve (Foote, pers. comm., 2009b). The last recorded observation at the ‘Ōla‘a Forest Reserve site occurred in 2001 (USFWS 2006b). Similar to other picture-wing fly species, primary threats include non-native wasp predation and loss of host plants. Many hosts of drosophilids are among the most susceptible to damage from non-native ungulates, especially when combined with competition from non-native plants. In addition, microclimate alteration, such as opening of the canopy or understory, may also adversely affect the flies, either directly through increased desiccation or by causing host plants to dry more rapidly and rot differently (Magnacca et al. 2008).

Candidate

Pomace fly; pāpala picture-wing (*Drosophila digressa*). The proposed common name for this species is the pāpala picture-wing, because of its close association with pāpala (*Charpentiera obovata*). Pāpala picture-wing generally occurs in mesic to wet forests ranging in elevation from 4,200 to 4,600 feet (1,280 to 1,402 meters), and is endemic to the Island of Hawai'i (USFWS 2009j). In the park, host plants of suitable size to provide breeding habitat are limited to 'Ōla'a Forest but, like *Clermontia hawaiiensis*, pāpala once grew to large stature in montane mesic kīpuka of the park. Park staff have been replanting it in mesic sites over the last several decades, but the trees are not yet the same stature as those in 'Ōla'a Forest where pāpala picture-wing has been found. Feral pigs degrade and destroy host plants and habitat in 'Ōla'a Forest by directly trampling plants and spreading non-native plant seeds (73 FR 75175–75244; USFWS 2009j). In addition, feral pigs probably eat young plants and uproot them while digging in the soil for invertebrates (USFWS 2009j). Non-native plants degrade host plant habitat and compete for light, space, and nutrients (73 FR 75175–75244). The greatest threat to this species is loss of host plants (USFWS 2009j). In areas where pigs have been removed, the black twig-borer can also cause serious damage to *Charpentiera* (Davis 1970; Foote, pers. comm., 2009b). Direct predation by non-native social insects, particularly yellowjacket wasps, is also a serious threat (73 FR 75175–75244). Pāpala picture-wing has been known to occur in the park, but has neither been confirmed nor collected on the island since 2006 despite general *Drosophila* surveys in its historical habitat (USFWS 2009j).

Plants

Endangered

Pendant Kihi fern; palai lā'au (*Adenophorus periens*). Palai lā'au is a small to medium-sized epiphytic (not rooted on the ground) fern. Its yellowish green fronds that taper at each end are usually between 4 to 16 inches (10 to 40 centimeters) long and covered with hairs (Pratt et al. 2009; USFWS 1999). Currently, palai lā'au is restricted to Hawai'i, Moloka'i, and Kaua'i at 2,300 to 4,260 feet (700 to 1,300 meters) in elevation. The largest Island of Hawai'i population is in Kahauale'a Natural Area Reserve, adjacent to the park (Pratt et al. 2009). It is possible that this species is extirpated from the park (Pratt et al. 2009). Historically, this species was found growing on trees in wet forests in the East Rift near or on Kane Nui o Hamo as late at the 1980s (Pratt et al. 1999). Unconfirmed reports also indicate this species may have been found in the 'Ōla'a area of the park (Higashino et al. 1988). On the Island of Hawai'i, the primary threat to this species is habitat degradation by pigs, which damage the understory plants, altering the moist, shady conditions apparently required by the fern. Other threats include infestation and replacement of native wet forest with non-native plant species (namely strawberry guava), habitat destruction by fires, and fumes from volcanic eruptions. As of 1999, it is estimated that the total number of individuals in the state may be less than 2,000 (USFWS 1999). Park recovery efforts have included fencing to exclude feral ungulates and controlling non-native plants from portions of wet forest in the East Rift and 'Ola'a.

Mauna Loa Silversword; Ka‘ū
Source: National Park Service

Mauna Loa silversword; Ka‘ū (*Argyroxiphium kauense*). Ka‘ū is a single stemmed or sparingly branched rosette shrub that reaches approximately 8 feet (2.5 meters) tall when flowering, and is topped by a rosette of silvery hairy leaves. Flowering generally occurs in August to September (Pratt et al. 2009). Endemic to the Island of Hawai‘i, Ka‘ū is known from three sites on Mauna Loa from 5,330 to 6,230 feet (1,625 to 1,900 meters) in elevation: Kahuku Unit, Kapāpala Forest Reserve, and Upper Waiākea Forest Reserve (NPS 2009j; Pratt et al. 2009). The only natural occurring population in the park contains approximately 700 individuals in a fenced exclosure at Kahuku at approximately 6,000 feet (1,829 meters) in an woodland transitional between closed forest and subalpine. Ka‘ū was introduced to the park’s Mauna Loa Unit in 1975, and in 1999–2005 thousands of seedlings were planted in two exclosures on the Mauna Loa Strip near 7,000 feet (2,135 meters) in elevation. Plantings have also been made in three new ungulate-proof exclosures at Kahuku (Pratt et al. 2009). In total, over 15,000 individuals have been planted inside protected fenced units in the park.

Individuals were first documented at Kahuku in the 1950s and were originally named *A. sandwicense* var. *kauense*. The named variety was elevated to its own species in 1957 and listed as endangered in 1993. Surveys conducted by Jacobi and Warshauer in the 1970s indicated more plants were present 30 years ago than today. Jacobi estimated the extent of Ka‘ū occurrence to be at least 10 times the current range at Kahuku (Jacobi and Warshauer 2006, as cited in Benitez et al. 2008). The small population sizes and possible inbreeding depression may pose threats to the species (USFWS 1996b). The most immediate threats, however, are non-native ungulates, primarily sheep, mouflon sheep, goats, and pigs (Pratt et al. 2009; USFWS 1996b). Critical habitat was designated for this species in four units totaling 14,431 hectares (35,657 acres) on the Island of Hawai‘i (USFWS 2009e). Part of its critical habitat is found in Hawai‘i Volcanoes National Park (Leonard 2009). The primary constituent elements for Ka‘ū are as follows:

1. Landform/forest type: moist, open forest; subalpine mesic shrubland; bogs; and weathered, old pāhoehoe or ‘a‘ā lava with well developed pockets of soil.
2. Plant community: *Asplenium peruvianum* var. *insulare*, *Carex alligata*, *Carex* sp., *Coprosoma ernodeoides*, *Coprosoma montana*, *Deschampsia nubigena*, *Dodonaea vascosa*, *Dubautia ciliolata*, *Gahnia gahniiformis*, *Geranium cuneatum*, *Leptecophylla tameiameiae*, *Metrosideros polymorpha*, *Plantago hawaiensis*, *Rhynchospora chinensis*, *Silene hawaiiensis*, or *Vaccinium reticulatum*.
3. Elevation: from 5,193 to 8,024 feet (1,583 to 2,246 meters) (USFWS 2003).

***Asplenium peruvianum* var. *insulare* (*Asplenium fragile* var. *insulare*)**. *Asplenium fragile* var. *insulare*, a member of the spleenwort family (Aspleniaceae), is an endangered fern with a short suberect stem and leaf stalks from 2 to 6 inches (5 to 15 centimeters) long (USFWS 1998a). This species is currently known to occur in eight populations on Hawai‘i between elevations of 5,250 and 7,800 feet (1,600 and 2,377 meters); those nearest to the park are Kūlani Correctional Facility, Kapāpala, and Ka‘ū forest reserves (Pratt et al. 2009; USFWS 1998a). *A. fragile* var. *insulare* was historically collected at additional sites on Mauna Kea, Mauna Loa, Hualālai, and near Hilo (Pratt et al. 2009). The Mauna Loa Unit above 5,500 feet (1,680 meters) in elevation and Kahuku Unit above 6,030 feet (1,840 meters) contain the only known populations of this fern in the park. One lava tube in the Mauna Loa Unit has supported a population of *A. fragile* var. *insulare* since 1943 (Pratt et al. 2009). At Kahuku, this species was found at four subalpine sites above Ka‘ū Forest Reserve (Benitez et al. 2008; Pratt et al. 2009). In the park, this species is known to occur in subalpine, montane seasonal, and alpine/aeolian environments, which are described in the “Vegetation” section of this chapter (NPS 2005a; USFWS 1998a). It is generally restricted to large-diameter, moist lava tubes at high elevation (Benitez et al. 2008; Pratt et al. 2009). The fern is typically found on tube walls and ceilings in the lighted zone near the opening, but some individuals have been found in deep, dark recesses of lava tubes. The fern has also been observed growing in lava cracks and on cliffs (Pratt et al. 2009). Feral goats and mouflon sheep are potential threats to *Asplenium fragile* var. *insulare,* although it seems to persist in lava tubes (Pratt et al. 2009; USFWS 1998a). Additional threats may include non-native plant species that infest lava tubes, such as common mullein (*Verbascum thaspus*) (Pratt et al. 2009). Park recovery efforts have included fencing to exclude feral ungulates and control of mullein in the Mauna Loa Unit.

Lindsey’s ‘ōhā wai; (*Clermontia lindseyana*). Lindsey’s ‘ōhā wai is a perennial tree that grows from approximately 8 to 20 feet (2.5 to 6 meters) tall. It can be either terrestrial or epiphytic, living on the surface of other plants (Pratt et al. 2009; USFWS 1996a). The extant populations of Lindsey’s ‘ōhā wai grow on the Island of Hawai‘i and the leeward slopes of Haleakalā, East Maui (Pratt et al. 2009). On the Island of Hawai‘i, plants have been reported from eastern Mauna Kea and eastern, southeastern, and southwestern Mauna Loa at elevations above 4,300 feet (1,311 meters) (Benitez et al. 2008; USFWS 1996a). In 1996, there were 12 known populations and 86 individuals thought to persist on the island. In the park, this species is known to occur naturally in several sites in the Kahuku Unit. These sites were found in mesic to wet ‘ōhi‘a forest located adjacent to the Ka‘ū Forest Reserve at 5,905 to 6,234 feet (1,800 to 1,900 meters) in elevation (Benitez et al. 2008; NPS 2009j; Pratt et al. 2009). Among the major threats to Lindsey’s ‘ōhā wai are trampling and grazing by cattle, trampling and browsing by goats, and rooting and trampling by pigs (USFWS 1996a). A 2008 survey indicated extensive damage from pig activity and either feral cattle or mouflon sheep browsing in the areas of Kahuku where ‘ōhā wai were observed (Benitez et al. 2008). Currently the species is protected in ungulate-free exclosures only in Hakalau Forest, Kūlani, and Kīlauea forest and as planted individuals inside fenced exclosures in the Mauna Loa and Kahuku Units of the park. A 2008 survey indicated extensive damage to naturally occurring individuals from pig activity and either feral cattle or mouflon sheep browsing in the areas of Kahuku where ‘ōhā wai were observed (Benitez et al. 2008).

Pele’s ‘ōhā wai; (*Clermontia peleana* subsp. *peleana*). Pele’s ‘ōhā wai is an epiphytic shrub or small tree that grows between 5 and 20 feet (1.5 and 6 meters) tall on large ‘ōhi‘a, koa, and ‘olapa trees (Pratt et al. 2009; USWFS 1996a). Endemic to the islands of Maui and Hawai‘i, plants have been found in rainforests of East Maui, and windward Mauna Kea and Mauna Loa between 1,740 to 3,770 feet (530 to 1,150 meters) elevation (Pratt et al. 2009; USFWS 1996a). In 1996, there were four known populations on the Island of Hawai‘i, consisting of a total of eight individuals (Pratt et al. 2009). This species was thought to be extinct in the wild when the last individual died by 2000. Recently, six individuals were discovered along the Wailuku River. Major habitat destruction resulting from non-native ungulates, particularly pigs, is a primary cause of the decline of this taxon. Slugs are also thought to be a limiting factor. Since 2001, the park has planted nearly 400 individuals in protected sites in the park’s ‘Ōla‘a Forest from which feral pigs have been removed (NPS 2009e).

Hāhā (*Cyanea hamatiflora* ssp. *carlsonii*). This species is a palm-like tree that grows to a height of approximately 10 to 26 feet tall (3 to 8 meters). It is typically found in ‘ōhi‘a-dominated montane wet forests at elevations between 4,000 and 5,700 feet (1,219 and 1,737 meters) (USFWS 1996a). There are only two known extant populations, both on the Island of Hawaiʻi, located on privately and state-owned land at Honuaula Forest Reserve and Keokea. At the time of federal listing, the two populations contained approximately 19 individuals. The declining Honuaula population currently has only 2 individuals, and the Keokea population contains 15 individuals (USFWS 2009f). Two subpopulations were planted in 1995 and 1996 in the native range: 45 individuals at Honuaula Forest Reserve and 6 individuals at Puʻuwaʻawaʻa (USFWS 1996a). In addition, two individuals were outplanted in a fenced area in South Kona in 2006 and one in Kīpāhoehoe Natural Area Reserve in 2008. The current status of the outplanted individuals, however, is not known (USFWS 2009f). Non-native plants are a serious threat to the long-term survival of this species. In addition, grazing and trampling by cattle and uprooting by feral pigs degrade habitat and open major sites for non-native plant invasion (USFWS 1996a). Although no plants have been documented in the park, designated critical habitat for Hāhā lies adjacent to the park (Leonard 2009; NPS 2009e). As mentioned previously, the ESA requires that such actions avoid "destruction" or "adverse modification" of designated critical habitat (USFWS 2009b). The primary constituent elements for this species on the Island of Hawaiʻi are as follows:

1. Landform/forest type: Mesic montane forest dominated by *Acacia koa* or *Metrosideros polymorpha*.
2. Plant community: *Athyrium* sp., *Cibotium* spp., *Clermontia clermontioides*, *Coprosma* sp., *Dryopteris* sp., *Hedyotis* sp., *Ilex anomala*, *Myoporum sandwicense*, or *Sophora chrysophylla*.
3. Elevation: 4,482 to 5,759 feet (1,366 to 1,755 meters) (USFWS 2003).

Hāhā (*Cyanea shipmanii*). *C. shipmanii* is a small unbranched or sparsely branched shrub that grows to a height of 8 to 13 feet (2.5 to 4 meters). This species is distinguished by its small flowers, slender stems, and stalked and divided leaves. Preferred habitat includes montane mesic forest dominated by ʻōhiʻa on the windward slopes of Hawaiʻi, at elevations between 5,400 and 6,200 feet (1,650 and 1,900 meters). At the time of federal listing in 1994, only four populations were known, containing fewer than 10 individuals (USFWS 1996a). By 2007, the species had declined to only 2 extant wild individuals in Upper Waiākea Forest Reserve and Puʻu Kipu Unit of the Kīlauea Reserve (USFWS 2009g). Just outside the park, a lone individual of *C. shipmanii* was recently discovered along the Kahuku boundary (PEPP 2009). Major threats to this species include non-native ungulates and non-native plant species (USFWS 1996a; USFWS 2009g). In particular, the remaining wild individual in the Upper Waiākea Forest Reserve is threatened from habitat destruction due to pigs and herbivory or disturbance by sheep. The Kīlauea populations are at risk from fruit and seed predation by rats (USFWS 2009g).

Hāhā; haʻiwale; kanawao keʻokeʻo (*Cyanea stictophylla*). *C. stictophylla* is a small tree or shrub approximately 2 to 20 feet (0.6 to 6 meters) in height. The stems are sparsely branched and occasionally equipped with sharp outgrowths. Hāhā is distinguished from other taxa in the genus by its large, deeply lobed flowers and small calyx lobes (USFWS 1996a). This species is endemic to the Island of Hawaiʻi, and is known from Kona and Kaʻū districts at elevations of 4,590–6,400 feet (1,400–1,950 meters) (Pratt et al. 2009). Preferred habitat of hāhā is generally lowland to montane, mesic to wet forest dominated by ʻōhiaʻa and koa (USFWS 1996a). In Hawaiʻi Volcanoes National Park, two plants were discovered inside a pit crater, which is not accessible to ungulates, located in the Kahuku pasture/mesic forest zone at 3,281 feet (1,000 meters) elevation (Benitez et al. 2008; NPS 2009j, 2009e). In 1996, there were three known populations and fewer than 20 known individuals on the Island of Hawaiʻi, with 46 outplanted individuals persisting in exclosures on Puʻuwaʻawaʻa and Kaʻū Forest Reserve. The primary reasons for decline of this species are destruction of habitat by cattle grazing and feral pigs (USFWS 1996a). Feral goats and mouflon sheep are also threats to this soft-wooded species (Pratt et al. 2009). The park is currently propagating and planting individuals inside protected exclosures. Critical habitat for this species is found in Hawai‘i Volcanoes National Park (Leonard 2009). The primary constituent elements for *C. stictophylla* on the Island of Hawai‘i are as follows:

1. Landform/forest type: *Acacia koa* or wet *Metrosideros polymorpha* forests.
2. Plant community: *Cibotium* sp., *Melicope* spp., *Urera glabra*.
3. Elevation: 3,466 to 6,288 feet (1,056 to 1,917 meters) (USFWS 2003).

Ha‘iwale (*Cyrtandra giffardii*). *Cyrtandra giffardii* is a small shrubby tree that grows from 10 to 20 feet in height with opposite leaves positioned on the upper nodes of the stem. The habitat for this species is found in mesic/wet forest environments dominated by tree fern at elevations between 2,400 and 4,900 feet (720 and 1,500 meters). In 1996, there were 11 known populations and more than 1,000 known individuals on the Island of Hawai‘i. As of 1994, 90 known individuals occurred in the Koa and Pu‘u fenced units of ‘Ōla‘a Forest in Hawai‘i Volcanoes National Park. Subsequent surveys identified several plants in adjacent fenced units (Pratt et al. 2009). The major threat to Ha`iwale is rooting and trampling by pigs and competition from invasive plants Known plants in the park are located in areas that have been fenced and managed to exclude pigs and control of non-native plants are carried out in portions of these units (USFWS 1996a). Critical habitat for this species is found in Hawai‘i Volcanoes National Park (Leonard 2009). The primary constituent elements for *C. giffardii* on the Island of Hawai‘i are as follows:

1. Landform/forest type: wet montane forest dominated by *Cibotium* sp. or *Metrosideros polymorpha*, and *Metrosideros polymorpha–Acacia koa* lowland wet forests.
2. Plant community: *Astelia menziesiana*, *Diplazium sandwichianum*, *Hedyotis terminalis*, *Perrottetia sandwicensis*, or other species of *Cyrtandra*.
3. Elevation: 2,146 to 4,723 feet (654 to 1,440 meters) (USFWS 2003).

Ha‘iwale (*Cyrtandra tintinnabula*). This endangered small shrub grows from approximately 3 to 7 feet (1 to 2 meters) in height. Its papery, toothed leaf blades are moderately covered with yellow-brown hairs. *C. tintinnabula* grows in lowland wet/mesic forest environments dominated by dense koa, ‘ōhi‘a, and tree fern (USFWS 1996a). This species is endemic to the Island of Hawai‘i and generally occurs between 2,390 and 3,410 feet (730 and 1,040 meters) elevation (Pratt et al. 2009). In 1996, there were three known populations and 18 known individuals on the Island of Hawai‘i (USFWS 1996a).In the park, *C. tintinnabula* was discovered in July 2001 growing on the lower walls of a prominent geological feature (‘Ōla‘a Trench) and two adjacent craters in the northeast quarter of ‘Ōla‘a Forest at 3,609 feet (1,100 meters) elevation (NPS 2009j; Pratt et al. 2009). Rooting and browsing by feral pigs directly damage and disturb the habitat of this species, breaking its weak and delicate stems. Because much of the native habitat is lost, appropriate pollinators may also be absent (USFWS 1996a).

Hau kuahiwi (*Hibiscadelphus giffardianus*). Hau kuahiwi is an endangered tree species that can grow up to 39 feet (12 meters) tall. Endemic to the Island of Hawai‘i, this species occurs naturally only at Kīpuka Puaulu near 4,000 feet (1,220 meters) elevation (NPS 2009j; Pratt et al. 2009). When it was discovered in 1911, there was only one tree remaining, which was found on the edge of a collapsed lava tube on the southwestern edge of the kīpuka (Pratt et al. 2009). At the time of federal listing in 1996, hau kuahiwi was extinct in the wild and known only from 11 reintroduced individuals at Kīpuka Puaulu in the park. Planted individuals are also found at Kīpuka Kī and a handful of sites in the montane seasonal environment of the Mauna Loa Strip, which is described in the “Vegetation” section of this chapter (NPS 2005a, 2009e; Pratt et al. 2009). As of 2008, the number of known planted individuals is estimated at over 400 (USFWS 2008f). In the past, habitat degradation and predation by cattle and feral pigs, as well as goats, were major threats to Hau kuahiwi. These threats have been controlled by the park, and all naturally occurring and planted individuals are in fenced areas. Current threats include competition from non-native plant species, fire, and rats that strip the bark and eat the seeds (Pratt et al. 2009; USFWS 2008f). In addition, the recently introduced two-spotted leaf hopper attacks the foliage of the plant species and may contribute to drought damage (Pratt et al. 2009). Critical habitat for this species is found in Hawaiʻi Volcanoes National Park (Leonard 2009). The primary constituent elements for Hau kuahiwi on the Island of Hawaiʻi are as follows:

1. Landform/forest type: mixed montane mesic forest.
2. Plant community: *Acacia koa*, *Coprosma rhynchocarpa*, *Dodonaea viscosa*, *Melicope* spp., *Metrosideros polymorpha*, *Myoporum sandwicense*, *Nestegis sandwicensis*, *Pipturus albidus*, *Psychotria* sp., *Sapindus saponaria*.
3. Elevation: 3,914 to 4,181 feet (1,193 to 1,274 meters) (USFWS 2003).

Hilo ischaemum (*Ischaemum byrone*). This perennial grass is distinguished from other native Hawaiian grasses by its tough outer flower bracts and dissimilar basic flower units. It contains creeping underground stems and erect stems that grow from 16 to 31 inches (40 to 80 centimeters) in height (USFWS 1996a). This perennial grass is found in scattered locations on the windward coastlines of Maui, Moloka`i, and Hawai`i islands. In 1996, there were 17 known populations and several thousand known individuals on the Island of Hawaiʻi (USFWS 1996a). In the park, Hilo ischaemum was found naturally along the immediate shoreline among boulders and rocks or in cracks in the pāhoehoe surface in the eastern coastal lowlands from Kamoamoa to Lae ʻApuki (Pratt et al. 2009). All of these sites were covered by lava flows from 1993 through 2006. Plants were salvaged from the largest population at Kamoamoa, propagated ex situ, and their progeny were planted at Lae Apuki, Hōlei Sea Arch, Kealakomo, Kahue, Kaʻaha, and Kalue in more western and drier locations than the naturally occurring populations. In 2010, less than 1% of the planting survived, almost but one of these plantings at the eastern most site at Hōlei Sea Arch. The most immediate threat to Hilo ischaemum in the park is lava flows. Feral goats may also be a potential threat (Pratt et al. 2009). Critical habitat for this species is found in Hawaiʻi Volcanoes National Park (Leonard 2009). The primary constituent elements for Hilo ischaemum on the Island of Hawaiʻi are as follows:

1. Landform/forest type: coastal wet to dry shrubland; near the ocean; rocks or pāhoehoe lava in cracks and holes.
2. Plant community: *Fimbristylis cymosa*, *Scacevola taccada*.
3. Elevation: 0 to 91 feet (0 to 28 meters) (USFWS 2003).

Kokiʻo (*Kokia drynarioides*). This small tree is endemic to the leeward slopes of Hualālai in North Kona on the Island of Hawaiʻi between 1,510 and 2,950 feet (460 and 900 meters) elevation (Pratt et al. 2009; USFWS 1994a). It reaches up to approximately 26 feet (8 meters) tall and has shallowly lobed leaves with large, ornamental, scarlet flowers (Pratt et al. 2009). This tree inhabits dry forests on rough, relatively unweathered lava flows and is found in mid-elevation and montane seasonal environments (NPS 2005a; USFWS 1994a). Kokiʻo is not historically known in the park; individuals were outplanted at Kīpuka Puaulu, Kīpuka Kī, Kīpuka Nēnē, Hilina Pali, and ʻĀinahou Ranch between 1924 and 1958, but only the Kīpuka Nēnē planting persists (NPS 2009e; Pratt et al. 2009). Currently, two populations exist: the first at Kaʻūpūlehu, located outside the park, containing one mature individual; and the second population at Kīpuka Nēnē, containing a single surviving individual. Seventy-five outplanted individuals at Kaʻūpūlehu appear to be reproducing (USFWS 2009h). Fire is a serious threat to the remaining trees due to the invasion of fire-prone non-native grasses. Past threats included domestic cattle and feral goats, which browsed and damaged native trees of the dry forests of North Kona, and interfered with tree reproduction and recruitment. Insects such as Chinese rose beetle are also reported to attack kokiʻo leaves (Pratt et al. 2009).

Zahlbruckner's pelea; alani (*Melicope zahlbruckneri*). This endangered tree is endemic to the southeastern portion of the Island of Hawai'i and reaches approximately 33 to 39 feet (10 to 12 meters) tall. This tree is known from few sites, including Kīpuka Puaulu and Moa'ula in Ka'ū District; Glenwood in Puna District; and recently reported from Laupāhoehoe Natural Area Reserve in Hamākua District (Pratt et al. 2009). In Hawai'i Volcanoes National Park, only one naturally occurring population of 20 trees is known (NPS 2009e; Pratt et al. 2009) from montane seasonal forest in Kīpuka Puaulu (NPS 2009j; Pratt et al. 2009). Four plants of alani have also been successfully planted at Kīpuka Kī (Pratt et al. 2009). Inside the park, ungulate threats have been controlled (USFWS 2008f). Current threats include seed predators, such as rats and insects; loss of natural pollinators; the recently introduced two-spotted leaf hopper; and competition from non-native plant species (Pratt et al. 2009; USFWS 2008f). Critical habitat for this species is found in Hawai'i Volcanoes National Park (Leonard 2009). The primary constituent elements for alani on the Island of Hawai'i are as follows:

1. Landform/forest type: *Acacia koa–Metroideros polymorpha* dominated montane mesic forest.
2. Plant community: *Coprosma rhynchocarpa*, *Melicope* spp., *Myoporum sandwicense*, *Nestegis sandwicensis*, *Pipturus albidus*, *Pisonia brunoniana*, *Psychotria hawaiiensis*, *Sapindus saponaria*, *Zanthoxylum dipetalum*.
3. Elevation: 3,476 to 4,383 feet (1,060 to 1,336 meters) (USFWS 2003).

Ma'aloa (*Neraudia ovata*). This endangered sprawling shrub is endemic to the leeward side of the Island of Hawai'i between 980 and 4,820 feet (300 and 1,470 meters). Its stems can reach approximately 3 to 9 feet (0.9 to 2.7 meters) long and male and female flowers are borne on separate plants. This shrub inhabits dry forests, open lava flows, and subalpine forest. Currently remaining natural populations of Ma'aloa include 14 to 18 mature individuals and up to 125 immature individuals. At the time of federal listing, the species was known from 11 individuals in two populations. In addition, plantings at various locations on the island, have resulted in approximately 327 individuals (USFWS 2008c). While the natural population of Ma'aloa was extirpated from the park, individuals were recently planted near the presumed original site, as well as at Kīpuka Kī and several sites along Hilina Pali Road (Pratt et al. 2009). The plantings of Ma'aloa the park are all in fenced units managed to exclude goats and mouflon sheep. Threats to this species include browsing by ungulates, competition with non-native shrubs and grasses, and insects (particularly the spiraling whitefly) (Pratt et al. 2009).

'Aiea (*Nothocestrum breviflorum*). Endemic to the Island of Hawai'i at elevations of 1,800 to 6,000 feet (550 to 1,830 meters), this tree species grows from approximately 33 to 39 feet (10 to 12 meters) in height. The trunk, about 18 inches (45 centimeters) in diameter, has a soft, sappy wood with dark brown bark. Habitats of 'aiea are found in montane seasonal environments, lowland dry forest, montane dry forest, and montane mesic forest (USFWS 1996a). Individuals generally occur on 'a'ā lava substrates at elevations ranging from 260 to 6,000 feet (180 to 1,830 meters). In 1996, there were six known populations on the Island of Hawai'i. In the park, this species was reported from dry forest near 1,804 feet (550 meters) to mesic forest at 4,300 feet (1,310 meters) (Pratt et al. 2009). The species was lost from these historical sites and exists in the park today only as plantings at Kīpuka Puaulu and Nāulu in areas fenced and protected from goats, mouflon sheep and cattle (Pratt et al. 2009). On the island, this species has been negatively impacted by cattle and sheep grazing, and by the introduction of non-native plant taxa such as Brazilian peppertree, which may afford enough fuel to support a destructive fire (USFWS 1996a).

Hōlei (*Ochrosia kilaueaensis*). Hōlei is a medium-sized tree, endemic to the Island of Hawai'i at elevations between 2,200 and 4,000 feet (670 and 1,220 meters). It grows to about 50 to 60 feet (15 to 18 meters) in height and contains a milky sap. It is found in montane seasonal environments and occurs at elevations between 2,200 and 4,000 feet (670 to 1,220 meters) (USFWS 1996a). In 1996, there was one possible extant population at Pu'uwa'awa'a on state-owned land; however, the population was last collected at an unknown date, and it is unknown how many individuals are present in the population, if any (USFWS 1996a). In the park, hōlei is known only from Kīpuka Puaulu, where the last tree was observed in 1927. It is now considered to be likely extirpated from the park, and possibly extinct (NPS 2009j; Pratt et al. 2009). If the species is still extant, potential threats include goats, domestic cattle, pigs, sheep, fire, and non-native plants. Feral goats browse and trample the native vegetation, disturbing the substrate and understory. Predation of fruits by black rats is also a potential threat to the viability of this species (Pratt et al. 2009; USFWS 1996a).

Kīponapona (*Phyllostegia racemosa*). Kīponapona is in the mint family (Lamiaceae), and is a climbing vine with many-branched, square stems and spicy-smelling leaves. Flower clusters, densely covered with short, soft hairs, are composed of 6 to 12 flowers. It is typically found epiphytically in disturbed koa, ʻōhiʻa, and hāpuʻu-dominated montane mesic or wet forests, at elevations between 4,650 and 6,070 feet (1,400 and 1,850 meters) (HDLNR 2005b). Although individuals were listed by USFWS as part of the park flora (Leonard 2009), no natural plants have been documented in the park. Outplantings of some individuals were made in the park, but none survived (NPS 2009e). Threats include habitat disturbance by feral pigs and cattle, logging, competition from non-native plant taxa, habitat change due to volcanic activity, and risk of extinction from naturally occurring events and/or reduced reproductive vigor due to the small number of existing populations and individuals (HDLNR 2005b).

Laukahi kuahiwi (*Plantago hawaiensis*). Laukahi kuahiwi is a perennial herb characterized by thick, leathery basal leaves and short stem containing red-brown wooly hairs (USFWS 1996a). It occurs at elevations from 5,900 to 8,040 feet (1,800 to 2,450 meters) mainly on the leeward side of the island, and its habitat is somewhat variable (USFWS 1996a). Laukahi kuahiwi grows in either montane wet sedgeland with mixed sedges and grasses, or in montane mesic forest growing with stunted koa and ʻōhiʻa; it is sometimes found growing in cracks in lava (USFWS 1996a). About 5,000 individuals are thought to be present in at least eight populations on the Island of Hawaiʻi (Benitez et al. 2008; USFWS 1996a). In the park, this species has been found naturally occurring on Mauna Loa near 7,000 feet (2,134 meters) elevation in subalpine and montane seasonal environments of Kahuku and the Mauna Loa units (NPS 2005a, 2009j, 2009e). Feral goats and mouflon sheep have been excluded from the two populations that occur on Kīpuka Kulalio and Kīpukamaunaʻiu in the Mauna Loa unit by protective fencing since the 1970s. Populations found in Kahuku are not fenced or protected from non-native ungulates (Pratt et al. 2009). Browsing by the ungulates affects the viability of this species by precluding the establishment of juveniles and damaging the habitat, thereby opening suitable sites for the establishment of non-native weeds (USFWS 1996a). Critical habitat for this species is found in Hawaiʻi Volcanoes National Park (Leonard 2009). The primary constituent elements for Laukahi kuahiwi on the Island of Hawaiʻi are as follows:

1. Landform/forest type: montane wet sedgeland (often in damp cracks of pāhoehoe lava) with mixed sedges and grasses, montane mesic forest, dry subalpine woodland, or *Metrosideros polymorpha* and native shrub.
2. Plant community: *Acacia koa*, *Coprosma ernodeoides*, *Coprosma montana*, *Dodonaea viscosa*, *Leptecophylla tameiameiae*, *Metrosideros polymorpha*, or *Vaccinium reticulatum*.
3. Elevation: 5,198 to 8,243 feet (1,584 to 2,513 meters) (USFWS 2003).

Hawaiʻi hala pepe (*Pleomele hawaiiensis*). This tree exhibits long, narrow leaves that are borne at the branch tips, and pale yellow flowers. It can grow to approximately 21 feet (6 meters) in height. Hawaiʻi hala pepe is endemic to dry (or occasionally moist) forests on old lava flows on the leeward side of the Island of Hawaiʻi at elevations of 985 to 2,820 feet (300 to 860 meters) (Pratt et al. 2009). In the park, this species has been identified in coastal lowland and mid-elevation seasonal forest environments at Nāulu Forest, Kealakomo Kīpuka, Poliokeawe Pali, the Great Crack and Kahuku (NPS 2005a, 2009j; Pratt et al. 2009). Fewer than two dozen plants have been observed in these areas. In 2001–2003, hala pepe was planted successfully at the Nāulu and Kealakomo sites. The species faces the threats that endanger many native plants of the dry lowlands, including fire spread by non-native grasses; non-native animals, including feral goats and rats; and non-native plant species (Pratt et al. 2009). Feral goats have been eliminated from hala pepe habitat in the older section of the park. Critical habitat for this species is found in Hawaiʻi Volcanoes National Park (Leonard 2009). The primary constituent elements for Hawaiʻi hala pepe on the Island of Hawaiʻi are as follows:

1. Landform/forest type: dry and mesic lowland forests of lama (*Diospyros sandwicensis*) and ʻōhiʻa (*Metrosideros polymorpha*).
2. Plant community: *Bidens micrantha* ssp. *ctenophylla, Bobea timonioides, Caesalpinia kavaiensis, Cocculus trilobus, Colubrina oppositifolia, Diospyros sandwicensis, Dodonaea viscosa, Erythrina sandwicensis, Kokia drynarioides, Metrosideros polymorpha, Myoporum sandwicense, Neraudia ovata, Nestegis sandwicensis, Nothocestrum breviflorum, Nototrichium sandwicense,Osteomeles anthyllidifolia, Psydrax odorata, Reynoldsia sandwicensis, Santalum paniculatum, Sida fallax,* or *Sophora chrysophylla*.
3. Elevation: 281 to 2,925 feet (86 to 892 meters) (USFWS 2003).

Poʻe; ʻihi mākole (*Portulaca sclerocarpa*). Poʻe is an endangered perennial with a fleshy, tuberous taproot that becomes woody with maturity. It inhabits montane dry shrubland and is often found on bare cinder, near steam vents, and in open ʻōhi'a-dominated woodlands at elevations between 3,380 and 5,340 feet (1,030 and 1,628 meters). In 1996, there were 12 known populations and more than 1,000 known individuals on the Island of Hawaiʻi (USFWS 1996a). In the park, this species grows in the Puhimau Geothermal Area, along Hilina Pali Road, and in Keanakākoʻi (NPS 2009j, 2009e). At the time of the 1996 USFWS report, the Puhimau Geothermal Area supported just under 1,000 plants, but since that time the population of this species has declined to fewer than 300 individuals (Pratt et al. 2009). In the park, a major threat to this species is competition from non-native grasses such as beardgrass and broomsedge, as well as potentially feral goats and rats which are seed predators. Critical habitat for this species is found in Hawaiʻi Volcanoes National Park (Leonard 2009). The primary constituent elements for Poʻe on the Island of Hawaiʻi are as follows:

1. Landform/forest type: montane dry shrubland, often on bare cinder, near steam vents, and in open *Metrosideros polymorpha*–dominated woodlands.
2. Plant community: *Dodonaea viscosa*, *Melanthera venosa*, *Sophora chrysophylla*.
3. Elevation: 3,380 to 5,340 feet (1,030 to 1,630 meters) (USFWS 1996a).

Loulu (*Pritchardia affinis*). Loulu is a palm tree that grows from 33 to 82 feet (10 to 25 meters) in height. It inhabits coastal lowland forest environments and coastal mesic forest on the leeward side of the Island of Hawaiʻi, possibly near or in brackish water, at elevations of 0 to 2,000 feet (0 to 610 meters). In 1996, there were eight known populations and between 50 and 65 known individuals on the Island of Hawaiʻi (USFWS 1996a). Until recent fires and lava flows in the park, there was one group of trees (probably planted) on the Kalapana Trail at 985 feet (300 meters) elevation (Pratt et al. 2009). More recently, this tree has been planted in coastal talus slopes behind the shoreline at Kāluʻe and in coastal strand vegetation at Keauhou in the park (NPS 2009j; Pratt et al. 2009).Continued development and human disturbance are serious threats to the viability of this species, as our feral pigs, which root and destroy seedings, preventing regeneration island-wide (USFWS 1996a). In the park's coastal lowlands, rats predation on seeds is probably the most important threat to loulu restoration efforts (Pratt et al. 2009). In some coastal lowland location, fire carried by alien grasses may be a threat.

‘Ōhai
Source: National Park Service

‘Ōhai (*Sesbania tomentosa*). ‘Ōhai is typically a sprawling shrub with branches up to 45 feet (14 meters), but may also be a small tree up to 20 feet (6 meters) in height (USFWS 1999). This species is found in coastal sites with plants growing in sand and ash pockets over pāhoehoe in disturbed coastal vegetation dominated by naupaka kahakai; coastal lowlands vegetated primarily with native pili and non-native grasses; and lowland dry woodlands of ‘ōhi‘a, native shrubs, and non-native grasses (Pratt et al. 2009). Less than 5,000 individuals of this plant are believed to exist (USFWS 1999). In Hawai‘i Volcanoes National Park, it has been identified in the ‘Āpua Point, Kīpuka Nēnē, Hilina Pali, Kamo‘oali‘i, Kū‘ē‘ē, and Kīpuka Pepeiau areas (NPS 2009j; Pratt et al. 2009). Feral goats and fire are major threats to this species. Rats, non-native grasses, and loss of natural pollinators are also potential threats to this tree species (Pratt et al. 2009). Critical habitat for this species is found in Hawai‘i Volcanoes National Park in fenced units that protect it from feral goats (Leonard 2009). The primary constituent elements for ‘Ōhai on the Island of Hawai‘i are as follows:

1. Landform/forest type: open, dry *Metrosideros polymorpha* forest with mixed native grasses, *Scavevola taccada* coastal dry shrubland on windswept slopes, and weathered basaltic slopes.
2. Plant community: *Dodonaea viscosa*, *Fimbristylis hawaiiensis*, *Ipomoea pes-caprae*, *Jacquemontia ovalifolia* ssp. *sandwicensis*, *Leptecophylla tameiameiae*, *Melanthera integrifolia*, *Myoporum sandwicense*, *Sida fallax*, *Sporobolus virginicus*, *Waltheria indica*.
3. Elevation: 0 to 3,025 feet (0 to 922 meters) (USDA-NRCS 2005).

White-bur cucumber; ‘ānunu (*Sicyos alba*). White-bur cucumber is a short-lived annual vine with black-spotted stems. Its habitat includes wet forest of ‘ōhi‘a, hāpu‘u, or tree ferns near 4,000 feet (1,220 meters) elevation (Pratt et al. 2009). In the park, this species is only known in the ‘Ōla‘a Forest (Pratt et al. 2009), but is also found in similar habitats just outside the park in ‘Ōla‘a Forest Reserve, and Pu‘u Maka‘ala Natural Area Reserve (NPS 2009j, 2009e). Threats to the survival of this plant include feral pigs and non-native plants (Pratt et al. 2009). Critical habitat for this species is found in Hawai‘i Volcanoes National Park (Leonard 2009). The primary constituent elements for White-bur cucumber on the Island of Hawai‘i are as follows:

1. Landform/forest type: *Metrosideros polymorpha–Cibotium glaucum*–dominated montane wet forests.
2. Plant community: *Astelia menziesiana*, *Athyrium microphyllum* and other ferns, *Broussaisia arguta*, *Cheirodendron trigynum*, *Coprosma* sp., *Cyanea tritomantha*, *Cyrtandra lysiosepala*, *Perrottetia sandwicensis*, *Platydesma spathulata*, *Pritchardia beccariana*, *Psychotria* sp., *Stenogyne* sp.
3. Elevation: 3,170 to 5,072 feet (966 to 1,546 meters) (USDA-NRCS 2005).

Spermolepis hawaiiensis. *Spermolepis hawaiiensis* is an endangered annual herb bearing small white flowers. This species is known from open areas in the lowland and montane zones, as well as cultivated fields at low elevation. On the Island of Hawai‘i, *S. hawaiiensis* is extant at several sites in Pōhakuloa Training Area and Pu‘u Anahulu (Pratt et al. 2009). In Hawai‘i Volcanoes National Park, historical records (1943) indicate its existence in coastal lowland and mid-elevational woodland environments west of Kīpuka Kahali‘i (Pratt et al. 2009). Since last documented, this area has been covered by lava. There have been unsuccessful attempts to establish plants through seed broadcasting along the Chain of Craters and Hilina Pali roads. Feral goats may have been a factor in the original decline of this species in the park (Pratt et al. 2009). Other threats include other ungulates, non-native plants, fire, and landslides (Pratt et al. 2009).

Stenogyne angustifolia. *Stenogyne angustifolia* is a sprawling perennial vine. Flowers are borne in the leaf axils and are maroon to yellow in color (USFWS 1993). The extant population of this species is found in dry subalpine shrubland, but plants of Moloka‘i, Maui, and leeward Hawai‘i formerly occurred in lower-elevation dry habitats. All known naturally occurring individuals on the Island of Hawai‘i are at the Pōhakuloa Training Area (a military training area) between 5,080 and 7,050 feet (1,550 and 2,150 meters) (Pratt et al. 2009). In the park, historical records indicate its existence between Kīlauea and Kapāpala, where it was collected in 1868 (NPS 2009j; Pratt et al. 2009). This species has also been planted at two sites in the Mauna Loa Strip; however, survival of plantings has been poor. Threats to the species include fire and competition with non-native plants. Trampling and disruption from non-native ungulates, including goats, sheep, and cattle, are also significant threats to *S. angustifolia* (Pratt et al. 2009).

Hawai‘i pricklyash; a‘e (*Zanthoxylum hawaiiense*). Hawai‘i pricklyash is a medium-sized tree with pale, smooth bark that reaches 26 feet (8 meters) in height. This species generally occurs in lowland dry and mesic forests, and montane dry forest, at elevations between 1,800 and 5,710 feet (550 and 1,740 meters) (USFWS 1996a). Individuals occur on lava flows and, in the park, prefer forests dominated by koa, ‘ōhi‘a, and mānele (Pratt et al. 2009). In 1996, five populations of this tree were known to occur at Pu‘uwa‘awa‘a and Pōhakuloa Training Area on the Island of Hawai‘i (USFWS 1996a). In the park, this species was reported from Kīpuka Puaulu in 1921, but the observation was not documented by a specimen, and there are no reported occurrences of this species between Pōhakuloa and the park. Feral goats, sheep, and pigs as well as domestic cattle are all threats to Hawai‘i pricklyash, but are excluded from Kīpuka Puaulu. Additional threats may include fire and non-native plants (Pratt et al. 2009).

Threatened

Haleakalā silversword; Hawaiian catchfly; ‘ahinahina; (*Argyroxiphium sandwicense* ssp. *macrocephalum*). This species is a single-stemmed rosette shrub that grows up to 10 feet (3 meters) tall (Pratt et al. 2009). ‘Ahinahina is endemic to the subalpine and alpine deserts of Haleakalā on East Maui; however, it was outplanted to Mauna Loa, where a few plants persist in the alpine environment of the park (NPS 2009j, 2009e). In its natural habitat, this species was threatened by feral goats until the Haleakalā Crater District was fenced and goats were removed. Feral goats, mouflon sheep, and pigs are potential threats to outplanted individuals in the park. Argentine ants (*Linepithema humile*) are a potential threat because of their impacts on insect pollinators (Pratt et al. 2009).

Hawaiian catchfly; Sheriff's catchfly (*Silene hawaiiensis*). Hawaiian catchfly is a sprawling shrub endemic to the Island of Hawai‘i found primarily in dry open areas in montane seasonal and subalpine environments (USFWS 1996a). In the park, plants occur on ash flows and dry lava flows and have been identified in the Mauna Loa Unit, Kīlauea Crater rim, and Ka‘ū Desert areas of the park (NPS 2009j; Pratt et al. 2009). One population in the park near 5,600 feet (1,710 meters) elevation lost more than 70 percent of its plants in 5 years, and a second population decreased by more than 50 percent from 1998 to 2000 because of browsing by mouflon sheep that penetrated a fenced area of the park (Pratt et al. 2009). In the Kahuku Unit, where mouflon sheep are abundant, only one documented and two reported (unconfirmed) individuals were discovered in 2005 surveys (NPS 2009e). These individuals were not relocated in subsequent surveys. In 1996, there were 11 known populations and around 11,000 known individuals on the Island of Hawai‘i (USFWS 1996a). Fragile branches and stems are easily broken or browsed almost to the base of the plant. As a result, feral animals (goats, pigs, and sheep) are detrimental to the survival of this species (USFWS 1996a). This plant is preferred forage for mouflon sheep, as evidenced by browsing and mortality described above resulting from ingress sheep on the Mauna Loa Unit. Recovery efforts in the park include six foot tall fences to exclude mouflon sheep and outplanting at Kahuku in fenced silversword exclosures.

Critical habitat for this species is found in Hawai‘i Volcanoes National Park (Leonard 2009). The primary constituent elements for Hawaiian catchfly on the Island of Hawai‘i are as follows:

1. Landform/forest type: weathered lava or variously aged lava flows and cinder substrates in montane and subalpine dry shrubland.
2. Plant community: *Dodonaea viscosa*, *Leptecophylla tameiameiae*, *Metrosideros polymorpha*, *Rumex giganteus*, *Sophora chrysophylla*, *Vaccinium reticulatum*.
3. Elevation: 3,352 to 7,915 feet (1,021 to 2,412 meters) (USDA-NRCS 2005).

Candidate

‘Akū (*Cyanea tritomantha*). ‘Akū is a palm-like tree approximately 6 to 10 feet (1.8 to 3 meters) tall (USFWS 2009k). This species is endemic to the Island of Hawai‘i, and has been documented in the Kohala Mountains in the north and farther south along the windward (eastern) sides of Mauna Kea, Mauna Loa, and Kīlauea volcanoes. The naturally occurring populations nearest the park are in Pu‘u Maka‘ala Natural Area Reserve and ‘Ōla‘a Forest Reserve (Pratt et al. 2009). Overall, there are 16 current populations of this tree totaling approximately 300 to 400 individuals (USFWS 2009k). In the park, it has been found in wet forest environments in the ‘Ōla‘a Forest (NPS 2009j). Feral pigs are probably the primary threat to this species. Potential additional threats include non-native slugs, other non-native invertebrates, and rats. Recovery efforts in the park include fencing of natural populations and plantings of individuals in protected fenced units in ‘Ōla‘a (NPS 2009e).

‘Ohe (*Joinvillea ascendens* ssp. *ascendens*). ‘Ohe is an erect herb that can reach approximately 5 to 16 feet (1.5 to 5 meters) tall and contains fruits that are reddish orange (Pratt et al. 2009; USFWS 2009l). It is primarily located in wet forest and streambeds at middle elevations. Habitat in the park is montane wet ‘ōhi‘a forest with hāpu‘u understory (Pratt et al. 2009). Currently, there are 38 known populations (10 on the Island of Hawai‘i) totaling approximately 180 individuals (USFWS 2009l). In the park, there has been only one documented collection in Ōla‘a Forest, near the middle of the Large Tract, south of the trench and crater feature (NPS 2009j; Pratt et al. 2009). Herbivory and disturbance by feral pigs are potential threats in unfenced areas of the ‘Ōla‘a Forest, where this plant was last observed (Pratt et al. 2009). Competition from non-native plant species is a potential threat as well, along with low seed germination (USFWS 2009l; Pratt et al. 2009).

Hōlei (*Ochrosia haleakalae*). Hōlei is a tree that can reach 7 to 26 feet (2 to 8 meters) tall, with white flowers and yellow or plum-colored mature fruits (USFWS 2008d). It is endemic to East Maui and the northeastern portion of the Island of Hawai‘i, where it is found at elevations between 2,300 and 3,940 feet (700 and 1,200 meters) (Pratt et al. 2009). There are 11 total known populations on Maui and Hawai‘i, totaling fewer than 130 wild individuals (USFWS 2008d). Hōlei is not native to the park. However, it was planted in montane mesic forest of koa, ‘ōhi‘a, and mānele in Kīpuka Puaulu (NPS 2009j, 2009e; Pratt et al. 2009). In wet forests, hōlei is most threatened by feral pigs. In dry and mesic forest habitats, hōlei is primarily threatened by feral goats, domestic cattle, non-native grasses, and wildfire (Pratt et al. 2009). The threats from non-native ungulates apply to plants in unfenced areas located outside the park.

Many-flowered phyllostegia (*Phyllostegia floribunda*). Also known as many-flowered Hawaiian mint, this candidate species is a subshrub with flowers (maroon to red, white on base) on short, leafless lateral branches (USFWS 2009n). Endemic to the Island of Hawaiʻi at elevations of 1,410 to 3,710 feet (430 to 1,130 meters), Many-flowered phyllostegia is found in wet lowland or montane forests (Pratt et al. 2009). Currently, the species is known from 10 locations totaling 20 to 30 individuals on state, federal, and private lands (USFWS 2009n). In the park, Many-flowered phyllostegia is found in the ʻŌlaʻa Forest, at one site on the east side of the Ag Unit; the East Rift forest in craters near Nāpau; and has been planted in ʻŌlaʻa Forest Koa Unit and Small Tract (NPS 2009j; Pratt et al. 2009). Many-flowered phyllostegia is typically found in the older sections of the park, where fencing has protected populations from non-native ungulate impacts. Feral pigs are likely the most significant threat to unprotected wet forests supporting this plant (Pratt et al. 2009). In general, endemic mints are highly vulnerable to non-native ungulate impacts (NPS 2009e).

Large-flower native buttercup; makou (*Ranunculus hawaiensis*). Large-flower native buttercup is a perennial herb reaching 79 inches (200 centimeters) in height (USFWS 2009o). Habitat for this species is mesic forest, on grassy or rocky slopes, and in open pastures. It has been recorded at elevations between 5,970 and 6,700 feet (1,820 to 2,040 meters) on East Maui and Hawaiʻi (Pratt et al. 2009). On the Island of Hawaiʻi, this herb was historically wide-ranging in Kona, Hualālai, Mauna Kea, and Kaʻū. Currently, this species is known from three locations on the Island of Hawaiʻi, with a total of 16 individuals (USFWS 2009o). In Hawaiʻi Volcanoes National Park, a single population of fewer than 10 plants has been identified in the western Kahuku Unit (NPS 2009j; Pratt et al. 2009). Non-native ungulates, including goats, mouflon sheep, and cattle, may impact this species. Rats, fire, and non-native grasses are all additional threats to Large-flower native buttercup (Pratt et al. 2009).

Largeleaf bur-cucumber; ʻānunu; large-leaved ʻānunu (*Sicyos macrophyllus*). This species is a perennial vine characterized by stems approximately 49 feet (15 meters) long and 2 inches (4 centimeters) in diameter (USFWS 2009m). Habitat for this species is montane mesic forest of koa, māmane, ʻōhiʻa, and mānele at elevations between 3,940 and 6,560 feet (1,200 to 2,000 meters). On Hawaiʻi, it has been recorded in montane wet forest and subalpine forest (Pratt et al. 2009). It is currently known from approximately 11 populations totaling fewer than 50 individuals (USFWS 2009m). In Hawaiʻi Volcanoes National Park, ʻānunu was identified at Kīpuka Kī in 2000 (NPS 2009j). Kīpuka Kī is located in the montane seasonal zone of the Mauna Loa Strip, which is fenced to exclude non-native ungulates (NPS 2009e). Non-native ungulates, domestic cattle, fire, rats, and non-native plants are all potential threats to the species (Pratt et al. 2009).

Species of Special Concern

NPS policy requires that state-listed species and others identified as species of management concern by the park are to be managed in parks in a manner similar to those that are federally listed. NPS is also cooperating in the protection and enhancement of species of concern listed by Hawaiʻi. The species of special concern list is adopted from an informal list, maintained by the USFWS Honolulu Office of Ecological Services, of species of concern, that is, species about which not enough is known to prepare a formal listing package. Many of these species were formerly Category 2 Candidate Endangered Species. This list is subject to change yearly.

In Hawaiʻi Volcanoes National Park, 8 animal species and 69 plant species have been identified as rare or sensitive. See table 8 for the list of species.

TABLE 8: SPECIES OF SPECIAL CONCERN IN HAWAI‘I VOLCANOES NATIONAL PARK

Scientific Name	Common Name	Status	Habitat Description and/or Location in the Park
Birds			
Anous minutus melanogenys	Noio, black noddy	Rare or Sensitive	Nests either on vegetation or on sea cliffs; occasionally nests on human-made structures that mimic cliff-nesting habitat. Found near the shoreline and offshore islets.
Bulweria bulwerii	‘Ou, Bulwer’s petrel	Rare or Sensitive	Nests in rocky holes, on crevices in cliffs, under rock overhangs, and on the ground under thick vegetation on small oceanic islands and offshore islets. In the park it is found adjacent to the shoreline.
Phaethon lepturus dorotheae	Koa‘ekea, white-tailed tropicbird	Rare or Sensitive	Found in craters and pit craters. Breeds by laying a single egg directly onto the ground or a cliff ledge.
Vestiaria coccinea	‘I‘iwi	Rare or Sensitive	Found above 4,100 feet (1,250 meters) elevation on the islands of Hawai‘i, Maui, and Kaua‘i; occurs at reduced densities below 3,300 feet (1,000 meters). In the park primarily above 5,000 feet (1,524 meters) and most abundant in upper montane seasonal and lower subalpine zones. ‘I‘iwi occupy mesic and wet forest dominated by ‘ōhi‘a (*Metrosideros polymorpha*) and koa (*Acacia koa*) (HDLNR 2005a).
Insects			
Drosophila engyochracea	NCN	Rare or Sensitive	Found in mesic forest kīpuka. Host plant is mānele (*Sapindus saponaria*) (Foote, pers. comm., 2009a). In the park, found only in two locations in the lower montane seasonal zone in the Mauna Loa Unit.
Drosophila hawaiiensis	NCN	Rare or Sensitive	Found in mesic forest kīpuka.
Drosophila silvestris	NCN	Rare or Sensitive	Grows between elevations of approximately 3,280 to 4,270 feet (1,000 to 1,300 meters) on the wetter slops of the volcanoes.
Megalagrion koelense	Koele mountain damselfly	Rare or Sensitive	Often found in the water-filled narrow leaf axils of plants in the East Rift and ‘Ōla‘a sections of the park.
Plants			
Alphitonia ponderosa	Kauila	Species of Concern	Found in dry to mesic lowland forest and lower mid-elevation woodlands. In the park, they are found near Kīpuka Nēnē, along Hilina Pali from the road terminus to Pepeiau, Kealakomo Kīpuka, Poliokeawe Pali, and in the western lowlands near the Great Crack. Plantings have persisted in the Nāulu Forest, Kīpuka Puaulu, and Kīpuka Ki (Pratt et al. 2009).
Anoectochilus sandvicensis	Honohono, Hawai‘i jewel orchid	Species of Concern	Found in wet forests at low to mid-elevations. In the park, they have recently been found at the ‘Ōla‘a Forest, Koa Unit, the East Rift SEA, and in a kīpuka west of Nāpau. They have also recently been planted in ‘Ōla‘a Koa Unit, Thurston Lava Tube, and Small Tract (Pratt et al. 2009).

Scientific Name	Common Name	Status	Habitat Description and/or Location in the Park
Antidesma pulvinatum	Hame	Rare	In the park, grows in dry to mesic lowland forest in Nāulu (one to two trees) (Pratt et al. 2009).
Asplenium schizophyllum	Fringed spleenwort	Species of Concern	Found in montane rain forests at 2,461–4,921 feet (750–1,500 meters) elevation. In the park, they are probably found only in the ʻŌlaʻa Forest (Pratt et al. 2009).
Bidens hawaiensis (B. skottsbergii)	Koʻokoʻolau, Hawaiʻi beggarticks	Rare	Found in mid-elevation ʻōhiʻa woodland in the park. they have been found at the ʻĀinahou Ranch, along the upper Hilina Pali Road, and near Kīpuka Puaulu and Koʻokoʻolau Craters. They have been planted at ʻĀinahou, the upper Hilina Pali Road, Kīpuka Nēnē, and in ʻōhiʻa woodland near Kīpuka Puaulu (Pratt et al. 2009).
Bobea timonioides	ʻAhakea	Species of Concern	Found in dry to mesic lama (*Diospyros sandwicensis*) forests at low elevations. In the park, they have been found in the Nāulu Forest, Kealakomo Kīpuka, and planted in the East Rift SEA south of the Makaopuhi Crater (Pratt et al. 2009).
Canavalia hawaiiensis	ʻAwikiwiki, Hawaiian jackbean	Rare	Grows in dry to mesic habitats. Found in Kukalauʻula, Puʻu Kapukapu, and above the Kalapana Trail in the park.
Capparis sandwichiana	Pua pilo, maiapilo, native caper	Species of Concern	Found on rocky coastlines and in dry coastal lowlands. They were historically found in the park offshore of Halape, and at low elevations near the eastern park boundary. However, recent plantings at Kalue near Halape did not persist (Pratt et al. 2009).
Chamaesyce celastroides	ʻAkoko	Rare	Grows in coastal dry shrubland on windward talus slopes and in mid-elevation seasonal environments at elevations of 30 to 2,100 feet (9 to 640 meters). Found naturally occurring in ʻĀinahou and along Hilina Pali road and the Kalapana trail; and as planted individuals in Kīpuka Pepeaio.
Charpentiera obovata	Pāpala	Rare	Found in wet to mesic ʻōhiʻa forest on soils over rock rubble. In the park, found in the Kahuku Unit, in Kīpuka Kī and in Kīpuka Puaulu, and the Mānele bend area along the Mauna Loa Strip Road (Benitez et al. 2008).
Clermontia hawaiiensis	ʻŌhā kēpau	Rare	In the park, plants grow in rainforest areas from low to high altitudes. Grows in the Kīlauea Crater Rim, East Rift, and ʻŌlaʻa. Planted in various mesic and wet forests on Kīlauea and lower Mauna Loa Unit.
Clermontia montis-loa	ʻŌhā	Rare	Found most commonly in ōhiʻa/hāpuʻu (*Cibotium* spp.) forest and less commonly in mesic to wet ʻōhiʻa forest. In the park, found primarily in ʻŌlaʻa and the Kahuku Unit eastern region (Benitez et al. 2008).
Cuscuta sandwichiana	Kaunaʻoa	Rare	In the park, plants grow in coastal areas, often in sandy soil. Grows in Kaʻaha.

Scientific Name	Common Name	Status	Habitat Description and/or Location in the Park
Cyanea pilosa ssp. *Longipedunculata*	Hāhā	Rare	Tend to grow in deep forest, often in narrow gulches where there is little wind. Grows in ʻŌlaʻa. Also found inside the park in the forested pit crater in Kahuku (subspecies remains undetermined); formerly found in the vicinity of the Thurston Lava Tube on Kīlauea (Benitez et al. 2008).
Cyrtandra menziesii	Haʻiwale	Species of Concern	Found in mesic to wet ʻōhiʻa forests. In the park, small populations have been found in the Kahuku Unit, in a crater at Puʻu ʻAkihi, in the southeastern section of the central pasture, and in a large forested crater surrounded by pasture (Pratt et al. 2009).
Embelia pacifica	Kilioe, Pacific embelia	Species of Concern	Grows in montane wet forests dominated by ʻōhiʻa and hāpuʻu and mesic kīpuka forests with a mix of koa, mānele and ʻōhiʻa. Found in the park at the ʻŌlaʻa Forest, at Kīpuka Puaulu, and at Kīpuka Kī (Pratt et al. 2009).
Erythrina sandwicensis	Wiliwili	Rare	Grows in lowland dry forests and shrublands. In the park, a few trees still remain in the coastal lowland and possibly at the Great Crack. There are plantings at Puʻu Kaone, ʻĀpua Point, Kāluʻe, the Nāulu Forest, the base of Hōlei Pali near Pali Uli, and northeast of the hairpin turn of the Chain of Craters Road (Pratt et al. 2009).
Eurya sandwicensis	Anini	Species of Concern	Found in wet to mesic forests and on windswept ridges. In the park, they have recently been found in the Kahuku Unit near the northern boundary of Kaʻū Forest Reserve, ʻŌlaʻa Small Tract (planted), and in the ʻŌlaʻa Forest near the Koa Unit boundary (Pratt et al. 2009).
Exocarpos gaudichaudii	Hulumoa, heau, Gaudichaud's exocarpus	Species of Concern	Grows in mesic forests, shrublands, and open ʻōhiʻa woodlands. Found in the park at ʻĀinahou Ranch, south of the ranch house in mid-elevation woodland (Pratt et al. 2009).
Exocarpos menziesii	Heau, Menzies' exocarpus,	Rare	Grows in subalpine ʻōhiʻa woodland and shrublands. Found in the park in the Kahuku Unit and less frequently in the Mauna Loa Unit (Benitez et al. 2008).
Fimbristylis hawaiiensis	Hawaiʻi fimbry	Species of Concern	Grows on old lava flows in coastal lowland and mid-elevation seasonal environments. Grows at Kaʻena Point, Kamoʻoaliʻi and other sites.
Fragaria chiloensis ssp. *sandwicensis*	ʻŌhelo papa, Hawaiian strawberry	Species of Concern	Found on Maui and the Island of Hawaiʻi, at an elevation of 3,800–10,070 feet (1,160–3,070 meters). This plant occurs at scattered localities in subalpine shrubland north of the boundary with Kaʻū Forest Reserve in the park (Pratt et al. 2009).
Gonocormus prolifer	NCN	Rare	Grow in areas that are damp, with shade on rocks or trees. In the park, plants are known from ʻŌlaʻa.
Jacquemontia ovalifolia ssp. *sandwicensis*	Pāʻu o hiʻiaka	Rare	Grows in the coastal strand at ʻĀpua Point, Keauhou, Kāluʻe and Ka`aha.

Scientific Name	Common Name	Status	Habitat Description and/or Location in the Park
Pritchardia beccariana	Loulu	Rare	In the park, plants are found in tall, wet forests at ʻŌlaʻa.
Liparis hawaiensis	ʻAwapuhi a Kanaloa, Hawaiian twayblade	Species of Concern	Found in wet to mesic forests at mid-elevations and more rarely in seasonal woodlands. In the park, they have been found in the ʻŌlaʻa Forest, the Kīlauea East Rift near Nāpau Crater, and between the Chain of Craters Road and Keanakākoʻi Crater. However, recent surveys in these areas have yielded no sightings, including in the Kahuku Unit (Benitez et al. 2008; Pratt et al. 2009).
Marattia douglasii	Pala, kapuaʻilio, Hawaiʻi marattia	Rare	Found in ʻōhiʻa/hāpuʻu forest. In the park, found in the Kahuku Unit, and less commonly in the ʻŌlaʻa Rainforest (Benitez et al. 2008).
Melicope hawaiensis	Manena	Species of Concern	Grows in mesic forests dominated by koa, ʻōhiʻa, and mānele as well as dry ʻōhiʻa forests. Found in the park at Kīpuka Puaulu and mid-elevation woodland along Kapāpala Ranch boundary. Also recently planted at Kīpuka Kī (Pratt et al. 2009).
Myrsine lanaiensis	Kōlea, Lanaʻi colicwood	Rare	Found in dry ʻōhiʻa woodland on lava substrate. In the park, found in the southwestern region of the Kahuku Unit and downslope of the ʻĀinahou Ranch house (Benitez et al. 2008).
Nestegis sandwicensis	Olopua	Rare	In the park, plants were formerly found in wet/mesic forest at 100 feet (30 meters) elevation above Kamoamoa. Now found only at 4,250 feet (1,295 meters) in Kīpuka Puaulu, Kīpuka Ki in montane mesic forest.
Nothocestrum longifolium	ʻAiea, longleaf nothecestrum	Rare	Grows in wet/mesic forest. In the park, found primarily in wet forest at ʻŌlaʻa and in mesic forest at Kīpuka Puaulu, Kīpuka Ki, and Kīpuka ʻAiea.
Nototrichium sandwicense	Kuluʻī, Hawaiian nototrichium	Rare	In the park, plants are found at elevations below approximately 750 feet (229 meters) in open dry forests, exposed ridges, and lava fields. Found at Poliokeawe Pali, this species was extirpated and reintroduced.
Phyllostegia ambigua	NCN	Rare	Grows in wet montane forests of ʻōhiʻa and hāpuʻu as well as subalpine forests. Found in the ʻŌlaʻa Forest Small Tract and the Kahuku Unit (Pratt et al. 2009).
Phyllostegia macrophylla	NCN	Rare	Grows on steep slopes and in gulches in diverse mesic to wet forests at an elevation of approximately 1,500 to 6,000 feet (457 to 1,829 meters). Grows in the ʻŌlaʻa region.
Phyllostegia stachyoides	NCN	Species of Concern	Found in mesic to wet montane forests of koa, mānele, and ʻōhiʻa in the park. One collection was found in 1915 at Kīpuka Puaulu in the park (Pratt et al. 2009).
Phyllostegia vestita	Island phyllostegia, clothed Hawaiian mint	Rare	Grows in wet montane forests of ʻōhiʻa and hāpuʻu tree ferns. Found in the park in the ʻŌlaʻa Forest Koa and New units, the East Rift SEA, the crater of Kane Nui o Hamo, and the ʻŌlaʻa Koa Unit (planted) (Pratt et al. 2009).

Scientific Name	Common Name	Status	Habitat Description and/or Location in the Park
Phytolacca sandwicensis	Pōpolo ku mai, Hawai‘i pokeweed	Rare	Historically found in mesic montane forests of koa, ‘ōhi‘a, and mānele as well as wet montane forests of ‘ōhi‘a and hāpu‘u. In the park, they have been found in the ‘Ōla‘a Forest’s Koa and Pu‘u units, and in Kahuku. Recently planted in Kīpuka Puaulu and Kīpuka Ki (Pratt et al. 2009).
Pisonia brunoniana	Pāpala kēpau, Australian catchbird tree	Rare	Found in mesic/wet forest environments and grows in Kīpuka Puaulu and Kīpuka Ki, where it is localized.
Pisonia umbellifera	Pāpala kēpau, umbrella catchbird tree	Rare	Grows in lowland forests.
Pittosporum confertiflorum	Hō‘awa	Rare	Grows in subalpine ‘ōhi‘a woodland and lowland mesic forests, occasionally on old pāhoehoe lava flows. Found in the park in the upper region of the Kahuku Unit and in the East Rift SEA, and less recently in the upper Mauna Loa SEA (Benitez et al. 2008).
Pittosporum hawaiiense	Hō‘awa, Hawaiian pittosporum	Species of Concern	Grows in mesic/wet forests at ‘Āinahou and in Kahuku pasture environments, though the identification in ‘Āinahou could have been a misidentification.
Pittosporum hosmeri	Hō‘awa, Hosmer's pittosporum	Rare	Grows in koa/‘ōhi‘a woodland forest on soil over old lava flows. Less frequently found in ‘ōhi‘a/hāpu‘u forest on substrates of soil over old pāhoehoe flows. In the park, found in numerous sites throughout the Kahuku Unit, and in the park in and around Kīpuka Puaulu and Kīpuka Ki (Benitez et al. 2008).
Plumbago zeylanica	‘Ilie‘e	Rare	Grows in coastal lowlands. Extirpated and replanted at Lae ‘Apuki, Hōlei.
Pneumatopteris hudsoniana	Hudson’s air fern, Laukahi	Rare	Found in lowland forests.
Portulaca villosa	‘Ihi, hairy purslane	Species of Concern	In the park, known only near the coast in shallow ash over pāhoehoe, in a site now covered by lava. Recently planted at four sites in the coastal strand but no plantings survived (Pratt et al. 2009)
Rauvolfia sandwicensis	Hao	Rare	Grows in dry to mesic forests. Found in the park at Nāulu and Hōlei Pali.
Reynoldsia sandwicensis	‘Ohe mākai, ‘ohe	Species of Concern	Grows predominately in dry to mesic lowland forests and less commonly in open vegetation on old lava flows. Found in the park along Poliokeawe Pali near the trail from ‘Āinahou Ranch to coastal Keauhou, east of ‘Āinahou, in the Kealakomo kīpuka, and recently planted at the Nāulu Forest and Kealakomo (Pratt et al. 2009).
Rhus sandwicensis	Neneleau	Rare	Grows in disturbed areas, especially along roadsides and in pastures from relatively wet to dry environments. In the park, plants grow above Nāulu and the Kalapana trail.

Scientific Name	Common Name	Status	Habitat Description and/or Location in the Park
Rubus macraei	‘Ākala	Species of Concern	Found in montane wet forests, bog margins, and subalpine shrubland. In the park, they have been found in the Kahuku Unit north of Ka‘ū Forest Reserve and historically reported in the upper Mauna Loa Strip (Pratt et al. 2009).
Rumex giganteus	Pāwale	Rare	Grows in wet ‘ōhi‘a/hāpu‘u forest, and mesic ‘ōhi‘a/koa woodland. In the park, found in four different sites in the Kahuku Unit and less frequently at the ‘Ōla‘a Forest, Kīpuka ‘Aiea, Mauna Loa SEA, and woodlands near Pu‘u Puai (Benitez et al. 2008).
Sanicula sandwicensis	Tall Hawaiian sanicle, snakeroot	Species of Concern	Grows in subalpine shrublands and woodlands, specifically ‘ōhi‘a woodland. In the park, a small population exists in the western section of the Kahuku Unit.
Sapindus saponaria	Mānele, ‘ae, soapberry	Rare	Grows in mesic forests with deep ash soil in and near Kīpuka Puaulu and Kīpuka Ki.
Scaevola kilaueae	Kīlauea naupaka, huahekili uka	Species of Concern	Found in the park’s mid elevation woodland and scrub in the Ka‘ū Desert, from the upper Chain of Craters in the east to the Keā‘moku Flow in the west, and along the upper Hilina Pali Road (Pratt et al. 2009).
Schiedea diffusa ssp. *macraei*	NCN	Species of Concern	Found in mountain rain forests and in ‘ōhi‘a/hāpu‘u forests. Found in the park in the ‘Ōla‘a Forest at the eastern edge of the Ag Unit exclosure and planted in the ‘Ōla‘a Koa Unit and Small Tract (Pratt et al. 2009).
Sicyos pachycarpus	Paha, kūpala	Rare	Grows in moist to wet forests at elevations of approximately 500 to 2,600 feet (152 to 792 meters). Probably occurred in Nāulu, but now extirpated.
Sisyrinchium acre	Mau‘u lā‘ili, Hawaiian blue-eyed-grass	Species of Concern	Grows in dry subalpine shrubland of scattered ‘ōhi‘a trees and native shrubs or bogs. In the park, plants are found in Kīpukamauna‘iu, in Kīpuka Kulalio, and in the subalpine shrubland at Kahuku (Pratt et al. 2009).
Stenogyne macrantha	Hawaiian stenogyne	Species of Concern	Found in montane ‘ōhi‘a/hāpu‘u rain forests. Found in the park in the ‘Ōla‘a Forest, Koa and Ag units, and planted in the Koa Unit and Small Tract.
Stenogyne scrophularioides	Scroph stenogyne, Mōhihi	Rare	Grows in montane ‘ōhi‘a/hāpu‘u rain forests. Found in the ‘Ōla‘a Forest’s Koa Unit (planted), New Unit, and Small Tract (planted and natural populations) (Pratt et al. 2009).
Stenogyne sessilis	Sessile stenogyne	Rare	In the park, plants were historically documented in Mauna Loa and recently discovered in Kahuku (Benitez et al. 2008).
Tetraplasandra hawaiensis	‘Ohe	Rare	Typically found in mesic to wet lowland forest. In the park, plants are known from Kīlauea' s East Rift, formerly near Nāulu, and Kamoamoa, and as a half dozen scattered individuals in pasture in Kahuku (Benitez et al. 2008; Wagner et al. 1999).

Scientific Name	Common Name	Status	Habitat Description and/or Location in the Park
Tetraplasandra kavaiensis	‘Ohe‘ohe	Rare	Grows in montane ‘ōhi‘a/hāpu‘u rain forests. Found in the park in the ‘Ōla‘a Forest near its boundary with Pu‘u Maka‘ala Natural Area Reserve (Pratt et al. 2009).
Tetraplasandra oahuensis	‘Ohe mauka	Rare	Grows in mesic valleys and wet forests. In the park, trees are found in ‘Ōla‘a.
Touchardia latifolia	Olonā	Rare	Plants are typically found in mesic valleys and wet forest from 230 to 3,937 feet (70 to 1,200 meters) elevation. In the park, plants are known from ‘Ōla‘a and from a single individual in Kahuku (Benitez et al. 2008; Wagner et al. 1999).
Trematolobelia grandifolia	Koli‘i, large-flower false lobelia	Species of Concern	Found in the exposed areas of montane and mid-elevation rain forests. Often grows on fallen logs and tree ferns in closed wet ‘ōhi‘a/hāpu‘u forests and occasionally on cliff tops near bogs. In the park, they are found in all of the fenced units of the ‘Ōla‘a Forest as well as in the unfenced Koa Kīpuka, the Kīlauea Caldera rim rain forest, the East Rift SEA, the forested pit crater at Kahuku, and on Kāne Nui o Hamo (Pratt et al. 2009).
Urera glabra	Ōpuhe	Rare	Typically found on slopes and gulch bottoms in mesic to wet forest. In the park, plants are found in wet forest of ‘Ōla‘a and Kīlauea's East Rift, in mesic forest on Mauna Loa and as a single individual in Kahuku (Benitez et al.2008).
Xylosma hawaiiense	Maua	Rare	In the park, plants occur in mesic forest at Kīpuka Puaulu, ‘Ōla‘a, and Nāulu.
Zanthoxylum dipetalum var. *dipetalum*	Kāwa‘u	Species of Concern	Grows in montane mesic forests of koa, ‘ōhi‘a, and mānele. Found naturally growing and planted in the park at Kīpuka Puaulu and Kīpuka Ki (Pratt et al. 2009).
Zanthoxylum kauaense (Z. maviense)	A‘e	Rare	Grows in mesic dry or wet forests, often composed of koa/’ōhi‘a and montane wet ‘ōhi‘a/hāpu‘u. Found in Kīpuka Puaulu and the ‘Ōla‘a Forest (Pratt et al. 2009).

Source: NatureServe 2009; NPS 2009j.

NCN = no common name.

RARE, UNIQUE, THREATENED, OR ENDANGERED SPECIES AND THE ROLE OF CLIMATE CHANGE

Please see the discussion in the “Vegetation” and “Native Wildlife and Wildlife Habitat” sections of this chapter for information on the role of climate change on the flora and fauna of Hawai‘i.

CULTURAL/HISTORIC RESOURCES

General Introduction to Hawai‘i and Western Contact

Initial settlement of Hawai‘i was likely based from Central East Polynesia (Marquesas, Society and Cook Islands) (Kirch 1985). Colonization may have occurred in the centuries around AD 500, although this is still a topic of debate among scholars (Graves and Addison 1995; Hunt and Holsen 1991; Kirch 1985). Having carried with them a cultural template from their Polynesian homeland, the original colonists established a religious and sociopolitical system that was soon to evolve into a uniquely Hawaiian culture (Moniz-Nakamura n.d.). Superb sailors, Polynesians migrated to Hawaiʻi by navigating with the sun and stars, reading the winds, currents, and the flight of seabirds. Sailing across 2,400 miles of open ocean in large double-hulled canoes, they brought with them items to ensure their survival: puaʻa (pigs), ʻilio (dogs), and moa (chickens); the roots of kalo (taro) and ʻuala (sweet potato); and the seeds and saplings of niu (coconut), maiʻa (banana), kō (sugar cane), and other edible and medicinal plants (NPS 2009k).

Stylistic similarities of fish hooks and linguistic evidence suggest that two-way voyaging existed between Hawaiʻi and other islands in Polynesia, but that this type of contact diminished over time (Fornander 1996 and Kamakau 1991 cited in Cachola-Abad 2000). It is not known when two-way voyaging ceased, however it had long stopped by the time of European contact in 1778 (Cachola-Abad 2000). By 1778 Hawaiian canoes had evolved to vessels that were suited only to coastal and inshore fishing or travel, and were not able to complete open-ocean navigation. The isolation from the rest of Polynesia resulted in the evolution of Hawaiian society into what is distinctively known as the Hawaiian culture (Moniz-Nakamura n.d.).

Polynesian colonizers employed their own traditional fishing and agricultural techniques where possible, and they adapted new techniques to fit the unique conditions of Hawaiʻi. Colonization of Hawaiʻi was assisted by the availability of certain critical resources such as water, natural vegetation, lithic sources, and marine resources, in addition to suitable habitats. To adapt to their environment colonizers were able to harmonize traditional and adaptive fishing, agricultural techniques, and the means for supplementing the resource base found in Hawaiʻi with the plants and animals they introduced. The environment provided Hawaiians with an abundance of resources and they took the opportunity to alter the natural native environment and shape it to a cultural landscape (Moniz-Nakamura n.d.).

Pigs, the only ungulate introduced by Polynesians to Hawaiʻi, were of the Asian variety. Therefore, they were smaller than the European pig. Pigs played an important role in the religious, political, social, and subsistence economy of ancient Hawaiʻi and into the mid-19th century; some of these traditions continue today in a modern society. Historically, under the *kapu* system, strict rules regarding the eating of pigs were observed, and some families cared for them like pets. By the late 18th century, Captain Cook noted that the pigs "were in abundance and ran without restraint among the houses" (Tomich 1986) while Ellis (2004) noted that pigs "were found sometimes in the mountains." Late in the 19th century and early 20th century a variety of botanists who traveled in the native forests on Hawaiʻi never mentioned seeing wild pigs in the forested areas (Cuddihy and Stone 1990). Handy and Handy (1972) as cited in Cuddihy and Stone (1990) stated, "only young pigs were allowed to run loose; older pigs were kept in pens."

This isolation of the Hawaiian Islands ended in 1778 with the arrival of British explorer Captain James Cook and his crew, who named the archipelago the Sandwich Islands. Cook's expedition opened Hawaiʻi to the world, and in the next century great change came to the people and the landscape with the arrival of sailors, merchants, missionaries, and businessmen, who altered the social and political structure and had permanent and long-lasting impacts on the culture and the natural landscape. The 19th century was a period of considerable change for the islands and its people. The coming of westerners brought many changes to the islands, including the introduction of new diseases, which decimated the native population; a weakening of the traditional political system with the death of Kamehameha I; the introduction of a market economy, which led to a shift toward land ownership; and the denunciation of the kapu (the socio-religious and socioeconomic system that had served Hawaiian culture for hundreds of years). These changes created a wide-reaching disquiet in Hawaiian society (Durst n.d.).

The first western introduction of hoofed animals to Hawaiʻi was the goat and European pig on Captain Cook's first voyage in 1778. Continued introductions of hoofed animals such as cattle, goats, sheep, European pigs, and horses in the late 18th and early 19th centuries led to widespread changes in the natural landscape. While horses, cattle, and larger pigs were welcome gifts to the monarchy, who realized their value, the price of acceptance was high for those who maintained a subsistence lifestyle.

By the time Captain George Vancouver visited in 1792, he reported that Kaiana, a chief from Kealakekua, had possession of several goats (Tomich 1986). Captain Vancouver left more goats that same year with chief Keeaumoku at Kawaihae. The following year, 1793, Vancouver introduced sheep to the Island of Hawaiʻi (the taxon was first introduced to the islands by Captain James Colnett on Kauaʻi in April 1791). In addition to his introductions of goats and sheep, Vancouver was the first to introduce cattle in 1793—as a gift to Kamehameha I. The following year, 1794, Vancouver returned and left another five head of cattle, including three bulls. Although the first few cattle did not survive, the subsequent animals did and flourished. The population of free roaming cattle grew and presented a very real threat to the native forest and the people who feared them. With the introduction of horses to Hawaiʻi in 1803 by Captain Richard Cleveland aboard the Lelia Byrd, bullock hunters were afforded a more mobile, safer, and faster way of traveling over the rugged landscape in the attempt to control feral cattle (Durst n.d.).

Vancouver strongly supported Cook's original intention to stock the islands with several species of domestic animals so that sailors would have ample supply of meat. To this end, he asked Kamehameha I to restrict killing of cattle, sheep, "and other European animals" for 10 years. Kamehameha reluctantly agreed to Vancouver's request for a kapu (restriction) (Tomich 1986), though he (Kamehameha) had the sole discretionary power to "appropriate a certain number of the male species, in case that sex became predominant, to the use of his own table" (Vancouver 1798).

The descendants of these first European imports made a major impact on Hawaiʻi's economy and ecosystem. Left unfettered, these animals ranged far and wide, where they multiplied and were not managed by the Native Hawaiians. By 1850 goats were reported to be abundant and widespread (Tomich 1986). The Reverend William Ellis, during his 1823 travels around the Island of Hawaiʻi, wrote that Joseph Goodrich (who was part of this missionary group) reported seeing wild cattle on Mauna Kea and dead sheep near the summit, suggesting these species had spread throughout the island (Ellis 2004). Goodrich described the cattle as "wild and ferocious," having been allowed to roam without challenge by humans for so long.

This resulted in animals damaging residences, destroying agricultural crops, heavily impacting the natural vegetation, and harming people, even killing a few who happened in their path (Tomich 1986). The native farmers were at the mercy of these wild beasts. In response to the destruction of upland native forests, village gardens, and taro farms, Hawaiians built stone walls of volcanic rock to keep the animals out of agricultural areas (Durst n.d.).

The original kapu placed on these taxa was not lifted until 1830, well past the 10-year prohibition date (Henke 1929). The decades that had passed allowed the non-native ungulates to multiply and spread, destroying native landscapes as they consumed their way across the islands. When the kapu was finally lifted, Native Hawaiians did not become involved in cattle hunting in the early years. They had come to fear the wild cattle because of the ferocity they had developed as they became feral (Ellis 2004). Thus, management of the wild cattle was left primarily to foreigners, who took advantage of an ever-growing market overseas for cattle meat and hide. Lacking the means to control the feral herds of cattle, the government hired a handful of foreign bullock hunters in an attempt to manage their ever-increasing numbers. As yet, Hawaiians did not consider beef as a foodstuff, but the demand by sailors and those outside of Hawaiʻi was great (Durst n.d.). Trading of beef, hides, and tallow soon supplanted the trade for the dwindling sandalwood. The growing shipments of beef and the demand for hides and tallow in

Honolulu resulted in the thinning out of the wild herds of cattle. Under the reign of Kamehameha III, a kapu on cattle was renewed from 1840 to 1844 in which the killing of the wild, unbranded cattle belonging to the monarchy was prohibited (The Polynesian 1841, 51; Hawaiian Historical Society Annual for 1931–1932, 23, as cited in Durst n.d.).

The cattle kapu was once again lifted in 1844. Though the first kahu pipi (cattle hunters) had success with animal control, it wasn't until vaqueros (Spanish for cowboys) came to Hawaiʻi that the real turning point in feral animal management occurred. Hunting was originally done on foot with the aid of dogs, experience, and cunning. Deep pits were dug near cattle watering holes and covered with vegetation, with the intent of capturing cattle in the pit. Once captured, the animals were dispatched with muskets. The animal was then skinned and butchered and the meat was salted, packed in barrels, and carried for miles by native people to markets at the coast.

Ranching in Hawaiʻi began prior to the lifting of the kapu on cattle. The industry flourished throughout the 20th century and is still visible today. Many Hawaiians became involved in the ranching business as renowned paniolo (Hawaiian cowboys). While cattle are perhaps the best-known ranching industry in the islands, goat and sheep ranching were also important industries. Many Hawaiians from the Puna and Kaʻū districts became deeply involved in the goat and cattle ranching business, as goats and cattle had become profitable trade items and an important food source. From 1836, yearly exports of cattle hides and goat skins had reached 6,000 and 20,000, respectively. By the 1860s and 1870s that figure had risen to 20,000 hides and 50,000 skins annually (Kemper and Kamins 1993). The meat from goats was also salted and dried and exported each month. The importance of goats to Puna and Kaʻū Hawaiians as a means of subsistence and market product is evident in the Boundary Commission testimonies, where ownership of the animals is described and identified by ahupua'a (Moniz-Nakamura n.d.). By 1862, within the current park boundary, goat ranching was widespread in Puna from Laeʻapuki to Panau and Kealakomo. By the early 20th century, goat hunting had become an important means of subsistence for those who lived in Puna and Kaʻū. Meat from goats was eaten by hunters and their families. Emma K. Kauhi (1996), a resident of nearby Kapaahu, relates that in 1925, the men from Kapaahu would go into the mountains in Paliuli in Pānau to hunt goats, donkeys, and wild cattle. Ms. Kauhi states, "A whole lot of men would go and build a corral and drive the goats inside and they would be shared out to all the people" (Moniz-Nakamura n.d.).

Non-native Ungulates and Cultural Resources in Hawaiʻi Volcanoes National Park

Prior to the NPS involvement with the ungulates, the Hawaiian Kingdom recognized the need to protect the water resources that supported the lucrative agricultural industry, and commercially valuable forest species (Buck 2003). On Sept 19, 1876, King David Kalākaua signed into law the *Act for the Protection and Preservation of Woods and Forest*, which directed the Minister of the Interior to set apart and protect forest lands (Hawaiʻi Laws Chapter XXX, 39) and authorized the superintendent (of the Kingdom of Hawaiʻi lands) to "have charge of the construction of fences and barriers required to protect the said woods and forest lands." On January 4, 1893, Queen Liliʻokulani approved the establishment of the Bureau of Agriculture and Forestry, which further defined the role of the Hawaiian government in preserving forest (Hawaiian State Archives-Com 2, Box 11). Under the Territory of Hawaiʻi, these efforts became the responsibility of the Board of Agriculture and Forestry. In Hawaiʻi Volcanoes National Park, animal control actions conducted by the territorial government began in 1927 and were assumed by the park in 1932 (NPS 1972).

Several areas within the current park boundary, including the districts of Puna and Kaʻū and specific locations of ʻĀinahou in Keauhou and Kahuku in Kaʻū, were focal cattle and goat ranching sites. However, feral goats, sheep, and cattle were widespread and beyond the boundaries of the ranches by the time the U.S. government established the national park on the Island of Hawai‘i in 1916. The control of these non-native ungulates became the responsibility of the NPS.

The NPS *Management Policies 2006* (NPS 2006b) recognizes the following categories of cultural resources: archeological resources, cultural landscapes, structures, museum objects, and ethnographic resources, as specific to *National Historic Preservation Act* property types. This document analyzes potential impacts to three of the five categories: archeological resources, cultural landscapes, and ethnographic resources. Museum objects and historic structures are not likely to be impacted by non-native ungulate management (see discussion in “Chapter 1: Purpose of and Need for Action,” “Issues Dismissed From Further Consideration”). The 13 National Register-listed properties in the park include buildings, trails, the Kīlauea caldera, the Puna-Ka‘ū Historic District and ‘Āinahou Ranch House and Gardens. Structures, such as cabins, trails and roads are unlikely to be affected by ungulate management. Other listed properties that may be affected by ungulate management are discussed under the appropriate cultural resource category (archeology, cultural landscapes, or ethnography). There is a high probability that many cultural resources exist in undocumented or unsurveyed areas of the park. The National Register and the sites listed is incomplete and does not reflect our current understanding and distribution of cultural resources. Consequently, the information that follows is provided based on current surveys that have been completed in addition to the properties listed on the National Register.

ARCHEOLOGICAL RESOURCES

The NPS has been the steward of the lands in Hawai‘i Volcanoes National Park for nearly 100 years. For centuries prior to European contact, this land was cared for and occupied by the Native Hawaiian people. The physical remnants of those who lived and thrived in this setting can still be seen today in the archeological resources that are spread across this vast landscape.

Archeological resources are the physical evidence of past human activity, including evidence of the effects of that activity on the environment (NPS 1998). An archeological overview and assessment of the park was prepared in 2008 (Tuggle and Tomonari-Tuggle 2008). It provides guidance to program managers in the form of recommendations for future study to meet legislative requirements. Recent analysis of all known survey projects indicate that 13% of the park has been surveyed to date. The coverage has been such that samples of most of the regions of the park have been obtained, and a general understanding of occupational patterns has been developed.

The archeological resources at Hawai‘i Volcanoes cross a range of prehistoric Native Hawaiian and Euro/American historic sites. Spatially, ruins extend from the coast to the upland alpine regions. Radiocarbon data suggest that Hawaiians settled in this region of Puna and Ka‘ū by the early 15th century. Evidence of their life on this lava landscape can be found in the remnants of house platforms and caves scattered throughout the lowland and upland areas. Enclosures, which may have been used to pen livestock, and excavated pits and rock mulch mounds suggest animal husbandry and widespread farming took place on what today appears to be barren lava. Five centuries ago, however, this area was host to thriving family communities, or *ohana*, who etched carvings (petroglyphs) that represented their families, traditions, and beliefs into the cooled lava surface.

The Native Hawaiians who lived in this region were linked together by trail systems, which connected families who lived and fished along the coast with farmers who lived and worked further inland. The intricate trail systems also provided people with access to prized resources, such as volcanic glass and basalt, used to make their tools; petrel nests, where seabirds were caught for food; shrines and other sacred sites used for worship and other activities (such as observing the movement of the sun and the changing of the seasons); plants collected for medicine and dyes; and trees harvested for wood for canoes and houses. These resources are a testament to those who chose to live in the shadow of Kīlauea and Mauna Loa and were shaped by the power of Pele (the Hawaiian goddess of volcanic activity).

Hawaiian Petroglyphs

Source: http://www.nps.gov/havo/photosmultimedia/Landscapes-in-the-park.htm.

Across the entire park, more than 300 archeological sites with associated subsites (approximately 2,000 plus) or features have been identified, evaluated, and recorded in the Archeological Sites Management Information System, the NPS database of archeological information (NPS 2009f). The recent addition of the Kahuku region has contributed to the park's database of sites. More archeological sites are expected to be found, as only a portion of the Kahuku Unit has been systematically surveyed (Quiseng 2008), and there are many other areas of the park for which survey and documentation are still needed.

Of the numerous known Native Hawaiian sites across the landscape, one of the most important sites in the park is the Puʻuloa Petroglyph Field, part of the National Register–listed Puna-Kaʻū Historic District, containing more than 23,000 petroglyphs that depict people, canoes, geometric shapes, and cupules, or *puka* (holes), in which umbilical cords were placed. Included in the historic district are the large agricultural fields in Pānau, Paliuli, and Kealakomo where sweet potato was planted. Another is the "1790 Footprints Area," which is listed on the National Register. Also present are native shrines (*heiau*) such as the Wahaʻula Heiau, built in the 13th century and significant for its connection to Paʻao, a priest who appeared on the island, ushering in the second massive migration wave (NPCA 2008). Another resource is a portion of the Ala Kahakai National Historic Trail (NHT), a 175-mile trail corridor with cultural and historical significance connecting and traversing hundreds of ancient Hawaiian settlement sites and over 200 ahupuaʻa, or traditional sea-to-mountain land divisions (NPS 2009h).

Many historic archeological sites can also be found throughout the park, associated with such events as World War II and ranching. Ranching features include houses, ranch walls, animal enclosures, and trails, including the Kahuku to Ainapo Trail that was used to drive cattle across the island. Families that used lands in Kaʻū and Puna that are now included within the park boundary tended goats—particularly in the Kalapana Extension. Structural remains of these activities provide a testament to the goat and cattle ranching activities that were widespread in the lands within the current park boundary. The park also contains the first airfield ever built on the island, the only physical remnant of the Wilkes Expedition at the summit of Mauna Loa, and an impressive example of early Hawaiian industry, the export of pulu, at the Pulu Factory.

The archeological sites located in Hawaiʻi Volcanoes National park are impacted by a number of natural and human-induced elements. These include, among other things, lava flows, fire, visitors, non-native ungulates, and time.

The archeological sites located in Hawaiʻi Volcanoes National park are impacted by a number of natural and human-induced elements. These include, among other things, lava flows, fire, visitors, non-native ungulates, and time. Sites located in areas where ungulates tend to gather are of particular concern, because of the impact ungulates have on these features. In the past, affected areas have included the large agricultural fields in Panau, Paliuli, and Kealakomo where sweet potato was planted. Currently, the area of greatest concern for damage to archeological sites by ungulates is the Kahuku Unit, as it contains the largest population of non-native ungulate species. The newly discovered Kau Field System in Kahuku contains lowlying features that were likely impacted by feral goats and sheep (Moniz-Nakamura, pers. comm. 2010). When under cultivation the fields may have been impacted by ungulates eating the plants. After the fields were abandoned the field systems were impacted by large numbers of ungulates that easily trample the features. Caves are especially vulnerable to damage, as ungulates tend to bed down in them, trampling fragile artifacts and knocking over walls. Surface sites are also vulnerable to ungulate activities such as trampling, grazing, digging, rooting, bedding, and depositing fecal material.

CULTURAL LANDSCAPES

Cultural landscapes are geographic areas associated with specific cultures or historical events, and they help illustrate how humans have adapted to and altered their surroundings (NPS 1998). The NPS recognizes four cultural landscape categories: historic designed landscapes, historic vernacular landscapes, historic sites, and ethnographic landscapes. The historic vernacular landscapes—landscapes that evolved through use by the people whose activities or occupancy shaped that landscape—at Hawaiʻi Volcanoes National Park that might be impacted by non-native ungulates or ungulate management activities are addressed below. (Ethnographic landscapes are discussed more fully in the “Ethnographic Resources” section below.)

Hawaiʻi Volcanoes National Park has identified 19 individual cultural landscapes in the park, which include trails, ranches, roads, historic districts, landing strips, and a military camp. However, only three historic properties with certified cultural landscapes have been thoroughly documented: Crater Rim Historic District, Kīlauea Historic District (formally the Kīlauea Administration and Employee Housing Historic District), and ʻĀinahou Ranch and Gardens. These have been documented through cultural landscape inventories (NPS 2004c, 2006d, 2006e) and have been determined eligible for listing on the National Register. ʻĀinahou Ranch House and Gardens was listed on the National Register in 1994 as significant under National Register criteria B (associated with the lives of persons significant in our past) and C (embodies distinctive characteristics of a type, period, or method of construction). The associated landscape features of the property were subsequently documented through the NPS Cultural Landscape Inventory process in 2004. It is currently the only certified cultural landscape affected by pigs. Crater Rim and Kīlauea Historic Districts are both managed as ungulate free areas.

Herbert C. Shipman leased land from Bishop Estate to establish ‘Āinahou Ranch before the park acquired it. The period of significance is from 1941 to 1971, which begins when Shipman first constructed his house as a safe haven from a possible Japanese invasion during World War II and ends when Shipman submitted his asking price for the property and terminated his lease with the B.P. Bishop Estate, thereby allowing the NPS to acquire it from the owner. During that period, he established a captive flock of nēnē at the ranch. The ca. 10-acre residential complex includes the main ranch house constructed in 1941 and outlying buildings and structures, including water tanks and sheds. An informally planted garden area of introduced ornamental trees and shrubs that provide a setting for the historic character surrounds the house. Other landscape features include informal and formal paths and trails, rock walls, fences, horse trails and the rubbish dumps. Additional historic landscape characteristics include, land use, views and vistas, and the site’s water collection and distribution system. The associated landscape features of the historic property were documented as a historic vernacular landscape through the Cultural Landscape Inventory process in 2004. The Cultural Landscape Inventory for the ‘Āinahou Ranch states that it is in “fair” condition, with structural repairs needed (NPS 2004c).

Additional historic properties (both eligible for and listed on the National Register) have yet to be inventoried for cultural landscape potential.

ETHNOGRAPHIC RESOURCES

The ethnography program at Hawai‘i Volcanoes National Park is one of the park’s most visible cultural resource programs. The park has a strong commitment to integrating native voices in interpretive materials, and the park acknowledges the “living culture” and embraces the sacredness of the summit area. The park maintains solid relationships with a number of Hawaiian elders, or *kupuna*, and Native Hawaiian Organizations as part of ongoing consultation for the protection of cultural resources in the lands of the park. Ethnographic work at Hawai‘i Volcanoes includes the studies titled *Native Hawaiian Use of Hawai‘i Volcanoes National Park: A Historical and Ethnographic Overview* and *Ethnographic Studies at Hawai‘i Volcanoes National Park*; both works were completed for the NPS by Charles Langlas (2003a, 2003b). Other work continues research on the understanding of the greater cultural landscapes found in the park lands.

Ethnographic resources are variations of natural resources and standard cultural resource types. They are subsistence and ceremonial locales and sites, structures, objects, and rural and urban landscapes that traditional users designate as culturally significant to their present way of life. The decision to call resources “ethnographic” depends on whether associated peoples perceive them as traditionally meaningful to their identity as a group and the survival of their lifeways (NPS 1998). Ethnographic resources abound in Hawai‘i Volcanoes National Park. The volcanic landscape, the volcano summits, and the vegetation connect the Hawaiian people to the park. These same resources have value for non-Hawaiians for a variety of reasons.

The volcanic landscape found throughout the park is considered an ethnographic landscape that is very important to the Native Hawaiians. The volcanic landscapes are recorded in countless chants and stories of Pele. These stories describe in detail the movement of lava, whether destructive or creative in nature. It also describes other phenomena associated with eruptions, such as earthquakes, tsunamis, and explosive eruptions. Pele is more than the goddess, she is volcanism, she is the molten lava creeping along the terrain, and she is also the magma that has cooled. This landscape sustains life for both plants and animals, including humans. To some Hawaiians, especially those who live in Puna, Kaʻū and South Kona, it is a sacred landscape: they understand that the land belongs to Pele and she can take it whenever she wants.

The longest traditional users of these resources are the Native Hawaiians. The lifestyle of the Hawaiian people was and still is greatly influenced by the landscape on which they live. The Hawaiians had a highly stratified social structure by the time Europeans arrived in Hawaiʻi (NPS 2009k). This system consisted of *nā akua* (gods), the *aliʻi* (chiefs), and the *makaʻainana* (commoners). The gods were pervasive in every aspect of society because the Native Hawaiians were directly tied to the natural world and their gods represented elements of nature—for example the sun (Kanehoalani), freshwater (Kanekawaiola), the ocean (Kanaloa), volcanism (Pele), forest (Laka), and others. All natural phenomena (including the Kanaka [mankind]) are intimately connected (Kealiʻikanakaʻoleohaililani 2009). The aliʻi (chiefs) governed their people on behalf of the gods. They saw to it that the appropriate rituals of reciprocity were observed.

The traditional Hawaiian land management system was very sophisticated. The island was divided much like a pie. The ahupuaʻa were wedge-shaped land divisions that extended vertically from the mountain to the sea and also included offshore fisheries (NPS 2009h). This ensured that people living in the ahupuaʻa had access to a wide range of resources necessary for living. Ahupuaʻa were considered political boundaries that separated chiefdoms. There are still smaller land sections in the ahupuaʻa (HDLNR 2003b). Horizontal land divisions in the ahupuaʻa were environmental zones demarcated by vegetation growth at various elevations. The top of the mountain is known as the kuahiwi; it is very sacred because of its height. Just below the kuahiwi is the kualono, a region where māmane and naio grow sparsely. Below the kualono the wao maʻukele or waokele is named for its wet soggy ground, because it lies within the rain belt. ʻŌhiʻa and koa dominate the canopy. The wao akua is the forested region just below the waokele, said to be occupied by forest spirits. It was important to keep this section of the forest intact and undisturbed because it supplied the seeds that generated new growth and kept the forest alive. The forested region located below the wao akua was known as the wao kanaka, a region where the people came to collect material for domestic purposes. The kula region is the upland grassy plains where pili was collected and used for thatching their homes. Finally, the kahakai, or shoreline, is where niu (coconut trees), hala (pandanus), and other useful plants grew (HDLNR 2003b).

These horizontal land divisions are still recognized and used by Native Hawaiian practitioners today. Practitioners of hula and Hawaiian medicine continue to collect plant material in various ecological zones, although some of the plants needed are no longer found or are harder to find in the wao kanaka due to development and other factors, such as invasive species, and practitioners have been pushed to different zones in order to find the material they need. The Hawaiians' relationship to the land was and still is very important. They know that the waokele and the wao akua are vital for the collection of the water that fills the island's aquifers. They are also aware of the regenerative energy of the forest; hence, the designation of the wao akua and waokele areas as undisturbed areas where the forest was kept intact. Certain ceremonies and rituals are still practiced in these areas.

The imposing presence of natural phenomena formed the basis of early Hawaiian lifestyle. Gods and goddesses were seen as personifications of natural objects and forces of nature. Native Hawaiian beliefs and practices taught that the entity or energy whose primary form or function is necessary for sustaining all life is the deity (Kealiʻikanakaʻoleohaililani 2009). Certain people, places, things, and times were sacred—they were kapu, or forbidden. Women ate apart from men and were restricted from eating pork, coconuts, bananas, and a variety of other foods. The aliʻi imposed kapu (restrictions) that regulated fishing and the harvesting of other resources, thus ensuring their conservation. Any breaking of kapu disturbed the stability of society; the punishment often was death (NPS 2009k).

Sacred or religious features in the park include natural features such as Kīlauea Caldera and Summit area and constructed features such as shrines, heiau, or burial sites. Kīlauea is used for rituals to Pele, goddess of volcanic activity, or to her relatives (Kamohoaliʻi, Hiʻiakaikapoliopele, and others). The sites for Pele are by far the most important (Langlas 2003a).

Native Hawaiians from the entire island, and even from the outer islands, go to Kīlauea Caldera to give hoʻokupu (offerings) to Pele and to ask for her help with their lives. Those religious activities have their roots in the Hawaiian past, from well before the time of European contact. Many of the Hawaiians who go to Kīlauea to make offerings to Pele are associated with various hālau hula (dance schools) (Langlas 2003b). Asian cultures have also adopted Pele as their deity, making special trips to the Island of Hawaiʻi for the day and leaving incense, fake money, and other food offerings at the edge of the crater.

The Polynesian pig figures prominently in Native Hawaiian culture. There are frequent references to pigs as god figures, gifts, and sacrificial offerings in ethnographic studies (Langlas 2003a, 2003b). However, in some cases, pigs were also depicted as wreaking havoc on resources. For example, Kamapua'a, the Hawaiian pig-god, was from the Island of Oahu, a place called Kaluanui (Asia-Pacific Digital Library 2010), but he traveled freely from Kauaʻi to Hawaiʻi. It is probable that Kamapuaʻa belonged to the cult of Lono, god of fertility. In some stories he is noted for finding freshwater springs. He was very strong and had the ability to change his body form from a pig, to a handsome man, or a humuhumunukunukuapuaʻa (trigger fish). Pigs were known to roam free, as it is recorded in the Kamapuaʻa traditions. In some stories Kamapuaʻa was a trickster and in other stories he was mean, devastating taro, sweet potato, and sugarcane patches—changing himself into a black hog, he devoured and trampled the sugarcane, rooted up taro, and upset calabashes filled with poi, eating everything in sight (Westervelt 1963). (The cultural significance of the black pig is that it is the most sacred sacrifice to be offered to the high gods [Beckwith 1981].) Kamapuaʻa and his followers were also known to have raided Chief Olopana's (chief of Oahu) chickens and knocked down fishpond walls, making them quite a nuisance. It is said that they passed along the Ewa side of the Island of Oahu, ravaging the land like a herd of swine. Olopana tried again and again to kill him in order to end his destruction but he was far too powerful. These stories are interesting because they illustrate that a pig problem existed prior to Western contact as Native Hawaiians struggled to control the pigs.

Following the introduction of European pigs, goats, cattle, and western economic concepts, Native Hawaiians and subsequent settlers began raising and hunting animals for commercial as well as personal uses (Langlas 2003a). By the 1920s in the Kalapana area, Native Hawaiians allowed their pigs, goats, and cows to forage for food, feeding them occasionally to keep them tame, and fencing the animals out of their houses, yards, and gardens. Several small cattle operations and a commercial goat ranch operated until the 1930s. Once families moved away from these locations and were no longer tending animals, large herds of wild goats were free to roam in areas that are now part of the park from Kapāpala to Panau (Langlas 2003a). Kalapana Hawaiians, along with other individuals from nearby communities, participated in park-authorized goat drives from the 1920s to the 1950s and in subsequent NPS-authorized pig control efforts. Goat drives ceased once large herds were removed from the park (NPS 1972).

According to Langlas (2003a), Native Hawaiians hunted for feral pigs in upper Kahaualeʻa (including outside the park), Kamoamoa, and Pānau (part of the Kalapana Extension) through the 1960s, and groups of people made periodic trips west along the coast from Kapaʻahu to fish and to hunt goat. (It should be noted that during this time any legal hunting of animals in the park was by private contractors or by individuals working under the deputy ranger program as part of the feral animal reduction program.) Traditional Native Hawaiian use of resources through fishing (including areas legislated under the 1938 Kalapana Extension Act), plus ritual practices, still continues in the park (Langlas 2003a).

Prior to becoming part of the park, private cattle ranches were established in several areas of the park. These included Mauna Loa, ‘Āinahou and the Kahuku unit. Starting in the 1860s, ranching activities were dispersed in Kahuku. Most of the cattle from that time were remnant populations of the first cattle brought to Kealakekua Bay, the Island of Hawai‘i, for Kamehamaha in 1793 (Bergin 2004). The open pasture lands that currently define cattle ranching in Hawai‘i, and particularly at Kahuku, developed after 1947 (Avery 2009). Prior to that, cattle were allowed to roam in the designated paddocks—no large landscape modification was carried out, with the exception of fencing. Although fencing in the form of dry laid walls was the norm, wire fences were introduced to this landscape. Ranching has become a traditional Hawaiian activity that began in the 1830s, first on Maui and then here on the Island of Hawai‘i with the Parker Ranch.

Hawai‘i Volcanoes has many other important human stories, such as contact, conflict, and integration of Hawaiians with foreigners; the scientific exploration and investigation of volcanoes, earthquakes, and adaptation to a changing landscape; and military history that includes the establishment of the Kīlauea Military Camp, the occupation of the park during World War II at both the Kīlauea and the Kahuku sections, buffalo soldiers, and Japanese internment (NPCA 2008). Each of these histories can be tied to a group of people who could attribute a cultural significance to their present way of life.

WILDERNESS

In 1978, under Public Law 95-625, *National Parks and Recreation Act* of 1978, the U.S. Congress designated 123,100 acres of wilderness at the park. There are 7,850 acres of land outside the park that were identified as potential wilderness that could become designated as wilderness should the park acquire those lands in the future (for a total of 130,950 acres). Wilderness areas at Hawai‘i Volcanoes National Park consist of four disjunct units: the Mauna Loa Unit, which includes the Mauna Loa Strip (above 5,000 feet (1,524 meters) in elevation) and the summit; the ‘Ōla‘a Unit, which includes the ‘Ōla‘a Forest; the East Rift Unit in the upper east rift zone; and the Ka‘ū Unit, encompassing the Ka‘ū Desert (below 3,000 feet (914 meters) in elevation) (see figure 8). Kahuku Unit is currently being evaluated for wilderness eligibility. Wilderness areas eligible for designation must possess at least the following characteristics (as identified in the *Wilderness Act*):

- The earth and its community of life are untrammeled by humans, where humans are visitors and do not remain.
- The area is undeveloped and retains its primeval character and influence without permanent improvements or human habitation.
- The area generally appears to have been affected primarily by the forces of nature, with the imprint of human work substantially unnoticeable.
- The area is protected and managed to preserve its natural conditions.
- The area offers outstanding opportunities for solitude or a primitive and unconfined type of recreation.

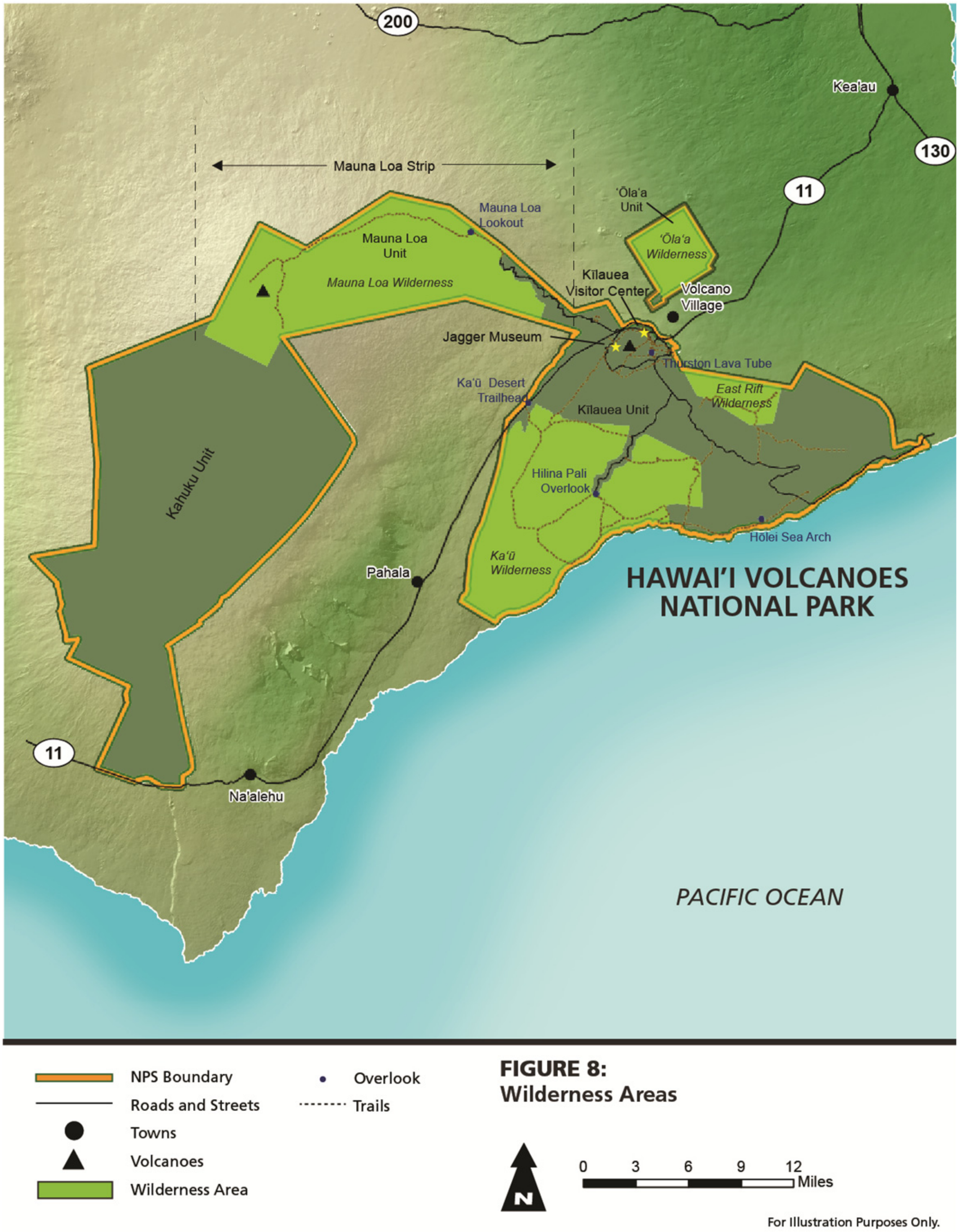

FIGURE 8:
Wilderness Areas

According to the final environmental statement for proposed wilderness at the park, the designated area would “preserve diverse segments of the Island of Hawai‘i in an undeveloped state—from the 13,680-foot summit of Mauna Loa to the Puna and Ka‘ū Coasts, and landscape ranging from barren lava to dense tropical forests and dry coastal reaches with numerous archeological sites” (NPS 1975b). In addition, the final EIS identified the need for management intervention to ensure the survival of endemic communities of plants and animals at risk by non-native species. Specific actions identified were construction of fences and the use of helicopter to exclude nonnative goats and pigs for the protection of park resources.

The management actions in this plan may affect the untrammeled and undeveloped nature of the wilderness areas, but will not have any effect on the opportunity for visitors to enjoy primitive and unconfined forms of recreation.

SOILS

Soils found in the geological region of the park consist mostly of lava, cinder, and rubble, which form organic matter through decomposition. The range in soil conditions reflects the geologic parent material; accumulations of organic matter in the soil and ground litter are the most important factors in soil development on these relatively young substrates. Pāhoehoe, ‘a‘ā, cinders, and weathered ash provide differing contributions of minerals and drainage characteristics, and soil age and composition have considerable influence over plant community composition and hydrology (TMA 2007). Throughout Hawai‘i Volcanoes National Park, sparsely vegetated, homogeneous soil substrates of volcanic origin are typical and include volcanic ash–based soils and well-draining, fertile soils. These newly formed soils originate from historic lava flows. Young ash deposits, for instance, are evident in the Devastation Trail area, where early successional vegetation has recently become established, as well as in other areas of the park that have undergone relatively recent geologic changes due to volcanic eruptions (Matson 1990).

SOIL ASSOCIATIONS

Table 9 lists the major soil associations present in the park and their respective acreages, as mapped by the USDA–NRCS (2009a). Figure 9 illustrates the areas in the park where each of these soil associations are found. Soil associations represent the largest and most general classification in a complex taxonomy for identifying soils. Associations are groups of soil types that consist of two or more dissimilar soil components occurring in a regularly repeating pattern. They represent a landscape that has a distinctive proportional pattern of soils and is named for the major soil types that it represents. It normally consists of one or more major soil series and at least one minor soil series, which are the lowest categories in the soil classification system.

Because the primary issue of concern related to soils is erosion, the soil erodibility factor, or K factor, of the soil series that compose the associations listed in table 9 were used to identify their erosion potential as low, moderate, or high. Although soil erodibility factors were not available for all these soil series, available data indicate that the erosion potential of park soils is predominantly low (USDA-NRCS 2009c). However, some soils, such as the Kīlauea series, have low to high erosion potential depending on the depth of the soil (USDA-NRCS 2009c).

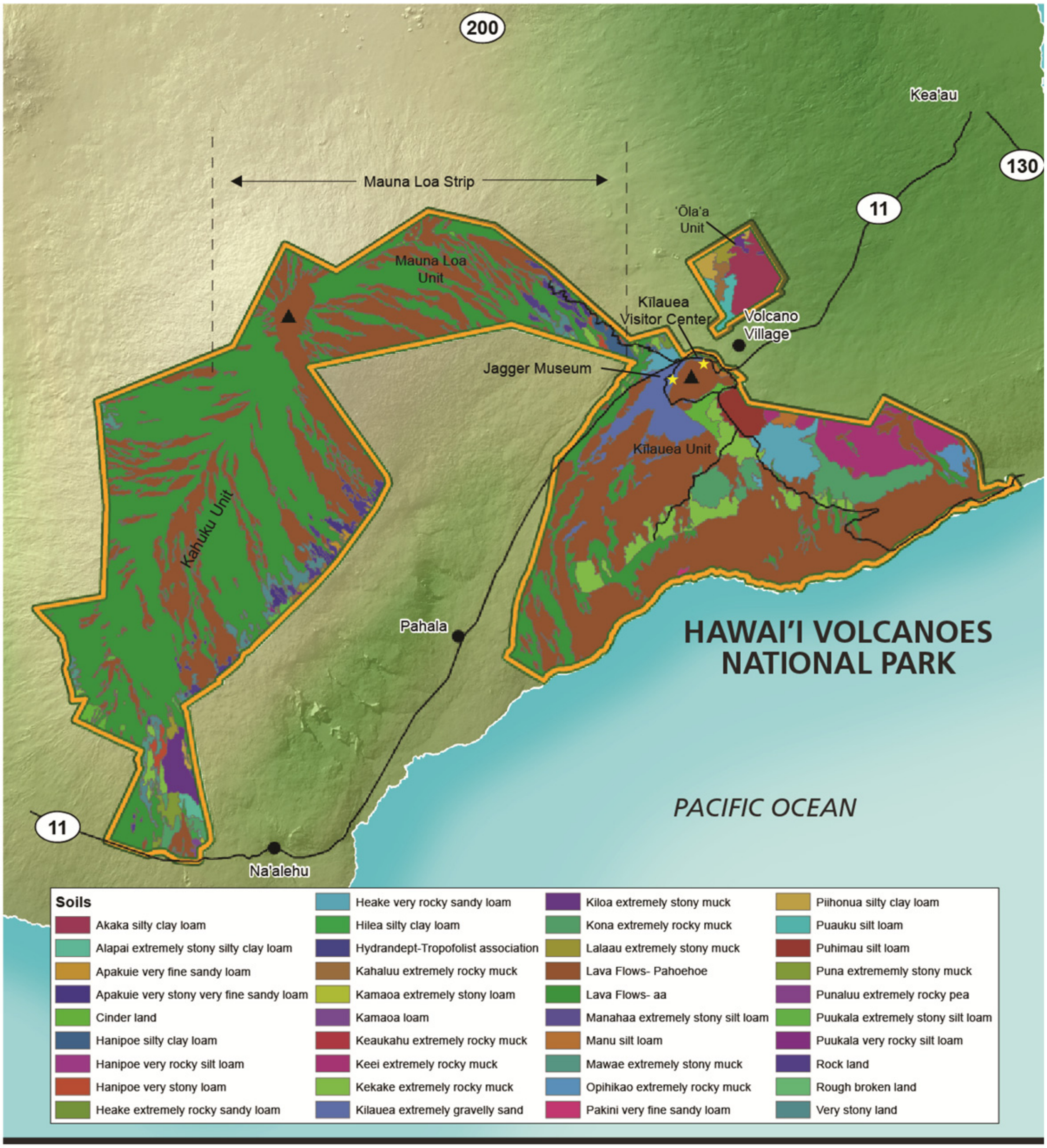

FIGURE 9:
Soils Map

TABLE 9: MAJOR SOIL ASSOCIATIONS PRESENT IN HAWAI‘I VOLCANOES NATIONAL PARK

Soil Association	Approximate Acreage
Kaiwiki-Honokaa	829
Kekake-Keei-Kahaluu	28,532
Kilohana-Kilauea-Huikau-Apakuie	19,445
Lava flows	296,819
Maile-Hanipoe	2,510
Malama-Lalaau-Hydrudands	2,949
Piihonua-Akaka	8,078
Puna-Papai-Kiloa-Kaimu	7,519
Waimea-Kikon	11
Total Acreage	**366,690**

Source: USDA-NRCS 2009a.

Note: acreages were calculated using geographic information systems data and overstate the total acreage of the park; they should be used for relative comparisons only.

SOUNDSCAPES

INTRODUCTION

According to the NPS, a soundscape is defined as the “total acoustic environment of an area,” which includes both natural and human sounds (NPS 2009c).

According to the NPS, a soundscape is defined as the “total acoustic environment of an area,” which includes both natural and human sounds (NPS 2009c). According to Section 4.9 of NPS *Management Policies 2006*, the natural soundscape of a park refers to the combination of all of the natural sounds occurring in the park, absent the human-induced sounds, as well as the physical capacity for transmitting those natural sounds (NPS 2006b). Natural sounds may range from bird calls and insect chirps to sounds produced by physical processes, like wind rushing through leaves on trees, thunder, pouring rain, and lava fountains and flows. In a 1998 survey in which people were asked to define the most important reasons for having national parks, 72 percent indicated that parks provide opportunities to experience natural peace and the sounds of nature. Further, visitor preference studies identified birds, animals, wind, and water as very pleasing sounds (NPS 2009c).

The soundscape at Hawai‘i Volcanoes includes both natural and human components. The “natural quiet” that occurs in the absence of human sound sources is also defined as the “natural ambient” sound level of a park. These natural ambient sound conditions exist in the absence of any human-produced noises. Common natural ambient sounds at Hawai‘i Volcanoes include wind, thunder, rain, the rustle of vegetation, ocean surf, birds, and insects, as well as the crackling, clinking, and rockfall sounds associated with new lava flows and eroding volcanic features. These sounds may be heard as a composite of sound, not individually.

Noise is generally defined as unwanted or intrusive sound. Noise can adversely affect park resources or values, including but not limited to natural soundscapes, wildlife, wilderness, and visitor experience. Human sound sources at Hawai‘i Volcanoes that are commonly perceived as noise include cars, buses, aircraft, and motorcycles; visitors yelling or talking loudly; sounds associated with cell phones, personal music players, and cameras; and mechanized maintenance equipment such as weed-whackers (Lawson et al. 2007).

The magnitude of noise is usually described by its sound pressure. The A-weighted decibel (dBA) scale is commonly used to describe noise levels because it reflects the frequency range to which the human ear is most sensitive. Sound levels measured using a dBA scale are generally expressed as dBA. Throughout this section, all noise levels are expressed in dBA. Several examples of sound pressure levels in the A-weighted scale are listed in table 10. Normal speech has a sound level of approximately 60 dBA.

TABLE 10: COMMON NOISE LEVELS AND THEIR EFFECTS ON THE HUMAN EAR

Source	Decibel Level (dBA)	Noise Level
Normal breathing	10	Very low
Leaves rustling at Canyonlands National Park	20	Very low
Soft whisper, quiet library (15 feet), Snake River (at 300 feet)	30	Low
Crickets at Zion National Park (at 16 feet), Snake River (at 100 feet)	40	Low
Light auto traffic (100 feet)	50	Medium
Conversational speech (3 feet), 4-stroke snowmobile (30 mph at 50 feet), automobile (45 mph at 100 feet)	60*	Medium
Personal watercraft (82 feet)	68–76	High
Vacuum cleaner, 2-stroke snowmobile (30 mph at 50 feet)	70	High
Off-road recreational vehicles	70–90	High
V8 “muscle” boat (82 feet)	85–86	High
Heavy truck or motorcycle (25 feet)	90	High
Thunder	100	High
Military jet at Yukon-Charley Rivers National Preserve (328 feet above ground level)	120	High
Shotgun	125	High

Sources: Kormanoff and Shaw 2000; Michael Minor and Associates n.d.; American Speech-Language-Hearing Association n.d.; NPS 2007c; and McCusker, pers. comm., 2007.

*Sound levels above 60 dBA begin to interfere with close-range conversational speech.

In 2003–2004, baseline acoustic data was collected throughout the park as part of the development of the ongoing ATMP/EIS related to the impacts of air tour overflights on park resources (FAA n.d.). This planning effort will inform future planning and soundscape management activities in various areas of the park (FAA 2006). Sound level measurements were conducted at 22 site locations from October 23, 2002, to June 1, 2003. Ultimately, 10 acoustic sampling areas were identified to acoustically represent regions of the park. The acoustic sampling areas largely reflect the natural ecological zones of the park. The baseline data representative of the various acoustic sampling areas and acoustic modeling of aircraft overflights will be used to further characterize soundscapes and determine potential impacts to park soundscapes from overflights as the ATMP/EIS planning process progresses. The results of these surveys are shown in table 11. While non-native ungulate management can occur anywhere throughout the park, these actions occur more frequently in zones 4 (Kahuku and ‘Ōla‘a), 5 (Kahuku) and 10 (Kahuku) (see table 11 and figure 10). It should be noted that sound measurements were not performed in the Kahuku Ranch Unit. Information collected from other sections of the park was used to extrapolate the natural ambient sound levels in Kahuku based on similarity of vegetation and terrain. These zones are shown in figure 10. Appendix D contains further information regarding the 10 acoustic sampling areas. The term L_{50} refers to the noise level exceeded for 50 percent of the day.

TABLE 11: MEASURED L_{50} NATURAL AMBIENT SOUND LEVELS

Acoustic Sampling Area[1]	Measurement Site	L50 Natural Ambient Sound Level (dBA)
Zone 1 (Shoreline)	1A	54.2
	1B	46.6
Zone 2 (Coastal Lowlands)	2A	28.3
	2B	32.7
	2C	29.1
Zone 3 (Sparsely Vegetated)	3A	31.4
	3B	29.1
	3C	32.7
	3D	20.4
Zone 4 (Montane Rain Forest)	4A	33.5
Zone 5 (Mauna Loa Montane/Subalpine)	5A	35.0
	5B	22.1
	5C	27.5
Zone 6 (Dry ʻŌhiʻa Woodlands)	6A	28.0
	6B	28.0
	6C	32.7
Zone 7 (Mauna Loa Alpine)[2]	no data	no data
Zone 8 (Lowland Rain Forest)	8A	42.6
	8B	38.2
	8C	29.7
Zone 9 (New Lava Flows)	9A	28.6
	9B	28.6
	9C	25.4
Zone 10 (Kahuku Pastures)	no data	no data

Source: FAA 2006.

[1]Kahuku was acquired subsequent to the measurement study, so no data were collected. Measurements conducted in older Hawaiʻi Volcanoes National Park units were extrapolated to Kahuku based on similar vegetation type and elevation.

[2]Weather and accessibility to Zone 7 prevented the ability to take measurements in this zone. However, sound levels for these zones were characterized based on the similarity in attributes when compared to Zone 3.

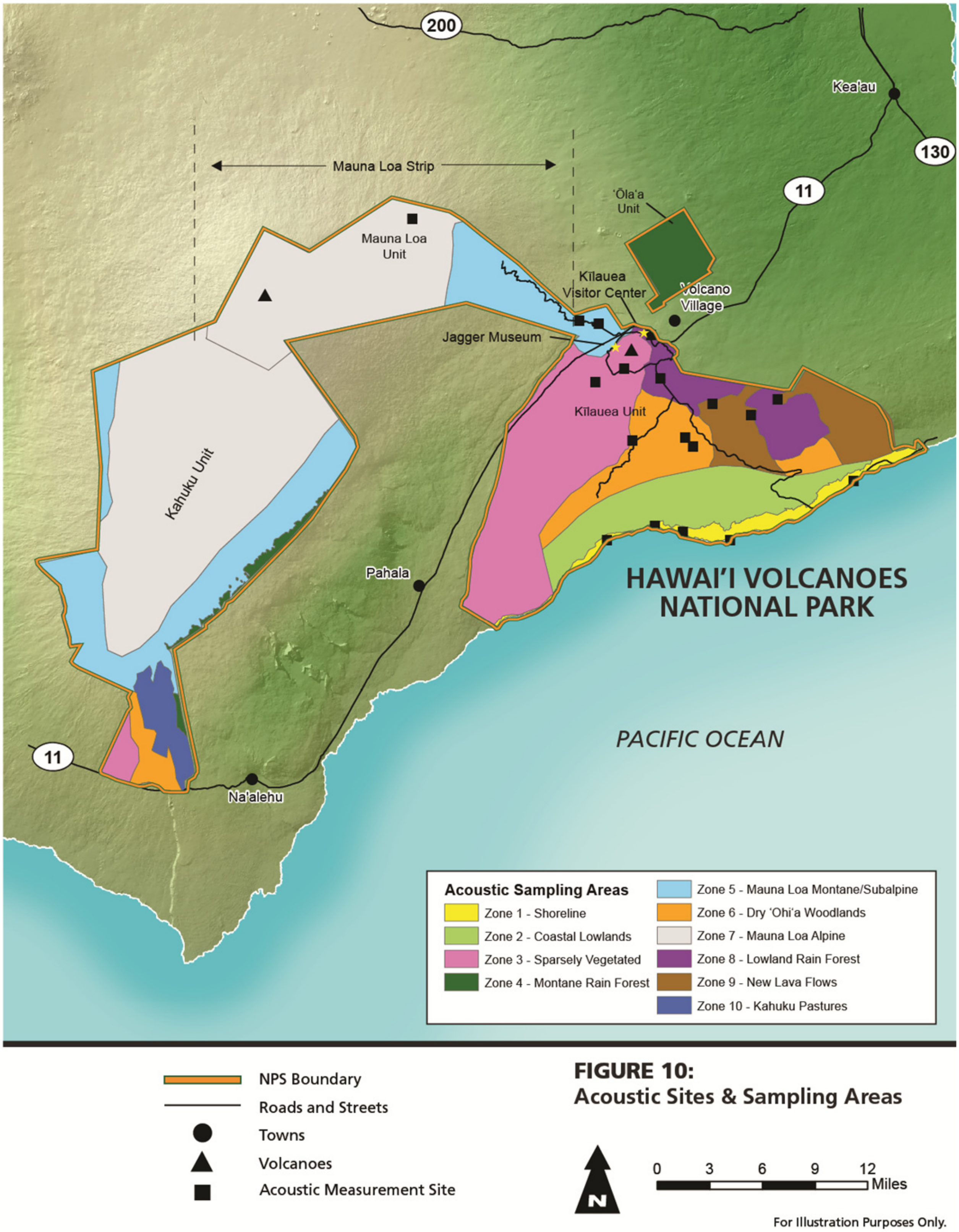

FIGURE 10:
Acoustic Sites & Sampling Areas

LAND MANAGEMENT ADJACENT TO THE PARK

As described in "Chapter 1: Purpose of and Need for Action," Hawai'i Volcanoes National Park is surrounded by other federal, state, and privately held land. Many of the agencies and organizations that own these lands, which include Hawai'i, Kamehameha Schools, and TNC, have specific management goals related to feral ungulates and are part of the TMA watershed partnership. The management of these lands, along with those owned by other landowners, has the potential to be affected by non-native ungulate management at Hawai'i Volcanoes National Park.

STATE OF HAWAI'I

The state manages natural area reserves, forest reserves, and game management areas on the Island of Hawai'i, several of which share boundaries with or are located near Hawai'i Volcanoes National Park. Areas in the state system have different management objectives. Protection of native ecosystems is the primary objective of natural area reserves, while game management is the primary objective in game management areas. Forest reserves balance several objectives that include providing mixed recreational use (including hunting) and protecting native plant communities and watersheds. The state is responsible for administering public hunting programs on these lands, as well as implementing additional non-native ungulate control.

In the late 1890s, the sugar industry and the growing population of Hawai'i realized that their abundant supply of high-quality water was threatened by the destruction of the forested mountain watersheds. Act 44, approved by the Territorial Legislature on April 25, 1903, created Hawai'i's forest reserve system, which became the largest public–private partnership in the history of the state (Buck 2003). During the early decades of the 20th century, public and private interests waged a massive campaign of fence building and feral animal removal to protect remaining native forests on Hawai'i. Fire control and large-scale tree-planting programs were implemented, and eventually more than 1.2 million acres would be included in the new forest reserve system (TNC 2003). Management activities, such as protective zoning, fencing, removal or control of feral animals, reforestation, and fire protection have reduced excessive erosion and loss of vegetative cover (Buck 2003).

Hawai'i County sponsors a feral pig pilot program. The program is overseen by the USDA Animal and Plant Health Inspection Service's (APHIS's) Wildlife Services and assists residents in getting rid of feral pigs that cause destruction on their properties. An *Environmental Assessment of Feral Swine Damage Management in Hawai'i County* was completed in 2008 (USDA-APHIS 2008).

NATURAL AREA RESERVES

The natural area reserves system was established in 1971 to "preserve and protect, in perpetuity, examples of Hawai'i's unique terrestrial and aquatic natural resources, in order that present and future generations may be able to learn about and appreciate these natural assets" (Natural Area Reserves System Commission 1997). The DLNR is mandated to protect these lands so that the natural resources remain as unmodified as possible. As a result, the natural area reserves system was also created to serve as a baseline to measure changes to other native ecosystems (Natural Area Reserves System Commission 1997).

According to the *Management Policies of the Natural Area Reserves System* (Natural Area Reserves System Commission 1997), the highest priority for these lands is conservation of natural resources, and the removal of feral non-native ungulates is an overriding consideration in the management of natural area reserves. In general, strategies are employed on these lands that reduce populations of non-native animals to the lowest possible level. The *Management Policies of the Natural Area Reserve System* states that sustained yield management of animals for hunting is not consistent with the intent of the natural area reserves, but where practicable, regulated public hunting could be used. Other control methods, including fencing, trapping, snaring, and aerial shooting, are also available if public hunting does not provide adequate control to meet objectives specified in the management plans for each natural area reserve (Natural Area Reserves System Commission 1997).

The plan for this reserve identifies goals and actions for non-native ungulate control that are aimed at reducing non-native ungulate populations (primarily pigs and cattle) to the lowest level possible in areas dominated by native species (HDLNR 1992a).

There are four natural area reserves adjacent to Hawaiʻi Volcanoes National Park: Kahaualeʻa, Puʻu Makaʻala, Kīpāhoehoe, and Manukā. The Kahaualeʻa Natural Area Reserve is located near the eastern boundary of the park and occupies 16,726 acres from 1,400 to almost 3,900 feet (427 to almost 1,189 meters) in elevation near the Kīlauea Iki Crater (HDLNR 1992a). The plan for this reserve identifies goals and actions for non-native ungulate control that are aimed at reducing non-native ungulate populations (primarily pigs and cattle) to the lowest level possible in areas dominated by native species (HDLNR 1992a). To achieve this objective, the state recommends fencing followed by public hunting supplemented by staff hunting, either on the ground with dogs or aerially (recommended in areas with cattle). Public hunting is a well-established activity in the Kahauale'a Natural Area Reserve (HDLNR 1992a, 2003b). The plan, which has yet to be implemented, also identifies the use of snares for effective pig control, but notes that it is not compatible with intensive public use or hunting with dogs (HDLNR 1992a).

The Puʻu Makaʻala Natural Area Reserve was established in 1981 and includes 12,000 acres ranging from 2,800 to 5,500 feet (853 to 1,676 meters) in elevation. The reserve surrounds three sides of the ʻŌlaʻa Forest Unit of Hawaiʻi Volcanoes National Park, and the plan for Puʻu Makaʻala identifies feral pigs as the most severe threat to natural resources (HDLNR 1989). This plan identifies the non-native ungulate control program as the first priority for long-term management of the reserve. Recommendations include fencing approximately 4,560 acres of the reserve followed by intensive snaring, trapping, and staff hunting to reduce feral pig populations to remnant levels in the enclosed areas. In the remaining areas, public hunting is used to control pig populations, with the intent of reducing the pig population to remnant levels, not sustained yield hunting (HDLNR 1989). Since implementation of the plan, approximately 3,000 acres has been controlled to remnant numbers of pigs, and efforts are underway in additional units.

The Kīpāhoehoe Natural Area Reserve is located in the South Kona district on the Island of Hawaiʻi. The reserve encompasses a 5,583-acre wedge-shaped section of the southwestern slope of Mauna Loa. The parcel includes roughly 2 miles of shoreline, and narrows to less than a mile across the top of the reserve, at an elevation of 5,600 feet (1,707 meters). The *Kīpāhoehoe Natural Area Reserve Management Plan* states that the primary threat to the native ecosystem in the upper portion of the reserve is the continuing uncontrolled disturbance and damage to vegetation caused by feral pigs, goats, cattle, and sheep (HDLNR 2002). The management plan identifies game drives, hunting with dogs (using public hunters whenever possible), fencing, and snaring as recommended management actions to prevent further destruction from these non-native ungulates (HDLNR 2002).

The Manukā Natural Area Reserve was established on the Island of Hawaiʻi in 1983, and occupies 25,550 acres on the southwest slope of Mauna Loa (HDLNR 1992b). The reserve protects 18 different natural communities, including dry and mesic forests, subalpine shrublands and forests, lowland and coastal shrublands and grasslands, anchialine pools, pioneer vegetation on lava flows, and lava tubes. The *Manukā Natural Area Reserve Management Plan* identifies reducing feral pig and goat damage as a primary goal of the reserve. In the management plan, fencing was proposed along the northwestern boundary and around the Kīpuka management unit. Furthermore, both public and staff hunting efforts were proposed to remove non-native ungulates (HDLNR 1992b).

FOREST RESERVES AND GAME MANAGEMENT AREAS

There are several forest reserves and game management areas in the vicinity of Hawai‘i Volcanoes National Park, including the Mauna Loa Forest Reserve and Game Management Area, Kapāpala Forest Reserve, Kapāpala (Cooperative) Game Management Area, Ka‘ū Forest Reserve, ‘Ōla‘a Forest Reserve, and Upper Waiakea Forest Reserve. Multiple management goals within forest reserves and game management include providing public recreational opportunities, protecting forest watersheds, supporting sustainable forest industry, and maintaining biological integrity of native ecosystems. According to the *Division of Fish and Wildlife Management Guidelines* (HDLNR n.d.a), game animal management in these areas falls into one of two categories for feral pigs, sheep, and goat: (1) control: mixed game and other uses, and (2) game control (public). In the first category, game management is an objective integrated with other uses. Under game control (public), the emphasis is on protecting native plant communities and watersheds through the use of public hunting. The Mauna Loa Forest Reserve and Game Management Area and the Waiakea Forest Reserve are designated mixed game and other uses for sheep and goats, and designated game control (public) for pigs. The Kapāpala (Cooperative) Game Management Area and Ōla‘a Forest Reserve are designated mixed game and other uses for pigs, goats and sheep while the Ka‘ū and Kapāpala forest reserves are designated as game control (public) for all three animals (HDLNR n.d.c).

NATIONAL WILDLIFE REFUGES

In 2008, the USFWS developed an environmental assessment to evaluate the potential environmental effects of building about 88,500 feet (27,000 meters) of fencing enclosing approximately 2,145 hectares (5,300 acres) of land in the Kona Forest Unit of the Hakalau Forest National Wildlife Refuge (USFWS 2008e). The fencing, which is not yet under construction, is intended to keep non-native ungulates and other mammals out of the area. The native forests of the Kona Forest Unit support four species of endangered forest birds, the endangered Hawaiian hoary bat, and a high diversity of native plant species, several of which are threatened or endangered. Until 2002, the Kona Forest Unit supported the last remaining ‘alalā (Hawaiian crows) in the wild. In the future, the area may serve as a place for their reintroduction into the wild.

KAMEHAMEHA SCHOOLS

Kamehameha Schools (Bishop Estate) is the largest private landowner in Hawai‘i. These lands were inherited by Princess Bernice Pauahi Bishop as the last royal descendant of the Kamehameha line and today total 365,800 acres of land throughout the state. In her will, she left her estate to Kamehameha Schools and mandated that her real estate be leased, sold, or managed to help generate revenue that would support the schools’ educational programs and services (Kamehameha Schools n.d.). Today, these lands are managed to derive an overall balance of economic, educational, cultural, environmental, and community returns as well as to protect and enhance native ecosystems (TMA 2007). As part of their involvement with the TMA, Kamehameha Schools is involved in fencing and non-native ungulate removal. In 2003, they ceased cattle operations and removed feral non-native ungulates from portions of the Keauhou Ranch designated for native forest restoration. The Keauhou Ranch is adjacent to the park.

The Nature Conservancy

TNC’s mission is to preserve the plants, animals, and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive (TMA 2007). TNC of Hawai‘i partners with indigenous communities, businesses, governments, multilateral institutions, and other nonprofits to address threats, including climate change, fire, and non-native species, to conservation of freshwater, forests, and marine ecosystems (TNC 2009).

On the Island of Hawai‘i, TNC owns and manages two preserves: the Kona Hema Preserve (8,061 acres in three contiguous units) and the Ka‘ū Preserve (3,548 acres in four noncontiguous units) (TNC 2006). TNC is involved with fencing and non-native ungulate removal on their lands. For example, the Kona Hema Units are fenced and approaching non-native ungulate–free status (TNC n.d.). In the Ka‘ū Preserve, TNC is managing the land to reduce populations of non-native animals and prevent new weed invasions. They are also working with neighboring landowners, local communities, state agencies, the NPS, and neighboring private landowners to protect the larger Ka‘ū forest (TNC 2009).

SOCIOECONOMICS

Hawai‘i Volcanoes National Park hosts an average of over 1.3 million visitors annually (see the “Visitor Use and Experience” section in this chapter). In 2007, there were 1.47 million visitors using the park for recreational and nonrecreational purposes. Over 95 percent of the spending associated with park visitation is from nonlocal visitors (Stynes 2008). Tourists primarily come to see volcanoes, rainforests, and the natural plant and animal life at the park. The uses of the park include viewing and understanding volcanic processes, seeing the park’s natural and cultural resources, practicing traditional cultural activities, and experiencing the relative solitude of the park’s backcountry.

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This socioeconomics section describes the more recent socioeconomic and demographic conditions and trends, the economic contribution of Hawai‘i Volcanoes National Park payroll and nonlocal visitation to the local economies, and the social benefits that the Volunteer Ungulate Control Program provides to the local community. As described in detail in chapter 1, although environmental justice populations of concern have been identified, there would be nominal to no impacts on these populations. Therefore, this issue is not discussed further in this chapter.

Socioeconomic Conditions and Trends

Since Hawai‘i Volcanoes National Park experiences such a large portion of nonlocal visitation, it is likely that visitors stay in communities (and spend money) across the Island of Hawai‘i. The socioeconomic study area therefore was chosen to be Hawai‘i County, which encompasses Hawai‘i Volcanoes National Park and includes the entire Island of Hawai‘i.

Demographic and Economic Overview

With an area of 4,028 square miles (10,432 square kilometers), the Island of Hawai‘i (or Hawai‘i County) is larger than all the other Hawaiian Islands combined and is the largest island in the United States. Fruits, nuts, and coffee are the island’s principal agricultural products. The Kona district in the western part of Hawai‘i is the coffee belt of the United States and is also known for its health resorts and offshore deep-sea fishing (Columbia Encyclopedia 2003). Hilo, on the east coast, is the island's largest city, chief port, and the county seat. In 2007, Hilo had a population of 50,289, comprising more than a quarter of the island's population (U.S. Census Bureau 2007a). All the coastal towns are linked by the Hawai'i Belt Road, which encircles the island.

Hawai'i County had an estimated population of 173,057 during 2007; the population has increased an average of 2.2 percent annually since 2000 (U.S. Census Bureau 2009b) for a total of 16 percent during this time period. The Island of Hawai'i is quite rural in nature, with 37 people per square mile. This can be compared with the state (189 people per square mile), Oahu (1,460), Maui (110), and Kaua'i (94) (U.S. Census Bureau 2000c). Table 12 summarizes a number of demographic and economic characteristics for Hawai'i County, Hawai'i, and the nation. In 2007, Hawai'i County and the state had slightly older populations than those of the nation. Poverty rates in the county are similar to those of the nation but higher compared to those of the state. The percentage of the population with bachelor's degrees is similar across the county, state, and nation.

TABLE 12: DEMOGRAPHIC CHARACTERISTICS OF HAWAI'I COUNTY, HAWAI'I, AND THE UNITED STATES, 2007

Estimate	HI County	HI State	USA
Demographic, Education, and Poverty Status			
Total population	173,057	1,283,388	301,621,159
Median age	38.6	38.1	36.7
High school education or higher	89.7%	89.4%	84.5%
Bachelor's degree or higher	27.6%	29.2%	27.5%
People below poverty level	12.8%	8.0%	13.0%
Race			
White	49.2%	34.3%	75.8%
Black	0.5%	2.8%	13.1%
American Indian or Alaskan Native	0.8%	0.3%	1.5%
Asian	34.4%	50.0%	5.0%
Native Hawaiian or Pacific Islander	13.3%	10.9%	0.3%
Some other race	1.9%	1.7%	6.7%
Hispanic or Latino	11.0%	8.2%	15.1%
Housing and Families			
Total housing units	63,250	506,751	127,895,430
Average family size	3.06	3.39	3.2
Percentage of households with one or more people under 18 years of age	36%	25%	34%

Source: U.S. Census Bureau 2007b, 2007c, 2007d.

In terms of race, the population of Hawai'i County comprises more white, Native Hawaiian or Pacific Islander, and Latino individuals and fewer Asian individuals than the population of the state. The county's racial percentages generally fall between those of the state and those of the nation, although they are closer to those of the state. Households in Hawai'i County are more apt to have children at home than households in the state or the nation, although the average family size is slightly smaller in the county compared to the state or the nation. This could indicate that there are fewer adults in the county's households, as compared with the state and the nation.

In 2007, Hawai‘i County's estimated median household income was less than that of the state and only slightly more than that of the nation. Between 2000 and 2007, the island's median household income grew 14 percent, much higher than the household income growth experienced in the state and the nation. These figures are summarized in table 13.

TABLE 13: REAL MEDIAN HOUSEHOLD INCOME (2007$)

Year	HI County	HI State	USA
2000*	$51,672	$64,673	$50,986
2007	$59,111	$63,746	$50,740
Percentage change, 2000 to 2007	+14%	−1%	0

Source: U.S. Census Bureau 2007b, 2007c, 2007d, 2000b.

*2000 household income figures for Hawai‘i County and the state were inflated with Bureau of Labor Statistics, Honolulu County Consumer Price Index, while the nation's household income was inflated with the U.S. Bureau of Labor Statistics, West Region's Consumer Price Index (U.S. Bureau of Labor Statistics 2009a, 2009b).

More recently, the economic downturn in the economy has likely reduced this income growth considerably. Less tourism, construction, and retail sales activities have been impacting economies of both the Island of Hawai‘i and Hawai‘i as a whole. One source indicated that the Island of Hawai‘i experienced an 8.8 percent drop in visitor arrivals in the first half of 2008, and visitor spending was down 2.2 percent over this same time period (Laney 2008).

In 2007, estimated average annual per capita personal income for Hawai‘i County was considerably lower than that of the nation and the state. Nominal personal income in the county has increased considerably between 2001 and 2007; however, once the inflation and cost of living increases have been removed, the income growth was 8 percent from 2001 to 2007, or on average, 1 percent annually. This growth is similar to that of the nation. Table 14 summarizes these personal income figures, which likely do not reflect the recent economic downturn affecting the national and state economies.

TABLE 14: REAL PER CAPITA PERSONAL INCOME FOR HAWAI‘I COUNTY, HAWAI‘I, AND THE UNITED STATES (2007$)*

Year	2001	2002	2003	2004	2005	2006	2007	% Change 2001–2007
Hawai‘i County	$27,502	$28,353	$28,368	$29,222	$30,128	$30,031	$29,702	+8%
Hawai‘i	$35,480	$36,080	$36,361	$37,755	$38,716	$38,913	$39,242	+11%
USA	$35,819	$35,434	$35,480	$36,291	$37,015	$37,962	$38,615	+8%

Source: Bureau of Economic Analysis 2009a, 2009b, 2009c.

*Personal income figures for Hawai‘i County and the state were inflated with U.S. Bureau of Labor Statistics, Honolulu County Consumer Price Index, while the nation's household income was inflated with the U.S. Bureau of Labor Statistics, West Region's Consumer Price Index (U.S. Bureau of Labor Statistics 2009a, 2009b).

Employment in Hawai‘i County has increased by 18 percent between 2000 and 2009. Hawai‘i has experienced more moderate job growth over this period of 10 percent. Although there has been employment growth since 2000 in Hawai‘i County, between April 2008 and April 2009 there has been a loss of almost 4,000 jobs, or over 6 percent of all jobs (State of Hawai‘i Department of Business, Economic Development, and Tourism 2009). Additionally, in April 2009, the unemployment rate in the county was estimated to be 9.7 percent (up from 2.9 percent in April 2007), compared with 6.8 percent in the state, and 8.9 percent in the nation (State of Hawai‘i Department of Business, Economic Development, and Tourism 2009; U.S. Bureau of Labor Statistics 2009c).

Major sources of employment in Hawai‘i County include accommodations and food services (17 percent), retail trade (14 percent), various government services (20 percent), and health care (10 percent). In 2009, agriculture accounted for 3 percent of the employment on the island. Between 2001 and 2009, educational services, other services, the arts, entertainment, recreation, and construction industries and activities have been driving the increase in employment. Employment declines over this time period were in manufacturing, accommodations, information, and agriculture. These employment-by-industry figures are summarized in table 15.

TABLE 15: TOTAL EMPLOYMENT BY INDUSTRY—HAWAI‘I COUNTY

Industry	1990		2000		2009		% Change* 1990–2009	% Change* 2000–2009
	Number	%	Number	%	Number	%		
Natural resources, mining, construction	3,500	7%	3,000	5%	4,500	7%	29%	50%
Manufacturing	2,400	5%	1,600	3%	1,450	2%	−40%	−9%
Wholesale trade	1,200	3%	1,300	2%	1,700	3%	42%	31%
Retail trade	6,700	14%	7,800	14%	9,150	14%	37%	17%
Transportation, warehousing, and utilities	2,400	5%	2,200	4%	2,650	4%	10%	20%
Information	600	1%	700	1%	650	1%	8%	−7%
Financial activities	2,300	5%	2,100	4%	2,750	4%	20%	31%
Professional & business services	2,500	5%	4,100	7%	4,700	7%	88%	15%
Educational services	300	1%	500	1%	1,200	2%	300%	140%
Health care & social assistance	2,500	5%	4,700	8%	6,350	10%	154%	35%
Arts, entertainment, & recreation	600	1%	1,100	2%	1,750	3%	192%	59%
Accommodations	6,200	13%	7,300	13%	6,150	9%	−1%	−16%
Food services & drinking places	3,900	8%	4,300	8%	5,100	8%	31%	19%
Other services	1,300	3%	1,200	2%	2,200	3%	69%	83%
Government	8,400	18%	11,200	20%	13,050	20%	55%	17%
Federal	800	2%	1,100	2%	1,300	2%	63%	18%
State	5,600	12%	7,800	14%	9,000	14%	61%	15%
Local	2,000	4%	2,300	4%	2,750	4%	38%	20%
Agriculture	3,200	7%	2,200	4%	2,100	3%	−34%	−5%
Total employment	48,000	100%	55,300	100%	65,350	100%	36%	18%

Source: State of Hawai‘i Department of Business, Economic Development, and Tourism 2009.

*Percentage change is positive unless marked negative.

PARK ECONOMIC CONTRIBUTIONS TO LOCAL ECONOMIES

Hawai'i Volcanoes National Park contributes to the local economy in several ways. First, it provides jobs to park employees, including seasonal, term, and permanent full- or part-time positions (see the "Park Management and Operations" section of this chapter for more detail). Park employees spend their income and wages in the local economies, which support additional jobs and income. In 2007 Hawai'i Volcanoes National Park employed 144 employees, who supported an additional 59 jobs in the local economy, for a total of 203 jobs.[1] This payroll spending contributes to the value added,[2] or the island's gross regional product, by an estimated $10.9 million. These park payroll benefits are summarized in table 16. The park may also support the local economy if local vendors are used; for example, through contracted lawn maintenance services or purchases of office supplies. These figures are not assessed in this socioeconomics section.

TABLE 16: 2007 HAWAI'I VOLCANOES NATIONAL PARK PAYROLL SPENDING IMPACTS

NPS Payroll and Impacts	NPS	Total (NPS and Supporting Jobs and Income)
Jobs	144	203
Labor income (includes payroll and benefits)	$7,803,000	$9,541,000
Total value added (i.e., gross regional product)	NA	$10,907,000

Source: Stynes 2008.

NA = not applicable.

Second, Hawai'i Volcanoes National Park attracts a large number of visitors from around the world. These visitors consume from local businesses such as restaurants, hotels, and retail outlets during their time in Hawai'i County, contributing to the local economy. The economic contribution of the visitor spending is a function of how many visitors arrive and how much money they spend while visiting. Visitor spending benefits for Hawai'i Volcanoes National Park have been estimated by Stynes (2008) and are summarized in table 17.

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[1] The local economy or local regions are defined as a 50-mile radius around the park, which is the primary impact region around most parks. Economic multipliers are based on regions or areas defined as groupings of counties to approximate a 50-mile radius of the park (Stynes 2008).

[2] *Value added* is defined as gross output (sales or receipts and other operating income, plus inventory change) minus intermediate inputs (consumption of goods and services purchased from other industries or imported). Value added consists of compensation of employees, taxes on production and imports less subsidies (formerly indirect business taxes and nontax payments), and gross operating surplus.

TABLE 17: NONLOCAL VISITOR SPENDING AND IMPACTS AT HAWAI‘I VOLCANOES NATIONAL PARK, 2007

Type of Impact	Nonlocal Spending and Associated Impacts
Visitor spending	$109,329,000
Total labor income	$43,661,000
Value added or gross regional product	$67,577,000
Jobs supported	2,199

Source: Stynes 2008.

During 2007, the park experienced a total of 1,467,779 recreational visitor days, primarily from nonlocal visitors. Total spending associated with Hawai‘i Volcanoes National Park was estimated to be $114 million, of which $109 million was spent by nonlocal visitors. The total labor income generated by this spending was almost $43 million, and the gross regional product was over $67 million. This economic activity supports 2,199 jobs in the local economy (Stynes 2008).

Total impacts of Hawai‘i Volcanoes National Park associated with payroll and visitor spending are summarized in table 18. In April 2007, there were 69,100 jobs in Hawai‘i County, of which 2,402 or 3.5 percent are estimated to be supported by Hawai‘i Volcanoes National Park payroll and visitation spending.

TABLE 18: TOTAL ECONOMIC CONTRIBUTION ASSOCIATED WITH PAYROLL SPENDING AND PARK VISITATION AT HAWAI‘I VOLCANOES NATIONAL PARK

	Total Payroll Impacts	Total Nonlocal Visitor Spending Impacts	Total
Spending	$7,803,000	$109,329,000	$117,132,000
Total labor income	$9,541,000	$43,661,000	$53,202,000
Total value added	$10,907,000	$67,577,000	$78,484,000
Jobs	203	2,199	2,402

Sources: Stynes 2008.

SOCIAL BENEFITS OF THE VOLUNTEER UNGULATE CONTROL PROGRAM

Hawai‘i Volcanoes National Park currently provides a Volunteer Ungulate Control Program to aid in managing the numbers of ungulates at the parks (see the alternative A discussion in chapter 2 for more details about this program). The program, which is open to the public, provides volunteers the opportunity to participate in ground shooting efforts for ungulate control in Kahuku. Volunteers, who are accompanied by park staff, are allowed to bring one guest.

In fiscal year 2007, 68 volunteers donated more than 950 hours to the program over 25 days; 1,130 hours of park staff time were required as well. During this year, 605 mouflon sheep and 3 feral pigs were removed from the park through the Volunteer Ungulate Control Program. Currently, the volunteers are allowed to keep the meat from the animals they shoot. The program continues to attracted high volunteer interest, and previous volunteers are enthusiastic about returning (NPS 2007b).

The majority of volunteers are from the Island of Hawai‘i, while some are from communities adjacent to the park. This program allows these local residents access to the park for recreation; provides interaction with the park staff, which supports social connectedness and public–federal relations; promotes communications among landowners of the region; and also allows local residents to assist in helping protect park resources (i.e., park stewardship).

VISITOR USE AND EXPERIENCE

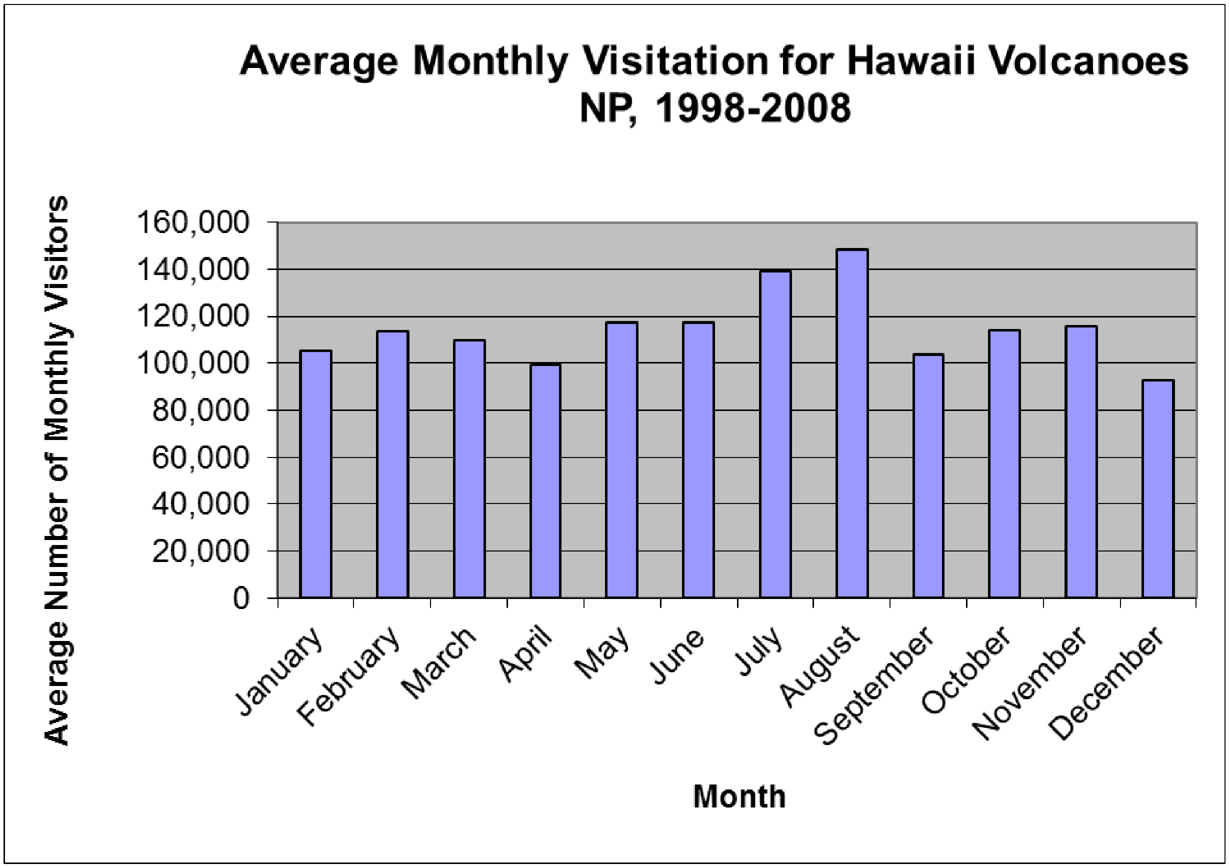
VISITATION

Visitors to Hawai‘i Volcanoes National Park have the opportunity to visit two of the world's most active volcanoes, take in views of volcanic landscapes, and learn about the geologic origins of the Hawaiian Islands, the native plants and animals unique to the area, and the distinct Native Hawaiian culture (NPS 2009a). During each year between 1998 and 2007, an average of 1,375,925 people visited the park (see table 19). Over this time, the largest decline in visitation was experienced from 2001 to 2002, when the annual number of visitors decreased by 17 percent. By contrast, the largest increase in visitation was experienced from 2003 to 2004, when the annual number of visitors increased by 32 percent. From 1998 to 2008, an average of approximately 115,000 people visited the park per month (figure 11). July and August represent slightly busier months overall, with over 140,000 visitors. December is, on average, the lightest month in terms of park visitation, with roughly 90,000 visitors to the park (NPS 2009b).

TABLE 19: VISITOR USE STATISTICS FOR HAWAI‘I VOLCANOES NATIONAL PARK, 1998–2008

Year	Visitation	Percentage Change from Previous Year
1998	1,352,373	—
1999	1,502,855	+11%
2000	1,514,636	+<1%
2001	1,343,286	−11%
2002	1,110,998	−17%
2003	991,875	−11%
2004	1,307,391	+32%
2005	1,661,196	+27%
2006	1,612,246	−3%
2007	1,467,779	−9%
2008	1,270,538	−13%
Average	**1,375,925**	

Source: NPS 2009b.



Source: NPS 2009b.

FIGURE 11: AVERAGE MONTHLY VISITATION FOR HAWAI'I VOLCANOES NATIONAL PARK, 1998–2008

VISITOR ACTIVITIES

The park provides ample opportunity for lava and wildlife viewing via scenic drives along the two popular main roads: Crater Rim Drive and Chain of Craters Road. Other popular activities include hiking, bicycling, camping, visiting the visitor centers, and taking part in various ranger-led programmed activities. These activities are available year-round (NPS 2009a).

An important park experience is created by the interplay of natural forces, including volcanism, weather, wildlife, vegetation, vistas, smells, color and shape of landform, air quality, and varied light. Volcanic activity continues to create spectacular formations and provides opportunities for visual interpretation of the volcanic processes. The varied landscape in the park contains the active caldera of Kīlauea Volcano, fragile lava features, deserts, rain forests, craters, rift zones, rare plants, and archeological sites.

Lava at the End of Chain of Craters Road

The park’s seven ecological zones harbor distinct plant and animal communities. Hawai‘i Volcanoes National Park also shelters an array of Hawaiian native species, including birds, carnivorous caterpillars, the largest dragonfly in the United States, crickets that inhabit new lava flows, endangered sea turtles, and the Hawaiian hoary bat. It is home to many engaging creatures (such as happy-face spiders, carnivorous caterpillars, lava crickets, picture wing flies, and honeycreepers), and a refuge for many endangered species (such as the Hawaiian goose, dark-rumped petrel, and Hawaiian hoary bat).The Hawaiian Islands are renowned in the scientific world for having evolved the most spectacular land bird assemblage on a remote oceanic archipelago (NPS 2009a). While visitor activities are generally available at all times of the year, the park superintendent may restrict use of any area or trail in order to protect visitors and the park’s resources. Volcanic eruptions and high levels of volcanic gases may also warrant closing an area or the entire park.

Primary Interpretive Themes

Primary interpretive themes describe what needs to be interpreted to provide visitors with opportunities to understand and appreciate the park’s purpose and significance. Identification of primary themes is part of a park’s basic foundation statement. Primary interpretive themes are derived from, and reflect, park significance. Additional perspectives may be obtained from the identification and analysis of fundamental and other important resources and values. It is anticipated that the primary interpretive themes may be revised through development of the park’s future Comprehensive Interpretive Plan.

The following primary interpretive themes have been developed for Hawaiʻi Volcanoes National Park (NPS 2010a):

- Monitoring the daily pulse of Hawaiʻi's active volcanoes leads to new discoveries and advances understanding of volcanic eruptions and hazard monitoring.
- The approachable active volcanoes of Mauna Loa and Kīlauea allow first-hand discovery and connection with one of the most fundamental forces in our world, in both its creative and destructive roles.
- In Hawaiʻi, active volcanism created an isolated home for a few immigrant species and gave rise to a rich, yet fragile, endemic biota. Due to the accelerating change brought about by human actions and introduced plants and animals, much of that unique heritage is being lost to extinction, challenging all of us to learn from the past and work together to preserve and restore the remaining native plants and animals.
- The park's designation as a World Heritage Site and International Biosphere Reserve attests to the compelling values that the park's unique geologic resources and island biota hold for people worldwide and its global importance as a benchmark for monitoring environmental change.
- Hawaiʻi Volcanoes National Park protects a diverse wilderness that stretches from rich coastline to stark alpine summit, providing visitors with opportunities to connect with nature's challenges, remote solitude, and wild spirit.
- Kīlauea Volcano, the home of Pelehonuamea, and Mauna Loa Volcano are sacred to many Native Hawaiians. The park is a place of birth and the physical representation of many spirits and forces; the active volcanism, the features of the terrain, and the plants and animals that live there are all important to the Native Hawaiian sense of identity, unity, and continuance.
- The journeys of the Hawaiian people, and those who followed, portray cultural clashes, adaptations, and assimilations that provide enduring lessons about human resourcefulness, interdependence, and respect on an active volcanic landscape.

KAHUKU UNIT

The Kahuku Unit is an 115,653-acre addition to Hawaiʻi Volcanoes National Park that includes the southwest rift zone of Mauna Loa Volcano. Resource values present at Kahuku are similar to those found in the other portions of Hawaiʻi Volcanoes National Park. Consequently, the existing primary interpretive themes of the park would also be used at Kahuku. Based on other planning actions, possible visitor uses in Kahuku could include guided geologic hikes, bird walks, car caravans, bicycle tours, service-based resource management interpretive programs (collection of seeds, sowing and planting of native plants, removal of non-native weeds, and cleanup of trash and other debris) open houses, special events, and paniolo (Hawaiian cowboy) Days (NPS 2006d). The Kahuku Unit is open to the public on weekends from 9:00 a.m. to 3:00 p.m.

VISITOR AND EMPLOYEE SAFETY

Non-native ungulate management actions, including the use of firearms, helicopters, and snaring, can affect the health and safety of visitors and employees. In addition, the presence of ungulates poses hazards, including threats of disease and bodily injury should humans come in direct contact with them. Existing regulations, including the NPS *Management Policies 2006* and several director's orders address some of these activities (see NPS *Management Policies 2006*, "Policies and Regulations," section 8) and would be implemented to ensure human health and safety during project implementation. Among other things, these policies and regulations contain specific language regarding how to ensure public health and safety in areas of NPS jurisdiction and specifying when appropriate certifications related to it are required (e.g., use of firearms and aviation).

HAZARDS ASSOCIATED WITH MANAGEMENT ACTIONS

Firearms—Ground Shooting

The use of firearms during ground shooting potentially poses a threat to the health of visitors and employees. In order to ensure safety, the current volunteer program mandates that volunteers be properly trained through a hunter education course. While conducting ungulate control projects, volunteers are supervised closely throughout the duration of removal efforts. Volunteers are supervised at a 1:2 ratio. Park staff members who are involved with ground shooting have the proper skills in the use of firearms and ensuring volunteer and public safety. Staff members also have experience with the use of firearms for the removal of wildlife.

Helicopter Operations

Helicopters are used in managing non-native ungulates. Health and safety concerns related to the use of helicopters range across a number of issues, including (1) mechanical failure resulting in a crash; (2) contact or entanglement with the main and/or tail rotor; and (3) rotor contact with trees, tall shrubs, power lines, etc., at capture/landing sites or during operation. Personnel involved with these activities have appropriate training, certification, skills, and proficiencies in helicopter operation and in the use of firearms for the removal of wildlife. Helicopter use generally occurs in open canopy areas where skilled shooters can effectively and quickly dispatch animals that briefly appear in open areas. Stringent policies and procedures are in place to ensure the safety of all helicopter operations, particularly ACETA (aerial capture, eradication, and tagging of animals) missions.

Snares

While snares pose hazards to employees or visitors should they come across a pig caught in a snare, they are generally used in remote locations or where there is limited potential for encounters. In addition, snare sites are well signposted to further limit this potential risk.

Other

Wildlife biologists and other field researchers who currently work in the park may come in contact with a variety of physical and biological hazards during the normal conduct of non-native ungulate management. Physical environmental hazards affecting field personnel include sunburn, exposure to weather, uneven terrain for walking or for driving vehicles, etc. Biological hazards include insect bites, plants, animals, parasites, fungi, bacteria, or viruses that may physically harm or cause disease in humans. While handling wildlife, staff and researchers can be kicked or bitten by the animals, causing physical harm to researchers. In addition, staff or researchers immobilizing an animal may be exposed to drugs that are latently dangerous to humans. Diseases may be transmitted from animals to humans, including bacteria and viruses that may enter humans through contact with the skin, eyes, mouth, and/or through inhalation. Park staff and researchers may be exposed to bacteria and virus vectors including mosquitoes.

HAZARDS ASSOCIATED WITH NON-NATIVE UNGULATES

Beyond management actions, the presence of non-native ungulates in Hawai‘i also creates health and safety risks. Park staff and visitor encounters with non-native ungulates can result in injuries, although a study of visitor incidents from 1992 through 2002 did not document any such injuries (Heggie 2005). In Kahuku, mouflon sheep attract feral dogs to the area, which chase and bring down animals; these animals in turn are a potential risk to visitors and staff. Non-native ungulates have also been known to carry diseases that are transmissible to humans. For example, feral swine can harbor at least 30 significant viral and bacteriological diseases, several of which are transmissible to humans (Seward et al. 2003).

In addition to potentially carrying disease themselves, non-native ungulates such as pigs also create suitable conditions for disease vectors, such as mosquitoes, to flourish.

In addition to potentially carrying disease themselves, non-native ungulates such as pigs also create suitable conditions for disease vectors, such as mosquitoes, to flourish. Wallows created by feral pigs in Hawai‘i catch rain and become habitat for mosquito larvae and other aquatic organisms. Tree fern hollows, which are created by feral pigs when they feed on the interior pulp of the tree, also create similar habitats. In one 2-acre study area at the park, 35 tree fern hollows were found to contain mosquito larvae and another 50-acre area contained five mud wallows that contained larvae. Larvae of four other families of Diptera were found in these wallows and hollows, as well as numerous species of parasitic nematodes (Baker 1975). Mosquitoes have the potential to transmit diseases including but not limited to malaria, West Nile virus, dengue, and encephalitis (Maryland Department of Agriculture 2009).

ACCIDENTS

Based on a review of incident data from 1992 through 2002 (see table 20), the most common visitor injuries included lacerations, abrasions, broken bones, sprains and strains, dehydration, respiratory irritation, allergic reactions, and thermal burns (Heggie 2005). No non-native ungulate–related injuries were documented. However most visitation is in areas that are ungulate free or with very low animal densities. In areas where higher numbers of animals remain (e.g., Kahuku), the presence of these animals could pose a threat to health and safety.

From 2004 to 2008, a total of 95 employee injuries were reported, 48 of which resulted in lost time. Injuries included muscle strains, sprains, bruises, cuts (including abrasions, lacerations, and puncture wounds), stings/bites, broken bones, heat exhaustion, allergic reactions, and chemical exposure, among others. The primary causes of these injuries included falls; lifting/moving equipment, materials, or debris; exposure to plants, insects, or chemicals; hiking, especially on rough terrain; and motor vehicle accidents (NPS 2009g).

TABLE 20: FATAL AND NONFATAL VISITOR INCIDENTS IN HAWAI‘I VOLCANOES NATIONAL PARK, 1992–2002

Classification	Fatal	Serious	Minor	No Injury	Unknown	Total (%)
Aircraft	16	7	18	6	4	50 (30)
Backcountry[a]	10	23	18	0	0	51 (30)
Frontcountry[b]	7	5	16	0	0	28 (17)
Road	6	10	1	19	0	36 (22)
Other (suicide)	1	0	0	0	0	1 (<1)

Source: Heggie 2005.

[a]Backcountry refers to primitive and undeveloped areas of the park where backpacking and wilderness hiking activities are common.

[b]Frontcountry regions are areas in the park within 1 kilometer (0.6 mile) of any park road or highway, where walking short interpretive and educational trails is common.

Of the 95 injuries reported, approximately 20 were associated with non-native ungulate management actions, primarily related to constructing fences or repairing/replacing the fences; 8 of these resulted in lost time. The nature and cause of injuries during these actions were consistent with those that occurred more generally in the park, including sprains/strains, cuts, insect stings, and broken bones from falls; lifting, moving, and/or operating equipment, materials, or debris; hiking; and exposure to plants. One staff member contracted leptospirosis while camping (NPS 2009g). Leptospirosis is a bacterial disease in animals that is considered an occupational hazard for people that work outdoors or with animals. It can be transmitted to humans when they come in contact with water, food, or soil containing urine from infected animals (CDC 2005).

PARK MANAGEMENT AND OPERATIONS

Hawai‘i Volcanoes National Park has seven divisions: Administration, Cultural Resources, Interpretation, Maintenance and Facilities Management, Natural Resources, Resource Protection, and Fire Management (Yoshida 2009a).

The total number of full-time employees was 93 in 2009. The park’s operating budget for the fiscal year of 2008 was $6,740,143 (Yoshida 2009b). Approximately 5 percent of this, or $320,000, was committed for non-native ungulate management. When combined with other funding sources, the annual budget for non-native ungulate management activities averaged approximately $922,000 from 2006 to 2008 (Loh, pers. comm., 2009b). Of this, approximately $530,000 went towards labor costs (including fence repair and replacement, animal monitoring and removal), $220,000 for material costs, $143,000 for administrative costs, and $29,000 for the Volunteer Ungulate Control Program.

ADMINISTRATIVE DIVISION

The Administrative Division oversees all human resources, budget operations, contracting, concessions, information technology, property, and cost of collections in the park. The division is responsible for the park’s revenues, which are collected in various ways: the entrance station, air tour fees, special use permits, commercial use authorizations, and donations. The division manages contracts that pertain to the acquisition of new areas, such as the newly acquired Kahuku area. Contracting support is also provided by the Pacific West Region’s Contracting Officer, with assistance from the Major Acquisition Buying Office, which helps all Pacific Island Network parks. Additionally, the Administrative Division provides support to local parks on the Island of Hawai‘i, including Pacific Island Parks. This includes a newly developed Servicing Human Resources Office at Hawai‘i Volcanoes National Park, which will be assisting all the Pacific Island Network parks with staffing. The division consists of 12 permanent full-time employees, 3 term employees, 2 seasonal employees, and 2 Student Temporary Employment Program employees (Yoshida 2009c). One employee is dedicated to the park’s IT system and is responsible for the park’s entire telecommunications system.

CULTURAL RESOURCES DIVISION

This division is responsible for compliance with Sections 106 and 110 of the *National Historic Preservation Act*, including surveying the entire park property for archeological and cultural resources. The division also manages the park’s museum, which contains approximately 300 library, archeological, natural, and artistic items. The division also manages contracts with individuals who enter the park to work on resource inventory documentation projects.

The Cultural Resources Division has four permanent, full-time employees, including one division chief and one Hawaiian community liaison. There are seven full-time employees on term appointments, whose terms are from 1 to 4 years in length. The division does not have a large number of volunteers, although the museum program currently has three volunteers. Student interns are rare; however, the division does occasionally use them. The museum curator, one of the division's full-time, permanent employees, is also responsible for acting as the museum curator at several of the other parks on the Island of Hawai‘i. In addition, the Cultural Resources Division shares 1 permanent employee with the Natural Resources Division, who is responsible for various administrative tasks (Schuster, pers. comm. 2009).

INTERPRETATION DIVISION

The Interpretation Division is responsible for public communications, outreach, publications, and permitting related to communications. These responsibilities involve conducting interpretation and outreach activities with the goal of conveying science and culture to the visiting public, to school groups, and to the surrounding community. The division conducts its activities via formal ranger interpretation programs, through school environmental education programs, and through informal roving interpretation programs. The Interpretation Division annually initiates new or existing outreach programs that are relevant and meaningful to the underserved communities surrounding the park. Volunteer programs play an integral role in the division's interpretive and educational functions. This division is also responsible for managing film permits in the park, and dispenses between 60 and 100 filming permits per year. The permits ensure that filming operations conducted by park visitors will not adversely impact park resources (Gale 2009a).

The park film, “Born of Fire … Born of the Sea,” shown on the hour, conveys a holistic story of the arrival of life and of non-native ungulates and other non-native species, and shows how the NPS takes care of the park. In the Kīlauea visitor center, exhibits tell the story of how generations of park employees have never given up in their fight against non-native species. The history and ecological significance of non-native ungulates in the park is reviewed in most of the park's interpretive programs, such as ranger walks and stewardship walks with the public (Gale 2009b).

The division has nine permanent staff members, two of whom are subject to furlough (temporary layoffs). There are three to four term staff members (on 1- to 4-year appointments) in any given year. There are eight seasonal employees. Volunteer labor provides for the equivalent of 10 additional full-time positions.

MAINTENANCE AND FACILITIES MANAGEMENT DIVISION

The Maintenance and Facilities Management Division provides custodial services and is responsible for the maintenance of buildings and facilities in the park; vehicles and equipment; utilities, water, sewers, and lights; and all trails, including front- and backcountry trails. They are also responsible for maintenance of the park's four cabins and three shelters.

The park's fencing program is managed by the Natural Resources Division (below), and not by the Maintenance and Facilities Management Division, as would be typical in a national park.

The division consists of 24 permanent employees, some of whom are subject to furlough; 17 seasonal or term appointment employees; and 1 employee of the Research Corporation of the University of Hawai‘i, acquired through a special agreement between the NPS and the University of Hawai‘i. Each seasonal employee provides approximately 1,039 hours per year. In some years, the division acquires a Ford Foundation student to assist on projects (Borne 2009).

NATURAL RESOURCES MANAGEMENT DIVISION

The Natural Resources Management Division is responsible for the protection and perpetuation of native ecosystems and native species, including conducting restoration activities related to protecting native species and perpetuating biological diversity. Many of the division's programs focus on non-native species management, perpetuation of rare species, fire ecology and fire restoration, and habitat restoration for extirpated or at-risk (threatened and endangered) species. The division also assists in wildland firefighting.

There are 12 full-time, permanent staff members, 7 of whom are subject to furlough; 1 additional administrative permanent staff member is shared with the Cultural Resources Division. Depending on the annual availability of special project funds, there are between 10 to 15 nonpermanent staff members (term or seasonal appointments). Volunteers make up an important component of the workforce. In 2008, volunteers contributed the equivalent of 16 full-time positions on various projects related to endangered species monitoring and recovery, habitat restoration, and non-native plant and animal management. Division responsibilities are divided among the following programs:

- The Wildlife Program, which is responsible for non-native ungulate control. The program focuses on fence inspection, repair, and replacement and on monitoring and removal of ingress animals. It is staffed by four permanent, full-time staff members (two of whom are subject to furlough) and by three to six seasonal or term staff members funded by special project funds.
- The Vegetation Management Program, which oversees habitat restoration, monitoring and control of non-native plants, fire ecology, and recovery of rare, threatened, and endangered plant species. The program also oversees the monitoring and control of non-native coqui frogs. This program is staffed by five permanent, full time staff members (four of whom are subject to furlough), three to six seasonal or term staff members funded by special project funds, and additional volunteer staff.
- The Hawaiian Petrel Program, which focuses on monitoring and protecting the endangered Hawaiian petrel. Program actions involve nest protection measures and bird monitoring. The program is staffed by part-time seasonal or term employees funded by special project funds.
- The Endangered Hawksbill Turtle Program, which focuses on monitoring and protecting the endangered hawksbill turtle. Program actions involve nest site protection, protection of hatchlings as they migrate from land to water, turtle monitoring, and informal environmental education. The program is implemented by volunteers directed by part-time seasonal staff who work collaboratively with specialists from the University of Hawaiʻi through a cooperative agreement.
- The Nēnē Goose Recovery Program, which focuses on recovering the endangered Hawaiian goose, or nēnē. Program actions involve identification of potential threats to the goose, including protection from predation by non-native pigs, and monitoring of the existing birds and their nests. The program is staffed by 2 permanent employees, subject to furlough staff members, and volunteer staff.
- The Air Quality Monitoring Program, which focuses on the collection of air quality measurements in several sites across the park. Field staff from the NPS and USGS cooperatively maintain instruments and collect data that is analyzed by USGS and the NPS Air Quality Monitoring Program.
- Through a cooperative agreement with the University of Hawaiʻi (referred to as the Cooperative Ecosystem Studies Unit or CESU), the Natural Resources Management Division collaborates with approximately 10 part-time or full-time university cooperators who provide technical

assistance with natural resources management programs related to rare species recovery and research on non-native species control (e.g., coqui frog invasion) and habitat restoration. These are nonpermanent positions that end at the completion of a project. The division also coordinates all research (e.g., geology, biology, social science studies) conducted in the park through the web-based NPS Research Permit and Reporting System. Between 30 and 50 permits are issued annually in the park.

The division has several formal and informal partnerships with external institutions. These include the USGS Pacific Islands Ecosystem Research Center (PIERC), and the USDA quarantine facility, all with offices based at the park that provide valuable monitoring and research services; Big Island Invasive Species Council, a partnership among federal, state, and county agencies to coordinate non-native plant management activities on the Island of Hawai‘i; the Friends of Hawai‘i Volcanoes National Park, who contribute volunteers and assist with raising funds for special projects; and the TMA, which coordinates conservation and watershed management activities among several federal and state agencies and private landowners (e.g., Kamehameha Schools, TNC).

PROTECTION DIVISION

The responsibility of the Protection Division is to ensure protection of the visiting public and of park resources. This responsibility involves law enforcement duties, including enforcement of criminal codes, traffic codes, and federal laws. The division also conducts search-and-rescue operations and assists with wildland firefighting. This division has exclusive jurisdiction for all law enforcement in the park. As a result, local, county, or state law enforcement agencies are unable to enter the park and enforce any laws unless they are invited by the Resource Protection Division or are in pursuit of a crime that occurred in their own jurisdiction.

The Protection Division consists of three groups. The first group is called Law Enforcement, and functions as the law enforcement response team for the park. This group currently consists of seven permanent, full-time employees, including the division chief. There are two additional seasonal, full-time employees that work for this group for a maximum of 6 months out of each year.

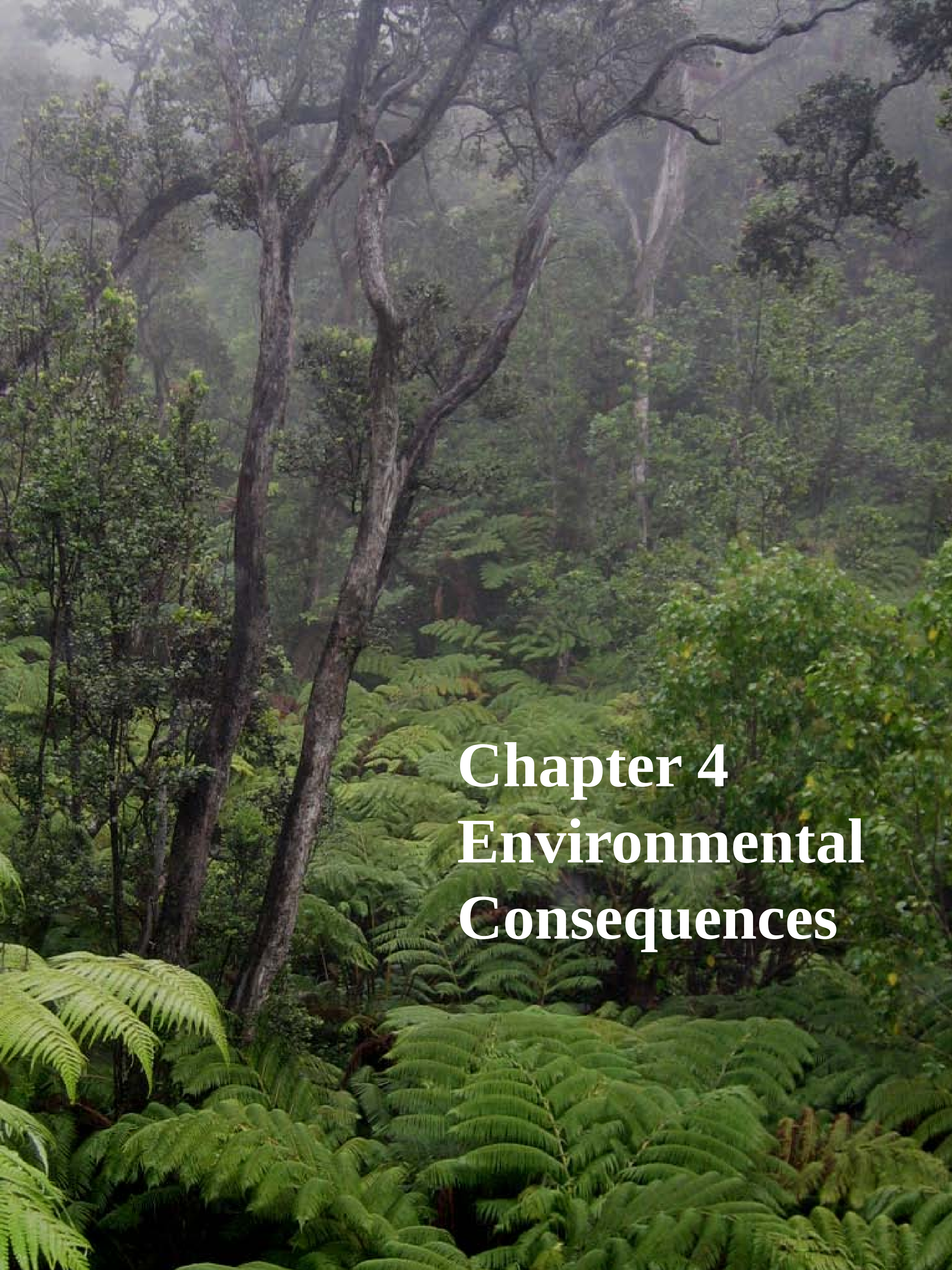
The second group is called Pacific Area Communications and is responsible for managing communications. They access criminal computer databases, make necessary phone calls, and function as a routine and emergency dispatch center. The group consists of one full-time, permanent supervisor and five full-time, permanent employees.

The third group is called the Eruption Crew. This group consists of four full-time employees who are appointed for a 1- to 4-year term. The crew is responsible for managing public safety as it relates to the unique volcanic hazards in the park. They oversee public safety interpretation as it pertains to volcanic hazards and conduct search-and-rescue operations during emergencies (Magno 2009).

FIRE MANAGEMENT DIVISION

The Fire Management Division is responsible for fire management at all 10 Pacific Island park units. This includes responding to wildland fires, preparing fire management plans, conducting fire management activities, managing hazardous fuels projects, and maintaining the qualification and certification program for wildland firefighters. The division oversees the park’s aviation program, which is a qualification and certification program for aviation personnel, and which uses helicopters leased from an off-site, external entity. The division also maintains seven remote weather stations. The Fire Management Division spends approximately 70 percent of its time in Hawai‘i Volcanoes National Park.

The division consists of 6 full-time, permanent employees, all of whom are qualified to fight wildland fires. During an average year, there might be two wildland fire emergencies. In such situations, the division will draw upon its trained “militia” made up of park staff from the other divisions, and individuals from the surrounding communities. The Hawaiʻi Volcanoes National Park firefighting militia consists of 45 qualified volunteers, approximately 20 of whom would be called upon during a wildland fire emergency.



Chapter 4 Environmental Consequences

CHAPTER 4: ENVIRONMENTAL CONSEQUENCES

This chapter analyzes both beneficial and adverse impacts that would result from implementing any of the alternatives considered in this plan/EIS. This chapter also includes a summary of laws and policies relevant to each impact topic, definitions of impact thresholds (i.e., negligible, minor, moderate, and major), methods used to analyze impacts, and the analysis methods used for determining cumulative impacts. As required by the CEQ regulations implementing NEPA, a summary of the environmental consequences for each alternative is provided in table 6 in chapter 2. The resource topics presented in this chapter, and the organization of the topics, correspond to the resource discussions contained in chapter 3.

GENERAL METHODOLOGY FOR ESTABLISHING IMPACT THRESHOLDS AND MEASURING EFFECTS BY RESOURCE

The following elements were used in the general approach for establishing impact thresholds and measuring the effects of the alternatives on each resource category:

- General analysis methods as described in guiding regulations, including the context and duration of environmental effects
- Basic assumptions used to formulate the specific methods used in this analysis
- Thresholds used to define the level of impact resulting from each alternative
- Methods used to evaluate the cumulative impacts of each alternative in combination with unrelated factors or actions affecting park resources.

These elements are described in the following sections.

GENERAL ANALYSIS METHODS

The analysis of impacts follows CEQ guidelines (40 CFR 1500–1508) and Director's Order 12 procedures (NPS 2001a) and is based on the underlying goal of developing a comprehensive and systematic framework for managing non-native ungulates that supports long-term ecosystem protection, supports natural ecosystem recovery, provides desirable conditions for active ecosystem restoration, and supports protection and preservation of cultural resources at Hawai'i Volcanoes. This analysis incorporates the best available scientific literature applicable to the region and setting, the species being evaluated, and the actions being considered in the alternatives.

For each resource topic addressed in this chapter, the applicable analysis methods are discussed, including assumptions and impact intensity thresholds.

ASSUMPTIONS

Several guiding assumptions were made to provide context for this analysis. These assumptions are described below.

ANALYSIS PERIOD

Goals, objectives, and specific implementation actions needed to manage non-native ungulates at the park are established for the next 20 years or until there is a change in conditions that warrants an update. Therefore, for the purposes of the analysis, the life of the plan and period used for assessing impacts is up to 20 years.

GEOGRAPHIC AREA EVALUATED FOR IMPACTS (AREA OF ANALYSIS)

The geographic study area (or area of analysis) for this plan includes Hawai‘i Volcanoes National Park in its entirety, and encompasses the Kīlauea, ‘Ōla‘a, Mauna Loa, and Kahuku areas. The area of analysis may extend beyond the park’s boundaries for some cumulative impact assessments. The specific area of analysis for cumulative impacts is described in table 21.

DURATION AND TYPE OF IMPACTS

The following assumptions are used for all impact topics (the terms “impact” and “effect” are used interchangeably throughout this document):

- *Short-term impacts*. Impacts would be temporary (i.e., this varies depending on the resource but may occur for a matter of minutes and hours up to weeks at a time), without lasting effects. Examples include impacts on vegetation during a field survey associated with non-native ungulate removal efforts.
- *Long-term impacts*. Impacts would be continuous throughout the life of the plan, with potentially permanent effects. Examples include ongoing impacts on park management and operations, or the beneficial effects on vegetation that result when non-native ungulates are removed.

  NOTE: All impacts to archeological resources are considered long term.
- *Direct impacts*. Impacts would occur as a direct result of non-native ungulate management actions.
- *Indirect impacts*. Impacts would occur from non-native ungulate management actions but would occur later in time or farther in distance from the action.

FUTURE TRENDS

Visitor use and demand are anticipated to remain relatively steady over the life of the plan. The number of yearly visitors to Hawai‘i Volcanoes National Park has been at an average of 1.4 million visitors per year between 1998 and 2007, although there have been increases and decreases from year to year. There is a possibility that the park could acquire additional adjacent lands throughout the life of this plan (20 years), which could affect park visitation, though acquisition of lands has yet to be ascertained. New facilities could be developed in Kahuku to allow for increased visitor access during the planning period. Considering past visitation trends and the potential for new visitor opportunities, it is expected that annual visitation over the life of the plan could increase slightly, with some variation from year to year.

Visitor use and demand are anticipated to remain relatively steady over the life of the plan. The number of yearly visitors to Hawai‘i Volcanoes National Park has been at an average of 1.4 million visitors per year between 1998 and 2007, although there have been increases and decreases from year to year.

TABLE 21: CUMULATIVE IMPACT SCENARIO

Impact Topic	Study Area	Temporal Boundaries	Past Actions	Current Actions	Future Actions (20 years)
Vegetation	Park and adjacent lands	1974 through life of the plan (20 years from implementation)	• Non-native plant and animal species management inside the park, including park fencing • Non-native plant and animal species management outside the park, including fencing and game management • Rare and sensitive species restoration activities (including establishment of small fence exclosures and implementation of USFWS recovery plans for sensitive species) • Restoration/rehabilitation activities for native plant communities • Fire ecology and management inside and outside the park • Management related to cultural resources, including historic properties • Other park management plans/actions • Research in the park • Other conservation actions/plans outside the park • Development inside the park, including land clearing (logging, ranching, agricultural use), fragmentation, and loss of vegetation • Development outside the park, including land clearing (logging, grazing, ranching, agricultural use), fragmentation, urbanization, and loss of vegetation • Acquisition of new lands (including Kahuku) • Park visitation	• Non-native plant and animal species management inside the park, including park fencing • Non-native plant and animal species management outside the park, including fencing and game management • Rare and sensitive species restoration activities (including establishment of small fence exclosures and implementation of USFWS recovery plans for sensitive species) • Restoration/rehabilitation activities for native plant communities • Fire ecology and management inside and outside the park • Management related to cultural resources, including historic properties • Other park management plans/actions • Other conservation actions/outside the park • Research in the park • Development inside the park • Development outside the park, including land clearing (logging, ranching, agricultural use), fragmentation, urbanization, and loss of vegetation • Park visitation • Development of the GMP • *Ala Kahakai National Historic Trail Management Plan*	• Non-native plant and animal species management inside the park, including park fencing • Non-native plant and animal species management outside the park, including fencing and game management • Rare and sensitive species restoration activities (including establishment of small fence exclosures and implementation of USFWS recovery plans for sensitive species) • Restoration activities for native plant communities • Fire ecology and management inside and outside the park • Management related to cultural resources, including historic properties • Other park management plans/actions • Research in the park • Other conservation actions/outside the park • Development inside the park • Development outside the park, including land clearing (logging, ranching, agricultural use), fragmentation, urbanization, and loss of vegetation • Proposed Mauna Loa trail system (ongoing feasibility study) • Implementation of the *Ala Kahakai National Historic Trail Management Plan* • Acquisition of new lands • Park visitation • Implementation of the GMP
Native Wildlife and Wildlife Habitat	Park and adjacent lands	1974 through life of the plan (20 years from implementation)	Same as vegetation, plus: • Increased overflights inside and outside the park (includes park administrative activities, commercial air tours, administrative activities of outside agencies, and military overflights)	Same as vegetation, plus: • Ongoing overflights inside and outside the park (includes park administrative activities, commercial air tours, administrative activities of outside agencies, and military overflights) • Development of the ATMP	Same as vegetation, plus: • Implementation of the ATMP
Rare, Unique, Threatened, or Endangered Species	Island of Hawai'i	1974 through life of the plan (20 years from implementation)	Same as native wildlife and wildlife habitat	Same as native wildlife and wildlife habitat	Same as native wildlife and wildlife habitat
Cultural/Historic Resources (archeological resources, cultural landscapes, ethnographic resources)	Park and adjacent lands	1974 through life of the plan (20 years from implementation)	Same as native wildlife and wildlife habitat	Same as native wildlife and wildlife habitat	Same as native wildlife and wildlife habitat
Wilderness	Designated wilderness areas	1974 through life of the plan (20 years from implementation)	Same as native wildlife and wildlife habitat, plus: • Research studies and instrumentation in the park	Same as native wildlife and wildlife habitat, plus: • Research studies and instrumentation in the park • Evaluation of new wilderness areas as part of the GMP process	Same as native wildlife and wildlife habitat, plus: • Research studies and instrumentation in the park • Development of a wilderness management plan
Soils	Park and downstream watershed	1974 through life of the plan (20 years from implementation)	Same as vegetation	Same as vegetation	Same as vegetation

Impact Topic	Study Area	Temporal Boundaries	Past Actions	Current Actions	Future Actions (20 years)
Soundscapes	Legislated boundary of the park	1974 through life of the plan (20 years from implementation)	• Park management actions/plans • Increased overflights inside and outside the park • Non-native plant and animal species management inside the park, including park fencing • Rare and sensitive species restoration activities (including establishment of small fence exclosures and implementation of USFWS recovery plans for sensitive species) • Restoration/rehabilitation activities for native plant communities • Fire ecology and management inside the park • Management related to cultural resources, including historic properties • Research in the park • Development inside the park, including land clearing (logging, ranching, agricultural use), fragmentation, and loss of vegetation • Park visitation	Same as past actions, plus: • Development of the GMP, including evaluation of new wilderness areas • Development of the ATMP	Same as current actions, plus: • Implementation of ATMP • Implementation of GMP • Development of a wilderness management plan
Land Management Adjacent to the Park	Park and adjacent communities	1974 through life of the plan (20 years from implementation)	• Non-native plant and animal species management inside the park, including park fencing • Non-native plant and animal species management outside the park, including fencing and game management • Fire ecology and management inside and outside the park • Other conservation actions/plans outside the park • Development outside the park, including land clearing (logging, ranching, agricultural use), fragmentation, urbanization, and loss of vegetation • Acquisition of new lands (including Kahuku)	• Non-native plant and animal species management inside the park, including park fencing • Non-native plant and animal species management outside the park, including fencing and game management • Fire ecology and management inside and outside the park • Other conservation actions outside the park • Development outside the park, including land clearing (logging, ranching, agricultural use), fragmentation, urbanization, and loss of vegetation • *Ala Kahakai National Historic Trail Management Plan*	• Non-native plant and animal species management inside the park, including park fencing • Non-native plant and animal species management outside the park, including fencing and game management • Fire ecology and management inside and outside the park • Other conservation actions/ outside the park • Development outside the park, including land clearing (logging, ranching, agricultural use), fragmentation, urbanization, and loss of vegetation • Proposed Mauna Loa trail system (ongoing feasibility study) • Implementation of the *Ala Kahakai National Historic Trail Management Plan* • Acquisition of new lands

Impact Topic	Study Area	Temporal Boundaries	Past Actions	Current Actions	Future Actions (20 years)
Socioeconomics	Park and adjacent communities	1974 through life of the plan (20 years from implementation)	• Development outside the park, including land clearing (logging, ranching, agricultural use), fragmentation, urbanization, and loss of vegetation • Development inside the park, including land clearing (logging, ranching, agricultural use), fragmentation, and loss of vegetation • Non-native plant and animal species management inside the park, including park fencing • Non-native plant and animal species management outside the park, including fencing and game management • Rare and sensitive species restoration activities (including establishment of small fence exclosures and implementation of USFWS recovery plans for sensitive species) • Restoration/rehabilitation activities for native plant communities • Fire ecology and management inside and outside the park • Acquisition of new lands (including Kahuku) • Investment in the local economy from the purchase of materials and equipment and providing employment opportunities on the island • Park visitation	Same as past actions, plus: • Development of the GMP • Development of the ATMP • *Ala Kahakai National Historic Trail Management Plan*	Same as current actions, plus: • Implementation of the ATMP • Implementation of the GMP • Proposed Mauna Loa trail system (ongoing feasibility study) • Implementation of the *Ala Kahakai National Historic Trail Management Plan*
Visitor Use and Experience	Legislated boundary of the park	1974 through life of the plan (20 years from implementation)	• Park education and stewardship programs; ranger-led interpretation activities • Increased overflights inside and outside the park • Closures due to volcanic activity • Non-native plant and animal species management inside the park, including park fencing • Rare and sensitive species restoration activities (including establishment of small fence exclosures and implementation of USFWS recovery plans for sensitive species) • Restoration/rehabilitation activities for native plant communities • Fire ecology and management inside the park • Management related to cultural resources, including historic properties • Other park management plans/actions • Research in the Park • Development inside the park, including land clearing (logging, ranching, agricultural use), fragmentation, and loss of vegetation • Acquisition of new lands (including Kahuku) • Park visitation	Same as past actions, plus: • Development of the GMP, including evaluation of new wilderness areas • Development of the ATMP • *Ala Kahakai National Historic Trail Management Plan*	Same as current actions, plus: • Implementation of the GMP • Implementation of the ATMP • Proposed Mauna Loa trail system (ongoing feasibility study) • Implementation of the *Ala Kahakai National Historic Trail Management Plan* • Development of a wilderness management plan

Impact Topic	Study Area	Temporal Boundaries	Past Actions	Current Actions	Future Actions (20 years)
Visitor and Employee Safety	Park boundary and adjacent lands	1974 through life of the plan (20 years from implementation)	• Acquisition of new lands (including Kahuku) • Use of community volunteers and Volunteers in Park (VIP) program for management actions • Non-native plant and animal species management inside the park, including park fencing • Fire ecology and management inside and outside the park • Development inside the park, including land clearing (logging, ranching, agricultural use), fragmentation, and loss of vegetation • Management related to cultural resources, including historic properties • Other park management plans/actions • Park visitation • Increased overflights inside and outside the park (includes park administrative activities, commercial air tours, administrative activities of outside agencies, and military overflights)	Same as past actions, plus: • Development of the GMP • Development of the ATMP • *Ala Kahakai National Historic Trail Management Plan*	Same as current actions, plus: • Implementation of the GMP • Implementation of the ATMP • Proposed Mauna Loa trail system (ongoing feasibility study) • Implementation of the *Ala Kahakai National Historic Trail Management Plan*
Park Management and Operations	Park and adjacent lands	1974 through life of the plan (20 years from implementation)	• Acquisition of new lands (including Kahuku) • Development inside the park, including land clearing (logging, ranching, agricultural use), fragmentation, and loss of vegetation • Development outside the park, including land clearing (logging, ranching, agricultural use), fragmentation, urbanization, and loss of vegetation • Fire ecology and management inside and outside the park • Increased overflights inside and outside the park • Park visitation • Closures due to volcanic activity • Employment opportunities for local community from implementing park management actions • Other park management plans/actions including the use of volunteers in park programs • Research in the park • Non-native plant and animal species management inside the park, including park fencing • Rare and sensitive species restoration activities (including establishment of small fence exclosures and implementation of USFWS recovery plans for sensitive species) • Restoration/rehabilitation activities for native plant communities • Fire ecology and management inside and outside the park • Management related to cultural resources, including historic properties • Other park management plans/actions	Same as past, plus: • Development of the GMP, including evaluation of new wilderness areas • Development of the ATMP • Evaluation of new wilderness areas in Kahuku unit • *Ala Kahakai National Historic Trail Management Plan* And except: • Acquisition of new lands	Same as current, plus: • Implementation of the GMP • Implementation of the ATMP • Proposed Mauna Loa trail system (ongoing feasibility study) • Implementation of the *Ala Kahakai National Historic Trail Management Plan* • Acquisition of new lands • Development of a wilderness management plan

INTENSITY OF IMPACTS

For all adverse impacts, the intensity of the impact is described as negligible, minor, moderate, or major. For each impact topic, a distinct set of impact thresholds is used to provide definition of what constitutes an impact of a given intensity. The impact thresholds are aligned to relevant standards based on regulations, scientific literature and research, or best professional judgment. The intensity of an impact on a given topic is determined by comparing the effect to the impact threshold definitions for that topic. Impact thresholds apply to adverse impacts only; beneficial impacts are described, but not assigned an intensity level.

CUMULATIVE IMPACTS ANALYSIS METHOD

The CEQ regulations for implementing NEPA require the assessment of cumulative impacts in the decision-making process for federal projects. Cumulative impacts are defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or nonfederal) or person undertakes such other actions" (40 CFR 1508.7). As stated in the CEQ handbook, *Considering Cumulative Effects under the National Environmental Policy Act* (CEQ 1997), cumulative impacts need to be analyzed in terms of the specific resource, ecosystem, and human community being affected and should focus on effects that are truly meaningful. Cumulative impacts are considered for all alternatives, including alternative A (no action).

Cumulative impacts are defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or nonfederal) or person undertakes such other actions" (40 CFR 1508.7).

Cumulative impacts were determined by combining the impacts of the alternative being considered with other past, present, and reasonably foreseeable future actions. Therefore, it was necessary to identify other ongoing or reasonably foreseeable future projects and plans at the park and, if applicable, the surrounding area. Table 21 summarizes the actions that could affect the various resources at the park, along with the plans and policies of both the park and surrounding jurisdictions, which were discussed in chapter 1. Additional explanation for most of these actions is provided in the "Cumulative Impacts Scenario" section in this chapter.

The analysis of cumulative impacts was accomplished using four steps:

- **Step 1**. Identify resources affected.

  Fully identify resources affected by any of the alternatives. These include the resources addressed as impact topics in chapters 3 and 4 of this document.

- **Step 2**. Set boundaries.

  Identify an appropriate spatial and temporal boundary for each resource. The temporal and spatial boundary for each resource topic is listed under each topic in table 21.

- **Step 3**. Identify cumulative action scenario.

  Determine which past, present, and reasonably foreseeable future actions to include with each resource. These are listed in table 21 and described below.

- **Step 4**. Perform cumulative impact analysis.

Summarize impacts of these other actions plus impacts of the proposed action to arrive at the total cumulative impact. This analysis is included for each resource in chapter 4.

CUMULATIVE IMPACTS SCENARIO

PAST, CURRENT, AND FUTURE ACTIONS IN AND AROUND HAWAI'I VOLCANOES

Depending on funding and staffing levels, many of the past and current park activities described below would be expected to continue in the foreseeable future. Environmental alterations due to climate change (see discussions in chapter 3) may increase the urgency for some of these activities.

Non-native Plant and Animal Species Management Inside the Park, Including Park Fencing

The NPS has been controlling non-native ungulates living inside the park. These efforts are described in detail in chapter 1. As part of these efforts, the NPS has been building and maintaining barrier fences to exclude non-native ungulates. These fencing efforts are also discussed in chapter 1 and as an element common to all alternatives in chapter 2. Since 2003, the NPS has been constructing boundary fences and conducting animal control using a combination of NPS staff and volunteers at Kahuku. Also, vegetation monitoring to evaluate the impact of ungulate removal actions (Katahira 1980; Loh and Tunison 1999; Loh et al. 2005; Tunison et al. 1994; Tunison et al. 1995) has been implemented in various areas of the park. These studies typically have shown an increase of native plant species, while non-native plant abundance may remain the same, increase, or decrease following removal of animals.

In addition to non-native ungulates, the park is also home to other non-native wildlife mammals such as rats, mongoose, and feral cats. In order to protect against predation, removal of small non-native mammals has been conducted around sensitive wildlife species. Trapping and baiting have been used in the vicinity of nesting sites during the breeding season. Other efforts to control non-native animal species have included the use of exclosures to protect vulnerable nēnē from small-mammals. Also, efforts have been made by researchers and park staff to monitor and limit the spread of several disruptive non-native insects and coqui frogs. These include Argentine ants (*Linepithema humile*) and western yellow jacket wasps (*Vespula pensylvanica*). These insects pose a major threat to the health of Hawaiian arthropod communities because they are predators capable of forming large populations in social colonies. In addition to conservation threats, yellow jackets directly impact human welfare and the economy. The NPS is supporting research on impacts caused by these insects and development of control methods (Gruner and Foote 2000; Peck et al. 2008).

Park staff has been monitoring and managing disruptive non-native (invasive) plants found in the park (NPS 1999a). Since the 1980s, strategies for invasive plant control implemented at the park have included (1) minimizing disturbances to the native vegetation such as those caused by non-native ungulates and wildfires, which facilitate the spread of invasive plants; (2) monitoring and mapping the distribution of invasive plants; (3) controlling small or localized infestations parkwide; (4) focusing control of widespread weeds in high priority management units called SEAs; (5) working with other agencies and groups in non-native plant management including development of treatment methods and biological control for some widespread weeds; (6) supporting research on the ecology, seed biology, and phenology of disruptive non-native plant pest species; and (7) educating the public in disruptive non-native plant impacts and the importance of non-native plant control (Tunison 1991).

Approximately 60 invasive plant species have been targeted for management using one or more of the above strategies. Many of these species have limited distributions or may have only recently established in the park. The strategy of removing small, locally distributed populations of non-native plants before they become widespread minimizes damage to native communities and prevents the need for more costly control in the future. Such early detection and control measures have been primarily focused along roads, trails, other corridors, and recently disturbed areas where many weeds first establish (NPS 2008a). Additional aerial and ground searches have been conducted to find more remote populations. The most disruptive weeds that are too widespread to be controlled throughout the park have been managed in SEAs. These high-priority areas were selected based on (1) the biological community's representativeness of a particular ecological zone and/or its rarity in the park or on the islands; (2) manageability and intactness, so that areas are accessible and the potential for native species recovery is high; (3) the units' concentrations of species diversity and rare species; and (4) the biological community's value for research and interpretation to the public (Kueffer and Loope 2009; Loh and Tunison 2009; NPS 2008a; Tunison and Stone 1992). Inside each SEA, periodic searches have been conducted by ground crews or by aerial surveys and target weeds removed from the area. Methods have varied from manual uprooting to chemically treating individuals. In 2007, there were 27 SEAs covering approximately 66,000 acres.

Fountain grass is a fire-promoting invasive grass that has invaded portions of Kona and South Kohala on the Island of Hawaiʻi and established in the park. Although initially widespread, over the last 15 years, systematic search (helicopter and ground sweeps) and removal efforts for fountain grass have prevented the buildup of dense populations in the park. In the new Kahuku addition, fountain grass is beginning to invade young lava flows. Park staff have been removing all individuals found in the park, and since 2004 been working with the adjacent Ocean View subdivision community to remove plants along roadsides of the subdivision.

Non-native Plant and Animal Species Management Outside the Park, Including Fencing and Game Management

Non-native ungulate management in the vicinity of the park has included fencing and control of ungulates on portions of the State Natural Area Reserves (Puʻu Makaʻala, Kīpāhoehoe, Manukā); in adjacent Keauhou Ranch, owned by Kamehameha Schools; and in nearby Kaiholena and Kona Hema Reserve, owned by TNC (see the "Land Management Adjacent to the Park" section of chapter 3). The USFWS developed an environmental assessment to evaluate the potential environmental effects of building about 88,500 feet (27,000 meters) of fencing enclosing approximately 2,145 hectares (5,300 acres) of land in the Kona Forest Unit of the Hakalau Forest National Wildlife Refuge. The fencing, which is not yet under construction, is intended to keep non-native ungulates out of the area. The native forests of the Kona Forest Unit support four species of endangered forest birds, the endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*), and a high diversity of native plant species, several of which are threatened or endangered. Until 2002, the Kona Forest Unit supported the last remaining ʻalalā (Hawaiian crows) in the wild, and the area has been identified as a possible place for their reintroduction (USFWS 2007).

The State of Hawaiʻi Division of Fish and Wildlife has been managing all hunting opportunities and management areas in Hawaiʻi. Management actions related to hunting outside the park are provided in the "Land Management Adjacent to the Park" section of chapter 3, specifically under the section on Hawaiʻi.

Since 2007, Hawaiʻi County has been sponsoring a pilot feral pig management program. The program has been overseen by the USDA APHIS's Wildlife Services and assists residents in getting rid of feral pigs that cause destruction on their properties. An *Environmental Assessment of Feral Swine Damage Management in Hawaiʻi County* was completed in 2008 (USDA-APHIS 2008).

Non-native plant control outside the park have included efforts to eradicate or contain the spread of incipient weeds on adjacent State Natural Area Reserves (Puʻu Makaʻala, Manukā, and Kīpāhoehoe) on Keauhou Ranch (Kamehameha Schools), and on TNC Lands. Much of the detection and control work has been coordinated by the TMA, of which each land agency is a participating member. TMA recently completed a weed management plan that prioritized management of target plants in different portions of the TMA (TMA 2009). Island-wide outreach, education, and search and control work to address incipient weeds has been conducted by the Big Island Invasive Species Council, a voluntary partnership of private citizens, community organizations, businesses, landowners, and government agencies to address invasive species issues on the Island of Hawaiʻi (BIISC 2010). Beginning in 2004, park staff have been working with the adjacent Ocean View subdivision to control invasive fountain grass on roadsides in the subdivision.

The State of Hawaiʻi Department of Agriculture (HDOA) also has assisted communities outside the park addressing other invasive species issues (e.g., coqui frog, little fire ant, nettle caterpillar, and erythrina gall wasp) (HDOA 2010). The primary mission of the HDOA Plant Pest Control Branch has been to provide a favorable environment for agricultural development in Hawaiʻi by limiting plant pest populations that have the potential to cause significant economic damage. This has been achieved through statewide programs using chemical, mechanical, biological, and integrated control measures to eradicate or control plant pests, including insects and mites, mollusks, weeds, and plant pathogens. Pest advisories have kept the public abreast of new threats to the Hawaiian environment (HDOA 2010).

Many of the activities described above would be expected to continue in the foreseeable future. Environmental alterations due to climate change (see discussions in chapter 3) may increase the urgency for some conservation activities.

Rare and Sensitive Species Restoration Activities

Within the park, recovery efforts have been focused on four “flagship” federally endangered species, the nēnē, the hawksbill turtle, the Hawaiian petrel, and the Mauna Loa silversword. These are charismatic species, which help build support for park habitat restoration and rare species recovery programs. Additional efforts have been focused on propagating and planting federally listed and rare plant species into areas protected from damage caused by non-native ungulates

Although relatively small, the park population of endangered nēnē has been increasing due to successful breeding seasons as a result of habitat management. Several small fenced exclosures and a breeding pen have been constructed that protect nēnē from predation by non-native predators. A 10-acre predator-proof pen, to accommodate injured birds, was recently constructed in 2011. Localized trapping has been done during breeding season to protect nests and goslings in unprotected areas of the park. These management actions have been primarily focused in the Kīlauea and Mauna Loa regions of the park. In Kahuku, researchers have been monitoring nēnē with satellite transmitters to better understand their movement and use of the area.

The hawksbill sea turtle, or honuʻea, is known to nest at three beaches (ʻĀpua Point, Halapē, and Keauhou) in the park and at several beaches along the Kaʻū coastline outside the park. The NPS has been partnering with other federal and state agencies and private landowners to monitor and protect turtles and nests along the remote Kaʻū coastline. Hawksbill sea turtle restoration involves searching for and protecting nests, removing trash and non-native vegetation, educating visitors, and, when needed, assisting hatchlings to the ocean. Since the project began in 1989, personnel have tagged 89 nesting turtles and protected 677 nests (NPS 2008a).

Park scientists have mapped and studied many of the Hawaiian petrel nesting sites on Mauna Loa within the park (Pratt et al. 2009). Hawaiian petrel restoration has relied on monitoring and protecting nests from small predators at three main breeding colonies in the Mauna Loa Unit. In Kahuku, a small number of nests were discovered during initial inventories conducted in 2006 but no subsequent monitoring has been done.

The park's Kahuku population of Mauna Loa silversword represents the westernmost extent and the largest of the three populations remaining in the world. This population has persisted in a 2-acre fenced exclosure, protected from mouflon and other non-native ungulates, since the 1970s. In 2005, a small 1/2-acre exclosure was constructed near the natural population, and between 2005 and 2009, three additional exclosures (2 to 25 acres in size) were constructed to accommodate approximately 10,000 plantings. In the Mauna Loa Unit, approximately 11,000 individuals were propagated and planted between 2000 and 2006 inside large fence units.

Additional efforts to propagate and plant rare and endangered plants have been conducted intermittently since the 1920s. The current program, which began in 1997, has focused on reestablishment of species in ungulate-control units. Recovery actions for these sensitive plant species are described in the "Rare, Unique, Threatened, or Endangered Species" section of chapter 3 and include monitoring of natural populations. In Kahuku, where large numbers of ungulates remain on the landscape, there are a total of 12 small fenced exclosures established in several areas. These exclosures vary in size from approximately 1 hectare to approximately 50 hectares. The exclosures serve as a temporary measure to protect individual plants or populations of highly vulnerable listed species from damage by ungulates; and assist park staff in evaluating recovery of native plant communities and species following animal exclusion.

Restoration/Rehabilitation Activities for Native Plant Communities

The overriding goal of the Natural Resource Program has been the restoration of native ecosystems and the recovery of biological diversity (NPS 2008a). The primary strategy for accomplishing these goals has been the control of invasive species described above. However, in areas highly modified by invasive species, reintroduction of native plant species has been undertaken to restore community structure. Since the early 1990s, several projects have been initiated to develop and refine techniques to restore plant biological diversity and community structure in areas where invasive species have been managed. These projects have included evaluating methods for reintroducing fire-tolerant native species in dry ʻōhiʻa woodland (Loh et al. 2007; Loh et al. 2009; McDaniel et al. 2008; Tunison et al. 2001), koa forest restoration of former pastures in both the Mauna Loa and Kahuku units of the park (McDaniel et al. n.d.), and examining fire use to restore pili grasslands (Tunison et al. 2001). In 2009, a 140 ac prescribe fire was implemented that looked at the response of a pili grassland to fire. Preliminary results from this burn along with several others conducted over the years in the coastal lowland, identified prescribe fire as a potential tool to remove non-native shrubs and trees and re-invigorate pili grass; however other fire-adapted non-native plants may thrive along with pili (Loh and McDaniel 2010).

Fire Ecology and Management Inside and Outside the Park

Changes in land use (e.g., deforestation for logging and grazing) and the spread of invasive plant species have altered the role of fire in Hawaiian ecosystems. In many cases, fire is carried by invasive plants, particularly grasses. Invasive plant species often respond favorably after fire and compete with recovering native plant species. The degree to which this happens varies by ecosystem (refer to the "Vegetation" section of chapter 3 for more detail). The worst-case scenario is in the mid-elevation seasonal woodlands. Fire is carried by fire-adapted non-native broomsedge, beardgrass, and molasses grass. These species recover rapidly after fire, suppressing native species recovery (NPS 2004b). In addition, increased human-caused fires, including arson, contribute to direct loss of native plant species while promoting the growth of non-native species, which leads to habitat fragmentation. Fire also contributes to the direct loss of cultural resources.

In the 1980s, the NPS established a fire management program based at Hawaiʻi Volcanoes National Park (see the "Fire Management Division" section in chapter 3); and a comprehensive fire management plan for the park was developed to address the threat of wildfire to human life, property, and cultural and natural resources (NPS 2005a, 2007b). The current fire management plan divides the park into seven fire management zones that reflect the different ecological zones. Within each zone, the potential for wildfire, fire history, fire impacts, resources at risk, and appropriate management strategies are identified. Because of the largely negative effects of fire on natural and cultural resources, the park has adopted an aggressive fire suppression policy. Implementation of the fire management plan by fire staff include monitoring for fire severity conditions and wildfires, implementing temporary restrictions and closures during times of high fire severity, maintenance of fuel breaks and water catchments, conducting fuel treatments and maintaining a trained militia made up of park staff and individuals from the community to respond to wildfire emergencies. For several burn areas, the park has developed prescriptions for restoring native plant communities following wildfire (Loh et al. 2007; Loh et al. 2009; McDaniel et al. 2008).

The communities of Ocean View and Volcano in Hawai‘i County lie adjacent to the park and are within the WUI environment, which is where wildlands meet houses and communities. The WUI poses the highest risk of loss of life and property due to wildland fires. Wildland fires originating in the park can threaten the communities of Volcano and Ocean View, including homes along Lorenzo Road in Ka‘ū, Volcano Village, and the Volcano Golf Course Community. Conversely, fires started in these neighboring communities could also impact the park. To reduce the threat of wildfire in the park and adjacent communities, the communities of Ocean View and Volcano have developed community wildfire protection plans cosponsored by the park and the Big Island Wildfire Coordinating Group (Laitinen 2006a, 2006b). These community wildfire protection plans outline the following mitigation measures to reduce damage from future wildfires: (1) installation of pre-staged static water tanks; (2) increased communication to residents regarding evacuation during an emergency; (3) creation/improvement of secondary access and ingress/egress roads, including identification of evacuation route roads within subdivisions; (4) reduction of fuel load along roadsides and in common areas; (5) reduction of non-native species that increase fire risk; (6) continued fire-prevention education and outreach; and (7) strengthening of Hawai‘i County fire ordinances. The park currently maintains a fuel break along a portion of its shared boundary with the Volcano Golf Course community and is working with the community of Hawaiian Ocean View Estates to contain the spread of invasive fountain grass, a fire-promoting species, along subdivision roads. Also, the park has memoranda of understanding with the state and county of Hawai‘i to provide mutual assistance in the event of large-scale wildfires in and around the park.

Management Related to Cultural Resources, Including Historic Properties

Many of the past and present actions for cultural resources are described in chapter 3. In addition to monitoring and protection of archeological features and cultural landscapes, the NPS has considered cultural resource values to protect and preserve traditional activities in park management actions. The NPS maintains access to sacred sites for traditional activities and integrates cultural values into management strategies for resources such as cultural landscapes and traditional cultural properties. In addition, the park carries out inventory and documentation of historic resources and cultural landscapes in the park, as well as identification of new cultural sites for interpretation and public access. The latter would contribute to cumulative effects on these resources, as well as on visitor use and experience.

Other Park Management Plans/Actions

Within the park, a variety of activities have been conducted that may contribute to cumulative impacts, such as various research, issuing special use permits, managing assets, and purchasing materials on the island. Law enforcement, maintenance, interpretive activities, and other visitor services, which are described in the “Park Management and Operations” section of chapter 3, may also have contributed to cumulative impacts, including when visitors encounter such activities in the park (e.g., search and rescue operations) or as a result of access restrictions (e.g., volcanic emissions). Hawai‘i Volcanoes National Park has offered a variety of interpretive programs that discuss the unique history of the park. In relation to non-native ungulate management, interpretive displays in the visitor center and on the park's website have provided information about these species.

In addition to park staff, volunteers have been used for a variety of activities throughout the park to assist with interpretive, cultural, and natural resource programs. Activities that involve the use of volunteers have the potential to affect park management and operations due to the oversight needed. Volunteer activities related to natural resources have included planting, removal of non-native plant species, monitoring endangered hawksbill turtles and nēnē, and assisting with non-native ungulate removal efforts at the Kahuku Unit. In addition to volunteers, many park employees come from the local communities surrounding the park (NPS 2006d). The volunteer program has provided opportunities for community members to participate in stewardship of park resources. The majority of volunteers that have participated in non-native ungulate management actions in the park have been island residents.

Law enforcement activities at the park have included protecting natural and cultural resources from poaching and harvesting, as well as enforcing general laws, rules, and regulations. Also, law enforcement personnel have conducted search-and-rescue operations and assisted with wildland firefighting.

Descriptions of many of the park management plans that will contribute to cumulative impacts are provided in chapter 1. In addition to these, are several plans in development described below.

Hawai'i Volcanoes National Park Air Tour Management Plan. Hawai'i Volcanoes is working with the Federal Aviation Administration (FAA) to develop an ATMP and EIS to determine acceptable and effective measures to mitigate or prevent the adverse impacts, if any, of commercial air tour operations on the park's natural and cultural resources (including Native Hawaiian practices) and visitor experience. A commercial air tour operation is defined as a flight conducted for compensation or hire in a powered aircraft where the purpose of the flight is sightseeing over a national park, within 0.5 mile of the boundary of any national park, or over tribal lands, during which the aircraft flies below a minimum altitude of 5,000 feet (1,524 meters) above ground level (AGL), or less than 1 mile laterally from any geographic feature in the park. In accordance with the *National Parks Air Tour Management Act*, the Hawai'i Volcanoes National Park ATMP may prohibit commercial air tour operations in whole or in part, and may establish conditions for conducting commercial air tour operations, among other stipulations. (FAA n.d., 2004, 2005). Future implementation of the plan will likely affect park management and operations, visitor use and experience, soundscapes, and visitor and employee safety.

Hawai'i Volcanoes National Park General Management Plan/Wilderness Study. The NPS is preparing a GMP/Wilderness Study and EIS to guide management of the park for the next 20 years. The GMP/Wilderness Study will address critical issues at the park, including planning for visitor services and park operations in a constantly changing volcanic landscape; natural resource preservation and restoration, protection of federally listed species; cultural resource protection and management; Native Hawaiian traditional use; transportation and congestion; and global climate change (NPS 2009d). The GMP/Wilderness Study will include a commercial services strategy; plans for visitor services and resource protection; and a wilderness study for the entire park, including the recently acquired Kahuku unit. Future implementation of the GMP/Wilderness Study will involve prescriptions for desired conditions related to the protection of natural resources balanced with those for visitor use, and will likely affect all the impact topics addressed in this plan/EIS.

Ala Kahakai National Historic Trail Comprehensive Management Plan/Environmental Impact Statement. The Ala Kahakai NHT extends approximately 175 miles from 'Upolu Point on the northern tip of the Island of Hawai'i down the Kona Coast and around South Point to the eastern boundary of Hawai'i Volcanoes National Park. Sections of the historic trail are located within Hawai'i Volcanoes. Completed in 2004, the comprehensive management plan for the Ala Kahakai NHT establishes the management guidelines needed to fulfill the preservation and public use goals for the NHT for approximately the next 15 years (NPS 2004d). The plan is based on the trail's purpose and its significant attributes, stories, and experiences, and is guided by the community vision for the trail. This plan offers strategies for resource protection, trail use, and facility development. The plan serves as the umbrella document under which more implementation plans will be prepared in the future. Future implementation could provide more opportunities for recreation, increase awareness of the island's unique natural and cultural resources, and support the local economy and tourist industry. The NPS, through the Ala Kahakai NHT office, will provide overall administration, coordination, and oversight of the Ala Kahakai NHT as directed by Congress, with an emphasis on ensuring consistency of preservation efforts, trail management operations, and development and maintenance standards, as well as conformance with applicable laws, regulations, and policies.

Proposed Mauna Loa Trail System (Ongoing Feasibility Study). A Mauna Loa trail system feasibility study, sponsored by The Hawai‘i Tourism Authority, Kamehameha Schools, and TNC, was completed in 2005 (TNC 2005). The purpose of this study was to plan, describe, and assess the feasibility of a mid-elevation trail system around the slopes of Mauna Loa on the Island of Hawai‘i. The "working" name of this network of trails is the Mauna Loa Trail System. The proposed 350-mile trail system would tie into and incorporate existing trails and 4-wheel-drive roads on public and private lands. Parts of the trail system are in Hawai‘i Volcanoes National Park. Future implementation would provide more opportunities for recreation, increase awareness of the island's unique natural and cultural resources, and support the local economy and tourist industry. Also, implementation would require close collaboration among public agencies, community organizations, and landowners; infrastructure improvements (e.g., parking, rest stops, information signs, maintenance/of existing 4-wheel-drive roads and trails, and construction of connector trails); and additional measures to provide for visitor safety, interpretation, and protection of natural and cultural resources.

Other Conservation Actions/Plans Outside the Park

Threatened and Endangered Species Recovery Plans. Many of the USFWS and National Oceanic and Atmospheric Administration recovery plans that have been developed for listed threatened and endangered species recommend the removal of non-native animals and building exclosures to protect these plants and animals. Plans that were considered in preparing this non-native ungulate management plan include the following: *Revised Recovery Plan for Hawaiian Forest Birds* (USFWS 2006a), *Final Recovery Plan for Four Species of Hawaiian Ferns* (USFWS 1998a), *Recovery Plan for the Ka‘ū Silversword* (USFWS 1996b), *Recovery Plan for the Big Island Plant Cluster* (USFWS 1996a), *Recovery Plan for the Multi-island Plants* (USFWS 1999), *Big Island II: Addendum to the Recovery Plan for the Big Island Plant Cluster* (USFWS 1997), *Draft Revised Recovery Plan for the Nēnē or Hawaiian Goose* (USFWS 2004), *Revised Recovery Plan for the ‘Alalā* (*Corvus hawaiiensis*) (USFWS 2009d), *Recovery Plan for the Hawaiian Hoary Bat* (USFWS 1998b), *Hawaiian Hawk Recovery Plan* (USFWS 1984), *Hawaiian Dark-rumped Petrel and Newell's Manx Shearwater Recovery Plan* (USFWS 1983) and *Recovery Plan for the U.S. Pacific Population of the Hawksbill Turtle* (NMFS and USFWS 1998).

The USFWS Pacific Islands Ecoregion, partnering with the State Division of Forestry and Wildlife, is in the early phases of planning for the reintroduction of the federally listed endangered ‘Alalā, or Hawaiian crow. The bird is extinct in the wild and individuals are currently being reared in captivity at Keauhou Bird Conservation Center and at Maui Bird Conservation Center. Areas in and adjacent to Kahuku are identified as potential release sites that may require non-native ungulate control measures to protect habitat.

Three Mountain Alliance. The TMA is a watershed management partnership composed of nine members: Kamehameha Schools; TNC; the State Department of Corrections Kūlani Correctional Facility;

the DLNR Division of Forestry and Wildlife; the USFS, NRCS, NPS, USFWS, and USGS. The overall management goal of the TMA has been to sustain the multiple ecosystem benefits provided by the three mountains of Kīlauea, Mauna Loa, and Hualālai by responsibly managing its watershed areas; native habitats and species; and historical, cultural, and socioeconomic resources for all who benefit from the continued health of the three mountains. Management programs have been developed to support these overall goals and include the following: habitat protection and restoration, watershed protection, compatible economic use, compatible recreation and ecotourism, education, awareness and public outreach, cultural and historical resource protection and research and monitoring that will support conservation management and recovery programs (TMA 2007, 2009; ʻŌlaʻa-Kīlauea Management Group 1999; ʻŌlaʻa-Kīlauea Partnership 2007). Many of the activities that have been implemented on the ground are described in this chapter under "Past, Current, and Future Actions in and Around Hawaiʻi Volcanoes" in the section titled "Non-native Plant and Animal Species Management Outside the Park, Including Fencing and Game Management."

Hawaiʻi Department of Land and Natural Resources. The DLNR has been conducting a plant habitat management project within various Natural Area Reserves on the Island of Hawaiʻi. The goals of the project has been to (1) protect and stabilize the ecosystem for native rare and endangered species, (2) fence areas to protect vegetation from predators, (3) control/eradicate non-native plant species, and (4) increase rare species populations by planting. Natural Area Reserve staff members have been working on fencing protected areas to keep non-native ungulates out of native areas. In the Kīpāhoehoe Natural Area Reserve, the maintenance of perimeter fences has been ongoing. Staff members at Kīpāhoehoe have also planted native plant species, and contributed to fire prevention by removing weeds along roads to prevent fires from spreading, and building water catchment systems in strategic locations to assist in fighting fires. In the Wright Road Unit of the Puʻu Makaʻala Natural Area Reserve, ungulate control efforts were completed, and planting and weed removal begun. In the Manukā Natural Area Reserve, efforts to control ungulates have been ongoing in upland areas (HDLNR n.d.b).

Please refer to the "Land Management Adjacent to the Park" section in chapter 3 and this chapter in the section titled "Non-native Plant and Animal Species Management Outside the Park, Including Fencing and Game Management" for descriptions on additional management actions and plans outside the park.

Development inside the Park, Including Land Clearing (Logging, Ranching, Agricultural Use), Fragmentation, and Loss of Vegetation

The development and maintenance of facilities at the park contribute to cumulative impacts. Facilities at the park include but are not limited to trails, roads, and structures (e.g., culverts, buildings, cabins, and shelters), some of which are historic; park rights-of-way (along roads and for utilities); campgrounds; parking lots; water catchment systems; and facilities associated with concessions and administrative support. At any time, maintenance of facilities, especially along roads, has the potential to affect visitor use and experience by restricting access and/or increasing traffic, which causes delays.

Various agricultural and logging activities, including ranching, have occurred historically in the park. These activities have resulted in land clearing and impacts from grazing that have contributed to fragmentation of habitat and loss of native vegetation. Kahuku, which was transferred to the NPS in 2003, was formally a cattle ranch. Large areas of native forest were commercially harvested and converted to grazing land, with the most damage occurring below 3,000 feet in elevation (914 meters) (NPS 2008d).

The interim operating plan for the Kahuku Unit (NPS 2006a) outlines measures that could be taken to improve natural resources, cultural resources, and visitor experience in this portion of the park. This plan highlights three actions related to roads and trails in Kahuku: (1) establish a safe access road into the Kahuku district; (2) maintain roads and trails determined to be necessary to interim operations of the area, including (but not limited to) grading, filling, construction of water bars, and mowing center islands; and (3) continue inventory and mapping of existing roads and trails for determination of future use (NPS 2006a). The GMP (in progress) will also identify additional uses and facilities in the park.

Development outside the Park, Including Land Clearing (Logging, Ranching, Agricultural Use), Fragmentation, Urbanization, and Loss of Vegetation

The park lies adjacent to several state forest reserves, Kamehameha School, and large private landholdings (e.g., TNC, Yee Hop, Hawaiʻi Outdoor Tours). While state forest reserves are relatively undeveloped, other areas have been extensively cleared for ranching and logging (e.g., Kapāpala Ranch, Yee Hop). In the Volcano Village area, there are several small plant nurseries and farms, a vineyard, and the Agricultural Experiment Station of the University of Hawaiʻi (Loh, pers. comm., 2009a).The communities of Volcano in the Puna District and Ocean View in the Kaʻū District border the park. The Puna community is located on the eastern side of the Big Island of Hawaiʻi, and shares borders with the South Hilo District to the north and Kaʻū District to the west. The County of Hawaiʻi approved the *Puna Community Development Plan* in September 2008 (Puna Community 2008). This plan outlines several goals, objectives, and actions to be taken for managing growth in Puna. The plan proposes to retain a rural character while protecting native and cultural resources, to reduce the overall number of buildable lots, and to prevent further sprawl. The first draft of the Kaʻū community development plan is currently in development. The Kaʻū community development plan is intended to cover the 13 elements of the general plan (County of Hawaiʻi 2005): economic, energy, environmental quality, flooding and other natural hazards, historic sites, natural beauty, natural resources and shoreline, housing, public facilities, public utilities, recreation, transportation, and land use.

In the future, general population increases and shifts in the demographic composition outside the park could result in continued development of retirement and second homes, ultimately resulting in increased urbanization. The most recently proposed residential and resort development, Kahuku Villages, is located below the Kahuku unit of the park (PBR Hawaii 2009). Increased urbanization can potentially contribute to habitat fragmentation and the spread of non-native plant species and result in the loss of traditional cultural resources.

Acquisition of New Lands (Including Kahuku)

As described in chapter 1, Hawaiʻi Volcanoes National Park originally included 35,865 acres (including Haleakalā on the Island of Maui). The area of Hawaiʻi Volcanoes, not including Haleakalā, was expanded through the years to 333,000 acres. The most recent of these expansions was the acquisition of the Kahuku Unit in 2003, which added approximately 116,000 acres to the park. Boundary expansion and acquisition of new lands creates new management challenges for the NPS, but also helps provide protection for resources that may not have previously existed. All lands considered for future acquisition could potentially be identified in the GMP.

Park Visitation

Park visitation has experienced variation throughout the years, although it has clearly increased since visitation records began being recorded in 1921 (NPS 2009b). Between 1974 and 2010, average annual visitation has been around 1.4 million. However, the park has experienced noteworthy visitation highs and lows, including a decrease from 1984 (which recorded over 2 million visitors) to 1985 (which recorded 816,652 visitors). Visitation climbed steadily until it experienced another decrease between 1997 and 2002.

Based on past rates of visitation, visitation both inside and outside the park will likely fluctuate throughout the life of this plan. Projected changes in air and ground travel would likely have impacts on local businesses and visitor experience as visitation patterns change. More opportunities for increased local lodging options, such as the establishment of bed and breakfasts in the gateway communities, could replace the more prevalent lodging options farther away in Kona.

The potential for the park to acquire new lands could increase possibilities for visitor use and enhance visitor experience and park visitation. This could result in an increase in park staff from local communities to manage such lands/uses. These changes could also result in longer visitor stays or repeat visitation.

Increased Overflights Inside and Outside the Park (Includes Park Administrative Activities, Commercial Air Tours, Administrative Activities of Outside Agencies and Military Overflights)

Since 1983, the number of airplanes and helicopters flying over national park units has increased dramatically. Much of the increase in flights, which are a substantial source of unnatural sounds in national parks, can be attributed to the growth of the air tour industry (Lawson et al. 2007). In the 1990s, Congress began to address the increasing number of air tours nationwide by mandating the FAA and the NPS to manage air tours over the parks. The *National Parks Air Tour Management Act* of 2000 requires the development of commercial ATMPs for parks in which air tours are conducted. The NPS has been working with the FAA to prepare an ATMP and EIS for Hawai‘i Volcanoes National Park. Flights over parks and surrounding areas include commercial air tour flights, park administrative flights, and occasional military overflights. Currently, air tour operators are authorized to conduct more than 28,000 flights annually over the park. In 2009, the number of air tours flying over the park was estimated to be about 15,000 annually. During peak periods of volcanic eruptive activity, the park can experience as many as 60 flights in a 4-hour period at eruption sites. Other agencies, such as the Department of Defense and the Drug Enforcement Agency, the electric company, and the local hospital, all use aircraft that travel over the park and contribute to cumulative impacts.

Research Studies and Instrumentation in the Park

Research studies and instrumentation, including GPS instrumentation, seismographs, battery cases, antennas, and small solar panels, in and outside wilderness areas have been used to study volcanic actions, monitor climate conditions, air quality, and measure changes in ecological conditions and cultural resources. Such studies have been conducted by various federal agencies (including the park), universities and research institutions. The USGS Hawaiian Volcano Observatory and PIERC are located on the summit of Kīlauea in the park. The former has been conducting long term monitoring of volcanic activity and has instrumentation deployed throughout the park, including designated wilderness, to assist with analysis of geohazards. Scientists from PIERC, USFS, and various universities have conducted a number of studies monitoring biological resources, geological resources and ecosystem processes. These research studies have involved the use of equipment in the park, including helicopters, which, coupled with the presence of researchers, could impact wilderness areas, visitor use, and other park resources (NPS 2008d). Inside the park are several weather and air quality monitoring stations and radio repeaters deployed in various areas to assist park operations and visitor safety.

Increased Investment in the Local Economy

The NPS has contributed to the local economy by providing jobs to park employees, including seasonal, term, and permanent full-time or part-time positions (see the “Park Management and Operations” section in chapter 3 for more detail). Many of the employees are hired from the resident population on the island. Park employees spend their income and wages in the local economies, which supports additional jobs and income. In 2007, Hawai'i Volcanoes National Park employed 144 full-time and part-time employees, who supported an additional 59 jobs in the local economy, for a total of 203 part-time and full-time jobs (Stynes 2008). This payroll spending contributes to the value added, or the island's gross regional product, by an estimated $10.9 million. Also, the NPS supports the local economy when local vendors are used for purchases, supplies, and/or contracted services, such as fencing supplies.

Park Education and Stewardship Programs; Ranger-led Interpretation Activities

Park staff have offered a wide range of ranger-led interpretation programs as well as other educational and stewardship programs. For more information related to these programs, please refer to the "Primary Interpretive Themes" section in chapter 3.

Closures Due to Volcanic Activity

Volcanic activity, including eruptions and smoke and ash plumes, have generally been commonplace at the park. Kīlauea, located within Crater Rim Drive, is one of the world's most active volcanoes. These volcanic activities have required quick responses by park management and staff in order to notify visitors and protect visitors and natural and cultural resources. Area closures due to volcanic activity have been sporadic and difficult to predict.

IMPACT TOPICS

VEGETATION

GUIDING REGULATIONS AND POLICIES

The NPS *Organic Act* of 1916 and the NPS *Management Policies 2006* (NPS 2006b) direct parks to provide for the protection of park resources. The NPS *Management Policies 2006* states that the NPS "will try to maintain all the components and processes of naturally evolving park ecosystems, including the natural abundance, diversity, and genetic and ecological integrity of the plant and animal species native to those ecosystems" (NPS 2006b, section 4.1). In addition, the NPS *Management Policies 2006* prohibits the displacement of native species by exotic species if displacement can be prevented (section 4.4.4). As described in chapter 1, section 4.4.4 also places a high priority on the control, including complete removal, of non-native species that have, or potentially could have, a substantial impact on park resources, including natural processes and the perpetuation of natural features, native species, or natural habitats.

The park's resource management goals, as articulated in several plans described in the "Relationship to Hawai'i Volcanoes National Park Planning Documents" section of chapter 1, also call for the protection of native vegetation in light of the damage caused by non-native ungulates. See chapter 1 for more details on these plans and their management goals.

METHODOLOGY, ASSUMPTIONS, AND IMPACT THRESHOLDS

Baseline information, including the condition and composition of the vegetation at Hawai'i Volcanoes National Park, was identified using maps and descriptions of the plant communities within the different ecological zones from the park's fire management plan (NPS 2005a). Information on non-native ungulate habitat and vegetation use was reviewed to identify which plant communities could be affected by management actions as well as by the presence of non-native ungulates themselves. This included reviewing areas currently managed for ungulates, and where recovery and active restoration is ongoing.

Recognizing that non-native ungulates not only cause the damage and removal of native plants, but also spread the seeds of non-native vegetation and create disturbances that facilitate their establishment, the analysis focuses on the impacts both to individual plants and to the plant communities they are part of. As described in chapter 1 and reiterated by the science team that convened for this project, the presence of even small populations or individuals of non-native ungulates has the potential to impact vegetation, including effects on natural function and character of native species (i.e., growth, abundance, reproduction, distribution, structure, composition or diversity), as well as plant community properties (i.e., size, integrity, continuity, or succession). Consequently, the removal of non-native ungulates is assumed to result in benefits to the natural function and character of plants, as well as plant community properties. However, the analysis also considers potential adverse effects of removing non-native ungulates, such as reduced grazing pressure on non-native weeds, which could increase in abundance and cause changes to fuel loads and fire regimes.

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Impact intensity thresholds were defined for adverse impacts. For this plan/EIS, assignment of intensity levels for vegetation impacts are based on the potential for changes to such characteristics as follows:

Negligible: Individual plants may be affected, but measurable or perceptible changes in the natural function and character of the plant community in terms of growth, abundance, reproduction, distribution, structure, or diversity of native species would not occur.

Minor: Effects on multiple plants would be measurable or perceptible. However, the natural function and character of plant communities in terms of growth, abundance, reproduction, distribution, structure, or diversity of native species would only be perceptible in small localized areas.

Moderate: A change would occur in the natural function and character of the plant communities in terms of growth, abundance, reproduction, distribution, structure, or diversity of native species, but not to the extent that plant community properties (i.e., size, integrity, or continuity) change.

Major: Effects on plant community properties (i.e., size, integrity, or continuity) would be readily apparent and would substantially change the natural function and character of the vegetation community (i.e., growth, abundance, reproduction, distribution, structure, or diversity of native species).

IMPACTS OF THE ALTERNATIVES

Alternative A: No Action (Continue Existing Non-native Ungulate Management Activities)

Analysis

In areas where ungulates are being managed, short-term adverse impacts on vegetation include those associated with temporary ground-based management actions (e.g., the presence of humans placing bait stations, shooting ungulates, setting traps and snares, and monitoring and collecting data, as well as constructing and repairing fences), including foot traffic and fence placement. Foot traffic would have the potential to affect individual plants, and a four foot wide corridor of vegetation could be cleared to install fences, but these activities would not alter the natural function or character of plant communities. In addition, fence alignments are located to minimize impacts on native vegetation and to avoid impacts on rare or sensitive vegetation.

In areas where ungulates remain on the landscape, removal of animals would support recovery of native vegetation. Studies conducted inside and outside the park show that non-native ungulate removal is an essential first step in the restoration of native Hawaiian vegetation. Removal of animals prevents further loss of native vegetation by herbivory, rooting and trampling. In rain forest, pigs selectively browse or uproot native mints, shrubs, and tree ferns, suppressing native vegetation and facilitating the spread of non-native plants. Following removal of pigs, native understory vegetation recovers rapidly, and subcanopy tree ferns and native trees begin to regenerate more rapidly in the absence of pigs (Loh and Tunison 1999). In former koa forest on Mauna Loa, exclusion of non-native goats and cattle assists native forest recovery and allows additional measures, such as planting of rare species and understory restoration efforts, to take place (McDaniel et al. n.d.; Tunison et al. 1994; Tunison et al. 1995). In portions of Kahuku, release from browsing pressure by the removal of mouflon has led to vigorous recruitment of koa and, to a lesser extent, other native plant species (HDLNR 2005c).

Removal of ungulates would assist park managers with control of non-native weed infestations (Tunison and Stone 1992). Non-native ungulates facilitate the spread of invasive non-native weeds by dispersing seeds of non-native species and creating vegetation openings for non-native plants to establish (Diong 1982; Lipp 1994; Stratton 1996). However, following the removal of ungulates non-native weed distributions and abundances may increase depending on habitat type, ecosystem vulnerability, existing threats, and other factors. For example, following pig removal from a rain forest unit, recovery of understory native vegetation (from 21 to 46 percent vegetation cover abundance) was accompanied by an increase in non-native weeds (from 2 to 11 percent vegetation cover abundance) (Loh and Tunison 1999). In contrast, several studies conducted in recovery sites around the state found no net difference in weed abundance following removal of feral animals, with some plant species decreasing or increasing in abundance. Often, the spread of non-native plant species occurred in spite of ungulate removal, not because of it (Aplet et al. 1991; Scowcroft and Conrad 1992; Stone et al. 1992). Implementation of weed control measures (see chapter 2) through existing plans would limit the potential adverse effects of non-native weeds on vegetation.

As vegetation recovers, fire risk may increase in certain (but not all) areas. For example in the coastal lowland wildfires increased in frequency and size when short-statured non-native grasses were replaced by tall fire-adapted non-native grasses following removal of animals (Tunison et al. 2001). In contrast, fire risk did not change in the mid-elevation seasonal woodlands. This is because fire-promoting non-native broomsedge and bush beard grass established and spread while goats were still present. Animals preferred to forage on native plants over the non-native grasses (Baker and Reeser 1972). Following goat exclusion, grasses remained abundant and fire risk remained high. Occurrence of wildfire has remained infrequent in the Mauna Loa montane zone despite the build-up of vegetation following release from grazing pressure by animals, and in the subalpine zone. Areas in the park that contain animals and are potential concerns for increased fire risk following their removal include montane naio-māmane woodlands in Kahuku and former koa-ʻōhiʻa forest in Kahuku that has been converted to pasture. However, keeping grazing animals on the landscape and allowing further loss of native vegetation would hinder the ability of native vegetation to recover after wildfires. In some areas, removing non-native animals would assist recovery of native plant communities and restoration of natural fire regimes. For example, re-establishment of a dense native plant understory could create more humid conditions that are less conducive for carrying wildfire (Freifelder et al. 1998). Implementation of fuel reduction treatments, monitoring and wildland fire suppression activities described in existing plans (see chapter 2), and weed sanitation protocols to prevent establishment and spread of new invasive species, would limit the potential adverse effects of non-native weeds and an altered fire regime on vegetation.

In addition to protecting and restoring native species and plant communities, removing non-native ungulates and restoring native vegetation cover would also help to counteract potential pressures of global climate change on vegetation. As noted in the “Vegetation and the Role of Climate Change” section of chapter 3, changes in temperature and moisture regimes may result in dramatic shifts in habitat range for a number of native plant and animal species and vegetation types, and the movement of invasive species (EPA 1998; Giambelluca et al. 2008; Nadkarni and Solano 2002; Root et al. 2003). Management of non-native ungulates would remove a key stressor on native ecosystems, thereby increasing the capacity of native species to adapt to changes in climate (NPS 2010c). Restoration of fragmented plant communities would restore habitat continuity and allow for the local migration of species in response to climate change. Also, removing ungulates would reduce the disturbance-facilitated establishment of non-native weeds, and remove a mechanism for their dispersal.

In summary, alternative A would result in short- and long-term negligible to minor adverse impacts on vegetation through implementation of ground-based management actions. In areas of the park already managed for ungulates, alternative A would produce negligible adverse impacts because the frequency and duration of management actions in these areas would be minimal. In these areas of the park, long-term beneficial impacts on vegetation would result from the continuation of animal exclusion in managed units. However, long-term beneficial impacts to the native vegetation would be unlikely for Kahuku and areas currently unmanaged (e.g., portions of ‘Ōla‘a), for which no established population-level objective and fencing strategy has been identified. Also, the implementation of management tools and monitoring would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities. Because alternative A would not incorporate the comprehensive, systematic approach described in the “Elements Common to All Action Alternatives” section in chapter 2, it would be uncertain whether the NPS would progress through management phases, monitor, and apply management tools consistently as staff and institutional knowledge change over time.

Cumulative Impacts

Other past, present, and reasonably foreseeable future actions in and around the park have affected or could affect native vegetation. Past actions parkwide (since 1974), include development of facilities (e.g., water reservoirs, building and road improvements); maintenance of landscaped areas, including cultural landscapes (e.g., historic gardens and lawns); and the management of cultural resources, including historic properties. Although management plans ensure protection of sensitive species and native habitat, future activities associated with the development and maintenance of facilities (grading, filling, construction, and inventory) at the park, including trails and roads, could contribute to localized trampling and removal of vegetation and short-term to long-term adverse impacts. Visitation at the park could also contribute to localized trampling of vegetation and introduction of non-native weeds if visitors wander off designated trails. In Kahuku, past actions including agricultural operations (including cattle grazing) and logging have resulted in large-scale land clearing and habitat fragmentation contributing to loss or degradation of native vegetation, particularly in lower-elevation areas (less than 5,000 feet in elevation (1,524 meters)). Past actions adjacent to the park include increased land clearing due to urbanization, agriculture, and logging. Grazing and urbanization adjacent to the park continue today, resulting in land clearing and vegetation loss. Land clearing, grazing, and adjacent urbanization in the future would continue to adversely impact native vegetation.

Changes in the fire regime due to habitat fragmentation and non-native species invasions pose a threat to native vegetation. Particularly in dry and seasonally dry vegetation types, fire is promoted by non-native plants and many non-native plant species recover quickly after fire, suppressing native species recovery (Hughes and Vitousek 1993; Tunison et al. 2001). In addition, increased human-caused fires contribute to direct loss of native vegetation. However, the park's fire management plan (NPS 2005a) outlines procedures and approaches for the monitoring and suppression of wildfires, mitigation measures to reduce the chance of wildfire, and maintenance and restoration of natural resources (see the "Past, Current, and Future Actions in and Around Hawai‘i Volcanoes" section in this chapter). The NPS and the Big Island Wildfire Coordinating Group have cosponsored community wildfire protection plans, which have been developed for local communities in the vicinity of the park, outlining mitigation measures to reduce the chances of wildfire occurring in these communities and the park (Laitinen 2006a, 2006b).

Many past, current, and future actions, plans, and programs at the park and surrounding areas provide benefits for native vegetation. Past actions such as fencing to exclude non-native ungulates have resulted in native vegetation recovery in many places of the park (these fencing efforts are discussed in chapter 1 and as an element common to all alternatives in chapter 2). The current weed management program, which includes monitoring and removal of incipient weeds, will address new weeds that may enter the park and contain the spread of highly invasive weeds into high-priority areas. The acquisition of the Kahuku Unit resulted in increased protection of natural resources in these lands by implementation of management actions under the interim operating plan. During the last 20 years, members of the TMA (formerly ‘Ōla‘a-Kīlauea Partnership) have constructed fences, excluded non-native ungulates, controlled weeds, and planted native vegetation in several areas adjacent to or near the park, which has resulted in recovery of native vegetation (see the "Past, Current, and Future Actions in and Around Hawai‘i Volcanoes" section in this chapter). The HDLNR, a TMA member, has implemented measures for fire prevention by removing weeds along roads to prevent fires from spreading, and by establishing water catchment systems in strategic areas to assist in fighting fires. Natural resource and watershed protection on lands in and adjacent to the park has previously supported and will continue to support the protection and recovery of native vegetation.

The future implementation of the GMP (currently in development) for the park will also involve prescriptions for desired conditions related to the protection of natural resources balanced with those for visitor use. However, areas adjacent to the park that are not managed for the conservation of native wildlife will likely continue to degrade due to the uncontained spread of non-native plant species and ongoing impacts caused by non-native ungulates.

Additional actions providing benefits for vegetation include park educational programs and interpretation activities, the implementation of USFWS recovery plans for sensitive species, and revegetation and sensitive species specific restoration activities. The overriding goal of these programs is the perpetuation of native ecosystems and the recovery of biological diversity in the park. The main strategies for accomplishing these goals are monitoring of rare populations, propagation and planting of individuals, and protection of habitat through removal of disruptive non-native species.

Some past, current, and future actions contribute to both beneficial and adverse impacts, depending on what stage of implementation they are in. For example, construction and maintenance of fences in the park would contribute to localized adverse impacts (due to corridor clearing for fences), but would also contribute to beneficial impacts once the fences are erected by keeping non-native ungulates out of fenced areas and assisting vegetation recovery across the larger landscape. Likewise, law enforcement activities would contribute to beneficial impacts by protecting vegetation from being damaged by visitors who wander off trails, but also would contribute to localized adverse impacts if law enforcement staff members need to go off trail.

The overall impacts of past, present, and future actions (inside and outside the park) on vegetation would be long-term beneficial and short- and long-term minor to moderate adverse. When combined with the impacts under alternative A, there would be short- and long-term minor to moderate adverse cumulative impacts on vegetation. Long-term beneficial cumulative impacts would be less likely under alternative A, because non-native ungulate management within the park would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities and implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.

Conclusion

Under alternative A, short- and long-term negligible to minor adverse impacts would result from the implementation of ground-based management actions. In areas of the park already considered ungulate free, alternative A would produce negligible adverse impacts because the frequency and duration of management actions in these areas would be minimal; and long-term beneficial impacts on vegetation would result from the continuation of animal exclusion. Long-term beneficial impacts would be unlikely for Kahuku and areas currently unmanaged (e.g., portions of ʻŌlaʻa), where no established population-level objective or fencing strategy has been identified in a comprehensive and systematic plan. The effects of alternative A, when combined with impacts of past, present, and reasonably foreseeable future actions on vegetation, would have short- and long-term minor to moderate adverse cumulative impacts on vegetation. Long-term beneficial cumulative impacts would be less certain under alternative A, because non-native ungulate management would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities and implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.

Alternative B: Comprehensive Management Plan that Uses Lethal Removal Techniques

Analysis

Removal of animals would result in long-term beneficial impacts on vegetation due to release from browsing pressure, rooting and trampling, as well as ecosystem restoration and recovery. Long-term beneficial impacts to vegetation would be fully realized under this alternative because the comprehensive, systematic approach described in the “Elements Common to All Action Alternatives” section in chapter 2 would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time.

Where ungulates are managed, short-term negligible to minor adverse impacts on vegetation would include those associated with temporary ground-based management actions (e.g., the presence of humans on foot, installing bait stations, setting traps and snares, and monitoring and collecting data, as well as constructing and repairing fences). The duration and frequency of actions and their associated impacts would decrease over the life of the plan as desired conditions are reached and the park moves from reduction into less intensive management phases.

The removal of ungulates could cause an increase in some non-native weeds, resulting in long-term adverse impacts on native plants and plant communities depending on a variety of factors. Also, fire risk could increase in certain areas where grazers and browsers are removed, while for other areas fire risk could decrease or remain unchanged. The implementation of weed and fire management programs (see chapter 2) through existing plans, and weed sanitation protocols to prevent establishment of invasive species, would limit the potential adverse effects of non-native weeds and an altered fire regime on vegetation.

Additionally, removal of non-native ungulates and restoration of native vegetation cover helps to counteract potential pressures of global climate change on vegetation by removing a key stressor on native ecosystems, helping reduce habitat fragmentation, and lessening disturbance-facilitated establishment of non-native weeds and their dispersal.

Removal of non-native ungulates and restoration of native vegetation cover helps to counteract potential pressures of global climate change on vegetation by removing a key stressor on native ecosystems, helping reduce habitat fragmentation, and lessening disturbance-facilitated establishment of non-native weeds and their dispersal.

In summary, alternative B would result in short- and long-term negligible to minor adverse impacts on vegetation through implementation of ground-based management actions. Long-term beneficial impacts to vegetation would be fully realized under this alternative because the comprehensive, systematic approach described in the "Elements Common to All Action Alternatives" section in chapter 2 would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative B would be the same as alternative A. The short- and long-term minor to moderate adverse and long-term beneficial impacts of past, present, and future actions, when combined with the impacts of implementing alternative B, would have short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts on vegetation. Under alternative B, long-term beneficial impacts to vegetation would be fully realized under this alternative because the comprehensive, systematic approach described in the "Elements Common to All Action Alternatives" section in chapter 2 would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time.

Conclusion

Under alternative B, short- and long-term negligible to minor adverse impacts on vegetation would result from the implementation of ground-based management actions. In areas of the park already managed for ungulates, alternative B would produce negligible adverse impacts because the frequency and duration of management actions in these areas would be minimal. Long-term beneficial impacts to vegetation would be fully realized under this alternative because the comprehensive, systematic approach described in the "Elements Common to All Action Alternatives" section in chapter 2 would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time.

The effects of alternative B, when combined with impacts of past, present, and reasonably foreseeable future actions on vegetation, would have short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts.

Alternative C: Comprehensive Management Plan that Maximizes Efficiency by Expanding Lethal Removal Techniques and Discontinuing the Use of Volunteers

Analysis

Similar to alternative B, alternative C would result in short- and long-term negligible to minor adverse impacts on vegetation through implementation of ground-based management actions. Long-term beneficial impacts to vegetation would be fully realized under this alternative.

Because lethal techniques would be expanded and enhanced, and volunteers would not be used during direct reduction efforts under alternative C, it is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, more quickly than under alternative B. The increased efficiency associated with discontinuing the use of volunteers is based on additional work required by NPS staff to recruit, administer, train and direct volunteers in the field, and data that show that park staff remove more ungulates per day when they conduct direct reduction (ground shooting) themselves, compared to when they are accompanied by volunteers (Stephens et al. 2008). Based on past participation, discontinuing the use of volunteers in other activities related to ungulate management (fence building, monitoring, baiting) would not noticeably affect the ungulate program, as volunteer interest in these activities has been infrequent and focused on the more accessible areas of the park, which limits the efficiency gained by using volunteers.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative C would be the same as alternative A. Similar to alternative B, the short- and long-term minor to moderate adverse and long-term beneficial impacts of past, present, and future actions, when combined with the impacts of implementing alternative C, would have short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts on vegetation.

Conclusion

Under alternative C, short- and long-term negligible to minor adverse impacts on vegetation would result from the implementation of ground-based management actions. Long-term beneficial impacts to the vegetation would be fully realized under this alternative. It is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, more quickly under alternative C than under alternative B. The effects of alternative C, when combined with impacts of past, present, and reasonably foreseeable future actions on vegetation, would have short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts.

Alternative D: Comprehensive Management Plan that Maximizes Flexibility of Management Techniques

Analysis

Similar to alternative B, alternative D would result in short- and long-term negligible to minor adverse impacts on vegetation through implementation of ground-based management actions. Long-term beneficial impacts to vegetation would be fully realized under this alternative.

Under alternative D, it is possible that increased human and vehicular traffic associated with potential relocation activities could cause additional vegetation disturbance during the process of capturing and relocating ungulates and driving animals to release sites. However, these impacts would be short-term and localized, and similar to impacts of other ground-based management actions.

Although the expansion and enhancement of lethal removal techniques under alternative D would be implemented with the goal of increasing the efficiency and cost effectiveness of ungulate management, the continued use of volunteers and the expansion of non-lethal techniques would counteract this to some extent. Inclusion of non-lethal removal would require additional staff time and park resources to capture, hold and relocate animals, and may increase the time associated with reduction actions over the life of the plan, as well as the time needed to reach the post-reduction phase. As a result, it is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, less quickly than under alternative C.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative D would be the same as alternative A. Similar to alternative B, the short- and long-term minor to moderate adverse and long-term beneficial impacts of past, present, and future actions, when combined with the impacts of implementing alternative D, would have short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts on vegetation.

Conclusion

Under alternative D, short- and long-term negligible to minor adverse impacts on vegetation would result from the implementation of ground-based management actions, including potential relocation activities. Long-term beneficial impacts to the vegetation would be fully realized under this alternative. It is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, less quickly under alternative D than under alternative C. The effects of alternative D, when combined with impacts of past, present, and reasonably foreseeable future actions on vegetation, would have short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts.

Alternative E: Comprehensive Management Plan that Increases Flexibility of Management Techniques While Limiting the Use of Volunteers

Analysis

Similar to alternative B, alternative E would result in short- and long-term negligible to minor adverse impacts on vegetation through implementation of ground-based management actions. Long-term beneficial impacts to vegetation would be fully realized under this alternative.

Similar to alternative D, it is possible that potential relocation activities could cause additional vegetation disturbance during the process of capturing and relocating ungulates and driving animals to release sites under alternative E.

Although the expansion and enhancement of lethal removal techniques under alternative E would be implemented with the goal of increasing the efficiency and cost effectiveness of ungulate management, the expansion of non-lethal techniques would counteract this to some extent. However, because volunteers would not be used during direct reduction efforts under alternative E, it is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, more quickly than under alternative D, but less quickly than under alternative C.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative E would be the same as alternative A. Similar to alternative B, the short- and long-term minor to moderate adverse and long-term beneficial impacts of past, present, and future actions, when combined with the impacts of implementing alternative E, would have short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts on vegetation.

Conclusion

Under alternative E, short- and long-term negligible to minor adverse impacts on vegetation would result from the implementation of ground-based management actions, including potential relocation activities. Long-term beneficial impacts to the vegetation would be fully realized under this alternative. It is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, more quickly under alternative E than under alternative D, but less quickly than under alternative C. The effects of alternative E, when combined with impacts of past, present, and reasonably foreseeable future actions on vegetation, would have short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts.

NATIVE WILDLIFE AND WILDLIFE HABITAT

GUIDING REGULATIONS AND POLICIES

The NPS *Organic Act* of 1916, NPS *Management Policies 2006* (NPS 2006b), and NPS *Reference Manual 77: Natural Resource Management* (NPS 1991) direct NPS managers to provide for the protection of park resources. The *Organic Act* requires that wildlife be conserved unimpaired for future generations, which has been interpreted to mean that native animal life is to be protected and perpetuated as part of a park unit's natural ecosystem. Parks rely on natural processes to control populations of native species to the greatest extent possible; otherwise, they are protected from harvest, harassment, or harm by human activities. The NPS *Management Policies 2006* makes restoration of native species a high priority. Management goals for wildlife include maintaining components and processes of naturally evolving park ecosystems, including natural abundance, diversity, and ecological integrity of plants and animals (NPS 2006b).

The Hawai‘i Volcanoes National Park GMP (in progress) and resource management plan (NPS 1999a) outline goals related to native wildlife and wildlife habitat that include restoring the park's ecosystems through removal of key non-native species followed by natural recovery and restoration efforts focused on localized areas, which can be expanded to a parkwide scale. See chapter 1 for more details on these plans and their management goals.

METHODOLOGY, ASSUMPTIONS, AND IMPACT THRESHOLDS

The evaluation of wildlife was based on a qualitative assessment of the anticipated impacts from the actions themselves, and also how expected changes to the ungulate populations and park vegetation would affect park wildlife or wildlife habitat. The park's wildlife species are directly affected by the natural abundance, biodiversity, and the ecological integrity of the vegetation that composes their habitat.

Available information on known wildlife, including unique or important native wildlife and wildlife habitat, was compiled and analyzed in relation to the management actions. Impact intensity thresholds were defined for adverse impacts. For this plan/EIS, assignment of intensity levels for native wildlife and wildlife habitat impacts are based on the potential for changes to such characteristics as follows:

Negligible: There would be no observable or measurable impacts to native species, their habitats, or the natural processes sustaining them. Impacts would be well within natural fluctuations. Habitat would retain current ecological integrity to support wildlife species.

Minor: Impacts on native species, their habitats, or the natural processes sustaining them would be detectable. Small changes to population numbers, population structure, genetic variability, and other demographic factors might occur, but would not affect population viability or stability. Occasional responses to disturbance by some individual wildlife could be expected, but without interference to factors affecting population levels. Management actions would not negatively affect the viability and stability of native species and their associated habitat. Impacts would be outside critical reproduction periods for native species.

Moderate: Impacts on native species, their habitats, or the natural processes sustaining them would be detectable. Changes to population numbers, population structure, genetic variability, and other demographic factors would occur, but species viability and stability would not be negatively affected by management actions. Frequent responses to disturbance by some individual wildlife could be expected, with some impacts on factors affecting population levels possible. Habitat would retain adequate ecological integrity to support viability of all native species. Some impacts might occur during critical periods of reproduction or in key habitat for native species.

Major: Impacts on native species, their habitats, or the natural processes sustaining them would be detectable. Population numbers, population structure, genetic variability, and other demographic factors might experience large-scale changes that could affect population stability and viability. Frequent responses to disturbance by some individual wildlife would be expected, with resulting decreases in population levels. Loss of habitat might affect the viability of at least some native species. Impacts would regularly occur during critical periods of reproduction or in key habitat for native species.

IMPACTS OF THE ALTERNATIVES

Alternative A: No Action (Continue Existing Non-native Ungulate Management Activities)

Analysis

Native wildlife and wildlife habitat would be temporarily disturbed during implementation of management actions, including monitoring, fence construction and maintenance, and non-native ungulate removal efforts. The use of helicopters (for monitoring, direct reduction, or fence construction and maintenance) would introduce unnatural noise in the park, and would temporarily disrupt and potentially displace some native species. Any activities, including monitoring, that involve low-flying aircraft may affect the behavior and ecology of wildlife both during and after overflights. Altered behavior includes changes in movement patterns, foraging and breeding behavior, and energy expenditure (Tracey and Fleming 2006). However, aerial operations are temporary, and any disruption would end once a management action is complete. The use of firearms, the presence of people associated with management actions, and the use of dogs would contribute to localized disturbance of wildlife during management actions. Firearm noise suppressors would be considered at the discretion of the park, and could reduce the disturbance to native wildlife. The short-term impacts would result from temporary actions, such as the use of firearms during ungulate removal and aerial operations, and construction and maintenance of fences, which would occur infrequently and would not result in lasting effects on native wildlife and wildlife habitat.

These impacts could occur during reproductive periods or in key habitat for native wildlife. However, the NPS takes certain steps to minimize the associated effects. For example, fence corridors are surveyed for sensitive plant and animal species prior to construction, repair, or replacement, and fence work is minimized or avoided in areas identified as sensitive bird or bat habitat during critical breeding seasons.

In addition, the potential long-term adverse impacts of fencing would be mitigated by modifying fencing, as necessary, to minimize impacts on native wildlife (e.g., the use of vinyl strips or flagging to make fencing more visible to petrels and the removal of barbed wire in areas where Hawaiian hoary bats are a concern) and address any changes in technology (to ensure effectiveness and avoid fence breaching). Although individuals could be temporarily displaced during implementation, they would return after management actions are completed, and population stability and viability would not be negatively affected by management actions. Any trampling of plants during management actions would have similar impacts to other routine field work, and would not affect the integrity of wildlife habitat.

The removal and exclusion of non-native ungulates would substantially reduce the threats they pose to native wildlife and wildlife habitat, and would support ecosystem protection, including recovery and restoration of native plants and animals. Reduction of ungulate browsing would enhance forest regeneration, increasing the availability of food and cover for species that depend on ground-layer and understory vegetation for survival. Thus, reduction of ungulate browsing would help support population viability of these species, including ground- and/or shrub-nesting birds (e.g., ‘ōma‘o and nēnē), and native invertebrates (such as the Kamehameha butterfly, Blackburn’s blue, and Hawaiian darner). Habitat for non-native mosquitoes would be reduced, which would help protect native forest birds from avian malaria and avian pox (NPS 1999a; USGS 2005a). The number of wildlife species that would benefit from these changes would increase as the vegetation becomes more diverse and abundant with reduced browsing pressure. Increased forest regeneration would also improve habitat for other species that inhabit the upper canopy. Although the removal of ungulates could cause an increase in non-native plants and alter the fire regime in some areas of the park, the implementation of weed and fire management programs (see chapter 2) through existing plans, and weed sanitation protocols to prevent establishment of invasive species, would minimize the potential effects on native wildlife and wildlife habitat.

Removal of non-native ungulates and restoration of native vegetation cover would also help to counteract potential pressures of global climate change on native wildlife and wildlife habitat. As noted in the “Vegetation and the Role of Climate Change” section in chapter 3, changes in temperature and moisture regimes may result in dramatic shifts in habitat range for a number of native plant and animal species and vegetation types, as well as facilitating disease transmission (e.g., avian malaria) and the movement of invasive species (Atkinson and LaPointe 2009; EPA 1998; Giambelluca et al. 2008; Nadkarni and Solano 2002; Root et al. 2003). Management of non-native ungulates would remove a key stressor on native ecosystems, thereby increasing the capacity of native species to adapt to changes in climate (NPS 2010c). Restoration of fragmented plant communities would assist the local migration of species in response to climate change. Also, removing ungulates would reduce the disturbance-facilitated establishment of non-native weeds, and remove a mechanism for their dispersal.

In summary, alternative A would result in short-term minor to moderate adverse impacts to native wildlife and wildlife habitat through implementation of monitoring and management actions, including fence construction and maintenance, aerial operations, and the use of firearms in the direct removal of non-native ungulates. In the older section of the park, long-term beneficial impacts to native wildlife and wildlife habitat would result from the continuation of animal exclusion in managed units. However, long-term beneficial impacts to native wildlife and wildlife habitat would be unlikely for Kahuku and areas currently unmanaged (e.g., portions of ‘Ōla‘a), for which no established population-level objective and fencing strategy has been identified. Also, the implementation of management tools and monitoring would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities. Because alternative A would not incorporate the comprehensive, systematic approach described in the “Elements Common to All Action Alternatives” section in chapter 2, it would be uncertain whether the NPS would progress through management phases, monitor, and apply management tools consistently over time.

Cumulative Impacts

Other past, present, and reasonably foreseeable future actions in and around the park have affected or could affect native wildlife and wildlife habitat. Past actions parkwide include development of facilities (e.g., water reservoirs, building and road improvements); maintenance of landscaped areas, including cultural landscapes (e.g., historic gardens and lawns); and the management of cultural resources, including historic properties. Although management plans ensure protection of native wildlife and wildlife habitat, future activities associated with the development and maintenance of facilities (grading, filling, construction, and inventory) at the park, including trails and roads, could contribute to localized short-term and long-term negligible to minor adverse impacts on native wildlife and wildlife habitat. Visitation at the park could also contribute to localized disturbances to native wildlife and wildlife habitat if visitors encounter any wildlife or damage habitat by wandering off designated trails. In Kahuku, past actions including agricultural operations (including grazing) and logging have resulted in large-scale land clearing and habitat fragmentation, contributing to short- and long-term moderate adverse impacts on native wildlife and wildlife habitat, particularly in lower-elevation areas (less than 5,000 feet elevation (1,524 meters)). Past actions adjacent to the park include increased land clearing due to urbanization, agriculture, and logging. Grazing and urbanization adjacent to the park continues today, resulting in land clearing and habitat loss. Land clearing, grazing, and adjacent urbanization in the future would continue to adversely impact native wildlife and wildlife habitat.

Since 1983, the number of commercial airplanes and helicopters flying over the park has increased dramatically, and are a substantial source of unnatural sounds in the park (Lawson et al. 2007). Other aviation activities over the park and surrounding areas include general aviation, commercial passenger flights, park administrative actions that include fire and emergency operations as well as resource protection. In response, the park is working with the FAA to develop an ATMP and EIS to determine effective measures to mitigate or prevent adverse impacts, if any, of commercial air tour operations on the park’s natural resources, including native wildlife and wildlife habitat. The implementation of an ATMP at the park would result in long-term benefits for native wildlife and wildlife habitat because measures would be established to prevent adverse impacts on the park’s natural resources from commercial air tour operations.

Changes in the fire regime due to habitat fragmentation and non-native species pose a threat to native wildlife and wildlife habitat as well. Particularly in dry and seasonally dry ecosystems, fire is promoted by non-native plants and many non-native species recover quickly after fire, suppressing native species recovery (Tunison et al. 2001). In addition, increased human-caused fires contribute to direct loss of native plant species, leading to habitat fragmentation. However, the park’s fire management plan (NPS 2005a) outlines procedures and approaches for the monitoring and suppression of wildfires, mitigation measures to reduce the chance of wildfire, and maintenance and restoration of natural resources, resulting in long-term benefits for native wildlife and wildlife habitat. The NPS and Big Island Wildfire Coordinating Group have cosponsored community wildfire protection plans, which have been developed by local communities in the vicinity of the park, outlining mitigation measures to reduce the chances of wildfires occurring in these communities (Laitinen 2006a, 2006b).

Many past, current, and future actions, plans, and programs at the park and in surrounding areas provide benefits for native wildlife and wildlife habitat. Past park actions such as fencing to exclude non-native ungulates have resulted in native vegetation and habitat recovery (these fencing efforts are discussed in chapter 1 and as an element common to all alternatives in chapter 2). The park’s current weed management program, which includes monitoring and removal of incipient weeds, will address new weeds that may enter the park and contain the spread of highly invasive weeds into high-priority wildlife habitat. The acquisition of the Kahuku Unit resulted in increased protection of native wildlife and wildlife habitat due to implementing management actions under the interim operating plan that were not previously being implemented. During the last 20 years, members of the TMA have constructed fences, excluded non-native ungulates, controlled weeds, and planted native vegetation in several areas adjacent or near the park. These actions have resulted in the recovery of native wildlife habitat. Natural resource and watershed protection in lands in and adjacent to the park has previously supported and will continue to support the protection and restoration of native wildlife species and their habitat. The future implementation of the GMP for the park will also involve prescriptions for desired conditions related to natural resources balanced with those for visitor use. Areas adjacent to the park that are not managed for the conservation of native wildlife will likely continue to degrade due to the uncontained spread of non-native plant species and ongoing impacts caused by non-native ungulates.

Additional actions providing benefits for native wildlife and wildlife habitat include park educational programs and interpretation activities, the implementation of USFWS recovery plans for sensitive species, implementation of the *Ala Kahakai National Historic Trail Management Plan*, and revegetation and sensitive species restoration activities. The overriding goal of these restoration plans is the perpetuation of native ecosystems and the recovery of biological diversity in the park. For rare or listed bird species and invertebrates, recovery efforts focus on habitat restoration through management of non-native plants and non-native animals.

Some past, current, and future actions contribute to both beneficial and adverse impacts, depending on what stage of implementation they are in. For example, construction and maintenance of fences in the park would contribute to localized minor adverse impacts while the fences are being erected (due to unnatural noise and habitat disruption from fence construction), but would also contribute to beneficial impacts once the fences are erected by keeping non-native ungulates out of certain areas. Likewise, law enforcement activities would contribute to beneficial impacts by protecting native wildlife and wildlife habitat from being disrupted or degraded by visitors, but it would also contribute to localized minor adverse impacts if law enforcement staff members disturb the wildlife themselves.

Although short- and long-term minor to moderate adverse impacts would result from past, present, and future human activities on the landscape (inside and outside the park), there would also be long-term beneficial impacts to native wildlife and wildlife habitat. When combined with the short-term minor to moderate adverse impacts under alternative A, there would be short- and long-term minor to moderate adverse cumulative impacts on native wildlife and wildlife habitat. Long-term beneficial cumulative impacts would be less likely under alternative A, because non-native ungulate management within the park would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities and implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.

Conclusion

Under alternative A, short-term minor to moderate adverse impacts would result from the implementation of monitoring and management actions. In the older section of the park, long-term beneficial impacts to native wildlife and wildlife habitat would result from the continuation of animal exclusion in managed units. However, long-term beneficial impacts to native wildlife and wildlife habitat would be unlikely for Kahuku and areas currently unmanaged (e.g., portions of Kahuku and ‘Ōla‘a), for which no established population-level objective and fencing strategy has been identified. The effects of alternative A, when combined with impacts of past, present, and reasonably foreseeable future actions on native wildlife and wildlife habitat, would have short- and long-term minor to moderate adverse cumulative impacts on vegetation. Long-term beneficial cumulative impacts would be less likely under alternative A, because management would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities and implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.

Alternative B: Comprehensive Management Plan that Uses Lethal Removal Techniques

Analysis

The removal of non-native ungulates from the park would result in long-term benefits to native wildlife and wildlife habitat from reduced browsing pressure, as well as from ecosystem restoration and recovery. Habitat for non-native mosquitoes would be reduced, which would help protect native forest birds from avian malaria and avian pox (NPS 1999a; USGS 2005a). The number of wildlife species that would benefit from these changes would increase as the vegetation becomes more diverse and abundant with reduced browsing pressure. Long-term beneficial impacts to native wildlife and wildlife habitat would be fully realized under this alternative because the comprehensive, systematic approach described in the “Elements Common to All Action Alternatives” section in chapter 2 would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time.

Native wildlife and wildlife habitat would be temporarily disturbed during implementation of management actions, including monitoring, fence construction and maintenance, and non-native ungulate removal efforts. Low-flying aircraft, may temporarily affect the behavior and ecology of wildlife. However, helicopter activities are temporary, and any disruption would end once a management action is complete. The use of firearms, the presence of people associated with management actions, and the use of dogs would contribute to localized disturbance of wildlife during management actions. Firearm noise suppressors would be considered at the discretion of the park, and could reduce the disturbance to native wildlife. The short-term impacts would result from temporary actions, such as the use of firearms during ungulate removal and aerial operations, and construction and maintenance of fences, which would occur infrequently and would not result in lasting effects on native wildlife and wildlife habitat.

The NPS would take steps to minimize adverse effects associated with this alternative. For example, fence corridors are surveyed for sensitive plant and animal species prior to construction, repair, or replacement, and fence work is minimized or avoided in areas identified as sensitive bird or bat habitat during critical breeding seasons. In addition, the potential long-term adverse impacts of fencing would be mitigated by modifying fencing, as necessary, to minimize impacts on native wildlife (e.g., the use of vinyl strips or flagging to make fencing more visible to petrels and the removal of barbed wire in areas where Hawaiian hoary bats are a concern) and address any changes in technology (to ensure effectiveness and avoid fence breaching). Although individuals could be temporarily displaced during implementation, they would return after management actions are completed, and population stability and viability would not be negatively affected by management actions. Any trampling of plants during management actions would have similar impacts to other routine field work, and would not affect the integrity of wildlife habitat.

Although the removal of ungulates could cause an increase in non-native plants and alter the fire regime in the park, the implementation of weed and fire management programs (see chapter 2) through existing plans, and weed sanitation protocols to prevent establishment of invasive species, would minimize the potential effects on native wildlife and wildlife habitat.

Additionally, removal of non-native ungulates and restoration of native vegetation would help to counteract potential pressures of global climate change on native wildlife and wildlife habitat by removing a key stressor on native ecosystems, thereby increasing the capacity of native species to adapt to changes in climate (NPS 2010c).

In summary, alternative B would result in short -term minor to moderate adverse impacts to native wildlife and wildlife habitat through implementation of monitoring and management actions, including fence construction and maintenance, aerial operations, and the use of firearms in the direct removal of non-native ungulates. Long-term beneficial impacts to native wildlife and wildlife habitat would be fully realized under this alternative because the comprehensive, systematic approach described in the "Elements Common to All Action Alternatives" section in chapter 2 would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative B would be the same as alternative A. The short- and long-term minor to moderate adverse and long-term beneficial impacts of past, present, and future actions, when combined with the impacts of implementing alternative B, would have short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts on wildlife and wildlife habitat. Under alternative B, long-term beneficial impacts would be fully realized under this alternative because the comprehensive, systematic approach described in the "Elements Common to All Action Alternatives" section in chapter 2 would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time.

Conclusion

Under alternative B, short-term minor to moderate adverse impacts would result from the implementation of monitoring and management actions. Long-term beneficial impacts to native wildlife and wildlife habitat would be fully realized under this alternative because the comprehensive, systematic approach described in the "Elements Common to All Action Alternatives" section in chapter 2 would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time. The effects of alternative B, when combined with impacts of past, present, and reasonably foreseeable future actions on wildlife and wildlife habitat, would have short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts.

Alternative C: Comprehensive Management Plan that Maximizes Efficiency by Expanding Lethal Removal Techniques and Discontinuing the Use of Volunteers

Analysis

Similar to alternative B, alternative C would result in short-term minor to moderate adverse impacts on native wildlife and wildlife habitat through implementation of management actions, including monitoring, fence construction and maintenance, and non-native ungulate removal efforts. Long-term beneficial impacts to native wildlife and wildlife habitat would be fully realized under this alternative.

Because lethal techniques would be expanded and enhanced, and volunteers would not be used during direct reduction efforts under alternative C, it is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, more quickly than under alternative B. The increased efficiency associated with discontinuing the use of volunteers is based on additional work required by NPS staff to recruit, administer, train and direct volunteers in the field, and data that show that park staff remove more ungulates per day when they conduct direct reduction (ground shooting) themselves, compared to when they are accompanied by volunteers (Stephens et al. 2008). Therefore, fewer reduction activities would result when compared to alternative B.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative C would be the same as alternative A. Similar to alternative B, the short- and long-term minor to moderate adverse and long-term beneficial impacts of past, present, and future actions, when combined with the impacts of implementing alternative C, would have short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts on wildlife and wildlife habitat.

Conclusion

Under alternative C, short-term minor to moderate adverse impacts would result from the implementation of monitoring and management actions. Long-term beneficial impacts would be fully realized under this alternative. It is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, more quickly under alternative C than under alternative B. The effects of alternative C, when combined with impacts of past, present, and reasonably foreseeable future actions on wildlife and wildlife habitat, would have long-term beneficial and short- and long-term minor to moderate adverse cumulative impacts.

Alternative D: Comprehensive Management Plan that Maximizes Flexibility of Management Techniques

Analysis

Similar to alternative B, alternative D would result in short-term minor to moderate adverse impacts on native wildlife and wildlife habitat through implementation of management actions, including monitoring, fence construction and maintenance, and non-native ungulate removal efforts. Long-term beneficial impacts to native wildlife and wildlife habitat would be fully realized under this alternative.

Under alternative D, it is possible that increased human and vehicular traffic associated with potential relocation activities could cause additional native wildlife and wildlife habitat disturbance during the process of capturing and relocating ungulates and driving animals to release sites. However, these impacts would be short-term and localized, and similar to impacts of other management actions.

Although the expansion and enhancement of lethal removal techniques under alternative D would be implemented with the goal of increasing the efficiency and cost effectiveness of ungulate management, the continued use of volunteers and the expansion of non-lethal techniques would counteract this to some extent. Inclusion of non-lethal removal would require additional staff time and park resources to capture, hold and relocate animals, and may increase the time associated with reduction actions over the life of the plan, as well as time needed to reach the post-reduction phase. As a result, it is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, less quickly than under alternative C.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative D would be the same as alternative A. Similar to alternative B, the short- and long-term minor to moderate adverse and long-term beneficial impacts of past, present, and future actions, when combined with the impacts of implementing alternative D, would have short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts on wildlife and wildlife habitat.

Conclusion

Under alternative D, short-term minor to moderate adverse impacts would result from the implementation of monitoring and management actions. Long-term beneficial impacts would be fully realized under this alternative. It is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, less quickly under alternative D than under alternative C. The effects of alternative D, when combined with impacts of past, present, and reasonably foreseeable future actions on wildlife and wildlife habitat, would have short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts.

Alternative E: Comprehensive Management Plan that Increases Flexibility of Management Techniques While Limiting the Use of Volunteers

Analysis

Similar to alternative B, alternative E would result in short-term minor to moderate adverse impacts on native wildlife and wildlife habitat through implementation of management actions, including monitoring, fence construction and maintenance, and non-native ungulate removal efforts. Long-term beneficial impacts to native wildlife and wildlife habitat would be fully realized under this alternative.

Similar to alternative D, it is possible that potential relocation activities could cause additional native wildlife and wildlife habitat disturbance during the process of capturing and relocating ungulates and driving animals to release sites under alternative E.

Although the expansion and enhancement of lethal removal techniques under alternative E would be implemented with the goal of increasing the efficiency and cost effectiveness of ungulate management, the expansion of non-lethal techniques would counteract this to some extent. However, because volunteers would not be used during direct reduction efforts under alternative E, it is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, more quickly than under alternative D, but less quickly than under alternative C.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative E would be the same as alternative A. Similar to alternative B, long-term beneficial impacts would be fully realized under this alternative. The short- and long-term minor to moderate adverse and long-term beneficial impacts of past, present, and future actions, when combined with the impacts of implementing alternative E, would have short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts on vegetation.

Conclusion

Under alternative E, short-term minor adverse impacts would result from the implementation of monitoring and management actions. It is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, more quickly under alternative E than under alternative D, but less quickly than under alternative C. The effects of alternative E when combined with impacts of past, present, and reasonably foreseeable future actions on wildlife and wildlife habitat, would have short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts.

RARE, UNIQUE, THREATENED, OR ENDANGERED SPECIES

GUIDING REGULATIONS AND POLICIES

The ESA (16 USC 1531 et seq.) and amendments (1973) mandate that all federal agencies consider the potential effects of their actions on species listed as threatened or endangered. If the NPS determines that an action may adversely affect a federally listed species, consultation with the USFWS is required to ensure that the action will not jeopardize the species' continued existence or result in the destruction or adverse modification of critical habitat.

The NPS *Management Policies 2006* states that potential effects of agency actions will also be considered on state- or locally listed species (NPS 2006b). The NPS is required to control access to important habitat for such species and to perpetuate their natural distribution and abundance and the ecosystems upon which they depend. NPS *Management Policies 2006* states that "[the NPS will] manage state and locally listed species in a manner similar to its treatment of federally listed species to the greatest extent possible" (NPS 2006b, section 4.4.2.3).

The park's natural resources management plan (NPS 1974) includes the following actions that pertain to rare, unique, or federally listed species:

- Propagating rare and endangered plant and animal species
- Reintroducing rare species into former range
- Protecting rare, endemic biota from depredation by introduced species
- Reducing feral ungulate numbers to allow endangered plants to survive and become reestablished (NPS 1974).

The park is further directed by their statement for management to "protect the park's remnant Hawaiian ecosystems, including endangered species, from further depredation and competition by those non-native animals and plants introduced by modern people" (NPS 1985).

The park provides habitat for 37 plants and 18 animals (including birds, insects, mammals, and reptiles) listed as threatened, endangered, or candidate species (see table 7 in chapter 3). These include species that historically have been found in or adjacent to the park but are no longer present (e.g., kīponapona, ‘ō‘ū), non-resident species (e.g., Hawaiian monk seal and honu [green turtle]) and outplanted individuals derived from species located outside the park (e.g., koki‘o).

The park provides habitat for 37 plants and 18 animals (including birds, insects, mammals, and reptiles) listed as threatened, endangered, or candidate species.

METHODOLOGY, ASSUMPTIONS, AND IMPACT THRESHOLDS

To assess impacts on listed species, the following process was used:

- Identification of which species are in areas likely to be affected by management actions described in the alternatives
- Analysis of habitat loss or alteration caused by the alternatives
- Analysis of disturbance potential of the actions and the species' potential to be affected by the actions.

The information in this analysis was obtained through best professional judgment of park staff and experts in the field (as cited in the text), and from information contained in chapter 1 and chapter 3.

The analysis for alternative A was organized to present a general discussion of the impacts that would occur on rare, unique, threatened, or endangered plants and animals. This is followed by a more detailed analysis of how these impacts would affect these species, including wildlife and plants. The analyses for subsequent alternatives build off this approach.

The following thresholds were used to determine impacts on rare, unique, threatened, or endangered species.

Federally Listed Species

The following thresholds were used to determine the magnitude of effects on federally listed special-status species and their associated habitat, including designated critical habitat that would result from implementation of any of the alternatives.

Adverse

Negligible: There would be no observable or measurable impacts on federally listed species, their habitats, or the natural processes sustaining them in the proposed project area.

Minor: Individuals may temporarily avoid areas. Impacts would not affect critical periods (e.g., breeding, nesting, denning, feeding, or resting) or habitat.

Moderate: Individuals may be impacted by disturbances that interfere with critical periods (e.g., breeding, nesting, denning, feeding, or resting) or habitat; however, the level of impact would not result in a physical injury, mortality, or extirpation from the park.

Major: Individuals may suffer physical injury or mortality or populations may be extirpated from the park.

Beneficial

Negligible: There would be no observable or measurable impacts on federally listed species; their habitats, including critical habitat designated under the ESA; or the natural processes sustaining them in a park site.

Minor: Impacts would result in slight increases to viability of the species in the park as species-limiting factors (e.g., habitat loss, competition, and mortality) are kept in check. Nonessential features of critical habitat in a park site would be slightly improved.

Moderate: Impacts would result in improved viability of the species, population structure, and species population levels in the park, as species-limiting factors (e.g., habitat loss, competition, and mortality) are reduced. Some essential features of critical habitat would be improved.

Major: Impacts would result in highly noticeable improvements to species viability, population structure, and species population levels in the park, as species-limiting factors (e.g., habitat loss, competition, and mortality) are nearly eliminated. All essential features of the critical habitat would be improved.

Species of Special Concern

The assessment of adverse impacts on both plant and animal species identified as species of special concern (but not listed at the federal level under the ESA) uses the same thresholds developed for the assessment of impacts on wildlife and wildlife habitat, as follows:

Negligible: There would be no observable or measurable impacts on native species, their habitats, or the natural processes sustaining them. Impacts would be well within natural fluctuations. Habitat would retain current ecological integrity to support native species.

Minor: Impacts on native species, their habitats, or the natural processes sustaining them would be detectable. Small changes in population numbers, population structure, genetic variability, and other demographic factors might occur, but would not affect population viability or stability. Occasional responses to disturbance by some individuals could be expected, but without interference to factors affecting population levels. Habitat would retain adequate ecological integrity to support viability of all native species. Impacts would be outside critical reproduction periods for native species.

Moderate: Impacts on native species, their habitats, or the natural processes sustaining them would be detectable. Changes in population numbers, population structure, genetic variability, and other demographic factors would occur, but species would remain stable and viable. Frequent responses to disturbance by some individuals could be expected, with some impacts on factors affecting population levels possible. Habitat would retain adequate ecological integrity to support viability of all native species. Some impacts might occur during critical periods of reproduction or in key habitat for native species.

Major: Impacts on native species, their habitats, or the natural processes sustaining them would be detectable. Population numbers, population structure, genetic variability, and other demographic factors might experience large-scale changes that could affect population stability and viability. Frequent responses to disturbance by some individuals would be expected, with resulting decreases in population levels. Loss of habitat might affect the viability of at least some native species. Impacts would regularly occur during critical periods of reproduction or in key habitat for native species.

IMPACTS OF THE ALTERNATIVES

Alternative A: No Action (Continue Existing Non-native Ungulate Management Activities)

Analysis

Impacts on Rare, Unique, Threatened, or Endangered Species

Rare, unique, threatened, or endangered species would be temporarily disturbed during implementation of management actions, including monitoring, fence construction and maintenance, and non-native ungulate removal efforts. The use of helicopters (for monitoring, direct reduction, or fence construction and maintenance) would introduce unnatural noise into the park and would temporarily disrupt and potentially displace some sensitive wildlife species. Any activities, including monitoring, that involve low-flying aircraft may affect the behavior and ecology of sensitive wildlife both during and after overflights. Altered behavior includes changes in movement patterns, foraging and breeding behavior, and energy expenditure (Tracey and Fleming 2006).

Similar disturbances to sensitive wildlife would occur from the use of firearms, the use of equipment for fencing (e.g., post drivers and rock drills), and the presence of people associated with ground-based management actions. Such actions include direct reduction with firearms, which can include the use of trained dogs; the setting of traps, snares, and bait stations; fence construction and repairs; and monitoring. Ground-based management actions would also have impacts on sensitive vegetation that would occur during routine field activities (e.g., trampling from foot traffic, vegetation clearing for fence corridors). Implementation of management actions would result in minor to moderate adverse impacts to rare, unique, threatened, or endangered species from displacement and disruption caused by habitat disturbance and unnatural noise. However, as described in chapter 2, all operations are intermittent and temporary, with fewer actions in ungulate free areas than in areas where animals remain (e.g., Kahuku, portions of ‘Ōla‘a). Although individuals could be temporarily displaced during implementation, they would return after management actions are completed, and population stability and viability would not be negatively affected by management actions. The duration and frequency of these actions would also decrease as the park moves from reduction into less intensive management phases.

These impacts could occur during reproductive periods or in key habitat for rare, unique, threatened, or endangered species. However, the park also takes certain steps to minimize the associated effects of non-native ungulate management actions, leading to long-term benefits for rare, unique, threatened, or endangered species. For example, fence corridors are surveyed for sensitive plant and animal species prior to construction, repair, or replacement, and fence work is minimized or avoided in areas identified as sensitive bird or bat habitat during critical breeding seasons. In addition, the potential long-term adverse impacts of fencing would be mitigated by modifying fencing, as necessary, to minimize impacts on native wildlife (e.g., the use of vinyl strips or flagging to make fencing more visible to petrels and avoiding the use of barbed wire in areas where Hawaiian hoary bats are a concern per comments received from USFWS) and address any changes in technology (to ensure effectiveness and avoid fence breaching). Firearm noise suppressors would be considered at the discretion of the park, and could reduce the disturbance to rare, unique, threatened, or endangered wildlife species. While foot traffic has the potential to affect individual plants, it would not appreciably affect their habitat, population levels, or the ability to support other sensitive species.

The removal and exclusion of non-native ungulates would substantially reduce the threats they pose to sensitive species and habitat, and would support ecosystem protection, including recovery and restoration of native plants and animals. Reduction of ungulate browsing would enhance forest regeneration, increasing the availability of food and cover for species that depend on ground-layer and understory vegetation for survival. Thus, reduction of ungulate browsing would help support the population viability of these species, including ground- and/or shrub-nesting birds (e.g., nēnē and ōmaʻo) and native invertebrates in the park. Habitat for non-native mosquitoes would be reduced, which would help protect vulnerable forest birds. The number of wildlife species that would benefit from these changes would increase as the vegetation becomes more diverse and abundant with reduced browsing pressure.

In addition to protecting and restoring rare, unique, threatened, or endangered species and their habitat, removal of non-native ungulates and restoration of native vegetation cover could also help counteract potential pressures of global climate change on sensitive plant and animal species. As noted in the "Vegetation and the Role of Climate Change" section of chapter 3, changes in temperature and moisture regimes may result in dramatic shifts in habitat range for a number of sensitive plant and animal species, facilitating disease transmission (e.g., avian malaria) and the movement of invasive species (Atkinson and LaPointe 2009; EPA 1998; Giambelluca et al. 2008; Nadkarni and Solano 2002; Root et al. 2003). Management of non-native ungulates will remove a key stressor on native ecosystems, thereby increasing the capacity of native species to adapt to changes in climate (NPS 2010c). Restoration of fragmented plant communities will assist the local migration of species in response to climate change. In addition, removing ungulates will reduce the disturbance-facilitated establishment of non-native plants and remove a mechanism for their dispersal.

Invertebrates. As described in chapter 3, there are three federally listed invertebrate species historically known in the park, as well as one candidate species: the damselfly *Megalagrion nesiotes* (endangered), pomace fly *Drosophila heteroneura* (endangered), *D. mulli* (threatened), and *D. digressa* (candidate). Although they have occurred historically, it is unknown whether these federally listed and candidate species currently occur in the park. However, habitat and host plants for these species do occur in the park, including designated critical habitat for *D. heteroneura* (687 acres of the total 4,582 acres designated on the island) (USFWS 2008b). The remaining invertebrate species are considered rare or sensitive, and are known to currently occur in the park (see table 8 in chapter 3).

Management actions are not expected to affect individual invertebrates. Any impacts on host plants or habitat would be limited to potential effects from foot traffic associated with ground-based management actions and vegetation clearing for fence corridors, as well as from fence construction. While foot traffic has the potential to affect individual host plants, it would not appreciably affect their habitat, population levels, or their ability to support these sensitive species. Vegetation clearing for fencing would be limited to a four foot wide corridor and avoid removing important host plants for listed species (see the "Elements Common to All Action Alternatives" section in chapter 2).

Exclusion of ungulates would support recovery of native host plants and critical habitat, which would assist in the recovery of rare invertebrates. Certain species of ʻōhā (*Clermontia* spp.), one of the primary host plants of *Drosophila heteroneura*, are known to be palatable and vulnerable to feral pigs and are considered to be indicators of pig damage in Hawaiʻi (Pratt et al. 1999). Fencing and pig control have already been implemented in the ʻŌlaʻa Forest to provide protection to host plants of *D. mulli*. Due to the small population size of *D. digressa* and its small habitat area, this species and its habitat are particularly vulnerable to the effects of ungulates, which destroy host plants and habitat by trampling plants, facilitating erosion, and spreading non-native plant seeds (USFWS 2008b).

In summary, alternative A would result in short-term negligible adverse effects on invertebrates, including the federally listed *Drosophila heteroneura* and *Megalagrion nesiotes*, through implementation of management actions. In the older section of the park, long-term beneficial effects to native host plants and critical habitat, including moderate to major beneficial effects for federally listed species, would result through the continuation of animal exclusion in managed units. However, long-term beneficial impacts would be unlikely for Kahuku and currently unmanaged areas (e.g., portions of ‘Ōla‘a), for which no established population-level objective and fencing strategy has been identified. Also, the implementation of management tools and monitoring would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities. Because alternative A would not incorporate the comprehensive, systematic approach described in the “Elements Common to All Action Alternatives” section in chapter 2, it would be uncertain whether the NPS would progress through management phases, monitor, and apply management tools consistently as staff and institutional knowledge change over time.

Mammals. The federally endangered Hawaiian hoary bat is widely distributed in the park between sea level and 7,500 feet (2,286 meters), with breeding primarily occurring at lower elevations. Under alternative A, temporary disruption of Hawaiian hoary bat habitat and behavior, as well as displacement, may result from implementation of management actions. However, steps would be taken to minimize impacts of actions such as avoiding the use of barbwire for construction of fencing (see chapter 2). As a result, management actions would have short-term minor to moderate adverse impacts on the Hawaiian hoary bat.

Much remains to be known about the roosting habitat, food requirements, and threats to the Hawaiian hoary bat before specific management actions can be identified (USFWS 1998b). Island-wide acoustic monitoring has identified the highest recorded bat densities in native-dominated forest, which suggests there may be some direct benefit to be gained for the bat by protecting and restoring native forest (Bonaccorso, pers. comm.). In the older section of the park, this may result in long-term minor to moderate beneficial effects on the Hawaiian hoary bat through the continuation of animal exclusion in managed units. However, long-term beneficial impacts would be unlikely for Kahuku and areas currently unmanaged (e.g., portions of ‘Ōla‘a), for which no established population-level objective and fencing strategy has been identified. Also, the implementation of management tools and monitoring would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities. Because alternative A would not incorporate the comprehensive, systematic approach described in the “Elements Common to All Action Alternatives” section in chapter 2, it would be uncertain whether the NPS would progress through management phases, monitor, and apply management tools consistently as staff and institutional knowledge change over time.

Birds. As described in chapter 3, federally listed bird species found in the park include nēnē, ‘io (Hawaiian hawk), ‘akiapōlā‘au, ‘ākepa, Hawai‘i creeper, ‘ō‘ū, ‘u‘au (Hawaiian petrel), and ‘a‘o (Newell’s shearwater). Other species found in the park include ‘akē ‘akē (band-rumped storm petrel), a candidate and state listed species, and several rare or sensitive species, including ‘i‘iwi, noio (black noddy), ‘ou (Bulwer’s petrel), and koa‘e-kea (white-tailed tropicbird).

As stated earlier in the discussion of “Impacts on Rare, Unique, Threatened, or Endangered Species,” actions under alternative A could temporarily disrupt native habitat or behavior of sensitive bird species in the park. Ground-based management actions could disrupt sensitive bird species, especially those that depend on ground-layer and understory vegetation. The unnatural noise and disturbance associated with helicopters, firearms, and fence construction could affect all birds, including those that nest in the upper canopy and higher above the ground. These actions would have little effect on birds that nest along the coast or on offshore islets, such as, noio, and ‘ou, as management actions are limited in these areas. Individual birds could be temporarily displaced during implementation of management actions, but would return after management actions are completed, and population stability and viability would not be negatively affected by management actions. While foot traffic has the potential to affect individual plants, it would not appreciably affect habitat for sensitive birds or their population levels. Trained dogs to assists with ground control efforts would not be used in known breeding/molting areas of the nēnē, and consultation with the nēnē biologist would be required prior to deployment in potential habitat.

There could be some long-term impacts for rare, unique, threatened, or endangered birds caused by fencing. Fence strikes are a concern for seabirds that use upland habitats (e.g., petrels), but fencing would be modified, as necessary, to minimize impacts on native wildlife (e.g., the use of vinyl strips or flagging to make fencing more visible to petrels) and address any changes in technology (to ensure effectiveness and avoid fence breaching).

The removal and exclusion of non-native ungulates would substantially reduce threats to sensitive bird species and maintain or restore habitat, including forest tree regeneration. Reduction of ungulate browsing would increase the availability of food and cover for species that depend on ground-layer and understory vegetation for survival. Increased forest regeneration would also improve habitat for other species that inhabit and feed in the upper canopy. Thus, reduction of ungulate browsing would help support population viability of these species, including ground- and/or shrub-nesting birds (e.g., ‘ōma‘o and nēnē). Habitat for non-native mosquitoes would be reduced, which would help protect native forest birds from avian malaria and avian pox (NPS 1999a; USGS 2005a). The number of wildlife species that would benefit from these changes would increase as the vegetation becomes more diverse and abundant with reduced browsing pressure and additional planting of species. Although the removal of ungulates could cause an increase in non-native plants and alter the fire regime in some areas of the park, the implementation of weed and fire management programs (see chapter 2) through existing plans would minimize the potential effects on sensitive bird species and their habitat.

In summary, alternative A would result in minor to moderate short-term and minor long-term adverse effects through implementation of non-native ungulate management activities (noted above). In the older section of the park, long-term beneficial effects on rare, unique, threatened, or endangered birds would occur, with moderate to major beneficial impacts on federally listed birds (e.g., nēnē, ‘io, ‘a‘o, ‘u‘au), through the continuation of animal exclusion in managed units. However, long-term beneficial impacts would be unlikely for Kahuku and areas currently unmanaged (e.g., portions of ‘Ōla‘a), for which no established population-level objective and fencing strategy has been identified. Also, the implementation of management tools and monitoring would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities. Because alternative A would not incorporate the comprehensive, systematic approach described in the “Elements Common to All Action Alternatives” section in chapter 2, it would be uncertain whether the NPS would progress through management phases, monitor, and apply management tools consistently as staff and institutional knowledge change over time.

Plants. There are a number of federally listed plant species found in the park and surrounding areas (see table 7 in chapter 3). Some of these species have designated critical habitat in the park, including Mauna Loa silversword, *Cyrtandra giffardii*, Hilo ischaemum, laukahi kuahiwi, po‘e, hau kuahiwi, Zahlbruckner’s pelea, Hawai‘i hala pepe, ‘ōhai, sheriff’s catchfly, and white-bur cucumber. Additional plant species are considered rare or species of concern, including several that are candidates for listing under the ESA (see tables 7 and 8 in chapter 3).

There are a number of federally listed plant species found in the park and surrounding areas. Some of these species have designated critical habitat in the park, including Mauna Loa silversword, Cyrtandra giffardii, Hilo ischaemum, laukahi kuahiwi, po‘e, hau kuahiwi, Zahlbruckner's pelea, Hawai‘i hala pepe, ‘ōhai, sheriff's catchfly, and white-bur cucumber.

As previously described under this alternative, impacts on rare, unique, threatened, or endangered plant species could occur from temporary actions associated with ground-based management actions, which would be limited to trampling from associated foot traffic and vegetation clearing for fence placement. However, impacts from fencing would be mitigated by surveying fence corridors and adjusting fence alignments to avoid impacting sensitive plants prior to construction, repair, or replacement.

The exclusion and removal of non-native ungulates would eliminate a source of mortality for sensitive plants and a vector for non-native species dispersal. Animal removal would support recovery and restoration of plant populations and their habitat, including critical habitat for some federally listed plant species. Although the removal of ungulates could cause an increase in non-native plants and alter the fire regime in some areas of the park, the implementation of weed and fire management programs (see chapter 2) through existing plans would minimize the potential effects on sensitive plant species and their habitat.

In summary, alternative A would result in minor to moderate short-term and minor long-term adverse effects through implementation of non-native ungulate management activities (noted above). In the older section of the park, long-term beneficial effects on rare, unique, threatened, or endangered plants would occur, with moderate to major beneficial impacts on federally listed plants, through the continuation of animal exclusion in managed units. However, long-term beneficial impacts would be unlikely for Kahuku and areas currently unmanaged (e.g., portions of ‘Ōla‘a), for which no established population-level objective and fencing strategy has been identified. Also, the implementation of management tools and monitoring would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities. Because alternative A would not incorporate the comprehensive, systematic approach described in the "Elements Common to All Action Alternatives" section in chapter 2, it would be uncertain whether the NPS would progress through management phases, monitor, and apply management tools consistently as staff and institutional knowledge change over time.

Cumulative Impacts

Other past, present, and reasonably foreseeable future actions in and around the park have affected or could affect rare, unique, threatened, or endangered species. Past actions parkwide include development of facilities (e.g., water reservoirs, building and road improvements); maintenance of landscaped areas, including cultural landscapes (e.g., historic gardens and lawns); and the management of cultural resources, including historic properties. Although management plans ensure protection of sensitive species and native habitat, future activities associated with the development and maintenance of facilities (grading, filling, construction, and inventory) at the park, including trails and roads, could contribute to localized short-term and long-term negligible to minor adverse impacts on rare, unique, threatened, or endangered species. Visitation at the park could also contribute to localized disturbances to rare, unique, threatened, or endangered species and their habitat if visitors encounter any species of special concern or damage habitat by wandering off designated trails. In Kahuku, past actions including agricultural operations (including grazing) and logging have resulted in large-scale land clearing and habitat fragmentation, contributing to short- and long-term moderate adverse impacts on rare, unique, threatened, or endangered species, particularly at lower elevations (<5,000 feet elevation (<1,524 meters)). Past actions adjacent to the park include increased land clearing due to urbanization, agriculture, and logging. Grazing and urbanization adjacent to the park continues today, resulting in land clearing and habitat loss.

Land clearing, grazing, and adjacent urbanization in the future would continue to adversely impact rare, unique, threatened, or endangered species.

Changes in the fire regime due to habitat fragmentation and non-native species pose a threat to rare, unique, threatened, or endangered species. Particularly in dry and seasonally dry ecosystems, fire is promoted by non-native plants and many non-native species recover quickly after fire, suppressing native species' recovery (Tunison et al. 2001). In addition, increased human-caused fires contribute to direct loss of sensitive plant species, leading to habitat fragmentation. However, the park's fire management plan (NPS 2005a) outlines procedures and approaches for the monitoring and suppression of wildfires, mitigation measures to reduce the chance of wildfire, and maintenance and restoration of natural resources, resulting in long-term benefits for rare, unique, threatened, or endangered species, with minor to moderate beneficial impacts on federally listed species. The NPS and Big Island Wildfire Coordinating Group have cosponsored community wildfire protection plans, which have been developed by local communities in the vicinity of the park, outlining mitigation measures to reduce the chances of wildfires occurring in neighboring areas (Laitinen 2006a, 2006b).

Since 1983, the number of airplanes and helicopters flying over the park has increased dramatically, and are a substantial source of unnatural sounds in the park (Lawson et al. 2007). Other aviation activities over the park and surrounding areas include general aviation, commercial passenger flights, park maintenance, and fire and emergency operations. In response, the park is working with the FAA to develop an ATMP and EIS to determine effective measures to mitigate or prevent adverse impacts, if any, from commercial air tour operations on the park's natural resources, including rare, unique, threatened, or endangered species. Because measures would be established to protect the park's natural resources from the potential adverse effects of commercial air tour operations, the implementation of an ATMP at the park would result in long-term benefits for rare, unique, threatened, or endangered animal species.

Many past, current, and future actions, plans, and programs at the park and in surrounding areas provide benefits for rare, unique, threatened, and endangered species. Past actions such as fencing to exclude non-native ungulates have resulted in native vegetation and habitat recovery, which has aided in recovery of rare, unique, threatened and endangered species. The park's current weed management program, which includes monitoring and removal of incipient weeds, will address new non-native plants that may enter the park and will contain the spread of highly invasive non-native plants into high-priority wildlife habitat. The acquisition of the Kahuku Unit has resulted in increased protection of natural resources (including wildlife habitat) on these lands due to implementing management actions under the interim operating plan that were previously not being implemented. During the last 20 years, members of the TMA have constructed fences, excluded non-native ungulates, controlled weeds, and planted native vegetation in several areas adjacent or near the park. These actions have resulted in long-term benefits for rare, unique, threatened, and endangered species through the recovery of native vegetation and habitat. Natural resource and watershed protection on lands in and adjacent to the park has previously supported and will continue to support the protection and restoration of rare, unique, threatened, or endangered species. The future implementation of the GMP for the park will also involve prescriptions for desired conditions related to the protection of natural resources, including rare, unique, threatened, or endangered species, balanced with those for visitor use. Areas adjacent to the park that are not managed for the conservation of native vegetation and wildlife habitat will likely continue to degrade due to the uncontained spread of invasive plant species and ongoing impacts caused by non-native ungulates.

Additional actions providing benefits for rare, unique, threatened, or endangered species include park educational programs and interpretation activities, the implementation of USFWS recovery plans for sensitive species, implementation of the *Ala Kahakai National Historic Trail Management Plan*, and revegetation and sensitive species restoration activities. The overriding goal of these restoration plans is the perpetuation of native ecosystems and the recovery of biological diversity in the park. For rare or listed bird species and invertebrates, recovery efforts focus on habitat restoration through management of non-native plants and non-native animals.

Some past, current, and future actions contribute to both beneficial and adverse impacts, depending on what stage of implementation they are in. For example, construction and maintenance of fences in the park would contribute to localized minor adverse impacts (due to corridor clearing for fences), but would also contribute to beneficial impacts once the fences are erected by excluding non-native ungulates and assisting in recovery through protection of several native, rare, and federally listed species and their habitats. Likewise, law enforcement activities would contribute to beneficial impacts by protecting rare, unique, threatened, and endangered species from being disturbed or displaced by visitors who violate park rules and regulations, but would also contribute to localized minor adverse impacts should law enforcement officials need to conduct activities that could disturb these species.

Although short- and long-term minor to moderate adverse impacts would result from past, present, and reasonably foreseeable future actions (inside and outside the park), there would be long-term beneficial impacts to rare, unique, threatened, or endangered species, with moderate to major benefits for federally listed species. When combined with the short-term minor to moderate adverse impacts under alternative A, there would be short- and long-term minor to moderate adverse cumulative impacts to rare, unique, threatened, or endangered species and their habitat. Long-term beneficial cumulative impacts would be less likely under alternative A, because non-native ungulate management within the park would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities and implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.

Conclusion

Under alternative A, short-term minor to moderate and long-term minor adverse impacts on rare, unique, threatened, or endangered species and their habitat would result from the implementation of non-native ungulate management actions. In the older section of the park, long-term beneficial impacts would result from the continuation of animal exclusion in managed units, with moderate to major beneficial impacts on federally listed species. However, long-term beneficial impacts would be unlikely for Kahuku and areas currently unmanaged (e.g., portions of ‘Ōla‘a), for which no established population-level objective and fencing strategy has been identified.

The effects of alternative A, when combined with impacts of past, present, and reasonably foreseeable future actions on rare, unique, threatened, or endangered species, would have short- and long-term minor to moderate adverse cumulative impacts. Long-term beneficial cumulative impacts, including moderate to major beneficial impacts on federally listed species, would be less likely under alternative A, because management would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities and implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.

Alternative B: Comprehensive Management Plan that Uses Lethal Removal Techniques

Analysis

Impacts on Rare, Unique, Threatened, or Endangered Species

The removal of non-native ungulates from the park would result in long-term benefits to rare, unique, threatened or endangered species and their habitat. Unlike alternative A, long-term beneficial impacts would be fully realized under this alternative because the comprehensive, systematic approach described in the "Elements Common to All Action Alternatives" section in chapter 2 would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time.

The removal and exclusion of ungulates would substantially reduce the threats they pose to rare, unique, threatened, or endangered species, and would support ecosystem protection, including recovery and restoration of native plants and animals. Reduction of ungulate browsing would enhance forest regeneration, increasing the availability of food and cover for wildlife species that depend on ground-layer and understory vegetation for survival. Thus, reduction of ungulate browsing would help support the population viability of these species, including ground- and/or shrub-nesting birds (e.g., nēnē and ōmaʻo) and native invertebrates in the park. Habitat for non-native mosquitoes would be reduced, which would help protect vulnerable forest birds. The number of wildlife species that would benefit from these changes would increase as the vegetation becomes more diverse and abundant with reduced browsing pressure.

> *The removal and exclusion of ungulates would substantially reduce the threats they pose to rare, unique, threatened, or endangered species, and would support ecosystem protection, including recovery and restoration of native plants and animals.*

In addition, removal of non-native ungulates and restoration of native vegetation would help to counteract potential pressures of global climate change on rare, unique, threatened, or endangered species. Management of non-native ungulates would contribute to the long-term beneficial effects on sensitive plant and animal species by removing a key stressor on native ecosystems, thereby increasing the capacity of native species to adapt to changes in climate (NPS 2010c). Restoration of fragmented plant communities will assist the local migration of species in response to climate change.

Rare, unique, threatened, or endangered species would be temporarily disturbed during implementation of management actions, including monitoring, fence construction and maintenance, and non-native ungulate removal efforts. The use of helicopters (for monitoring, direct reduction, or fence construction and maintenance), the use of firearms, the use of equipment for fencing, and the presence of people associated with ground-based management actions would introduce unnatural noise in the park, temporarily disrupting and potentially displacing some sensitive species. Any activities, including monitoring, that involve low-flying aircraft may affect the behavior and ecology of wildlife both during and after overflights. However, aerial operations are temporary, and any disruption would end once a management action is complete. The use of firearms, the presence of people associated with management actions, and the use of dogs would contribute to wildlife disturbance. Although individuals could be temporarily displaced during implementation of management actions, they would return after actions are completed, and population stability and viability would not be negatively affected by management actions. These impacts could occur during reproductive periods or in key habitat for native wildlife; however, the park would take certain steps to minimize the associated effects (see the "Elements Common to All Action Alternatives" section in chapter 2), leading to long-term benefits for rare, unique, threatened, or endangered species.

Despite some minor to moderate short-term and minor long-term adverse effects of non-native ungulate removal (noted above), long-term beneficial effects on rare, unique, threatened, or endangered species and their habitat would occur under alternative B, with moderate to major beneficial impacts on federally listed species. Long-term beneficial impacts would be fully realized under this alternative, because the comprehensive, systematic approach described in the "Elements Common to All Action Alternatives" section in chapter 2 would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative B would be the same as alternative A. The short- and long-term minor to moderate adverse and long-term beneficial impacts of past, present, and future actions, when combined with the impacts of implementing alternative B, would have short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts on rare, unique, threatened, or endangered species, with moderate to major beneficial cumulative impacts for federally listed species. Under alternative B, long-term beneficial impacts to rare species and their habitat would be fully realized under this alternative because the comprehensive, systematic approach described in the "Elements Common to All Action Alternatives" section in chapter 2 would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time.

Conclusion

Under alternative B, short-term minor to moderate and long-term minor adverse impacts on rare, unique, threatened, or endangered species and their habitat would result from the implementation of monitoring and management actions. Long-term beneficial impacts would be fully realized under this alternative, with moderate to major beneficial impacts on federally listed species because the comprehensive, systematic approach described in the "Elements Common to All Action Alternatives" section in chapter 2 would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time.

The effects of alternative B, when combined with impacts of past, present, and reasonably foreseeable future actions, would have short- to long-term minor to moderate adverse and long-term beneficial and cumulative impacts, with moderate to major beneficial cumulative impacts on federally listed species.

Alternative C: Comprehensive Management Plan that Maximizes Efficiency by Expanding Lethal Removal Techniques and Discontinuing the Use of Volunteers

Analysis

Impacts on Rare, Unique, Threatened, or Endangered Species

Similar to alternative B, alternative C would result in minor to moderate short-term and minor long-term adverse impacts on rare, unique, threatened, or endangered species through implementation of management actions. Long-term beneficial impacts would be fully realized under this alternative, with moderate to major beneficial impacts for federally listed species.

Because lethal techniques would be expanded and enhanced, and volunteers would not be used during direct reduction efforts under alternative C, it is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, more quickly than under alternative B. The increased efficiency associated with discontinuing the use of volunteers is based on additional work required by NPS staff to recruit, administer, train and direct volunteers in the field, and data that show that park staff remove more ungulates per day when they conduct direct reduction (ground shooting) themselves, compared to when they are accompanied by volunteers (Stephens et al. 2008).

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative C would be the same as alternative A. Similar to alternative B, the short- and long-term minor to moderate adverse and long-term beneficial impacts of past, present, and future actions, when combined with the impacts of implementing alternative C, would have short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts on rare, unique, threatened, or endangered species, with moderate to major beneficial cumulative impacts for federally listed species.

Conclusion

Under alternative C, minor to moderate short-term and minor long-term adverse effects on rare, unique, threatened, or endangered species and their habitat would result from the implementation of monitoring and management actions. Long-term beneficial effects would be fully realized under this alternative, with moderate to major beneficial impacts on federally listed species. It is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, more quickly under alternative C than under alternative B. The effects of alternative C, when combined with impacts of past, present, and reasonably foreseeable future actions on rare, unique, threatened, or endangered species, would have short- to long-term minor to moderate adverse and long-term beneficial and cumulative impacts, with moderate to major beneficial cumulative impacts on federally listed species.

Alternative D: Comprehensive Management Plan that Maximizes Flexibility of Management Techniques

Analysis

Impacts on Rare, Unique, Threatened, or Endangered Species

Similar to alternative B, alternative D would result in minor to moderate short-term and minor long-term adverse impacts on rare, unique, threatened, or endangered species through implementation of management actions. Long-term beneficial impacts would be fully realized under this alternative, with moderate to major beneficial impacts for federally listed species.

Under alternative D, it is possible that increased human and vehicular traffic associated with potential relocation activities could cause additional disturbance to rare species and their habitat during the process of capturing and relocating ungulates and driving animals to release sites. However, these impacts would be short-term and localized, and similar to impacts of other management actions.

Although the expansion and enhancement of lethal removal techniques under alternative D would be implemented with the goal of increasing the efficiency and cost effectiveness of ungulate management, the continued use of volunteers and the expansion of non-lethal techniques would counteract this to some extent. Inclusion of non-lethal removal would require additional staff time and park resources to capture, hold and relocate animals, and may increase the time associated with reduction actions over the life of the plan, as well as time needed to reach the post-reduction phase. As a result, it is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, less quickly than under alternative C.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative D would be the same as alternative A. Similar to alternative B, the short- and long-term minor to moderate adverse and long-term beneficial impacts of past, present, and future actions, when combined with the impacts of implementing alternative D, would have short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts on rare, unique, threatened, or endangered species, with moderate to major beneficial cumulative impacts for federally listed species.

Conclusion

Under alternative D, minor to moderate short-term and minor long-term adverse effects on rare, unique, threatened, or endangered species and their habitat would result from the implementation of monitoring and management actions. Long-term beneficial effects would be fully realized under this alternative, with moderate to major beneficial impacts on federally listed species. It is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, less quickly under alternative D than under alternative C. The effects of alternative D, when combined with impacts of past, present, and reasonably foreseeable future actions on rare, unique, threatened, or endangered species, would have short- to long-term minor to moderate adverse and long-term beneficial and cumulative impacts, with moderate to major beneficial cumulative impacts on federally listed species.

Alternative E: Comprehensive Management Plan that Increases Flexibility of Management Techniques While Limiting the Use of Volunteers

Analysis

Impacts on Rare, Unique, Threatened, or Endangered Species

Similar to alternative B, alternative E would result in minor to moderate short-term and minor long-term adverse impacts on rare, unique, threatened, or endangered species through implementation of management actions. Long-term beneficial impacts would be fully realized under this alternative, with moderate to major beneficial impacts for federally listed species.

Under alternative E, it is possible that increased human and vehicular traffic associated with potential relocation activities could cause additional disturbance to rare species and their habitat during the process of capturing and relocating ungulates and driving animals to release sites. However, these impacts would be short-term and localized, and similar to impacts of other management actions.

Although the expansion and enhancement of lethal removal techniques under alternative E would be implemented with the goal of increasing the efficiency and cost effectiveness of ungulate management, the expansion of non-lethal techniques would counteract this to some extent. However, because volunteers would not be used during direct reduction efforts under alternative E, it is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, more quickly than under alternative D, but less quickly than under alternative C.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative E would be the same as alternative A. Similar to alternative B, the short- and long-term minor to moderate adverse and long-term beneficial impacts of past, present, and future actions, when combined with the impacts of implementing alternative E, would have short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts on rare, unique, threatened, or endangered species, with moderate to major beneficial cumulative impacts for federally listed species.

Conclusion

Under alternative E, short- and long-term minor to moderate adverse effects on rare, unique, threatened, or endangered species and their habitat would result from the implementation of monitoring and management actions. Long-term beneficial effects would be fully realized under this alternative, with moderate to major beneficial impacts on federally listed species. It is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, more quickly under alternative E than under alternative D, but less quickly than under alternative C. The effects of alternative E, when combined with impacts of past, present, and reasonably foreseeable future actions on rare, unique, threatened, or endangered species, would have short- to long-term minor to moderate adverse and long-term beneficial and cumulative impacts, with moderate to major beneficial cumulative impacts on federally listed species.

CULTURAL/HISTORIC RESOURCES

GUIDING REGULATIONS AND POLICIES

The NPS categorizes cultural resources as archeological resources, cultural landscapes, historic structures, museum objects, and ethnographic resources.

The descriptions of effects on cultural resources that are presented in this section are intended to comply with the requirements of both NEPA and Section 106 of the *National Historic Preservation Act*. In accordance with the regulations of the Advisory Council on Historic Preservation (Advisory Council) implementing Section 106 (36 CFR 800, "Protection of Historic Properties"), impacts on cultural resources are to be identified and evaluated by (1) determining the area of potential effects; (2) identifying cultural resources present in the area of potential effects that are either listed on or eligible to be listed on the National Register; (3) applying the criteria of an *adverse effect* to affected cultural resources either listed on or eligible to be listed on the National Register; and (4) considering ways to avoid, minimize, or mitigate adverse effects.

METHODOLOGY, ASSUMPTIONS, AND IMPACT THRESHOLDS

Under the Advisory Council's regulations, a determination of either *adverse effect* or *no adverse effect* must also be made for affected cultural resources eligible for listing on the National Register. An adverse effect occurs whenever an impact alters, directly or indirectly, any of the characteristics that qualify the resource for inclusion on the National Register (for example, diminishing the integrity of the resource's location, design, setting, materials, workmanship, feeling, or association). Adverse effects also include reasonably foreseeable effects caused by the proposal that would occur later in time, be farther removed in distance, or be cumulative (36 CFR 800.5, "Assessment of Adverse Effects"). A determination of *no adverse effect* means there would either be no effect or that the effect would not diminish in any way the characteristics that qualify the cultural resource for inclusion on the National Register.

Archeological Resources

Adverse

Duration: All impacts to archeological resources are considered long term.

Negligible: The impact on archeological sites is at the lowest level of detection, barely perceptible and not measurable. For purposes of Section 106, the determination of effect would be *no adverse effect*.

Minor: The impact on archeological sites is measurable or perceptible, but it is slight and localized within a relatively small area of a site or group of sites. The impact does not affect the character-defining features of a listed or eligible National Register archeological site and would not have a permanent effect on the integrity of any archeological sites. For purposes of Section 106, the determination of effect would be *no adverse effect*.

Moderate: The impact is measurable and perceptible. The impact is readily apparent and/or changes one or more character-defining features of an archeological resource to the extent that its National Register eligibility is jeopardized. For purposes of Section 106, the determination of effect would be *adverse effect*.

Major: The impact on archeological sites is substantial, noticeable, and permanent. For National Register eligible or listed archeological sites, the impact changes one or more character-defining features of an archeological resource, diminishing the integrity of the resource to the extent that it is no longer eligible for listing on the National Register. For purposes of Section 106, the determination of effect would be *adverse effect*.

Beneficial

Duration: All impacts to archeological resources are considered long term.

Negligible: The impact on archeological sites is at the lowest level of detection, barely perceptible and not measurable. For purposes of Section 106, the determination of effect would be *no adverse effect*.

Minor: A site would be preserved in its natural state. For purposes of Section 106, the determination of effect would be *no adverse effect*.

Moderate: The site would be stabilized. For purposes of Section 106, the determination of effect would be *no adverse effect*.

Major: Active intervention would be undertaken to preserve the site. For purposes of Section 106, the determination of effect would be *no adverse effect*.

Cultural Landscapes

Adverse

Negligible: Impact is at the lowest levels of detection, with neither adverse nor beneficial consequences. The determination of effect for Section 106 would be *no adverse effect*.

Minor: Alteration of patterns or features of the landscape would not diminish the overall integrity of the landscape. The determination of effect for Section 106 would be *no adverse effect*.

Moderate: Alteration of patterns or features of the landscape would diminish the overall integrity of the landscape. The determination of effect for Section 106 would be *adverse effect*. A memorandum of agreement is executed between the NPS and applicable state or tribal historic preservation officer and, if necessary, the Advisory Council in accordance with 36 CFR 800.6(b). Measures identified in the memorandum of agreement to minimize or mitigate adverse impacts reduce the intensity of impact under NEPA from major to moderate.

Major: Alteration of patterns or features of the landscape would diminish the overall integrity of the landscape. The determination of effect for Section 106 would be *adverse effect*. Measures to minimize or mitigate adverse impacts cannot be agreed upon and the NPS and applicable state or tribal historic preservation officer and/or Advisory Council are unable to negotiate and execute a memorandum of agreement in accordance with 36 CFR 800.6(b).

Beneficial

Negligible: Impact is at the lowest levels of detection, with neither adverse nor beneficial consequences. The determination of effect for Section 106 would be *no adverse effect*.

Minor: Preservation of landscape patterns and features in accordance with the Secretary of the Interior’s Standards for the Treatment of Historic Properties with Guidelines for the Treatment of Cultural Landscapes. The determination of effect for Section 106 would be *no adverse effect*.

Moderate: Rehabilitation of a landscape or its patterns and features in accordance with the Secretary of the Interior’s Standards for the Treatment of Historic Properties with Guidelines for the Treatment of Cultural Landscapes. The determination of effect for Section 106 would be *no adverse effect*.

Major: Restoration of a landscape or its patterns and features in accordance with the Secretary of the Interior’s Standards for the Treatment of Historic Properties with Guidelines for the Treatment of Cultural Landscapes. The determination of effect for Section 106 would be *no adverse effect*.

Ethnographic Resources

Adverse

Negligible: The impact would be barely perceptible and would neither alter resource conditions, such as traditional access or site preservation, nor the relationship between the resource and the affiliated group’s body of beliefs and practices. There would be no change to a group’s beliefs and practices. For purposes of Section 106, the determination of effect would be *no adverse effect*.

Minor: The impact would be slight but noticeable and would neither appreciably alter resource conditions, such as traditional access or site preservation, nor the relationship between the resource and the affiliated group's body of beliefs and practices. For purposes of Section 106, the determination of effect would be *no adverse effect*.

Moderate: The impact would be apparent and would alter resource conditions. The alternative or its outcome would interfere with traditional access, site preservation, or the relationship between the resource and the affiliated group's beliefs and practices, even though the group's beliefs and practices would survive. For purposes of Section 106, the determination of effect would be *adverse effect*.

Major: The impact would alter resource conditions. The alternative or its outcome would block or greatly affect traditional access, site preservation, or the relationship between the resource and the affiliated group's beliefs and practices, to the extent that the survival of a group's beliefs and/or practices would be jeopardized. For purposes of Section 106, the determination of effect would be *adverse effect*.

Beneficial

Negligible: The impact would be barely perceptible and would neither alter resource conditions, such as traditional access or site preservation, nor the relationship between the resource and the affiliated group's body of beliefs and practices. There would be no change to a group's beliefs and practices. For purposes of Section 106, the determination of effect would be *no adverse effect*.

Minor: The action would allow traditional access and/or accommodate a group's traditional practices or beliefs. For purposes of Section 106, the determination of effect would be *no adverse effect*.

Moderate: The action would facilitate a group's beliefs and practices. For purposes of Section 106, the determination of effect would be no *adverse effect*.

Major: The action would encourage a group's beliefs or practices. For purposes of Section 106, the determination of effect would be *no adverse effect*.

ARCHEOLOGICAL RESOURCES: IMPACTS OF THE ALTERNATIVES

Alternative A: No Action (Continue Existing Non-native Ungulate Management Activities)

Analysis

Under alternative A, management actions that could adversely affect archeological resources are construction of fences for boundaries and internal exclosures. Placement of fences could damage surface features and unknown subsurface archeological sites when posts are driven into the ground. In addition, viewsheds associated with sensitive archeological sites could be negatively impacted by fences. Prior to construction, repair or replacement, fences are surveyed as needed and fence locations rerouted to avoid impacts to archeological resources and to minimize disturbance to the cultural viewshed. Conversely, removal and exclusion of non-native ungulates would protect archeological sites by preventing trampling of features and artifacts by animals, and destabilizing of the soil surrounding cultural deposits and human remains.

Alternative A would result in long-term negligible to minor adverse impacts on archeological sites and associated viewsheds. In the older section of the park, long-term minor to moderate beneficial impacts would result from the continuation of animal exclusion in managed units. However, long-term benefits would be unlikely for Kahuku and areas currently unmanaged (e.g., portions of ‘Ōla‘a), for which no established population-level objective and fencing strategy has been identified. Also, the implementation of management tools and monitoring would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities. Because alternative A would not incorporate the comprehensive, systematic approach described in the “Elements Common to All Action Alternatives” section in chapter 2, it would be uncertain whether the NPS would progress through management phases, monitor, and apply management tools consistently as staff and institutional knowledge change over time.

Cumulative Impacts

Other past, present, and reasonably foreseeable future actions in and around the park have affected or could affect archeological resources. Although management plans ensure protection of archeological resources, future activities associated with the development and maintenance of facilities (grading, filling, construction, and inventory) at the park, including trails, roads, shelters and campsites, could contribute to long-term adverse impacts on archeological resources. Development both inside and directly outside (the latter applicable if archeological sites are close to or stretch across park boundaries) the park, including historic roads, trails, and other structures, has likely impacted archeological sites in the park because of ground disturbance during construction. While all archeological sites are subject to direct or indirect impacts, shrines, mounds, stone alignments, and rock art are especially susceptible to damage, either directly or indirectly, by development. Development outside the park contributes to damage, as roads and trails encroach on park boundaries and provide access to sensitive archeological sites. Grazing and past ranching activities (in the park and on adjacent lands) can be destructive to archeological sites, as ground is disturbed and cultural material is trampled or uprooted. While park visitation is essential to the park, past and projected increased access and off-trail travel can impact archeological resources such as culturally modified caves when visitors inadvertently or purposely vandalize sites. Law enforcement activities would minimize these impacts by protecting archeological resources from being damaged by visitors who violate park rules and regulations.

Changes in the fire regime due to habitat fragmentation and non-native species invasions pose a threat to archeological resources as well. Fire can damage shrines and rock art by splitting and flaking of rock fragments. However, the park’s fire management plan (NPS 2005a) outlines procedures and approaches for the monitoring and suppression of wildfires, and mitigation measures to reduce the chance of wildfire and of damage to archeological features. The NPS and Big Island Wildfire Coordinating Group have cosponsored community wildfire protection plans, which have been developed by local communities in the vicinity of the park, outlining mitigation measures to reduce the chances of wildfires occurring in adjacent communities (Laitinen 2006a, 2006b).

Many past, current, and future actions, plans, and programs at the park and in surrounding areas provide benefits for archeological resources. Natural resource and watershed protection on lands in and adjacent to the park has previously supported and will continue to support the protection of archeological resources by managing ingress of non-native ungulates and implementing mitigation measures. The future implementation of the GMP for the park will also involve prescriptions for desired conditions related to the protection of cultural resources, including archeological resources, balanced with those for visitor use.

In addition, past acquisitions, such as Kahuku, and future acquisitions of new lands would contribute to the inventory of archeological resources in the park. Future implementation of several management plans, including those in development—the GMP and the *Ala Kahakai National Historic Trail Management Plan* (NPS n.d.a, 2004d)—would have long-term minor beneficial impacts on archeological resources because the plans contain mitigation measures for the protection of cultural resources.

These past, present, and reasonably foreseeable future actions would have long-term minor to moderate adverse and long-term minor beneficial impacts on archeological resources. Past, present, and reasonably foreseeable future actions, when combined with impacts under alternative A, would result in long-term minor to moderate adverse cumulative impacts. Long-term beneficial cumulative impacts would be less likely under alternative A, because non-native ungulate management within the park would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities and implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.

Conclusion

Under alternative A, long-term negligible to minor adverse impacts on archeological sites and associated viewsheds would result from the implementation of management actions. In the older section of the park, long-term minor to moderate beneficial impacts would result from the continuation of animal exclusion in managed units. However, long-term benefits would be unlikely for Kahuku and areas currently unmanaged (e.g., portions of ‘Ōla‘a), for which no established population-level objective and fencing strategy has been identified in a comprehensive and systematic plan. The effects of alternative A, when combined with impacts of past, present, and reasonably foreseeable future actions on archeological resources, would have long-term minor to moderate adverse cumulative impacts on archeological resources. Long-term beneficial cumulative impacts would be less likely under alternative A, because management would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities and implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.

Alternative B: Comprehensive Management Plan that Uses Lethal Removal Techniques

Analysis

Under alternative B, management actions that could adversely affect archeological resources are construction of fences for boundaries and internal exclosures. However, impacts would be mitigated by conducting surveys and rerouting fence alignments to avoid impacts to archeological resources and to minimize disturbance to the cultural viewshed. Consequently, adverse impacts would be long-term, negligible to minor. In the long term, there would be minor to moderate beneficial impacts from the removal and exclusion of non-native ungulates, which would protect archeological sites by preventing trampling of features and artifacts by animals, and destabilizing of the soil surrounding cultural deposits and human remains. Beneficial impacts would be fully realized under this alternative because the comprehensive, systematic approach described in the “Elements Common to All Action Alternatives” section in chapter 2, would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative B would be the same as alternative A. The long-term minor to moderate adverse and long-term minor beneficial impacts of past, present, and reasonably foreseeable future actions on archeological resources, when combined with the impacts of implementing alternative B, would have long-term minor to moderate adverse and long-term moderate beneficial cumulative impacts on archeological resources. Under alternative B, long-term beneficial impacts to rare species and their habitat would be fully realized under this alternative because the comprehensive, systematic approach described in the "Elements Common to All Action Alternatives" section in chapter 2 would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time.

Conclusion

Under alternative B, long-term negligible to minor adverse impacts on archeological sites and associated viewsheds would result from the implementation of management actions. Long-term minor to moderate beneficial impacts to archeological resources would be fully realized under this alternative because the comprehensive, systematic approach described in the "Elements Common to All Action Alternatives" section in chapter 2 would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time.

The effects of alternative B, when combined with impacts of past, present, and reasonably foreseeable future actions on archeological resources, would have long-term minor to moderate adverse and long-term moderate beneficial cumulative impacts.

Alternative C: Comprehensive Management Plan that Maximizes Efficiency by Expanding Lethal Removal Techniques and Discontinuing the Use of Volunteers

Analysis

Similar to alternative B, alternative C would result in long-term negligible to minor adverse impacts on archeological resources. Long-term minor to moderate beneficial impacts to archeological resources would be fully realized under this alternative.

Because lethal techniques would be expanded and enhanced, and volunteers would not be used during direct reduction efforts under alternative C, it is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, more quickly than under alternative B. The increased efficiency associated with discontinuing the use of volunteers is based on additional work required by NPS staff to recruit, administer, train and direct volunteers in the field, and data that show that park staff remove more ungulates per day when they conduct direct reduction (ground shooting) themselves, compared to when they are accompanied by volunteers (Stephens et al. 2008).

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative C would be the same as alternative A. Similar to alternative B, the long-term minor to moderate adverse and long-term minor beneficial impacts of past, present, and reasonably foreseeable future actions on archeological resources, when combined with the impacts of implementing alternative C, would have long-term minor to moderate adverse and long-term moderate beneficial cumulative impacts.

Conclusion

Under alternative C, long-term negligible to minor adverse impacts on archeological sites and associated viewsheds would result from the implementation of management actions. Long-term minor to moderate beneficial impacts would be fully realized under this alternative. It is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, more quickly under alternative C than under alternative B. The effects of alternative C, when combined with impacts of past, present, and reasonably foreseeable future actions on archeological resources, would have long-term minor to moderate adverse and long-term moderate beneficial cumulative impacts.

Alternative D: Comprehensive Management Plan that Maximizes Flexibility of Management Techniques

Analysis

Similar to alternative B, alternative D would result in long-term negligible to minor adverse impacts on archeological resources. Long-term minor to moderate beneficial impacts to archeological resources would be fully realized under this alternative.

Under alternative D, it is possible that increased human and vehicular traffic associated with potential relocation activities could cause additional trampling and damage to archeological resources during the process of capturing and relocating ungulates and driving animals to release sites. However, surveys would be conducted and holding pens and driving routes located away from sensitive resources to minimize the potential for impacts.

Although the expansion and enhancement of lethal removal techniques under alternative D would be implemented with the goal of increasing the efficiency and cost effectiveness of ungulate management, the continued use of volunteers and the expansion of non-lethal techniques would counteract this to some extent. Inclusion of non-lethal removal would require additional staff time and park resources to capture, hold and relocate animals, and may increase the time associated with reduction actions over the life of the plan, as well as the time needed to reach the post-reduction phase. As a result, it is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, less quickly than under alternative C.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative D would be the same as alternative A. Similar to alternative B, the long-term minor to moderate adverse and long-term minor beneficial impacts of past, present, and reasonably foreseeable future actions on archeological resources, when combined with the impacts of implementing alternative D would have long-term minor to moderate adverse and long-term moderate beneficial cumulative impacts on archeological resources.

Conclusion

Under alternative D, long-term negligible to minor adverse impacts on archeological sites and associated viewsheds would result from the implementation of management actions. Long-term minor to moderate beneficial impacts would be fully realized under this alternative. It is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, less quickly under alternative D than under alternative C. The effects of alternative D, when combined with impacts of past, present, and reasonably foreseeable future actions on archeological resources, would have long-term minor to moderate adverse and long-term moderate beneficial cumulative impacts.

Alternative E: Comprehensive Management Plan that Increases Flexibility of Management Techniques While Limiting the Use of Volunteers

Analysis

Similar to alternative B, alternative E would result in long-term negligible to minor adverse impacts on archeological resources. Long-term minor to moderate beneficial impacts to archeological resources would be fully realized under this alternative.

Similar to alternative D, it is possible that potential relocation activities could cause additional trampling and damage to archeological resources during the process of capturing and relocating ungulates and driving animals to release sites under alternative E.

Although the expansion and enhancement of lethal removal techniques under alternative E would be implemented with the goal of increasing the efficiency and cost effectiveness of ungulate management, the expansion of non-lethal techniques would counteract this to some extent. However, because volunteers would not be used during direct reduction efforts under alternative E, it is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, more quickly than under alternative D, but less quickly than under alternative C.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative E would be the same as alternative A. Similar to alternative B, the long-term minor to moderate adverse and long-term minor beneficial impacts of past, present, and reasonably foreseeable future actions on archeological resources, when combined with the impacts of implementing alternative E would have long-term minor to moderate adverse and long-term moderate beneficial cumulative impacts on archeological resources.

Conclusion

Under alternative E, long-term negligible to minor adverse impacts on archeological sites and associated viewsheds would result from the implementation of management actions. Long-term minor to moderate beneficial impacts would be fully realized under this alternative. It is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, more quickly under alternative E than under alternative D, but less quickly than under alternative C. The effects of alternative E, when combined with impacts of past, present, and reasonably foreseeable future actions on archeological resources, would have long-term minor to moderate adverse and long-term moderate beneficial cumulative impacts.

CULTURAL LANDSCAPES: IMPACTS OF THE ALTERNATIVES

Alternative A: No Action (Continue Existing Non-native Ungulate Management Activities)

Analysis

In general, non-native feral and wild ungulates would probably not be considered a component of any of the cultural landscapes in the park. The connection that non-native ungulates have with the cultural landscape is their adverse impact on vegetation. Ungulate browsing, trampling, and rototilling cause depletion in the park's native herbaceous and shrub vegetation, as well as continuing to prevent the regeneration of native plant species. Removal and exclusion of animals would protect the remaining plant species and cultural plantings that have existed historically in the park and allow for reestablishment and/or reintroduction of historical species resulting in long-term minor beneficial impacts.

Although not designated a cultural landscape, portions of Kahuku (particularly the Parker period, pre-1947) could be eligible for future listing. With the cessation of commercial cattle operations, the additional removal of non-native feral and wild ungulates could result in the return of native plant communities and invasive plants, which would consequently alter the ranching landscape. The impacts of invasive weeds would be minimized by implementation of current weed management programs. Also, the park could decide to maintain contributing elements of the ranching landscape if there is future determination for listing (e.g., similar to ‘Āinahou Ranch House and Gardens). This alternative would have both long-term minor beneficial effects and possible long-term minor adverse impacts on cultural landscapes.

The woven-wire, 6-foot fences would introduce new structural elements into the park’s overall landscape. The exact locations of fences would be determined during implementation. In Kahuku and ‘Āinahou, where there are historic and existing pasture fences, the park would use these existing alignments for non-native ungulate fences as much as feasible in order to minimize the introduction of new fence lines. Also, placing fences behind vegetation or taking advantage of topography would help to conceal them from sight. Existing fence corridors have been surveyed for sensitive cultural areas and would be resurveyed prior to fence repair or replacement as needed. Although construction of fencing would cause long-term minor adverse impacts on cultural landscapes, there would be long-term beneficial impacts from the preservation of endemic flora and fauna of the park, which are a part of the cultural landscapes.

Alternative A would result in long-term minor adverse impacts on cultural landscapes. In the older section of the park, long-term minor beneficial impacts on cultural landscapes would result from the continuation of animal exclusion in managed units. However, long-term benefits would be unlikely for cultural landscapes still inhabited by non-native ungulates, for which no established population-level objective and fencing strategy has been identified. Also, the implementation of management tools and monitoring would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities. Because alternative A would not incorporate the comprehensive, systematic approach described in the “Elements Common to All Action Alternatives” section in chapter 2, it would be uncertain whether the NPS would progress through management phases, monitor, and apply management tools consistently as staff and institutional knowledge change over time.

Cumulative Impacts

Other past, present, and reasonably foreseeable future actions in and around the park have affected or could affect cultural landscapes. Development inside the park, including historic roads, trails, and other structures, can impact cultural landscapes in the park. Development outside the park contributes to damage, as roads and trails encroach on park boundaries and affect views associated with cultural landscapes. Grazing and past ranching activities (in the park and on adjacent lands) can be destructive to cultural landscapes if the theme of the designated landscape is not related to ranching. For example, the Crater Rim Historic District, the Kīlauea Historic District, and some of the other landscapes, such as military camps, were not designated based on a ranching theme. While tourism is essential to the park, past and projected increased access and off-trail travel can impact cultural landscapes by adding incongruent elements. As mentioned previously, past, present, and proposed fencing can impact visual elements of cultural landscapes. The cumulative impacts from these actions would be long term, minor, and adverse.

Many past, current, and future actions, plans, and programs at the park and surrounding areas provide benefits for cultural landscapes. The acquisition of the Kahuku Unit resulted in the increased protection of cultural resources on these lands due to implementing management actions under the interim operating plan that were not previously being implemented. The future implementation of the GMP (currently in development) for the park will also involve prescriptions for desired conditions related to the protection of cultural landscapes balanced with those for visitor use, which is expected to increase as a result of increased tourism inside and outside the park. Additional actions providing long-term beneficial impacts for cultural landscapes include park educational programs and interpretation activities, the future development and implementation of the ATMP, and the *Ala Kahakai National Historic Trail Management Plan* (FAA n.d.; NPS 2004d).

Changes in the fire regime due to habitat fragmentation and non-native species invasions pose a threat to cultural landscapes. Particularly in dry and seasonally dry vegetation types, fire is promoted by non-native plants and many non-native plant species recover quickly after fire, suppressing native species recovery (Tunison et al. 2001). However, the park's fire management plan (NPS 2005a) outlines procedures and approaches for the monitoring and suppression of wildfires, mitigation measures to reduce the chance of wildfire, and impacts to cultural resources. The NPS and Big Island Wildfire Coordinating Group have cosponsored community wildfire protection plans, which have been developed by local communities in the vicinity of the park, outlining mitigation measures to reduce the chances of wildfire occurring in communities that could potentially alter the cultural landscapes in the park (Laitinen 2006a, 2006b). The cumulative impacts from these actions would be long term, minor, and adverse.

These past, present, and reasonably foreseeable future actions would have long-term minor adverse and beneficial impacts on cultural landscapes. When combined with the long-term minor adverse impacts under alternative A, there would be long-term, minor, both adverse and beneficial cumulative impacts to cultural landscapes. Long-term beneficial cumulative impacts associated with alternative A, would be less likely because non-native ungulate management within the park would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities and implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.

Conclusion

Under alternative A, long-term minor adverse impacts on cultural landscapes would result from implementation of management actions. Designed landscapes would be less impacted than either historic vernacular landscapes or ethnographic landscapes. In the older section of the park, long-term minor beneficial impacts on cultural landscapes would result from the continuation of animal exclusion in managed units. However, long-term benefits would be unlikely for cultural landscapes still inhabited by non-native ungulates, for which no established population-level objective and fencing strategy has been identified in a comprehensive and systematic plan. The effects of alternative A, when combined with impacts of past, present, and reasonably foreseeable future actions on cultural landscapes, would have long-term minor adverse cumulative impacts on cultural resources. Long-term beneficial cumulative impacts would be less certain under alternative A, because management would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities and implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.

Alternative B: Comprehensive Management Plan that Uses Lethal Removal Techniques

Analysis

Alternative B would result in long-term minor adverse impacts to cultural landscapes. The woven-wire, 6-foot fences would introduce new structural elements into the park's overall landscape. The exact locations of fences would be determined during implementation. Where there are historic and existing pasture fences, the park would use these existing alignments for non-native ungulate fences as much as feasible in order to minimize the introduction of new fence lines. Also, placing fences behind vegetation or taking advantage of topography would help to conceal them from sight. Existing fence corridors have been surveyed for sensitive cultural areas and would be resurveyed prior to fence repair or replacement as needed. Although construction of fencing would cause long-term minor adverse impacts on cultural landscapes, there would be long-term beneficial impacts from the preservation of the remaining plant species and cultural plantings that have existed historically in the park and allow for reestablishment and/or reintroduction of historical species.

Although not designated a cultural landscape, portions of Kahuku (particularly the Parker period, pre-1947) could be eligible for future listing. With the cessation of commercial cattle operations, the additional removal of non-native feral and wild ungulates could result in the return of native plant communities as well as invasive plants, which would consequently alter the ranching landscape. The impacts of invasive weeds would be minimized by implementation of current weed management programs. Also, the park could decide to maintain contributing elements of the ranching landscape if there is future determination for listing (e.g., similar to ʻĀinahou Ranch House and Gardens). This alternative would have both long-term minor beneficial effects and possible long-term minor adverse impacts on cultural landscapes.

Alternative B would result in long-term minor adverse and long-term minor beneficial impacts on cultural landscapes. Beneficial impacts would be fully realized under this alternative because the comprehensive, systematic approach described in the "Elements Common to All Action Alternatives" section in chapter 2, would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative B would be the same as alternative A. The long-term minor adverse and beneficial impacts of past, present, and reasonably foreseeable future actions on cultural landscapes, when combined with the impacts of implementing alternative B, would have long-term, minor, both adverse and beneficial cumulative impacts on cultural landscapes. Under alternative B, long-term beneficial impacts would be fully realized under this alternative because the comprehensive, systematic approach described in the "Elements Common to All Action Alternatives" section in chapter 2 would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time.

Conclusion

Under alternative B, long-term minor adverse impacts to cultural landscapes would result from the implementation of management actions. Designed landscapes would be less impacted than either historic vernacular landscapes or ethnographic landscapes. Long-term minor beneficial impacts to cultural landscapes would be fully realized under this alternative because the comprehensive, systematic approach described in the "Elements Common to All Action Alternatives" section in chapter 2 would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time.

The effects of alternative B, when combined with impacts of past, present, and reasonably foreseeable future actions on cultural landscapes, would have long-term minor adverse and long-term minor beneficial cumulative impacts.

Alternative C: Comprehensive Management Plan that Maximizes Efficiency by Expanding Lethal Removal Techniques and Discontinuing the Use of Volunteers

Analysis

Similar to alternative B, alternative C would result in long-term minor adverse impacts to cultural landscapes. Long-term minor beneficial impacts would be fully realized under this alternative.

Because lethal techniques would be expanded and enhanced, and volunteers would not be used during direct reduction efforts under alternative C, it is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, more quickly than under alternative B. The increased efficiency associated with discontinuing the use of volunteers is based on additional work required by NPS staff to recruit, administer, train and direct volunteers in the field, and data that show that park staff remove more ungulates per day when they conduct direct reduction (ground shooting) themselves, compared to when they are accompanied by volunteers (Stephens et al. 2008).

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative C would be the same as alternative A. Similar to alternative B, the long-term minor adverse and beneficial impacts of past, present, and reasonably foreseeable future actions on cultural landscapes, when combined with the impacts of implementing alternative C, would have long-term, minor, both adverse and beneficial cumulative impacts on cultural landscapes.

Conclusion

Under alternative C, long-term minor adverse impacts to cultural landscapes would result from the implementation of management actions. Designed landscapes would be less impacted than either historic vernacular landscapes or ethnographic landscapes. Long-term minor beneficial impacts to cultural landscapes would be fully realized under this alternative. It is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, more quickly under alternative C than under alternative B. The effects of alternative C, when combined with impacts of past, present, and reasonably foreseeable future actions on cultural landscapes, would have long-term minor adverse and long-term minor beneficial cumulative impacts.

Alternative D: Comprehensive Management Plan that Maximizes Flexibility of Management Techniques

Analysis

Similar to alternative B, alternative D would result in long-term minor adverse impacts to cultural landscapes. Long-term minor beneficial impacts would be fully realized under this alternative.

Although the expansion and enhancement of lethal removal techniques under alternative D would be implemented with the goal of increasing the efficiency and cost effectiveness of ungulate management, the continued use of volunteers and the expansion of non-lethal techniques would counteract this to some extent. Inclusion of non-lethal removal would require additional staff time and park resources to capture, hold and relocate animals, and may increase the time associated with reduction actions over the life of the plan, as well as the time needed to reach the post-reduction phase. As a result, it is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, less quickly than under alternative C.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative D would be the same as alternative A. Similar to alternative B, the long-term minor and beneficial adverse impacts of past, present, and reasonably foreseeable future actions on cultural landscapes, when combined with the impacts of implementing alternative D, would have long-term, minor, both adverse and beneficial cumulative impacts on cultural landscapes.

Conclusion

Under alternative D, long-term minor adverse impacts to cultural landscapes would result from the implementation of management actions. Designed landscapes would be less impacted than either historic vernacular landscapes or ethnographic landscapes. Long-term minor beneficial impacts to cultural landscapes would be fully realized under this alternative. It is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, less quickly under alternative D than under alternative C. The effects of alternative D, when combined with impacts of past, present, and reasonably foreseeable future actions on cultural landscapes, would have long-term minor adverse and long-term minor beneficial cumulative impacts.

Alternative E: Comprehensive Management Plan that Increases Flexibility of Management Techniques While Limiting the Use of Volunteers

Analysis

Similar to alternative B, alternative E would result in long-term minor adverse impacts to cultural landscapes. Long-term minor beneficial impacts would be fully realized under this alternative.

Although the expansion and enhancement of lethal removal techniques under alternative E would be implemented with the goal of increasing the efficiency and cost effectiveness of ungulate management, the expansion of non-lethal techniques would counteract this to some extent. However, because volunteers would not be used during direct reduction efforts under alternative E, it is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, more quickly than under alternative D, but less quickly than under alternative C.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative E would be the same as alternative A. Similar to alternative B, the long-term minor adverse and beneficial impacts of past, present, and reasonably foreseeable future actions on cultural landscapes, when combined with the impacts of implementing alternative E, would have long-term, minor, both adverse and beneficial cumulative impacts on cultural landscapes.

Conclusion

Under alternative E, long-term minor adverse impacts to cultural landscapes would result from the implementation of management actions. Designed landscapes would be less impacted than either historic vernacular landscapes or ethnographic landscapes. Long-term minor beneficial impacts to cultural landscapes would be fully realized under this alternative. It is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, more quickly under alternative E than under alternative D, but less quickly than under alternative C. The effects of alternative E, when combined with impacts of past, present, and reasonably foreseeable future actions on cultural landscapes, would have long-term minor adverse and long-term minor beneficial cumulative impacts.

ETHNOGRAPHIC RESOURCES: IMPACTS OF THE ALTERNATIVES

Alternative A: No Action (Continue Existing Non-native Ungulate Management Activities)

Analysis

Implementation of management actions, including monitoring, direct reduction with firearms, and fencing, would temporarily create noise from the use of helicopters and/or firearms that could affect cultural practitioners in the area. Temporary closures, due to control efforts, could also interfere with cultural practitioners. However, closures are usually for a few hours and rarely last more than a day. Also, management actions are typically confined to specific areas. Similarly, monitoring activities and fence construction involving the use of helicopters are also intermittent. Judging by past experience, closures would generally be used infrequently, and the public would be notified of them in advance so they can adjust their plans. Consequently, there would be short-term minor adverse impacts associated with implementation of management actions.

Ungulate control would support the protection and restoration of the native flora and fauna regarded as ethnographic resources to Native Hawaiians. Although Polynesian pigs were held in regard in Native Hawaiian legends, the European pig has since replaced the Polynesian stock. This new, larger animal became feral and ventured into native forest where it proved destructive to the native flora. In the Hawaiian culture everything has a degree of sacredness, including the native plants, birds, insects and the communities they form. In particular, upland plant communities are valued for supplying aquifers and providing the seed sources for forest regeneration.

During consultation meetings held with the Kupuna Consultation Group, one of the concerns voiced was that people should be able to hunt to put food on their table. Although subsistence hunting has never been legal in the park, under alternative A, there would be limited opportunities for meat salvage by volunteers, who typically participate once in ground shooting operations directed by park staff. In addition, the park is surrounded by public hunting areas in state game and forest reserves that are used by the communities near the park.

Alternative A would result in short-term minor adverse impacts on ethnographic resources through implementation of management actions. In the older section of the park, long-term moderate to major beneficial impacts would result through the continuation of animal exclusion in managed units. However, long-term beneficial impacts would be unlikely for Kahuku and areas currently unmanaged (e.g., portions of ‘Ōla‘a), for which no established population-level objective and fencing strategy has been identified. Also, the implementation of management tools and monitoring would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities. Because alternative A would not incorporate the comprehensive, systematic approach described in the “Elements Common to All Action Alternatives” section in chapter 2, it would be less likely that the

NPS would progress through management phases, monitor, and apply management tools consistently as staff and institutional knowledge change over time.

Cumulative Impacts

Other past, present, and reasonably foreseeable future actions in and around the park have affected or could affect ethnographic resources. Although management plans ensure protection of ethnographic resources, past, present and future activities associated with the development and maintenance of facilities (grading, filling, construction, and inventory) at the park, including trails and roads, administrative buildings, and campsites, contribute to long-term adverse impacts on ethnographic resources. Development both inside and directly outside the park, including historic roads, trails, and other structures, has likely impacted ethnographic resources in the park because of the ground, vegetation, and other resource disturbance during construction. While all ethnographic resources are subject to direct or indirect impacts, sacred shrines, mounds, stone alignments, and rock art are especially susceptible to damage, either directly or indirectly, by development. Development outside the park contributes to damage as roads and trails encroach on park boundaries and provide access to ethnographic resource locations. Grazing and ranching activities (in the park and in adjacent lands) can be destructive to ethnographic resources, as native vegetation and wildlife habitat are removed. While park visitation is essential to the park, past and projected increased access and off-trail travel can impact ethnographic resources, such as culturally modified caves, if visitors inadvertently or purposely vandalize sensitive sites. As mentioned previously, past, present, and proposed future fencing can damage ethnographic resources. The impacts from these past, present, and reasonably foreseeable future would be long term, minor, and adverse.

Changes in the fire regime due to habitat fragmentation and non-native species invasions pose a threat to ethnographic resources as well. However, the park's fire management plan (NPS 2005a) outlines procedures and approaches for the monitoring and suppression of wildfires, mitigation measures to reduce the chance of wildfire, and impacts to cultural and natural resources. The NPS and Big Island Wildfire Coordinating Group have cosponsored community wildfire protection plans, which have been developed by local communities in the vicinity of the park, outlining mitigation measures to reduce the chances of wildfires occurring (Laitinen 2006a, 2006b).

Many past, current, and future actions, plans, and programs at the park and in surrounding areas provide benefits for ethnographic resources. Natural resource and watershed protection on lands in and adjacent to the park has previously supported and will continue to support the protection of ethnographic resources by managing ingress of non-native ungulates into the park. Law enforcement activities would contribute to beneficial impacts by protecting ethnographic resources from being damaged by visitors who violate park rules and regulations. The future implementation of the GMP for the park will also involve prescriptions for desired conditions related to the protection of cultural resources, including ethnographic resources, balanced with those for visitor use. In addition, past acquisitions, such as Kahuku, and future acquisitions of new lands would contribute to the knowledge of ethnographic resources in the park. Future implementation of several management plans, including those in development—the GMP and the *Ala Kahakai National Historic Trail Management Plan* (NPS n.d.a, 2004d) —would have long-term minor beneficial impacts on ethnographic resources because the plans contain mitigation measures for the protection of cultural and natural resources.

Increased past and present aviation activities have the potential to impact ethnographic resources. Viewsheds from sacred sites could be disrupted by noise and visual intrusion from aircraft overhead. The future implementation of the ATMP will likely help mitigate impacts on ethnographic resources. The ATMP would manage commercial aviation activities to specifically mitigate impacts on park resources.

These past, present, and reasonably foreseeable future actions would have both short- and long-term minor adverse impacts and short- and long-term minor to moderate beneficial impacts on ethnographic resources. When combined with the impacts of alternative A, there would be short- and long-term minor adverse cumulative impacts on ethnographic resources. Long-term benefits would be less likely under alternative A, because management would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities and implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.

Conclusion

Under alternative A, short-term minor adverse impacts on ethnographic resources would result from the implementation of management actions. In the older section of the park, long-term moderate to major beneficial impacts would result from the continuation of animal exclusion in managed units. However, long-term beneficial impacts would be unlikely for Kahuku and areas currently unmanaged (e.g., portions of ʻŌlaʻa), for which no established population-level objective and fencing strategy has been identified in a comprehensive and systematic plan. The effects of alternative A, when combined with impacts of past, present, and reasonably foreseeable future actions on ethnographic resources, would have short- and long-term minor adverse cumulative impacts. Long-term beneficial cumulative impacts would be less likely under alternative A, because management would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities and implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.

Alternative B: Comprehensive Management Plan that Uses Lethal Removal Techniques

Analysis

Alternative B would result in short-term minor adverse impacts to ethnographic resources. Monitoring, direct reduction with firearms, and fencing, would temporarily create noise from the use of helicopters and/or firearms that could affect cultural practitioners in the area. Temporary closures, due to control efforts, could also interfere with cultural practitioners. However, closures are usually for a few hours and rarely last more than a day. Also, management actions are typically confined to specific areas. Similarly, monitoring activities and fence construction involving the use of helicopters are also intermittent. Judging by past experience, closures would generally be used infrequently, and the public would be notified of them in advance so they can adjust their plans.

Ungulate control would support the protection and restoration of the native flora and fauna regarded as ethnographic resources to Native Hawaiians. Although Polynesian pigs were held in regard in Native Hawaiian legends, the European pig has since replaced the Polynesian stock. This new, larger animal became feral and ventured into native forest where it proved destructive to the native flora. In the Hawaiian culture everything has a degree of sacredness, including the native plants, birds, insects and the communities they form. In particular, upland plant communities are valued for supplying aquifers and providing the seed sources for forest regeneration.

During consultation meetings held with the Kupuna Consultation Group, one of the concerns voiced was that people should be able to hunt to put food on their table. Subsistence hunting has never been legal in the park. Although qualified volunteers participating in ground shooting would not be allowed to salvage meat, the NPS would pursue opportunities to salvage and donate meat when practicable. In addition, the park is surrounded by public hunting areas in state game and forest reserves that are used by the communities near the park.

Alternative B would result in short-term minor adverse impacts on ethnographic resources through implementation of management actions. Long-term moderate to major beneficial impacts resulting from the protection and recovery of native plants and animals valued as ethnographic resources would be fully realized under this alternative because the comprehensive, systematic approach described in the "Elements Common to All Action Alternatives" section in chapter 2, would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative B would be the same as alternative A. The short- and long-term minor adverse impacts and short- and long-term minor beneficial impacts of past, present, and reasonably foreseeable future actions on ethnographic resources, when combined with the impacts of implementing alternative B, would have short- and long-term minor adverse and long-term moderate to major beneficial cumulative impacts. Long-term beneficial impacts would be fully realized under this alternative because the comprehensive, systematic approach described in the "Elements Common to All Action Alternatives" section in chapter 2 would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time.

Conclusion

Under alternative B, short-term minor adverse impacts on ethnographic resources would result from the implementation of management actions. Long-term moderate to major beneficial impacts would be fully realized under this alternative because the comprehensive, systematic approach described in the "Elements Common to All Action Alternatives" section in chapter 2 would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time.

The effects of alternative B, when combined with impacts of past, present, and reasonably foreseeable future actions on ethnographic resources, would have short- and long-term minor adverse and long-term moderate to major beneficial cumulative impacts.

Alternative C: Comprehensive Management Plan that Maximizes Efficiency by Expanding Lethal Removal Techniques and Discontinuing the Use of Volunteers

Analysis

Similar to alternative B, alternative C would result in short-term minor adverse impacts to ethnographic resources. Under this alternative, volunteers would not assist with animal removal efforts and meat would not be salvaged. However, there would continue to be opportunities to hunt in state and forest reserves surrounding the park. Long-term moderate to major beneficial impacts resulting from the protection and recovery of native plants and animals valued as ethnographic resources would be fully realized under this alternative.

Because lethal techniques would be expanded and enhanced, and volunteers would not be used during direct reduction efforts under alternative C, it is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, more quickly than under alternative B. The increased efficiency associated with discontinuing the use of volunteers is based on additional work required by NPS staff to recruit, administer, train and direct volunteers in the field, and data that show that park staff remove more ungulates per day when they conduct direct reduction (ground shooting) themselves, compared to when they are accompanied by volunteers (Stephens et al. 2008).

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative C would be the same as alternative A. Similar to alternative B, the short- and long-term minor adverse impacts and short- and long-term minor beneficial impacts of past, present, and reasonably foreseeable future actions on ethnographic resources, when combined with the impacts of implementing alternative C, would have short- and long-term minor adverse and long-term moderate to major beneficial cumulative impacts.

Conclusion

Under alternative C, short-term minor adverse impacts on ethnographic resources would result from the implementation of management actions. Long-term moderate to major beneficial impacts would be fully realized under this alternative. The effects of alternative C, when combined with impacts of past, present, and reasonably foreseeable future actions on ethnographic resources, would have short- and long-term minor adverse and long-term moderate to major beneficial cumulative impacts.

Alternative D: Comprehensive Management Plan that Maximizes Flexibility of Management Techniques

Analysis

Similar to alternative B, alternative D would result in short-term minor adverse impacts to ethnographic resources. Long-term moderate to major beneficial impacts resulting from the protection and recovery of native plants and animals valued as ethnographic resources would be fully realized under this alternative.

Although the expansion and enhancement of lethal removal techniques under alternative D would be implemented with the goal of increasing the efficiency and cost effectiveness of ungulate management, the continued use of volunteers and the expansion of non-lethal techniques would counteract this to some extent. Inclusion of non-lethal removal would require additional staff time and park resources to capture, hold and relocate animals, and may increase the time associated with reduction actions over the life of the plan, as well as the time needed to reach the post-reduction phase. As a result, it is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, less quickly than under alternative C.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative D would be the same as alternative A. Similar to alternative B, the short- and long-term minor adverse impacts and short- and long-term minor beneficial impacts of past, present, and reasonably foreseeable future actions on ethnographic resources, when combined with the impacts of implementing alternative D, would have short- and long-term minor adverse and long-term moderate to major beneficial cumulative impacts.

Conclusion

Under alternative D, short-term minor adverse impacts on ethnographic resources would result from the implementation of management actions. Long-term moderate to major beneficial impacts would be fully realized under this alternative. The effects of alternative D, when combined with impacts of past, present, and reasonably foreseeable future actions on ethnographic resources, would have short- and long-term minor adverse and long-term moderate to major beneficial cumulative impacts.

Alternative E: Comprehensive Management Plan that Increases Flexibility of Management Techniques While Limiting the Use of Volunteers

Analysis

Similar to alternative B, alternative E would result in short-term minor adverse impacts to ethnographic resources. Long-term moderate to major beneficial impacts resulting from the protection and recovery of native plants and animals valued as ethnographic resources would be fully realized under this alternative.

Although the expansion and enhancement of lethal removal techniques under alternative E would be implemented with the goal of increasing the efficiency and cost effectiveness of ungulate management, the expansion of non-lethal techniques would counteract this to some extent. However, because volunteers would not be used during direct reduction efforts under alternative E, it is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, more quickly than under alternative D, but less quickly than under alternative C.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative E would be the same as alternative A. Similar to alternative B, the short- and long-term minor adverse impacts and short- and long-term minor beneficial impacts of past, present, and reasonably foreseeable future actions on ethnographic resources, when combined with the impacts of implementing alternative E, would have long-term, minor, adverse and long-term, moderate to major beneficial cumulative impacts on ethnographic resources.

Conclusion

Under alternative E, short-term minor adverse impacts on ethnographic resources would result from the implementation of management actions. Long-term moderate to major beneficial impacts would be fully realized under this alternative. The effects of alternative E, when combined with impacts of past, present, and reasonably foreseeable future actions on ethnographic resources, would have short- and long-term minor adverse and long-term moderate to major beneficial cumulative impacts.

Assessment of Effect for National Historic Preservation Act Section 106

After applying the Advisory Council's criteria of adverse effects (36 CFR 800.5, "Assessment of Adverse Effects") and receiving initial comments from the State Historic Preservation Office, the Office of Hawaiian Affairs, and from the Kupuna Consultation Group, the NPS has concluded the following assessment of effect for all alternatives.

Alternative A: No Action (Continue Existing Non-native Ungulate Management Activities)

Construction of fencing could affect archeological resources; however, field surveys of proposed fence alignments would be conducted prior to construction and fences relocated to avoid archeological resources and to minimize disturbance to the cultural viewshed. Fences and ungulate removal would provide long-term benefits for cultural landscapes negatively impacted by non-native ungulates, but fences would also introduce new elements to park landscapes. Although management actions would reduce animal populations inside the park, there would be opportunities for the public to hunt in state game and forest reserves surrounding the park and on the island. In addition, opportunities for volunteers from the public to participate in ungulate removal and fence construction activities would continue. Control of ungulates would support protection of the native plants and animals valued in Hawaiian culture, which would have beneficial impacts on ethnographic resources. However, long-term beneficial impacts would be less likely under alternative A than under the action alternatives, because management would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities and implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.

The NPS has determined that alternative A would have *no adverse effect* on archeological resources, cultural landscapes, and ethnographic resources in the park, as there would be no moderate or major modifications, ground-disturbing activities, or alterations made to known cultural resources, or alteration of resource conditions, traditional access, site preservation, or the relationship between the resource and the affiliated group’s beliefs and practices.

Alternative B: Comprehensive Management Plan that Uses Lethal Removal Techniques

Construction of fencing could affect archeological resources; however, field surveys of proposed fence alignments would be conducted prior to construction and fences relocated to avoid archeological resources. Fences and ungulate removal would provide long-term benefits for cultural landscapes negatively impacted by non-native ungulates, but fences would also introduce new elements to park landscapes. Although management actions would reduce animal populations inside the park, there would be opportunities for the public to hunt in state game and forest reserves surrounding the park and on the island. Opportunities for volunteers from the public to participate in ungulate removal and fence construction activities would continue. Although volunteers would not be able to keep the meat, the NPS would pursue opportunities to salvage and donate meat when practicable. Control of ungulates would support protection of the native plants and animals valued in Hawaiian culture and allow traditionally used native plant species to thrive, which would have beneficial impacts on ethnographic resources.

The NPS has determined that alternative B would have *no adverse effect* on archeological resources and cultural landscapes, and ethnographic resources in the park, as there would be no moderate or major modifications, ground-disturbing activities, or alterations made to known cultural resources, or alteration of resource conditions, traditional access, site preservation, or the relationship between the resource and the affiliated group’s beliefs and practices.

Alternative C: Comprehensive Management Plan that Maximizes Efficiency by Expanding Lethal Removal Techniques and Discontinuing the Use of Volunteers

Construction of fencing could affect archeological resources; however, actions would be located away from known sensitive cultural sites. The exact locations of boundary and exclosure fences would be determined during implementation, but it is assumed that the fences would have a long-term benefit from the preservation of endemic flora and fauna of the park, which contribute to cultural landscapes. Although management actions would reduce animal populations inside the park, there would be opportunities for the public to hunt in state game and forest reserves surrounding the park and on the island. Control of ungulates would support protection of the native plants and animals valued in Hawaiian culture and allow traditionally used native plant species to thrive, which would have beneficial impacts on ethnographic resources.

The NPS has determined that alternative C would have *no adverse effect* on archeological resources and cultural landscapes, and ethnographic resources in the park, as there would be no moderate or major modifications, ground-disturbing activities, or alterations made to known cultural resources, or alteration of resource conditions, traditional access, site preservation, or the relationship between the resource and the affiliated group's beliefs and practices.

Alternative D: Comprehensive Management Plan that Maximizes Flexibility of Management Techniques

Construction of fencing and holding pens for relocation activities could affect archeological resources; however, actions would be located away from known sensitive cultural sites. The exact locations of boundary and exclosure fences would be determined during implementation, but it is assumed that the fences would have a long-term benefit from the preservation of endemic flora and fauna of the park, which contribute to cultural landscapes. Although management actions would reduce animal populations inside the park, there would be opportunities for the public to hunt in state game and forest reserves surrounding the park and on the island. Opportunities for volunteers from the public to participate in ungulate removal and fence construction activities would continue. Although volunteers would not be able to keep the meat, the NPS would pursue opportunities to salvage and donate meat when practicable. Control of ungulates would support protection of the native plants and animals valued in Hawaiian culture and allow traditionally used native plant species to thrive, which would have beneficial impacts on ethnographic resources.

The NPS has determined that alternative D would have *no adverse effect* on archeological resources and cultural landscapes, and ethnographic resources in the park, as there would be no moderate or major modifications, ground-disturbing activities, or alterations made to known cultural resources, or alteration of resource conditions, traditional access, site preservation, or the relationship between the resource and the affiliated group's beliefs and practices.

Alternative E: Comprehensive Management Plan that Increases Flexibility of Management Techniques While Limiting the Use of Volunteers

Construction of fencing and holding pens for relocation activities could affect archeological resources; however, actions would be located away from known sensitive cultural sites. The exact locations of boundary and exclosure fences would be determined during implementation, but it is assumed that the fences would have a long-term benefit from the preservation of endemic flora and fauna of the park, which contribute to cultural landscapes. Although management actions would reduce animal populations inside the park, there would be opportunities for the public to hunt in state game and forest reserves surrounding the park and on the island. Opportunities for volunteers from the public to participate in ungulate removal and fence construction activities would continue, although volunteers would not assist with ground shooting activities. Control of ungulates would support protection of the native plants and animals valued in Hawaiian culture and allow traditionally used native plant species to thrive, which would have beneficial impacts on ethnographic resources.

The NPS has determined that alternative E would have *no adverse effect* on archeological resources and cultural landscapes, and ethnographic resources in the park, as there would be no moderate or major modifications, ground-disturbing activities, or alterations made to known cultural resources, or alteration of resource conditions, traditional access, site preservation, or the relationship between the resource and the affiliated group's beliefs and practices.

WILDERNESS

GUIDING REGULATIONS AND POLICIES

The *Wilderness Act*, passed on September 3, 1964, established a national wilderness preservation system, "administered for the use and enjoyment of the American people in such manner as will leave [these areas] unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character, and for the gathering and dissemination of information regarding their use and enjoyment as wilderness" (16 USC 1131). The *Wilderness Act* further defined wilderness as "an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, and which is protected and managed to preserve its natural conditions" (16 USC 1131). The *Wilderness Act* gives the agency managing the wilderness responsibility for preserving the wilderness character of the area and devoting the area to the public purposes of recreational, scenic, scientific, educational, conservation, and historical use (16 USC 1133). Certain uses are specifically prohibited, except for areas where these uses have already become established. The act states that "there shall be no commercial enterprise and no permanent road within any wilderness area designated by this chapter and except as necessary to meet minimum requirements for the administration of the area…. There shall be no temporary road, no use of motor vehicles, motorized equipment or motorboats, no landing of aircraft, no other form of mechanical transport, and no structure or installation within any such area" (16 USC 1133).

Section 6.3.5 of NPS *Management Policies 2006* requires that all management decisions affecting wilderness must be consistent with the "minimum requirement" concept. This concept is a documented process used to determine whether administrative actions, projects, or programs undertaken by the NPS or its agents and affecting wilderness character, resources, or the visitor experience are necessary, and if so, how to minimize impacts (NPS 2006b). This analysis was conducted for all alternatives using the minimum requirements decision guide from the Arthur Carhart National Wilderness Training Center, and can be found in appendix B.

As described in section 6.3.7 of NPS *Management Policies 2006*, "The principle of nondegradation will be applied to wilderness management…. Natural processes will be allowed, insofar as possible, to shape and control wilderness ecosystems. Management should seek to sustain the natural distribution, numbers, population composition, and interaction of indigenous species. Management intervention should only be undertaken to the extent necessary to correct past mistakes, the impacts of human use, and influences originating outside of wilderness boundaries" (NPS 2006b).

Director's Order 41: *Wilderness Preservation and Management* (NPS 1999c) was developed to provide accountability, consistency, and continuity to NPS wilderness management efforts and to otherwise guide NPS efforts in meeting the requirements set forth by the *Wilderness Act* of 1964.

Director's Order 41 sets forth guidance for applying the minimum requirement concept to protect wilderness and for the overall management, interpretation, and uses of wilderness. With regard to natural resource management in wilderness, it reaffirms management policies and states, "Management intervention should only be undertaken to the extent necessary to correct past mistakes, the impacts of human use, and the influences originating outside of wilderness boundaries" (NPS 1999c).

METHODOLOGY, ASSUMPTIONS, AND IMPACT THRESHOLDS

In considering environmental impacts on wilderness, NPS *Management Policies 2006* requires that the analysis take into account (1) wilderness characteristics and values, including the primeval character and influence of the wilderness; (2) the preservation of natural conditions (including the lack of human-caused noise); and (3) assurances that there will be outstanding opportunities for solitude, that the public will be provided with a primitive and unconfined type of recreational experience, and that wilderness will be preserved and used in an unimpaired condition (NPS 2006b, section 6.3.4.3).

The management actions in this plan may affect the untrammeled and undeveloped nature of the wilderness areas, but will not have any effect on the opportunity for visitors to enjoy primitive and unconfined forms of recreation.

Impact intensity thresholds were defined for adverse impacts. For this plan/EIS, assignment of intensity levels for wilderness impacts are based on the potential for changes to such characteristics as follows:

Negligible: There would be no discernible impact on opportunities for solitude. The natural character of wilderness and its untrammeled nature would not be affected.

Minor: There would be slight impacts on opportunities for solitude in limited areas of the wilderness. The natural character of wilderness or its untrammeled nature would not be noticeably affected.

Moderate: The opportunities for solitude would be noticeably reduced, in limited areas of the wilderness. The natural character of portions of the wilderness or its untrammeled nature could be noticeably affected.

Major: The opportunities for solitude would be substantially reduced, throughout the wilderness area. The natural character of wilderness or its untrammeled nature would be clearly altered on a large scale.

IMPACTS OF THE ALTERNATIVES

Alternative A: No Action (Continue Existing Non-native Ungulate Management Activities)

Analysis

Current management actions in wilderness areas include monitoring, removal of ingress animals, and fence maintenance and inspection. These actions would continue in existing non-native ungulate managed areas and could potentially expand to include fence construction and reduction activities in unmanaged areas of wilderness (e.g., portions of ‘Ōla‘a) and areas that may be considered for future wilderness designation (e.g., upper elevations of Kahuku).

For management units where animals have been excluded, disruptions to solitude by removal efforts do not occur frequently (see description in the “Elements Common to All Action Alternatives” section in chapter 2). Monitoring is done on foot or by helicopter. During monitoring, helicopters would be used in open vegetation areas, with a frequency of 3 to 4 times per year. These actions are typically conducted in the early morning to minimize impacts on visitors, and because the early morning is the optimal time for locating feral animals. In dense vegetation, monitoring is conducted on the ground via hiking, typically at 2-month intervals, during fence inspection activities. If non-native ungulates are identified, removal actions, which could include trapping, snaring, and/or direct reduction with firearms, would be initiated. In forest, dense vegetation obscures and attenuates sound from these intrusions. It is assumed that removals, including those outside of wilderness, would occur approximately 5 to 20 times per year (spread out across the various units) when ingress is detected, and that some of these would require helicopter assistance. For areas where animal populations remain (e.g., portions of ‘Ōla‘a and upper elevations of Kahuku evaluated for wilderness eligibility), removal activities would initially be more frequent and then decrease once animals are excluded. The short-term human control or manipulation of ungulate populations, even though they are non-native, would affect the untrammeled nature of the wilderness areas. The use of helicopters would temporarily affect the undeveloped quality of the wilderness areas. The noise and presence of people would introduce sounds that are not part of the natural environment, and could disturb wildlife during implementation.

Maintaining a fence in wilderness would create a visual intrusion, and affect the undeveloped nature of the area. In open habitat, the presence of a fence would create a hazard for some species, such as native birds (petrels) and bats. Installation of fence posts in lava substrates may require using a motorized rock drill. Use of remote cameras may also introduce a modern element into the wilderness. Mitigation measures would be used to minimize impacts in wilderness areas. For example, fences are generally located away from visitor campsites and most trails, or are obscured by dense vegetation so that these intrusions are minimized. The areas affected visually by the fence would also be small relative to the large protected areas. The effects of introducing remote cameras could be mitigated by placing these in inconspicuous locations. The NPS would constantly evaluate fence design to minimize impacts, and would mitigate bird or bat fence strikes by using vinyl strips or flagging, by avoiding the use of barbed wire, and by placing fence in areas less likely to impact the petrels and bats. To minimize impacts on natural and cultural resources, fence alignments would be surveyed and rerouted to avoid cultural features and sensitive plant and animal species, and to avoid removal of large trees and rare plants. Fence work would be minimized or avoided in habitats of sensitive wildlife during the breeding seasons for these species.

The lack of roads and terrain unsuitable for stock animals in wilderness necessitates the use of helicopters for transport of fence material, equipment, tools, and camp supplies to fenced areas. Old fence material would be dismantled and hauled out by helicopter. For fence segments in more remote areas, a temporary administrative camp would be established for the duration of the repair work. All landings, drop sites, and temporary camps would be surveyed and placed to minimize impacts on surroundings. The use of the helicopter would minimize damage that would otherwise be caused by vehicles and pack animals traveling across lava surfaces and through dense vegetation. As determined by the Minimum Requirements Decision Guide, the use of pack animals is not practical, considering the large loads of fence material and equipment and the difficulty of traversing earth cracks and the highly uneven, fragile lava surfaces and dense vegetation off-trail. Such management activities would require vegetation clearing and leveling of surfaces along the travel routes, which would result in greater long-term adverse impacts than helicopter use.

The exclusion and removal of non-native ungulates would support recovery of natural conditions in wilderness, including the recovery of native plants and animals. Removal of ungulates would eliminate a source of mortality for sensitive native plants and remove a vector for non-native species dispersal.

The exclusion and removal of non-native ungulates would support recovery of natural conditions in wilderness, including the recovery of native plants and animals.

In summary, alternative A would result in short- and long-term minor to moderate adverse impacts to wilderness through fences, helicopter work and ground activities related to removal efforts and fence construction and maintenance. In the older section of the park, long-term beneficial impacts on wilderness through the recovery of natural conditions would result from the continuation of animal exclusion in managed units. However, long-term benefits to the native vegetation would be unlikely for Kahuku (for which wilderness eligible areas are being considered) and areas currently unmanaged (e.g., portions of ‘Ōla‘a), for which no established population-level objective and fencing strategy has been identified. Also, the implementation of management tools and monitoring would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities. Because alternative A would not incorporate the comprehensive, systematic approach described in the "Elements Common to All Action Alternatives" section in chapter 2, it would be less likely that the NPS would progress through management phases, monitor, and apply management tools consistently as staff and institutional knowledge change over time.

Cumulative Impacts

Various past, present, and reasonably foreseeable future actions would enhance wilderness and contribute to beneficial impacts on wilderness areas in the park. The completion and implementation of the GMP (which includes a wilderness study for the Kahuku Unit; in progress), and the future development of a wilderness management plan would address actions to be taken to sustain the natural and untrammeled condition of wilderness areas in the park, and will also include a wilderness eligibility assessment for the Kahuku District. The implementation of the fire management plan addresses the use of wildland fires and prescribed fires to restore natural characteristics of wilderness areas in the park. The acquisition of new lands (including Kahuku) could have beneficial impacts on wilderness, in that wilderness-like areas could potentially become legislated wilderness areas in the park.

There are also some past, current, and future actions that have contributed or would contribute to negligible to minor adverse cumulative effects on wilderness areas in the park. The installation of temporary instrumentation devices in wilderness areas has caused negligible to minor adverse impacts on the integrity of the wilderness areas in the park. The equipment includes GPS instrumentation, seismographs, climatology instrumentation, batteries, antennas, solar panels, and radio repeaters for research and to assist emergency operations. Several wilderness campsites include non-historic shelters, latrines, and catchments. Fragmentation and loss of habitat through non-native species invasions, development outside the park, and land management practices (including those outside the park) has altered the distribution and abundance of native plants and wildlife that contribute to natural character of wilderness. The change in the fire ecology and management for the island from habitat fragmentation and non-native species invasion has increased fire danger through the spread of various non-native plant species, which threatens the integrity and preservation of wilderness. Visitation at the park could also contribute to disturbances to wilderness by visitors trampling vegetation, disturbing wildlife, introducing human sounds, and reducing opportunities for solitude. While providing increased access and opportunities for visitor appreciation of wilderness areas, implementation of the *Ala Kahakai National Historic Trail Comprehensive Management Plan* and the proposed Mauna Loa trail system may also have short-term adverse impacts on wilderness due to noise and trampling associated with implementing these plans.

Increased overflights inside and outside the park, including those that are a result of volcanic activity and subsequent increased visitation, contribute to the impacts on the natural and quiet nature of wilderness, which can also impact wildlife living in wilderness. The park is working with the FAA to prepare an ATMP and EIS (FAA n.d.) with the objective of mitigating or preventing the significant adverse impacts, if any, of commercial air tour operations on the natural and cultural resources and visitor experiences of the park. This would offset some impacts of commercial air tours. Helicopters would continue to be used for administrative use above park lands, including wilderness, but due to the much lower frequency of administrative flights, these would contribute fewer adverse impacts to park resources compared to commercial overflights.

Some past, current, and future actions contribute to both beneficial and adverse impacts, depending on what stage of implementation they are in. For example, control of non-native species (e.g., plants and small non-native mammals) in wilderness would have short-term adverse impacts on wilderness due to vegetation trampling by staff and noise from equipment. However, these short-term impacts would have no overall effect on the ecological integrity of wilderness, and once activities are completed there would be long-term beneficial impacts. Similarly, the maintenance of trails in wilderness areas would have short-term adverse impacts on wilderness due to the presence of people and the disturbance caused by staff and associated equipment; however, once the maintenance is complete and the trails are improved, wilderness visitors would experience long-term beneficial impacts as a result of improved access in areas that provide solitude and primitive recreational experiences. The implementation of conservation actions outside the park, including USFWS recovery plans for sensitive species, would have short-term adverse impacts on wilderness as a result of NPS and USFWS staff entering areas adjacent to park wilderness and conducting management operations. However, the restoration of sensitive native species and habitat would contribute to long-term beneficial impacts on the natural character of adjacent park wilderness areas. The implementation of park management actions inside wilderness (including the use of boundary and interior fencing, fence inspection and repair, and vegetation and sensitive species restoration) has had adverse impacts on wilderness. But these actions would also have long-term beneficial impacts as a result of protection of the natural conditions of ecological integrity, biological diversity, and natural sounds (the latter caused by native birds and insects) that would occur across large areas of wilderness.

These past, present, and reasonably foreseeable future actions would have short-term and long-term minor to moderate adverse impacts on wilderness, as well as long-term beneficial effects. Actions such as staff trampling vegetation, overhead helicopter flights, and other park management operations in wilderness would have short-term adverse impacts and long-term beneficial impacts on wilderness, whereas fences would have both long-term adverse and long-term beneficial impacts on wilderness. Past, present, and reasonably foreseeable future actions, when combined with the impacts under alternative A, would result in short- and long-term minor to moderate adverse cumulative impacts on wilderness. Long-term beneficial impacts would be less likely under alternative A, because non-native ungulate management within the park would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities and implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.

Conclusion

Under alternative A, short- and long-term minor to moderate adverse impacts to wilderness would result from fences, helicopter work and ground activities related to removal efforts and fence construction and maintenance. In the older section of the park, long-term beneficial impacts on wilderness through the recovery of natural conditions would result from the continuation of animal exclusion in managed units. Long-term beneficial impacts would be unlikely for the Kahuku unit and areas currently unmanaged (e.g., portions of ‘Ōla‘a), where no established population-level objective or fencing strategy has been identified in a comprehensive and systematic plan. The effects of alternative A, when combined with impacts of past, present, and reasonably foreseeable future actions on wilderness, would have short- and long-term minor to moderate adverse cumulative impacts. Long-term beneficial cumulative impacts would be less likely under alternative A, because non-native ungulate management would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities and implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.

Alternative B: Comprehensive Management Plan that Uses Lethal Removal Techniques

Analysis

For management units in the maintenance phase, disruptions to solitude by removal efforts do not occur frequently (see description in the “Elements Common to All Action Alternatives” section in chapter 2).

Monitoring is done on foot or by helicopter. During monitoring, helicopters would be used in open vegetation areas, with a frequency of 3 to 4 times per year. These actions are typically conducted in the early morning to minimize impacts on visitors, and because the early morning is the optimal time for locating feral animals. In dense vegetation, monitoring is conducted on the ground via hiking, typically at 2-month intervals, during fence inspection activities. If non-native ungulates are identified in these maintenance areas, removal actions, which could include trapping, snaring, and/or direct reduction with firearms, would be initiated. In forest, dense vegetation obscures and attenuates sound from these intrusions. It is assumed that removals associated with the maintenance phase of management, including those outside of wilderness, would occur approximately 5 to 20 times per year (spread out across the various units) when ingress is detected, and that some of these would require helicopter assistance. For areas in the reduction and post-reduction phases (e.g., portions of ‘Ōla‘a and upper elevations of Kahuku evaluated for wilderness eligibility), removal activities would initially be more frequent and then decrease once animals are excluded. The short-term human control or manipulation of ungulate populations, even though they are non-native, would affect the untrammeled nature of the wilderness areas. The use of helicopters would temporarily affect the undeveloped quality of the wilderness areas. The noise and presence of people would introduce sounds that are not part of the natural environment, and could disturb wildlife during implementation.

Maintaining a fence in wilderness would create a visual intrusion, and affect the undeveloped nature of the area. In open habitat, the presence of a fence would create a hazard for some species, such as native birds (petrels) and bats. Installation of fence posts in lava substrates may require using a motorized rock drill. Use of remote cameras may also introduce a modern element into the wilderness. Mitigation measures would be used to minimize impacts in wilderness areas. For example, fences are generally located away from visitor campsites and most trails, or are obscured by dense vegetation so that these intrusions are minimized. The areas affected visually by the fence would also be small relative to the large protected areas. The effects of introducing remote cameras could be mitigated by placing these in inconspicuous locations. The NPS would constantly evaluate fence design to minimize impacts, and would mitigate bird or bat fence strikes by using vinyl strips or flagging, by avoiding the use of barbed wire, and by placing fence in areas least likely to impact the petrels and bats. To minimize impacts on natural and cultural resources, fence alignments would be surveyed and rerouted to avoid cultural features and sensitive plant and animal species, and to avoid removal of large trees and rare plants. Fence work would be minimized or avoided in habitats of sensitive wildlife during the breeding seasons for these species.

The lack of roads and terrain unsuitable for stock animals in wilderness necessitates the use of helicopters for transport of fence material, equipment, tools, and camp supplies to fenced areas. Old fence material would be dismantled and hauled out by helicopter. For fence segments in more remote areas, a temporary administrative camp would be established for the duration of the repair work. All landings, drop sites, and temporary camps would be surveyed and placed to minimize impacts on surroundings. The use of the helicopter would minimize damage that would otherwise be caused by vehicles and pack animals traveling across lava surfaces and through dense vegetation. As determined by the Minimum Requirements Decision Guide, the use of pack animals is not practical, considering the large loads of fence material and equipment and the difficulty of traversing earth cracks and the highly uneven, fragile lava surfaces and dense vegetation off-trail. Such management activities would require vegetation clearing and leveling of surfaces along the travel routes, which would result in more long-term adverse impacts than helicopter use.

The exclusion and removal of non-native ungulates would support recovery of natural conditions in wilderness, including the recovery of native plants and animals. Removal of ungulates would eliminate a source of mortality for sensitive native plants and remove a vector for non-native species dispersal.

In summary, alternative B would result in short- and long-term minor to moderate adverse impacts to wilderness through fences. Long-term beneficial impacts to wilderness through exclusion of non-native ungulates and supporting recovery of natural conditions would be fully realized under alternative B because the comprehensive, systematic approach described in the “Elements Common to All Action Alternatives” section in chapter 2, would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative B would be the same as alternative A. The short- and long-term minor to moderate adverse and long- term beneficial impacts of past, present, and reasonably foreseeable future actions on wilderness, when combined with the impacts of implementing alternative B, would have short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts. Long-term beneficial impacts to wilderness through exclusion of non-native ungulates and supporting recovery of natural conditions would be fully realized under alternative B because the comprehensive, systematic approach described in the “Elements Common to All Action Alternatives” section in chapter 2, would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time.

Conclusion

Under alternative B, short- and long-term minor to moderate impacts on wilderness would result from fences, helicopter work and ground activities related to removal efforts and fence construction and maintenance. Long-term beneficial impacts to wilderness would be fully realized under this alternative because the comprehensive, systematic approach described in the “Elements Common to All Action Alternatives” section in chapter 2, would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time.

The effects of alternative B, when combined with impacts of past, present, and reasonably foreseeable future actions on wilderness, would have short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts.

Alternative C: Comprehensive Management Plan that Maximizes Efficiency by Expanding Lethal Removal Techniques and Discontinuing the Use of Volunteers

Analysis

Similar to alternative B, alternative C would result in short- and long-term minor to moderate adverse impacts to wilderness through use of fences, helicopter work and ground activities related to removal efforts and fence construction and maintenance. Long-term beneficial impacts to wilderness through exclusion of non-native ungulates and supporting recovery of natural conditions would be fully realized under alternative C.

Because lethal techniques would be expanded and enhanced, and volunteers would not be used during direct reduction efforts under alternative C, it is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, more quickly than under alternative B. The increased efficiency associated with discontinuing the use of volunteers is based on additional work required by NPS staff to recruit, administer, train and direct volunteers in the field, and data that show that park staff remove more ungulates per day when they conduct direct reduction (ground shooting) themselves, compared to when they are accompanied by volunteers (Stephens et al. 2008). Therefore, fewer reduction activities would result when compared to alternative B.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative C would be the same as alternative A. Similar to alternative B, the long-term beneficial and short-term and long-term minor to moderate adverse impacts of past, present, and reasonably foreseeable future actions on wilderness, when combined with the impacts of implementing alternative C, would have long-term beneficial and short- and long-term minor to moderate adverse cumulative impacts.

Conclusion

Under alternative C, short- and long-term minor to moderate impacts on wilderness would result from fences, helicopter work and ground activities related to removal efforts and fence construction and maintenance. Long-term beneficial impacts to wilderness would be fully realized under this alternative. It is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, more quickly under alternative C than under alternative B. The effects of alternative C, when combined with impacts of past, present, and reasonably foreseeable future actions on wilderness, would have short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts.

Alternative D: Comprehensive Management Plan that Maximizes Flexibility of Management Techniques

Analysis

Similar to alternative B, alternative D would result in short- and long-term minor to moderate adverse impacts to wilderness through use of fences, helicopter work and ground activities related to removal efforts and fence construction and maintenance. Long-term beneficial impacts to wilderness through exclusion of non-native ungulates and supporting recovery of natural conditions would be fully realized under alternative D.

Under alternative D, it is possible that increased human and helicopter traffic associated with potential relocation activities could cause additional disturbance to wilderness during the process of capturing and relocating ungulates and driving animals to release sites. However, these impacts would be short-term and localized, and similar to impacts of other management actions.

Although the expansion and enhancement of lethal removal techniques under alternative D would be implemented with the goal of increasing the efficiency and cost effectiveness of ungulate management, the continued use of volunteers and the expansion of non-lethal techniques would counteract this to some extent. Inclusion of non-lethal removal would require additional staff time and park resources to capture, hold and relocate animals, and may increase the time associated with reduction actions over the life of the plan, as well as time needed to reach the post-reduction phase. As a result, it is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, less quickly than under alternative C.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative D would be the same as alternative A. Similar to alternative B, the short- and long-term minor to moderate adverse impacts and long-term beneficial impacts of past, present, and reasonably foreseeable future actions on wilderness, when combined with the impacts of implementing alternative D, would have long-term beneficial and short- and long-term minor to moderate adverse cumulative impacts.

Conclusion

Under alternative D, short- and long-term minor to moderate impacts on wilderness would result from fences, helicopter work and ground activities related to removal efforts and fence construction and maintenance. Long-term beneficial impacts to wilderness would be fully realized under this alternative. It is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, less quickly under alternative D than under alternative C. The effects of alternative D, when combined with impacts of past, present, and reasonably foreseeable future actions on wilderness, would have short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts.

Alternative E: Comprehensive Management Plan that Increases Flexibility of Management Techniques While Limiting the Use of Volunteers

Analysis

Similar to alternative B, alternative E would result in short- and long-term minor to moderate adverse impacts to wilderness through use of fences, helicopter work and ground activities related to removal efforts and fence construction and maintenance. Long-term beneficial impacts to wilderness through exclusion of non-native ungulates and supporting recovery of natural conditions would be fully realized under alternative E.

Similar to alternative D, it is possible that potential relocation activities could cause additional disturbance to wilderness during the process of capturing and relocating ungulates and driving animals to release sites under alternative E.

Although the expansion and enhancement of lethal removal techniques under alternative E would be implemented with the goal of increasing the efficiency and cost effectiveness of ungulate management, the expansion of non-lethal techniques would counteract this to some extent. However, because volunteers would not be used during direct reduction efforts under alternative E, it is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, more quickly than under alternative D, but less quickly than under alternative C.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative E would be the same as alternative A. Similar to alternative B, the short- and long-term minor to moderate adverse impacts and long-term beneficial impacts of past, present, and reasonably foreseeable future actions on wilderness, when combined with the impacts of implementing alternative E, would have long-term beneficial and short- and long-term minor to moderate adverse cumulative impacts.

Conclusion

Under alternative E, short- and long-term minor to moderate impacts on wilderness would result from fences, helicopter work and ground activities related to removal efforts and fence construction and maintenance. Long-term beneficial impacts to wilderness would be fully realized under this alternative. It is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, more quickly under alternative E than under alternative D, but less quickly than under alternative C. The effects of alternative E, when combined with impacts of past, present, and reasonably foreseeable future actions on wilderness, would have short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts.

SOILS

GUIDING REGULATIONS AND POLICIES

In supporting federal and state regulations, the NPS *Management Policies 2006* states that the NPS will actively seek to understand and preserve the soil resources of parks, and prevent, to the extent possible, the unnatural erosion, physical removal, or contamination of the soil or its contamination of other resources (NPS 2006b, section 4.8.2.4).

METHODOLOGY, ASSUMPTIONS, AND IMPACT THRESHOLDS

Impact intensities for soils were derived from the available soils information and park staff observations of the effects on soils from compaction and loss of vegetation due to browsing and trampling by non-native ungulates. Within the park, impacts on soils include increased erosion, compaction, and nonpoint-source runoff related to the removal of vegetation.

Impact intensity thresholds were defined for adverse impacts. For this plan/EIS, assignment of intensity levels for soil impacts are based on the potential for changes to such characteristics as follows:

Negligible: The impact is not detectable or measurable and causes very little or no physical disturbance, compaction, or unnatural erosion when compared with current conditions.

Minor: The impact is slight but detectable in some areas, with few perceptible effects of physical disturbance, compaction, or unnatural erosion of soils.

Moderate: The impact is readily apparent and has measurable effects of physical disturbance, compaction, or unnatural erosion of soils.

Major: The impact is readily apparent and has severe effects of physical disturbance, compaction, or unnatural erosion of soils.

IMPACTS OF THE ALTERNATIVES

Alternative A: No Action (Continue Existing Non-native Ungulate Management Activities)

Analysis

Impacts on soils would be limited to those associated with temporary ground-based management actions (e.g., the presence of humans placing bait stations, shooting ungulates, setting traps and snares, and monitoring and collecting data, as well as constructing and repairing fences), including foot traffic. Impacts would include those associated with any routine field activity, including temporary increases in soil compaction and possible erosion. Fencing would involve minor soil disturbances and trampling of any vegetation in the removal areas. The NPS would continue to pursue safe and effective non-toxic alternatives to the use of lead bullets. As part of direct reduction activities, trained dogs could be used to locate and flush or immobilize non-native ungulates to facilitate direct reduction from the ground (or from the air). Impacts on soils from these activities would be similar to those associated with routine field activities and would not have noticeable effects on soils. The duration and frequency of these actions would also decrease as the park moves from reduction into less intensive management phases. As a result, there would short-term, localized negligible adverse impacts on soils during management actions.

Removal of non-native ungulates would limit the threats they pose and would support recovery and restoration of soils. Soil disturbance results from digging by feral pigs or general disturbance related to non-native ungulates, such as removal of vegetation as a result of grazing by large numbers of goats, sheep, and mouflon. Heavy, sustained use by ungulates can weaken or kill vegetation, reduce soil cover, and thereby contribute to and accelerate surface erosion (USFWS n.d.). This is especially true in areas with steep slopes, along water flow paths, and in areas exposed to wind. Increased erosion also has the potential to decrease soil fertility. Consequently, reduction of ungulate browsing would eliminate a source of soil compaction and erosion. Improvements in native vegetation, including ground cover, would further reduce soil erosion potential.

In summary, alternative A would result in short-term, localized negligible adverse impacts to soils through ground-based management actions. In the older section of the park, long-term beneficial impacts on soil would result from the continuation of animal exclusion in current management units. However, long-term benefits to soil would be unlikely for Kahuku and unmanaged portions of ‘Ōla‘a, for which no established population-level objective and fencing strategy has been identified. Also, the implementation of management tools and monitoring would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities. Because alternative A would not incorporate the comprehensive, systematic approach described in the “Elements Common to All Action Alternatives” section in chapter 2, it would be less likely that the NPS would progress through management phases, monitor, and apply management tools consistently as staff and institutional knowledge change over time.

Cumulative Impacts

Other past, present, and future actions in the areas adjacent to the park have affected or could affect soils. In particular, adverse effects have occurred and continue to occur from the introduction of non-native plant species and associated changes in the fire regime on the island. These plants and the fires they help create can reduce native vegetation cover, which contributes to erosion and loss of soil productivity. Past ranching activities in the park have also led to loss of vegetation and similar impacts on soils. Other actions that have caused or could cause increased soil loss or compaction include increased visitation and development inside the park, including development and maintenance of facilities, fences, and trails.

Other park management plans and actions, such as the fire management plan (NPS 2005a), contribute beneficially to soil resources. Fire management actions are designed to reduce the risk of fire caused by fire-promoting grasses, which provides an indirect benefit to soils (fewer fires mean less erosion), enhancing soil stability. The future implementation of the GMP for the park (currently in development) would also involve prescriptions for desired conditions related to the protection of natural resources balanced with those for visitor use, which is expected to increase as a result of increased tourism in the area. Effective non-native ungulate management in areas adjacent to the park would limit soil disturbance and allow for the recovery of native vegetation, which contributes to soil stability and productivity along park boundaries. Revegetation and sensitive species restoration activities (including USFWS recovery plans) would also contribute to such benefits. Law enforcement activities would contribute to beneficial impacts by protecting vegetation from being disturbed or displaced (which contributes to erosion and loss of soil productivity) by visitors who violate park rules and regulations, but would also contribute to localized minor adverse impacts should law enforcement officials need to conduct activities that could disturb vegetation (contributing to accelerated erosion and soil disturbance).

The acquisition of the Kahuku unit resulted in the increased protection of natural resources on these lands, including soils, due to implementing management actions under the interim operating plan that were not previously being implemented. The TMA partnership focuses on watershed protection efforts and providing important habitat for native species on thousands of acres, including areas adjacent to the park.

Natural resource and watershed protection on lands in and adjacent to the park has previously supported and will continue to support the protection and recovery of native vegetation, which contributes to soil stability. Areas adjacent to the park that are not managed for the conservation of native vegetation will likely continue to degrade due to the uncontained spread of invasive species.

These past, present, and reasonably foreseeable future actions would have short-term and long-term minor to moderate adverse and long-term beneficial impacts on soils. When combined with the impacts under alternative A, there would be short- and long-term minor to moderate adverse cumulative impacts on vegetation. Long-term beneficial cumulative impacts would be less likely under alternative A, because non-native ungulate management within the park would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities and implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.

Conclusion

Under alternative A, short-term, localized negligible adverse impacts to soils would result from ground-based management actions. In the older section of the park, long-term beneficial impacts on soil would result from the continuation of animal exclusion in current management units. Long-term beneficial impacts would be unlikely for the Kahuku unit and unmanaged portions of ‘Ōla‘a, where no established population-level objective or fencing strategy has been identified in a comprehensive and systematic plan.

The effects of alternative A, when combined with impacts of past, present, and reasonably foreseeable future actions on soil, would have short- and long-term minor to moderate adverse cumulative impacts. Long-term beneficial cumulative impacts would be less likely under alternative A, because non-native ungulate management would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities and implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.

Alternative B: Comprehensive Management Plan that Uses Lethal Removal Techniques

Analysis

Impacts to soils under alternative B would be limited to those associated with temporary ground-based management actions (including the presence of humans on foot, placing bait stations, shooting ungulates, setting traps and snares, monitoring and collecting data, constructing and repairing fences, and using dogs). Impacts would include those associated with any routine field activity, including temporary increases in soil compaction and possible erosion. Fencing would involve minor soil disturbances and trampling of any vegetation in the removal areas. The NPS would continue to pursue safe and effective non-toxic alternatives to the use of lead bullets. As part of direct reduction activities, trained dogs could be used to locate and flush or immobilize non-native ungulates to facilitate direct reduction from the ground (or from the air). Impacts on soils from these activities would be similar to those associated with routine field activities and would not have noticeable effects on soils. The duration and frequency of these actions would also decrease as the park moves from reduction into less intensive management phases. As a result, there would short-term, localized negligible adverse impacts on soils during management actions.

Removal of non-native ungulates would limit the threats they pose and would support recovery and restoration of soils. Soil disturbance results from digging by feral pigs or general disturbance related to non-native ungulates, such as removal of vegetation as a result of grazing by large numbers of goats, sheep, and mouflon. Heavy, sustained use by ungulates can weaken or kill vegetation, reduce soil cover, and thereby contribute to and accelerate surface erosion (USFWS n.d.). This is especially true in areas with steep slopes, along water flow paths, and in areas exposed to wind. Increased erosion also has the potential to decrease soil fertility. Consequently, reduction of ungulate browsing would eliminate a source of soil compaction and erosion. Improvements in native vegetation, including ground cover, would further reduce soil erosion potential.

As a result, under alternative B there would short-term, localized negligible adverse impacts on soils during management actions. Removal of non-native ungulates would limit the threats they pose to soils, resulting in long-term beneficial impacts. These benefits would be fully realized under alternative B because the comprehensive, systematic approach described in the “Elements Common to All Action Alternatives” section in chapter 2, would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative B would be the same as alternative A. The long-term beneficial and short-term and long-term minor to moderate adverse impacts of past, present, and reasonably foreseeable future actions on soils, when combined with the impacts of implementing alternative B, would have long-term beneficial and short- and long-term minor to moderate adverse cumulative impacts. These benefits would be fully realized under alternative B because the comprehensive, systematic approach described in the “Elements Common to All Action Alternatives” section in chapter 2, would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time.

Conclusion

Under alternative B, short-term, localized negligible adverse impacts to soils would result from ground-based management actions. Long-term beneficial impacts to soils would be fully realized under this alternative because the comprehensive, systematic approach described in the “Elements Common to All Action Alternatives” section in chapter 2, would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time.

The effects of alternative B, when combined with impacts of past, present, and reasonably foreseeable future actions on soil, would have short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts.

Alternative C: Comprehensive Management Plan that Maximizes Efficiency by Expanding Lethal Removal Techniques and Discontinuing the Use of Volunteers

Analysis

Similar to alternative B, alternative C would result in short-term, localized negligible adverse impacts to soils from ground-based management actions. Long-term beneficial impacts to soils would be fully realized under alternative C.

Because lethal techniques would be expanded and enhanced, and volunteers would not be used during direct reduction efforts under alternative C, it is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, more quickly than under alternative B. The increased efficiency associated with discontinuing the use of volunteers is based on additional work required by NPS staff to recruit, administer, train and direct volunteers in the field, and data that show that park staff remove more ungulates per day when they conduct direct reduction (ground shooting) themselves, compared to when they are accompanied by volunteers (Stephens et al. 2008). Therefore, fewer reduction activities would result when compared to alternative B.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative C would be the same as alternative A. Similar to alternative B, the long-term beneficial and short-term and long-term minor to moderate adverse impacts of past, present, and reasonably foreseeable future actions on soils, when combined with the impacts of implementing alternative C, would have long-term beneficial and short- and long-term minor to moderate adverse cumulative impacts on soils.

Conclusion

Under alternative C, short-term, localized negligible adverse impacts to soils would result from ground-based management actions. Long-term beneficial impacts to soils would be fully realized under this alternative. It is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, more quickly under alternative C than under alternative B. The effects of alternative C, when combined with impacts of past, present, and reasonably foreseeable future actions on soil, would have short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts.

Alternative D: Comprehensive Management Plan that Maximizes Flexibility of Management Techniques

Analysis

Similar to alternative B, alternative D would result in short-term, localized negligible adverse impacts to soils from ground-based management actions. Long-term beneficial impacts to soils would be fully realized under alternative D.

Under alternative D, it is possible that increased human and vehicular traffic associated with potential relocation activities could cause additional disturbance to soils during the process of capturing and relocating ungulates and driving animals to release sites. However, these impacts would be short-term and localized, and similar to impacts of other management actions.

Although the expansion and enhancement of lethal removal techniques under alternative D would be implemented with the goal of increasing the efficiency and cost effectiveness of ungulate management, the continued use of volunteers and the expansion of non-lethal techniques would counteract this to some extent. Inclusion of non-lethal removal would require additional staff time and park resources to capture, hold and relocate animals, and may increase the time associated with reduction actions over the life of the plan, as well as time needed to reach the post-reduction phase. As a result, it is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, less quickly than under alternative C.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative D would be the same as alternative A. Similar to alternative B, the long-term beneficial and short-term and long-term minor to moderate adverse impacts of past, present, and reasonably foreseeable future actions on soils, when combined with the impacts of implementing alternative D, would have long-term beneficial and short- and long-term minor to moderate adverse cumulative impacts on soils.

Conclusion

Under alternative D, short-term, localized negligible adverse impacts to soils would result from ground-based management actions. Long-term beneficial impacts to soils would be fully realized under this alternative. It is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, less quickly under alternative D than under alternative C. The effects of alternative D, when combined with impacts of past, present, and reasonably foreseeable future actions on soil, would have short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts.

Alternative E: Comprehensive Management Plan that Increases Flexibility of Management Techniques While Limiting the Use of Volunteers

Analysis

Similar to alternative B, alternative E would result in short-term, localized negligible adverse impacts to soils from ground-based management actions. Long-term beneficial impacts to soils would be fully realized under alternative E.

Similar to alternative D, it is possible that potential relocation activities could cause additional disturbance to soils during the process of capturing and relocating ungulates and driving animals to release sites under alternative E.

Although the expansion and enhancement of lethal removal techniques under alternative E would be implemented with the goal of increasing the efficiency and cost effectiveness of ungulate management, the expansion of non-lethal techniques would counteract this to some extent. However, because volunteers would not be used during direct reduction efforts under alternative E, it is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, more quickly than under alternative D, but less quickly than under alternative C.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative E would be the same as alternative A. Similar to alternative B, the long-term beneficial and short-term and long-term minor to moderate adverse impacts of past, present, and reasonably foreseeable future actions on soils, when combined with the impacts of implementing alternative E, would have long-term beneficial and short- and long-term minor to moderate adverse cumulative impacts on soils.

Conclusion

Under alternative E, short-term, localized negligible adverse impacts to soils would result from ground-based management actions. Long-term beneficial impacts to soils would be fully realized under this alternative. It is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, more quickly under alternative E than under alternative D, but less quickly than under alternative C. The effects of alternative E, when combined with impacts of past, present, and reasonably foreseeable future actions on soil, would have short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts.

SOUNDSCAPES

GUIDING REGULATIONS AND POLICIES

The NPS *Organic Act* (16 USC 1) establishes and authorizes the NPS "to conserve the scenery and the national and historic objects and wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations" (NPS 2009g). An important part of the ecological communities that the NPS wishes to preserve in national parks is the natural soundscape. Thus, there are many laws, regulations, and policies that guide the protection and management of natural soundscapes.

These laws cover several aspects of sound, including air tour management and overflights, visitor use, motorized equipment, and soundscape management.

Regarding general park soundscape management, NPS *Management Policies 2006*, section 4.9, requires that the NPS "preserve, to the greatest extent possible, the natural soundscapes of parks." Additionally, the NPS "will restore to the natural condition wherever possible those park soundscapes that have become degraded by the unnatural sounds (noise), and will protect natural soundscapes from unacceptable impacts" (NPS 2006b). Additionally, Director's Order 47: *Soundscape Preservation and Management* (NPS 2000) was developed to emphasize NPS policies "that will require, to the fullest extent practicable, the protection, maintenance, or restoration of the natural soundscape resource in a condition unimpaired by inappropriate or excessive noise sources." This director's order also directs park managers to measure acoustic conditions, differentiate existing or proposed human-caused sounds that are consistent with park purposes, set acoustic goals based on the sounds deemed consistent with the park purpose, and determine which noise sources are impacting the parks.

NPS Management Policies 2006, section 4.9, requires that the NPS "preserve, to the greatest extent possible, the natural soundscapes of parks." The NPS "will restore to the natural condition wherever possible those park soundscapes that have become degraded by the unnatural sounds (noise), and will protect natural soundscapes from unacceptable impacts" (NPS 2006b).

Primarily as a result of the growth of the air tour industry, the number of airplane and helicopter flights over national parks has increased. Consequently, in the 1990s Congress mandated the FAA and the NPS to manage air tours over parks to ensure that park resources do not suffer any loss of value due to air tour activities. As such, the *National Parks Air Tour Management Act* of 2000 requires the development of commercial ATMPs (NPS 2003b). Further, NPS *Management Policies 2006*, section 8.4, mandates that all necessary steps be taken to avoid or mitigate adverse effects from aircraft overflights in order to reduce adverse effects on resources and visitor enjoyment (NPS 2006b).

METHODOLOGY, ASSUMPTIONS, AND IMPACT THRESHOLDS

The methodology used to assess impacts on the natural soundscape from the management of non-native ungulates in Hawai'i Volcanoes National Park is consistent with NPS *Management Policies 2006* and Director's Order 47: *Soundscape Preservation and Noise Management* (NPS 2006b, 2000). The policies require the type, magnitude, duration, and frequency of occurrence of noise to be determined for the affected environment, as well as the significance of noise levels or impacts.

In addition to the impacts of noise on the soundscape in general, noise intrusions can impact specific resources in the park. The Hawai'i Volcanoes National Park resources most likely to be affected by management activities include the park's natural soundscape, wilderness areas, cultural resources, and noise-sensitive wildlife, primarily birds. These potential impacts are discussed in this plan/EIS under their respective impact topics—for example, impacts of noise on wildlife are discussed under "Native Wildlife and Wildlife Habitat" and impacts of noise on visitors are discussed under "Visitor Use and Experience." Analysis in this section is intended to disclose impacts on the natural soundscape in general, recognizing that sound is an intrinsic part of other resources and values at Hawai‘i Volcanoes National Park.

The primary elements associated with the management of non-native ungulates that may result in intrusions of noise on the natural soundscape include the use of vehicles, helicopters, and firearms in addition to gas generators, pneumatic post drivers, and rock drills for the construction and/or maintenance of fencing. Impacts were evaluated using the following assumptions and published information about vehicular, firearm, helicopter, and construction equipment noise, as well as data obtained from earlier acoustic measurements at Hawai‘i Volcanoes National Park. Additionally, consideration was given to the frequency and duration of management activities, as discussed in chapter 2. The impact analysis area for soundscapes includes the entire park as defined by 10 acoustic sampling areas for which the earlier acoustic measurements were conducted as part of the development of the Hawai‘i Volcanoes National Park ATMP. See appendix D for complete descriptions of acoustic sampling area information. No additional sound measurements were collected, nor was any noise modeling conducted.

The primary elements associated with the management of non-native ungulates that may result in intrusions of noise on the natural soundscape include the use of vehicles, helicopters, and firearms in addition to gas generators, pneumatic post drivers, and rock drills for the construction and/or maintenance of fencing.

Noise levels generated by vehicular sources vary by the volume of the traffic, the speed of the traffic, and the number of vehicles contributing to the volume. Typically, the loudness of traffic noise is increased by heavier traffic volumes, higher speeds, and greater numbers of trucks (FHWA 1995). Additionally, inclines cause greater laboring of vehicle engines, thereby resulting in increased traffic noise levels, especially for heavy trucks. However, as the distance from the vehicular source increases, noise levels are affected by terrain features, human-made obstacles, vegetation, and the distance from the source in general. Typically, noise levels drop off at a rate of 3 dBA per doubling of distance from the vehicular sound source (FHWA 1995). In Hawai‘i Volcanoes National Park, it is assumed that vehicles used for the management of non-native ungulates would be traveling at very low speeds, as park roadway speed limits range between 15 and 35 miles per hour (NPS 2008c).

Noise levels generated by firearms are highly dependent on the type of firearm as well as the ammunition used. For example, a comparison of shotgun noise data with centerfire rifle noise level data and centerfire pistol data reveal a range of sound levels from 150 to 170 decibels. Although these noise levels are extremely high, the explosive shockwave that emanates from the gun barrel (referred to as the muzzle blast) usually lasts 3 to 5 milliseconds and is strongest in the direction the barrel is pointing (Maher 2006). The acoustic wave associated with the muzzle blast propagates through the air, encountering meteorological and topographical features that alter the sound received at greater distances from the firearm (Maher 2007).

For the purposes of analyzing impacts from helicopters, it is assumed that flight paths could potentially cover the entire park; however, the degree of disturbance to the soundscape caused by the overflights is influenced by numerous factors, including the height AGL, the speed at which the helicopters fly, flight duration, frequency of flights, the percentage of time when only the natural soundscape is audible, and the time between flights. These are some of the measures that will be used to quantify disturbance or noise impacts on park resources for this NEPA analysis. It is assumed that a Hughes 500C helicopter, flying approximately 300 feet (91 meters) AGL, will be used for aerial assistance. Sound exposure levels for reasonable level flyover (LFO) speeds ranging from 60 to 130 knots, as well as a maximum noise level (L_{max}[1] value), were calculated based on best available information contained in the FAA report entitled *Helicopter Noise Exposure Curves for Use in Environmental Impact Assessment, November 1982*. The report depicts noise power distance curves for LFOs at speeds ranging between 60 and 130 knots, which account for how the noise power produced by the helicopter is changing with airspeed. The actual sound exposure level was computed based on applying an adjustment factor to the values obtained from the curves to account for the noise event duration change as the helicopter speed changes. The appropriate adjustment factors for each LFO were computed using the equation and applicable values for a Hughes 500C helicopter given in table 4.5-1 of the FAA report (FAA 1982). Sound exposure levels for LFOs ranging between 60 and 130 knots are depicted in table 22. The L_{max} value for 300 feet (91 meters) AGL was computed based on figure 4.4-1 in the FAA report, which depicts L_{max} values for several helicopters at 400 feet (122 meters) AGL for various glideslope angles.[2] A standard logarithmic equation, accounting for spherical spreading from a point source at a rate of 6 dBA per doubling or halving of distance, was applied to determine the L_{max} value at 300 feet (91 meters) AGL (CALTRANS 1998).[3]

TABLE 22: HUGHES 500C LEVEL FLYOVER SOUND EXPOSURE LEVELS

LFO Speed (knots)	LFO SEL (dBA)
60	88.98
80	85.72
100	85.22
120	87.98
130	91.52

SEL = sound exposure levels.

Construction equipment, including rock drills, gasoline generators, and pneumatic post drivers, that would potentially be used for the construction and/or maintenance of boundary fences would generate noise. The Federal Highway Administration's roadway construction noise model contains a list of the maximum noise levels (L_{max}) produced by common construction equipment at a distance of 50 feet, as listed in the equipment specifications. According to this list, the L_{max} at 50 feet (15 meters) from a rock drill and typical pneumatic tools is 85 dBA. The maximum noise emission level produced by a gasoline generator is dependent on several factors, including the size of the generator, whether or not it is equipped with mufflers, and the horsepower rating. Generally, given the fact that these boundary fences are or

[1] The SEL and Lmax were computed, as these are both values computed by the FAA's Integrated Noise Model, which is designed for modeling aircraft noise.

[2] For purposes of identifying the Lmax from the chart, a zero-degree glideslope angle was assumed applicable to a LFO condition.

[3] The logarithmic equation used to compute geometric divergence, also known as spherical spreading, is given by:

$$dBA2 = dBA1+20*\log10(D1/D2)$$

where

dBA1 = known reference noise level
D1 = reference distance at which noise level (dBA1) is known
D2 = distance at which noise level is desired
dBA2 = calculated noise level at desired distance (D2)

would be installed in remote locations, it is likely that the generator used to power the pneumatic post driver and rock drill for fence installment would be small. The main noise contributors from fence maintenance and construction would be the pneumatic post driver and rock drill. The generator noise would likely be inaudible during use of the rock drill and pneumatic post driver, although the noise from the generator would contribute to the overall sound level produced. Further, as the construction equipment used for fence installation may be thought of as point sources of noise, the radiation pattern is such that the noise level will drop off at a rate of 6 dBA per doubling of distance from the source (CALTRANS 1998). However, additional attenuation would be realized at distances from the equipment source due to vegetation and topography.

Thresholds were formulated for identifying soundscape impacts for use throughout the park as indicators of the magnitude of impact for each of the alternatives. Noise levels in the thresholds were selected qualitatively by describing them as very low, low, medium, and high (see table 10 in chapter 3). Impact intensity thresholds were defined for adverse impacts. For this plan/EIS, assignment of intensity levels for soundscape impacts are based on the potential for changes to such characteristics as follows:

Negligible: Natural sounds are audible and discernible, although human-caused noise may be audible very infrequently in local areas. When noise is present, it is at very low levels (mostly not measurable), passing, and rarely audible from a distance.

Minor: Natural sounds are audible and discernible, although human-caused noise is present occasionally in local areas. When noise is present, it is at measurable but low levels, passing, and rarely audible at a distance.

Moderate: Human-caused noise is present occasionally across most of an area. When present, it is at medium levels that may mask natural sounds briefly, and may be audible at a distance. High noise levels may occur, but would be very brief in duration.

Major: Human-caused noise is commonly present throughout an area and masks natural sounds for extended periods of time at medium to high noise intensity levels. Noise is audible at a distance and may be of high intensity in close proximity to the source.

IMPACTS OF THE ALTERNATIVES

Alternative A: No Action (Continue Existing Non-native Ungulate Management Activities)

Analysis

Actions associated with the use of firearms, vehicles, helicopters, and fence maintenance equipment under alternative A would have short-term moderate adverse impacts in all acoustic sampling areas at the park, as noise events from management actions would result in low to medium noise levels over brief intervals or high noise levels over very brief intervals. Most non-native ungulate removal efforts involve monitoring, snaring, trapping, and/or ground shooting; when needed, aerial operations are short, lasting no more than a couple of hours (see description in the “Elements Common to All Action Alternatives” section in chapter 2). Some aerial assistance may also be required during monitoring for non-native ungulates prior to reduction, and would be needed for fence repairs. Use of helicopters for these efforts would be intermittent and would last up to several hours at a time. Currently, ACETA flights last from 1 to 2 hours, during which the helicopter is flying at approximately 300 feet (91 meters) AGL searching for ungulates. When target animals are sighted, the helicopter then descends to between 30 and 60 feet (between 9 and 18 meters) AGL, depending on the surrounding vegetation. Due to the height of helicopter flights, noise levels generated at ground level would be well above the natural ambient sound level; however, such increases would be short term, only lasting for the duration of the management event. Ground shooting efforts may last a full day at a time, but it is assumed that shooting would not occur continuously for all hours during the management activity. Depending on where they are located, the use of firearms (either from the air or ground) would cause temporary increases in noise levels above the natural ambient levels to levels that could be considered high, for very brief periods of time. The use of noise suppressors for ground shooting would be considered, which would reduce impacts on the natural soundscape. However, noise associated with management actions would still temporarily mask natural sounds while management actions are being executed, and some noise (e.g., helicopters) could be audible at a distance, affecting the overall soundscape.

As part of non-native ungulate management, fence maintenance could require the use of a gasoline generator, pneumatic post driver, and rock drill. Noise levels generated by these pieces of equipment would be high in the immediate vicinity of the fence construction and would attenuate to medium levels at greater distances from the source. Generally, fences are located away from visitor campsites and most trails or they are obscured by dense vegetation so that noise is attenuated and intrusions are minimized.

Vehicle usage for non-native ungulate management activities in portions of zones that contain accessible roadways would contribute minimally to impacts on soundscapes. In most areas of the park, the number of vehicle trips associated with management activities, as well the volume of vehicles at any given time, would be insignificant and would not be noticeable relative to the vehicles traveling on these roadways for standard visitor uses, thereby resulting in negligible adverse impacts. In Kahuku, the number of vehicle trips associated with the management activities, as well as the volume of vehicles at any given time, would be few; however, though infrequent, the vehicle trips would be noticeable considering that few vehicles currently enter this area. No long-term effects on the natural quiet would occur from management actions.

The removal and exclusion of non-native ungulates would support the restoration of vegetation, which in turn would help attenuate human-caused sounds. It would also improve wildlife habitat, which could lead to an increase in natural sounds as populations of insects and birds increase.

In summary, alternative A would result in short-term moderate adverse impacts to soundscapes because ground-based and aerial management actions have the potential for brief periods of low to medium noise levels, with the potential for very brief moments of high noise levels. In the older section of the park, long-term beneficial impacts on soundscapes would result through the continuation of ungulate exclusion in current management units. However, long-term benefits would be unlikely for Kahuku and areas currently unmanaged (e.g., portions of ‘Ōla‘a), for which no established population-level objective and fencing strategy has been identified. Also, the implementation of management tools and monitoring would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities. Because alternative A would not incorporate the comprehensive, systematic approach described in the “Elements Common to All Action Alternatives” section in chapter 2, it would be less likely that the NPS would progress through management phases, monitor, and apply management tools consistently as staff and institutional knowledge change over time.

Cumulative Impacts

Many past, current, and reasonably foreseeable future actions, plans, and programs affect the natural soundscape of the park, which could contribute to beneficial cumulative impacts on natural soundscapes.

For example, non-native animal management inside the park and restoration of vegetation and sensitive species (including those addressed as part of USFWS recovery plans) may positively affect sound propagation to reduce intrusive human-induced sounds in portions of the park. The fire management plan would also contribute to the protection of vegetation, which could positively affect sound attenuation. Furthermore, the implementation of the ATMP in the future will provide acceptable and effective measures to mitigate or prevent significant adverse impacts, if any, from commercial air tour operations on the natural soundscape. Future implementation of the GMP will also provide beneficial effects on the natural soundscape, given that the GMP will address resource protection for the entire park.

Aside from actions resulting in beneficial effects, there are several past, current, and future actions, plans, and programs that could contribute to adverse cumulative effects on the natural soundscape. For example, some of the actions noted above may have short-term impacts from noise associated with the presence of people and equipment during implementation. Additionally, development and maintenance of park facilities, including roads and boundary fences, may result in temporarily increased noise levels and sounds inconsistent with park purposes or uses, thereby adversely affecting the natural soundscape. Additionally, air tour flights can occur with frequency in one area of the park, concentrating air tours on paths or in certain areas due to the volcanic activity visible. Changes in volcanic activity often result in increased visitation and subsequent increases in air tour numbers, which in turn may cause increased intrusions of human-created sounds on the natural soundscape of the park. Hawai‘i Volcanoes National Park has been known to experience 30 to 60 air tour flights per day when lava is visible. Although the creation of the ATMP might help to limit the numbers and impacts of air tours, the noise from air tours is anticipated to continue to add to the cumulative impacts on the soundscape. Impacts are anticipated to be greater prior to ATMP implementation. Changes in visitation at the park would likely also contribute to localized disturbances of natural soundscapes due to fluctuations in visitors in particular locations. Law enforcement activities would contribute to localized minor adverse impacts should law enforcement officials need to conduct activities that could disturb the natural soundscape, such as operating vehicles.

Activities on adjoining lands outside park boundaries could also impact park soundscapes. Land-clearing activities, such as those associated with logging, agriculture, and urbanization, not only contribute short-term impacts on soundscapes from the presence of people and equipment, but also long-term impacts from the loss of vegetation. This may affect sound propagation such that unwanted noise sources may travel more freely through open areas with less vegetation cover, thereby lengthening the extent of impacts from a particular sound source.

These past, present, and reasonably foreseeable future actions would have short-term moderate adverse and long-term beneficial impacts on soundscapes. Past, present, and reasonably foreseeable future actions, when combined with the short-term moderate adverse impacts of alternative A, would result in short-term moderate adverse cumulative impacts on soundscapes. Long-term beneficial cumulative impacts would be less likely under alternative A, because non-native ungulate management within the park would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities and implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.

Conclusion

Under alternative A, short-term moderate adverse impacts to soundscapes would result from ground-based and aerial management actions. In the older section of the park, long-term beneficial impacts on soundscapes would result through the continuation of ungulate exclusion in current management units. Long-term beneficial impacts would be unlikely for the Kahuku unit and areas currently unmanaged (e.g., portions of ‘Ōla‘a), where no established population-level objective or fencing strategy has been identified in a comprehensive and systematic plan. The effects of alternative A, when combined with impacts of past, present, and reasonably foreseeable actions on soundscapes, would have short-term moderate adverse cumulative impacts. Long-term beneficial cumulative impacts would be less likely under alternative A, because non-native ungulate management would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities and implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.

Alternative B: Comprehensive Management Plan that Uses Lethal Removal Techniques

Analysis

Alternative B would result in short-term moderate adverse impacts caused by the use of firearms, vehicles, helicopters, and fence maintenance equipment, which would create low to medium noise levels over brief intervals or high noise levels over very brief intervals. Most non-native ungulate removal efforts involve monitoring, snaring, trapping, and/or ground shooting; when needed, aerial operations are short, lasting no more than a couple of hours (see description in the “Elements Common to All Action Alternatives” section in chapter 2). Some aerial assistance may also be required during monitoring for non-native ungulates prior to reduction, and would be needed for fence repairs. Use of helicopters for these efforts would be intermittent and would last up to several hours at a time. Currently, ACETA flights last from 1 to 2 hours, during which the helicopter is flying at approximately 300 feet (91 meters) AGL searching for ungulates. When target animals are sighted, the helicopter then descends to between 30 and 60 feet (between 9 and 18 meters) AGL, depending on the surrounding vegetation. Due to the height of helicopter flights, noise levels generated at ground level would be well above the natural ambient sound level; however, such increases would be short term, only lasting for the duration of the management event. Ground shooting efforts may last a full day at a time, but it is assumed that shooting would not occur continuously for all hours during the management activity. Depending on where they are located, the use of firearms (either from the air or ground) would cause temporary increases in noise levels above the natural ambient levels to levels that could be considered high, for very brief periods of time. The use of noise suppressors for ground shooting would be considered, which would reduce impacts on the natural soundscape. However, noise associated with management actions would still temporarily mask natural sounds while management actions are being executed, and some noise (e.g., helicopters) could be audible at a distance, affecting the overall soundscape.

As part of non-native ungulate management, fence maintenance could require the use of a gasoline generator, pneumatic post driver, and rock drill. Noise levels generated by these pieces of equipment would be high in the immediate vicinity of the fence construction and would attenuate to medium levels at greater distances from the source. Generally, fences are located away from visitor campsites and most trails or they are obscured by dense vegetation so that noise is attenuated and intrusions are minimized.

Vehicle usage for non-native ungulate management activities in portions of zones that contain accessible roadways would contribute minimally to impacts on soundscapes. In most areas of the park, the number of vehicle trips associated with management activities, as well the volume of vehicles at any given time, would be insignificant and would not be noticeable relative to the vehicles traveling on these roadways for standard visitor uses, thereby resulting in negligible adverse impacts. In Kahuku, the number of vehicle trips associated with the management activities, as well as the volume of vehicles at any given time, would be few; however, though infrequent, the vehicle trips would be noticeable considering that few vehicles currently enter this area. No long-term effects on the natural quiet would occur from management actions.

The removal and exclusion of non-native ungulates would support the restoration of vegetation, which in turn would help attenuate human-caused sounds. It would also improve wildlife habitat, which could lead to an increase in natural sounds as populations of insects and birds increase.

Long-term beneficial and short-term moderate adverse impacts on soundscapes would result from implementation of alternative B. Long-term benefits would be fully realized because the comprehensive, systematic approach described in the “Elements Common to All Action Alternatives” section in chapter 2 would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative B would be the same as alternative A. The short-term moderate adverse and long-term beneficial impacts of past, present, and reasonably foreseeable future actions on soundscapes, when combined with the impacts of implementing alternative B, would have short-term moderate adverse and long-term beneficial cumulative impacts. Long-term benefits would be fully realized because the comprehensive, systematic approach described in the “Elements Common to All Action Alternatives” section in chapter 2 would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time.

Conclusion

Under alternative B, short-term moderate adverse impacts to soundscapes would result from the use of firearms, vehicles, helicopters, and fence maintenance equipment. Long-term beneficial impacts to soundscapes would be fully realized under this alternative because the comprehensive, systematic approach described in the “Elements Common to All Action Alternatives” section in chapter 2 would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time.

The effects of alternative B, when combined with impacts of past, present, and reasonably foreseeable actions on soundscapes, would have short-term moderate adverse and long-term beneficial cumulative impacts.

Alternative C: Comprehensive Management Plan that Maximizes Efficiency by Expanding Lethal Removal Techniques and Discontinuing the Use of Volunteers

Analysis

Similar to alternative B, alternative C would result in short-term moderate adverse impacts to soundscapes in all acoustic sampling areas in the park. Long-term beneficial impacts to soundscapes would be fully realized under alternative C.

Because lethal techniques would be expanded and enhanced, and volunteers would not be used during direct reduction efforts under alternative C, it is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, more quickly than under alternative B. The increased efficiency associated with discontinuing the use of volunteers is based on additional work required by NPS staff to recruit, administer, train and direct volunteers in the field, and data that show that park staff remove more ungulates per day when they conduct direct reduction (ground shooting) themselves, compared to when they are accompanied by volunteers (Stephens et al. 2008). Therefore, fewer reduction activities would result when compared to alternative B.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative C would be the same as alternative A. Similar to alternative B, the long-term beneficial and short-term moderate adverse impacts of past, present, and reasonably foreseeable future actions on soundscapes, when combined with the impacts of implementing alternative C, would have long-term beneficial and short-term moderate adverse cumulative impacts.

Conclusion

Under alternative C, short-term moderate adverse impacts to soundscapes would result from the use of firearms, vehicles, helicopters, and fence maintenance equipment. Long-term beneficial impacts to soundscapes would be fully realized under this alternative. It is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, more quickly under alternative C than under alternative B. The effects of alternative C, when combined with impacts of past, present, and reasonably foreseeable actions on soundscapes, would have short-term moderate adverse and long-term beneficial cumulative impacts.

Alternative D: Comprehensive Management Plan that Maximizes Flexibility of Management Techniques

Analysis

Similar to alternative B, alternative D would result in short-term moderate adverse impacts to soundscapes in all acoustic sampling areas in the park. Long-term beneficial impacts to soundscapes would be fully realized under alternative D.

Under alternative D, it is possible that increased human and vehicular traffic associated with potential relocation activities could cause additional disturbance to soundscapes during the process of capturing and relocating ungulates and driving animals to release sites. However, these impacts would be short-term and localized, and similar to impacts of other management actions.

Although the expansion and enhancement of lethal removal techniques under alternative D would be implemented with the goal of increasing the efficiency and cost effectiveness of ungulate management, the continued use of volunteers and the expansion of non-lethal techniques would counteract this to some extent. Inclusion of non-lethal removal would require additional staff time and park resources to capture, hold and relocate animals, and may increase the time associated with reduction actions over the life of the plan, as well as time needed to reach the post-reduction phase. As a result, it is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, less quickly than under alternative C.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative D would be the same as alternative A. Similar to alternative B, the long-term beneficial and short-term moderate adverse impacts of past, present, and reasonably foreseeable future actions on soundscapes, when combined with the impacts of implementing alternative D, would have long-term beneficial and short- and long-term minor to moderate adverse cumulative impacts.

Conclusion

Under alternative D, short-term moderate adverse impacts to soundscapes would result from the use of firearms, vehicles, helicopters, and fence maintenance equipment. Long-term beneficial impacts to soundscapes would be fully realized under this alternative. It is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, less quickly under alternative D than under alternative C. The effects of alternative D, when combined with impacts of past, present, and reasonably foreseeable actions on soundscapes, would have short-term moderate adverse and long-term beneficial cumulative impacts.

Alternative E: Comprehensive Management Plan that Increases Flexibility of Management Techniques While Limiting the Use of Volunteers

Analysis

Similar to alternative B, alternative E would result in short-term moderate adverse impacts to soundscapes in all acoustic sampling areas in the park. Long-term beneficial impacts to soundscapes would be fully realized under alternative E.

Similar to alternative D, it is possible that potential relocation activities could cause additional disturbance to soundscapes during the process of capturing and relocating ungulates and driving animals to release sites under alternative E.

Although the expansion and enhancement of lethal removal techniques under alternative E would be implemented with the goal of increasing the efficiency and cost effectiveness of ungulate management, the expansion of non-lethal techniques would counteract this to some extent. However, because volunteers would not be used during direct reduction efforts under alternative E, it is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, more quickly than under alternative D, but less quickly than under alternative C.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative E would be the same as alternative A. Similar to alternative B, the long-term beneficial and short-term moderate adverse impacts of past, present, and reasonably foreseeable future actions on soundscapes, when combined with the impacts of implementing alternative E, would have long-term beneficial and short-term moderate adverse cumulative impacts.

Conclusion

Under alternative E, short-term moderate adverse impacts to soundscapes would result from the use of firearms, vehicles, helicopters, and fence maintenance equipment. Long-term beneficial impacts to soundscapes would be fully realized under this alternative. It is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, more quickly under alternative E than under alternative D, but less quickly than under alternative C. The effects of alternative E, when combined with impacts of past, present, and reasonably foreseeable actions on soundscapes, would have short-term moderate adverse and long-term beneficial cumulative impacts.

LAND MANAGEMENT ADJACENT TO THE PARK

GUIDING REGULATIONS AND POLICIES

The CEQ regulations implementing NEPA (40 CFR 1502.16 and 1506.2[d]) and Director's Order 12 (NPS 2001a) require that the NPS consider the possible conflicts between an action and the objectives of other federal, state, local, or tribal land use plans, policies, and controls for an area.

METHODOLOGY, ASSUMPTIONS, AND IMPACT THRESHOLDS

The assessment of potential impacts on land management adjacent to the park focuses on the effects of non-native ungulate management activities in the park on the goals and objectives for the numerous federal, state, and nonprofit entities surrounding the park, as well as other conservation efforts and development outside the park. Management of non-native ungulates is assumed to be compatible with the goals and objectives of the land use plans/of those agencies that also engage in non-native ungulate management, such as the Natural Area Reserves System, Kamehameha Schools, and TNC, and would not affect the land management of these entities adversely. The social and economic effects on adjacent private lands are considered under the "Socioeconomics" impact topic discussed in this chapter. According to NPS-NEPA practice, impact intensity thresholds are defined for adverse impacts based on the potential for changes to such characteristics, as follows:

Negligible: Goals and objectives for adjacent land management would not be impacted, and there would be minimal changes in how these areas are administered. These changes would not be of any measurable or perceptible consequence.

Minor: Impacts would not preclude an agency's ability to meet goals and objectives for surrounding lands, although there could be some effects that are not compatible. Changes in how areas are administered could occur, but they would be simple and would not appreciably affect the agency responsible for managing the land.

Moderate: Impacts would not be compatible with an agency's goals and objectives for surrounding lands, although impacts would not preclude their ability to meet the related desired conditions. Changes in how areas are administered would be required, but they would be simple and would not appreciably affect the agency responsible for managing the land.

Major: Impacts would not be compatible with an agency's goals and objectives for surrounding lands and would preclude their ability to meet the related desired conditions. Changes in how areas are administered would be required and would appreciably affect the agency responsible for managing the land.

IMPACTS OF THE ALTERNATIVES

Alternative A: No Action (Continue Existing Non-native Ungulate Management Activities)

Analysis

Under alternative A, park staff would continue to monitor and remove ingress ungulates from existing managed units. Where existing boundary fences occur, impacts of removal efforts on non-native ungulate populations outside the park would be negligible. For adjacent landowners seeking to protect native species and ecosystems on portions of their lands (e.g., state, federal and private non-profit members of TMA) they could experience benefits from the repair, installation, and maintenance of park boundary fences, which would also serve as boundary fences on their lands. Also, recovery of native species and habitat as a result of ungulate management inside the park would benefit adjacent members sharing similar goals, through facilitating species movement into the area and restoring habitat connectivity. The NPS would continue to coordinate with these entities by sharing information, allowing access to NPS lands for research, and providing assistance at similar to current levels.

Impacts of any future removal efforts would be uncertain for areas adjacent to currently unmanaged portions of the park and for which no population objective or fencing strategy has been identified (e.g., portions of ‘Ōla‘a and Kahuku). Without a comprehensive plan articulating these goals and management implementation, non-native ungulate removal could potentially impact populations outside the park. Local concentrations of these animals could remain the same, increase, or decrease, depending on the actions taken by park staff and the location of future fences. Adjacent lands with the potential to be impacted include state lands with goals for game management, as well as areas managed by federal and state agencies, and nonprofit organizations who seek to protect native species and ecosystems through ungulate removal and fencing. However, for these and other landowners adjacent to the park, actions on NPS lands to manage non-native ungulates would not change how their lands are administered and would not preclude adjacent land managers from ultimately achieving their desired conditions.

In summary, alternative A would result in short- and long-term negligible to moderate adverse and beneficial impacts on land management adjacent to current park management units. Where existing boundary fences occur, impacts of removal efforts on non-native ungulate populations outside the park would be negligible. However, impacts of any future removal efforts would be uncertain for areas adjacent to currently unmanaged portions of the park (e.g., portions of ‘Ōla‘a and Kahuku).

Cumulative Impacts

Other past, present and reasonably foreseeable future actions on adjacent lands, including the introduction of non-native ungulate game species to the island, can influence the population of non-native ungulates in the park and in adjacent lands. Other activities, such as land clearing, grazing, ranching, and development outside the park (partly as a result of community planning in the area) have decreased available habitat in the area. Although no additional game animals have been brought to the island, the state currently maintains these populations in adjacent lands for hunting, an activity which is expected to continue for the life of this plan. Other past actions that still occur and would be expected to continue to occur include grazing; ranching; development leading to urbanization, which includes a shift in demographics and an increase in the demand for second homes on the island; and changes in the fire regime on the island.

As the number of non-native species increases, habitat alteration occurs and the native species in the area decline. Related impacts on natural and cultural resources create long-term minor to moderate adverse impacts for some land managers with a focus on preserving natural and cultural resources, as these impacts are not compatible with their management objectives. For those land managers that depend on non-native ungulates as a game species, their continued presence could result in long-term beneficial impacts.

Other actions occurring on the island both in the past and into the future include non-native ungulate management and fencing efforts outside the park on state and federal lands to remove and exclude ungulates, implementation of USFWS recovery plans for sensitive species inside and outside the park, control of other non-native species both inside the park and on adjacent lands, and other conservation efforts inside and outside the park. These activities would benefit agencies and other entities adjacent to the park whose land management goals included perpetuation of native species and ecosystems. These actions would all have long-term beneficial impacts on land management at the park, as well as on surrounding lands.

Land management on adjacent lands is also influenced by past, present, and future park planning efforts, such as land acquisition (the past acquisition of Kahuku and any potential future acquisitions), development and implementation of the GMP, fire management plans, the proposed Mauna Loa trail system (an ongoing feasibility study), the implementation of the *Ala Kahakai National Historic Trail Management Plan*, and air tour planning (including current activities and the future implementation of the ATMP). Many of these plans would have beneficial impacts on land management on NPS lands, as well as adjacent lands. Fire management at the urban/wildland interface would benefit land management on adjacent lands, as large-scale fire events would be prevented. Further beneficial impacts could result from the NPS acquisition of any future lands by preserving these lands and managing them in accordance with NPS policies. These policies, which direct management of non-native species, vegetation, wilderness, and fire, would have beneficial impacts on any lands managed by the NPS.

These past, present, and reasonably foreseeable future actions would have long-term minor to moderate adverse and beneficial impacts to land management agencies adjacent to the park. Past, present, and reasonably foreseeable future actions, when combined with the impacts of alternative A, would have long-term minor to moderate adverse and beneficial cumulative impacts on land management adjacent to the park.

Conclusion

Alternative A would result in short- and long-term negligible to moderate adverse and beneficial impacts on land management adjacent to current park management units. Where existing boundary fences occur, impacts of removal efforts on non-native ungulate populations outside the park would be negligible. However, impacts of any future removal efforts would be uncertain in areas currently unmanaged and for which no population objective or fencing strategy has been identified (e.g., portions of ‘Ōla‘a and Kahuku). The long-term minor to moderate adverse and beneficial impacts of past, present, and reasonably foreseeable future actions on land management adjacent to the park, when combined with the impacts of implementing alternative A, would have long-term minor to moderate adverse and beneficial cumulative impacts on land management adjacent to the park.

Alternative B: Comprehensive Management Plan that Uses Lethal Removal Techniques

Analysis

Under alternative B, park boundary fences would limit the impact of removal efforts inside the park on non-native ungulate populations outside the park. Where existing boundary fences occur, impacts of removal efforts on non-native ungulate populations outside the park would be negligible. Proposed new boundary fences, would minimize impacts of removal efforts conducted inside the park on populations outside the park. Local concentrations of these animals could remain the same, increase, or decrease, depending on available forage, appropriate habitat, and carrying capacity on adjacent lands.

Adjacent lands with the potential to be impacted include areas managed by federal and state agencies, as well as nonprofit organizations that practice non-native ungulate management on portions of their lands through removal and fencing. Entities in this group include the NPS, USFWS, State of Hawaiʻi, Kamehameha Schools, and TNC. Under alternative B, the NPS would continue to coordinate with these entities by sharing information, allowing access to NPS lands for research, and providing assistance at similar to current levels. Actions on NPS lands to manage non-native ungulates would not change how these lands are administered and would not preclude adjacent land managers from ultimately achieving their desired conditions. As co-members of the TMA share property boundaries with the NPS, they could experience benefits from the repair, installation, and maintenance of park boundary fences, which would also serve as boundary fences on their lands. Also, recovery of native species and habitat as a result of ungulate management inside the park would benefit recovery efforts by adjacent members, via facilitating native species movement into the area and restoring habitat connectivity.

In addition to these interests, state lands with goals for game management also exist adjacent to the park. Management in the adjacent State Forest Reserves and Game Management Areas includes regulations to maintain game animal populations, such as bag limits, combined with objectives related to recreation and forestry. For these and other state or privately owned lands, actions on NPS lands to manage non-native ungulates would not change how these lands are administered and would not preclude adjacent land managers from ultimately achieving their desired conditions. Consequently, a potential change in non-native ungulate populations outside the park would have short- and long-term negligible to minor adverse and beneficial impacts on these areas, depending on how they would continue to be managed for multiple uses.

In summary, alternative B would result in short- and long-term negligible to minor adverse and beneficial impacts on land management adjacent to current park management units.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative B would be the same as alternative A. The long-term minor to moderate adverse and beneficial impacts of past, present, and reasonably foreseeable future actions on land management adjacent to the park, when combined with the impacts of implementing alternative B, would have long-term, minor to moderate adverse and beneficial cumulative impacts on land management adjacent to the park.

Conclusion

Alternative B would result in short- and long-term negligible to minor adverse and beneficial impacts on land management adjacent to the park. Proposed new boundary fences, would minimize impacts of removal efforts conducted inside the park on populations outside the park. The long-term minor to moderate adverse and beneficial impacts of past, present, and reasonably foreseeable future actions on land management adjacent to the park, when combined with the impacts of implementing alternative B, would have long-term, minor to moderate adverse and beneficial cumulative impacts on land management adjacent to the park.

Alternative C: Comprehensive Management Plan that Maximizes Efficiency by Expanding Lethal Removal Techniques and Discontinuing the Use of Volunteers

Analysis

Similar to alternative B, alternative C would result in short- and long-term negligible to minor adverse and beneficial impacts on land management adjacent to current park management units. Boundary fences would minimize impacts of removal efforts on non-native ungulate populations outside the park.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative C would be the same as alternative A. Similar to alternative B, the long-term minor to moderate adverse and beneficial impacts of past, present, and reasonably foreseeable future actions on land management adjacent to the park, when combined with the impacts of implementing alternative C, would have long-term, minor to moderate adverse and beneficial cumulative impacts on land management adjacent to the park.

Conclusion

Alternative C would result in short- and long-term negligible to minor adverse and beneficial impacts on land management adjacent to current park management units. Boundary fences would minimize impacts of removal efforts on non-native ungulate populations located outside the park. The long-term minor to moderate adverse and beneficial impacts of past, present, and reasonably foreseeable future actions on land management adjacent to the park, when combined with the impacts of implementing alternative C, would have long-term, minor to moderate adverse and beneficial cumulative impacts on land management adjacent to the park.

Alternative D: Comprehensive Management Plan that Maximizes Flexibility of Management Techniques

Analysis

Similar to alternative B, alternative D would result in short- and long-term negligible to minor adverse and beneficial impacts on land management adjacent to current park management units. Boundary fences would minimize impacts of removal efforts on non-native ungulate populations outside the park.

Under alternative D, the NPS would investigate the possibility of relocating non-native ungulates, such as feral sheep, mouflon and pigs, to other lands. In order to minimize potential adverse impacts of moving animals, all potential relocation activities would require willing recipients and would be carried out in close cooperation with the state. When considering areas to relocate animals, the NPS would avoid sites where undesirable impacts to the environment could occur (e.g., rare native plants and animals, critical habitat, soils, cultural resources etc.). Any necessary permissions and permits would be obtained prior to relocation activities. Prior to transporting animals to other locations, any necessary disease testing required by the state would be conducted. Relocation could provide some benefits to the willing recipient depending on their land management objectives (e.g., increasing game opportunities).

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative D would be the same as alternative A. Similar to alternative B, the long-term minor to moderate adverse and beneficial impacts of past, present, and reasonably foreseeable future actions on land management adjacent to the park, when combined with the impacts of implementing alternative D, would have long-term, minor to moderate adverse and beneficial cumulative impacts on land management adjacent to the park.

Conclusion

Alternative D would result in short- and long-term negligible to minor adverse and beneficial impacts on land management adjacent to current park management units. Boundary fences would minimize impacts of removal efforts on non-native ungulate populations located outside the park. When considering areas to relocate animals, the NPS would avoid sites where undesirable impacts to the environment could occur. The long-term minor to moderate adverse and beneficial impacts of past, present, and reasonably foreseeable future actions on land management adjacent to the park, when combined with the impacts of implementing alternative D, would have long-term, minor to moderate adverse and beneficial cumulative impacts on land management adjacent to the park.

Alternative E: Comprehensive Management Plan that Increases Flexibility of Management Techniques While Limiting the Use of Volunteers

Analysis

Similar to alternative B, alternative E would result in short- and long-term negligible to minor adverse and beneficial impacts on land management adjacent to current park management units. Boundary fences would minimize impacts of removal efforts on non-native ungulate populations outside the park.

Similar to alternative D, potential relocation activities would require willing recipients and would be carried out in close cooperation with the state. When considering areas to relocate animals, the NPS would avoid sites where undesirable impacts to the environment could occur (e.g., rare native plants and animals, critical habitat, soils, cultural resources etc.) could occur. Any necessary permissions and permits would be obtained prior to relocation activities. Prior to transporting animals to other locations, any necessary disease testing required by the state would be conducted. Relocation could provide some benefits to the willing recipient depending on their land management objectives (e.g., increasing game opportunities).

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative E would be the same as alternative A. Similar to alternative B, the long-term minor to moderate adverse and beneficial impacts of past, present, and reasonably foreseeable future actions on land management adjacent to the park, when combined with the impacts of implementing alternative E, would have long-term, minor to moderate adverse and beneficial cumulative impacts on land management adjacent to the park.

Conclusion

Alternative E would result in short- and long-term negligible to minor adverse and beneficial impacts on land management adjacent to current park management units. Boundary fences would minimize impacts of removal efforts on non-native ungulate populations located outside the park. When considering areas to relocate animals, the NPS would avoid sites where undesirable impacts to the environment could occur. The long-term minor to moderate adverse and beneficial impacts of past, present, and reasonably foreseeable future actions on land management adjacent to the park, when combined with the impacts of implementing alternative E, would have long-term, minor to moderate adverse and beneficial cumulative impacts on land management adjacent to the park.

SOCIOECONOMICS

GUIDING REGULATIONS AND POLICIES

NEPA requires an EIS for any major federal action that significantly affects the human environment, including the socioeconomic effects of a proposal. In addition, NEPA requires that agencies examine the indirect effects of their proposed actions, which are defined as "reasonably foreseeable impacts that occur removed in time or space from the proposed action" (40 CFR 1508.8). For instance, such indirect effects of an agency's proposal could include impacts on land uses and resources of neighboring local, state, or federal land jurisdictions. In addition, the NPS *Management Policies 2006* charges the NPS with working "cooperatively with others to improve the condition of parks … and to integrate parks into sustainable ecological, cultural, and socioeconomic systems" (NPS 2006b, section 2.1.3). The same policies discuss impacts as "the likely effect of an action or proposed action upon specific natural, cultural, or socioeconomic resources" (NPS 2006b, glossary).

METHODOLOGY, ASSUMPTIONS, AND IMPACT THRESHOLDS

The study area analyzed for the socioeconomic impacts of the proposed alternatives is Hawai'i County, which encompasses Hawai'i Volcanoes National Park and includes the entire Big Island of Hawai'i.

This section analyzes the relationships among the non-native ungulate management options and socioeconomic variables in the region. The relevant socioeconomic variables identified in this analysis include the number of recreational visits, the economic impacts of park recreation and tourism on spending, park spending and payroll impacts, income and jobs in the local economy, and the social values of local communities, visitors, and adjacent private landowners. The socioeconomic impacts from each alternative are evaluated for visitation and recreation; nonmarket social values, and NPS spending and payroll. The specific impacts are discussed in more detail below.

The NPS uses the Money Generation Model to estimate the economic impacts of park unit recreation visits and park payroll on local economies. The economic impacts of Hawai'i Volcanoes National Park were evaluated using the Money Generation Model for the year 2007 (Stynes 2008). Current policies and prevailing conditions provide the basis for constructing baseline conditions in the no-action alternative. Each action alternative is assessed relative to the no-action alternative.

Impact intensity thresholds were defined for adverse impacts. For this plan/EIS, assignment of intensity levels for socioeconomic impacts are based on the potential for changes to such characteristics as follows:

Negligible: The effects on neighboring landowners or other socioeconomic conditions would be below or at the level of detection.

Minor: The effects on neighboring landowners or other socioeconomic conditions would be small but detectable. The alternative would affect only a few adjacent landowners.

Moderate: The effects on neighboring landowners or other socioeconomic conditions would be readily apparent. Changes would be confined locally, and would affect more than a few adjacent landowners.

Major: The effects on neighboring landowners or other socioeconomic conditions would be readily apparent and substantial. Changes would extend beyond the local area, and would affect the majority of adjacent landowners.

IMPACTS OF THE ALTERNATIVES

Alternative A: No Action (Continue Existing Non-native Ungulate Management Activities)

Analysis

Visitation and Recreation Spending

Hawai‘i Volcanoes National Park attracts millions of visitors a year; between 1990 and 2009, the park experienced an average of approximately 1.3 million visitors annually. These visitors spend their money on hotels, restaurants, and retail, supporting local business in the region. In 2007, total spending from nonlocal visitors was estimated to be $109 million, generating $67 million in gross regional product, $43 million in labor income, and supporting 2,199 jobs on the island (Stynes 2008).

Under the no-action alternative, implementation of management actions, including monitoring, direct reduction with firearms, and fencing, would temporarily create noise from the use of helicopters and/or firearms that could have social effects on visitors, local communities, or adjacent private landowners. However, the use of helicopters is limited typically to one to two hours and are confined to specific areas of the park. Fences are generally located away from visitor campsites and most trails or are obscured by dense vegetation, which reduces the potential for visual and aesthetic impacts.

Temporary closures could be used to minimize visitor exposure to management actions, but they also could preclude visitors from accessing an area to engage in desired recreational opportunities. Considering past experience, closures would generally be used infrequently, and the public would be notified of them in advance so they can adjust their plans. Actions may begin in the early morning and continue throughout the day; however, in areas where visitor use is high, actions would typically be limited to the early morning or off-peak hours in order to reduce impacts on visitor use, reducing the frequency and duration of closures. In addition, the entire park would not be closed to the public for management actions. A diversity of key visitor destinations would always be open and available for visitation to accommodate park visitors during any localized temporary closures.

Because temporary impacts from management actions would not appreciably affect visitor satisfaction at the park or cause changes in the number of visitors, alternative A would not affect the contribution that tourism and recreational spending has to local economies.

Nonmarket Social Values

Local economies are not expected to be affected, as there are no changes in visitation expected; however, there are non-market social and environmental values that would be affected by the recreational experience and condition of the resource. For example, visitors and residents who value a quiet, natural experience could be adversely affected in the short term due to temporary closures, noise, and the presence of fencing. Conversely, visitors would experience beneficial impacts as a result of increased opportunities for viewing native species and ecosystems (please refer to the “Visitor Use and Experience” section of this chapter).

Although lethal methods of non-native ungulate control are notably efficient and cost-effective approaches to meet the objective of zero ungulates in park lands, these lethal methods could be more controversial and less socially acceptable than other, non-lethal, methods. As a result, alternative A is expected to have short-term minor adverse impacts on the experiences and perceptions of some residents, visitors, and stakeholders. Over time, these adverse effects will decrease as fewer ungulates will need to be removed by lethal methods.

Conversely, the volunteer control program provides social benefits to local residents, and the program attracts high volunteer interest (NPS 2007c). The majority of volunteers are typically from local communities on the Island of Hawaiʻi. This program allows local residents to participate in the protection of resources in the park; provides interaction with the park staff, which supports social connectedness and public–federal relations; and promotes communication among landowners of the region. As the participants typically participate only once in the volunteer program, and because the park is surrounded by public hunting areas in state game and forest reserves that are routinely used by the communities in the areas of concern, the benefits derived from the NPS volunteer control program are relatively minor. Therefore, it is expected that the social effects of alternative A would continue to have short-term beneficial impacts on community residents who participate in this program.

The non-native ungulate management actions under alternative A would reduce threats posed by animals to native ecosystems, and support protection of rare, unique, threatened, or endangered species and their habitat in the park that contribute to the park's designation as a biosphere reserve and world heritage site, which attracts visitors from around the world. In the older section of the park, such long-term beneficial impacts would result through the continuation of ungulate exclusion in current management units. However, long-term benefits would be unlikely for Kahuku and areas currently unmanaged (e.g., portions of ʻŌlaʻa), for which no established population-level objective and fencing strategy has been identified. Also, the implementation of management tools and monitoring would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities. Because alternative A would not incorporate the comprehensive, systematic approach described in the "Elements Common to All Action Alternatives" section in chapter 2, it would be less likely that the NPS would progress through management phases, monitor, and apply management tools consistently as staff and institutional knowledge change over time.

NPS Spending and Payroll

Hawaiʻi Volcanoes National Park also contributes to the local economy by providing jobs to park employees, including seasonal, term, and permanent full-time or part-time positions (see the "Park Management and Operations" section of chapter 3 for more detail). The park also supports the local economy when local vendors are used for purchases, supplies, and/or contracted services, such as fencing supplies.

Under alternative A, the socioeconomic impacts of the non-native ungulate management program would have beneficial impacts on local communities as a result of park payroll and spending on non-native ungulate control, fencing, and related supplies. Funding for non-native ungulate monitoring and removal, fence repair and replacement equaled a total of $921,000 per year, averaged across the 3 years from FY 2006 to FY 2008 (Loh, pers. comm., 2010a), and included management activities in the Kahuku unit (i.e., new fence construction, monitoring and ungulate removal, and administration of the Volunteer Ungulate Control Program). This was approximately 14 percent of the park budget in FY 2008.

Cumulative Impacts

Other past, present, and reasonably foreseeable future actions in and around the park have affected or could affect the socioeconomic resources in the region. Although there have been historic actions that have caused adverse impacts on the natural environmental conditions, there are cumulative management actions that have the possibility to reverse and improve these resource conditions, beneficially impacting socioeconomic variables in the long term.

Land clearing, habitat fragmentation, and loss of vegetation, all resulting from past logging activities, agricultural use (including ranching), and development (including residential growth from retirees, demand for second homes, and community land use plans), contribute negatively to those visitors, residents (including landowners adjacent to the park), and second homeowners seeking more pristine conditions. Non-native species introductions and resulting changes in the fire regime also contribute to degradation of natural resources, which affects social values for some residents and visitors. However, past logging activities, agricultural use (including ranching), and development (including growth from retirees, demand for second homes, and community land use plans) have also contributed to an increase in money coming into and being spent in the community. Increased aviation activities inside and outside the park can create excessive noise from overflights, negatively impacting visitors and residents who value natural quiet, while at the same time contributing to the positive economic growth on the island (e.g., commercial air tours).

Some of these negative effects would be offset by other past, present, and reasonably foreseeable future actions. In addition to these negative effects, many past, current, and future actions, plans, and programs at the park would enhance the experience of visitors, residents, and second homeowners. For example, aviation activities would be managed in accordance with the forthcoming ATMP, which would minimize impacts on park resources. Non-native species management actions that would benefit visitors, residents, and second homeowners by protecting and restoring native habitat on these lands include fencing efforts outside the park on state and federal lands to remove and exclude non-native ungulates; control of other non-native species, both inside the park and on adjacent lands; implementation of USFWS recovery plans for sensitive species in the park; and conservation efforts outside the park. These native ecosystems are what many visitors come to Hawai‘i to experience, thus increasing tourism (and tourism spending) when these conditions are met. Fire management activities in the park and on surrounding lands also contribute to these benefits. Fire management at the WUI by both the NPS and local communities would also benefit adjacent private landowners, as large-scale fire events would be contained or mitigated through implementation of the park’s fire management plans, community wildfire protection plans, and agreements among federal, state, and county agencies to provide mutual assistance in the event of wildfire. These changes improve the social and environmental values of residents and visitors. If improvements are such that visitation is expected to increase, positive economic impacts on local economies could occur.

Further beneficial impacts would result from the NPS acquisition of Kahuku, as well as the future acquisition of any new lands, by preserving these lands and managing them in accordance with NPS policies. The acquisition of new lands (including Kahuku) would provide for increased areas for visitors and residents to use and experience, and could also alleviate crowding in other sections of the park. Park educational programs and interpretation activities increase awareness of the ecosystems in the park, as well as the cultural importance of the park. The forthcoming GMP will address issues such as (but not limited to) enhancing the visitor experience (e.g., interpretation and educational objectives as well as visitor facilities), cultural and natural resources management, transportation (e.g., roads and trails), commercial services, park spending, and employment. All of these actions would have beneficial impacts on socioeconomics, as they would influence visitation to the park, thus increasing money being spent at the park and in surrounding communities. If NPS employment increases as a result of these activities, this would also have beneficial impacts on local communities.

The state currently maintains populations of feral pigs, goats, mouflon, and sheep on adjacent state lands for hunting, an activity that is expected to continue for the life of this plan. Hunters obtain recreational and social values from these lands and are also allowed to retain the meat from these activities.

These past, present, and reasonably foreseeable future actions would have long-term minor adverse and long-term beneficial impacts on socioeconomic variables, such as visitor spending, economic contribution to local economies, and social and environmental values. Past, present, and reasonably foreseeable future actions, when combined with the short-term negligible to minor adverse impacts, and long-term beneficial impacts of alternative A, would have short- and long-term minor adverse and long-term beneficial cumulative impacts on socioeconomic resources.

Conclusion

Under alternative A, non-native ungulate management program would have beneficial impacts on local communities as a result of park payroll and spending on non-native ungulate control, fencing, and related supplies. Impacts to non-market social values would be minor, short-term, and adverse during control activities. There would be no measurable effect on park visitation and recreation spending. Long-term beneficial impacts to non-market social values through the restoration of native species and communities would be less likely for the Kahuku unit and areas currently unmanaged (e.g., portions of ‘Ōla‘a), where no established population-level objective, or fencing strategy, or management implementation has been identified in a comprehensive and systematic plan.

The effects of alternative A, when combined with the impacts of past, present, and reasonably foreseeable future actions on socioeconomic resources, would have short-and long-term minor adverse impacts and long-term beneficial impacts on socioeconomic resources. Long-term beneficial cumulative impacts would be less likely under alternative A, because implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.

Alternative B: Comprehensive Management Plan that Uses Lethal Removal Techniques

Analysis

Visitation and Recreation

Under alternative B, implementation of management actions, including monitoring, direct reduction with firearms, and fencing, would temporarily create noise from the use of helicopters and/or firearms that could have social effects on visitors, local communities, or adjacent private landowners. However, the use of helicopters is limited typically to one to two hours and confined to specific areas of the park. Fences are generally located away from visitor campsites and most trails or are obscured by dense vegetation, which reduces the potential for visual and aesthetic impacts.

Temporary closures could be used to minimize visitor exposure to management actions, but they also could preclude visitors from accessing an area to engage in desired recreational opportunities. Considering past experience, closures would generally be used infrequently, and the public would be notified of them in advance so they can adjust their plans. Actions may begin in the early morning and continue throughout the day; however, in areas where visitor use is high, actions would typically be limited to the early morning or off-peak hours in order to reduce impacts on visitor use, reducing the frequency and duration of closures. In addition, the entire park would not be closed to the public for management actions. A diversity of key visitor destinations would always be open and available for visitation to accommodate park visitors during any localized temporary closures.

Because temporary impacts from management actions would not appreciably affect visitor satisfaction at the park or cause changes in the number of visitors, alternative B would not affect the contribution that tourism and recreational spending has to local economies.

Nonmarket Social Values

Alternative B is expected to have short-term minor adverse impacts on the experiences and perceptions of some residents, visitors, and stakeholders, who may prefer non-lethal relocation approaches over lethal ground and aerial shooting methods and snaring methods. Additionally, visitors and residents who value a quiet, natural experience could be adversely affected in the short term due to temporary closures, noise, and the presence of fencing. As the reduction phase concludes, these adverse effects will decrease as fewer numbers of non-native ungulates will need to be removed by lethal methods.

There may be less interest among some members of the public to participate in direct reduction activities because volunteers would not be able to keep the meat or any part of the animal. However the NPS, would investigate the possibility of meat donation. Also, while the volunteer program is popular and enthusiastically supported by local residents, most participants have typically participated only once. Since the park is surrounded by state game and forest reserves, there would remain opportunities available for residents to participate in hunting activities. Therefore, it is expected that the social effects of alternative B would be minor on community residents who would participate in this program. Therefore, it is expected that the social effects of alternative B would continue to have short-term beneficial impacts on community residents who participate in this program.

The non-native ungulate management actions under alternative B would result in long-term benefits to native ecosystems, and support protection of rare, unique, threatened, or endangered species and their habitat in the park that contribute to the park's designation as a biosphere reserve and world heritage site, which attracts visitors from around the world. These benefits would be fully realized under alternative B because the comprehensive, systematic approach described in the "Elements Common to All Action Alternatives" section in chapter 2 would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time.

NPS Spending and Payroll

Under alternative B, short term, beneficial impacts on local communities are expected as a result of park payroll and spending on fencing and related supplies. In the longer term, as the reduction phase concludes and the park progresses into the maintenance phase, it is possible that fewer expenditures on fencing materials and supplies would reduce these benefits for local communities.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative B would be the same as alternative A. The impacts of past, present, and reasonably foreseeable future actions on socioeconomic resources, when combined with the impacts of implementing alternative B, would have long-term beneficial and short- and long-term minor adverse cumulative impacts. These benefits would be fully realized under alternative B because the comprehensive, systematic approach described in the "Elements Common to All Action Alternatives" section in chapter 2 would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time.

Conclusion

Under alternative B, non-native ungulate management program would have beneficial impacts on local communities as a result of park payroll and spending on non-native ungulate control, fencing, and related supplies. Impacts to non-market social values would be minor, short-term, and adverse during control activities. There would be no measurable effect on park visitation and recreation spending. Long-term beneficial impacts to non-market social values through the restoration of native species and communities would be fully realized under alternative B because the comprehensive, systematic approach described in the "Elements Common to All Action Alternatives" section in chapter 2 would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time.

The impacts of past, present, and reasonably foreseeable future actions on socioeconomic resources, when combined with the impacts of implementing alternative B, would have short- and long-term minor adverse and long-term beneficial cumulative impacts.

Alternative C: Comprehensive Management Plan that Maximizes Efficiency by Expanding Lethal Removal Techniques and Discontinuing the Use of Volunteers

Analysis

Visitation and Recreation

Under alternative C, the need for temporary closures for control activities would be reduced, as the reduction phase would be shorter compared to alternative A. Because temporary impacts from management actions would not appreciably affect visitor satisfaction at the park or cause changes in the number of visitors, alternative C would not affect the economic contribution that visitation and recreational spending has to local economies.

Nonmarket Social Values

Similar to alternative B, visitors and residents who value a quiet, natural experience could be adversely affected in the short term due to temporary closures, noise, and the presence of fencing. Although lethal methods of non-native ungulate control are notably efficient and cost-effective approaches to meeting the objective of zero ungulates on park lands, these lethal methods could be more controversial and less socially acceptable than other non-lethal methods. Alternative C allows for lethal methods, potential expansion of these lethal tools and approaches, and possibly applying these methods to additional species. Therefore, alternative C is expected to have short-term minor adverse impacts on the experience and perceptions of some residents, visitors, and stakeholders, who may prefer non-lethal relocation approaches over lethal ground and aerial shooting methods and snaring methods. As the reduction phase concludes, these adverse effects will decrease as fewer numbers of ungulates will need to be removed by lethal methods.

Under alternative C, the use of volunteers for direct reduction with firearms would not continue. Although the volunteer program is popular and enthusiastically supported by local residents, most participants have typically participated only once (occasionally twice, if the participant is the guest of another participant). Since the park is also surrounded by state game and forest reserves, there are plenty of substitute opportunities available for residents to participate in hunting activities. Therefore, even with no volunteer program available, individuals would still be able to participate in game activities outside the park and obtain meat elsewhere, resulting in minor adverse impacts on the social values.

As the park moves through the reduction phase into the maintenance phase and desired conditions are reached, the threats to native ecosystems posed by non-native ungulates would be substantially decreased. The park would be able to reestablish some of the natural features that attract visitors and enhance the quality of visitors' and residents' experiences. In addition, the frequency of management actions is expected to decrease, and the expected time and resources required to meet ungulate control objectives are also expected to be less, compared to alternative B. As a result, recreational and environmental values are likely to be beneficially affected by management activities under alternative C in the long term.

NPS Spending and Payroll

Under alternative C, the socioeconomic impacts of the non-native ungulate management program are expected to be similar to those of alternative A, as fencing and other supplies will be needed for the management activities, and park employment is not expected to change. Therefore, long-term beneficial effects on local communities would continue under alternative C as a result of park payroll and spending on fencing and related supplies. Resources previously allocated to administering the Volunteer Ungulate Control Program, would be redirected to monitoring, and reduction efforts, which could expedite the time to reach the maintenance phase. It is possible that fewer expenditures on fencing materials and supplies could occur as the park moves to the maintenance phase in new areas, which may reduce the beneficial impacts on local communities over time.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative C would be the same as alternative A. Similar to alternative B, the impacts of past, present, and reasonably foreseeable future actions on socioeconomic resources, when combined with the impacts of implementing alternative C, would have short- and long-term minor adverse and long-term beneficial cumulative impacts.

Conclusion

Alternative C would have no measurable effect on park visitation and recreation values. Impacts to non-market social values would be minor, short-term, and adverse during control activities, and long-term and beneficial over the long-term. Impacts on participants in the volunteer program are expected to be minor, as substitute hunting opportunities are available. Beneficial effects from NPS spending and payroll would be short- and long-term. Resources previously allocated to administering the Volunteer Ungulate Control Program, would be redirected to monitoring, and reduction efforts, which could expedite the time to reach desired conditions. Overall, there would be short-term minor adverse impacts, and long-term beneficial impacts on socioeconomics in the area. The impacts of past, present, and reasonably foreseeable future actions on socioeconomic resources, when combined with the impacts of implementing alternative C, would have short- and long-term minor adverse and long-term beneficial cumulative impacts.

Alternative D: Comprehensive Management Plan that Maximizes Flexibility of Management Techniques

Analysis

Visitation and Recreation

Under alternative D, the socioeconomic impacts on local economies associated with visitation and recreational spending would be the same as those of alternative B. Because temporary impacts from management actions would not appreciably affect visitor satisfaction at the park or cause changes in the number of visitors, there would be no effect on the contribution of visitation and recreational spending to local economies.

Nonmarket Social Values

Similar to alternative B, the social effects of alternative D on visitors' and residents' recreational and environmental values are expected to be short-term minor adverse and long term beneficial.

Although lethal methods (e.g., ground and aerial shooting methods and snaring) of ungulate control are notably efficient and cost-effective approaches to meeting the objective of zero ungulates in park lands, these lethal methods could be more controversial and less socially acceptable than other, non-lethal, methods. Alternative D allows for both lethal and non-lethal methods. If the park implements non-lethal control methods where possible, this may be perceived by some stakeholders as more acceptable than the current program under alternative A. Therefore, alternative D is expected to have short-term negligible to minor adverse impacts on the perceptions of some residents, visitors, and stakeholders, who may prefer non-lethal relocation approaches over lethal methods. Conversely, the additional resources needed to implement non-lethal methods (e.g., capture and relocation of animals) may delay the NPS in reaching desired conditions and result in more reduction efforts, which would contribute to adverse impacts to social values. As the reduction phase concludes, these adverse effects will decrease as fewer numbers of ungulates will need to be removed by lethal methods.

NPS Spending and Payroll

Similar to alternative B, beneficial impacts on local communities are expected as a result of spending on fencing and related supplies. In the long term, as the reduction phase concludes and the park progresses into the maintenance phase, it is possible that fewer expenditures on fencing materials and supplies would reduce these benefits for local communities. Under alternative D, the park may take longer to reach the maintenance phase, as resources would be redirected to exploring non-lethal methods of control (including capture, holding and translocating animals) which may delay the NPS is reaching desired conditions.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative D would be the same as alternative A. Similar to alternative B, the impacts of past, present, and reasonably foreseeable future actions on socioeconomic resources, when combined with the impacts of implementing alternative D, would have short- and long-term minor adverse and long-term beneficial cumulative impacts.

Conclusion

Alternative D would have no measurable effect on park visitation and recreation values. Impacts to non-market social values would be minor, short-term, and adverse during control activities, and long-term and beneficial over the long-term. Some beneficial impacts to social values would be gained among individuals who prefer non-lethal relocation approaches over lethal methods. Conversely, the additional resources needed to implement non-lethal methods (e.g., capture and relocation of animals) may delay the NPS in reaching desired conditions and result in more reduction efforts, which would contribute to adverse impacts to social values. Beneficial effects from NPS spending and payroll would be short- and long-term. Overall, there would be short-term minor adverse impacts, and long-term beneficial impacts on socioeconomics in the area. The impacts of past, present, and reasonably foreseeable future actions on socioeconomic resources, when combined with the impacts of implementing alternative D, would have short- and long-term minor adverse and long-term beneficial cumulative impacts.

Alternative E: Comprehensive Management Plan that Increases Flexibility of Management Techniques While Limiting the Use of Volunteers

Analysis

Visitation and Recreation

Under alternative E, the socioeconomic impacts on local economies associated with visitation and recreational spending would be the same as those of alternative D. Because temporary impacts from management actions would not appreciably affect visitor satisfaction at the park or cause changes in the number of visitors, there would be no effect on the contribution of visitation and recreational spending to local economies.

Nonmarket Social Values

Similar to alternative D, the social effects of alternative E on visitors' and residents' recreational and environmental values are expected to be short-term minor adverse and long term beneficial.

Under alternative E, the Volunteer Ungulate Control Program would continue, although volunteers would not be used for direct reduction with firearms. While the majority of volunteer interest among local residents has been in participation with ground shooting efforts, most participants have typically participated only once (occasionally twice, if the participant is the guest of another participant). Consequently, the modification is not expected to cause adverse impacts on residents since other game and forest reserves are available for hunting opportunities. Individuals will still be able to participate in game activities outside the park and obtain meat elsewhere, with minor adverse impacts on the social values.

NPS Spending and Payroll

Similar to alternative D, beneficial impacts on local communities are expected as a result of spending on fencing and related supplies. In the long term, as the reduction phase concludes and the park progresses into the maintenance phase, it is possible that fewer expenditures on fencing materials and supplies would reduce these benefits for local communities.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative E would be the same as alternative A. Similar to alternative B, the impacts of past, present, and reasonably foreseeable future actions on socioeconomic resources, when combined with the impacts of implementing alternative E, would have short- and long-term minor adverse and long-term beneficial cumulative impacts.

Conclusion

Similar to all action alternatives, alternative E would have no measurable effect on park visitation and recreation values. Impacts to non-market social values would be minor, short-term, and adverse during control activities, and long-term and beneficial over the long-term. Similar to alternative D, some beneficial impacts to social values would be gained among individuals who prefer non-lethal relocation approaches over lethal methods. Conversely, the additional resources needed to implement non-lethal methods (e.g., capture and relocation of animals) may delay the NPS in reaching desired conditions and result in more reduction efforts, which would contribute to adverse impacts to social values. Impacts on the volunteer program participants are expected to be minor, as substitute hunting opportunities are readily available. Beneficial effects from NPS spending and payroll would be short- and long-term. Resources previously allocated to administering volunteer ground shooting efforts, would be redirected to monitoring, and reduction efforts, which could expedite the time to reach desired conditions. Overall, there would be short-term minor adverse impacts, and long-term beneficial impacts on socioeconomics. The impacts of past, present, and reasonably foreseeable future actions on socioeconomic resources, when combined with the impacts of implementing alternative E, would have short- and long-term minor adverse and long-term beneficial cumulative impacts.

VISITOR USE AND EXPERIENCE

GUIDING REGULATIONS AND POLICIES

The NPS *Management Policies 2006* (NPS 2006b) states that the enjoyment of park resources and values by the people of the United States is part of the fundamental purpose of all parks and that the NPS is committed to providing appropriate, high-quality opportunities for visitors to enjoy the parks.

The importance of visitor use and experience is highlighted in Hawai‘i Volcanoes National Park’s foundation statement, which states that the park “protects, studies, and provides access to Kīlauea and Mauna Loa, two of the world’s most active volcanoes; and perpetuates endemic Hawaiian ecosystems and the traditional Hawaiian culture connected to these landscapes” (NPS 2010a). The value of the visitor experience is also stated in the park’s significance statement, which emphasizes the variety of natural and cultural resource experiences that the park provides to visitors. These include opportunities to experience diverse ecosystems that are the result of over 30 million years of evolution, wide climate variation, and the extreme isolation of the Hawaiian Islands. Furthermore, the international biosphere reserve designation, conferred in 1980, recognizes the park’s long-term commitment to scientific study, monitoring, and the protection of the range of unique tropical forests and woodlands. The world heritage designation, conferred in 1986, is based on the “on-going geologic processes of volcanism, of endemic and native biota and human interrelationships with the lands” (UNESCO 1987).

While preservation and conservation are key components of the NPS *Management Policies 2006*, it also instructs park units to provide for recreational opportunities. The NPS achieves its preservation and conservation purposes by working to maintain all native plants and animals as parts of the natural ecosystem, emphasizing recreational activities compatible with such efforts.

METHODOLOGY, ASSUMPTIONS, AND IMPACT THRESHOLDS

Past visitor use data, comments from the public, and personal observations of visitation patterns were used to estimate the effects of the alternative actions on visitors. It is assumed that annual recreational visitation over the life of the plan will remain relatively steady at about 1.3 million recreational visitors per year, with slight variations from year to year (NPS 2009b). Impact intensity thresholds were defined for adverse impacts. For this plan/EIS, assignment of intensity levels for visitor use and experience impacts are based on the potential for changes to such characteristics as follows:

Negligible: The impact would be barely detectable and/or would affect few visitors. Visitors would not likely be aware of the effects associated with management actions.

Minor: The impact would be detectable and/or would affect some visitors. Visitors would likely be aware of the effects associated with management actions. The changes in visitor use and experience would be slight but detectable; however, visitor satisfaction would not be measurably affected.

Moderate: The impact would be readily apparent and/or would affect many visitors. Visitors would be aware of the effects associated with management actions. Visitor satisfaction might be measurably affected. Some visitors may choose to pursue activities in other available local or regional areas.

Major: The impact would affect the majority of visitors. Visitors would be highly aware of the effects associated with management actions, and visitor satisfaction could decrease substantially. Changes in visitor use and experience would be readily apparent. Some visitors would choose to pursue activities in other available local or regional areas.

IMPACTS OF THE ALTERNATIVES

Alternative A: No Action (Continue Existing Non-native Ungulate Management Activities)

Analysis

Implementation of management actions, including monitoring, direct reduction with firearms, and fencing, would temporarily create noise from the use of helicopters and/or firearms that could affect visitor use and experience. However, the use of helicopters is limited: aerial monitoring and shooting operations, last a matter of hours, and are confined to specific areas. While ground shooting operations could last up to 12 hours, shooting activities are not continuous, and all management actions are confined to specific areas and, as much as possible, conducted during early morning hours to minimize impacts on visitors as well as increase efficiency of control efforts. Similarly, monitoring activities and fence construction/involving the use of helicopters are also intermittent. In addition, fences are generally located away from visitor campsites and most trails or are obscured by dense vegetation, which reduces the potential for visual impacts.

Temporary closures could be used to minimize visitor exposure to such impacts, but they also could preclude visitors from accessing an area to engage in desired recreational opportunities. The Kahuku unit is currently open to visitors on weekends from 9:00 a.m. to 3:00 p.m., but closures in this area could occur due to non-native ungulate management actions. Temporary closures may be necessary in portions of the Kīlauea, Mauna Loa Strip, and ‘Ōla‘a sections of the park. These are typically very limited in number and based largely on the amount of animal ingress detected in managed units. In addition to the temporary closures to minimize visitor exposure to removal operations, the park typically limits the removal to the early mornings and off-peak hours. In addition, the entire park would not be closed to the public for management actions. A diversity of key visitor destinations would always be open and available for visitation to accommodate park visitors during any localized temporary closures. Judging by past experience, closures would generally be used infrequently, and the public would be notified of them in advance so they can adjust their plans.

Fencing could result in adverse impacts on visitor use and experience for those who do not want to see such structures in natural environments. However, as noted previously, fences are generally located away from visitor campsites and most trails or are obscured by dense vegetation.

Ungulate exclusion and removal would support native ecosystems recovery, vegetation, and efforts to restore rare species, and the park would be able to reestablish some of the natural features that attract visitors and enhance their experience. In addition, the park would continue to provide information about non-native ungulates in the visitor center and programs conducted in local schools and communities.

These educational and interpretive programs increase public awareness and understanding of non-native ungulate impacts to park resources and the need for park actions.

In summary, alternative A would result in short- and long-term minor adverse effects on visitor use and experience through temporary closures and disruptions caused by ungulate control measures and fence construction and repair, and the long-term presence of fences. In the older section of the park, long-term beneficial impacts to the visitor experience resulting from the recovery of native vegetation and wildlife habitat would continue in managed units. However, long-term benefits would be less likely for Kahuku and areas unmanaged (e.g., portions of ʻŌlaʻa), for which no established population-level objective and fencing strategy has been identified. Also, the implementation of management tools and monitoring would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities. Because alternative A would not incorporate the comprehensive, systematic approach described in the "Elements Common to All Action Alternatives" section in chapter 2, it would be less likely that the NPS would progress through management phases, monitor, and apply management tools consistently as staff and institutional knowledge change over time.

Cumulative Impacts

Many past, present, and reasonably foreseeable future actions, plans, and programs at the park would contribute to beneficial effects on visitor use and experience. The acquisition of new lands (including Kahuku) would provide for an increased diversity of areas for visitors to use and experience, and could also alleviate crowding in other sections of the park. Park educational programs and interpretation activities increase visitors' awareness of the ecosystems in the park, as well as the cultural importance of the park. Law enforcement activities and other management actions would continue to keep visitors safe from criminal activity and personal injury by restricting dangerous areas of the park (lava flows, etc.). Rare and sensitive species restoration activities (including the implementation of USFWS recovery plans) would continue to provide increased habitat for sensitive native species found in the park, which would provide more opportunities for visitors to see these species, augmenting their appreciation for native Hawaiian plants and wildlife. The development and subsequent implementation of the GMP and the wilderness management plan would provide for increased management actions throughout the entire park that meet the needs of the various visitors and visitor activities found at the park, including in wilderness areas. The development and subsequent implementation of the ATMP would dictate how, where, and how often aerial tours may take place above the park, while taking into account soundscapes and visitor experience. The implementation of the *Ala Kahakai National Historic Trail Management Plan* (NPS 2004d) would provide visitors with increased hiking opportunities inside and outside the park. Restoration of native plant communities inside the park would provide increased habitat for sensitive vegetation species found in the park, which would provide more opportunities for visitors to experience the native flora. The proposed Mauna Loa trail system, could provide visitors with increased recreational activities and would increase awareness of the island's unique natural and cultural resources.

There are also some past, current, and future actions that would contribute to adverse cumulative effects on visitor use and experience. Temporary closures in the park due to volcanic activity can potentially impact visitor use and experience adversely if visitors are not able to access desirable locations in the park. Increased aviation activities inside and outside the park can create excessive noise from overflights, negatively impacting visitor experience. Visitation in the park could have adverse impacts on visitor experience due to the potential of overcrowding in certain locations, traffic delays, and a reduced sense of solitude in the park.

Some past, current, and future actions contribute to both beneficial and adverse impacts, depending on what stage of implementation they are in. For example, development in the park would have adverse impacts on visitor use and experience during the construction phase due to access closures and impacts from noise; however, once construction is complete, visitors would experience beneficial impacts due to increased and/or improved facilities at the park, such as roads and visitor centers. The change in the fire ecology due to habitat fragmentation and non-native species can negatively alter the landscape and create more fire-susceptible areas in the park; however, fire management would implement measures to protect human life, property, and cultural resources, as well as maintaining or restoring natural resources.

These past, present, and reasonably foreseeable future actions would have short- and long-term minor adverse impacts on visitor use and experience, as well as long-term beneficial effects. Past, present, and reasonably foreseeable future actions, when combined with the impacts of alternative A, would have short- and long-term minor adverse impacts and long-term beneficial cumulative impacts on visitor use and experience. Long-term beneficial cumulative impacts would be less likely under alternative A, because non-native ungulate management within the park would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities and implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.

Conclusion

Under alternative A, short- and long-term minor adverse affects on visitor use and experience would result from temporary closures and disruptions caused by ungulate control measures and fence construction and repair, and the long-term presence of fences. In the older section of the park, long-term beneficial impacts to the visitor experience resulting from the recovery of native vegetation and wildlife habitat would continue in managed units. Long-term beneficial impacts would be less likely for the Kahuku unit and areas currently unmanaged (e.g., portions of ‘Ōla‘a), where no established population-level objective or fencing strategy has been identified in a comprehensive and systematic plan. The effects of alternative A, when combined with impacts of past, present, and reasonably foreseeable future actions on visitor use and experience, would have short- and long-term minor adverse cumulative impacts. Long-term beneficial cumulative impacts would be less likely under alternative A, because non-native ungulate management would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities and implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.

Alternative B: Comprehensive Management Plan that Uses Lethal Removal Techniques

Analysis

Under alternative B, short- and long-term minor adverse affects on visitor use and experience would result from temporary closures and disruptions caused by ungulate control measures and fence construction and repair, and the long-term presence of fences. However, the use of helicopters is limited for aerial monitoring and shooting operations which last a matter of hours, and both ground and aerial shooting operations are confined to specific areas. As much as possible, actions are conducted during early morning hours to minimize impacts on visitors as well as increase efficiency of control efforts. Similarly, monitoring activities and fence construction involving the use of helicopters are also intermittent. In addition, fences are generally located away from visitor campsites and most trails or are obscured by dense vegetation, which reduces the potential for visual impacts.

Temporary closures could be used to minimize visitor exposure to such impacts, but they also could preclude visitors from accessing an area to engage in desired recreational opportunities. These closures are typically very limited in number (see the “Frequency and Duration of Management Actions” section in chapter 2). In addition, the park typically limits the removal to the early mornings and off-peak hours.

In addition, the entire park would not be closed to the public for management actions. A diversity of key visitor destinations would always be open and available for visitation to accommodate park visitors during any localized temporary closures. Judging by past experience, closures would generally be used infrequently, and the public would be notified of them in advance so they can adjust their plans. Additionally, as the park moves from the reduction phase to the maintenance phase, it is expected that fewer closures would be needed.

A diversity of key visitor destinations would always be open and available for visitation to accommodate park visitors during any localized temporary closures. Judging by past experience, closures would generally be used infrequently, and the public would be notified of them in advance so they can adjust their plans.

Fencing could result in adverse impacts on visitor use and experience for those who do not want to see such structures in natural environments. However, as noted previously, fences are generally located away from visitor campsites and most trails or are obscured by dense vegetation.

Ungulate exclusion and removal would support native ecosystems recovery, vegetation, and efforts to restore rare species. Once desired conditions are reached, the threats to native ecosystems posed by non-native ungulates would be substantially decreased, and the park would be able to reestablish some of the natural features that attract visitors and enhance their experience. In addition, the implementation of a comprehensive plan would provide a framework for the development of interpretive programs aimed towards enhancing visitor awareness and understanding of non-native ungulate management actions and why they are necessary for the protection of park resources.

As a result, there would be long-term beneficial and short- and long-term minor adverse effects on visitor use and experience under alternative B. These benefits would be fully realized under alternative B because the comprehensive, systematic approach described in the “Elements Common to All Action Alternatives” section in chapter 2 would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative B would be the same as alternative A. The short-term and long-term minor adverse and long-term beneficial impacts of past, present, and reasonably foreseeable future actions on visitor use and experience, when combined with the impacts of implementing alternative B, would have short- and long-term minor adverse and long-term beneficial cumulative impacts. Long-term beneficial impacts to visitor use and experience would be fully realized under this alternative because the comprehensive, systematic approach described in the “Elements Common to All Action Alternatives” section in chapter 2 would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time.

Conclusion

Under alternative B, short- and long-term minor adverse affects on visitor use and experience would result from temporary closures and disruptions caused by ungulate control measures and fence construction and repair, and the long-term presence of fences. Long-term beneficial impacts to visitor use and experience would be fully realized under this alternative because the comprehensive, systematic approach described in the “Elements Common to All Action Alternatives” section in chapter 2 would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time.

The effects of alternative B, when combined with impacts of past, present, and reasonably foreseeable future actions on visitor use and experience, would have short- and long-term minor adverse cumulative and long-term beneficial impacts.

Alternative C: Comprehensive Management Plan that Maximizes Efficiency by Expanding Lethal Removal Techniques and Discontinuing the Use of Volunteers

Analysis

Similar to alternative B, alternative C would result in short- and long-term minor adverse effects on visitor use and experience through temporary closures and disruptions caused by ungulate control measures and fence construction and repair, and the long-term presence of fences. Long-term beneficial impacts to visitor use and experience would be fully realized under alternative C.

Because lethal techniques would be expanded and enhanced, and volunteers would not be used during direct reduction efforts under alternative C, it is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, more quickly than under alternative B. The increased efficiency associated with discontinuing the use of volunteers is based on additional work required by NPS staff to recruit, administer, train and direct volunteers in the field, and data that show that park staff remove more ungulates per day when they conduct direct reduction (ground shooting) themselves, compared to when they are accompanied by volunteers (Stephens et al. 2008). Therefore, fewer reduction activities would result when compared to alternative B.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative C would be the same as alternative A. Similar to alternative B, the long-term beneficial and short- and long-term minor adverse impacts of past, present, and reasonably foreseeable future actions, when combined with the impacts of implementing alternative C, would have long-term beneficial and short- and long-term minor adverse cumulative impacts on visitor use and experience.

Conclusion

Under alternative C, short- and long-term minor adverse affects on visitor use and experience would result from temporary closures and disruptions caused by ungulate control measures and fence construction and repair, and the long-term presence of fences. Long-term beneficial impacts to visitor use and experience would be fully realized under this alternative. It is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, more quickly under alternative C than under alternative B. The effects of alternative C, when combined with impacts of past, present, and reasonably foreseeable future actions on visitor use and experience, would have short- and long-term minor adverse cumulative and long-term beneficial impacts.

Alternative D: Comprehensive Management Plan that Maximizes Flexibility of Management Techniques

Analysis

Similar to alternative B, alternative D would result in short- and long-term minor adverse effects on visitor use and experience through temporary closures and disruptions caused by ungulate control measures and fence construction and repair, and the long-term presence of fences. Long-term beneficial impacts to visitor use and experience would be fully realized under alternative D.

Although the expansion and enhancement of lethal removal techniques under alternative D would be implemented with the goal of increasing the efficiency and cost effectiveness of ungulate management, the continued use of volunteers and the expansion of non-lethal techniques would counteract this to some extent. Inclusion of non-lethal removal would require additional staff time and park resources to capture, hold and relocate animals, and may increase the time associated with reduction actions over the life of the plan, as well as time needed to reach the post-reduction phase. As a result, it is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, less quickly than under alternative C.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative D would be the same as alternative A. Similar to alternative B, the long-term beneficial and short- and long-term minor adverse impacts of past, present, and reasonably foreseeable future actions, when combined with the impacts of implementing alternative D, would have long-term beneficial and short- and long-term minor adverse cumulative impacts on visitor use and experience.

Conclusion

Under alternative D, short- and long-term minor adverse affects on visitor use and experience would result from temporary closures and disruptions caused by ungulate control measures and fence construction and repair, and the long-term presence of fences. Long-term beneficial impacts to visitor use and experience would be fully realized under this alternative. It is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, less quickly under alternative D than under alternative C. The effects of alternative D, when combined with impacts of past, present, and reasonably foreseeable future actions on visitor use and experience, would have short- and long-term minor adverse cumulative and long-term beneficial impacts.

Alternative E: Comprehensive Management Plan that Increases Flexibility of Management Techniques While Limiting the Use of Volunteers

Analysis

Similar to alternative B, alternative E would result in short- and long-term minor adverse effects on visitor use and experience through temporary closures and disruptions caused by ungulate control measures and fence construction and repair, and the long-term presence of fences. Long-term beneficial impacts to visitor use and experience would be fully realized under alternative E.

Although the expansion and enhancement of lethal removal techniques under alternative E would be implemented with the goal of increasing the efficiency and cost effectiveness of ungulate management, the expansion of non-lethal techniques would counteract this to some extent. However, because volunteers would not be used during direct reduction efforts under alternative E, it is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, more quickly than under alternative D, but less quickly than under alternative C.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative E would be the same as alternative A. Similar to alternative B, the long-term beneficial and short- and long-term minor adverse impacts of past, present, and reasonably foreseeable future actions, when combined with the impacts of implementing alternative E, would have long-term beneficial and short - and long-term minor adverse cumulative impacts on visitor use and experience.

Conclusion

Under alternative E, short- and long-term minor adverse affects on visitor use and experience would result from temporary closures and disruptions caused by ungulate control measures and fence construction and repair, and the long-term presence of fences. Long-term beneficial impacts to visitor use and experience would be fully realized under this alternative. It is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, more quickly under alternative E than under alternative D, but less quickly than under alternative C. The effects of alternative E, when combined with impacts of past, present, and reasonably foreseeable future actions on visitor use and experience, would have short- and long-term minor adverse cumulative and long-term beneficial impacts.

VISITOR AND EMPLOYEE SAFETY

GUIDING REGULATIONS AND POLICIES

The NPS *Management Policies 2006* states that, "While recognizing that there are limitations on its capability to totally eliminate all hazards, the Service … will seek to provide a safe and healthful environment for visitors and employees." The NPS *Management Policies 2006* also states that "the Service will reduce or remove known hazards and apply other appropriate measures, including closures, guarding, signing, or other forms of education" (NPS 2006b, section 8.2.5.1).

METHODOLOGY, ASSUMPTIONS, AND IMPACT THRESHOLDS

The purpose of this impact analysis is to identify the level of impact that implementing each of the proposed alternatives would have on the safety of visitors and employees at Hawai‘i Volcanoes National Park.

Impact intensity thresholds were defined for adverse impacts. For this plan/EIS, assignment of intensity levels for visitor and employee safety impacts are based on the potential for changes to such characteristics as follows:

Negligible: There would be no discernible effects on visitor or employee safety; slight injuries could occur.

Minor: Any visitor injury would require first aid that could be provided by park staff. Injuries to employees may require a doctor's attention.

Moderate: Any visitor or employee injury would require further medical attention beyond what is available at the park. Injuries to employees would result in time off.

Major: An employee or visitor injury would result in permanent disability or death.

IMPACTS OF THE ALTERNATIVES

Alternative A: No Action (Continue Existing Non-native Ungulate Management Activities)

Analysis

The use of firearms and helicopters during direct reduction activities, including the use of helicopters for monitoring and fencing, would pose the greatest safety risk to staff, including qualified volunteers, and other authorized agents. Personnel involved would have the appropriate skills and proficiencies in helicopter operation and in the use of firearms for the removal of wildlife. These skills would reduce the chances that an accident would occur.

Qualified volunteers would be used for direct reduction with firearms in more accessible areas and where animals are abundant (i.e., Kahuku areas below 5,000 feet in elevation (1,524 meters)). This minimizes safety risks associated with accessing difficult or remote terrain. Other safety concerns related to the use of qualified volunteers during direct reduction by firearms are addressed in part by the requirements for becoming a volunteer, which include completing a registration form, obtaining a hunter education certificate or card, presenting a registration of the firearm to be used and a Hawai‘i hunting license, and being able to spend a minimum of 8 hours hiking over rough terrain. With these measures in place, the possibility of having issues related to the safety of both the volunteers and the staff engaging in management activities would be reduced. A minimum of one NPS employee would directly supervise and escort every two volunteers; these staff members would direct volunteers as to which animals should be removed. Park employees would help decrease the chances of an accident occurring because they are trained in firearm use and ungulate management. Also, areas where volunteers are used for ground shooting efforts are temporarily closed to the public to avoid risks to visitors.

Encounters with animals during any management action (especially snaring, baiting, and trapping, which require handling ungulates) would expose staff and qualified volunteers to potential health and safety risks, such as physical harm from kicks and bites, or possibly disease. The park conducts a job hazard analysis to identify potential safety hazards and implements corrective measures to minimize risks to staff and volunteers.

Visitors could also be exposed to health and safety risks during implementation of management actions that use firearms or snares. Measures to minimize visitor exposure include conducting management actions during early morning hours, off-peak visitation times, or closing an area for the duration of the management activity. Snares are typically used in more remote areas, where visitation is low, and are mapped, flagged and signs posted.

As evidenced by data over the last 5 years (described in the “Visitor and Employee Safety” section in chapter 3), the measures in place limit the potential effects on employee (and qualified volunteer) health and safety to physical environmental hazards and accidents associated with routine field activities (e.g., sprains, cuts, and broken bones from hiking, lifting, moving, and/or operating equipment, materials, or debris; insect stings; exposure to plants; and exposure to disease). Some of these incidents have required time off and medical attention beyond what could be provided at the park. Data from 1992 through 2002 (described in the “Visitor and Employee Safety” section in chapter 3) also show that there have been no visitor incidents related to non-native ungulate management activities. As a result, there would be short-term minor to moderate adverse impacts on health and safety during implementation of management actions. As the number of ungulates are reduced, the frequency and duration of management actions, as well as the associated health and safety risks, would decrease.

The presence of non-native ungulates in the park creates a potential safety hazard for visitors and employees (e.g., potential for wildlife–vehicle collisions, potential for interactions that could result in physical harm) from encounters with these animals during routine operations or activities (e.g., when hiking or driving in the park). Similarly, non-native ungulates have been known to carry diseases that are transmissible to humans. For example, feral swine can harbor at least 30 significant viral and bacteriological diseases, several of which are transmissible to humans (Seward et al. 2003). However, as described in chapter 3, data on employee and visitor incidents do not indicate that any such encounters or disease transmittals have occurred in recent years. With the exception of Kahuku, most areas frequented by park visitors are ungulate free or have very low numbers of ungulates. Ungulates also create suitable habitat for mosquitoes, which potentially can carry diseases transmissible to humans. In Kahuku the potential for human encounters with feral dogs that are attracted to mouflon would be reduced through non-native ungulate removal and fencing. Additionally, as desired conditions are reached, the potential for ungulate encounters would be minimized, as would the creation of mosquito habitat.

In summary, alternative A would result in short-term minor to moderate adverse impacts on visitor and employee safety. In the older section of the park, long-term beneficial impacts to visitor and employee safety would continue in managed units. However, long-term benefits of removing animals would be unlikely for Kahuku and areas currently unmanaged (e.g., portions of ‘Ōla‘a), for which no established population-level objective and fencing strategy has been identified. Also, the implementation of management tools and monitoring would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities. Because alternative A would not incorporate the comprehensive, systematic approach described in the “Elements Common to All Action Alternatives” section in chapter 2, it would be less likely that the NPS would progress through management phases, monitor, and apply management tools consistently as staff and institutional knowledge change over time. Because of this uncertainty, animals could potentially remain on the landscape indefinitely, increasing exposure of employees and visitors to safety risks associated with ungulate management activities.

Cumulative Impacts

Other past, present, and reasonably foreseeable and future actions would contribute beneficially to the health and safety of park visitors and employees. The GMP, ATMP, *Ala Kahakai National Historic Trail Management Plan*, the proposed Mauna Loa trail system (an ongoing feasibility study) would develop objectives and, through plan implementation, address visitor and employee safety. Also, fire management inside and outside the park and at the WUI would benefit health and safety, as large-scale fire events would be managed to reduce these risks.

There are some past, current, and future actions that would contribute adverse effects to visitor and employee safety. For example, development inside the park, trail maintenance, cultural and natural resources monitoring in the field, and native and non-native plant and animal species management inside the park all pose safety risks for those employees and volunteers conducting these activities, such as accidents with machinery and other inherent risks associated with manual labor and working outdoors. Aviation activities have risks (e.g., potential for crashes) inside and outside the park. While aviation accidents rarely occur, due to the volcanic activity in the park, vog (volcanic smog) reduces air visibility, creating a hazard for air traffic. The acquisition of new lands would require additional management and would eventually provide new visitor use areas. The routine fieldwork and visitor uses in these areas could increase the potential for accidents and injuries. Law enforcement activities would contribute to beneficial impacts by protecting visitors from being injured (by wandering off designated trails or through encounters with wildlife), but could also contribute to adverse impacts on employee safety should law enforcement officials become injured while performing their duties.

These past, present, and reasonably foreseeable future actions would have short- and long-term minor to moderate adverse and long-term beneficial impacts on visitor and employee safety. Past, present, and reasonably foreseeable future actions, when combined with the short-term minor to moderate adverse impacts and long-term beneficial effects on visitor and employee safety of alternative A, would have short- and long-term minor to moderate adverse cumulative impacts on visitor and employee safety. Long-term beneficial cumulative impacts would be less likely under alternative A, because non-native ungulate management within the park would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities and implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.

Conclusion

Under alternative A, short- and long-term minor to moderate adverse impacts on visitor and employee safety would result from implementation of management actions. In the older section of the park, long-term beneficial impacts to visitor and employee safety would continue in managed units. Long-term beneficial impacts would be unlikely for the Kahuku unit and areas currently unmanaged (e.g., portions of ‘Ōla‘a), where no established population-level objective or fencing strategy has been identified in a comprehensive and systematic plan. The effects of alternative A, when combined with impacts of past, present, and reasonably foreseeable future actions on visitor and employee safety, would have short- and long-term minor to moderate adverse cumulative impacts. Long-term beneficial cumulative impacts would be less likely under alternative A, because non-native ungulate management would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities and implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.

Alternative B: Comprehensive Management Plan that Uses Lethal Removal Techniques

Analysis

Under alternative B there would be short- and long-term minor to moderate adverse impacts on visitor and employee safety through implementation of management actions.

The use of firearms and helicopters during direct reduction activities, including the use of helicopters for monitoring and fencing, would pose the greatest safety risk to staff, including qualified volunteers, and other authorized agents. Personnel involved would have the appropriate skills and proficiencies in helicopter operation and in the use of firearms for the removal of wildlife. These skills would reduce the chances that an accident would occur.

Qualified volunteers would be used for direct reduction with firearms during the reduction phase in more accessible areas of Kahuku (i.e., areas below 5,000 feet in elevation (1,524 meters)). This minimizes safety risks associated with accessing difficult or remote terrain. Other safety concerns related to the use of qualified volunteers during direct reduction by firearms are addressed in part by the requirements for becoming a volunteer, which include completing a registration form, obtaining a hunter education certificate or card, presenting a registration of the firearm to be used and a Hawai‘i hunting license, and being able to spend a minimum of 8 hours hiking over rough terrain. With these measures in place, the possibility of having issues related to the safety of both the volunteers and the staff engaging in management activities would be reduced. A minimum of one NPS employee would directly supervise and escort every two volunteers; these staff members would direct volunteers as to which animals should be removed. Park employees would help decrease the chances of an accident occurring because they are trained in firearm use and ungulate management. Also, areas where volunteers are used for ground shooting efforts are temporarily closed to the public to avoid risks to visitors.

Encounters with animals during any management action (especially snaring, baiting, and trapping, which require handling ungulates) would expose staff and qualified volunteers to potential health and safety risks, such as physical harm from kicks and bites, or possibly disease. The park conducts a job hazard analysis to identify potential safety hazards and implements corrective measures to minimize risks to staff and volunteers.

Visitors could also be exposed to health and safety risks during implementation of management actions that use firearms or snares. Measures to minimize visitor exposure include conducting management actions during early morning hours, off-peak visitation times, or closing an area for the duration of the management activity. Snares are typically used in more remote areas, where visitation is low, and are mapped, flagged and signs posted.

As evidenced by data over the last 5 years (described in the "Visitor and Employee Safety" section in chapter 3), the measures in place limit the potential effects on employee (and qualified volunteer) health and safety to physical environmental hazards and accidents associated with routine field activities (e.g., sprains, cuts, and broken bones from hiking, lifting, moving, and/or operating equipment, materials, or debris; insect stings; exposure to plants; and exposure to disease). Some of these incidents have required time off and medical attention beyond what could be provided at the park. Data from 1992 through 2002 (described in the "Visitor and Employee Safety" section in chapter 3) also show that there have been no visitor incidents related to non-native ungulate management activities. As a result, there would be short-term minor to moderate adverse impacts on health and safety during implementation of management actions. As the park moves from the reduction phase to the maintenance phase, the frequency and duration of management actions, as well as the associated health and safety risks, would decrease.

The presence of non-native ungulates in the park creates a potential safety hazard for visitors and employees (e.g., potential for wildlife–vehicle collisions, potential for interactions that could result in physical harm) from encounters with these animals during routine operations or activities (e.g., when hiking or driving in the park). Similarly, non-native ungulates have been known to carry diseases that are transmissible to humans. For example, feral swine can harbor at least 30 significant viral and bacteriological diseases, several of which are transmissible to humans (Seward et al. 2003). However, as described in chapter 3, data on employee and visitor incidents do not indicate that any such encounters or disease transmittals have occurred in recent years. With the exception of Kahuku, most areas frequented by park visitors are ungulate free or have very low numbers of ungulates. Ungulates also create suitable habitat for mosquitoes, which potentially can carry diseases transmissible to humans. In Kahuku the potential for human encounters with feral dogs that are attracted to mouflon would be reduced through non-native ungulate removal and fencing. Additionally, as desired conditions are reached, the potential for ungulate encounters would be minimized, as would the creation of mosquito habitat.

In summary, alternative B would result in short-term minor to moderate adverse impacts on visitor and employee safety and long-term beneficial impacts through removing the potential safety hazard for visitors and employees from encounters with non-native ungulates, and reducing habitat for mosquitoes, which potentially can carry diseases transmissible to humans. These benefits would be fully realized under alternative B because the comprehensive, systematic approach described in the "Elements Common to All Action Alternatives" section in chapter 2 would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative B would be the same as alternative A. The short- and long-term minor to moderate adverse and long-term beneficial impacts of past, present, and reasonably foreseeable future actions on visitor and employee safety, when combined with the impacts of implementing alternative B, would have short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts on visitor and employee safety in the park.

Conclusion

Under alternative B, short- and long-term minor to moderate adverse impacts on visitor and employee safety would result from implementation of management actions. Long-term beneficial impacts to visitor and employee safety would be fully realized under this alternative. The effects of alternative B, when combined with impacts of past, present, and reasonably foreseeable future actions on visitor and employee safety, would have short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts.

Alternative C: Comprehensive Management Plan that Maximizes Efficiency by Expanding Lethal Removal Techniques and Discontinuing the Use of Volunteers

Analysis

Similar to alternative B, alternative C would result in short- and long-term minor to moderate adverse impacts on visitor and employee safety through implementation of management actions. Long-term beneficial impacts to visitor and employee safety would be fully realized under alternative C.

Because lethal techniques would be expanded and enhanced, and volunteers would not be used during direct reduction efforts under alternative C, it is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, more quickly than under alternative B. The increased efficiency associated with discontinuing the use of volunteers is based on additional work required by NPS staff to recruit, administer, train and direct volunteers in the field, and data that show that park staff remove more ungulates per day when they conduct direct reduction (ground shooting) themselves, compared to when they are accompanied by volunteers (Stephens et al. 2008). Therefore, fewer reduction activities would result when compared to alternative B.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative C would be the same as alternative A. Similar to alternative B, when combined with the impacts of implementing alternative C, there would be short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts on visitor and employee safety in the park.

Conclusion

Under alternative C, short- and long-term minor to moderate adverse impacts on visitor and employee safety would result from implementation of management actions. Long-term beneficial impacts to visitor and employee safety would be fully realized under this alternative. It is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, more quickly under alternative C than under alternative B. The effects of alternative C, when combined with impacts of past, present, and reasonably foreseeable future actions on visitor and employee safety, would have short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts.

Alternative D: Comprehensive Management Plan that Maximizes Flexibility of Management Techniques

Analysis

Similar to alternative B, alternative D would result in short- and long-term minor to moderate adverse impacts on visitor and employee safety through implementation of management actions. Long-term beneficial impacts to visitor and employee safety would be fully realized under alternative D.

Under alternative D, there would be additional safety risks associated with potential relocation activities through handling of ungulates during capture, holding, and relocation. However, these impacts would be short term and similar to impacts associated with other management actions.

Although the expansion and enhancement of lethal removal techniques under alternative D would be implemented with the goal of increasing the efficiency and cost effectiveness of ungulate management, the continued use of volunteers and the expansion of non-lethal techniques would counteract this to some extent. Inclusion of non-lethal removal would require additional staff time and park resources to capture, hold and relocate animals, and may increase the time associated with reduction actions over the life of the plan, as well as time needed to reach the post-reduction phase. As a result, it is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, less quickly than under alternative C.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative D would be the same as alternative A. Similar to alternative B, when combined with the impacts of implementing alternative D, there would be short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts on visitor and employee safety in the park.

Conclusion

Under alternative D, short- and long-term minor to moderate adverse impacts on visitor and employee safety would result from implementation of management actions. Long-term beneficial impacts to visitor and employee safety would be fully realized under this alternative. It is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, less quickly under alternative D than under alternative C. The effects of alternative D, when combined with impacts of past, present, and reasonably foreseeable future actions on visitor and employee safety, would have short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts.

Alternative E: Comprehensive Management Plan that Increases Flexibility of Management Techniques While Limiting the Use of Volunteers

Analysis

Similar to alternative B, alternative E would result in short- and long-term minor to moderate adverse impacts on visitor and employee safety through implementation of management actions. Long-term beneficial impacts to visitor and employee safety would be fully realized under alternative E. Similar to alternative D, there would be additional safety risks associated with potential relocation activities.

Although the expansion and enhancement of lethal removal techniques under alternative E would be implemented with the goal of increasing the efficiency and cost effectiveness of ungulate management, the expansion of non-lethal techniques would counteract this to some extent. However, because volunteers would not be used during direct reduction efforts under alternative E, it is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, more quickly than under alternative D, but less quickly than under alternative C.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative E would be the same as alternative A. Similar to alternative B, when combined with the impacts of implementing alternative E, there would be short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts on visitor and employee safety in the park.

Conclusion

Under alternative E, short- and long-term minor to moderate adverse impacts on visitor and employee safety would result from implementation of management actions. Long-term beneficial impacts to visitor and employee safety would be fully realized under this alternative. It is expected that the NPS would reach the desired conditions, and therefore fully realize beneficial impacts, more quickly under alternative E than under alternative D, but less quickly than under alternative C. The effects of alternative E, when combined with impacts of past, present, and reasonably foreseeable future actions on visitor and employee safety, would have short- and long-term minor to moderate adverse and long-term beneficial cumulative impacts.

PARK MANAGEMENT AND OPERATIONS

GUIDING REGULATIONS AND POLICIES

Park management and operations refers to the staff and budget available to protect and preserve vital park resources, provide for an effective visitor experience, and implement any selected plan.

METHODOLOGY, ASSUMPTIONS, AND IMPACT THRESHOLDS

The discussion of impacts on park operations focuses on the ability of park staff to protect and preserve resources and to provide the services for which each division was developed, given current funding and staffing levels. Impact intensity thresholds were defined for adverse impacts. For this plan/EIS, assignment of intensity levels for visitor use and experience impacts are based on the potential for changes to such characteristics as follows:

Negligible: Park operations would not be affected.

Minor: Park operations would be affected, and the effect would be detectable, but current levels of funding and staff would be adequate and other park operations would not be reduced.

Moderate: Park operations would be affected, the effect would be readily apparent, and increased staff and funding would be needed or other park operations would have to be reduced and/or priorities changed.

Major: Park operations would be affected, the effect would be readily apparent, and increased staff and funding would be needed or other park programs would have to be eliminated.

IMPACTS OF THE ALTERNATIVES

Alternative A: No Action (Continue Existing Non-native Ungulate Management Activities)

Analysis

Continuation of ungulate management actions associated with alternative A would impose a substantial demand on staff time and resources, most notably the Natural Resources Division. This division includes the wildlife program, which has four permanent employees and is exclusively dedicated to implementation of the non-native ungulate management program (see chapter 3), including construction, inspection, and maintenance of fencing; removals; and oversight of the Volunteer Ungulate Control Program. Additionally, Natural Resources Division staff members conduct ungulate removal efforts as part of the nēnē (Hawaiian goose) recovery program; are responsible for monitoring associated with non-native ungulate management; and participate in formal park partnerships (e.g., the TMA). From FY 2006 to FY 2008, the average cost to implement non-native ungulate management activities was $921,000 per year (Loh, pers. comm., 2010a).

As part of the non-native ungulate reduction program, an average of $641,000 was spent annually on management actions in the Kīlauea, ʻŌlaʻa, and Mauna Loa sections of the park, where most fenced units have successfully excluded target ungulate species (New Unit in ʻŌlaʻa still has animals). Approximately $408,000 of this was for fence maintenance and replacement, approximately $108,000 was for administrative costs, approximately $65,000 was for the kennel used in control efforts, and approximately $38,000 was for ungulate control efforts in fenced units (Loh, pers. comm., 2010a). Approximately $22,000 was for pig control in nēnē habitat in Kīlauea during the breeding season. In the Kahuku Unit where large numbers of animals remain, approximately $185,000 was spent on fencing, while $60,000 was spent on non-native ungulate removal efforts, and approximately $35,000 to administrative costs (Loh, pers. comm., 2010a). Of the $60,000 spent on non-native ungulate removal efforts in the Kahuku Unit, approximately $29,000 was spent on managing the volunteer program. The majority of this was for staff time spent coordinating and supervising ground shooting efforts (Loh, pers. comm., 2010a). The primary purpose of volunteer participation has been to increase awareness of non-native ungulate issues and engage the surrounding community and general public in stewardship of park resources. In terms of cost efficiency, field data show that park staff are more efficient conducting direct reduction (ground shooting) themselves, compared to when they are accompanied by volunteers (Stephens et al. 2008).

Under alternative A, expanding management, including new fence construction, requires substantial park expenditures. The commitment of time and resources requires park staff to seek additional funding and/or shift priorities from implementation of other ungulate management and native species recovery efforts. The costs of ungulate removal efforts would decrease once animals are reduced. However, there would be long-term needs for ongoing monitoring, periodic removal of ingress animals, and maintenance and replacement of fences.

Non-native ungulate management actions contribute to impacts on other park divisions as well. For example, increased purchasing and staffing related to fence construction and animal control requires staff time from the Administration Division for those efforts. The Protection Division is not typically affected by non-native ungulate management, but staff may be called upon to enforce temporary closures while non-native ungulate removal actions are occurring. The Interpretation Division includes non-native ungulate management in their communications programs, requiring staff time and materials to implement these programs. Each division's efforts are handled with existing staff and within existing budgets. As a result, there would be short- and long-term negligible to minor adverse impacts on the other park divisions.

In summary, alternative A would result in short- and long-term negligible to moderate adverse impacts on park management and operations. There could be increase costs associated with alternative A, because management would not have a comprehensive plan to guide implementation. There would be less likelihood that the NPS would progress through management phases, monitor, and apply management tools consistently (and effectively) as staff and institutional knowledge change over time. The greatest uncertainty would be for Kahuku and areas currently unmanaged (e.g., portions of ʻŌlaʻa), for which no established population-level objective and fencing strategy has been identified.

Cumulative Impacts

Other past, present, and reasonably foreseeable future actions, plans, and programs place demands on park staff and budget, and contribute to adverse cumulative impacts on park management and operations. Some of these impose burdens on staff from all divisions. An important recent action was the acquisition of the Kahuku unit, which has created new management responsibilities for park staff and resulted in long-term moderate adverse impacts on park management and operations. The development of new management plans, such as the GMP and the ATMP, affects all divisions, requiring allocation of staff time during both development and implementation.

All past, present, and reasonably foreseeable future actions would be affected by fluctuations in the level and availability of park staff and the amount of funding that the park can spend on a particular action. Funding in particular is a complicated issue, and can present a challenge for a given park action. Ten percent of the Interpretation Division's budget is accounted for by donated money. Approximately half of the Natural Resources Division's budget is accounted for by special funding from competitive NPS Service-wide or regional programs, such as the Pacific West Region natural cyclic maintenance program, which helps fund costs for fence replacement in the parks, and by non-agency or nonfederal special funding sources (Loh, pers. comm., 2010b). The amount of funding that the park successfully secures in a given year may vary; this constitutes a long-term adverse impact on park management and operations due to the constraints it places on budget and on policy development.

Other past, present, and reasonably foreseeable future actions would contribute to impacts on park management and operations that may vary by division. For example, addressing new invasive species challenges (e.g., coqui frogs, Australian tree fern) directly impacts the Natural Resources Division. Implementation of the fire management plan impacts the Fire Management Division and other park divisions that assist with fuels monitoring and treatments, and during wildland fire suppression activities. Development and maintenance of new park facilities would have additional impacts on park management and operations, including the Maintenance and Facilities Management Division, which could require additional staff and budgets.

These past, present, and reasonably foreseeable future actions would have long-term moderate adverse impacts on park management and operations. Past, present, and reasonably foreseeable future actions, when combined with the long-term moderate adverse impacts on park management and operations of alternative A, would have long-term moderate adverse cumulative impacts on park management and operations.

Conclusion

Alternative A would result in long-term moderate adverse impacts on the Natural Resources Division and short- and long-term negligible to minor adverse impacts on other divisions, including Interpretation, Administration, and Protection. There could be increased costs associated with alternative A, because management would not have a comprehensive plan to guide implementation. There would be less likelihood that the NPS would progress through management phases, monitor, and apply management tools consistently (and effectively) as staff and institutional knowledge change over time. The greatest uncertainty would be for Kahuku and areas currently unmanaged (e.g., portions of ʻŌlaʻa), for which no established population-level objective and fencing strategy has been identified.

The effects of alternative A, when combined with impacts of past, present, and reasonably foreseeable future actions on park management and operations, would have long-term moderate adverse cumulative impacts.

Alternative B: Comprehensive Management Plan that Uses Lethal Removal Techniques

Analysis

Under alternative B, management during the reduction and post-reduction phases, including new fence construction, requires substantial park expenditures. The commitment of time and resources requires park staff to seek additional funding and/or shift priorities from implementation of other ungulate management and native species recovery efforts. The costs of ungulate removal efforts would decrease after the transition to the maintenance phase. However, there would be long-term needs for ongoing monitoring, periodic removal of ingress animals, and maintenance and replacement of fences.

Non-native ungulate management actions contribute to impacts on other park divisions as well. For example, increased purchasing and staffing related to fence construction and animal control requires staff time from the Administration Division for those efforts. The Protection Division is not typically affected by non-native ungulate management, but staff may be called upon to enforce temporary closures while non-native ungulate removal actions are occurring. The Interpretation Division includes non-native ungulate management in their communications programs, requiring staff time and materials to implement these programs. Each division's efforts are handled with existing staff and within existing budgets. As a result, there would be short- and long-term negligible to minor adverse impacts on the other park divisions.

In summary, alternative B would result in short- and long-term negligible to moderate adverse impacts on park management and operations. Administration of a meat donation program would require additional staff time to transport carcasses/meat, identify willing recipients, and complete any necessary state requirements. Compared to alternative A, there would be overall increased cost efficiency associated with alternative B, because ungulate management would be guided by the fencing strategy, population objective, and comprehensive and systematic approach described in the "Elements Common to All Action Alternatives" section in chapter 2, rather than relying on the institutional knowledge of staff which would change overtime.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative A would be the same as alternative A. The long-term moderate adverse impacts of past, present, and reasonably foreseeable future actions on park operations and management, when combined with the impacts of implementing alternative B, would have long-term moderate adverse cumulative impacts.

Conclusion

Alternative B would result in long-term moderate adverse impacts to the Natural Resources Division and short- and long-term negligible to minor adverse impacts to other park divisions. Compared to alternative A, there would be increased cost efficiency associated with alternative B, because ungulate management would be guided by the fencing strategy, population objective, and comprehensive and systematic approach described in the “Elements Common to All Action Alternatives” section in chapter 2. The effects of alternative B, when combined with impacts of past, present, and reasonably foreseeable future actions on park management and operations, would have long-term moderate adverse cumulative impacts.

Alternative C: Comprehensive Management Plan that Maximizes Efficiency by Expanding Lethal Removal Techniques and Discontinuing the Use of Volunteers

Analysis

Similar to alternative B, alternative C would result in long-term moderate adverse impacts to the Natural Resources Division and short- and long-term negligible to minor adverse impacts to other park divisions. Compared to alternative B, there would be cost efficiency gained through the discontinuation of volunteers in ground shooting efforts. The increased efficiency associated with discontinuing the use of volunteers is based on additional work required by NPS staff to recruit, administer, train and direct volunteers in the field, and data that show that park staff remove more ungulates per day when they conduct direct reduction (ground shooting) themselves, compared to when they are accompanied by volunteers (Stephens et al. 2008).

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative C would be the same as alternative A. Similar to alternative B, the long-term moderate adverse impacts of past, present, and reasonably foreseeable future actions on park operations and management, when combined with the impacts of implementing alternative C, would have long-term moderate adverse cumulative impacts.

Conclusion

Alternative C would result in long-term moderate adverse impacts to the Natural Resources Division and short- and long-term negligible to minor adverse impacts to other park divisions. Compared to alternative B, there would be cost efficiency gained through the discontinuation of volunteers in ground shooting efforts. The effects of alternative C, when combined with impacts of past, present, and reasonably foreseeable future actions on park management and operations, would have long-term moderate adverse cumulative impacts.

Alternative D: Comprehensive Management Plan that Maximizes Flexibility of Management Techniques

Analysis

Similar to alternative B, alternative D would result in long-term moderate adverse impacts to the Natural Resources Division and short- and long-term negligible to minor adverse impacts to other park divisions. Compared to alternatives B and C, there would be increased costs and demand on staff time associated with potential relocation of animals. In addition to capturing animals, constructing holding pens, and transporting animals, park staff would need to identify willing recipients, and complete any necessary state requirements and permits for relocating animals.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative D would be the same as alternative A. Similar to alternative B, the long-term moderate adverse impacts of past, present, and reasonably foreseeable future actions on park operations and management, when combined with the impacts of implementing alternative D, would have long-term moderate adverse cumulative impacts.

Conclusion

Alternative D would result in long-term moderate adverse impacts to the Natural Resources Division and short- and long-term negligible to minor adverse impacts to other park divisions. Compared to alternatives B and C, there would be increased costs and demand on staff time associated with potential relocation of animals. The effects of alternative D, when combined with impacts of past, present, and reasonably foreseeable future actions on park management and operations, would have long-term moderate adverse cumulative impacts.

Alternative E: Comprehensive Management Plan that Increases Flexibility of Management Techniques While Limiting the Use of Volunteers

Analysis

Similar to alternative B, alternative E would result in long-term moderate adverse impacts to the Natural Resources Division and short- and long-term negligible to minor adverse impacts to other park divisions. Similar to alternative C, there would be cost efficiency gained through the discontinuation of volunteers in ground shooting efforts. However, similar to alternative D, there would be increased costs and demand on staff time associated with potential relocation of animals.

Cumulative Impacts

The past, present, and reasonably foreseeable future actions under alternative E would be the same as alternative A. Similar to alternative B, the long-term moderate adverse impacts of past, present, and reasonably foreseeable future actions on park operations and management, when combined with the impacts of implementing alternative E, would have long-term moderate adverse cumulative impacts.

Conclusion

Alternative E would result in long-term moderate adverse impacts to the Natural Resources Division and short- and long-term negligible to minor adverse impacts to other park divisions. Compared to alternatives B and D, there would be cost efficiency gained through the discontinuation of volunteers in ground shooting efforts. Compared to alternatives B and C, there would be increased costs and demand on staff time associated with potential relocation of animals. The effects of alternative E, when combined with impacts of past, present, and reasonably foreseeable future actions on park management and operations, would have long-term moderate adverse cumulative impacts.

SUSTAINABILITY AND LONG-TERM MANAGEMENT

The NPS is required to consider the relationship between short term uses of the environment and the maintenance and enhancement of long-term productivity (NEPA section 102(2)(C)(iv). In doing so, the NPS considers the long-term impacts of its actions, and whether its actions involve tradeoffs between immediate use of resources and long-term productivity and sustainability of resources.

ALTERNATIVES A, B, C, D, AND E

All of the alternatives considered in this plan/EIS involve non-native ungulate management activities that would support the long-term protection of the park's natural and cultural resources and support natural ecosystem recovery. None of the alternatives involve consumption of environmental resources beyond that associated with carrying out non-native ungulate management activities, such as limited amounts of fuel and materials consumption.

Through the removal of non-native ungulates, all alternatives would enhance the sustainability of park resources by supporting long-term ecosystem protection; supporting natural ecosystem recovery and providing desirable conditions for active restoration; and protecting and preserving cultural resources.

Sustainability would be best promoted by the action alternatives (alternatives B, C, D, and E) because of their comprehensive, systematic approach to non-native ungulate management. Although alternative A would also promote sustainability of park resources, the alternative's lack of a comprehensive, systematic approach would reduce the likelihood that management would be carried out consistently over time. Management would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities and implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time. The greatest uncertainty would be for the Kahuku unit and other areas currently unmanaged (e.g., portions of ʻŌlaʻa), where no established population-level objective or fencing strategy has been identified.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

The NPS is required to consider if its actions involve a irreversible or irretrievable commitment of resources (NEPA section 102(2)(C)(v)). A resource commitment is considered irreversible if it involves use of and impacts to a non-renewable resource (or a resource renewable only over a long period of time) such that future options for use of that resource are limited. A resource commitment is considered irretrievable if it involves consumption of resources not renewable or recoverable for future use.

ALTERNATIVES A, B, C, D, AND E

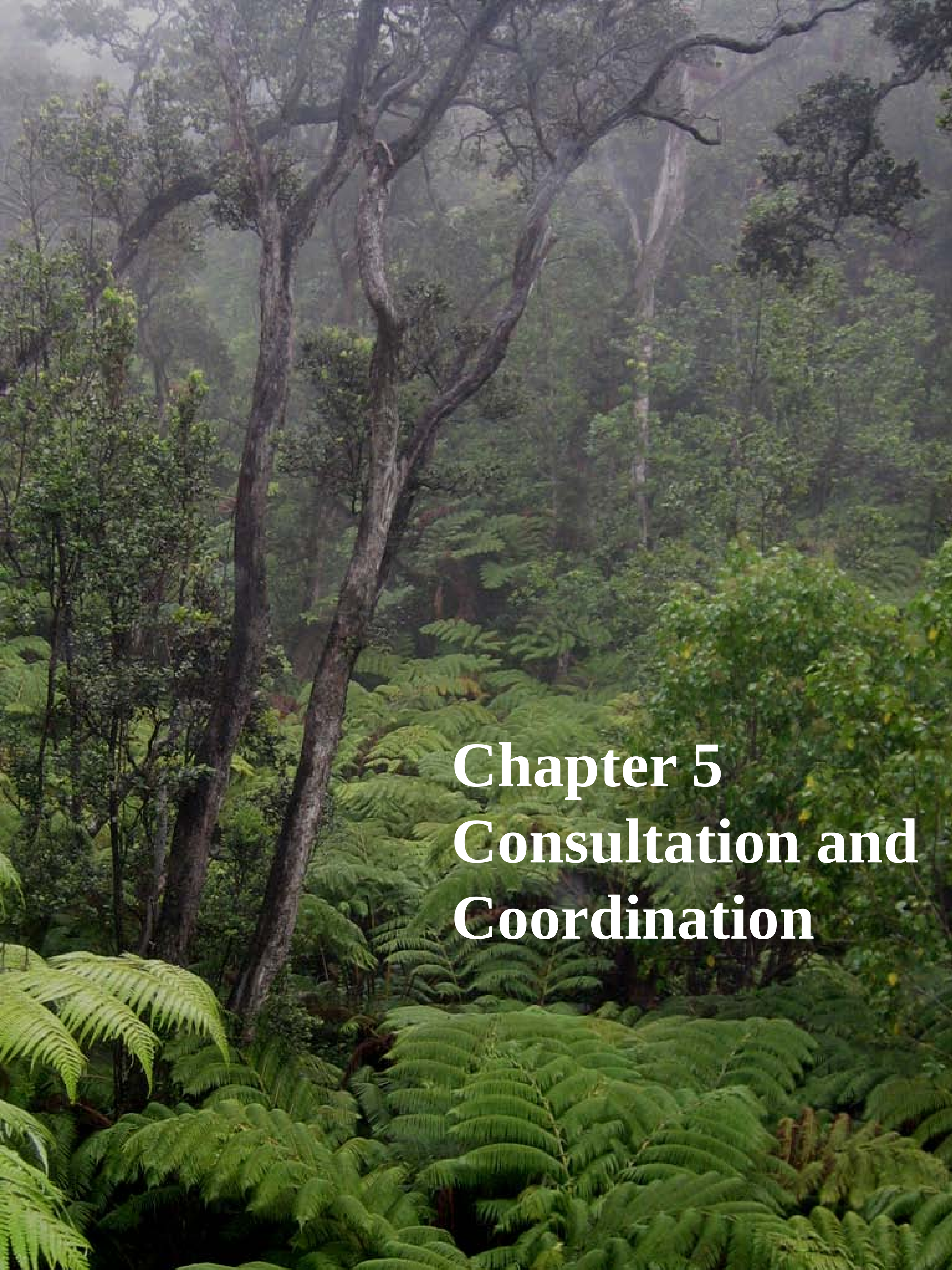
None of the alternatives would result in an irreversible or irretrievable commitment of resources beyond that associated with carrying out non-native ungulate management activities, such as limited amounts of fuel and materials consumption.

UNAVOIDABLE ADVERSE IMPACTS

The NPS is required to consider if its actions would result in impacts that could not be fully mitigated or avoided (NEPA section 102(2)(C)(ii)).

ALTERNATIVES A, B, C, D, AND E

There would be some unavoidable adverse impacts during implementation of management actions, such as disturbances to wildlife and visitors caused by associated noise. Although noise from the use of helicopters, firearms, and fencing equipment would be minimized to the extent practicable (e.g., firearm noise suppressors would be considered; fences are generally located far from visitor use areas), the effects would not be eliminated. Education and interpretation efforts would help mitigate some impacts to visitors by explaining the need for management relevant to protecting resources many come to experience.



Chapter 5 Consultation and Coordination

CHAPTER 5: CONSULTATION AND COORDINATION

Throughout the development of this plan/EIS, substantial coordination efforts have been undertaken to provide information to and solicit information from federal, state, and local officials as well as the general public. This chapter provides a summary of the outreach and consultation activities conducted during the planning process. Chapter 5 also contains lists of science team members and personnel involved in preparing the plan/EIS.

HISTORY OF PUBLIC INVOLVEMENT

The public involvement activities for this plan/EIS fulfill the requirements of the NEPA and NPS Director's Order 12 (NPS 2001a).

THE SCOPING PROCESS

The NPS divides the scoping process into two parts: internal scoping and external or public scoping. Internal scoping entails discussions among NPS personnel regarding the purpose of and need for management actions, issues, management alternatives, mitigation measures, the analysis boundary, appropriate level of documentation, available references and guidance, and other related topics.

Public scoping is the early involvement of the interested and affected public in the environmental analysis process. The public scoping process helps ensure that people have an opportunity to comment and contribute early in the decision-making process. For this plan/EIS, project information was distributed to individuals, agencies, and organizations early in the scoping process, and people were given opportunities to express concerns or views and to identify important issues or other alternatives.

Public scoping is the early involvement of the interested and affected public in the environmental analysis process and helps ensure that people have an opportunity to comment and contribute early in the decision-making process.

Taken together, internal and public scoping are essential elements of the NEPA planning process. The following sections describe the various ways scoping was conducted for this impact statement.

INTERNAL SCOPING

Internal scoping meetings were held at the park March 20–22, 2007. Internal scoping is the use of NPS staff to decide what topics need to be analyzed in the plan/EIS. The meetings were attended by personnel from the park, the NPS Environmental Quality Division, and NPS Pacific West Region, as well as the USGS Pacific Island Ecosystem Research Center. Based on these meetings, the interdisciplinary team defined the purpose of, need for, and objectives of the plan, identified potential issues, discussed preliminary alternatives, and defined data needs. The results of the meetings were captured in a report now on file as part of the administrative record for this plan/EIS.

PUBLIC SCOPING

Public scoping efforts for this planning process focused on the means or processes to be used to include the public, the major interest groups, and local public entities. Based on past experience, park staff places a high priority on meeting the intent of public involvement in the NEPA process and giving the public an opportunity to comment on proposed actions.

Public Notification

The public scoping process began on February 13, 2008, with the publication of a Notice of Intent in the FR (73 FR 30:8362–8363). The Notice of Intent invited the public to submit comments on the scope of the planning process and potential alternatives through May 19, 2008. In conjunction with the publication of the notice of intent, the park also released a newsletter that was mailed in March 2008 to the project's preliminary mailing list of government agencies, organizations, businesses, and individuals. The newsletter announced the public scoping meetings and provided background on non-native ungulates in relation to the ecosystem at the park. It also summarized the purpose of and need for a plan to protect and restore native ecosystems by managing non-native ungulates, and provided the plan objectives. Publicity also consisted of a website announcement, press releases, and informal contact with interested users. Public Notification included directing comments to the Planning, Environment, and Public Comment (PEPC) website at http://parkplanning.nps.gov/havo/.

Public Scoping Meetings

The NPS held public scoping meetings from April 29 through May 1, 2008, as follows:

- April 29, 2008 (5:30 p.m. to 8:30 p.m.): Hilo, Hawai'i; University of Hawaiʻi at Hilo; 33 people attended.
- April 30, 2008 (5:00 p.m. to 8:00 p.m.): Nāʻālehu, Hawai'i; Naalehu Community Center; 29 people attended.
- May 01, 2008 (5:00 p.m. to 8:00 p.m.): Kona, Hawai'i; Kona Outdoor Circle Educational Center and Botanical Garden; 19 people attended.

Each of the meetings included presentations on non-native ungulate issues at the park and on the planning process, a listening session, and open house. Park staff and other NPS specialists were on hand to record public comments, answer questions, and provide additional information to meeting attendees. The NPS received 112 pieces of correspondence during the scoping period, all of which were entered into the NPS web-based PEPC system. Each piece of correspondence was either directly entered by the commenter, uploaded as comments were submitted at the public scoping meetings, or sent in hardcopy form to the park.

Public Scoping Comments

The public scoping comment period was open from February 13, 2008, to May 19, 2008. During this period, public scoping meetings were held. Each public meeting provided numerous methods for the community to provide input on the proposed project. During the listening sessions, comments from the speakers were recorded on flipcharts and computers. During the open house portion of the meetings, each information station had a flipchart where an assigned staff person could take comments on a particular topic at issue, or on any other topic on which community members had concerns or questions. Comment sheets were provided that could be filled out and returned if commenters preferred not to make comments at the stations. A return address was provided on the comment sheets to mail back to the park at a later date if the attendees chose not to fill out sheets at the meeting. Those attending the meetings were also given a brochure providing additional opportunities for commenting on the project, including directing comments to the PEPC website at http://parkplanning.nps.gov/havo/.

The Comment Analysis Process

Comment analysis is a process used to compile and correlate similar public comments into a usable format for decision makers and the plan/EIS interdisciplinary NPS planning team. Comment analysis assists the team in organizing, clarifying, and addressing technical information pursuant to NEPA regulations. It also aids in identifying the topics and issues to be evaluated and considered throughout the planning process.

The process includes seven main components:

- Entering correspondence that was not received directly into the PEPC database
- Reviewing all correspondence
- Developing a coding structure
- Employing PEPC for comment management
- Reading and coding public comments from correspondence received
- Interpreting and analyzing the comments to identify issues and themes
- Preparing a comment summary.

A coding structure was developed to help sort comments into logical groups by topic and issue. The NPS derived the coding structure from an analysis of the range of topics discussed during internal scoping, past planning documents, and the comments themselves. The coding structure was designed to capture all comment content rather than to restrict or exclude any ideas.

The NPS PEPC database was used to manage the comments. The database stores the full text of all correspondence and allows each comment to be coded by topic and issue. The database tallies the total number of pieces of correspondence and comments received, sorts and reports comments by particular topics or issues, and provides demographic information on the sources of each comment.

Analysis of the public comments involved assigning codes to statements made in the public's letters, email messages, and written comment forms. All comments were read and analyzed, including those of a technical nature; opinions, feelings, and suggestions for alternative elements to be considered in the plan/EIS; and comments of a personal or philosophical nature.

A comment analysis report was prepared that summarized concern statements as well as the full text of all comments corresponding to the appropriate concern statement (NPS 2008e). All scoping comments were considered to be important as useful guidance and public input to the public scoping process. With regard to development of the plan/EIS, comments in favor of or against the proposed action or alternatives, those that only agree or disagree with NPS policy, and those that offer opinions or provide information not directly related to the issues or impact analysis were considered non-substantive comments. Although the analysis process attempts to capture the full range of public concerns, the content analysis report should be used with caution. Comments from people who chose to respond do not necessarily represent the sentiments of the entire public.

Of the 458 comments received, 331 were related to the alternative concepts; 79 comments were related to the affected environment at the park; 2 comments were related to the impact analysis; and 14 comments were concerned with the purpose and need of the plan/EIS. A number of comments received suggested incorporating public hunting into lethal removal efforts.

AGENCY CONSULTATION

ENDANGERED SPECIES ACT CONSULTATION

In accordance with the *Endangered Species Act* of 1973, Section 7 consultation with the USFWS concerning impacts to threatened and endangered species have been initiated by the NPS, as needed. To date, this has involved sending a request to the USFWS for input during initial scoping. This letter and the response from USFWS are both provided in appendix A. In their response, the USFWS provided a list of threatened and endangered species that occur in or close to the park. These species were included in the affected environment and impacts analysis conducted for this plan/EIS.

NATIONAL HISTORIC PRESERVATION ACT CONSULTATION

The NPS has initiated consultation with several groups under Section 106 of the *National Historic Preservation Act*. To date, the NPS submitted has submitted a letter to the following groups; these letters, and any responses received are both provided in appendix A:

- Advisory Council on Historic Preservation
- Department of Land and Natural Resources, Historic Preservation Division, State Historic Preservation Officer
- Department of Land and Natural Resources, Historic Sites Division
- Department of Hawaiian Home Lands
- Office of Hawaiian Affairs
- Hui Malama I Na Kupuna O Hawai‘i Nei
- Historic Hawai‘i Foundation
- Kalapana Community Organization
- The Kalapana Community Ohana
- Ho‘akea Public Relations LLC
- The Nature Conservancy of Hawai‘i
- Hawai‘i Island Burial Council, State Historic Preservation Division
- Kalauonaone o Puna Association
- Kupuna Consultation Group.

NATIVE HAWAIIAN CONSULTATION

Park staff members have discussed this plan/EIS during regularly scheduled Kupuna consultation meetings held on February 20 and May 12, 2008. Park staff provided informational presentations during both meetings, and provided the opportunity for participants to provide feedback and ask questions. Notes from these meetings have been entered into the administrative record for this project.

LIST OF RECIPIENTS OF THE DRAFT PLAN / ENVIRONMENTAL IMPACT STATEMENT

The following agencies, organizations, and businesses, as well as other entities and individuals, either received a copy of the draft plan/EIS or were notified of the documents' availability on PEPC.

FEDERAL DEPARTMENTS AND AGENCIES

- Advisory Council on Historic Preservation
- United States Department of Agriculture
  - Forest Service Institute of Pacific Islands Forestry
  - Natural Resources Conservation Service
  - Wildlife Services
- United States Department of Commerce
  - National Oceanic and Atmospheric Administration
  - National Marine Fisheries Service
- United States Department of Energy
  - Conservation and Renewable Energy Group
- United States Department of the Interior
  - National Park Service
    - Ala Kahakai National Historic Trail
    - Haleakalā National Park
    - Inventory and Monitoring Program
    - Kalaupapa National Park
    - Kaloko-Honokohau National Historic Park
    - Pacific West Region–Honolulu Office
    - Pu‘uhonua o Honaunau National Historic Park
    - Pu‘ukohola Heiau National Historic Site
- United States Geological Survey
  - Hawaiian Volcano Observatory
  - Pacific Island Ecosystems Research Center
- United States Fish and Wildlife Service
  - Hakalau Wildlife Refuge
  - Pacific Islands Fish and Wildlife Office
- United States House of Representatives
- The Honorable Neil Abercrombie
- The Honorable Mazie Hirono
- United States Senate
- The Honorable Daniel K. Inouye

HAWAI‘I AGENCIES

- Big Island Invasive Species Committee
- Department of Hawaiian Home Lands
- East Hawai‘i Governor’s Liaison Officer
- Hawai‘i Department of Business, Economic Development, and Tourism
- Hawai‘i Department of Health
  - Office of Environmental Quality Control
- Hawai‘i Department of Land and Natural Resources
  - Hawai‘i State Parks
  - Division of Conservation and Resources Enforcement
  - Division of Forestry and Wildlife
    - Natural Area Reserves System
    - Olinda Endangered Species Facility

- Historic Preservation Division
  - Historic Sites Division
  - Land Division
- Office of Conservation and Coastal Lands
  - State Parks
- Office of Hawaiian Affairs
  - Hilo CRC
- State Plant Extinction Prevention Program
- Hawaiʻi Department of Public Safety
  - Kūlani Correctional Facility
- Hawaiʻi Department of Public Works
  - Environmental Office
- Hawaiʻi Department of Transportation
  - State Highways Division
- Hawaiʻi House of Representatives
  - Jerry Chang
- Hawaiʻi Hunting Advisory Council
- Hawaiʻi Island Burial Council
- Hawaiʻi Office of the Lieutenant Governor
  - Honorable Brian Schatz
- Hawaiʻi State Library
- Hawaiʻi State Senate
  - Faye P. Hanohano, District 4
  - Lorraine Inouye, District 1
  - Paul Whalen, District 3
  - Robert Herkes, District 5
  - Gil Kahele, District 2
- Hawaiʻi Visitors and Convention Bureau
- University of Hawaiʻi
  - Botany Department
  - Cooperative Extension Services
  - Department of Zoology
  - Office of Mauna Kea Management
  - Cooperative Ecosystem Studies Unit
  - Urban and Regional Planning Program

COUNTY AND LOCAL AGENCIES

- County of Hawaiʻi
- County of Hawaiʻi Native Hawaiian Chamber of Commerce
- County of Hawaiʻi Public Access, Open Space, and Natural Resources Preservation Commission
- County of Hawaiʻi Research and Development
- Big Island Visitor Bureau
- Hawaiʻi Community College
- Hawaiʻi County Council
- Hawaiʻi County Fire Department
- Hilo Public Library
- Holualoa Public Library
- Honokaʻa Public Library
- Japanese Chamber of Commerce
- Kailua-Kona Public Library
- Keaʻau Public Library
- Kealakekua Public Library
- Laupahoehoe Public Library
- Mountain View Public Library
- Naʻalehu Public Library
- North Kohala Public Library
- Ocean View Chamber of Commerce
- Pahala Public Library
- Pahoa Public Library
- Thelma Parker Public Library

ORGANIZATIONS AND BUSINESSES

- Ahahui Kaʻahumanu O Kona
- AECOS, Inc.
- Ahahui Malama I Ka Lokahi
- Association of Watershed Partnerships
- Audubon Naturalist Society
- Woodend Sanctioned Headquarters
- Big Island Bird Hunters
- Big Island Bow Hunters
- Big Island Field Trial Association
- Big Island Gun Club
- Big Island Trap Club
- Bishop Museum
- Carnegie Institution
- Department of Global Ecology
- Chaminade University
- Conservation Council of Hawaiʻi
- Council for Native Hawaiian Advancement

- Defenders of Wildlife
- Ducks Unlimited
- Earthjustice
- Environment Hawai‘i, Inc.
- Forest Solutions, Inc.
- Friends of Hawai‘i Volcanoes National Park
- Hanapi Foundation
- Hawai‘i Audubon Society
- Hawai‘i Hunting Tours
- Hawai‘i Island Archery Club
- Hawai‘i Island Chamber of Commerce
- Hawai‘i Natural History Association
- Hawaiian Ecosystems at Risk
- Hawaiian Silversword Foundation
- Historic Hawai‘i Foundation
- Ho‘akea Public Relations, LLC
- Hokukano Ranch
- Ho‘opuloa Hawaiian Civic Club
- Hualalai Archery Club
- Hui Malama I Na Kupuna O Hawai‘i Nei
- Hulihe‘e Palace
- Humane Society of the United States
- Ilioulaokalani Coalition
- International Archaeological Research Institute, Inc.
- Kahauloa Hunt Club
- Kahua Ranch LTD
- Kai Malino Ranch
- Kalapana Community Organization
- Kalauonaone o Puna Association
- Kamehameha Schools
- Kapāpala Ranch
- Kealia Ranch
- Keauhou Bird Conservation Center
- Ken Direction Corporation
- Kennedy Wilson
- Kilauea Military Camp
- Kilauea Sporting Skeet Club
- Kona Hawaiian Civic Club
- Kona Historical Society
- Kona Outdoor Circle
- Kuakini Hawaiian Civic Club of Kona
- Kupuna Consultation Group
- Laiopua 2020
- Lanihau Partners
- Mahealani Ranch
- Marine and Coastal Solutions International, Inc.
- Mauka to Makai Ohana Club
- Mauna Loa Outfitters
- McCandless Ranch
- National Park Foundation
- National Parks Conservation Association
- National Wild Turkey Federation
- Volcano Chapter
- National Wildlife Federation
- Native Hawaiian Advisory Council
- Native Hawaiian Legal Corporation
- Natural Resources Defense Council
- North Kohala Gun Club
- Ocean View Community Association
- Oceanit
- Palani Ranch
- Pig Hunters of Hawai‘i
- Public Employees for Environmental Responsibility
- Queen Liliuokalani Trust
- Quill Group
- Royal Order of Kamehameha
- Sierra Club
  - Moku Loa group
- Stanford University
  - Biology Department
- The Kalapana Community Ohana
- The Kalapana Ohana Association
- The Mountain Institute
- The Nature Conservancy of Hawai‘i
- The Nature Sounds Society
- The Wilderness Society
- Three Mountain Alliance
- TREE Center Hawai‘i
- Volcano Art Center
- Volcano Community Association
- Volcano Golf and Country Club
- Volcano House
- West Hawai‘i Today
- Wilderness Watch
- Yee Hop Enterprises

SCIENCE TEAM MEMBERS

Name	Affiliation/Expertise
Ian Cole	Hawai‘i Division of Forestry and Wildlife Natural Area Reserves System/wildlife resources, invasive species control
Clifford Smith	Professor emeritus of Botany, University of Hawai‘i / non-native ungulate management in Hawai‘i
Jack Jeffrey	Hakalau Forest National Wildlife Refuge, USFWS / natural resource restoration, alien species control (predators, plants, ungulates), endangered plant and bird recovery
Steve Hess	USGS PIERC, Biological Resources Discipline / studying mouflon sheep at Kahuku since 2004
Jim Jacobi	USGS PIERC, Biological Resources Discipline / plant ecology, bird populations, impacts to ecosystems
Loyal Mehrhoff	USGS PIERC, Biological Resources Discipline / Center Director
Peter Gogan	USGS Northern Rocky Mountain Science Center / wildlife research biologist; involved with non-native ungulate management plan at Point Reyes National Seashore
Peter Dratch	Endangered Species Program, NPS Biological Resources Management Division / Program Manager
Kirsten Leong	Human Dimensions of Biological Resource Management, NPS Biological Resources Management Division / Program Manager
Mark Wotawa	Endangered Species Program, NPS Biological Resources Management Division / threatened and endangered species, invasive species.
Rhonda Loh	Hawai‘i Volcanoes / Chief of Natural Resource Management
Howard Hoshide	Hawai‘i Volcanoes / wildlife biologist; oversees non-native ungulate management program at the park
Ben Kawakami	Hawai‘i Volcanoes / pest controller; oversees volunteer program for non-native ungulate management at the park
Tom Flanagan	NPS Environmental Quality Division / NPS Project Manager for EIS, NEPA Specialist
Dan Niosi	NPS Environmental Quality Division / NPS Project Manager for EIS, NEPA Specialist
Jeff Gutierrez	The Louis Berger Group / environmental planner

LIST OF PREPARERS AND CONSULTANTS

Name	Title
National Park Service	
Keola Awong	Anthropologist, Hawai‘i Volcanoes National Park
Ron Borne	Chief of Maintenance, Hawai‘i Volcanoes National Park
Tom Flanagan	Environmental Protection Specialist, Environmental Quality Division
Danielle Foster	Environmental Protection Specialist, Hawai‘i Volcanoes National Park
Jim Gale	Chief of Interpretation, Hawai‘i Volcanoes National Park
Lora Gale	Park Planner, Hawai‘i Volcanoes National Park
Howard Hoshide	Wildlife Biologist, Hawai‘i Volcanoes National Park
Darcy Hu	Pacific Island Network (PACN) Science Advisor, Hawai‘i Volcanoes National Park
Ben Kawakami	Pest Controller, Hawai‘i Volcanoes National Park
Mardie Lane	Public Information officer, Hawai‘i Volcanoes National Park
Catherine Lentz	Environmental Protection Specialist, Hawai‘i Volcanoes National Park
Rhonda Loh	Chief of Natural Resources Management, Hawai‘i Volcanoes National Park
Talmadge Magno	Chief of Protection, Hawai‘i Volcanoes National Park
Sierra McDaniel	Botanist, Hawai‘i Volcanoes National Park
Keola Medeiros	Pest Controller, Hawai‘i Volcanoes National Park
Kathleen Misajon	Wildlife Biologist, Hawai‘i Volcanoes National Park
Joe Molhoek	PACN Fire Management Officer, Hawai‘i Volcanoes National Park
Jadelyn Moniz-Nakamura	Archeologist, Hawai‘i Volcanoes National Park
Cindy Orlando	Superintendent, Hawai‘i Volcanoes National Park
Laura Schuster	Chief of Cultural Resources, Hawai‘i Volcanoes National Park

Name	Title
U.S. Geological Survey	
David Foote	Entomologist, Pacific Island Ecosystem Research Center
Steve Hess	Research Biologist, Pacific Island Ecosystem Research Center
Linda Pratt	Botanist, Pacific Island Ecosystem Research Center
The Louis Berger Group	
Lucy Bambrey	Cultural Resource Specialist
Holly Bender	Economist
Megan Blue-Sky	Environmental Scientist
Lori Fox	Planner
Jeff Gutierrez	Environmental Planner, Deputy Project Manager
Dr. Lisa McDonald	Resource Economist
Kasey Pearson	Environmental Scientist
Lia Peckman	Environmental Scientist
Josh Schnabel	Environmental Planner
Dayna Sherwood	Environmental Analyst
Nancy Van Dyke	Senior Consultant
Landon Vine	Environmental Scientist
Doug Wetmore	Environmental Planner
The Final Word	
Juanita Barboa	Technical Editor
Sherrie Bell	Technical Editor / Document Designer
Laurel Porter	Technical Editor

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GLOSSARY

‘a’a flows—These volcanic lava flows result in discontinuous lava surfaces; the hallmark of an ‘a’a lava flow is the very rough surface it produces when it cools and solidifies.

Action Alternative—An alternative that proposes a different management action or actions to address the purpose, need, and objectives of the plan; one that proposes changes to the current management. Alternatives B and C are the action alternatives in this planning process. See also: “No-Action Alternative.”

Affected Environment—A description of the existing environment that may be affected by the proposed action (40 CFR 1502.15).

Ahupua‘a—Traditional Hawaiian land division usually extending from the uplands to the sea.

Authorized Agents—For the purposes of this plan, authorized agents could include NPS personnel, other federal, state, or local agency personnel, and skilled professionals. Authorized agents would be certified in firearms training, and specially trained in wildlife management with firearms. Skilled professionals would include nonprofit groups, fully insured business entities, or others engaged in wildlife management activities that include direct reduction with firearms. Skilled professionals would possess all necessary permits.

Alpine—A high elevation region above tree line characterized by dry, cool climate and sparse to almost non-existent vegetation (Wagner et al. 1999). Frosts are frequent at night. In the park, this environment typically occurs above 8,500 feet elevation.

Avian—Pertaining to or characteristic of birds.

Cervid—A member of the deer family, such as white-tailed deer, mule deer, elk, moose, and caribou.

Closure—An area delineated by posts with string between them, prohibiting vehicle and/or pedestrian access (except in alternative A, where sometimes string is not used between posts).

Coastal Lowland—The coastal lowland environment includes the coastal strand along the immediate shoreline and the coastal plain makai of the large fault scarps or pali, usually located one to several miles away from the shoreline, and woodland communities on the face of the pali. The coastal lowland environment is typically warm and dry. Rainfall varies from about 60 inches per year in the eastern park boundary to less than 20 inches in the west. Summer drought conditions characterize the area (NPS 2005e).

Code—A grouping centered on a common subject. The codes were developed during the scoping process and were used to track major subjects.

Comment—A comment is a portion of the text within a correspondence that addresses a single subject. It could include such information as an expression of support or opposition to the use of a potential management tool, additional data regarding the existing condition, or an opinion debating the adequacy of an analysis.

Concern—Concerns are statements that summarize the issues identified by each code. Each code was further characterized by concern statements to provide a better focus on the content of comments. Some codes required multiple concern statements, while others did not.

Contractor—For the purposes of this plan, a contractor would be a fully insured business entity, nonprofit group, or other entity engaged in wildlife management activities that include the direct reduction with firearms.

Correspondence—A correspondence is the entire document received from a commenter. It can be in the form of a letter, email, written comment form, note card, open house transcript, or petition.

Council on Environmental Quality (CEQ)—Established by Congress within the Executive Office of the President with passage of the *National Environmental Policy Act of 1969*. CEQ coordinates federal environmental efforts and works closely with agencies and other White House offices in the development of environmental policies and initiatives.

Criteria Pollutants—The 1970 amendments to the *Clean Air Act* requiring the U.S. Environmental Protection Agency to set National Ambient Air Quality Standards for certain pollutants known to be hazardous to human health. Environmental Protection Agency has identified and set standards to protect human health and welfare for six pollutants: ozone, carbon monoxide, total suspended particulates, sulfur dioxide, lead, and nitrogen oxide. The term, “criteria pollutants” derives from the requirement that Environmental Protection Agency must describe the characteristics and potential health and welfare effects of these pollutants. It is on the basis of these criteria that standards are set or revised.

Cultural Landscape—A geographic area (including both cultural and natural resources and the wildlife or domestic animals therein) associated with a historic event, activity, or person or exhibiting other cultural or aesthetic values.

Cultural Resources—Prehistoric and historic districts, sites, buildings, objects, or any other physical evidence of human activity considered important to a culture, subculture, or community for scientific, traditional, religious, or other reason.

Decibels—A unit of relative sound loudness, electric voltage, or current equal to ten times the common logarithm of the ratio of two readings.

Depredation—Damage or loss the act of preying upon.

Direct Reduction—Lethal removal of non-native ungulates; includes both sharpshooting and capture/euthanasia.

Ecosystem—An ecological system; the interaction of living organisms and the nonliving environment producing an exchange of materials and energy between the living and nonliving.

Endangered Species—“…any species (including subspecies or qualifying distinct population segment) that is in danger of extinction throughout all or a significant portion of its range (ESA Section 3(6)).” The lead federal agency, U.S. Fish and Wildlife Service, for the listing of a species as endangered is responsible for reviewing the status of the species on a five-year basis.

Endangered Species Act (ESA) (16 USC 1531 et seq.)—An Act to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved and to provide a program for the conservation of such endangered species and threatened species.

Endemic—Native to or confined to a particular region.

Environment—The sum total of all biological, chemical, and physical factors to which organisms are exposed; the surroundings of a plant or animal.

Environmental Assessment (EA)—A concise public document, prepared in compliance with NEPA, that briefly discusses the purposes and need for an action, and provides sufficient evidence and analysis of impacts to determine whether to prepare an environmental impact statement or finding of no significant impact (40 CFR 1508.9).

Environmental Consequences—Environmental effects of project alternatives, including the proposed action, any adverse environmental effects which cannot be avoided, the relationship between short-term uses of the human environment, and any irreversible or irretrievable commitments of resources which would be involved if the proposal should be implemented (40 CFR 1502.16).

Estuarine—Formed, deposited, growing in, inhabiting, or found in the widening channel of a river where it nears the sea or in an area of fresh water and salt (tidal) water mixing.

Ethnographic Resource—Any site, structure, object, landscape, or natural resource feature assigned traditional legendary, religious, subsistence, or other significance in the cultural system of a group traditionally associated with it.

Executive Order—Official proclamation issued by the President that may set forth policy or direction or establish specific duties in connection with the execution of federal laws and programs.

Exposure—Exposure occurs whenever and wherever a person is subjected to electric, magnetic or electromagnetic fields other than those originating from physiological processes in the body and other natural phenomena.

Extirpated Species—A species that is no longer present in an area where it once lived.

Fauna—Animals, especially the animals of a particular region or period, considered as a group.

Fertility Control—A method or methods used to limit the numbers of animals in a population by decreasing the reproductive success of the animals, such as contraception or sterilization.

Finding of No Significant Impact (FONSI)—A document prepared by a federal agency showing why a proposed action would not have a significant impact on the environment and thus would not require preparation of an Environmental Impact Statement. A FONSI is based on the results of an Environmental Assessment.

Floodplain—The flat or nearly flat land along a river or stream or in a tidal area that is covered by water during a flood.

Flora—Plants considered as a group, especially the plants of a particular country, region, or time.

Habitat—The environment in which a plant or animal lives (includes vegetation, soil, water, and other factors).

Herbivore—An animal that eats a diet consisting primarily of plant material.

Historic District—An area that generally includes within its boundaries a significant concentration of properties linked by architectural style, historical development, or a past event.

Invasive Species—Non-native species disrupting and replacing native species.

Irreversible—A term that describes the loss of future options. Applies primarily to the effects of use of nonrenewable resources, such as minerals or cultural resources, or to those factors, such as soil productivity that are renewable only over long periods of time.

Makai—Oceanside, towards the sea.

Mauka—Inland, upland, towards the mountain.

Migratory—The act of moving from one spatial unit to another.

Monitoring—A process of collecting information to evaluate if an objective and/or anticipated or assumed results of a management plan are being realized (effectiveness monitoring) or if implementation is proceeding as planned (implementation monitoring).

Montane—Most of the montane seasonal fire environment in the park lies on the lower slopes of Mauna Loa Strip mauka of mid-elevation seasonal woodland at 4,000 foot elevation and makai of the subalpine fire environment zone at 6,700 foot elevation. In Kahuku, the area between 5,000 and 6,000 feet in elevation on the southwest facing slope between Manukä and Kipahoehoe Natural Area Reserves can also be characterized as montane seasonal (NPS 2005e).

National Environmental Policy Act (NEPA)—The Act as amended articulates the federal law that mandates protecting the quality of the human environment. It requires federal agencies to systematically assess the environmental impacts of their proposed activities, programs, and projects including the "no-action" alternative of not pursuing the proposed action. NEPA requires agencies to consider alternative ways of accomplishing their missions in ways which are less damaging to the environment.

National Historic Preservation Act of 1966 (16 USC 470 et seq.)—An Act to establish a program for the preservation of historic properties throughout the nation, and for other purposes, approved October 15, 1966 [Public Law 89-665; 80 STAT. 915; 16 USC. 470 as amended by Public Law 91-243, Public Law 93-54, Public Law 94-422, Public Law 94-458, Public Law 96-199, Public Law 96-244, Public Law 96-515, Public Law 98-483, Public Law 99-514, Public Law 100-127, and Public Law 102-575].

National Register of Historic Places (National Register)—A register of districts, sites, buildings, structures, and objects important in American history, architecture, archaeology, and culture, maintained by the Secretary of the Interior under authority of Section 2(b) of the *Historic Sites Act of 1935* and Section 101(a)(1) of the *National Historic Preservation Act of 1966*, as amended.

No-Action Alternative—The alternative in which baseline conditions and trends are projected into the future without any substantive changes in management (40 CFR 1502.14(d)). Alternative A is the no-action alternative in this planning process.

Non-native Species—Any introduced plant, animal or protist species that is not native to the area and may be considered a nuisance; also called exotic or alien species.

Organic Act—Enacted in 1916, this act commits the National Park Service to making informed decisions that perpetuate the conservation and protection of park resources unimpaired for the benefit and enjoyment of future generations.

Pahoehoe flows—These volcanic lavas flows result in continuous surfaces. Pahoehoe lavas are thin and they flow smoothly in tongues or lobes and are characterized by a glassy, plastic skin. When the pahoehoe lava flow cools, it often solidifies to a smooth surface.

Pali—Cliffs or ridges.

Population (or Species Population)—A group of individual plants or animals that have common characteristics and interbreed among themselves and not with other similar groups.

Population Reduction—Removing animals randomly within a population in an attempt to reduce animal density, and thus decrease CWD transmission rates.

Qualified volunteers—For the purposes of this plan, qualified volunteers would include individuals identified through an NPS-developed application and selection process. Before assisting with removal actions with firearms, these individuals would need to meet a number of requirements including

- filling out a registration form;
- obtaining a Hunter Education Certificate or card;
- presenting registration of the firearm to be used and a Hawai‘i hunting license;
- providing their own transportation; and
- being able to spend a minimum of eight hours hiking over rough terrain.

Reproductive Control—A method or methods used to limit the numbers of animals in a population by decreasing the reproductive success of the animals, such as contraception or sterilization.

Scoping—An early and open process for determining the extent and variety of issues to be addressed and for identifying the significant issues related to a proposed action (40 CFR 1501.7).

Subalpine—This zone extends from 6,500 to 8,500 feet (1,981 to 2,591 meters) (and higher). The average annual temperature ranges from 40°F to 50°F, with occasional winter frost. Low-lying clouds cause fog-drip from trees and shrubs, which contributes to precipitation.

Successional—“Successional” refers to the process of ecosystem development as brought about by changes in the populations of species that results in the creation of a geographic region with particular characteristics. Early successional refers to species that tend to more quickly give way to other species (weeds, nonnative varieties, etc.), typically representing lower quality habitat. Late-successional refers to more persistent species, and tend to be associated with higher value habitat.

Ungulate—A hoofed, typically herbivorous, animal; includes horses, cows, deer, elk, and bison.

Wetlands—The U.S. Army Corps of Engineers (Federal Register, 1982) and the Environmental Protection Agency (Federal Register, 1980) jointly define wetlands as: Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

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Appendices

APPENDIX A: AGENCY CONSULTATION

United States Department of the Interior

Hawai`i Volcanoes National Park
P. O. Box 52
Hawaii National Park, HI 96718-0052
808/985-6000
808/967-8186 (FAX)

In Reply Refer to:

H4217 (HAVO)
xL7617

March 20, 2008

Mr. Patrick Leonard, Field Supervisor
US Fish and Wildlife Service
Pacific Islands Ecoregion
300 Ala Moana Blvd, Rm 3-122
PO Box 50088
Honolulu HI 96850

Dear Patrick:

Subject: Request for Informal Section 7 Consultation, Protecting & Restoring Native Ecosystems by Managing Non-Native Ungulates Plan/EIS

The National Park Service (NPS) is initiating informal Section 7 consultation for a proposed undertaking at Hawai'i Volcanoes National Park. The NPS has begun preparation of a draft environmental impact statement (EIS) to address the long-term management of non-native ungulates within Hawai'i Volcanoes National Park. The purpose of the plan is to refine strategies for managing non-native ungulates that support long-term ecosystem protection; support recovery and restoration of native vegetation and other natural resources; and protect and preserve cultural resources. The NPS will comply with the National Environmental Policy Act of 1969 (NEPA) in the preparation of the EIS.

We request your input on any issues related to the project. In addition, we seek information about the presence of listed rare, threatened, or endangered species in the vicinity of the park. Your participation will help ensure that potential environmental impacts are adequately considered. A scoping newsletter is enclosed with this letter. It provides a brief background on the issue of ungulates in the park and the purpose and need for action. We appreciate your careful consideration of this material.

The week of April 29, 2008, Hawai'i Volcanoes National Park will be holding scoping meetings at three locations on the Island of Hawai'i. They are as follows:

Tuesday, April 29, 5:30 pm-8:30 pm, Hilo:
University of Hawai'i at Hilo
University Classroom Building (UCB), first floor, Room 100
200 W. Kawili St.
Hilo, Hawai'i

Mr. Patrick Leonard, Field Supervisor
Page 2
March 20, 2008

Wednesday, April 30, 5:00 pm-8:00 pm, Na'alehu:
Na'alehu Community Center
95-5635 Mamalahoa Highway
Na'alehu, Hawai'i

Thursday, May 1, 5:00 pm-8:00 pm: Kailua-Kona
Kona Outdoor Circle Educational Center and Botanical Gardens
76-6280 Kuakini Highway
Kailua-Kona, Hawai'i

In addition to attending the public meetings, comments may be provided in two other ways:

Mail:
Cindy Orlando
Superintendent, Hawai'i Volcanoes National Park
RE: Protecting & Restoring Native Ecosystems by Managing Non-Native Ungulates Plan/EIS
P.O. Box 52
Hawaii National Park, HI 96718-0052

Electronically:
Through the NPS Planning, Environment and Public Comment project Web site at http://parkplanning.nps.gov/HAVO.

We appreciate your participation in the EIS process and look forward to receiving your comments. If you have any questions please contact Dr. Rhonda Loh, Chief of Natural Resources Management, at 808-985-6098.

Sincerely,

Cynthia Orlando

Cynthia L. Orlando
Superintendent

Enclosure

United States Department of the Interior

Hawai`i Volcanoes National Park
P. O. Box 52
Hawaii National Park, HI 96718-0052
808/985-6000
808/967-8186 (FAX)

In Reply Refer to:

H4217 (HAVO)
xL7617

March 20, 2008

Laura Thielen
State Historic Preservation Officer
Department of Land and Natural Resources
601 Kamokila Boulevard, Room 555
Kapolei, HI 96707

Dear Laura:

Subject: Protecting & Restoring Native Ecosystems by Managing Non-Native Ungulates Plan/EIS

In accordance with the Advisory Council on Historic Preservation regulations, 36 CFR Part 800 Protection of Historic Properties, the National Park Service (NPS) is initiating Section 106 consultation for a proposed undertaking at Hawai'i Volcanoes National Park. The NPS has begun preparation of a draft environmental impact statement (EIS) to address the long-term management of non-native ungulates within Hawai'i Volcanoes National Park. The purpose of the plan is to refine strategies for managing non-native ungulates that support long-term ecosystem protection; support recovery and restoration of native vegetation and other natural resources; and protect and preserve cultural resources. The NPS will comply with the National Environmental Policy Act of 1969 (NEPA) in the preparation of the EIS.

Your participation in the Section 106 and NEPA processes will help ensure that potential environmental impacts are adequately considered. A scoping newsletter is enclosed with this letter. It provides a brief background on the issue of ungulates in the park and the purpose and need for action. We appreciate your careful consideration of this material.

The week of April 29, 2008, Hawai'i Volcanoes National Park will be holding scoping meetings at three locations on the Island of Hawai'i. They are as follows:

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University of Hawai`i at Hilo
University Classroom Building (UCB), first floor, room 100
200 W. Kawili St.
Hilo, Hawai'i

Laura Thielen
Page 2
March 20, 2008

Wednesday, April 30, 5:00pm-8:00pm, Na'alehu:
Na'alehu Community Center
95-5635 Mamalahoa Highway
Na'alehu, Hawai'i

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Kona Outdoor Circle Educational Center and Botanical Gardens
76-6280 Kuakini Highway
Kailua-Kona, Hawai'i

In addition to attending the public meetings, comments may be provided in two other ways:

Mail:
Cindy Orlando
Superintendent, Hawai'i Volcanoes National Park
RE: Protecting & Restoring Native Ecosystems by Managing Non-Native Ungulates Plan/EIS
P.O. Box 52
Hawaii National Park, HI 96718-0052

Electronically:
Through the NPS Planning, Environment and Public Comment project Web site at http://parkplanning.nps.gov/HAVO.

We invite your organization to participate in the Section 106 and NEPA consultation for this undertaking and look forward to receiving your comments. If you have any questions please contact Dr. Rhonda Loh, Chief of Natural Resources Management, at 808-985-6098 or Laura C. Schuster, Chief of Cultural Resources, at 808-985-6130.

Sincerely,

Cynthia L. Orlando

Cynthia L. Orlando
Superintendent

Enclosure

Laura Thielen
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March 20, 2008

cc:
Nance McMahan
Department of Land and Natural Resources
P O Box 261
Honolulu HI 96809

Department of Land and Natural Resources
Historic Preservation Division
601 Kamokila Boulevard, Room 555
Kapolei HI 96707

Department of Land and Natural Resources
Historic Sites Division
601 Kamokila Boulevard, Room 555
Kapolei HI 96707

Hawai'i Island Burial Council
c/o State Historic Preservation Division
601 Kamokila Boulevard, Room 555
Kapolei HI 96707

La'akea Suganuma
835 Ahuwale Street
Honolulu HI 96821

Kalauonaone o Puna Association
c/o Mr. Leroy Dikito, President
P O Box 1582
Pāhoa HI 96778

Darryl Yagodich
Department of Hawaiian Home Lands
P O Box 1879
Honolulu HI 96805

Lukela Ruddle
Office of Hawaiian Affairs, Hilo CRC
162-A Baker Avenue
Hilo HI 96720

Laura Thielen
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March 20, 2008

Cindy Orlando
Kupuna Consultation Group
P O Box 52
Hawaii National Park HI 96718

Clyde Namu'o
Office of Hawaiian Affairs
711 Kapi'olani Boulevard, Suite 500
Honolulu HI 96813

Director
Advisory Council on Historic Preservation
Old Post Office Building
1100 Pennsylvania Avenue, Suite 803
Washington D.C. 20004

Samuel M. Gon III
The Nature Conservancy of Hawai'i
923 Nu'uanu Avenue
Honolulu HI 96817

Robert Keli'iho'omalu
The Kalapana Community Ohana
RR1, Box 4972
Pāhoa HI 96778

Pi'ilani Ka'awaloa
Kalapana Community Organization
P O Box 688
Pāhoa HI 96778

Marion Kelly
4117 Black Point Road
Honolulu HI 96816

Kiersten Faulkner
Historic Hawai'i Foundation
680 Iwilei Road, Suite 690
Honolulu HI 96817

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March 20, 2008

Edward Ayau
Executive Director
Hui Malama I Na Kupuna ‘O Hawai‘i Nei
622 Wainaku Avenue
Hilo HI 96720

Lani Ma‘a Lapilio
Ho‘akea Public Relations LLC
1001 Bishop Street
Pauahi Tower, 27th Floor
Honolulu HI 96813

Kamana‘o Mills
Department of Hawaiian Home Lands
P O Box 1879
Honolulu HI 96805

United States Department of the Interior

Hawai`i Volcanoes National Park
P. O. Box 52
Hawaii National Park, HI 96718-0052
808/985-6000
808/967-8186 (FAX)

In Reply Refer to:

L7617 (HAVO)

March 20, 2008

The Honorable Neil Abercrombie
U. S. Congress
1502 Longworth HOB
Washington D. C. 20515

Dear Congressman Abercrombie:

Subject: Protecting & Restoring Native Ecosystems by Managing Non-Native Ungulates Plan/EIS

The National Park Service (NPS) has initiated preparation of a draft environmental impact statement (EIS) to address the long-term management of non-native ungulates within Hawai'i Volcanoes National Park. The purpose of the plan is to refine strategies for managing non-native ungulates that support long-term ecosystem protection; support recovery and restoration of native vegetation and other natural resources; and protect and preserve cultural resources. The NPS will comply with the National Environmental Policy Act of 1969 (NEPA) in the preparation of the EIS.

We invite you to participate in the EIS scoping process. Your participation will help ensure that potential environmental impacts are adequately considered during the preparation of the EIS. A scoping newsletter is enclosed with this letter. It provides a brief background on the issue of ungulates in the park and the purpose and need for action. We appreciate your careful consideration of this material.

During the week of April 29, 2008, the park will hold scoping meetings at three locations on the Island of Hawai'i. They are as follows:

Tuesday, April 29, 5:30pm-8:30pm, Hilo:
- University of Hawai'i at Hilo
  University Classroom Building (UCB), first floor, room 100
  200 W. Kawili St.
  Hilo, Hawai'i

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  95-5635 Mamalahoa Highway
  Na'alehu, Hawai'i

The Honorable Neil Abercrombie
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March 20, 2008

Thursday, May 1, 5:00 pm-8:00 pm: Kailua-Kona
Kona Outdoor Circle Educational Center and Botanical Gardens
76-6280 Kuakini Highway
Kailua-Kona, Hawai'i

In addition to attending the public meetings, comments may be submitted as follows:

By Mail:
Cindy Orlando
Superintendent, Hawai'i Volcanoes National Park
RE: Protecting & Restoring Native Ecosystems by Managing Non-Native Ungulates Plan/EIS
P.O. Box 52
Hawaii National Park, HI 96718-0052

Electronically:
Through the NPS Planning, Environment and Public Comment project Web site http://parkplanning.nps.gov/HAVO.

We appreciate your participation in the EIS process and look forward to receiving your comments. If you have any questions please contact Dr. Rhonda Loh, Chief of Natural Resources Management, at (808) 985-6098.

Sincerely,

Cynthia L. Orlando
Superintendent

Enclosure

cc: The Honorable Neil Abercrombie
U. S. Congress
300 Ala Moana Boulevard, Room 4-104
Honolulu HI 96750

N1621

June 2, 2011

Dr. Loyal Mehrhoff, Field Supervisor

HAVO # 393

United States Department of the Interior

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

In Reply Refer To:
12200-2008-TA-0159

MAY 1 9 2008

RECEIVED
MAY 2
HAWAII VOLCANOES NAT'L PARK

Ms. Cynthia Orlando, Superintendent
Hawaii Volcanoes National Park
P. O. Box 52
Hawaii National Park, Hawaii 96718-0052

Subject: Technical Assistance for the Preparation of an Environmental Impact Statement for Hawaii Volcanoes National Park's Plan to Protect and Restore Native Ecosystems by Managing Non-Native Ungulates

Dear Ms. Orlando:

We received your letter on March 24, 2008, requesting our input into your plan to manage non-native ungulates and restore native ecosystems within Hawaii Volcanoes National Park (Park). You requested our comments to assist you in drafting your Environmental Impact Statement (EIS) for this project. The purpose of the plan is refine strategies for managing non-native ungulates to support long-term ecosystem protection; support the recovery and restoration of native vegetation and other natural resources; and protect and preserve cultural resources. Native rainforests on the Island of Hawaii are among the most diverse ecosystems in the State and are a key area for preserving ecological diversity in the Hawaiian Islands. The U. S. Fish and Wildlife Service (Service) agrees, ungulate management is an essential step towards restoring the ecological integrity of the Park's native ecosystems. We would like to thank you for extending our deadline to reply to this letter to May 19, 2008.

Hawaiian ecosystems evolved in the absence of mammalian herbivores and as a consequence, are extremely vulnerable to damage by introduced ungulates. From telephone conversations with Dr. Rhonda Loh it is our understanding, one of the ungulate management alternatives the Park is considering involves fencing large portions of the Park. It is well known that efforts to restore and protect native Hawaiian ecosystems are unsuccessful if ungulates are present (Cuddihy *et al.* 1990, Loope 1998, Scott *et al.* 1986, Stone *et al.* 1985). Excluding and removing ungulates alone, has lead to substantial improvements to native ecosystem integrity in Hawaii (Hawaii Conservation Alliance 2005). According to our records, at least 36 federally listed threatened or endangered taxa occur in, or in close proximity to the Park (see Table 1) and there is federally designated critical habitat for 14 taxa within the park (see Table 2). Undoubtedly, most, if not all, of these taxa would benefit from ungulate exclosure and removal. In addition to

TAKE PRIDE IN AMERICA

Ms. Cynthia Orlando 2

destroying native understory plants by browsing, trampling and rooting, ungulates facilitate invasion by noxious weeds. Furthermore, disturbance from ungulates suppresses the natural regeneration of canopy species which eventually leads to a loss of native forests. The majority of natural resource managers and researchers agree, feral pigs are the biggest threat to the survival of Hawaiian forest birds and their habitats (Jacobi 1976, Mountainspring 1986, 1987, Mueller-Dombois *et al.* 1981, Scott *et al.* 1986, Spatz *et al.* 1975). Based on the information above, we believe that fencing and ungulate removal will be the most effective alternative to achieve the Plan goals.

We also recommend that a preferred alignment for fences be identified within your EIS. Prior to fence construction, biological surveys should be conducted along the proposed fence alignment to determine the location of listed plants, Hawaiian petrel (*Pterodroma sandwichensis*) or Newell's shearwater (*Puffinus auricularis newelli*) colonies (collectively known as seabirds). The alignment can then be adjusted to not only avoid impacting plants and seabird colonies, but to include them within the fenced area. Fences should be located at least 15 feet away from listed plants, 30 feet away from seabird colonies, and should be marked with mylar tape. The mylar tape makes fencing more visible to seabirds which reduces collisions with fences (R. Swift 2004).

The endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*) is also known to occur within the Park. Hawaiian hoary bats forage for insects from as low as 3 feet to higher than 500 feet above the ground. Fencing large portions of the Park as a method for controlling ungulates will contribute to the recovery of the majority of the Park's biota. However, when barbed wire is used in the fencing, Hawaiian hoary bats can become entangled (Donna Ball, pers. comm. and Jeff Burgett, pers. comm). There is evidence that barbed wire fences in open areas pose a greater risk to bats than barbered wire fences in forested areas (John Jeffrey, pers. comm.). If the Park's management objectives can be met without using barbed wire as a component of fences, we recommend eliminating barbed wire from existing and planned fences. Eliminating barbed wire from fences in open areas is especially important.

We appreciate the opportunity to provide preliminary comments for the preparation of your EIS and look forward to reviewing the draft document. The removal of ungulates would enhance the recovery of listed taxa, promote integrity within critical habitat units, and benefit the Park's ecosystems in general. If you have questions regarding this letter, please contact Dr. Jeff Zimpfer, Fish and Wildlife Biologist, Consultation and Technical Assistance Program (phone: 808-792-9431; fax: 808-792-9581).

Sincerely,

for Patrick Leonard
Field Supervisor

Ms. Cynthia Orlando

3

Table 1. Threatened and endangered species within and adjacent to Hawaii Volcanoes National Park.

Scientific Name	Common Name	Status
Plants		
Adenophorus periens	palai laau	Endangered
Argyroxiphium kauense	Kau silversword	Endangered
Argyroxiphium sandwicense subsp. *macrocephalum*	ahinahina, silversword	Threatened
Asplenium peruvianum var. *insulare*	no common name	Endangered
Clermontia lindseyana	oha	Endangered
Cyanea stictophylla	oha	Endangered
Cyrtandra giffardii	haiwale	Endangered
Hibiscadelphus giffardianus	hau kuahiwi	Endangered
Ischaemum byrone	Hilo ischaemum	Endangered
Kokia drynarioides	kokio	Endangered
Melicope zahlbruckneri	alani	Endangered
Neraudia ovata	maaloa	Endangered
Nothocestrum breviflorum	aiea	Endangered
Ochrosia kilaueaensis	holei	Endangered
Phyllostegia racemosa	kiponapona	Endangered
Plantago hawaiensis	laukahi kuahiwi	Endangered
Pleomele hawaiiensis	halapepe	Endangered
Portulaca sclerocarpa	ihi	Endangered
Pritchardia affinis	loulu	Endangered
Sesbania tomentosa	ohai	Endangered
Sicyos alba	anunu	Endangered
Silene hawaiiensis	no common name	Threatened
Spermolepis hawaiiensis	no common name	Endangered
Stenogyne angustifolia	no common name	Endangered
Birds		
Branta sandvicensis	nene, Hawaiian goose	Endangered
Buteo solitarius	io, Hawaiian hawk	Endangered
Hemignathus munroi	akiapolaau	Endangered
Loxops coccineus coccineus	Hawaii akepa	Endangered
Oreomystis mana	Hawaii creeper	Endangered
Psittirostra psittacea	ou, honeycreeper	Endangered
Pterodroma sandwichensis	uau, Hawaiian dark-rumped petrel	Threatened
Puffinus auricularis newelli	Ao, Newell's Shearwater	Endangered
Reptile		
Eretmochelys imbricata	hawksbill sea turtle	Endangered
Mammal		
Lasiurus cinereus semotus	opeapea, Hawaiian hoary bat	Endangered

Ms. Cynthia Orlando 4

Table 2. Federally designated critical habitat within and adjacent to Hawaii Volcanoes National Park.

Scientific Name	Common Name	Status
Plants		
Argyroxiphium kauense	Kau silversword	Endangered
Cyanea hamatiflora ssp. *carlsonii*	haha	Endangered
Cyanea stictophylla	oha	Endangered
Cyrtandra giffardii	haiwale	Endangered
Hibiscadelphus giffardianus	hau kuahiwi	Endangered
Ischaemum byrone	Hilo ischaemum	Endangered
Melicope zahlbruckneri	alani	Endangered
Plantago hawaiiensis	laukahi kuahiwi	Endangered
Pleomele hawaiiensis	halapepe	Endangered
Portulaca sclerocarpa	ihi	Endangered
Sesbania tomentosa	ohai	Endangered
Melicope zahlbruckneri	alani	Endangered
Sicyos alba	anunu	Endangered
Silene hawaiiensis	no common name	Threatened

Ms. Cynthia Orlando 5

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LINDA LINGLE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

STATE HISTORIC PRESERVATION DIVISION
601 KAMOKILA BOULEVARD, ROOM 555
KAPOLEI, HAWAII 96707

LAURA H. THIELEN
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

RUSSELL Y. TSUJI
FIRST DEPUTY

KEN C. KAWAHARA
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AQUATIC RESOURCES
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FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

April 15, 2008 4.18.08

Ms. Cindy Orlando
Superintendent, Hawai`i Volcanoes National Park
P.O. Box 52
Hawaii National Park, HI 96718

LOG NO: 2008.1139
DOC NO: 0804TS10
Archaeology

Dear Ms. Orlando:

SUBJECT: National Historic Preservation Act (NHPA) Section 106 Review – Protecting and Restoring Native Ecosystems by Managing Non-Native Ungulates Plan/EIS Puna and Ka`u Districts, Island of Hawai'i

Thank you for the opportunity to comment on the aforementioned project, which we received on March 24, 2008. Public scoping meeting are to be held in April and May, we offer the following comments:

We do not expect that historic properties will be affected by this undertaking. The SHPD supports the implementation the Plan as it will have positive effects on the many and varied cultural resources of HVNP. These include limiting the potentially destructive influence of ungulates on prehistoric sites as well as restoring cultural landscapes, both of which will be appreciated by visitor and resident alike.

We look forward to reviewing the final Plan/EIS when it is ready. If you have any questions or concerns regarding this letter please contact Assistant Hawaii Island Archaeologist, Tim Scheffler at (808) 981-2979 or, timothy.e.scheffler@hawaii.gov.

Aloha,

Nan McMahon

Laura H. Thielen,
State Historic Preservation Officer

TS

PHONE (808) 594-1888

FAX (808) 594-1

STATE OF HAWAI'I
OFFICE OF HAWAIIAN AFFAIRS
711 KAPI'OLANI BOULEVARD, SUITE 500
HONOLULU, HAWAI'I 96813

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HAWAII VOLCANOES NAT'L PAR

HRD08/3587

May 2, 2008

Cynthia L. Orlando, Superintendent
Hawai'i Volcanoes National Park
P.O. Box 52
Hawai'i National Park, HI 96718-0052

RE: Protecting & Restoring Native Ecosystems by Managing Non-Native Ungulates Plan/EIS, Hawai'i Volcanoes National Park, Hawai'i

Aloha e Cynthia L. Orlando,

The Office of Hawaiian Affairs (OHA) is in receipt of the above-mentioned letter dated March 20, 2008. The National Park Service (NPS) is initiating Section 106 consultation for a proposed undertaking at Hawai'i Volcanoes National Park. The NPS has begun preparation of a draft environmental impact statement (EIS) to address the long-term ecosystem protection; support recovery and restoration of native vegetation and other natural resources; and protect and preserve cultural resources. OHA has reviewed the project and offers the following comments.

OHA has substantive obligations to protect the cultural and natural resources of Hawai'i for its beneficiaries, the people of this land. The Hawaii Revised Statutes mandate that OHA "[s]erve as the principal public agency in the State of Hawaii responsible for the performance, development, and coordination of programs and activities relating to native Hawaiians and Hawaiians; . . . and [t]o assess the policies and practices of other agencies impacting on native Hawaiians and Hawaiians, and conducting advocacy efforts for native Hawaiians and Hawaiians." (HRS § 10-3)

The proposed undertaking by the NPS at the Hawai'i Volcanoes National Park (HVNP) does take preventative measures to ensure the protection of natural and cultural resources within the park. OHA is concerned with any destructive methods of ungulate control that would endanger any cultural and natural resources. Methods such as fencing, which would include ground disturbance, could directly impact any historic site that may lie in its location.

Cynthia L. Orlando, Superintendent
May 2, 2008
Page 2

OHA requests that a comprehensive archaeological inventory survey for the proposed project area be conducted and submitted to the Department of Land and Natural Resources – Historic Preservation Division for review and approval. OHA should be allowed the opportunity to comment on the criteria assigned to any cultural or archaeological sites identified within the archaeological inventory survey. Consideration must also be afforded to any individuals accessing the project area for constitutionally protected traditional and customary purposes, in accordance with the Hawai'i State Constitution, Article XII, section 7.

We request the applicant's assurances that should iwi kūpuna or Native Hawaiian cultural or traditional deposits be found during the construction of the project, work will cease, and the appropriate agencies will be contacted pursuant to applicable law.

In addition, OHA recommends that the applicant include the local community in the planning process for any relocation and removal of non-native ungulates from the HVNP. Recent ungulate control projects in other natural area preserves in the state of Hawai'i have encountered opposition because of the lack of communication between the agency and the local community. OHA asks that the inclusion of modern as well as traditional methods be considered during the planning stages of this project.

Furthermore, this submission to our office does not constitute a proper Section 106 consultation according to the National Historic Preservation Act of 1966, Section 106 and its implementing regulations, 36 CFR 800. According to §800.11, documentation standards for proper consultation include a description of the undertaking, the specific accepting federal agency, a determination of the Area of Potential Effect (APE), and photographs, maps, drawings, etc.

We look forward to receiving an official Section 106 consultation letter in order to complete proper consultation as afforded by §800.2(c)(2), *Consultation on historic properties of significance to Indian tribes and Native Hawaiian organizations*. The Act, Section 301(18) names OHA as an official Native Hawaiian organization. In order for proper consultation between the NPS and OHA to be conducted, proper documentation standards must be adhered to.

Lastly, OHA is in support of control measures that will protect natural and cultural resources and preserve the cultural landscapes in the HVNP. Our office looks forward to the forthcoming Plan/Environmental Impact Statement and will offer further comments upon review of the document.

Cynthia L. Orlando, Superintendent
May 2, 2008
Page 3

Thank you for the opportunity to comment. If you have further questions, please contact Jason Jeremiah (808) 594-1816 or e-mail him at jasonj@oha.org.

'O wau iho nō me ka 'oia'i'o,

Clyde W. Nāmu'o
Administrator

C: OHA Hilo CRC Office

OHA Kona CRC Office

Laura Thielen
State Historic Preservation Officer
Department of Land and Natural Resources
601 Kamokila Boulevard, Room 555
Kapolei, Hawai'i 96707

US FISH AND WILDLIFE SERVICE, PACIFIC ISLANDS ECOREGION

300 Ala Moana Blvd, Rm 3108, PO Box 50088
Honolulu, HI 96850

Subject: Request for Informal Section 7 Consultation, Protecting and Restoring Native Ecosystems by Managing Non-Native Ungulate Plan/EIS at Hawai'i Volcanoes National Park

Dear Dr. Mehrhoff:

Hawai`i Volcanoes National Park would like to continue interagency consultation under Section 7 of the Endangered Species Act for the preparation of a draft environmental impact statement (DEIS) to address the long-term management of non-native ungulates within Hawai'i Volcanoes National Park. Consultation on this project was initiated in March 2008. Since that time, the park has been preparing a Draft Environmental Impact Statement/Plan. The plan/DEIS is expected to be release for public review in Fall 2011, and will provide a parkwide framework to systematically guide non-native ungulate management activities over the next decades. The plan/DEIS will address the impacts of non-native ungulates, which include loss of native ecosystems, especially native plant and animal communities; loss of sensitive native species, including state- and federally-listed species; and loss of irreplaceable cultural resources.

To meet these objectives, the NPS concluded that the population-level objective for all action alternatives would be zero non-native ungulates (e.g. cattle, goats, sheep, mouflon sheep, axis deer, pigs), or as low as practicable in managed areas, recognizing the possibility of remnant populations and ingress animals. Existing ungulate fence barriers would continue to be inspected and repaired as needed. Also, under all proposed action alternatives, the NPS would:

- complete a boundary fence for the Kahuku unit (see enclosed map),
- complete a boundary fence for unmanaged portions of 'Ōla'a rainforest tract,

In Kahuku unit, the boundary fence would extend for several miles into sparsely vegetated lava fields before terminating at the 11,000 foot elevation where potential for animal ingress would be low. In addition, localized internal fencing could be constructed to assist in the control of non-native ungulates, if needed. Also, a boundary fence could be established on the east end of Kīlauea if active lava flow ceased and ingress of feral goats or other ungulates occurred in significant numbers. The actual sequence of fencing would be based on conditions on the ground as the implementation of other parts of the plan occurs. Design of fencing would be 4 feet to 6 feet in height depending on the species in the area, but could be modified based on new information and future experimentation to exclude multiple non-native ungulate species.

In addition to fence construction, the following tools could be used to locate and remove non-native ungulates: ground and aerial shooting, snaring, trapping, baiting, the use of dogs to assist ground shooting, and relocation. The park would also use judas animals and consider luring non-native ungulates into larger groups by inducing estrus in captive females inorder to more effectively locate animals. Volunteers under the direction of NPS staff in the field could assist in fencing, monitoring, capturing and removing animals.

While these actions would support the recovery and long term restoration of sensitive species, management actions could also potentially harm individuals or populations of rare species. Federally-listed threatened or endangered species could be temporarily disturbed during implementation of management actions, including monitoring, fence construction and maintenance, and non-native ungulate removal efforts. The use of helicopters (for monitoring, direct reduction, or fence construction and maintenance), the use of firearms, the use of motorized equipment for fencing, and the presence of people associated with ground-based management actions would introduce unnatural noise in the park, temporarily disrupting and potentially displacing some sensitive species. Any activities, including monitoring, that involve low-flying aircraft may affect the behavior and ecology of wildlife both during and after overflights. These impacts could occur during reproductive periods or in key habitat for native wildlife.

In response to the initial letter from USFWS (received by the park on May 19th 2008, copy enclosed) that provided technical assistance and additional input provided by subject experts from USGS-PIERC and NPS, the following measures were identified to minimize potential impacts to endangered species and habitat associated with ungulate removal, fence repair, replacement, and new construction:

- Ungulate removal efforts could occur year round depending on where and when animals are detected and may include actions conducted during critical periods for sensitive species. Trap placement and bait selection is done in consultation with NPS subject experts and the park botanist so as to avoid potential impacts to nēnē and other sensitive native plant and animal species in the area. The use of dogs to assist with locating animals would be avoided in known areas where nēnē or other ground nesting sensitive native species occur. In areas where ungulate (e.g. goat) presence is detected in low numbers, the use of judas animals (including the use of estrus lures) would facilitate park staff in locating individuals. Low-flying helicopter work would be minimized in sensitive wildlife habitat during critical periods. However, if control actions are required (e.g. due to animal ingress), park staff would confer with the appropriate wildlife biologist to determine if sensitive species are in the area, and depending on the determination, consult with USFWS prior to implementation of control actions. Personnel involved in removal efforts would follow park sanitation protocols for inspecting and cleaning equipment, personal gear, and vehicles so as to reduce the risk of bringing non-native plants and animals into an area.

- All potential relocation activities would require willing recipients and would be carried out in close cooperation with the state. When considering areas to relocate animals, the NPs would avoid sites where undesirable impacts to the environment could occur (e.g. rare native plants and animals, critical habitat, soils, cultural resources etc). Any necessary permissions and permits would be obtained prior to relocation activities. Prior to transporting animals to other locations, any necessary disease testing required by the state would be conducted.

- Botanical surveys conducted prior to fence corridor clearing would mark all listed and rare plant species in the area, including helicopter staging areas. Fence alignment would be adjusted so that no endangered or rare species observed in the vicinity of the fence line would be affected by the proposed project (at least 15 feet away from listed plants per comments received from USFWS).

  Impacts to native vegetation associated with fence corridor clearing would be limited to a 4-foot corridor. Plant removal would be limited to common understory vegetation, brush, and small trees less than 6 inches in diameter.

- In areas where Hawaiian petrel and Newell's shearwater occur or fly over, to reduce the risk of fence strikes, white vinyl strips, flagging, or similar material would be attached to the top strand of the fence that protrudes above the canopy. In addition to strips on the top strand of the fence, strips would be attached along the middle of the fence where the fence is found on open or sparsely vegetated lava flows. If improved marking strategies emerge they could be used in place of the current practice. Fence alignment would be adjusted to avoid impacts on seabird colonies (at least 30 feet away from seabird colonies per comments received from USFWS).

- Sanitation protocols for inspecting and cleaning personnel clothing, boots, and gear; project equipment; vehicles; and construction material would be followed to reduce the risk of bringing non-native plants and animals into the area. For a minimum of 1 year following completion of the project, worksites would be inspected and treated to remove non-native species that may have entered the area.

- In endangered forest bird habitat (ʻākepa, Hawaiʻi creeper, ʻakiapōlāʻau, ʻōʻū), fence alignment would be adjusted to avoid cutting large trees. The proposed specifications for vegetation clearing (described above) limits removal to trees less than 6 inches in diameter. This would protect ʻōhiʻa (*Metrosideros polymorpha*) or koa trees with a diameter of 3 feet (1 meter) or greater, which are preferred nesting habitat for ʻākepa. To the extent practical, construction activities and helicopter transport of fence materials would be scheduled before or after the peak breeding season for endangered forest birds (February through July). If an endangered forest bird or active nest is detected in or near the project area during construction, the NPS would halt construction activity and not resume until coordination with the USFWS has occurred.

- In Hawaiian hawk habitat, to the extent practical, helicopter transport of fence materials and construction activities would be scheduled before or after the breeding and nesting seasons (March through September). For construction during the breeding season, a nest search of the area proposed for fence corridor construction and surrounding environs would be conducted by the park biologist or a qualified alternate immediately prior to the onset of construction to ensure that no nests are in the vicinity. If an active nest is detected during construction, construction activity would be halted and will not resume until coordination with the USFWS has occurred.

- Trained NPS staff would evaluate helicopter staging areas prior to transport of material to drop sites, and sites may be relocated, if needed, to reduce impacts to nēnē. If nēnē are observed during construction activity along the fence line, appropriate NPS staff would be contacted to evaluate the situation, and the construction would be suspended until the birds move on of their own accord or coordination with the USFWS occurs.

- In order to reduce potential disturbance to Hawaiian hoary bats, no tree (>15 ft height) removal or trimming would occur when lactating or non-volant bats are present (May through August, $\leq$5,000-ft elevation). Additionally, no barbed wire would be used in new fence construction in order to minimize potential bat entanglement. Where potential entanglement may occur (e.g., in open areas), barbed wire would be removed from existing fences.
- To protect potential host plants and habitat for the picture-wing fly (*Drosophila heteroneura*, *Drosophila mulli*), impacts on native vegetation associated with fence corridor clearing would be limited to a 4-foot corridor. Plant removal would be limited to common understory vegetation, brush, and small trees less than 6 inches in diameter, and avoid removal of important host plants (e.g. *Clermontia* spp., *Cyanea* spp. *Trematlobelia* spp., *Pritchardia* spp.).

  Although these species were not identified in the initial list of federally designated species provided by USFWS, subsequent determination of species and critical habitat designation in the park required that these species be considered in this planning effort.

Although individuals of listed animal species could be temporarily displaced during implementation of management actions, they would return after actions are completed, and population stability and viability would not be negatively affected by management actions. We request your concurrence with our assessment that by incorporating the aforementioned measures, the proposed project is not likely to adversely affect federally listed species at Hawai‘i Volcanoes National Park. Please address any questions to Rhonda Loh, Chief of Natural Resources Management, (rhonda_loh@nps.gov, 808-985-6098).

Sincerely,

Cindy Orlando
Superintendent

cc:
Rhonda Loh
Danielle Foster
Howard Hoshide

Danielle
Report
X files

United States Department of the Interior

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

JUL 18 2011

In Reply Refer To:
2011-I-0347
2010-I-0118
2008-TA-0159

Memorandum

7.21.11

To: Superintendent, Hawaii Volcanoes National Park
Hawaii National Park, Hawaii

From: Field Supervisor, Pacific Islands Fish and Wildlife Office, Fish and Wildlife Service Honolulu, Hawaii

Subject: Informal Section 7 Consultation for Long-term Management of Non-native Ungulates within Hawaii Volcanoes National Park, Island of Hawaii

Pursuant to section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 USC 1531 *et seq.*) the U.S. Fish and Wildlife Service (Service) has reviewed your June 6, 2011, letter requesting our concurrence with your determination that proposed long-term management of non-native ungulates within Hawaii Volcanoes National Park (Park), is not likely to adversely affect threatened or endangered species or critical habitat. The proposed project, which will be addressed in a Draft Environmental Impact Statement (DEIS), addresses implementation of non-native ungulate control to support long-term ecosystem and cultural resources protection within the Park. The proposed action entails ungulate removal efforts and the completion of boundary fences for the Park's Kahuku unit and the Olaa rainforest tract. According to our records, 37 threatened or endangered taxa (Table 1) and critical habitat for 14 taxa (Table 2) occur in or in close proximity to the Park.

Our assessment of potential impacts of the proposed action is based on: (1) your June 06, 2011, letter; (2) phone calls between Jodi Charrier (Service, and Rhonda Loh, Park; (3) our January 21, 2010, Informal Section 7 Consultation Letter for "Three Miles of Boundary Fence Replacement for Kahuku Unit, Hawaii Volcanoes national Park, Island of Hawaii" (2010-I-0118); (4) our May 19, 2008, Technical Assistance Letter for the "Preparation of an Environmental Impact Statement for Hawaii Volcanoes National Park's Plan to Protect and Restore native Ecosystems by Managing Non-Native Ungulates" (2008-TA-0159); and (5) other information available to us. A complete administrative record is on file in our office.

Table 1. Threatened and endangered species within and adjacent to Hawaii Volcanoes National Park.

Scientific Name	Common Name	Status
Plants		
Adenophorus periens	palai laau	Endangered
Argyroxiphium kauense	Kau silversword	Endangered
Argyroxiphium sandwicense subsp. *macrocephalum*	ahinahina, silversword	Threatened
Asplenium peruvianum var. *insulare*	no common name	Endangered
Clermontia lindseyana	oha	Endangered
Cyanea stictophylla	oha	Endangered
Cyrtandra giffardii	haiwale	Endangered
Hibiscadelphus giffardianus	hau kuahiwi	Endangered
Ischaemum byrone	Hilo ischaemum	Endangered
Kokia drynarioides	kokio	Endangered
Melicope zahlbruckneri	alani	Endangered
Neraudia ovata	maaloa	Endangered
Nothocestrum breviflorum	aiea	Endangered
Ochrosia kilaueaensis	holei	Endangered
Phyllostegia racemosa	kiponapona	Endangered
Plantago hawaiensis	laukahi kuahiwi	Endangered
Pleomele hawaiiensis	halapepe	Endangered
Portulaca sclerocarpa	ihi	Endangered
Pritchardia affinis	loulu	Endangered
Sesbania tomentosa	ohai	Endangered
Sicyos alba	anunu	Endangered
Silene hawaiiensis	no common name	Threatened
Spermolepis hawaiiensis	no common name	Endangered
Stenogyne angustifolia	no common name	Endangered
Invertebrates		
Drosophila heteroneura	Hawaiian picture-wing fly	Endangered
Drosophila mulli	Hawaiian picture-wing fly	Threatened
Birds		
Branta sandvicensis	nene, Hawaiian goose	Endangered
Buteo solitarius	io, Hawaiian hawk	Endangered
Hemignathus munroi	akiapolaau	Endangered
Loxops coccineus coccineus	Hawaii akepa	Endangered
Oreomystis mana	Hawaii creeper	Endangered
Psittirostra psittacea	ou, honeycreeper	Endangered
Pterodroma sandwichensis	uau, Hawaiian dark-rumped petrel	Threatened
Puffinus auricularis newelli	Ao, Newell's Shearwater	Endangered
Reptile		
Eretmochelys imbricata	hawksbill sea turtle	Endangered
Mammal		
Lasiurus cinereus semotus	opeapea, Hawaiian hoary bat	Endangered

Table 2. Federally designated critical habitat within and adjacent to Hawaii Volcanoes National Park.

Scientific Name	Common Name	Status
Plants		
Argyroxiphium kauense	Kau silversword	Endangered
Cyanea hamatiflora ssp. *carlsonii*	haha	Endangered
Cyanea stictophylla	oha	Endangered
Cyrtandra giffardii	haiwale	Endangered
Hibiscadelphus giffardianus	hau kuahiwi	Endangered
Ischaemum byrone	Hilo ischaemum	Endangered
Melicope zahlbruckneri	alani	Endangered
Plantago hawaiiensis	laukahi kuahiwi	Endangered
Pleomele hawaiiensis	halapepe	Endangered
Portulaca sclerocarpa	ihi	Endangered
Sesbania tomentosa	ohai	Endangered
Melicope zahlbruckneri	alani	Endangered
Sicyos alba	anunu	Endangered
Silene hawaiiensis	no common name	Threatened

Project Description

The Park will implement measures to eradicate or reduce as low as practicable numbers of non-native ungulates (e.g. cattle, goats, sheep, mouflon sheep, axis deer, pigs) and inspect and repair existing ungulate fences within the Park. In addition, ungulate boundary fences for the Kahuku unit and the Olaa rainforest tract will be completed. Our office completed an informal consultation addressing construction of the first three miles of ungulate fencing for the Kahuku unit in January 2010 (2010-I-0118). The continuation of this fence will extend for several miles into sparsely vegetated lava fields before terminating at the 11,000-foot (ft) (3,353-meter (m)) elevation where potential for animal ingress would be low. Additional boundary fencing may be installed on the east end of Kilauea or on localized, internal areas if needed. The proposed fencing for the Olaa rainforest tract will approximately double the size of the existing fenced area. The proposed project will clear a corridor of vegetation with a maximum width of 4 ft (1.2 m). Fencing will be 4-6 ft (1.2-1.8 m) in height depending on the species in the area, but could be modified based on new information and future experimentation to exclude multiple non-native ungulate species.

The following tools may be used to locate and remove non-native ungulates: ground and aerial shooting, snaring, trapping, baiting, the use of dogs to assist ground shooting, and relocation. The park will also use judas animals and consider luring non-native ungulates into larger groups by inducing estrus in captive females in order to more effectively locate animals. Helicopters may be used for monitoring, aerial shooting, animal removal, and for transporting crews and materials. Ungulate removal efforts may occur year-round depending on where and when animals are detected and may include actions conducted during critical periods for sensitive species.

Superintendent, Hawaii Volcanoes National Park 4

Avoidance and Minimization Measures
Your June 6, 2011, letter indicates the following measures, which you developed in cooperation with staff from our office and USGS will be implemented to minimize and avoid potential project effects to the listed species and critical habitat:

1. To avoid potential impacts to nene and other sensitive native plant and animal species in the ungulate removal area, trap placement and bait selection will be done in consultation with Park subject experts and the Park botanist. The use of dogs to assist with locating animals will be avoided in areas where nene or other ground nesting sensitive native species occur. Trained Park staff will evaluate helicopter staging areas prior to transport of material to drop sites, and sites may be relocated, if needed to reduce impacts to nene. If nene are observed during construction activity along the fence line, appropriate Park staff will be contacted to evaluate the situation; and the construction will be suspended until the birds move on their own accord or coordination with the Service occurs.

2. Low-flying helicopter work will be minimized in sensitive wildlife habitat during critical periods.

3. Personnel involved in removal efforts will follow park sanitation protocols for inspecting and cleaning equipment, personal gear, and vehicles so as to reduce the risk of bringing non-native plants and animals into an area.

4. Botanical surveys conducted prior to fence corridor clearing and helicopter staging areas will mark all listed and rare plant species in the area. Fence alignment and helicopter staging areas will be adjusted so that no endangered or rare species observed in the vicinity of the fence line will be affected by the proposed project (at least 15 ft (4.6 m) away from listed plants).

5. Impacts to native vegetation associated with fence corridor clearing will be limited to a 4-ft (1.2-m) corridor. Plant removal will be limited to common understory vegetation, brush, and small trees less than 6 inches (in) (15.2 centimeters (cm)) in diameter.
6. To reduce the risk of fence strikes in areas where Hawaiian petrels (*Pterodroma sandwichensis*) or Newell's shearwaters (*Puffinus newelli*) occur or fly over, white vinyl strips, flagging, or similar material will be attached to the top strand of fencing that protrudes above the canopy. In addition to strips on the top strand of the fence, strips will be attached along the middle of the fence where the fence is found on open or sparsely vegetated lava flows. Fence alignment will be adjusted to at least 30 ft (9.1 m) away from seabird colonies.

7. All Park sanitation protocols for inspecting and cleaning personnel clothing, boots and gear, project equipment, vehicles and construction material will be followed to reduce bringing non-native plants, insects and coqui frogs (*Eleutherodactylus coqui*) into the area. For a minimum of one year following completion of the project, worksites will be inspected and treated to remove non-native species that may have entered the area.

8. In endangered forest bird habitat fence alignment will be adjusted to avoid cutting large trees. Ohia (*Metrosideros polymorpha*) and koa (*Acacia koa*) trees with a diameter of 3 ft (1 m) are preferred nesting habitat for akepa. To the extent practicable, construction activities and helicopter transport of fence materials will be scheduled before or after the peak breeding season for endangered forest birds (February through July). If an endangered forest bird or active nest is detected in or near the project area during construction, the Park will halt construction activity and not resume until coordination with the Service has occurred.

9. In Hawaiian hawk habitat, to the extent practical, helicopter transport of fence materials and construction activities will be scheduled before or after the breeding and nesting seasons (March and September). For construction during the breeding season, a nest search of the area proposed for fence corridor construction and surrounding environs will be conducted by the Park biologist or a qualified alternate immediately prior to the onset of construction to ensure that no nests are in the vicinity. If an active nest is detected during construction, construction activity will be halted and will not resume until coordination with the Service has occurred.

10. To reduce potential disturbance to Hawaiian hoary bats, no tree (>15-ft (4.6-m) height) removal or trimming will occur when lactating or non-volant bats are present (May-August, ≤5,000-ft (1,524-m) elevation). Additionally, no barbed wire will be used in new fence construction in order to minimize potential bat entanglement. Where potential entanglement may occur (e.g., in open areas), barbed wire will be removed from existing fences.

11. To protect potential host plants and habitat for the picture-wing fly (*Drosophila heteroneura, Drosophila mulli*), impacts on native vegetation associated with fence corridor clear4ing will be limited to a 4-ft (1.2-m) corridor. Plant removal will be limited to common understory vegetation, brush , and small trees less than 6 in (15.2 cm) in diameter, and avoid removal of important host plants (e.g., *Clermontia* spp., *Cyanea* spp., *Trematlobelia* spp., *Pritchardia* spp.).

In addition, in a July 5, 2011, Park Chief of Natural Resources Management Rhonda Loh confirmed the project will incorporate the following measures to avoid impacts from humans and vehicles when construction or eradication efforts occur in the vicinity of listed plants: Vehicles will stay on existing road and trails. If off-road use is needed, routes will be surveyed and listed plants will be clearly marked with flagging or tape. Park staff with appropriate botany expertise will supervise workers within fenced units. All listed species long fence construction corridors will be clearly marked with flagging or tape.

Effects
Fence construction will require temporary removal of a small amount of native non-listed understory vegetation resulting in an insignificant impact to listed species and critical habitat. In addition, project-related noise (such as that resulting from helicopter and dog use) may infrequently impact nesting and roosting birds. Noise impacts will be of short duration and low

frequency such that we do not anticipate it will result in changes in reproductive success or survival of listed bird species.

The Service supports ungulate removal as an essential step towards restoring the ecological integrity of native ecosystems in Hawaii. Hawaiian ecosystems evolved in the absence of mammalian herbivores and as a consequence, are extremely vulnerable to damage by introduced ungulates. Disturbance from ungulates suppresses the natural regeneration of native species which eventually leads to total loss of native forests. The majority of natural resource managers and researchers agree that feral pigs are the biggest threat to the survival of Hawaiian forest birds and their habitats (Jacobi 1976, Mountainspring 1986, 1987, Mueller-Dombois *et al.* 1981, Scott *et al.* 1986, Spatz *et al.* 1975). It is well known that efforts to restore and protect native Hawaiian ecosystems are unsuccessful where ungulates are not removed (Cuddihy *et al.* 1990, Loope 1998, Scott *et al.* 1986, Stone *et al.* 1985). Excluding and removing ungulates has led to substantial improvements to native ecosystem integrity in Hawaii (Hawaii Conservation Alliance 2005). The proposed removal of ungulates from the Park will be beneficial to listed taxa, the primary constituent elements of the critical habitat units, and the Park's ecosystems in general.

Summary

The long-term management of non-native ungulates and fence installation at the Park will enable the removal of ungulates that adversely impact the Park's listed resources. Project impacts to listed resources, due to noise and vegetation removal, will be insignificant. Based on this and the above information, we concur that the proposed project may affect, but is not likely to adversely affect listed species within the Park (see Tables 1 and 2). Unless the project description changes, or new information reveals that the effects of the proposed action may affect listed species or critical habitat in a manner or to an extent not considered, or a new species or critical habitat is designated that may be affected by the proposed action, no further action pursuant to the ESA is necessary. If you have questions regarding this consultation, please contact Jodi Charrier, Fish and Wildlife Biologist, at 808-792-9400.

Sincerely,

for

Loyal Mehrhoff
Field Supervisor

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APPENDIX B: MINIMUM REQUIREMENTS DECISION GUIDE

ARTHUR CARHART NATIONAL WILDERNESS TRAINING CENTER

MINIMUM REQUIREMENTS DECISION GUIDE

WORKSHEETS

". . . except as necessary to meet minimum requirements for the administration of the area for the purpose of this Act..."

– the Wilderness Act, 1964

Please refer to the accompanying MRDG *Instructions* for filling out this guide.
The spaces in the worksheets will expand as necessary as you enter your response.

The MRDG Instructions may be found at: http://www.wilderness.net/mrdg/

Project Title: **Protecting and Restoring Native Ecosystems by Managing Non-native Ungulates**

Step 1: Determine if any administrative action is necessary.

Description: Briefly describe the situation that may prompt action.

The situation that prompts action is the degradation of park resources by introduced non-native ungulates at Hawai'i Volcanoes National Park. The draft plan/EIS for Protecting and Restoring Native Ecosystems by Managing Non-native Ungulates considers a range of management alternatives for protecting and restoring native species and ecosystems by removing non-native ungulates. The following section describes the purpose and need for the draft plan/EIS, and the existing conditions that prompt administrative action in wilderness areas at the park.

Purpose

The purpose of this plan/EIS is to develop a comprehensive and systematic framework for managing non-native ungulates that supports long-term ecosystem protection; supports natural ecosystem recovery and provides desirable conditions for active ecosystem restoration; and supports protection and preservation of cultural resources. A plan/EIS is needed to address the impacts of non-native ungulates, which include loss of native ecosystems, especially native plant and animal communities; loss of sensitive native species, including state- and federally-listed species; and loss of irreplaceable cultural resources.

Need

The management plan/EIS is needed to address the following items.

- The impacts of non-native ungulates that result in
  - the loss of native ecosystems, especially native plant and animal communities;
  - the loss of sensitive native species including state and federally listed species; and
  - the loss of irreplaceable cultural resources.
- Park compliance with the NPS *Management Policies 2006*, Section 4.4.4 Management of Exotic Species, which states that non-native species will not be allowed to displace native species if displacement can be prevented.
- Park compliance with the *1916 Organic Act* (16 United States Code [USC] 1) that states that the purpose of the national parks is "to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."
- Park compliance with the *Redwoods National Park Expansion Act of 1978* (P.L. 95-250, 92 Stat. 163, as amended, 1978), which emphasizes the protection and preservation of natural resources in national parks. This act re-emphasized that park management must be consistent with the conservation portion of the organic act, that conservation is the single purpose of the national parks.
- Park compliance with its enabling legislation (16 USC 396) (P.L. 95-635, 16 USC 1132) which established the park and states that the park "shall be perpetually dedicated and set apart as a public park or pleasuring ground for the benefit and enjoyment of the people of the United States. . ." It provides for the "preservation from injury of all timber, birds, mineral deposits, and natural curiosities or wonders within said park, and their retention in their natural condition as nearly as possible."
- Park compliance with the Wilderness Act of 1964 (Section 2a), which states that designated wilderness areas "shall be administered for the use and enjoyment of the American people in such manner as will leave them unimpaired for future use as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character [...]."
-

Existing Conditions

Hawaiian ecosystems evolved without large mammalian herbivores, and introduced mouflon, cattle, sheep, pigs and other large non-native ungulates are the primary threats to terrestrial native ecosystems, including designated wilderness areas at the park. Through trampling, browsing and bark stripping, non-native ungulates destroy habitat, inhibit native forest regeneration and cause local extinctions of sensitive species. Non-native ungulates also cause increased soil disturbance and erosion, as well as dispersal and spread of highly disruptive invasive plants. There are over 300 federally-listed threatened and endangered species in the Hawaiian Islands. Approximately 90% of these species are endemic to the State. Hawai'i Volcanoes National Park contains habitat for over 35 federally-listed endangered and threatened plants and animals (includes 8 historical species), and additional candidate species and species of concern, many of which are highly susceptible to impacts from non-native ungulates. Included are at least sixteen federally-listed endangered and threatened species that occur or were last documented in designated Wilderness in the park (*Adenophorus periens, Argyroxiphium kauense, Asplenium peruvianum* var. *insulare, Branta sandvicensis, Buteo solitarius, Cyrtandra giffardii, Cyrtandra tintinnabula, Lasiurus cinereus subsp. semotus, Plantago hawaiensis, Pleomele hawaiiensis, Psittirostra psittacea, Pterodroma sandwichensis, Puffinus auricularis newelli, Sesbania tomentosa, Sicyos alba, Silene hawaiiensis*). Upper elevation areas of Kahuku being evaluated for wilderness eligibility supports additional habitat for critically endangered forest birds and plants (e.g. *Argyroxiphium kauense, Hemignathus munro, Loxops coccineus subsp. coccineus, Oreomystis mana*).

NPS staff has been successfully controlling non-native ungulates in large portions of the park since the 1970's. Components of the non-native ungulate control strategy involved: 1) the use of barrier fences to isolate populations, 2) removal of individuals at substantially greater rates than can be replenished by reproduction and ingress from adjoining areas to reach a population goal of zero ungulates, 3) barrier fence inspection and maintenance, and 4) vigilance in monitoring and removal to prevent non-native ungulate population ingress and increase. This strategy has assisted the recovery of native species and natural conditions in large portions of the park.

Wilderness consists of four distinct units, the Ka'ū Desert unit including the dry southwestern portion of Kīlauea and several miles of coastline, the East Rift unit containing mesic and wet forest on the eastern portion of Kīlauea, the 'Ōla'a unit, which contains the 'Ōla'a forest and is separate and just north of the visitor center, and the Mauna Loa unit containing the upper portion and summit of Mauna Loa. Approximately 9.9 miles of interior and 44.4 miles of park boundary fencing occur in designated Wilderness. The upper portions of the Kahuku unit are currently being evaluated for wilderness eligibility and are included in this analysis.

Administrative Actions Analyzed in this Minimum Requirements Analysis

Under all alternatives proposed in the plan/EIS, non-native ungulate removal activities in wilderness areas may include any combination of the following: direct reduction with firearms (ground and aerial), snaring, baiting, trapping, and/or relocation, and fence construction, replacement, inspection, and maintenance. Construction, replacement, inspection, and maintenance of exclusionary fences include the use of helicopters to deliver supplies to construct, maintain and repair fences, and also to haul away old fence materials. Construction and maintenance of fences may also include the use of machetes and chainsaws to clear dense vegetation and rock drills to install fence posts and anchor bolts in rock substrate. Helicopters are used for monitoring animals, animal capture and aerial shooting. See Step 2 of this appendix for details on these activities.

To determine if administrative action is <u>necessary</u>, answer the questions listed in A - F on the following pages by answering Yes, No, or Not Applicable and providing and explanation.

A. Describe Options Outside of Wilderness

Is action necessary <u>within</u> wilderness?

Yes: ☒ **No:** ☐

Explain: Ecological integrity, biological diversity, and native Hawaiian cultural heritage embodied in the native plants and animals need to be preserved inside the park, including designated wilderness areas. Native species are key components of the natural conditions in wilderness. Non-native ungulates detract from natural conditions through their impacts that result in the loss of native species and habitats. So, while removal and exclusion occurs outside of wilderness, it is also necessary within wilderness.

B. Describe Valid Existing Rights or Special Provisions of Wilderness Legislation

Is action necessary to satisfy valid existing rights or a special provision in <u>wilderness legislation</u> (the Wilderness Act of 1964 or subsequent wilderness laws) that <u>allows</u> or <u>requires</u> consideration of the Section 4(c) prohibited uses? Cite law and section.

Yes: ☐ **No:** ☐ **Not Applicable:** ☒

Explain: There are no special provisions in The Wilderness Act of 1964 or subsequent wilderness legislation that specifically addresses non-native ungulate removal efforts.

C. Describe Requirements of Other Legislation

Is action necessary to meet the requirements of <u>other laws</u>?

Yes: ☒ **No:** ☐ **Not Applicable:** ☐

Explain:

Maintenance removal and exclusion of non-native ungulates in wilderness areas is required to meet provisions of legislation that established Hawai'i National Park (later to become Hawai'i Volcanoes National Park). This legislation passed on August 1, 1916 (39 Stat. 432) declared:

> That the tracts of land on the Island of Hawai'i and the Island of Maui, in the Territory of Hawai'i...shall be perpetually dedicated and set apart as a public park or pleasuring ground for the benefit and enjoyment of the people of the United States..." and provide for, "...the preservation from injury of all timber, birds, mineral deposits, and natural curiosities or wonders within said park, and their retention in their natural condition as nearly as possible.

Non-native ungulate removal and exclusion also helps the NPS meet their responsibilities related to the 1916 Organic Act (16 USC 1), the Redwoods National Park Expansion Act of 1978 (P.L. 95-250, 92 Stat. 163, as amended, 1978), and the Endangered Species Act (16 U.S.C. Ch. 35, Sec. 1531-1544).

Provisions of the NPS Organic Act (39 Stat. 535, codified at 16 U.S.C. sections 1 through 4) directed the U.S. Department of the Interior and the NPS to manage units "to conserve the scenery and the natural and historic objects and wildlife therein and to provide for the enjoyment of the same in such a manner and by such a means as will leave them unimpaired for the enjoyment of future generations" (16 USC 1). The Redwood National Park Expansion Act of 1978 reiterates this mandate by stating that the NPS must conduct its actions in a manner that will ensure no "derogation of the values and purposes for which these various areas have been established, except as may have been or shall be directly and specifically provided by Congress" (16 USC 1a-1). By not managing non-native ungulates in wilderness areas, the park would be ignoring documented impacts that have the potential to cause significant negative cumulative effects on wilderness resources and values. Therefore, removal and exclusion of remnant non-native ungulate populations in wilderness areas is necessary to meet the requirements of the NPS Organic Act and NPS Redwood National Park Expansion Act.

Removal and exclusion of non-native ungulates has been identified by USFWS recovery plans as a requisite action to protect habitat and control threats to several plant and bird species found in Hawai'i Volcanoes National Park that are listed under the Endangered Species Act (USFWS 1984, 1996, 1997, 1998, 1999, 2003).

D. Describe Other Guidance

Is action necessary to conform to direction contained in agency policy, unit and wilderness management plans, species recovery plans, or agreements with tribal, state and local governments or other federal agencies?

Yes: ☒ **No:** ☐ **Not Applicable:** ☐

Explain:

NPS Management Policies provide guidance for wilderness management. For example, Section 2.3.1.10 states that "...wilderness should be taken into consideration in subsequent program management and implementation plans (comprehensive management plans for wilderness and general management plans)" Such planning should also be in compliance with NPS Management Policies 2006, Section 6.3.4. and Section 6.3.5 which respectively state, "Proposals having the potential to impact wilderness resources will be evaluated in accordance with NPS procedures for implementing the National Environmental Policy Act;" and "All management decisions affecting wilderness must be consistent with the minimum requirement concept."

Ungulate exclusion and removal is consistent with NPS Management Policies (2006) outlined in Chapter 4, section 4.4.4.2 Removal of Exotic Species Already Present and Section 4.4.2.3 Management of Threatened or Endangered Plants and Animals. Section 4.4.4.2 (Removal of Exotic Species Already

Present) states that, "All exotic plant and animal species that are not maintained to meet an identified park purpose will be managed—up to and including eradication—if (1) control is prudent and feasible, and (2) the exotic species:
•interferes with natural processes and the perpetuation of natural features, native species or natural habitats, or
•disrupts the genetic integrity of native species, or
•disrupts the accurate presentation of a cultural landscape, or
•damages cultural resources, or
•substantially hampers the management of park or adjacent lands, or
•poses a public health hazard as advised by the U.S. Public Health Service (which includes the Centers for Disease Control and the NPS public health program), or
•creates a hazard to public safety."

Section 4.4.2.3, states that NPS "will survey for, protect, and strive to recover all species native to national park system units that are listed under the Endangered Species Act. The Service will fully meet its obligations under the NPS Organic Act and the Endangered Species Act to both proactively conserve listed species and prevent detrimental effects on these species." This section also specifically states that the NPS will undertake active management programs to control detrimental nonnative species.
As mentioned previously, removal and exclusion of non-native ungulates has been identified by USFWS recovery plans as a requisite action to protect habitat and control threats to several plant and bird species found in Hawai'i Volcanoes National Park that are listed under the Endangered Species Act (USFWS 1984, 1996, 1997, 1998, 1999, 2003).

According to the 1975 final environmental statement for proposed wilderness at the park, the designated area would "preserve diverse segments of the island of Hawai'i in an undeveloped state—from the 13,680-foot summit of Mauna Loa to the Puna and Ka'ū Coasts, and landscape ranging from barren lava to dense tropical forests and dry coastal reaches with numerous archeological sites" (NPS 1975b). In addition, the final EIS identified the need for management intervention to ensure the survival of endemic communities of plants and animals at risk by non-native species. Specific actions identified were construction of fences and the use of helicopter to exclude nonnative goats and pigs for the protection of park resources.

E. Wilderness Character

Is action necessary to preserve one or more of the qualities of wilderness character including: Untrammeled, Undeveloped, Natural, Outstanding opportunities for solitude or a primitive and unconfined type of recreation, or other unique components that reflect the character of this wilderness area?

Untrammeled: **Yes:** ☐ **No:** ☒ **Not Applicable:** ☐

Explain:

Undeveloped: **Yes:** ☐ **No:** ☒ **Not Applicable:** ☐

Explain:

Natural: **Yes:** ☒ **No:** ☐ **Not Applicable:** ☐

Explain:

Removal and exclusion of non-native ungulates is necessary to protect the natural conditions, native biological diversity, ecological integrity, and natural sounds (generated by native birds and insects) that characterize the wilderness areas at Hawai'i Volcanoes National Park. Monitoring and maintenance of fences are necessary to prevent re-entry of animals. Destruction of native vegetation and soil erosion will occur if the animals are not removed. Native biodiversity, including rare, threatened and endangered species will be lost and critical habitat destroyed if large herbivores inhabit the park. The risk is imminent particularly for small populations of rare species. For example, within the older section of Hawai'i Volcanoes National Park, a large number of individuals from a planted population of the federally endangered Mauna Loa silversword and a natural population of the threatened catchfly (*Silene hawaiiensis*) on the Mauna Loa Strip were damaged when several mouflon sheep breached a barrier fence in the mid-1990's. The park contains significant populations of several endangered plant and animal species remaining in the wild. The loss of park populations or individuals would critically impact the global status of these species.

Outstanding opportunities for solitude or a primitive and unconfined type of recreation:

Yes: ☐ **No:** ☒ **Not Applicable:** ☐

Explain:

Other unique components that reflect the character of this wilderness:

Yes: ☒ **No:** ☐ **Not Applicable:** ☐

Explain:

Preserving the natural conditions of native ecosystems through the removal and exclusion of non-native ungulates also protects the cultural heritage of the indigenous Hawaiians embodied by the native plants and animals.

F. Describe Effects to the Public Purposes of Wilderness

Is action necessary to be consistent with one or more of the public purposes for wilderness (as stated in Section 4(b) of the Wilderness Act) of recreation, scenic, scientific, education, conservation, and historical use?

Recreation: **Yes:** ☒ **No:** ☐ **Not Applicable:** ☐

Explain:
Action would support recreational opportunities. Visitors in wilderness areas of the park come to experience the geologic and natural landscapes, and observe the unique native flora and fauna. Loss of the native wildlife and flora due to the presence of non-native ungulates would detract from the visitor experience in park wilderness.

Scenic: **Yes:** ☒ **No:** ☐ **Not Applicable:** ☐

Explain:
Visitors in wilderness areas of the park come to experience the natural landscapes, and witness the unique native flora and fauna. Loss of these resources due to the presence of non-native ungulates would detract from the visitor experience in park wilderness.

Scientific: **Yes:** ☒ **No:** ☐ **Not Applicable:** ☐

Explain:
Recognized as an international biosphere reserve and world heritage site, Hawai'i Volcanoes National Park is identified worldwide as a unique place for the study of evolutionary processes and tropical forest ecosystems. Managing non-native ungulates in a manner that will restore the natural ecosystem will allow wilderness areas to continue to serve as places for scientific inquiry and education related to evolution and the study of globally unique flora and fauna.

Education: **Yes:** ☒ **No:** ☐ **Not Applicable:** ☐

Explain:

Recognized as an international biosphere reserve and world heritage site, Hawai'i Volcanoes National Park is identified worldwide as a unique place for the study of evolutionary processes and tropical forest ecosystems. Managing non-native ungulates will allow wilderness areas to continue to serve as places to learn about the processes of evolution and the study of globally unique flora and fauna.

Conservation: **Yes:** ☒ **No:** ☐ **Not Applicable:** ☐

Explain:

The park contains habitat for over 50 federally listed endangered, threatened, and candidate endangered plant and animal species and additional Species of Concern and rare species. Many are found only on the island of Hawai'i, including designated wilderness in the park. Also protected are unique native plant and animal communities. Exclusion of non-native ungulates by fencing, monitoring, and removal of animals is needed to preserve these rare and critical habitats, and associated species. Removal of non-native ungulates has been identified by USFWS recovery plans as a requisite action to protect habitat and reduce threats to several federally endangered plant and bird species present at the park (USFWS 1984, 1996, 1997, 1998, 1999, 2003).

Historical use: **Yes:** ☐ **No:** ☐ **Not Applicable:** ☒

Explain:

Step 1 Decision: Is any administrative action necessary in wilderness?

Yes: ☒ **No:** ☐ **More information needed:** ☐

Explain:

Under all alternative proposed by the plan/EIS, fencing and removal of non-native ungulates are required in wilderness areas to ensure the native plant and animal species which contribute to wilderness character are not lost. Fence maintenance is also needed as non-native ungulates will breach them if they are not repaired or replaced. As described previously, destruction of native vegetation will occur and result in the loss of native plant communities, which contributes to loss of habitat and native wildlife. Native biodiversity, including rare, threatened and endangered species will be lost and critical habitat destroyed if large herbivores are able to enter the park. The risk is imminent, as noted in the example described previously when several mouflon sheep damaged populations of the federally endangered Mauna Loa silversword and the threatened catchfly. Impacts to these natural resources also affects native Hawaiian cultural heritage. Fence inspections, ground and aerial monitoring, and control actions are necessary to ensure management actions are successful; to identify and remove remnant or ingress animals; and to ensure fences are maintained

If action is necessary, proceed to Step 2 to determine the minimum activity.

Step 2: Determine the minimum activity.

Please refer to the accompanying MRDG *Instructions* for information on identifying alternatives and an explanation of the effects criteria displayed below.

Description of Alternatives

For each alternative, describe what methods and techniques will be used, when the activity will take place, where the activity will take place, what mitigation measures are necessary, and the general effects to the wilderness resource and character.

Alternative # A, B, C, D, and E

Description:
Under all alternatives, the NPS would implement the following management activities to remove non-native ungulates from areas that include designated wilderness. However, under Alternative A (no action alternative), they would not be part of a comprehensive, systematic management plan and consequently there would be less certainty that management actions would continue over time as institutional knowledge may be lost as a result of administrative and staff changes.

Population Objective

Under the no action alternative, population level objectives in existing management units (including wilderness units) would continue to be zero non-native ungulates (or as low as practicable) in order to protect and support restoration of ecosystems in the park. No established population level objective would be identified for future management areas in a comprehensive plan to guide future management in the park.

Under all action alternatives the population level objective would be zero non-native ungulates, or as low as practicable in all managed areas as part of a parkwide comprehensive plan to guide future management in the park, recognizing the possibility of remnant populations and ingress animals.

Fencing

Under all alternatives, the NPS would continue maintaining or replacing deteriorated boundary and internal fences to delineate managed non-native ungulate removal areas and exclude non-native ungulates from sensitive resource areas, including restoration plots. Fence repair/replacement would rely on helicopters to supply fence material, equipment and camp supplies to work sites located along fences. Vehicles are used only on existing administrative roads located in non-wilderness. A combination of machetes (brush), and chainsaw (e.g. to clear large logs fallen across fence corridors) is used to clear vegetation away from fences. Installation of fence posts and anchors into lava surfaces require using a motorized rock drill to secure posts and anchor bolts 6 to 10 inches into the rock. Old fence material is hauled out by helicopter. Several tons of fencing (~6 tons/mile, 1-5 miles a year) is replaced annually in the interior and along the boundary of designated wilderness. Many areas are not accessible using existing roads and trails. The heavy load weights, treacherous or fragile terrain (e.g. uneven ‘a‘ā, fragile pāhoehoe, earth cracks) and dense jungle vegetation (in rain forest) does not allow for non-mechanized transport by stock animals. Work crews may be required to camp overnight in temporary camps located in remote areas.

Under alternative A, existing conditions, there would be no comprehensive plan identifying a fencing strategy for unmanaged areas of the park. Under the action alternatives B-E, the NPS would:

- complete a boundary fence for the Kahuku Unit which could include portions inside eligible Wilderness areas

- complete a boundary fence for unmanaged portions of the ‘Ōla‘a Wilderness Unit

In addition, localized internal fencing could be constructed to assist in the control of non-native ungulates, if needed. Boundary fences could be established on the east end of Kīlauea (East Rift Wilderness Unit) if active lava flow ceased and ingress of goats or other large ungulates occurred. The actual sequence of fencing would be based on conditions on the ground as the implementation of other parts of the plan occurs.

Monitoring and Removal

Many of the management tools used to locate and remove animals (e.g. ground and aerial searches and reduction with firearms, dogs, snares, baits) are used by all alternatives, but may vary by species or location. Additional techniques that include the use of infrared cameras, cracker shells, inducing estrus, and relocation of animals are identified under the action alternatives (see Chapter 2. table 4 Consideration for Implementing Management Tools). However under alternative A, there would be no plan to provide a comprehensive, systematic approach for guiding these activities. Implementation of non-native ungulate management would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities; and it would be uncertain whether the NPS would progress through management phases, monitor, and apply management tools consistently as staff and institutional knowledge change over time.

Under the action alternatives B-E, ungulate management under a comprehensive, systematic plan would be divided into four phases, as follows:

1. **Initial assessment**. Occurs prior to initiation of control work, and includes monitoring to estimate initial abundance levels and distribution and to determine the amount of resources that will be necessary to manage non-native ungulates in prescribed areas.
2. **Reduction**. This first phase of control work typically begins at or near maximum population density, and usually after ingress has been controlled by fences. The goal of this phase is to reduce the population as much as possible in a short period of time, thereby reducing population recruitment and curtailing excessive ecosystem damage.
3. **Post-reduction**. This phase occurs when remnant levels of non-native ungulates have been achieved and the animals often become more difficult to detect, monitor, and manage.
4. **Maintenance**. The goal of this phase is to prevent ingress to management units in which non-native ungulates have been fully removed.

Removal Efforts

Reduction/Post-reduction: Frequency and duration of the reduction/post-reduction phases for mouflon, pigs, and goats in upper Kahuku, for which portions are currently being evaluated for wilderness eligibility, have been estimated based on reduction efforts in the west (approximately 12,600 ac) and mauka (approximately 8,900 ac) Kahuku units (FY 2003–FY 2009). During this phase, the annual number of full-day removal efforts using ground shooting averaged 20 and varied between 8 and 28. The annual number of helicopter-assisted (herding and/or aerial shooting) reduction/post-reduction efforts for mouflon and goats averaged 7 and varied between 0 and 19, typically increasing to 2 to 3 times a month as animals became more wary of ground-pursuit methods. Aerial shooting generally lasts 1.5 to 2 hours, while ground shooting can last up to 10 hours per day. The reduction phase would typically take place over a period of 6 to 36 months, depending on the size of the unit, whether the unit is expanded, and availability of funding. For the purposes of the analysis, it is assumed that reduction/post reduction would continue at a similar pace for the foreseeable future, resulting in about 20 removal efforts per year within a unit. Up to one-third of the removal efforts would include helicopter assistance. Frequency and duration of the reduction/post-reduction phases in remaining unmanaged areas (4,500 acre) of ʻŌlaʻa Wilderness Unit have been based on feral pig control efforts in the New unit (1,900 acre) of the ʻŌlaʻa area from FY 2005 to FY 2007. During this time, staff conducted an average of 24 full-day removal efforts using ground shooting with dogs and snaring during this period. A similar intensity of effort per acre would be assumed for remaining unmanaged areas. The number of reduction efforts would decrease over the life of the plan as non-native ungulates are removed and excluded from an area and the NPS moves into the maintenance phase.

Maintenance: Information on the frequency and duration of management actions during the maintenance phase is based on efforts conducted in non-native ungulate control units in the Kīlauea (which includes portions of East Rift and Kaʻū Wilderness Units), Mauna Loa (which includes portions of the Mauna Loa Wilderness Unit), and ʻŌlaʻa (which includes portions of ʻŌlaʻa Wilderness Unit) sections

of the park. Because non-native ungulate populations targeted for control have generally been excluded and removed in these areas, management actions are focused on removing ingress animals. The frequency of maintenance activities varies based on the number of non-native ungulates that breach an area in any given year. Between October 2004 and September 2009, the park conducted an average of approximately fifteen removal efforts per year across all units in the maintenance phase (both wilderness and non-wilderness areas). During that period, four efforts (three involving goats and one involving mouflon) were helicopter assisted (i.e., aerial shooting). Aerial operations last no more than a couple of hours. The remaining removal efforts were conducted using snaring, trapping, and/or ground shooting. These ground operations generally last 6 to 8 hours. Removal efforts typically begin at first light to minimize impacts on visitors and to maximize effectiveness. For the purposes of this analysis, it is assumed that maintenance efforts would continue at a similar level for the foreseeable future, resulting in about five to twenty-five removal efforts per year across all units in the maintenance phase. Approximately one-third of these efforts per year would require helicopter assistance.
In mid-elevation, seasonally dry nēnē habitat on Kīlauea, baiting and live trapping would be the primary tool for removing feral pigs from the vicinity of nests and goslings. These localized activities would be conducted annually and limited to the breeding season (October thru March) and include portions of the Ka'ū Wilderness Unit.

Relocation

Under alternatives D and E, management activities for relocating animals would employ similar survey and capture techniques (aerial and ground surveys, live traps), but could require additional efforts to transport or drive animals out of the area. This would likely require additional helicopter (to drive animals) and ground support, including construction of temporary corrals, and could potentially prolong the reduction/post reduction phases for some areas.

Monitoring

1) Initial assessment phase. Initial assessments are conducted prior to initiation of control work. The goal of monitoring during this phase is to estimate initial abundance levels, distribution, and to determine the amount of resources that will be necessary to manage ungulates within prescribed areas.
   a) Aerial surveys for feral cattle, goats, sheep, and mouflon sheep
      i) Line or belt transects spaced 500–1,000 m apart depending on vegetation density. These are typically done once prior to removal efforts.
   b) Ground-based transect survey for feral pigs
      i) Transects spaced 400–500 m apart. Presence of scat, tracks, digging, wallows, rubs, and browse are recorded on 50 m^2 plots. This is typically done once prior to removal efforts.

2) Reduction phase. This first phase of control work begins typically at or near maximum population density, and usually after trespass has been controlled by fences. The goal of this phase is to reduce the population as much as possible in a short period of time, thereby reducing population recruitment, and curtailing excessive ecosystem damage. Repeated systematic surveys may be used to determine population trajectory and the rate of removal necessary for further population reduction. Systematic surveys may become less effective as abundance decreases.
   a) Repeated aerial surveys as in 1a) may be used to assess the effect of control work during the reduction phase for feral cattle, goats, sheep, and mouflon. This may be done at 12 to 24 month intervals.
   b) Repeated ground-based transect surveys as in 1b) may be used to assess the effect of control work during the reduction phase for feral pigs. This may be done at 12 to 24 month intervals.

3) Post-reduction phase. This phase occurs when remnant levels of ungulates have been achieved and ungulates often become more difficult to detect, monitor, and manage. Transect-based systematic methodology becomes less effective because ungulates may congregate in small groups between original transects. Remaining ungulates may also learn to avoid locations visited repeatedly by staff. Monitoring is typically done in conjunction with removal efforts (see Reduction/Post reduction removal efforts for frequency of activities).
   a) Systematic sweeps with staff spaced at regular distances of approximately 200 m increases the probability of detecting ungulates. Sweeps may be oriented perpendicular to original transects.

b) Systematic sweeps as in 3a) with the assistance of dogs may be used to detect feral pigs, and in some cases, other ungulate species.
c) To increase the chances of encountering ungulates, staff may follow game trails, check areas with preferred forage, escape terrain, or other locations favored by ungulates. Areas with ungulates detections are visited repeatedly.
d) Judas animals are effective means of locating remnant ungulates in units being managed because they usually join with their conspecifics (Taylor Katahira 1988).
e) Aerial scouting. Short non-systematic overflights may be useful to locate ungulates where ungulates have been observed frequently in the past, in favorable habitats, or to verify reports at other locations from other agencies.

4) Maintenance phase. The goal of this phase of management is to prevent ingress to management units in which ungulates have been fully removed. Detecting ungulates during this phase is potentially the most difficult because there may be only one or a few individuals which have re-entered management units. It may be necessary to employ several monitoring methods simultaneously.
   a) Fence inspection
      i) Monthly perimeter inspection of fences is the primary means of assessing management unit integrity. Fence breaches caused by fallen trees, tipped-up trees, or uprooted anchors indicate a high probability of ingress. Ungulate sign and fence condition assessment is recorded on standardized data sheets and reported immediately. GPS locations or marker tags on fences may be used to relocate fence damage and ungulate sign. Other monitoring methods may be initiated when ingress has been detected.
   b) Systematic sweeps
      i) Systematic sweeps as in 3a) may be used when fence inspections indicate ingress has occurred. Dogs are generally not used during these sweeps because sign from a small number of ungulates may become obscured.
   c) Judas animals
      i) Judas animals as in 3d) are effective means of locating some ungulates which have entered managed units because they usually join their conspecifics (Taylor Katahira 1988). This method may be avoided to reduce further damage in areas where sensitive native plants occur.
   d) Browse survey
      i) Ungulates such as mouflon may occasionally jump over intact fences which renders fence inspection inadequate as a stand-alone monitoring technique. The presence of any tracks, scat, browse, or bark stripping indicates ingress has occurred. Browse is most likely to occur on highly palatable native plants. Such preferred plants therefore serve as indicator species during browse surveys.
   e) Monitoring rare plantings and natural plant populations
      i) Rare native plant species such as silverswords and *Silene* spp. provide an opportunity for efficient ungulate monitoring because these species are preferentially eaten before less palatable species. Botanical specialists may monitor and care for these species during restoration efforts and will therefore often be the first to notice and report browse damage. This monitoring is done opportunistically, typically between 6 month and 2 year intervals.
   f) Remote-triggered cameras.
      i) Infrared-triggered remote cameras may be used to monitor fence lines and sensitive plant species. These types of cameras are useful in identifying ungulate species if this is not clear from other monitoring methods.
   g) Ad-hoc methods
      i) Occasionally other methods may be necessary to detect small numbers of ungulates such as opportunistic observations from ground or aircraft, or the use of night-vision or thermal imaging equipment. The amount of time staff are present in management units increases the likelihood of encountering small numbers of ungulates. Observations from staff of other agencies are also encouraged.

Effects:

Wilderness Character
"Untrammeled"

Monitoring and removal of non-native ungulates: Controlling the ungulates, even though they are non-native, would negatively impact the untrammeled quality of wilderness (free from human control or manipulation). However, actions to eliminate the ungulate population would decrease over time; therefore the amount of trammeling would decrease over time. Over the long-term, elimination of the ungulate population would assist recovery of natural conditions and the untrammeled nature of the wilderness character by reducing evidence of human manipulation.

Fencing: The fencing itself does not impact the untrammeled character of wilderness. Human activities or actions that control or manipulate the components or processes of ecological systems inside the wilderness are what impact the untrammeled quality of wilderness.

"Undeveloped"

Monitoring and removal of non-native ungulates: Actions taken to monitor or remove ungulates would not change the undeveloped nature of the wilderness area as they do not involve the use of permanent or temporary structures that would change the character of the area.

Fencing: Repairing and maintaining the fence would maintain a modern structure in wilderness. The use of motorized equipment and mechanized transport for the construction, repair, inspection, and maintenance of fences will also have a negative impact on the undeveloped quality. Use of remote cameras, temporary corrals, or holding pens may introduce a modern element into the wilderness. These are temporary and could be mitigated by placing them into inconspicuous areas.

"Natural"

Monitoring and removal of non-native ungulates: Short-term effects would occur from the periodic use of helicopters and firearms to monitor for and/or remove non-native ungulates from wilderness areas. During times of management actions, these actions would introduce activities that are not part of the natural environment, such as the potential for noise from helicopters or firearms to disturb wildlife. These actions would be temporary, and intermittent. Once these actions are completed, long-term benefits would occur from the protection of the natural conditions of ecological integrity, biological diversity and natural sounds (latter caused by native birds and insects) across large areas of wilderness.

Fencing: Short-term effects would result from noise caused by motorized equipment and helicopters potentially disturbing wildlife. Long- term adverse effects include the trampling and loss of vegetation along fence corridors, as well as the potential impacts on native birds (petrels) and bats in the area. However, mitigation measures are used to minimize the potential for bird-fence strikes (such as the use of bird tape and strategic placement of fence) or impalement (avoiding the use of barb-wire). Long-term benefits are protection of the natural conditions of ecological integrity, biological diversity, and natural sounds (latter caused by native birds and insects) across large areas of wilderness. Fence corridors are resurveyed for sensitive plant and animal species prior to repair or replacement. Fence work is minimized or avoided in areas identified as sensitive forest bird and bat habitat during critical breeding seasons. Helicopter operations will follow park Standard Operating Procedures for administrative flights. All landings, drop sites, and temporary camps will be surveyed and placed to minimize impacts to ecological systems.

"Outstanding opportunities for solitude or a primitive and unconfined type of recreation"
Other unique components that reflect the character of this wilderness

Monitoring and removal of non-native ungulates: There would be a temporary intrusion caused by helicopter and/or firearm noise that could disrupt opportunities for solitude. In most cases, areas where management actions would occur are located miles away from visitor campsites and most trails; dense vegetation also obscures and attenuates sound from these intrusions so they would be short-term and localized disturbances to solitude.

Long-term benefits would result from the improvement of the wilderness character in the absence of non-native ungulates, and the improvement in the primitive wilderness experience in these areas.

Fencing: There would be a temporary intrusion caused by helicopters (noise and sight), equipment noise, and temporary employee tent camps. In most cases, however, fences are located miles away from visitor campsites and most trails; dense vegetation also obscures and attenuates sound from these intrusions and they would be temporary. Minimum tools will always be considered in an effort to minimize noise, visual and environmental impacts. This would apply to initial construction as well as maintenance activities. Every effort will also be made to evaluate and select appropriate fencing alignment in order to minimize visual impacts especially in areas that may be more prone to contact by visitors.

Heritage and Cultural Resources

Exclusion of animals will provide long term benefits through the protection of archeological features and cultural landscapes from damage caused by trampling and soil erosion. In addition, protection of native vegetation and wildlife habitat will preserve an important component of Native Hawaiian heritage. Potential impacts cause by fences will be mitigated by conducting surveys prior to fence construction and repair and avoiding cultural features. Helicopter operations will follow park Standard Operating Procedures for administrative flights. All landings, drop sites, and temporary camps will be surveyed and placed to minimize impacts to surroundings.

Maintaining Traditional Skills

Not applicable

Special Provisions

Not applicable

Economics and Timing Constraints

Implementation of activities strictly by hand tools and ground crews would not allow for management objectives and purpose of the plan to be met. Mechanized equipment is necessary to transport several tons of fencing (~6 tons/mile, 1-5 miles a year) that are replaced annually in the interior and along the boundary of designated wilderness. Many areas are not accessible using existing roads and trails. The heavy load weights, treacherous or fragile terrain (e.g. uneven ʻaʻā, fragile pāhoehoe, earth cracks) and dense jungle vegetation (in rain forest) does not allow for non-mechanized transport by stock animals. Mechanized equipment is needed to effectively monitor and reach all ungulates in remote areas. In open terrain, feral goats, mouflon sheep, and axis deer are extremely agile, fast moving animals that require rapid pursuit over highly uneven or treacherous terrain and across large expanses. Effective search and removal, particularly for remnant populations, require a combination of ground and aerial pursuit in order to successfully apprehend animals, which is not possible by ground pursuit methods alone.

Additional Wilderness-specific Comparison Criteria

Not applicable

Safety of Visitors, Personnel, and Contractors

Visitor and employee concerns related to safety include the use of firearms by volunteers and park staff during removal actions; use of helicopters; and visitors encountering management actions while in the park. There is also a danger posed by encountering non-native ungulates while in the park. However, removal efforts typically occur far removed from where most visitation occurs and, if necessary, limited and temporary closures could be implemented to protect visitors. Fences and other management actions are generally far removed from trails or campsites, and visitors seldom travel cross-country because of the lack of available water and challenging terrain. All staff using helicopters or firearms have specific training in these activities. Helicopter transport is considered the safest method for transporting large loads given the fragile lava surfaces and uneven terrain. Crews must follow established work safety procedures for all management actions.

Comparison of Alternatives

Under all alternatives, there would be impacts caused by searching and removing animals and constructing and maintaining fences. Many of these impacts would be short-term and temporary, and efforts would be made to evaluate and select appropriate fencing alignment in order to minimize visual impacts caused by fences especially in areas that may be more prone to contact by visitors.

Under Alternative A: No Action (Continue Existing Non-native Ungulate Management Activities), the NPS would continue current management of non-native ungulates, thereby supporting the protection and recovery of native plant and animal species, and the protection of cultural resources. However, the lack of a comprehensive management plan to guide future actions means that the implementation of non-native ungulate management would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities. As a result, consistent application of management tools over time would be uncertain, meaning that the benefits to wilderness character would be less than under the action alternatives.

Under all action alternatives, managing populations of non-native ungulates would perpetuate or assist long-term recovery of the natural conditions that contribute to the character of the wilderness at Hawai‘i Volcanoes National Park. Alternative C (Comprehensive Management Plan that Maximizes Efficiency by Expanding Lethal Removal Techniques and Discontinuing the Use of Volunteers) would be the quickest to reach the maintenance phase. Consequently, there would be slightly fewer impacts caused by removal efforts, and benefits to native species and natural conditions of wilderness could be realized sooner than by other action alternatives.

Under alternatives D and E, management activities for relocating animals would employ similar survey and capture techniques (aerial and ground surveys, live traps) as other action alternatives, but could require additional efforts to transport or drive animals out of the area. This would likely require additional helicopter (to drive animals) and ground support, including construction of temporary corrals, and could potentially prolong the reduction/post reduction phases for some areas. However once animal populations are removed, impacts to wilderness would be similar among all action alternatives.

It may be useful to compare each alternative's benefits and adverse effects to each of the criteria in tabular form, keeping in mind the law's mandate to "preserve wilderness character."

	Alt A: Existing Conditions	Alt B	Alt C	Alt D	Alt E
Untrammeled	-	-	-	-	-
Undeveloped	-	-	-	-	-
Natural	+	+	+	+	+
Solitude or Primitive Recreation	+,-	+,-	+,-	+,-	+,-
Unique components	NA	NA	NA	NA	NA
WILDERNESS CHARACTER	++/---	++/---	++/---	++/---	++/---

	Alt A: Existing Conditions	Alt B	Alt C	Alt D	Alt E
Heritage & Cultural Resources	+	+	+	+	+
Maintaining Traditional Skills	NA	NA	NA	NA	NA
Special Provisions	NA	NA	NA	NA	NA
Economics & Timing	+	+	+	+	+
Additional Wilderness Criteria	NA	NA	NA	NA	NA
OTHER CRITERIA SUMMARY	+	+	+	+	+

	Alt A: Existing Conditions	Alt B	Alt C	Alt D	Alt E
SAFETY (PUBLIC AND WORKERS)	+,-	+,-	+,-	+,-	

Safety Criterion

Documentation:

Several tons of fencing (~6 tons/mile, 1-5 miles a year) are replaced annually in the interior and along the boundary of designated wilderness. Many areas are not accessible using existing roads and trails. The heavy load weights, treacherous or fragile terrain (e.g. uneven ‘a‘ā, fragile pāhoehoe, earth cracks) and dense jungle vegetation (in rain forest) does not allow for safe non-mechanized transport by stock animals. Injuries incurred by hiking or carrying heavy loads are the most common work-related accidents among work crews (NPS 2009m).

Step 2 Decision: What is the Minimum Activity?

Please refer to the accompanying MRDG *Instructions* before describing the selected alternative and describing the rationale for selection.

Selected alternative:

Monitoring and removal of non-native ungulates: All action alternatives (B-E) require the implementation of reduction, post reduction, and maintenance phases of non-native ungulate management, including monitoring and removal. Details of the actions are provided in Step 1. Helicopters would be used to conduct periodic sweeps to determine the presence or absence of non-native ungulates in wilderness areas. If non-native ungulates are identified, removal actions, using a firearm (from the ground or by air), trapping or snaring will be initiated. Actions would be more frequent during the reduction/post reduction phases than in the maintenance phase.

Fencing: Helicopters would be used to transport fence material, equipment, tools and camp supplies to fences located in wilderness. Details of these actions are provided in Step 1. Deteriorated fence will be repaired or replaced. A combination of machete (brush), and chainsaw (e.g. to clear large logs fallen across fence corridors) is used to clear vegetation away from fences. Installation of fence posts and anchors into lava surfaces may require using a motorized rock drill. Old fence material will be dismantled and hauled out by helicopter. For fence segments in more remote areas, a temporary administrative camp may be established for the duration of the repair work.

Rationale for selecting this alternative (including safety criterion, if appropriate):

The proposed management actions described under alternative B-E to remove non-native ungulates are appropriate and necessary for the long-term management of park resources, including wilderness areas. The activities proposed are part of a clearly defined plan and mitigations exist to minimize any impact on the wilderness. Long-term beneficial impacts to natural conditions would be fully realized under the action alternatives because the comprehensive, systematic approach described in Chapter 2 "Elements Common to All Action Alternatives" would ensure that the NPS would progress through ungulate management phases, monitor, and apply management tools consistently over time. Long-term beneficial impacts would be less likely under alternative A, because management would depend largely on the professional judgment, past experience, and scientific knowledge of NPS staff responsible for conducting management activities and implementation of management tools could become increasingly inconsistent as staff and institutional knowledge change over time.

Although visitors may hear the noise (temporary) and see the fence (long-term), monitoring and removal of non-native ungulates and construction/maintenance of fences is necessary to preserve the natural qualities that make up the wilderness character and preserve cultural resources for present and future generations to experience in designated wilderness. Removal of non-native ungulates and maintenance of fences protect and allow the recovery of native species (including rare and federally listed species), critical habitat, and ecosystems processes by preventing further destruction caused by non-native ungulates. Such actions will also result in restoring and insuring the long term protection of the original wilderness values associated with Hawai'i Volcanoes National Park and fulfilling the intent of the Wilderness Act of 1964 as well as NPS Management Policies 2006 addressing "Wilderness Preservation and Management".

Effective removal of all non-native ungulates requires full access to all areas of the park including areas not accessible by roads or trails or by stock animals. In open terrain, feral goats, mouflon sheep, and axis deer are extremely agile, fast moving animals that require rapid pursuit over highly uneven or treacherous terrain and across large expanses. Effective search and removal, particularly for remnant populations, require a combination of ground and aerial pursuit in order to successfully apprehend animals, which is not possible by ground pursuit methods alone.

Helicopter support is needed to assist with transport of fence material and equipment to construct and repair fences in remote wilderness areas. Several tons of fencing (~6 tons/mile, 1-5 miles a year) is replaced annually in the interior and along the boundary of designated wilderness. Many areas are not accessible using existing roads and trails. In addition to the heavy loads, the expansive lava substrates characterized by jagged ʻaʻā flows and fragile pāhoehoe flows, limit the safe use of stock animals in many areas of the park. In rain forest, the dense understory vegetation and hidden earth cracks do not permit the use of stock animals or hiking of heavy loads away from trails. Helicopter transport, although a temporary intrusion on wilderness character, minimizes long-term impacts to lava surfaces and vegetation. If stock were to be used, it would require vegetation clearing and leveling of surfaces along the travel routes, which would result in long-term impacts, compared to the short-term impacts caused by helicopter use.

In rocky substrates, the use of motorized equipment (e.g. Cobra rock drill) is needed to secure fence posts and anchor bolts. Using a manual post pounder, fence posts and anchors are driven 6 to 10 inches in rock in pre-drilled holes spaced 5 to 10 feet apart. There are over 130 miles of fence in the park, including 50+ miles in designated wilderness. The hard lava substrates, depth, and quantity of drill holes required make the manual use of a hand held star drill impractical and increases safety concerns for work crews. Operators installing fence posts on solid pahoehoe lava will typically drill 100 to 130 1 1/2" X 10" holes per work day using the Cobra rock drill. Work crews using the manual technique would only be able to install a small fraction of what a crew could install using the Cobra rock drill, thus significantly prolonging impacts to wilderness character caused by activities during fence construction. In addition the star drill requires considerable skill by the operator to consistently strike the target with a sledgehammer while a 2nd person holds the fence or anchor bolt. Fatigue and the potential for the sledgehammer to strike the holder increases with repetitive use. While the machete is the primary tool for clearing brush from fence lines, limited use of chainsaw is required to clear large snags or heavy woody debris lying across the fence corridor.

Monitoring and reporting requirements:
Vegetation and non-native ungulate monitoring to determine progress toward restoration goals would be conducted as needed. For vegetation this could be done annually or at 5 to 20 year intervals depending upon the vegetation type and environment. Ungulate monitoring would be done according to the monitoring phases described above. Impacts to wilderness character caused by fences (miles in wilderness), helicopter (hours), and use of motorized tools (number of projects) would be reported annually.

Check any Wilderness Act Section 4(c) uses approved in this alternative:

- ☒ mechanical transport
- ☒ motorized equipment
- ☐ motor vehicles
- ☐ motorboats
- ☒ landing of aircraft
- ☐ temporary road
- ☒ structure or installation

Record and report any authorizations of Wilderness Act Section 4(c) uses according to agency procedures.

Approvals	Signature	Name	Position	Date
Prepared by:	[signature]	Rhonda K Loh	Chief of Natural Resources	8/18/11
Approved:	[signature]	Cindy Orlando	Superintendent	8.22.11

APPENDIX C: PROGRESSION OF MONITORING TECHNIQUES CURRENTLY USED DURING UNGULATE MANAGEMENT AT HAWAI‘I VOLCANOES NATIONAL PARK

A progression of monitoring techniques is currently used to evaluate ungulate management at Hawai‘i Volcanoes National Park, depending on phase of management, species, and the environment being managed. Management phases include (1) initial assessment, (2) reduction, (3) post-reduction, and (4) maintenance. When ungulates such as mouflon sheep are abundant and inhabit relatively open environments, particularly during the initial assessment phase, systematic aerial surveys are an effective means to assess population levels. Feral pigs, however, are the most problematic ungulate to assess during all management phases because they inhabit environments with dense vegetation, making them unlikely to be detected from aircraft even at high population levels. Therefore, ground-based systematic monitoring techniques are often used when feral pigs are at high population levels. Systematic monitoring techniques are less effective for all species at low population levels because ungulates may congregate in small numbers between original monitoring locations. Adaptive strategies and combinations of multiple techniques may be necessary to monitor small numbers of ungulates remaining in management units. Monthly perimeter inspection of fences is the primary means of assessing the integrity of management units during the maintenance phase. Occasionally, some monitoring techniques may be used out of sequence or during other phases of ungulate management, as needed.

1) **Initial Assessment Phase**. Initial assessments are conducted prior to initiation of control work. The goal of monitoring during this phase is to estimate initial abundance levels and distribution, and to determine the amount of resources that will be necessary to manage ungulates within prescribed areas.
    a) Aerial surveys for feral cattle, goats, sheep, and mouflon sheep
        i) Line or belt transects spaced 500–1,000 meters apart depending on vegetation density. Methods may follow Hess et al. (2006).
    b) Ground-based transect survey for feral pigs
        i) Transects spaced 400–500 meters apart. Presence of scat, tracks, digging, wallows, rubs, and browse are recorded on 50-square meter plots. Plot density may range from 50 to 310 per square kilometer. Methods and analysis follow Anderson and Stone (1994).
2) **Reduction Phase**. This first phase of control work begins typically at or near maximum population density, and usually after trespass has been controlled by fences. The goal of this phase is to reduce the population as much as possible in a short period of time, thereby reducing population recruitment and curtailing excessive ecosystem damage. Repeated systematic surveys may be used to determine population trajectory and the rate of removal necessary for further population reduction. Systematic surveys may become less effective as abundance decreases.
    a) Repeated aerial surveys as in 1a may be used to assess the effect of control work during the reduction phase for feral cattle, goats, sheep, and mouflon sheep.
    b) Repeated ground-based transect surveys as in 1b may be used to assess the effect of control work during the reduction phase for feral pigs.

3) **Post-reduction Phase**. This phase occurs when remnant levels of ungulates have been achieved, and ungulates often become more difficult to detect, monitor, and manage. Transect-based systematic methodology becomes less effective because ungulates may congregate in small groups between original transects. Remaining ungulates may also learn to avoid locations repeatedly visited by staff.
    a) Systematic sweeps with staff spaced at regular distances of approximately 200 meters increases the probability of detecting ungulates. Sweeps may be oriented perpendicular to original transects.
    b) Systematic sweeps as in 3a with the assistance of dogs may be used to detect feral pigs, and in some cases, other ungulate species.
    c) To increase the chances of encountering ungulates, staff may follow game trails and check areas with preferred forage, escape terrain, or other locations favored by ungulates. Areas with ungulates detections are visited repeatedly.
    d) Judas goats or Judas cattle are effective means of locating remnant ungulates in units being managed because they usually join with their conspecifics (Taylor and Katahira 1988).
    e) Aerial scouting. Short nonsystematic overflights may be useful in locating ungulates where ungulates have been observed frequently in the past or in favorable habitats, or to verify reports at other locations from other agencies.
4) **Maintenance Phase**. The goal of this phase of management is to prevent ingress to management units in which ungulates have been fully removed. Detecting ungulates during this phase is potentially the most difficult because there may be only one or a few individuals which have reentered management units. It may be necessary to employ several monitoring methods simultaneously in combination.
    a) Fence inspection
        i) Monthly perimeter inspection of fences is the primary means of assessing management unit integrity. Fence breaches caused by fallen trees, tipped-up trees, or uprooted anchors indicate a high probability of ingress. Ungulate sign and fence condition assessment is recorded on standardized data sheets and reported immediately. Global positioning system (GPS) locations or marker tags on fences may be used to relocate damaged fences and ungulate sign. Other monitoring methods may be initiated when ingress has been detected.
    b) Systematic sweeps
        i) Systematic sweeps as in 3a may be used when fence inspections indicate ingress has occurred. Dogs are generally not used during these sweeps because sign from a small number of ungulates may become obscured.
    c) Judas animals
        i) Judas goats or Judas cattle as in 3d are effective means of locating some ungulates that have entered managed units because they usually join their conspecifics (Taylor and Katahira 1988). This method may be avoided to reduce further damage in areas where sensitive native plants occur.
    d) Browse survey
        i) Ungulates such as mouflon sheep may occasionally jump over intact fences, rendering fence inspection inadequate as a stand-alone monitoring technique. The presence of any tracks, scat, browse, or bark stripping indicates ingress has occurred. Browse is most likely to occur on highly palatable native plants. Such preferred plants therefore serve as indicator species during browse surveys.

e) Monitoring rare plantings and natural plant populations

   i) Rare native plant species such as silverswords and Silene spp. provide an opportunity for efficient ungulate monitoring because these species are preferentially eaten before less palatable species. Botanical specialists may monitor and care for these species during restoration efforts and will therefore often be the first to notice and report browse damage.

f) Remote-triggered cameras

   i) Infrared-triggered remote cameras may be used to monitor fence lines and sensitive plant species. These types of cameras are useful in identifying ungulate species if this is not clear from other monitoring methods.

g) Ad hoc methods

   i) Occasionally other methods may be necessary to detect small numbers of ungulates such as opportunistic observations from ground or aircraft, or the use of night-vision or thermal imaging equipment. The amount of time staff are present in management units increases the likelihood of encountering small numbers of ungulates. Observations from staff of other agencies are also encouraged.

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APPENDIX D: ACOUSTIC SAMPLING AREAS INFORMATION

MEASURED L50 NATURAL AMBIENT SOUND LEVELS

Acoustic Sampling Area[1]	Measurement Site	L50 Natural Ambient Sound Level (dBA)
Zone 1 (Shoreline)	1A	54.2
	1B	46.6
Zone 2 (Coastal Lowlands)	2A	28.3
	2B	32.7
	2C	29.1
Zone 3 (Sparsely Vegetated)	3A	31.4
	3B	29.1
	3C	32.7
	3D	20.4
Zone 4 (Montane Rain Forest)	4A	33.5
Zone 5 (Mauna Loa Montane/Subalpine)	5A	35.0
	5B	22.1
	5C	27.5
Zone 6 (Dry Ohi'a Woodlands)	6A	28.0
	6B	28.0
	6C	32.7
Zone 7 (Mauna Loa Alpine)[2]	N/A	N/A
Zone 8 (Lowland Rain Forest)	8A	42.6
	8B	38.2
	8C	29.7
Zone 9 (New Lava Flows)	9A	28.6
	9B	28.6
	9C	25.4
Zone 10 (Kahuku Pastures)	N/A	N/A

Source: USDOT-FAA 2006, unpublished data

Notes:

1. Kahuku was acquired subsequent to the measurement study, so no data were collected. Measurements conducted in older sections of the park were extrapolated to Kahuku based on vegetation type and elevation.

2. Weather and accessibility to Zone 7 prevented the ability to take measurements in this zone. However, sound levels for these zones were characterized based on the similarity in attributes when compared to Zone 3.

Zone 1 (Shoreline). Sounds from surf and waves as well as birds are prominent natural sound characteristics of this zone. This zone is also comprised of strong trade winds, bluffs, and low shoreline vegetation with elevations ranging from sea level to approximately 100 feet. Additional sounds within this zone include aircraft overflights, vehicles, and hikers, especially in the vicinity of measurement site

1B, which is nearest to the lava eruption viewing area. L50 natural ambient sound levels range between 50 to 55 dBA in the southwestern portion of this zone and 45 to 50 dBA in the northeastern portion of this zone. Variability within the zone may be attributed to differences in visitor activity (USDOT-FAA 2006).

Zone 2 (Coastal Lowlands). This zone extends over an elevation range of 100 to 1,500 feet, has strong trade winds like the shoreline due to the mountains, contains low grass or scrub vegetation as well as widespread barren lava flows, and has natural animal sounds (i.e., compared to pets brought by park visitors) that are negligible. Near the measurement site locations (2A, 2B, and 2C), sound sources include wind noise through the grass, insect noise, and vehicle noise. L50 natural ambient sound levels within this zone range between 25 to 35 dBA, where variability may be attributed to differences in visitor uses throughout the zone (USDOT-FAA 2006).

Zone 3 (Sparsely Vegetated). Elevations within this zone range between 700 and 3,800 feet, with recent lava flows and low vegetative cover. The predominant natural sound source in this zone is the trade winds. In the vicinity of the measurement locations, winds, insect noises and aircraft activity also contribute to sound levels. L50 natural ambient sound levels range between 30 to 35 dBA in the northernmost tip and southern portion of this zone and between 20 and 30 dBA in other portions of this zone. Variations may be attributed to differences in visitor activity and higher wind speeds in some locations (USDOT-FAA 2006). Data was extrapolated to areas of similar vegetation and topography for Kahuku, since no ambient data was collected for this area of the park.

Zone 4 (Montane Rain Forest). This zone encompasses the tree fern rain forest on slopes of Mauna Loa, with elevations between 3,300 and 4,400 feet in ʻŌlaʻa, and from 5,000 to 6,200 feet elevation in Kahuku. The dominant natural sounds include rain on the tree canopy, crickets, and some bird sounds within specific locations. L50 natural ambient sound levels within this zone range between 30 to 35 dBA (USDOT-FAA 2006). Data was extrapolated to areas of similar vegetation and topography for Kahuku, since no ambient data was collected for this area of the park.

Zone 5 (Mauna Loa Montane/Subalpine). This zone covers an elevation range between 4,000 and 8,500 feet on the Mauna Loa slopes. It contains forest, shrublands, grasslands, and lava flows. Wind speeds are less than along the coast and bird sounds are heard in the forested portions of the zone. Additional sounds sources observed near the measurement locations within this zone include vehicle noise from the nearby Mauna Loa Strip Road and aircraft activity. L50 natural ambient sound levels range between 20 to 25 dBA in the western portion of this zone, 25 to 30 dBA in the central portion, and 30 to 35 dBA in the easternmost portion. Based on the measurement data collected at sites 5A, 5B, and 5C, variations in sound level ranges may be attributable to differences in air tour activities within the zone (USDOT-FAA 2006). Data was extrapolated to areas of similar vegetation and topography for Kahuku, since no ambient data was collected for this area of the park.

Zone 6 (Dry ʻOhi'a Woodlands). Elevations within this zone range between 1,000 and 3,300 feet, with forests, woodlands, and savannas. The predominant natural sound source is the trade winds rushing through the forest canopy. Additional sounds observed at the measurement locations within this zone include insect noise and aircraft events. L50 natural ambient sound levels range between 25 to 30 dBA throughout most of this zone and between 30 and 35 dBA in the portion adjacent to zones 2, 8, and 9. Variability in the sound levels may be attributed to aircraft activities (USDOT-FAA 2006). Data was extrapolated to areas of similar vegetation and topography for Kahuku, since no ambient data was collected for this area of the park.

Zone 7 (Mauna Loa Alpine). This zone comprises the barren portion on Mauna Loa from approximately 8,500 to 13,677 feet. The climate is dry, and although winds are not strong, the dominant natural sounds in this zone are winds rushing over the lava fields, as well as occasional birds. Weather and accessibility to this zone proved to be issues during the measurement period, and therefore ambient data collected from zone 3, which has similar vegetative and topographical cover to zone 7, was used to characterize the acoustics of zone 7. L50 natural ambient sound levels range between 30 and 35 dBA throughout the entire portion of this zone (USDOT-FAA 2006).

Zone 8 (Lowland Rain Forest). Located along the edge of Kilauea Caldera and the East Rift Zone, elevations within this zone range between 2,000 and 4,000 feet. Dominant natural sound sources include rain on vegetation and a great number of birds in the closed canopy forest. Additional sounds observed at the measurement site locations within this zone include traffic noise from Highway 11 at sites 8A and 8B, and aircraft activity at site 8C, which is near Napau Crater. L50 natural ambient sound levels range between 25 to 30 dBA in the portion of the zone where measurement site 8C is located and between 35 to 45 dBA in the remaining portion of the zone where measurement sites 8A and 8B are located. Variability in the sound levels within the zone may be attributable to human activity, including aircraft sounds and traffic noise (USDOT-FAA 2006).

Zone 9 (New Lava Flows). This zone is located on the East Rift Zone of Kilauea, where elevations range between 8,500 and 13,677 feet, and includes recent lava flows (within the past 40 years). Sounds within this zone from the newest lava flows include: bench collapses, rock fall from cinder cones and pit crater edges, crackling of cooling pahoehoe flows and sounds of clinkers falling in moving ‘a’a flows, gas venting, methane explosions, and falling trees on the edge of lava flows (USDOT-FAA 2006, 18). Additional sound sources observed near the measurement sites include birds and insects and aircraft activity, especially near measurement site 9A, which was along an air tour flight path. L50 natural ambient sound levels range between 25 to 30 dBA throughout the entire zone (USDOT-FAA 2006).

Zone 10 (Kahuku Pastures). This zone was added to Hawai‘i Volcanoes subsequent to measurement data collection and contains woodlands and rainforests, lava flows, ancient archaeological sites, and Mauna Loa’s southwest rift zone. Since no ambient data was collected for this area of the park, vegetative and topographical comparisons were used between this zone and zones where ambient data was collected to characterize the acoustics of Zone 10. Knowing this zone contains rare and endangered plant, bird, and insect species, the predominant natural sound sources expected include bird and insect sounds. L50 natural ambient sound levels were estimated between 25 to 30 dBA. Variations may be attributable to traffic noise from Highway 11 (USDOT-FAA 2006).

Literature Cited in Appendix D

U.S. Department of Transportation, Federal Aviation Administration (FAA)

2006 Baseline ambient sound levels in Hawai‘i Volcanoes National Park. Unpublished data. April 2006.

APPENDIX E: NON-IMPAIRMENT DETERMINATION

In addition to determining the environmental consequences of implementing the preferred and other alternatives, NPS *Management Policies 2006* (section 1.4) requires analysis of potential effects to determine whether or not the preferred alternative would impair a park's resources and values. The preferred alternative for managing non-native ungulates in Hawaii Volcanoes National Park is alternative D.

The fundamental purpose of the national park system, established by the *Organic Act* and reaffirmed by the *General Authorities Act*, as amended, begins with a mandate to conserve park resources and values. NPS managers must always seek ways to avoid, or to minimize to the greatest degree practicable, adverse impacts on park resources and values. However, the laws do give the National Park Service (NPS) the management discretion to allow impacts on park resources and values when necessary and appropriate to fulfill the purposes of the park. That discretion is limited by the statutory requirement that the NPS must leave resources and values unimpaired unless a particular law directly and specifically provides otherwise.

The prohibited impairment is an impact that, in the professional judgment of the responsible NPS manager, would harm the integrity of park resources or values, including the opportunities that otherwise would be present for the enjoyment of those resources or values (NPS *Management Policies 2006*). Whether an impact meets this definition depends on the particular resources that would be affected; the severity, duration, and timing of the impact; the direct and indirect effects of the impact; and the cumulative effects of the impact in question and other impacts.

An impact on any park resource or value may, but does not necessarily, constitute impairment. An impact would be more likely to constitute impairment to the extent that it affects a resource or value whose conservation is

- necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park, or
- key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park, or
- identified in the park's general management plan or other relevant NPS planning documents as being of significance.

An impact would be less likely to constitute impairment if it is an unavoidable result of an action necessary to preserve or restore the integrity of park resources or values and it cannot be further mitigated.

Impairment may result from visitor activities, NPS administrative activities, or activities undertaken by concessioners, contractors, and others operating in the park. Impairment may also result from sources or activities outside the park.

A determination of impairment is made for each of the resource impact topics carried forward and analyzed in the environmental impact statement for the preferred alternative. Impairment findings are not necessary for visitor experience, public health and safety, environmental justice, and park operations. These impact areas are not generally considered to be park resources or values according to the *Organic Act*, and cannot be impaired the same way that an action can impair park resources and values.

The park purpose and significance were used as a basis for determining if the preferred alternative would cause impairment. The following park purpose statement was developed for the Hawai‘i Volcanoes National Park General Management Plan, which is currently being developed:

> Hawai‘i Volcanoes National Park protects, studies, and provides access to Kilauea and Mauna Loa, two of the world’s most active volcanoes; and perpetuates endemic Hawaiian ecosystems and the traditional Hawaiian culture connected to these landscapes.

In particular, significance statements recently developed for the General Management Plan clearly relate to the need to control non-native and invasive species in the park:

> Hawai‘i Volcanoes National Park protects, restores and studies unique and diverse ecosystems and endemic species that are the result of over 30 million years of evolution on an active volcanic landscape, wide climate variation, and the extreme isolation of the Hawaiian Islands.

Hawai‘i Volcanoes National Park encompasses the largest and most ecologically diverse wilderness in the Pacific Islands.

Vegetation

Under the preferred alternative, a low level of short and long-term adverse effects on vegetation would result from implementation of ungulate management actions. Short-term impacts on vegetation would include those associated with temporary ground-based management actions (human foot traffic, installation of bait stations, setting traps and snares, use of holding pens, and monitoring and collecting data, as well as fencing construction and repair). Impacts on vegetation would be short- and long-term, negligible, and adverse.

In addition, the removal of ungulates could cause an increase in non-native weeds and fire risk in some areas of the park. Implementation of weed control measures and the fire management plan would limit the potential adverse effects so that impacts would not likely be greater than minor.

Over the long-term, benefits to native vegetation would occur from reduced populations and ultimate removal of ungulates. As populations of pig, cattle, goat and mouflon decrease, native understory and tree species would begin to recover. Thus, removing ungulates is an important part of native forest restoration, in conjunction with other measures such as planting native plants, and non-native plant removal.

Because long-term adverse impacts of the preferred alternative on vegetation would be no greater than minor, and the contribution to overall adverse cumulative impacts would be limited, there would be no impairment of vegetation under alternative D.

Native Wildlife and Wildlife Habitat

Under the preferred alternative, short-term minor to moderate adverse effects on native wildlife and habitats would result from implementation of ungulate management actions. Native wildlife and wildlife habitat would be temporarily disturbed during monitoring, fence construction and maintenance, and ungulate removal efforts. The use of helicopters (for monitoring, direct reduction, or fence construction and maintenance) and the use of firearms would introduce unnatural noise in the park, and temporarily disrupt and potentially displace some native species.

Over the long-term, benefits to native wildlife and habitats would occur from removal of ungulates. Reduction of ungulate browsing throughout the park would enhance forest regeneration, increasing availability of food and cover for native species. Habitat for non-native mosquitoes would be reduced, which would help protect native forest birds. The number of wildlife species that would benefit from these changes would increase as the vegetation became more diverse and abundant with reduced browsing pressure.

Because short-term adverse impacts of the preferred alternative on native wildlife and habitats would be no greater than minor to moderate, and the contribution to overall adverse cumulative impacts would be limited, there would be no impairment of native wildlife and habitats under alternative D.

Rare, Unique, Threatened, or Endangered Species

Under the preferred alternative, short-term minor to moderate, and long-term minor adverse effects on rare, unique, threatened, and endangered species would result from implementation of ungulate management actions. Species would be temporarily disturbed during implementation of monitoring, fence construction and maintenance, and non-native ungulate removal efforts. The use of helicopters (for monitoring, direct reduction, or fence construction and maintenance) would introduce unnatural noise in the park, and would temporarily disrupt and potentially displace some sensitive wildlife species. Any activities, including monitoring, that involve low-flying aircraft may affect the behavior and ecology of sensitive wildlife both during and after overflights. Altered behavior includes changes in movement patterns, foraging and breeding behavior, and increased energy expenditure.

Similar disturbances to sensitive wildlife would occur from the use of firearms; the use of equipment for fencing (e.g., post drivers and rock drills); and the presence of people associated with ground-based management actions. Such actions include direct reduction with firearms, which can include the use of trained dogs; the setting of traps, snares, and bait stations; fence construction and repairs; and monitoring. Ground-based management actions would also have impacts on sensitive vegetation that would occur during routine field activities (e.g., trampling from foot traffic, vegetation clearing for fence corridors). Although individuals could be temporarily displaced during implementation, they would return after management actions are completed, and population stability or viability would not be negatively affected. The duration and frequency of these actions would also decrease over the life of the plan as desired conditions are reached and the park moves into less intensive management phases. Long-term impacts from fences and fence corridors would be minimized through the use of flagging to mark and avoid sensitive plant species and reduce the risk of fence strikes. Adherence to sanitation and inspection protocols would reduce the risk of other non-native species introductions.

Over the long-term, the removal and exclusion of ungulates would substantially reduce the threats they pose to sensitive species and habitat, and would support ecosystem protection, including recovery and restoration of native plants and animals. Reduction of ungulate browsing throughout the park would enhance forest regeneration, increasing the availability of food and cover for species that depend on ground and understory vegetation for survival. Thus, reduction of ungulate browsing would help support population viability of these species, including ground- and shrub-nesting birds (e.g., Hawaiian honeycreeper species and nēnē) and native invertebrates in the park. Habitat for non-native mosquitoes would be reduced, which would help protect sensitive forest birds. The number of wildlife species that would benefit from these changes would increase as the vegetation becomes more diverse and abundant with reduced browsing pressure.

Because adverse impacts of the preferred alternative on rare, unique, threatened, and endangered species would be no greater than short-term minor to moderate, and long-term minor adverse, the contribution to overall adverse cumulative impacts would be limited, there would be no impairment of rare, unique, threatened, and endangered species under alternative D.

Cultural Resources

Under the preferred alternative, a negligible to minor level of long-term adverse effects on cultural resources would result from implementation of ungulate management actions. Construction of fencing could affect archeological resources; however, actions would be located away from known sensitive cultural sites. Fences and ungulate removal would provide long-term benefits for cultural landscapes negatively impacted by non-native ungulates, but fences would also introduce new elements to park landscapes. Although management actions would reduce animal populations inside the park, there would be opportunities for the public to hunt in state game and forest reserves surrounding the park and on the island. Control of ungulates would support protection of the native plants and animals valued in Hawaiian culture and allow traditionally used native plant species to thrive, which would have beneficial impacts on ethnographic resources.

Because long-term adverse impacts of the preferred alternative on cultural resources would be no greater than minor, and the contribution to overall adverse cumulative impacts would be limited, there would be no impairment of cultural resources under alternative D.

Wilderness

Under the preferred alternative, a minor to moderate level of short- and long-term adverse effects on wilderness resources and values would result from implementation of ungulate management actions. Maintaining fencing in wilderness would impact the untrammeled nature of the areas, create a visual intrusion, and affect the undeveloped nature of the area. Use of remote cameras may also introduce a modern element into the wilderness. Use of a motorized rock drill, and other noises and sounds associated with management activities would be temporary intrusions on the natural quite and solitude of an area. The trampling and loss of vegetation along fence corridors and during ground-based management actions would be similar to that associated with routine field activities, having long-term, localized impacts, and would not affect the integrity of the natural character of the wilderness areas.

Over the long-term, benefits to wilderness resources and values would occur from removal of ungulates. Alternative D would support recovery of natural conditions in wilderness by assisting in the restoration of native species and ecosystems.

While short- and long-term minor to moderate adverse impacts would occur under the preferred alternative, there would also be long-term benefits on wilderness resources and values, and the contribution to overall adverse cumulative impacts would be limited. Consequently, there would be no impairment of wilderness resources and values under alternative D.

Soils

Under the preferred alternative, a low level of short- and long-term adverse effects on soils would result from implementation of ungulate management actions. Impacts on soils would be limited to those associated with ground-based management actions, including human foot traffic, placing bait stations and holding pens, shooting ungulates, setting traps and snares, monitoring and collecting data, fencing construction and repair, and use of dogs. Impacts would include soil disturbance, temporary increases in soil compaction, and possible erosion. The NPS would continue to pursue safe and effective non-toxic alternatives to the use of lead bullets.

Over the long-term, benefits to soils would occur from removal of ungulates. Alternative D would ultimately limit the threats they pose and would support recovery and restoration of soils. Improvements in native vegetation, including ground cover, would reduce soil erosion potential.

Because long-term adverse impacts of the preferred alternative on soils would be no greater than localized negligible, and the contribution to overall adverse cumulative impacts would be limited, there would be no impairment of soils under alternative D.

Soundscapes

Under the preferred alternative, a moderate level of short-term adverse effects on soundscapes would result from implementation of ungulate management actions. Most non-native ungulate removal efforts involve snaring, trapping, and/or ground shooting; when needed, aerial operations during maintenance efforts are very short, lasting no more than a couple of hours. Some aerial assistance may also be required during monitoring for non-native ungulates prior to reduction, and would be needed for fence construction and repairs. Use of helicopters for these efforts would be intermittent and would last up to several hours at a time. Ground-shooting efforts may last a full day at a time, but it is assumed that shooting would not occur continuously for all hours during the management activity. As part of non-native ungulate management, fence maintenance could require the use of a gasoline generator, pneumatic post driver, and rock drill. Noise levels generated by these pieces of equipment would be high in the immediate vicinity of the fence construction and would attenuate to medium levels at greater distances from the source. Vehicle usage for the management activities in portions of zones that contain accessible roadways would contribute minimally to impacts on soundscapes. In most areas of the park, the number of vehicle trips associated with the management activities, as well the volume of vehicles at any given time, would be insignificant and would not be noticeable, thereby resulting in negligible adverse impacts.

No long-term adverse effects on the natural quiet would occur from ungulate management. However, the removal and exclusion of non-native ungulates would ultimately have long-term beneficial effects on soundscapes by restoring vegetation, which attenuates noise, and improving habitat, which could lead to an increase in wildlife (which contribute natural sounds).

Because adverse impacts of the preferred alternative on soundscapes would be no greater than short-term moderate, and the contribution to overall adverse cumulative impacts would be limited, there would be no impairment of soundscapes under alternative D.

As the nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering wise 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 the enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people. The department also promotes the goals of the Take Pride in America campaign by encouraging stewardship and citizen responsibility for the public lands and promoting citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

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