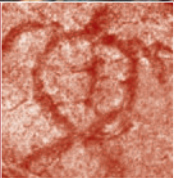


STATE  
♦ OF THE ♦  
PARKS®

July 2008

# HAWAI'I VOLCANOES NATIONAL PARK

A Resource Assessment



National Parks Conservation Association®  
*Protecting Our National Parks for Future Generations®*

# STATE ♦ OF THE ♦ PARKS®

## Center for State of the Parks

More than a century ago, Congress established Yellowstone as the world's first national park. That single act was the beginning of a remarkable and ongoing effort to protect this nation's natural, historical, and cultural heritage.

Today, Americans are learning that national park designation alone cannot provide full resource protection. Many parks are compromised by development of adjacent lands, air and water pollution, invasive plants and animals, and rapid increases in motorized recreation. Park officials often lack adequate information on the status of and trends in conditions of critical resources.

The National Parks Conservation Association initiated the State of the Parks® program in 2000 to assess the condition of natural and cultural resources in the parks, and determine how well equipped the National Park Service is to protect the parks—its stewardship capacity. The goal is to provide information that will help policymakers, the public, and the National Park Service improve conditions in national parks, celebrate successes as models for other parks, and ensure a lasting legacy for future generations.

For more information about the methodology and research used in preparing this report and to learn more about the Center for State of the Parks®, visit [www.npca.org/stateoftheparks](http://www.npca.org/stateoftheparks) or contact: NPCA, Center for State of the Parks®, P.O. Box 737, Fort Collins, CO 80522; Phone: 970.493.2545; E-mail: [stateoftheparks@npca.org](mailto:stateoftheparks@npca.org).

Since 1919, the National Parks Conservation Association has been the leading voice of the American people in protecting and enhancing our National Park System. NPCA, its members, and partners work together to protect the park system and preserve our nation's natural, historical, and cultural heritage for generations to come.

- \* More than 340,000 members
- \* 23 regional and field offices
- \* More than 120,000 activists

A special note of appreciation goes to those whose generous grants and donations made this report possible: MSST Foundation, Dorothy Canter, Ben and Ruth Hammett, and anonymous donors.

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## REPORT SUMMARY



DAVE BOYLE

Emerging from the sea nearly 460,000 years ago, the island of Hawai'i is the youngest island in the Hawaiian archipelago, which is more than 2,000 miles long. This island chain, the most geographically remote in the world, is located in the Pacific Ocean, 2,390 miles west of California. It comprises eight main islands and more than 100 minor islands, islets, and atolls, all the product of undersea volcanic activity. As undersea volcanoes erupted, mountains built

up from the sea floor. Thus, the Hawaiian Islands are the projecting tops of one of Earth's largest mountain ranges.

For thousands of years, human beings have been drawn to the mysterious allure and awesome power of volcanoes. Polynesians first settled the island of Hawai'i between the 5th and 7th centuries; another group of Polynesians followed in the 13th century. This later group brought a number of cultural traditions that

The Hawaiian Islands are the product of volcanic activity that built up mountains from the sea floor. Hawai'i Volcanoes National Park was established in 1916 for the study and protection of Mauna Loa and Kilauea, two active volcanoes.

Hawai'i Volcanoes National Park features active craters and calderas, as well as hundreds of lava tubes, steam vents, sea arches, cracks, and caves. This is a view of the Halema'uma'u Crater.



G. BRAD LEWIS

Both tourists and scientists have been attracted to Hawai'i's volcanic features for more than a century.

remain today. Native peoples worshipped a variety of deities, including Pelehonuamea (Pele of the sacred earth) as the volcano goddess, imbuing the area around Mauna Loa and Kilauea, two of the island's primary volcanoes, with great spiritual importance.

Europeans learned of the Hawaiian Islands from Captain James Cook, who first visited them in 1778. Other Europeans and Americans were initially drawn there by the promise of commerce. After two missionaries, William Ellis and Asa Thurston, reported on the activity of Kilauea in 1823, interest in Hawai'i increased. The active volcanoes on the island attracted both tourists and scientists, including volcanologist Thomas Jaggar. Today, these volcanoes continue to draw visitors to their beauty. Watching red-hot lava glow in the fading light of dusk and reach the sea with a hiss of steam is an experience unequalled for many.

Hawai'i Volcanoes National Park, established in 1916, was initially created for the study and protection of the impressive volcanic

features of Mauna Loa and Kilauea. Mauna Loa is considered to be the largest freestanding mountain in the world and last erupted in 1984. Kilauea is one of the most active volcanoes in the world and has been erupting since 1983. Hundreds of lava tubes, steam vents, sea arches, cracks, and caves are found in the park, as well as active craters and calderas, most of which are accessible by trails that offer stunning views. Since its inception, the park has grown in size, most recently in 2003 with the addition of the Kahuku district. Today the park spans 333,000 acres.

As products of more than 70 million years of evolution in a remote island setting, almost all of the Hawaiian archipelago's native terrestrial plants and animals are endemic—found nowhere else on Earth. They contribute to global biodiversity and the study of evolutionary processes, and they also play important roles in the culture of Native Hawaiians. Human activities, first with the arrival of Polynesians and later with European contact, greatly altered



DAVE BOYLE

## HAWAII VOLCANOES NATIONAL PARK AT A GLANCE

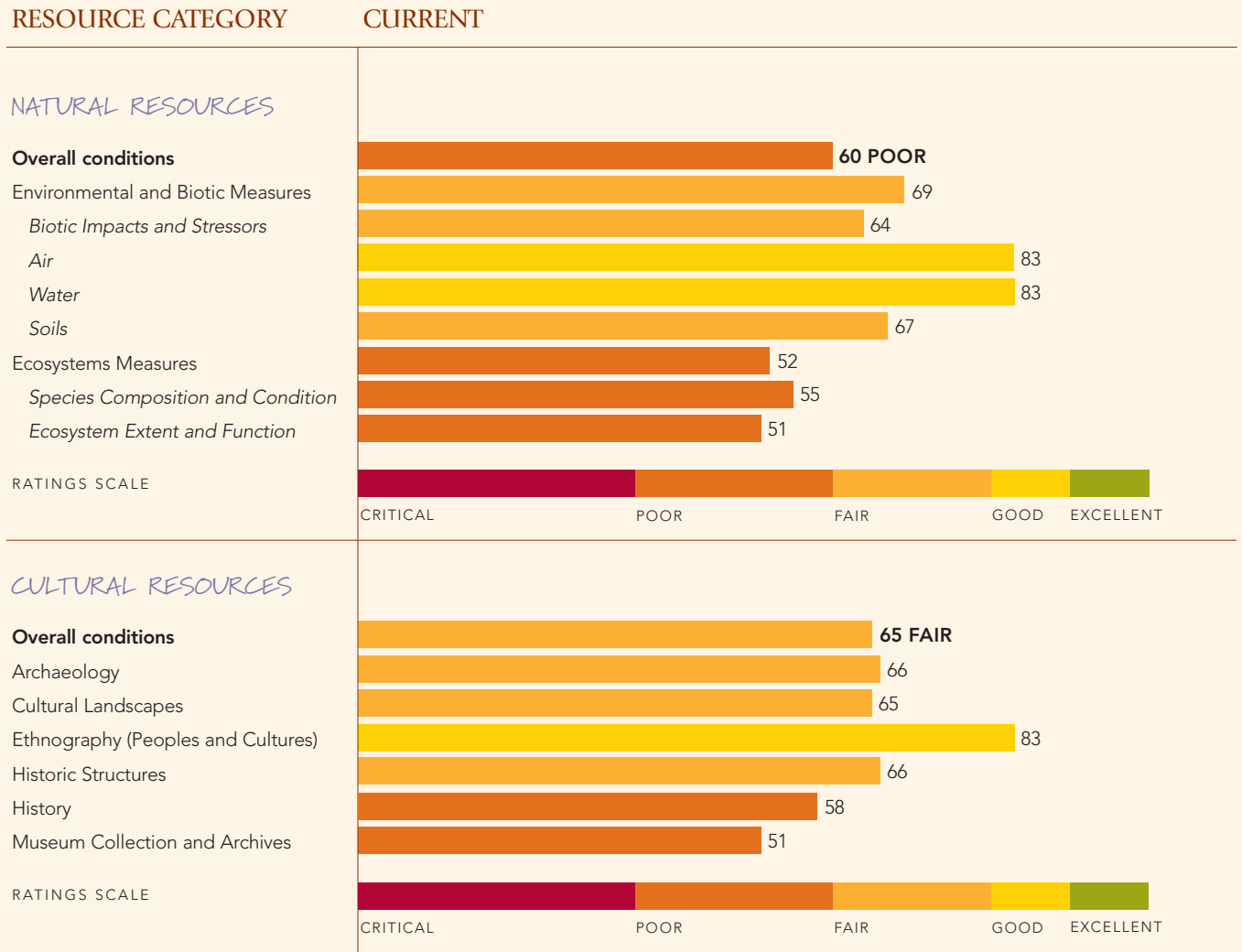
- The park contains two of the most active volcanoes in the world—Mauna Loa and Kīlauea. Both erupt with fast-moving, effusive, high-temperature lava. This especially fluid lava forms a gentle dome shape; these types of volcanoes are called shield volcanoes. Kīlauea also has a well-documented explosive side that most recently revealed itself on May 18, 1924.
- Hawai'i Volcanoes National Park is open to visitors 24 hours a day, 365 days a year. Each year, more than 1.6 million people visit the park to experience the volcanoes and the park's other natural and cultural features. Due to the unpredictable and changeable nature of the park's volcanoes, conditions can change on a daily basis. Visit the park's website and visitor center for current conditions, and always heed all posted signs and warnings.
- Designated as both an International Biosphere Reserve and a World Heritage Site, Hawai'i Volcanoes National Park preserves the intimate connection between the natural history of the region and Native Hawaiian culture and life. The volcanoes, forest, and plants within the park are important to the heritage of Native Hawaiians and serve religious or spiritual purposes.
- The park boasts the largest federally managed tract (33,000 acres) of tropical rainforest in the National Park System.
- About 90 percent of the native species on Hawai'i are endemic—they are found nowhere else on Earth. The island's isolation, varied topography, tropical climate, and history of disturbances caused by lava flows all contribute to this high rate of endemism. A number of these endemic species are protected under the Endangered Species Act.
- An unattended thatched house provided shelter for visitors to the Kīlauea area in the mid-1840s. In 1866, the first Crater Hotel was officially established near the Kīlauea Caldera and hosted historic figures such as Mark Twain, who wrote about his experiences there in the book *Roughing It*. Throughout the years, the hotel has evolved. The 1877 version of the hotel, called the Volcano House, is in the National Register of Historic Places and now serves as the Volcano Art Center Gallery. In 1941, a larger version of the Volcano House Hotel was built after fire destroyed much of the previous structure; it still provides accommodations for visitors.
- Pu'uloa Petroglyph Field, part of the Puna-Ka'ū Historic District, contains more than 23,000 petroglyphs, or images that are carved into the lava and depict people, boats, and geometric shapes. The hill is a site sacred to Native Hawaiians who place the umbilical cords of their children there to ensure they have long lives. The bulk of the 23,000 petroglyphs are related to this practice.

Hawai'i Volcanoes National Park protects the largest tract of tropical rainforest in the National Park System.



G. BRAD LEWIS

When interpreting the scores for natural and cultural resource conditions, recognize that critical information upon which the ratings are based is not always available. This limits data interpretation to some extent. For Hawai'i Volcanoes National Park, 63 percent of the natural resource information required by the methodology was available, and 98 percent of the cultural resource information was available.



The findings in this report do not necessarily reflect past or current park management. Many factors that affect resource conditions are a result of both human and natural influences over long periods of time, in many cases before a park was established. The intent of the Center for State of the Parks® is to document the present status of park resources and determine which actions can be taken to protect them into the future.

the natural environment of Hawai'i. In areas protected from further human development, non-native plants and animals are the two most serious threats to remaining natural areas. Today, combating these invasive species is the number one natural resources management activity in the park.

The archaeological record of Hawai'i Volcanoes National Park spans a period beginning in A.D. 1200; regular lava flows that have occurred about every 1,000 years have covered over many areas, obscuring records of the park's earlier prehistory. But the centuries of contact with foreign visitors have left a tangible record of the past. Journals kept by foreign explorers tell the stories of cultural contact in the 18th century; stories of American merchants and missionaries in the 19th century also provide glimpses into the past. The establishment of the park, scientific research, and World War II are other stories that can be shared with visitors. Most importantly, Hawaiian cultural traditions, hula, and chant teach today's visitors and park staff about the island's history.

The archaeological record in the park is broad and includes petroglyphs, shrines, trails, tool-making locations, house sites, and other evidence of daily activities. While important volcano related stories are told at the park, other cultural resources—especially those such as

archaeological sites, which have left a mark on the landscape—need further interpretation. Additionally, more Native Hawaiian perspectives need interpretation.

### RATINGS

Current overall conditions of the known **natural resources** in Hawai'i Volcanoes National Park rated a score of 60 out of 100. This is at the upper limit of the “poor” range. Ratings were assigned through an evaluation of park research and monitoring data using NPCA's Center for State of the Parks comprehensive assessment methodology (see “Appendix”). Invasive species are the number one threat to park biodiversity.

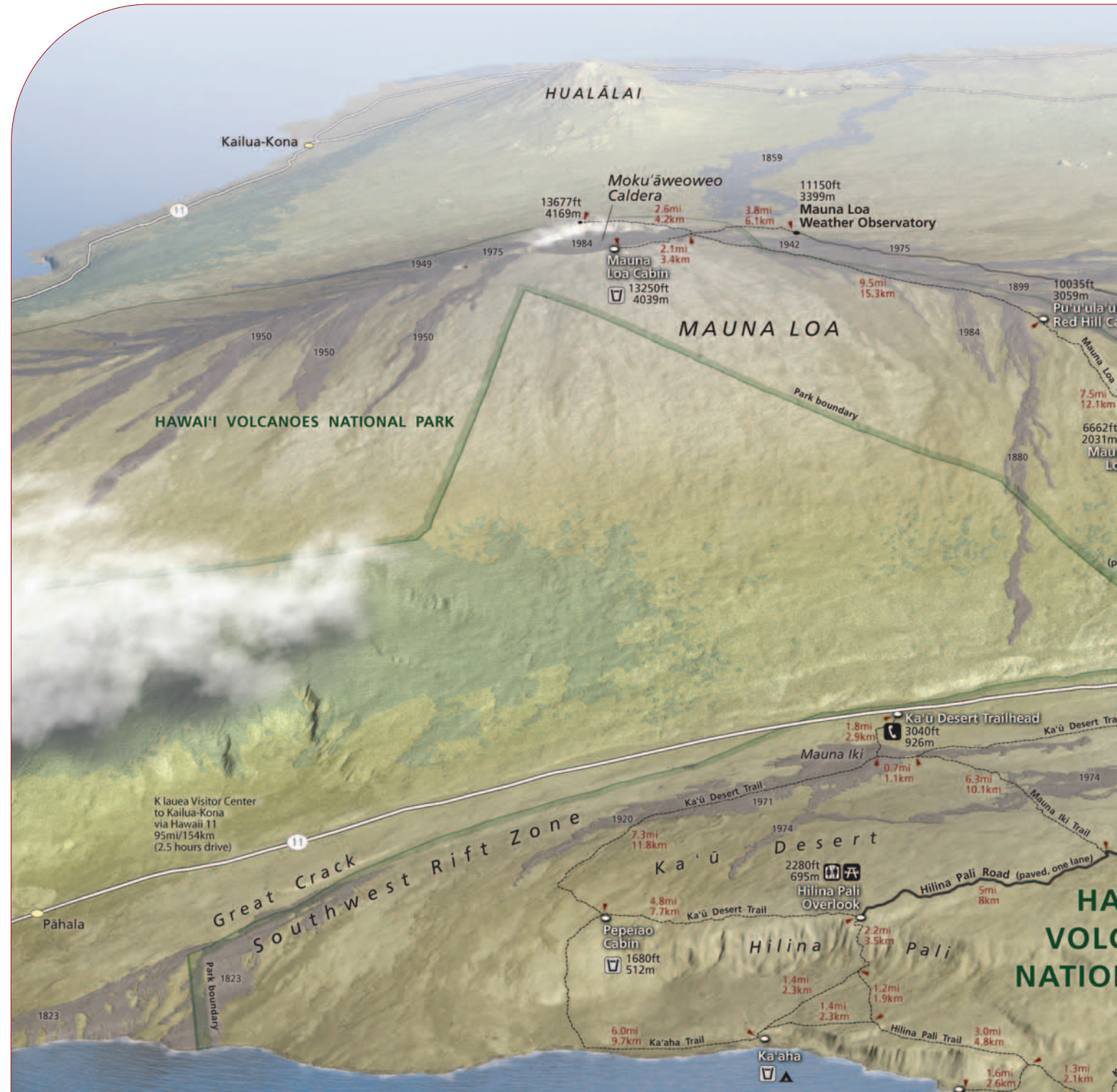
Overall conditions of the park's known **cultural resources** rated 65 out of a possible 100, indicating “fair” conditions. The scores for cultural resources are based on the results of indicator questions that reflect the National Park Service's own *Cultural Resource Management Guideline* and other policies related to cultural and historical resources.

The park has a very strong ethnography program and relationships with Native Hawaiian groups. Staff are actively working to strengthen other facets of the cultural resources program, which require additional staff and funds.

DAVE BOYLE



Native Hawaiian cultural traditions teach park visitors and staff about the island's history. Here, techniques once used by bird catchers are shown. Long ago, skilled bird catchers would capture birds so that their feathers could be plucked to use as ornamentation for royalty. Feather collection from native forest birds has essentially ended, but feather arts are still practiced using feathers from domesticated species such as pheasants.



**About the map**

The computer-generated map above looks northwest across the Big Island. Because of perspective, areas in the foreground appear larger than comparably sized areas in the background. Vertical exaggeration is used.

- Pullout
- Hiking trail
- Distance indicator and trail distance
- Historic lava flow and date
- Picnic area
- Self-guiding trail
- Wheelchair accessible
- Drinking water
- Water—must be treated before drinking
- Food service
- Restrooms (wheelchair access)
- Lodging
- Gas station
- Emergency phone
- Campground
- Primitive campground





**MAUNA KEA**

Hilo to Kailua-Kona  
via Hawaii 19  
100mi/161km  
(2 hours drive)

**Kilauea Visitor Center**

'Ōla'a Forest  
HAWAII VOLCANOES  
NATIONAL PARK

**KILAUEA**  
(see detail map)

**HAWAII VOLCANOES  
NATIONAL PARK**

**East Rift Zone**

Kupaianaha  
Lava Shield  
1983-2000s

**PACIFIC OCEAN**

## RESOURCE MANAGEMENT HIGHLIGHTS

### Natural Resources

- **Invasive species management is ongoing.** Management of invasive species is the park's highest natural resource priority, and it is where most of the park's efforts are focused. Since the 1970s, restoration of native ecosystems has focused on management of non-native feral ungulates and invasive plants. The park has more than 100 miles of boundary and interior fences that exclude ungulates from sensitive areas. Within these protected areas, efforts to control highly invasive plants are focused in special ecological areas (SEAs). SEAs are selected on the basis of high native biological diversity, uniqueness, intactness, and manageability. In 2006, staff repaired and upgraded more than six miles of fence, constructed four miles of new boundary fence, and removed highly invasive faya tree, kāhili ginger, strawberry guava, and other target plants across about 41,000 acres in 15 of the park's 24 SEAs.

The park has several rare species recovery efforts under way, including a program focusing on endangered hawksbill sea turtles.

- **Restoration of plant communities continues.** Even when invasive species are removed, native plants are not always able to recover on their own. In highly degraded systems, additional measures, such as planting and seeding, are required to restore native plant diversity. In 2006, more than 10,000 individual plants were planted and 3 million seeds were broadcast into restoration sites located in formerly grazed koa forest and fire-damaged dry 'ōhi'a woodland. School groups and community volunteers provided about half of the labor, collecting seeds, assisting in the nursery, and planting seedlings.
- **Rare species recovery is ongoing.** The park provides habitat for 54 federally listed endangered, threatened, and candidate endangered plants and animals (including eight historical species), as well as additional sensitive and rare species. Special programs like the hawksbill turtle recovery program build support for park habitat restoration and rare species recovery efforts. Like many of the rare species recovery efforts in the park, the hawksbill program is supported largely by volunteers who monitor nests and assist hatchlings with their journeys to the water. Volunteers also educate the public about the importance of leaving nests undisturbed and the fact that light pollution from homes, streetlights, and other sources can confuse hatchlings heading for the sea. The program has strengthened community relations and continues to serve as a model for restoration and volunteer programs within the Park Service. In 2007, the park won Hawai'i's Living Reef Award for this program.

NATIONAL PARK SERVICE



- **Partnerships provide support for conservation.** Habitat fragmentation, habitat degradation, and uncontrolled non-native species invasion on lands surrounding the park are major concerns for the long-term viability of park ecosystems and species. To address these concerns, the park has fostered relationships with various state, federal, and nonprofit agencies to collaborate on conservation issues. The park is a founding member of the Three Mountain Alliance (formerly Kīlauea Partnership), the largest cooperative land management effort in the state of Hawai'i. In 2006, members joined together to re-establish five highly endangered plant species and remove invasive species from state and private lands adjacent to the park.

### Cultural Resources

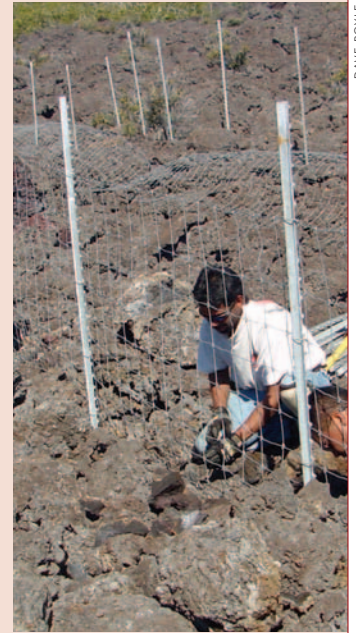
- **Storage for museum paintings improved.** The park boasts an extensive collection of historic paintings. A new rolling shelf system allows paintings to be hung individually in storage, replacing a potentially damaging system of stacking. These historic paintings were recently the subject of a Master's thesis by the current museum curator.
- **Ethnography program continues to thrive.** One of the park's strengths is its ethnography program and its solid relationship with kūpuna (Hawaiian elders) groups. The park consults with kūpuna to ensure requirements set forth in Section 106 of the National Historic Preservation Act are met. This relationship, which has developed over the last ten years, has helped to incorporate more Native Hawaiian voices and perspectives into all significant park programs and projects, and it is a

cornerstone in the development of a healthy cultural resources management program.

- **Park preserves Native Hawaiian resources.** The lands within the boundaries of Hawai'i Volcanoes National Park—stretching from the mountains to the sea—hold the remnants of traditional ancient Hawaiian life. The park protects and preserves these resources, including 314 archaeological sites that are listed in the Archeological Sites Management Information System, a database of parks' archaeological resources. These sites consist of more than 2,000 features—an impressive number considering that less than 5 percent of the park has been surveyed for archaeological sites. Additional surveys, which will require additional funding, are likely to uncover even more sites.

### Stewardship

- **Park programs inspire resource stewardship.** Educational and interpretive programs play a key role in inspiring visitors and local residents to become stewards of the park and help participants understand the universal values the park represents (e.g., human connections to the environment). In addition to educational and interpretive programs that engage visitors and local residents, the park provides a variety of service-based opportunities that include regular service days during which volunteers help pull weeds, plant trees, and provide other assistance caring for park resources. In addition, some of the commercial tour companies operating in the park offer "voluntourism" programs for their customers—opportunities to engage in resource protection as part of their recreational park experience.



More than 100 miles of fencing protect sensitive areas from non-native animals like sheep and goats.

Within the National Park System as a whole, Hawai'i Volcanoes National Park has among the highest number of threatened and endangered species, including the endemic Hawaiian goose or nēnē.

## KEY FINDINGS

- Issues with invasive non-native plant and animal species predominate at the park, with the extent of the issues varying among park ecosystems. In general, lowland areas are more affected by invasive species and past human land use. Upper elevation areas, native pioneer communities on young lava flows, and rainforest are in much better shape, particularly in the backcountry and other remote areas. Hawai'i Volcanoes National Park has among the highest number of threatened and endangered species in the National Park System largely because of the damage caused by non-native species. Native bird populations, in particular, have suffered from habitat loss, avian disease introduced by invasive species, and predation by introduced predators—pressures that are exacerbated by climate change. The park has developed strategies such as fencing and weed control to manage non-native species—and these have contributed to recoveries of native species—but funds are needed to continue these efforts and to expand them to other areas of the park where invasive plants and feral ungulates, domestic cattle, predators, and other non-native animals continue to cause problems.
- As a national park centered on active volcanoes, Hawai'i Volcanoes must contend with the unique challenges presented by its volcanic surroundings. Volcanic smog, or “vog,” which forms when volcanic gases react with moisture, sunlight, and oxygen, is a concern for park employees, visitors, and nearby communities. Vog can irritate the human respiratory system and obscure scenic vistas. In winter months, the shift in winds allows gas emissions from Kīlauea to remain in the most heavily visited sections of the park such as the southwest rift zone and summit developed areas; on some occasions, portions of the park are closed to protect visitor health. The park's website and exhibits at the Kīlauea Visitor Center give air quality updates every 15 minutes. The corrosive environment created by vog, along with ongoing seismic and eruptive activity, also pose a challenge for outdoor interpretive panels and affect the park's entire infrastructure.
- Education and interpretation are key tools that help the park achieve its mission of protecting resources. But visitors and local residents do not have access to critical resource information because the park is not adequately staffed—and that makes it difficult to build a constituency and increase supporters.
- Because of the seismic activity in the park, historic structures—and the park's entire infrastructure—require upgrades to meet current building codes for structures in earthquake zones. This retrofitting will require extensive survey work and money.
- Archaeological surveys are needed to accurately assess sites and their artifacts, many of which are at risk of being destroyed by lava flows and ash. Because of budget shortfalls and limited staff availability, only 3 to 5 percent of the park has been surveyed. The park has an archaeological overview and assessment under contract that will address gaps in the current program, provide direction for future projects, and allow park personnel to better identify, preserve, and protect valuable sites by developing funding proposals and completing projects.



JAY ROBINSON

- Caves, which are found throughout the park and may contain archaeological artifacts, should be mapped, inventoried, and monitored. These are very time-consuming processes. Though the park has accomplished some of this work, a lack of staff has prevented resource managers from surveying all known caves in the park, leaving potentially significant relics undiscovered and vulnerable.
- Existing staff positions remain vacant at the park because there are no funds to hire people to fill them. New staff positions are also needed to boost natural resources and cultural resources management programs as well as visitor services and law enforcement. Funding shortfalls also prevent the park from accomplishing needed science and resource management activities, including setting up operations in the new Kahuku district; boosting core interpretive content to support rangers and visitors; restoring threatened and endangered species; combating invasive species; and furthering cultural resource management programs.
- The park's current general management plan is more than 30 years old and does not address the current eruption at Kīlauea, which began in 1983 and contin-

ues to shape the park and result in the loss of structures (visitor center) and infrastructure (roads/trails). In addition, the current outdated plan does not include the addition of new lands in the Kahuku district, though the park is in the process of developing a new general management plan that will include Kahuku. The most recent resource management plan was written in 1999. Declining funding and inadequate staffing are the root cause of the delay in updating plans.

- Many park visitors arrive on tour buses and are hurried through sites and exhibits by private guides. These types of visits concern park staff because they may not provide adequate education and interpretation for visitors. Park staff would like to develop a certification program for park partners, bus drivers, concession employees, and ecotourism operators to ensure that the interpretation provided meets professional standards, aligns with the park's mission and themes, reflects current science, and is sensitive and supportive of Hawaiian heritage. Large tour groups, which do not arrive on a set schedule, also overwhelm the visitor center, staff, and concessions facilities, detracting from the park experience of other guests.



DAVE BOYLE

Several thousand non-native mouflon sheep roam the park, damaging native ecosystems by eating plants and stripping bark from trees. The park is in serious need of funds to manage the sheep and other non-native species.

### ISOLATED ISLAND BOASTS EXPANSIVE NATIONAL PARK

The Hawaiian archipelago is considered the most isolated island chain on the planet, located in the northern Pacific Ocean 2,390 miles from California, 3,850 miles from Japan, 4,900 miles from China, and 5,280 miles from the Philippines. This isolation has contributed to a unique biotic composition rich in endemic species.

The southernmost island in the archipelago of eight major islands is Hawai'i Island. It is the highest oceanic island in the world and is home to Hawai'i Volcanoes National Park. Situated on the southern flanks of Mauna Loa and Kīlauea, two of the most active volcanoes in the world, the park encompasses 333,000 acres of land, comprising about 13 percent of the total land area of Hawai'i Island. This large expanse exhibits an exclusive slice of flora, fauna, geology, climate, and topography found nowhere else on Earth. In recognition of this diversity, the park was designated an International Biosphere Reserve by the United Nations Educational, Scientific, and Cultural Organization (UNESCO) in 1980.

The park is divided into two management districts—the Kīlauea section and Kahuku. The Kīlauea section, with an area of 217,000 acres (123,000 are designated wilderness), contains the summit regions of both Mauna Loa and Kīlauea; the active southwest and east rift zones of Kīlauea; the southwest and northeast rift zones of Mauna Loa; and the detached 'Ōla'a rainforest tract. The Kīlauea section of the park houses the visitor center, the Jaggar Museum, and Crater Rim Drive, the 11-mile auto loop around the summit of Kīlauea. It also includes about 29 miles of coastline, though Park Service jurisdiction ends at the high tide line, excluding marine ecosystems from the park. The variety of ecosystems and habitats found in the Kīlauea section is extremely diverse, ranging from subalpine to coastal lowland and from wet forest to xeric systems.

The park's other management district and most recent addition is Kahuku. Acquired in 2003, this 116,000-acre parcel encompasses the southwest rift zone of Mauna Loa. The addition of Kahuku added more rare and endangered species to the park's inventory and extended the overall land area to be protected in perpetuity by the Park Service. Responsibility for this acquisition has increased the need for invasive species management, biological inventory and monitoring, reforestation, archaeological surveys, interpretive programs, and law enforcement—yet the park did not receive any additional staff to manage and protect resources in Kahuku. An increase to the park's operational budget for Kahuku is proposed for 2009.

Despite the large size of the park, most visitation is concentrated along the Chain of Craters Road and Crater Rim Drive. Condensed visitor use has limited most visitor impacts to the auto route, allowing the park to dedicate the majority of its resources to preserving and restoring natural communities. Visitation is increasing, however, which will likely result in more widely spread human impacts. The park is now the top tourist attraction in the state, with more than 1.6 million visitors in 2006.

### MAUNA LOA AND KĪLAUEA—THE LURE OF LAVA

All of the Hawaiian Islands began as an eruption point beneath the sea floor of the Pacific Ocean. With each new eruption, magma from inside the earth flowed out as lava, gradually building up each of the islands. Eventually they emerged from the sea to become volcanic islands, rather than underwater volcanoes. The island of Hawai'i is comprised of five volcanoes; Mauna Loa and Kīlauea are the two main active volcanoes in the park. Known as "shield volcanoes," they are a result of predominantly effusive volcanic eruptions of especially fluid lava. These eruptions gradually build layers upon layers of lava, creating a gently sloping dome shape.

Hawai'i's geographic isolation has contributed to a unique biotic composition rich in species found nowhere else on Earth.



DAVE BOYLE



Each year more than 1.6 million people visit Hawai'i Volcanoes National Park. Some experience the park by cruising along scenic drives, while others explore hiking trails.

Mauna Loa is the largest freestanding mountain in the world, measuring more than 56,000 feet from its base on the ocean floor to 13,677 feet above sea level. This volcano features two active rift zones, areas associated with the rise and eruption of magma. Rift zones feature eruptive fissures, cinder and spatter cones, lava flows, ground cracks, and faults. At the summit of Mauna Loa is Moku'aweoweo—the volcano's caldera. A caldera—derived from the Spanish word for cauldron—is a vast depression at the top of a volcanic cone, formed when an eruption substantially empties the reservoir of magma beneath the cone's summit. Eventually the summit collapses inward, creating the basin-like shape. Like all the Hawaiian island volcanoes, Mauna Loa releases basalt lavas, which are high in silica and low in sodium and potassium. Mauna Loa averages an eruption every 20 years, with its last eruption in 1984.

Located on Mauna Loa's southern flank, Kīlauea is a much smaller volcano, but its current eruption, now in its 25th year, represents the most voluminous outpouring of lava on the volcano's east rift zone in the past five centuries. By January 2007, lava had added about 212 acres to Kīlauea's southern shore. Kīlauea was formed mainly by fast-flowing lava, and it remains the most active volcano in the world—the current eruption cycle at the Pu'u 'Ō'ō vent started in 1983. Pu'u 'Ō'ō is located along the eastern border of the park—affecting ecosystems within park borders and local communities just outside of them. In the early stages of the current eruption episode, lava flows covered the coastal highway and Waha'ula Visitor Center in the park, and lava flows destroyed the nearby residences of Kalapana in 1990.

Visitors take advantage of abundant oppor-

tunities to experience the volcanoes. Tour buses and private cars cruise along Crater Rim Drive and Chain of Craters Road, while hikers and backpackers explore scenic trails. Lava tubes are also a popular feature formed from the kind of lava—pahoehoe—that flows from the park's two volcanoes. They form when flowing lava cools on the surface, allowing subsurface flows to continue moving. The flowing lava eventually exhausts its source and cools, resulting in a tube beneath the ground. The remains of historically extinct native species and early Polynesian artifacts have been found in Hawaii's older lava tubes. The Thurston Lava Tube, a 500-year-old lava cave located near the park's entrance, is maintained by park staff and is popular with tourists. It is located in tropical rainforest.

Areas untouched by lava flows are another tourist draw. Called kīpuka, these large and small areas are islands of plant and animal life surrounded by a sea of lava. Kīpukapuauulu,

located on the slopes of Mauna Loa, is reached by a scenic hiking trail. It is special for its extremely rare koa-manele forest type (globally imperiled by The World Conservation Union), which contains some of the richest and most diverse plant species assemblages in the park, including a number of rare and endangered plants and rare insects.

The park's volcanoes attract scientists as well as tourists. The Hawaiian Volcano Observatory, located on the rim of Kīlauea Caldera and operated by the U.S. Geological Survey (USGS), enjoys a worldwide reputation as a leader in the study of active volcanism. Due to their usually benign natures, Kīlauea and Mauna Loa can be studied up-close and in relative safety. In addition to research, the USGS works with emergency-response officials to protect people and property from earthquakes and volcano related hazards.

The Thurston Lava Tube formed more than 500 years ago when flowing lava cooled on the surface and subsurface lava continued to flow. Eventually the lava stopped flowing, leaving behind an open tube that can be explored by today's visitors.



KELLY COURKAMP





## THE HAWAI'I VOLCANOES ASSESSMENT



JAY ROBINSON

### NATURAL RESOURCES— LANDSCAPE PROVIDES REFUGE FOR MANY

The assessment rated the overall condition of natural resources at Hawai'i Volcanoes National Park a 60 out of 100, which ranks park resources in “poor” condition, due largely to the long-term, negative impacts of invasive non-native species.

### LAND USE—HISTORIC AND CONTEMPORARY USES SHAPE LANDSCAPES

As a result of the extreme geographic isolation of the Hawaiian Islands, only a subset of organisms typically found on continental systems colonized them prior to the arrival of humans. For the most part, colonizing species had to be able to fly, be light enough to be carried by the wind and ocean currents, or piggyback on flying

The endangered Mauna Loa silver sword is found only in the subalpine zone on Mauna Loa. The plant is a symbol of the region, and park staff are partnering with several other agencies and organizations to aid its recovery.

JAY ROBINSON



The assemblages of plants and animals that developed in Hawai'i are unlike any in the world.

creatures. Consequently, no four-legged mammals, no terrestrial reptiles and amphibians, and no ants or mosquitoes colonized the islands. The few plants and animals that did make it to the islands adapted and evolved under special circumstances—in the absence of large mammalian herbivores and predators, and with few competitors and diseases—for millions of years. The resulting assemblages of plants and animals that developed are unlike any in the world. More than 90 percent of the animals and vascular plants are endemic—found only in the Hawaiian Islands.

In the last 1,500 years, the Hawaiian Islands underwent dramatic human-caused changes to their natural environments. Polynesians who originally settled the islands between the 5th and 7th centuries dramatically altered lowland vegetation by converting forests and scrublands to agricultural fields. They also introduced non-native species and harvested plants and animals for building supplies, food, and cultural relics. Archaeological research continues to find evidence that Hawaiians greatly altered their environment in ways that affected many endemic species. While the majority of alterations to native Hawaiian ecosystems followed

the arrival of English explorer James Cook in 1778, it is estimated that 71 native bird species were already driven to extinction prior to the arrival of Europeans, through a combination of habitat loss, invasive predators (rats and dogs), and over-harvest.

The impact of European settlers, however, appears to have had more extensive and damaging results, both spatially and systematically. Land clearing for cattle ranching, logging, agriculture, human settlement, and forestry (cultivation of non-native species) contributed to the loss of large forest tracts. The introduction of large ungulates such as cattle, goats, sheep, and European pigs into a system that had no prior contact with large animals greatly altered the natural environment and resulted in destruction of native plants and animals that depended on the habitat, alteration of soils through compaction and erosion, and deterioration of watersheds. Introduction of cattle also greatly affected the Native Hawaiian lifestyle. Wild cattle devastated Hawaiian agricultural fields and forced people to build walls around their homes or around entire villages.

Also associated with post-European contact was the rapid and large-scale introduction (both deliberate and inadvertent) of invasive non-native plants and other non-native animals (e.g., mongoose, cats, mosquitoes, ants, and wasps) that upset the fragile environment. By 2000, more than 70 of the 127 species and subspecies of birds that had thrived since prehistoric times had been lost because of European contact, and about one-third of the endemic Hawaiian vascular flora was listed as federally endangered or threatened.

Within Hawai'i Volcanoes National Park, effects on natural resources by human land use reflect those changes that occurred across the Hawaiian Islands. Manipulation by Polynesians occurred primarily at low elevations, while land clearing for cattle ranching extended into upland areas within the park. Although the Mauna Loa Strip—the narrow area of the park

northwest of Crater Rim Drive—was added to the park in 1927, cattle grazing continued there until 1948. Since the removal of cattle, regeneration of koa (*Acacia koa*), often called “Hawaiian mahogany,” and other species has occurred. The park acquired ‘Āinahou Ranch, which was a cattle ranch from the 1930s to 1974, and parts of it now serve as a preserve for the Hawaiian goose (*Branta sandvicensis*). Areas within the recently acquired Kahuku district have been used for cattle grazing and timbering since the 1860s. Both practices continued until the park acquired the Kahuku property. Timbering has now ceased in Kahuku, but domestic cattle grazing continues under a special use permit that expires in April 2009.

Parklands have also historically supported a wide range of other activities, including military operations. During World War II the Ka’ū Desert was used as an aerial bombing range for wartime activities (1940-1950). Long-term scientific observation has also been a focus on

the island. Volcanism has been studied since the early 19th century and continues to be studied at the Hawaiian Volcano Observatory. Other scientific inquiry includes evolutionary studies of some of the island’s endemic species.

#### PLANT LIFE—PARK HARBORS SIX UNIQUE LIFE ZONES

Hawai’i’s isolation and geologic history, combined with other factors such as climate, have resulted in a wide range of vegetation and habitat types, leading to a high level of biodiversity. Elevation in the park ranges from sea level to 13,677 feet, and rainfall varies from less than 20 inches each year on the dry leeward side of the island to greater than 130 inches each year on the windward side of the island. This variation allows for a complex mosaic of vegetative communities. Six major vegetation systems exist at Hawai’i Volcanoes National Park, each with its own beauty and challenges. Overall, the park is home to about 400 native plant species,

A kīpuka in Kahuku supports the park’s only māmane-naio forest. Native māmane trees are favorite foods for non-native ungulates, but the trees are making a comeback in areas where these animals have been removed.

DAVE BOYLE



including 29 that are federally listed as threatened or endangered (35 if candidate species are included; see page 24).

Above 8,500 feet, the eastern slope of Mauna Loa supports an alpine environment dominated by native species. This system has remained relatively unaltered by browsing herbivores due to the lack of forage. The environment is populated by scattered mosses and low-growing, native shrubs. The alpine ecosystem exists almost completely within park boundaries, and it is the most intact ecosystem in the park.

Lower elevations on Mauna Loa's eastern slope and on the southwestern slope of the mountain in the Kahuku district support subalpine environments. These areas also contain some of the park's most intact native communities, with few non-native invasive plant species, though sheep and goats have depleted populations of some native subalpine plants. Subalpine plant species include the endangered Mauna Loa silversword (*Agyroxiphium kauense*), as well as the native 'ōhi'a tree (*Metrosideros polyporpha*), which has brilliant scarlet blossoms that are sacred to and associated with Pele, the volcano goddess. Subalpine areas also support stunning kīpuka. In Kahuku, one significant kīpuka contains the park's only example of māmane-naio forest. Māmane (*Sophora chrysophylla*), a leguminous tree, is highly preferred by ungulates. This species is making a comeback in areas where ungulates have been removed from the park. Naio (*Myoporum sandwicense*) wood is hard and durable; Native Hawaiians used naio timbers as the main support of houses.

The park's montane seasonal communities, found at elevations from 3,800 to 6,700 feet on the Mauna Loa Strip and within the Kahuku district, exhibit the highest bird diversity in the park and high species richness overall. This life zone comprises mesic forest, rainforest, shrub-

land, and grasslands and includes koa, a tree long prized for its beautiful wood. Where the koa forests still exist, they range from healthy native communities at higher elevations, to systems dominated by matting, non-native grass understories that inhibit koa tree seedlings. Koa wilt, a deadly fungal disease, has been observed on the Mauna Loa Strip, a concern for managers working to regenerate koa forests.

At 1,500 to 3,500 feet in elevation, the park's lowland rainforests, found in the 'Ōla'a Tract and Kīlauea's East Rift, compose the largest federally protected tropical rainforest in the United States. Forty-two percent of rainforest in the state of Hawai'i has been lost, underscoring the importance of protecting remaining areas. The 'Ōla'a Tract's vegetation is predominantly native, while the Kīlauea rainforest is dotted with an understory of non-native plants and trees. The invasive faya tree (*Morella faya*), introduced to the Hawaiian archipelago in the 19th century and first recorded in the park in 1960, has established itself on Kīlauea. Strawberry guava (*Psidium cattleianum*), another invasive non-native species, is becoming increasingly common in both tracts. Feral pigs greatly facilitate establishment of invasive plants by dispersing seeds and removing native vegetation by rooting.

Lower elevations on the southern slope of Kīlauea and in Kahuku support a submontane seasonal environment. Fire-adapted, non-native grasses plague this system, and in portions of Kīlauea it is infested with faya tree, which directly competes for nutrients, water, and light with the native, dominant 'ōhi'a tree. This community is more prone to fires, due to the invasion of non-native grasses such as broomsedge (*Andropogon virginicus*) and bushy beardgrass (*Schizachyrium condensatum*), which became widespread in the 1960s in the older parts of the park and are currently spreading in the actively grazed cattle pastures at Kahuku. Since the 1960s, more than two-thirds of this zone in older parts of the park have burned,

Hawai'i Volcanoes National Park is home to about 400 native plant species, including three species of endemic 'ama'u fern. The young fronds of these ferns are often tinged red to block harmful rays from the sun. A red dye can be made from the trunk and new fronds.



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Forty-two percent of rainforest in the state of Hawai'i has been lost, underscoring the importance of protecting remaining areas like those within Hawai'i Volcanoes National Park.

leaving more than 7,000 acres severely damaged. Native plant species that once thrived there are now uncommon or rare due to past impacts by feral goats and wildfire.

Coastal lowlands are the most disturbed environments in the park because feral goats overran them. Goats were not eradicated from these areas until the 1970s. The native ecosystems within this zone include dry forest and woodlands, open and closed scrublands, and grasslands. The relict dry forests and closed scrublands occur primarily in kīpuka on the southern and western flanks of Kīlauea, with the central lowlands dominated by grasslands. Today, non-native grasses such as broom sedge, natal redtop (*Melinis repens*), and thatching grass (*Hyparrhenia rufa*) are the most prevalent and system-altering invasive plants in the central lowlands. Invasive woody species, such as Christmas berry (*Schinus terebinthifolia*) and lantana (*Lantana camara*), compete with the remaining native trees and shrubs, including lama (*Diospyros sandwicensis*), 'ōhi'a, and alaha'e

(*Psydrax odorata*). The highly invasive and flammable fountain grass (*Pennisetum setaceum*) was once widespread in the lowlands but is currently reduced to scattered individuals due to a systematic campaign to eradicate populations.

#### NATIVE WILDLIFE IN THE PARK—AT RISK FROM HABITAT LOSS AND NON-NATIVE SPECIES

Birds are the most watchable form of wildlife at Hawai'i Volcanoes National Park, because they are active during the day and can be easily identified and located by their song. At least 87 species of birds are known to currently inhabit or visit Hawai'i Island, though 41 of these are non-native, and as previously mentioned, an estimated 71 bird species had been driven to extinction before the arrival of Europeans to the islands. Of the 23 surviving endemic Hawaiian songbird species, those living within Hawai'i Volcanoes National Park include six 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*). The latter three species are federally listed as endangered.

Native bird populations on Hawai'i have been affected by habitat loss from development, introduced avian disease, declines in native insects, historical hunting, and predation by introduced carnivore species. Loss of bird habitat is greatest in the coastal lowlands and submontane forests of the island. The reduction in habitat, coupled with the invasion of mosquitoes that carry diseases like avian malaria, has placed the majority of native birds at risk.

The park has just one native terrestrial mammal, the endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*), which lives on the island. Visitors may catch glimpses of the bats flying over bays and roadways at dusk. The only native marine mammal is the federally listed endangered Hawaiian monk seal (*Monachus schauinslandi*), which uses parts of the park's coastline. The remaining 12 mammals in the park are all non-native.

No land-dwelling reptiles or amphibians are native to the island of Hawai'i, though the hawksbill sea turtle (*Eretmochelys imbricata*) nests on park beaches and the green sea turtle (*Chelonia mydas*) is observed in nearby waters and occasionally onshore.

The park hosts a number of interesting inver-

tebrates such as the giant Hawaiian damner (*Anax strenuous*), the largest native Hawaiian insect with a wingspan of nearly six inches; Hawaiian cave tree crickets (*Thaumatogryllus cavicola*) that live on the ceilings of lava tubes; and the happy-face spider (*Theridion grallator*), whose body markings inspired its name. Invertebrates within Hawai'i Volcanoes have been surveyed more extensively than other units within the Park Service's Pacific Island Network of national parks. Surveys have found that 98 percent of the native invertebrates documented in the park only occur in Hawai'i. The health of these species depends on the health of the native plant communities that they use for food and shelter. Degradation of native plant communities affects invertebrates, as does the invasion of non-native species that compete with or feed upon native invertebrates.

#### THREATENED AND ENDANGERED SPECIES—HAWAII VOLCANOES TOPS THE LIST

Hawai'i Volcanoes currently provides habitat for 54 federally listed threatened, endangered, and candidate species (see pages 24 and 25). This includes eight species that were historically sighted (e.g., the last sighting of the endangered 'ō'ū, *Psittirostra psittacea*, was in the park in the 1980s). The U.S. Fish and Wildlife Service recognizes an additional 25 plant species as species of concern, and about 50 plant and animal species are recognized as sensitive or rare among park resource managers and U.S. Geological Survey—Biological Resource Division scientists. Since the park was established, about 30 plant species have become locally extirpated in the park. Of the park's native vertebrate fauna, a disproportionately high percentage—more than one-third—are considered imperiled. Deforestation, habitat degradation, invasive plants and animals, disease, and other human activities are the major threats to the survival of rare species.

The term "flagship species" refers to scientifically important and representative native

The giant Hawaiian damner is the largest native Hawaiian insect. Its wingspan is nearly six inches.

NATIONAL PARK SERVICE





Endangered hawksbill turtle hatchlings make their way to the sea. With the help of dedicated volunteers, the park monitors and protects turtle nests and educates the public about ways to minimize disturbance to nests and turtles.

species, often endangered, for a given location. Management focus on flagship species builds support for park habitat restoration and other rare species recovery efforts. Flagship species at Hawai'i Volcanoes National Park include the hawksbill turtle, Hawaiian goose, Hawaiian petrel (*Pterodroma sandwichensis*), and Mauna Loa silversword.

Population management of rare species requires an intensive, long-term commitment of resources. The current recovery programs rely largely on a cadre of devoted volunteers, strategic partnerships, and year-to-year competitive funding sources from within the Park Service, other federal agencies, and private contributions. With the exception of the four flagship species, monitoring to evaluate the status of all rare and listed species is needed but currently not occurring due to funding limitations.

#### Hawksbill Turtle

The hawksbill turtle is a federally protected endangered species that nests along the park's

beaches. Although the turtles spend only part of their lives within the park's boundaries, this beach time—nesting and the birth of offspring—is a critical stage in their lifecycles. This underscores the important role park protection plays in fostering the survival of this endangered species.

In the park and adjacent beaches, threats to the turtles include predation of nests and hatchlings by non-native predators, inadvertent trampling by humans, loss of nest habitat to invasive vegetation and human development (outside the park), confusion caused by artificial lighting, and entanglement with floating marine debris (e.g., fishing nets).

The park's hawksbill monitoring and protection program is largely funded on a year-to-year basis by the U.S. Fish and Wildlife Service, National Oceanic and Atmospheric Administration, Park Service competitive funding sources (e.g., Challenge Cost Share Program), and state and private contributions. On-the-ground implementation of the program

Typically, Hawaiian petrels dive into their nesting burrows high on Mauna Loa at night, and then they fly back out to sea before sunrise. This bird was stunned when it mistakenly flew into a window. It was released by park staff once it recovered.



KATHLEEN MISALON

is dependent on dedicated volunteers who monitor nests, assist hatchlings in their race towards the water, and educate the public about turtle nests and ways to minimize disturbance. In 2006, volunteers contributed more than 20,000 hours to the project—the equivalent of almost ten full-time employees. In 2005, beaches adjacent to and inside the park recorded the highest nesting rates since 1999 and the highest hatchling rates since 1995.

#### Hawaiian Goose

The Hawaiian goose, known locally as the nēnē, receives special attention through the park's resource management program. The nēnē, a federally listed endangered species endemic to the Hawaiian Islands, is also the state bird of Hawai'i. The species went from numbers estimated at 25,000 when Captain Cook arrived in 1778, to about 30 wild birds in the 1950s. The current population statewide is estimated at about 2,000 birds on the islands of Hawai'i, Maui, Molokai, and Kauai.

Initial recovery efforts during the 1960s and 1970s were based on captive breeding and release programs. Hawai'i Volcanoes has since shifted the focus of its program toward habitat management and predator control in an attempt to improve the self-sustainability of the wild population. Feral cats, pigs, rats, and mongooses pose a major threat to nēnē nests, goslings, and adults. The park constructed a fence to exclude pigs from 400 acres of nesting and brooding habitat, which resulted in a significant increase in reproductive success. The park also conducted a pilot project, erecting a smaller-scale fence designed to exclude cats and mongooses. This fence has successfully excluded predators and may have broader applications protecting other nēnē areas and other species.

Although the total population of nēnē in the park is still small (200 birds), it is increasing. The success of the 2006 and 2007 breeding seasons has significantly contributed to the population increase within the park, producing 40 and 30 fledglings, respectively. In previous



years, the average fledgling count was around 15. The park has two staff dedicated to monitoring and predator protection. Year-to-year funding is sought to support volunteers to assist with monitoring and protection efforts.

### Hawaiian Petrel

The Hawaiian petrel is a federally listed endangered bird that nests in the park. Because of predators and habitat loss, the petrel is now confined to remnant nesting habitat in the subalpine region on Mauna Loa. Management of this species is difficult in the park—nesting areas are remote, petrels are nocturnal at their nest sites, and nests are deep in underground burrows, making them difficult to monitor. The most serious threat to this species is the presence of feral cats that eat nesting adults, chicks, and eggs.

The park's Hawaiian petrel monitoring and protection program is largely funded on a year-to-year basis by the U.S. Fish and Wildlife Service, the State of Hawai'i, and private contributions from sources like the Hawai'i Natural History Association. In 2006, the park was fortunate to receive a small American Bird Conservancy grant for petrel colony management. Feral cats were trapped and existing colonies were monitored for predation and breeding success. During nest checks and inventories, evidence of feral cats and depredation was found at all three known petrel colonies, reconfirming the wide distribution and destructive habits of these carnivores. In seabird colonies, a single cat can kill many birds. With fewer than 100 known active nests throughout the park, every nest lost is devastating to the population.

### Mauna Loa Silversword

The Kahuku district is home to the largest (estimated 700 individuals) of three remaining natural populations of the federally listed endangered Mauna Loa silversword. This spectacular plant, found only near the active

volcano of Mauna Loa, is considered symbolic of the region, much as the Saguaro cactus (*Carnegiea gigantea*) is an icon of the Sonoran desert. The giant rosette plants live for ten to 50 years, flower only once, and then die. As obligate cross-pollinators, they require another plant nearby to set their seed. Park managers are working to aid recovery of the Mauna Loa silversword by planting seedlings within fenced areas of the Mauna Loa Strip and in Kahuku. On the Mauna Loa Strip, a five-year program largely funded by the Park Service's Natural Resources Protection Program was recently completed, with more than 13,000 seedlings planted in a fenced enclosure to protect the area from non-native animals. Aided by the University of Hawai'i's Rare Plant Facility, the Division of Forestry and Wildlife, the Hawaiian Silversword Foundation, and the U.S. Fish and Wildlife Service, park staff monitor the transplanted seedlings. So far, the seedling survival rate is 90 percent.

### Rare Plant Recovery

About one-third of the endemic Hawaiian vascular flora is federally listed as threatened or endangered. Hawai'i Volcanoes National Park provides habitat for 35 endangered, threatened,

Recovery efforts for the Mauna Loa silversword include planting thousands of seedlings in fenced areas to protect them from non-native animals.



DAVE BOYLE

## FEDERALLY LISTED PLANT SPECIES AT HAWAII VOLCANOES NATIONAL PARK

### Endangered

Pendant kiki fern *Adenophorus periens* (historical)  
Mauna Loa silversword, Ka'ū silversword *Argyroxiphium kauense*  
'Āhinahina, Mauna Kea silversword *Argyroxiphium sandwicense* ssp.  
*sandwicense*  
Fern (no common name) *Asplenium peruvianum*  
Uhiuhi *Caesalpinia kavaiensis* (historical)  
'Ōhā wai *Clermontia lindseyana*  
'Ōhā wai *Clermontia peleana*  
Hāhā *Cyanea stictophylla*  
Ha'iwale *Cyrtandra giffardii*  
Ha'iwale *Cyrtandra tintinnabula*  
Hau kuahiwi *Hibiscadelphus giffardianus*  
Hilo ischaemum *Ischaemum byrone*  
Koki'o, Hawai'i tree cotton *Kokia drynarioides*  
Alani *Melicope zahlbruckneri*  
Big Island ma'aloa *Neraudia ovata*  
'Aiea *Nothocestrum breviflorum*  
Hōlei *Ochrosia kilaueaensis* (historical)  
Hawaiian mint *Phyllostegia parviflora*  
Laukāhi kuahiwi, Hawai'i plantain *Plantago hawaiiensis*  
Hala pepe, Hawai'i hala pepe *Pleomele hawaiiensis*  
'Ihi mākole *Portulaca sclerocarpa*  
Loulou *Pritchardia affinis*  
'Ōhai *Sesbania tomentosa*  
'Ānunu *Sicyos alba*  
Hawaiian spermolepis *Spermolepis hawaiiensis*  
Narrowleaf stenogyne *Stenogyne angustifolia*  
A'e, Hawai'i prickly ash *Zanthoxylum hawaiiense*

### Threatened

'Āhinahina, Haleakalā silversword *Argyroxiphium sandwicense* ssp.  
*macrocephalum*  
Hawai'i catchfly *Silene hawaiiensis*

### Candidate Species

'Aku 'aku *Cyanea tritomantha*  
'Ohe *Joinvillea ascendens* ssp. *ascendens*  
Hōlei *Ochrosia haleakalae*  
Hawai'i phyllostegia *Phyllostegia floribunda*  
Makou, Hawaiian buttercup *Ranunculus hawaiiensis*  
'Ānunu *Sicyos macrophyllus*

and candidate plant species in addition to about 50 species of concern and rare species.

The park has a long history of propagating and planting rare Hawaiian plant species. Some of this work began as early as the 1920s. Current efforts are focused on stabilizing populations of more than two-dozen threatened and endangered species through propagation and planting into areas free of non-native ungulates. The park's rare plant recovery program is collaboratively funded on a year-to-year basis by the U.S. Fish and Wildlife Service, Park Service competitive funding sources (e.g., Natural Resource Preservation Program), and state and private contributions (e.g., Hawaiian Silversword Foundation). In 2006, with funding provided by the Natural Resource Preservation Program, the park re-established seven endangered plant species that were historically documented in the park. Among the planted individuals was the extremely rare *Clermontia peleana*, a species formerly believed extinct. It was only recently rediscovered (five individuals) in the wild in 2007.

The park propagates threatened and endangered Hawaiian plants to aid in species recovery efforts.



## NON-NATIVE ANIMALS—DESTROYING HABITATS AND EATING NATIVE PLANTS AND WILDLIFE

Hawai'i Volcanoes National Park is plagued by a variety of non-native animals that includes both herbivores such as cattle, goats, sheep, and pigs, and small predators such as cats, rats, and mongooses. The only terrestrial mammals native to Hawai'i were two bat species, one now extinct. Accordingly, the island flora and fauna evolved in the absence of big grazing and browsing animals and mammalian predators. Many of the defensive adaptations to grazing and browsing were lost. For example, many Hawaiian nettles lack stings, and mint varieties lack repellent odors. While grazing and browsing animals have had the greatest impact on habitat within the park, the introduced predators affect native wildlife the most directly. Native Hawaiian fauna evolved without significant predators and are generally unable to defend themselves. Bird eggs and chicks are especially at risk from hungry rats, cats, and mongooses. Ground nesting species such as the endangered hawksbill sea turtle and Hawaiian goose are particularly hard hit.

As indicated in the "Land Use" section, the first ungulates (hoofed mammals) arrived with the Polynesians who brought domestic pigs to the islands. Domestic goats, European pigs, sheep, and cattle were introduced to the Hawaiian Islands in the late 18th century; many became feral and spread into natural areas. Mouflon sheep (*Ovis gmelini musimon*) were introduced to Hawai'i in the 1960s. These non-native ungulates proliferated in Hawai'i because of an equable climate, abundant food sources, vegetation poorly adapted to herbivorous mammals (and therefore palatable), and a lack of predators.

Non-native ungulates have caused some of the most extensive damage to Hawai'i's native ecosystems. Feral pigs disturb soils by rooting for forage, damage vegetation through browsing, and increase breeding grounds for non-

## FEDERALLY LISTED ANIMAL SPECIES AT HAWAI'I VOLCANOES NATIONAL PARK

### Endangered

Nēnē, Hawaiian goose *Branta sandvicensis*

'Io\*, Hawaiian hawk *Buteo solitarius*

'Alalā, Hawaiian crow *Corvus hawaiiensis* (historical)

Honuea, Hawksbill turtle *Eretmochelys imbricata*

'Akiapōlā'au *Hemignathus munroi*

Pomace fly (no common name) *Drosophila heteroneura* (historical)

Pomace fly (no common name) *Drosophila mulli*

'Ōpe'ape'a, Hawaiian hoary bat *Lasiurus cinereus semotus*

'Ākepa, Honeycreeper *Loxops coccineus coccineus*

Hawai'i creeper *Oreomystis mana*

'Ō'ū *Psittirostra psittacea* (historical)

Īlioholoikauaua, Hawaiian monk seal *Monachus schauinslandi* (non-resident)

'Ua'u, Hawaiian petrel *Pterodroma sandwichensis*

### Threatened

Honu, Green sea turtle *Chelonia mydas*

'A'o, Newell's shearwater *Puffinus auriculari*

### Candidate Species

'Akē'akē, Band-rumped storm petrel *Oceanodroma castro*

'Ōpae'ula, Anchialine pool shrimp *Metabetaeus lohena*

Pinapinao, Hawaiian damselfly *Megalagrion nesiotes* (historical)

*Megalagrion xanthomelas* (historical)

\* Status is currently Endangered, but proposed for reclassification as Threatened

Endangered Hawaiian monk seals, the park's only native marine mammals, use parts of the park's coastline.



JAY ROBINSON

Fencing allows park managers to control the movement of non-native animals such as pigs, goats, and sheep, limiting the damage they cause to native ecosystems. Constructing and maintaining the fences is extremely labor intensive; the park needs more funds for fencing in areas that are currently unprotected.



JAY ROBINSON

native mosquitoes by creating wallows. They also help spread invasive non-native plants by dispersing seeds, eating existing plants, and disturbing soils. Mouflon sheep reduce native diversity by eating vegetation and stripping trees of bark.

The park has a long history of controlling non-native ungulates. Early efforts to remove feral goats and pigs were initially conducted by the Territorial Government from 1927 to 1931 as part of a regional effort to protect watersheds. Domestic cattle grazing was terminated in the Mauna Loa Strip in 1948 and in the 'Āinahou Ranch upon its acquisition by the park in the early 1970s. Beginning in the early 1970s, a systematic program of fencing and direct reduction eliminated goats from many parts of the park. This program was expanded to eliminate feral pigs from selected areas beginning in the early 1980s.

Fencing is a primary management tool for restoring the park's native ecosystems, as it allows managers to control the immigration,

movement, and impacts of non-native animals such as pigs, goats, and sheep. In the older section of Hawai'i Volcanoes National Park, there are 93 miles of boundary and interior fences that were constructed to exclude these animals. About 170,000 acres are managed to eliminate feral goats, mouflon sheep, and cattle. Feral pigs are excluded from about 43,000 acres of interior fenced units (13 units) that protect selected rainforest, montane, and lowland communities. While these efforts have resulted in the recovery of native species in many areas of the park, the cost to maintain ungulate-free areas challenges park operating budgets. An eight-person crew of resource management staff spends about one week each month inspecting, repairing, and maintaining the existing fences. (In fact, the dedication staff pour into these ongoing efforts is interpreted in one of the park's exhibits.) Full replacement of fences occurs every ten to 25 years, depending on deterioration rates. But park operating budgets are not sufficient to cover costs for

fence replacement and construction of new fences to protect resources at risk in unmanaged areas of the older part of the park and in the new Kahuku district. Thus, the park seeks additional funding through other sources within the Park Service, other federal agencies, and private organizations.

Feral ungulates remain a problem in unmanaged areas of the park. Outside the pig exclusion units, there is localized trapping of pigs to protect nests and goslings of the endangered nēnē from predation during their breeding season. Feral pigs remain a problem in unmanaged rainforest communities in the 'Ōla'a tract, in native dominated lowland communities, and in the vicinity of sensitive plant species on Kīlauea. The Kahuku district, which increased the park by 116,000 acres, contains large tracts of native ecosystem affected by ungulates. The new addition supports a population of several thousand mouflon sheep, anywhere from several hundred to several thousand feral sheep, an unknown number of pigs, and smaller populations of feral cattle and goats. As part of the forest restoration strategy, a special use permit that expires in 2009 allows domestic cattle to graze in pastures below 5,000 feet in elevation. If cattle had been removed immediately, weeds would have overtaken the area—but continued grazing is allowing the park time to develop a restoration strategy. Efforts to begin management of Kahuku and expand animal control efforts in the older portion of the park are constrained by limited funding.

#### INVASIVE PLANTS—PARK USES VARIOUS RESTORATION METHODS TO COMBAT NON-NATIVE SPECIES

Hawai'i's isolation and geologic history, combined with other factors such as climate, have resulted in a wide range of vegetation and habitat types that lead to a high level of biodiversity. At least 90 percent of Hawai'i's native terrestrial flora and fauna are endemic to the archipelago—they are found nowhere else.

Many of the park's ecosystems are becoming increasingly rare on the island and in the state of Hawai'i, so efforts to protect these natural systems and communities from further decline are especially important.

Invasive plant species pose a serious threat to the special ecosystems at Hawai'i Volcanoes National Park. There are about 600 non-native plant species within the park, 100 of which are considered invasive or highly disruptive to native species and ecosystems. In general, lower elevation ecosystems harbor more invasive species than upper elevation ecosystems (alpine, subalpine), pioneer communities on young lava flows, and remote rainforest. At their very worst, invasive species replace native plant communities and cause the local extirpation of native species. In some cases, natural disturbance cycles, nutrient cycles, and hydrologic regimes are altered. For example, altered plant communities dominated by fire-adapted non-native grasses promote the occurrence of fires and increase the magnitude and effects of fires. At Hawai'i Volcanoes National Park, the frequency and intensity of fires over the last 30 years have tripled, while the size of fires has increased 60-fold. Often, fires create conditions that allow non-native plants to replace native ones.

The control of invasive plant species often requires multiple steps and a long-term commitment to monitoring. Hawai'i Volcanoes has employed a variety of strategies to control invasive plants—strategies that are tailored to specific locations, targeted species, and the history of invasions. For small, localized distributions of invasive plants, the goal is to eradicate individuals before infestations become widespread and difficult to manage. Successful eradication relies on frequent systematic searches (from the air or on the ground) to detect new invasions. In most cases, park-wide eradication of widespread invasive plants is not feasible. Instead, park staff focus efforts on high-priority areas called special ecological areas (SEAs), to exclude the most disruptive species.

Controlling non-native invasive plants is an ongoing effort at Hawai'i Volcanoes National Park.



DAVE BOYLE

The park plants native species as part of its efforts to restore ecosystems that have been damaged by non-native animals and plants or previous land uses.



DAVE BOYLE

The establishment of SEAs in 1985 marked a shift in the management strategies employed by the park. SEAs focus efforts to manage invasive species and restore native ecosystems to highly defined areas that are chosen for their rarity, the exemplary nature of the vegetation type, vegetation intactness, plant species diversity and richness, and manageability of non-native plants. After fences are built to exclude non-native grazers such as pigs and goats, an SEA may be left to naturally recover without removal of invasive non-native plants or the assistance of plantings and seeding. This technique is used most often in areas that retain a significant level of native plants or seeds in the soil bank. Although this is the most cost-effective method, it becomes increasingly ineffective where invasive species are dominant.

In highly invaded areas, staff may use manual, mechanical, and/or chemical methods to remove invasive plants from an SEA. Depending on local conditions, systems may be allowed to recover without additional active

management. More often, additional measures to introduce rare species are needed to restore biological diversity (see "Resource Management Highlights").

In highly altered areas that lie outside of SEAs, further active management, often experimental in approach, is required. The Kīpuka Pepeiao burn restoration, Mauna Loa Strip forest understory restoration, and Kahuku pasture reforestation experiment are three examples of projects that are employing native planting and seeding.

The Kīpuka Pepeiao burn restoration project included planting and seeding 21 fire-tolerant native species into a formerly 'ōhi'a-dominated woodland, which burned in a lightning-ignited fire in 2004. Without intervention, the burnt area would have been vulnerable to invasive plant species, likely resulting in the conversion of these native woodlands to undesirable non-native grass savannas. Reintroduction of formerly dominant but fire-sensitive native plants such as 'ōhi'a and pūkiawe would be

## PARTNERSHIPS BENEFIT PARK AND LOCAL COMMUNITIES

Habitat fragmentation, habitat degradation, and uncontrolled non-native species invasion on adjacent lands threaten long-term ecosystem stability inside the park. Today, Hawai'i Volcanoes National Park is surrounded by a combination of state land and privately owned land, creating opportunities for partnerships and potential conflicts over land use and management goals. The State of Hawai'i, which owns the majority of the lands adjacent to the park, manages multiple conservation districts designated as natural area reserves (NARS), forest reserves, and game management cooperatives. Each serves one or more purposes (e.g., native ecosystem preservation, agroforestry, recreation, sustained yield). The Kapāpala Ranch operates on lands leased from the State of Hawai'i at the western border of the park's Mauna Loa Strip. Its location is of concern, as the continued grazing of cattle there reduces the extent of native ecosystems and increases the buffer area needed to prevent the spread of invasive species into the park.

Kamehameha Schools (formerly the Bishop Estate) is the next largest adjacent landowner after the State of Hawai'i, which includes the Kūlanī Correctional Facility. These and a number of other entities participate with the National Park Service in the Three Mountain Alliance (formerly the 'Ōla'a-Kīlauea Partnership), a cooperative, multi-agency landscape-level management effort to protect habitats. In 2003, Keauhou Ranch (owned by Kamehameha Schools) ceased cattle operations and designated portions of the ranch to native reforestation.

There are also several communities located adjacent to the park: Ocean View abuts the park on the southwest boundary of Kahuku; Nā'ālehu, Wai'ōhinu, and Pāhala are to the southeast of Kahuku on Highway 11; and Volcano is just east of the park entrance.

Park staff are concerned about proposed development of 46,000 to 56,000 new homes in Volcano, which would result in a loss of habitat and fragmentation of remaining rain-forest, with devastating effects on honey-creepers and other native species. Educating surrounding landowners about what they can do to limit this fragmentation (e.g., maintaining the forest canopy instead of completely clearing their lots) is critical to fostering the survival of native Hawaiian species. Landowners should also be educated about how to avoid creating areas of standing water, which allow mosquitoes that carry avian diseases to breed.

A problem that goes hand-in-hand with development is the presence of unmanaged non-native species along the park's borders. This is a major threat to the park's natural communities. Educating all landowners in surrounding communities about the impacts of non-native species on natural systems benefits both park resources and private landowners. By controlling non-native plants on their land, private landowners limit the spread of these plants into the park and minimize the increased risk of fire that is associated with non-native plants. The park is actively working with neighboring communities to contain the spread of invasive fountain grass (Ocean View) and coqui frogs, an invasive animal (Volcano). Many other partnerships, both formal and informal, also exist. This interaction between the park and local residents strengthens the role of the park within the surrounding communities; serves as an example for future outreach; empowers local communities to participate in hands-on stewardship; and results in improved park resource protection. The park needs additional staff to continue to provide this outreach at a level that fulfills these goals.

counterproductive, given the widespread abundance of non-native grasses that will recover rapidly, increase fuel loads, and lead to future fires. Instead, the park created modified native communities by reintroducing fire-tolerant native species such as māmane, naio, and 'iliahi, which used to be abundant in the area but were depleted by feral goats. In 2006 and 2007, park staff partnered with student and community volunteers to plant 2.6 million seeds and 5,136 plants. The site is currently being monitored to determine the long-term success of the project in establishing native communities that can persist under the new fire regime established by non-native grasses.

The Mauna Loa Strip forest project aims to restore a structurally sound koa forest in former pastureland. Restoration is a three-phase endeavor, beginning with the removal of invasive non-native plants, followed by planting of canopy species, and finally planting the more sensitive native understory species. The intensive time requirements of this phased restoration management result in smaller sections being restored at a given time, but the project provides incremental glimpses of the success of each phase, and it will ultimately result in a structurally complete forest with diverse age classes and populations.

Restoration in the Kahuku district began in 2005, with experiments designed to test restoration methods for koa-'ōhi'a forest in cattle pastures. (This district contains about 12,000 acres of pasture paddocks that include more than 7,000 acres of former koa-'ōhi'a forest.) The pastures' understory was cleared by bulldozing in the early 1970s, leaving an open canopy of native 'ōhi'a and koa trees with small clumps of native vegetation in steep or inaccessible sites. Evidence suggests that the forest once comprised a rich variety of species and provided habitat for rare birds and plants. In fall 2005, four ungulate-proof fenced exclosures (areas fenced off to protect vegetation from grazing) were constructed in different parts of the

paddock system to evaluate natural recovery of koa-'ōhi'a forest following exclusion of cattle, sheep, and pigs; to test grass removal techniques to help foster native seeds in the soil bank and reduce competition by non-native grasses; and to develop methods for increasing diversity of native plant species by planting and sowing seeds of 13 native species. More than 700,000 seeds and 1,727 seedlings of native species were planted in the four exclosures. By spring 2006, hundreds of koa seedlings had emerged in response to ungulate removal and grass removal. This site is currently being monitored, which will provide information to help guide recommendations for future restoration work.

Invasive plant management is funded through the park's base budget and year-to-year competitive funding sources. In 2006, the equivalent of eight full-time staff were devoted to protecting native ecosystems from invasive plants. Three of these were Hawai'i Volcanoes National Park staff; the rest of the assistance came from the Pacific Island Network Exotic Plant Management Team, the National Fire Program, other Park Service funding sources, and community volunteers.

#### AIR QUALITY—VOLCANIC EMISSIONS CREATE UNIQUE ISSUES

Encompassing parts of two active volcanoes, Hawai'i Volcanoes National Park's air quality is affected by eruptions and gas emissions. Emissions from Kīlauea volcano, particularly at Halema'uma'u and Pu'u 'Ō'ō, affect air quality the most. In general, air quality is good, but in concentrated areas around eruption sites, craters, and steam vents, it decreases dramatically.

Kīlauea releases nearly 4,000 tons of sulfur dioxide gas each day, a key component of volcanic smog or "vog." As defined by the U.S. Geological Survey, vog is "a mixture that includes gases but is predominately aerosols (tiny particles and droplets) formed when volcanic gas (most importantly, sulfur dioxide)

On clear days, visitors  
can see for miles.



KELLY COURKAMP AND GAIL DETHLOFF



reacts with moisture, oxygen, and sunlight. It is this unique mixture of gas and aerosols that makes vog both difficult to study and potentially more harmful than either gases or particles alone." What the U.S. Geological Survey has learned from limited studies about the aerosols that comprise vog is that most of them are acidic and of a size that lodges easily inside human lungs.

The presence of vog within the park varies throughout the year, depending upon the direction and strength of the wind. On days with no wind, gas pools on the summit of Kilauea and reduces visibility. Visitors may not even be able to see a few miles. The Hawai'i State Department of Health (DOH) has recently begun to develop an index that would identify levels of vog for areas of the island of Hawai'i. While the precise hazards associated with vog are unknown at this time, if vog levels can be categorized, humans can reduce their risk of vog-induced health problems by controlling their exposure to high levels.

In 2005, the U.S. Geological Survey initiated a wide-ranging air quality monitoring program for Hawai'i Volcanoes National Park, a Class I air quality area (receiving the highest level of protection under the Clean Air Act). Staff at the Hawaiian Volcano Observatory collect sulfur dioxide data at the Jaggar Museum and the Kilauea Visitor Center. Ultraviolet (UV) radiation is monitored as part of the U.S. Environmental Protection Agency's UV Monitoring Program. Because occasional high levels of sulfur dioxide are a health concern, concentrations of this gas are reported immediately to park staff so they can take precautionary measures, if needed. Visitors can get updates of current sulfur dioxide levels every 15 minutes at the Kilauea Visitor Center and on the park's website. This provides visitors with knowledge of the locations of poor air quality. Visitors with heart or lung conditions or asthma are advised to avoid these areas and stay in clean air.

The park also participates in national air



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quality networks, such as IMPROVE (Interagency Monitoring of Protected Visual Environments, monitors visibility), NADP/NTN (National Atmospheric Deposition Program/National Trends Network, monitors wet deposition of sulfur and nitrogen compounds), CASTNet (Clean Air Status Trends Networks, monitors dry deposition of sulfur and nitrogen compounds), and PRIMENet (Park Research and Intensive Monitoring of Ecosystems Network). Wet deposition of sulfur is high, while wet deposition of nitrogen is relatively low. Ozone is monitored at the Thurston Lava Tube, and levels are below those that would damage vegetation.

Volcanic smog ("vog") obscures views and can be dangerous to human health. The Hawaiian Volcano Observatory monitors levels of sulfur dioxide, a primary component of vog, and reports this information to park staff so they can take precautionary measures, if needed.

## NOISE POLLUTION AFFECTS WILDLIFE AND VISITORS

Noise—from both human activities and non-native animals—is a source of concern at Hawai'i Volcanoes National Park. Human-caused noise is considered a potential stressor on bird populations. The increasing frequency of air tours, due to the nearly constant volcanic activity of Kīlauea's southeast rift zone, could affect the park's bird populations and visitor experience. Soundscape research completed by Virginia Tech in 2007 showed that most park visitors prefer natural sounds and that frequent sounds of helicopters (more than one per hour) were annoying and not befitting a national park experience. The number of tour buses running within the park is also increasing, adding to noise levels and emissions. State Highway 11 runs through the park adding noise, as does park work such as mowing, construction, and other operational activities.

The introduction of the non-native coqui frog (*Eleutherodactylus coqui*) poses a threat on the horizon for the park. Most notably, this frog has a piercing call that can reach 90 decibels, which could affect visitor experience and drown out the natural sounds of native wildlife. While it currently is not an official resident, sightings have been made in the park, and populations do exist in nearby Volcano. Coqui frogs, native to Puerto Rico, have voracious appetites, putting native insects and spiders at risk, and compete with native birds for these food resources. Noise impacts on native wildlife have not been studied yet.

Non-native coqui frogs have piercing calls that could affect visitor experience and park wildlife.



USDA APHIS PHOTO

## WATER RESOURCES—PARK PROTECTS SPECIAL POOLS

Precipitation almost immediately drains into the soil or lava substrate, so Hawai'i Volcanoes National Park does not have much surface water, with one notable exception—anchialine pools in the coastal lowlands. These pools are common throughout the main Hawaiian Islands, but they do not occur in any other location in the United States. Found along the coast, these freshwater and brackish pools are exposed portions of the groundwater table. Although they are not traditional tide pools, the water levels fluctuate with the tides. They provide unique habitat and niches, and they host a variety of endemic species such as the anchialine pool shrimp (*Metabetaeus lohena*), which is a candidate for protection under the Endangered Species Act. These pools are also historically significant, as they provided rare sources of permanent water supply to the Polynesian communities that settled along the coastline. Though not used for drinking water because of high salt levels, the pools were used for bathing, food harvest, and other purposes.

Hawai'i Volcanoes National Park includes about 11 percent of all the anchialine pools in the state of Hawai'i, and the park is one of only three locations where these resources are legally protected. To ensure these pools and their resident species are adequately protected into the future, the park must educate visitors on proper behavior and use of the pools. Funds are needed to develop and produce interpretive media such as maps and brochures and to support additional staff to patrol and monitor backcountry areas.

Although the park does not have jurisdiction over marine waters, the Park Service recently entered into an agreement with the National Oceanic and Atmospheric Administration to work together to interpret ocean stewardship issues.



DAVE BOYLE

### **CULTURAL RESOURCES— NATIVE HAWAIIAN VOICES NEED MORE INTERPRETATION**

Hawai'i Volcanoes National Park scored an overall 65 out of 100 for cultural resource conditions, including archaeology, cultural landscapes, history, historic structures, museum collection and archives, and ethnography (peoples and cultures), indicating that the resources are in “fair” condition.

Cultural resources at Hawai'i Volcanoes include archaeological sites (e.g., petroglyphs and native shrines) and districts, museum collections (e.g., a historic painting collection, natural and cultural history collections, library,

and archives), buildings, other structures, cultural landscapes, and ethnographic resources (e.g., traditional cultural properties). Other resources include remnants of agricultural fields (planting mounds), salt-drying fields, lithic (stone) quarries, volcanic glass quarries, habitation sites, refuge caves, and human footprints preserved in volcanic ash. Historic resources include the first airfield built on Hawai'i Island, Civilian Conservation Corps erosion-control features, historic dumpsites, ancient trails, and historic roads. Initiated in 1994, the cultural resources program is relatively new to the park and requires additional funding and staff in order to better manage resources.

Petroglyphs carved into the lava depict people, boats, geometric shapes, and puka—Native Hawaiian record-keeping symbols.

### HUMAN HABITATION OF HAWAI'I ISLAND

Polynesians settled the island of Hawai'i between the 5th and 7th centuries; the exact date is still debated by archaeologists. The first colonizers to arrive in the Hawaiian Islands were no different from the family they left behind. They brought with them the same cultural template of beliefs and styles for building houses, fields, and temples. They also brought domesticated plants and animals. Having carried with them a cultural template from their Polynesian homeland, they established a religious and sociopolitical system that was soon to evolve into a uniquely Hawaiian culture.

Evidence indicates that people traveled back and forth between Hawai'i and other Polynesian islands for a period of time. By the time Europeans visited Hawai'i in the late 18th century, however, Hawaiian canoes had evolved to vessels that were suited only to coastal or in-shore fishing or travel and were not able to complete open-ocean navigation. As two-way traveling between Hawai'i and other Polynesian islands ceased, Hawai'i became isolated and Hawaiian society significantly changed and evolved into what is distinctively known as the Hawaiian culture.

To adapt to the environmental hazards of catastrophic weather and geologic conditions on Hawai'i, Polynesian colonizers employed their own traditional fishing and agricultural techniques where possible, and they adapted new techniques to fit the unique conditions of Hawai'i. The colonizers also supplemented the native resource base with plants and animals brought from their homeland. They used native resources as much as possible and shaped their surroundings into cultural landscapes.

Over time, a uniquely Hawaiian culture developed in the islands.

Adaptation to this new land led to a highly stratified social structure by the time Europeans discovered Hawai'i. This tri-part system consisted of the gods, the ali'i (chiefs), and the maka'āinana (commoners). The gods and religion were pervasive in every aspect of society; the ali'i managed society on behalf of the gods, while the maka'āinana labored to produce the goods needed to fuel the society. The maka'āinana grew staple crops such as taro, sweet potatoes, yams, and breadfruit. Low rock walls, mounds, and pits remain today as evidence of these agricultural activities.

The imposing presence of the volcanoes formed the basis of early Hawaiian religious beliefs. Gods and goddesses were seen as personifications of natural objects and forces of nature. One of the Hawaiian deities was Pele, the goddess of the volcanoes, who was believed to reside within Kīlauea. Her poetic name, *Ka wahine 'ai honua*, translates into "the woman who devours the land," a direct reference to volcanic eruptions and lava flows. Native Hawaiians, recognizing Pele's power and importance, treated the area around the volcanoes with great honor and respect.

This isolation of Native Hawaiians ended in 1778 with the arrival of British explorer Captain James Cook and his crew, who traveled along the Hawaiian coastline, trading with Native Hawaiians. The potential for larger trade and expansion, as well as the perceived exotic nature of Hawaiian lives and groups, captivated Cook. Other European and American groups quickly followed to take advantage of the promise of commerce. The islands became valuable to seafarers, due to their strategic location in the Pacific Ocean: Hawai'i offered a mid-ocean stop to re-supply ships with fresh food and water and to engage in trade for goods such as sandalwood. Most ships that visited the North Pacific in the closing years of the 18th century took advantage of the islands for rest and recuperation.

Missionaries, agriculturalists, and traders soon arrived on Hawai'i, and the establishment



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This historic postcard, which is part of the park's archives, depicts early visitors marveling at the volcanic activity.

of sugar and pineapple plantations marked an economic transition for the islands. Although agriculture had been a large component of pre-contact life, the transformation to a capitalist market economy was significant.

After two missionaries, William Ellis and Asa Thurston, reported on the activity of Kīlauea in 1823, interest in Hawai'i increased. Scientists were eager to study the active volcano, and in 1840 the United States government funded a research expedition at Kīlauea headed by Captain Charles Wilkes. In 1912, Thomas A. Jaggar, a well-known geologist with the Massachusetts Institute of Technology, recommended Kīlauea as a research center for volcanology and seismology. Kīlauea's almost continual activity, as well as its relative safety (in comparison to other active volcanoes), made the island ideal for observation. With the support of substantial donations, Jaggar established an observatory on the rim of the volcano. Many people visited Kīlauea in the late 19th and early 20th centuries, traveling over land via rough trails and roads or by ships that docked at Keauhou Landing and Punalu'u.

As the 20th century progressed, air travel

meant easier access to the island of Hawai'i and tourism in the region increased. With the influx of tourists and scientists, the island garnered federal attention for both its resources and its historical importance. In 1916, Congress officially incorporated Hawai'i National Park, which included Haleakalā on Maui. In 1961, Haleakalā became a separate national park. Today Hawai'i Volcanoes National Park spans 333,000 acres.

#### ETHNOGRAPHY (PEOPLES AND CULTURES)—NATIVE CULTURE INTEGRAL TO PROGRAMS

The ethnography program at Hawai'i Volcanoes National Park is one of the park's most visible cultural resource programs. It is notable for its strong commitment to integrating native voices and acknowledging the "living culture" aspect of traditional uses of park resources. This is seen in the new interpretive signs and interpretive programs throughout the park, including the park brochure, which uses traditional Hawaiian language to identify places of interest. Continued efforts to integrate significant cultural knowledge include identification of

Cultural demonstrations and festivals educate visitors about Native Hawaiian traditions.



traditional cultural properties within the park. This involves collaboration between park staff and traditionally associated peoples who share their knowledge of traditional cultural properties. Park staff are eager to continue this collaborative work and will be requesting funding to support it.

The park has solid relationships with kūpuna (Hawaiian elders) and other Native Hawaiian groups and individuals, and meets with them regularly. Kūpuna groups share concerns and inform park staff of the need to use park property for ceremonies or other observances. The park has also worked closely with the kūpuna to accommodate the collection of certain plants and plant materials for traditional uses. The plant-picking permit system has resulted in further understanding of native culture as the park maintains a database for the permits and documents what kinds of plants are collected and the locations where they are collected. Park staff also work with Native Hawaiian organizations and individuals such as

the kūpuna on compliance with Native American Graves Protection and Repatriation Act issues such as the treatment of Native Hawaiian funerary objects.

Working with the kūpuna through the park's compliance with federal legislation provides resource protection and integration of information for interpretation within Hawai'i Volcanoes National Park. The park interprets Native Hawaiian culture in a variety of ways, including exhibits in the visitor center. For example, in consultation with park staff, the kūpuna recommended that the park present a depiction of Pele with features that are more Polynesian than Caucasian. The park partnered with the Mountain Institute's Sacred Mountain Program—which works to develop interpretive materials and educate people about the cultural importance of mountains—to solicit artists to submit paintings of Pele. More than 140 paintings were submitted; one was selected by the kūpuna to hang in the Kīlauea Visitor Center. Similar interpretive partnerships continue.

Other cultural resource program areas benefit from the collaboration with the kūpuna and individuals who have strong ties to the Kīlauea area. The archaeology program benefits from Native Hawaiian discussions of temples, shrines, and traditional uses of plants and other resources, while the park's interpreters gain much information that can be incorporated into programs to educate the public about the park's history and resources. Continued collaboration among all facets of resources management and interpretation at the park will be critical to ensure the Native Hawaiian story is told alongside and in conjunction with the natural resource history of the park.

Other ethnographic work at Hawai'i Volcanoes National Park includes a 2003 study titled *Native Hawaiian Use of Hawai'i Volcanoes National Park: A Historical and Ethnographic Overview*, which discusses traditional use of the area, information that could be used to further inform interpretation and guide management decisions. The park also has copies of collected oral histories that are currently being translated. Once translated, the information they contain will be made more accessible to researchers and the public. Funds are needed to support the collection of additional oral histories from Native Hawaiian elders before the opportunity is lost. Because the park employs limited cultural resources staff, private contractors are now researching cultural values of Native Hawaiians associated with the Mauna Loa area. Other potential topics of ethnographic study include the Kahuku addition and Native Hawaiian heiau (shrines).

### HISTORY—RICH NATIVE HISTORY UNTAPPED

The distinctive environment of Hawai'i Volcanoes National Park—most vividly represented by its active volcanoes, but also by rainforests and its exceptional flora and fauna—is matched by the striking human history of the region. A program focusing on the relationship

between humans and their environment has been and continues to be a major focus of the cultural resource program. Hawai'i Volcanoes National Park has many important histories that need to be understood, such as contact, conflict, and integration of Hawaiians with foreigners; the scientific exploration and investigation of volcanoes, earthquakes, and adaptation to a changing landscape; the impact of feral animals on the island ecosystem; the significance of ranching in Hawai'i; 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. Currently, however, much of the park's attention is directed to volcanic resources and volcanic activity. While the volcanic story is key to Hawai'i Volcanoes National Park, understanding the broader human relationships to the park landscape is crucial. How different groups have responded to and altered the volcanic landscape is an important part of the park's larger story and is being developed.

The park has never had a comprehensive historic resource study; instead, it has had several special studies that focus on resources within the developed area of the park. A comprehensive historic resource study would provide baseline documentation for interpretation, inventory, evaluation, and management of historic resources. One historic resource study of the park's early years (from 1916 through 1945) has been completed, focusing on historic structures and the National Park Service's design and built environment. Other studies are proposed for the future, but funds are needed to support this work.

Resource managers believe other historical studies focusing on tourism, World War II activities at Hawai'i Volcanoes, ranching, commercial enterprises, scientific studies, Native Hawaiian perspectives, and the park's relationship with Native Hawaiians warrant considera-

Understanding how different groups of people have responded to and altered the volcanic landscape is an important part of the park's larger story.



tion because they would contribute to larger understandings of park resources and they would enrich resource interpretation. For example, the history of tourism would reflect the numerous shifts in outside perceptions of Hawai'i. Some of the most engaging historical interpretation includes live programs and media such as waysides, exhibits, DVDs, and podcasts that convey eyewitness accounts of volcanic eruptions occurring over the past 100 years. Continued support for this kind of historical interpretation is critical to help visitors comprehend the incredible power that volcanoes have to alter the landscape.

A full-time historian would allow the park to complete research to add to the existing natural history narratives. A staff historian would also be instrumental in current efforts to update the park's administrative history, which due to a lack of references and factual errors, is considered unreliable. While the park has requested separate funding to complete the administrative history, acquiring a full-time historian would greatly increase the likelihood of its completion.

### CULTURAL LANDSCAPES—INVENTORIES REQUIRE EXPERTISE

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. At this time, managers at Hawai'i Volcanoes have identified 11 "parent" cultural landscapes in the park that include trails, ranches, roads, historic districts, landing strips, and a military camp. All 11 of these parent landscapes are eligible for listing in the National Register of Historic Places, and the nomination process has begun. Several of these parent landscapes are broken down further into component landscapes.

Additional cultural landscapes that focus on Polynesian or Hawaiian land-use patterns may be identified through an intensive program of archaeological inventory and analysis. Such studies also routinely include extensive cultural history studies. The park's ability to continue inventory and analysis would be enhanced by permanent funding; currently this work proceeds on a project-by-project basis, only as funds are available.

Landscape surveys should be completed prior to and independent of management planning. Often, cultural landscape surveys at the park are "piggy-backed" onto other projects as

A cultural landscape inventory of the historic 'Āinahou Ranch indicates it is in good condition, though some structural repairs are needed. The Friends of Hawai'i Volcanoes National Park helps the park maintain the grounds at the ranch house.



JAY ROBINSON



part of compliance with Section 106 of the National Historic Preservation Act. While this enables cultural resource staff to complete surveys, it does not allow them to selectively choose which landscapes will be surveyed. Instead, they survey landscapes that are being examined for other factors—making them response based rather than actively chosen.

Three of the park's identified parent cultural landscapes—Crater Rim Historic District, Kīlauea Historic District, and 'Āinahou Ranch and Gardens—have been documented through cultural landscape inventories, but the remaining landscapes need similar study. The cultural landscape inventory for Crater Rim Historic District, the loop auto tour area that provides visitor access to the Kīlauea volcano, notes that the landscape is in good condition, with no immediate action required to maintain it at this level. The cultural landscape inventory for the Kīlauea Historic District—the administration and employee housing district—gives this landscape a “good” rating as well. Because the Park Service, the park concessionaire, and visitors use the entire district, it is intensely used and receives ongoing maintenance.

Herbert C. Shipman owned 'Āinahou Ranch before the park acquired it. In 1941, Shipman established a captive flock of nēnē at the ranch. He donated several of these birds to Territorial Government and British captive breeding programs in 1950. Though it is unclear if these birds contributed to the current breeding stock within Hawai'i Volcanoes National Park, they were important in overall efforts to conserve the species. The cultural landscape inventory for 'Āinahou Ranch states that it is in fair condition, with structural repairs needed. The park has completed several preservation projects to repair gutters and windows at the ranch house. The gardens were identified as being in good condition, although a current site map with accurate horticultural information is needed. The park's partner organization, the Friends of Hawai'i Volcanoes National Park, works with

park staff to organize most of the grounds maintenance at the ranch house.

In addition to the friends group, other partnerships exist that benefit the cultural landscapes program. For example, park staff work with students from the American Studies Department at the University of Hawai'i—Mānoa to inventory and develop preservation plans for the park's cultural resources, landscapes, and potential landscapes.

The cultural landscapes program at Hawai'i Volcanoes is limited by the lack of full-time staff with the professional qualifications needed to successfully complete cultural landscape inventories that meet regional and national guidelines. The success of the collaboration between the park's cultural resource program and the University of Hawai'i may provide a way to develop interns that can be involved with the existing regional cultural landscape program.

#### HISTORIC STRUCTURES—SOME AT RISK FROM EARTHQUAKES

The historic structures at Hawai'i Volcanoes National Park reflect the diversity of the region's history. The various heiau (shrines) represent Native Hawaiians, while the Volcano House is tied to themes of early tourism and scientific research. Most of the structures on the park's List of Classified Structures are associated with early park development and the Civilian Conservation Corps (CCC) in the 1930s. A variety of architectural styles are represented by the park's structures, including elements of the 19th-century “Arts and Crafts” movement, early 20th-century “Park Service Rustic” styles, and aspects of Native Hawaiian architecture. In addition, the combination of different ethnic groups on the island (Native Hawaiians, Japanese, Chinese, Filipino, and others) resulted in diverse architectural styles. In sum, the park has 215 structures; of these, 153 are in good condition, 51 are in fair condition, ten are in poor condition, and one is in unknown condition.



This structure housed Civilian Conservation Corps workers during the 1930s.

DAVE BOYLE

The Volcano Art Center, a nonprofit educational organization, operates a gallery in the historic 1877 Volcano House.



DAVE BOYLE

There are currently eight registered properties of state and national significance included in the National Register of Historic Places, while another seven nominations are in various stages of completion. The eight buildings and sites currently listed in the National Register are the Puna-Ka'ū Historic District, the 1790 Footprints Area, the Kīlauea Crater, the Whitney Vault, the 'Āinapō Trail, the 'Āinahou Ranch House, the Old Volcano House, and the Wilkes Campsite. The park's cultural resource program periodically receives funds to complete nominations and research on specific properties. Additional funds for research would benefit the park greatly; it would also help to hire an architectural historian to complete surveys on candidate structures, sites, and districts. This work would help inform current work on a new general management plan for the park.

High-profile historic structures in the park receive the most interpretation, while lower profile sites are not incorporated into interpretation of the park as a whole and may not receive funding for the maintenance projects

needed. The Old Volcano House, however, is one of the park's premier historic structures. Built in 1866 to accommodate the influx of visitors to the region, it featured four bedrooms, a parlor, and a dining room. Following a partial restoration in 1976, the building now houses the Volcano Art Center Gallery.

The Jaggard Museum, while not listed in the National Register of Historic Places, is one of the park's most highly visited historic structures. It is the park's first museum, which was established in 1927 through a partnership between Jaggard and the surrounding community. The Jaggard Museum will be the focus of a complete rehabilitation by 2016—the electrical, fire suppression, heating, ventilating, and air conditioning (HVAC), and security systems need updating, as do the interpretive displays, which focus on the volcanic activity of the region.

Many of the historic buildings that provide public access are in need of seismic retrofitting to meet health and safety codes. These seismic upgrades are time-consuming and expensive, requiring considerable building documentation

as part of the required compliance with historic preservation legislation.

Work on the historic structures—whether for seismic retrofits, adding handicap accessibility, or historic preservation—requires the supervision of a full-time historical architect or an architectural historian. Hiring either a historical architect or an architectural historian who is familiar with the varied building styles at Hawai'i Volcanoes would benefit future rehabilitation, preservation, and interpretation of the park's historic structures.

#### ARCHAEOLOGY—SHRINES, CAVES, ROCK ART, AND FOOTPRINTS BECKON

Hawai'i Volcanoes National Park is rich with archaeological sites. Although just 3 to 5 percent of the park's acreage has been surveyed, 314 archaeological sites and more than 2,000 sub-sites or features have been identified, evaluated, and recorded in the Archeological Sites Management Information System—a system-wide database of archaeological information. The recent addition of the Kahuku region will contribute even more sites to the park.

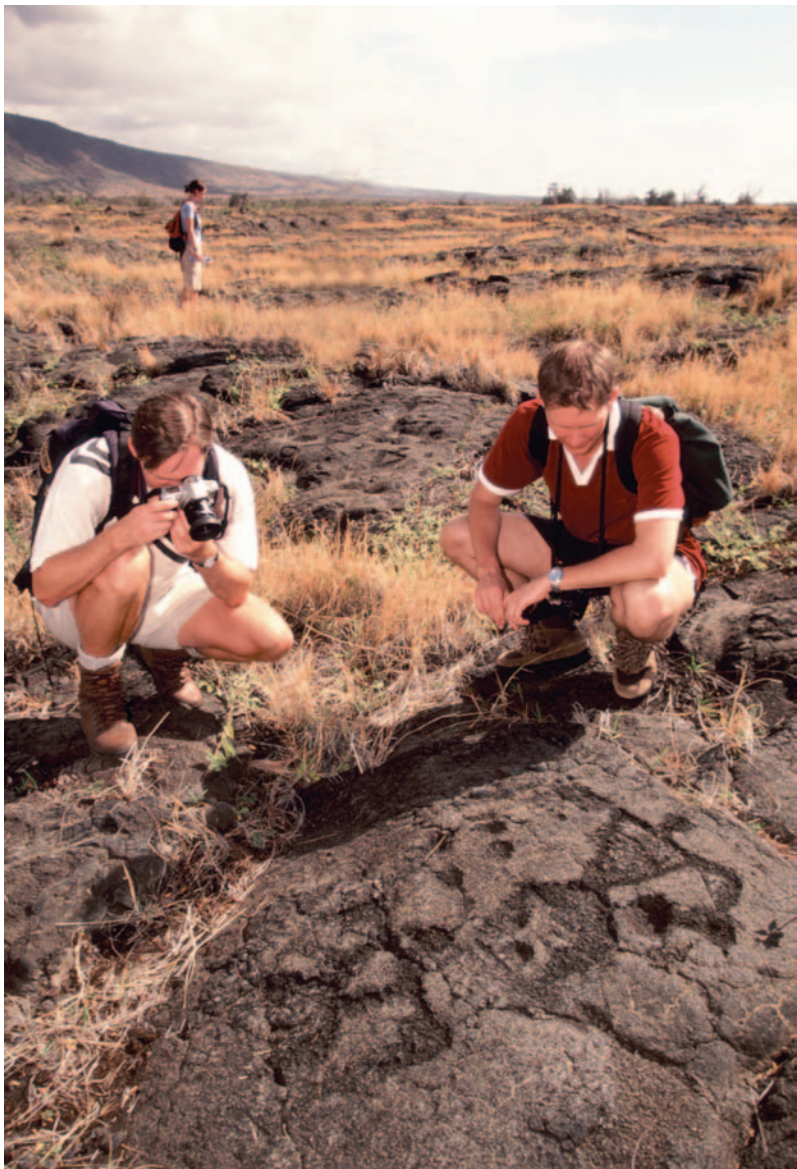
An archaeological overview and assessment, due later this year, is in progress. This project will identify and assess known and potential archaeological resources within the park and identify further work that is needed. Currently, funding shortages limit additional archaeological work and prevent systematic archaeological surveys. Instead, survey work often occurs after sites and artifacts are discovered as a result of natural resources management activities. For example, while conducting fieldwork, natural resource staff often encounter archaeological sites like caves or rock cairns. They notify cultural resource managers of their discoveries, and when time and budget permit, a survey is undertaken. Consequently, the process is response based, which makes it difficult for cultural resource staff to prioritize sites based on factors like vulnerability and importance. Ultimately, a comprehensive, park-wide archae-

ological management plan would allow park personnel to better identify, preserve, and protect valuable sites.

Due to volcanic activity in the park, prospective archaeological sites are at risk for destruction by lava flow or volcanic ash, so research and documentation of these sites must be conducted as soon as possible in the event they are lost. Since only a small fraction of the park has been surveyed for archaeological significance, artifacts such as tools or baskets may be lost before staff are aware of their existence.

One of the most important archaeological sites in the park is the Pu'uloa Petroglyph Field, part of the Puna-Ka'ū Historic District listed in the National Register of Historic Places. This site contains more than 23,000 petroglyphs that

More than 23,000 petroglyphs cover the landscape at the Pu'uloa Petroglyph Field. The park is developing exhibits to help visitors better understand the petroglyphs and the park's cultural connections.



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More interpretation is needed to teach visitors the significance of the fossilized human footprints impressed in layers of ash at the 1790 Footprints Area.

depict people, canoes, geometric shapes, and *puka*—Native Hawaiian record-keeping symbols. While petroglyphs are found throughout the Hawaiian Islands, the majority of them are found at Pu'u'loa. Many visitors view the petroglyphs there, but there is little Park Service interpretation of the larger meanings of the carvings. Providing deeper interpretation would enrich visitors' experiences of the resource, help them better understand the park's cultural connections, and could help them more fully realize the importance of protecting the park's diverse resources. Exhibits are currently being developed.

In the National Register of Historic Places, the "1790 Footprints Area," located within the Ka'ū Desert part of the park, is one of its most intriguing sites. It is a field of fossilized human

footprints, impressed in layers of hardened desert ash that were deposited by explosive eruptions over the course of several centuries. These layers of ash provide evidence of the violent nature of Kīlauea, a volcano normally considered benign and gentle. It is a testament to the endurance of the Hawaiian people that, despite lava flows and earthquakes, they were not driven from the region. Little interpretation exists in the main visitor center regarding the 1790 Footprints Area; waysides or other interpretive materials are needed to communicate to visitors the site's significance.

Historical accounts indicate that native shrines—*heiau*—are located throughout the park, but a lack of funding has prevented the park from thoroughly studying or even locating what is believed to be a large majority of them. Archaeological surveys have evaluated some of these, however, detailing most specifically the Waha'ula Heiau. Waha'ula Heiau was built in the 13th century and is significant for its connection to Pa'ao, a "mysterious figure" who appeared on the island, ushering in the second massive migration wave. The beginning of *heiau luakini*—human sacrifice—and ceremonial worship of Hawaiian gods is traced to this temple. In 1989, lava began to inundate Waha'ula Heiau, which was once the park's primary interpretive site for archaeological resources; by 1997, the site was totally covered. The park is trying to fill the gap in interpretation this loss has caused. Additional interpretive information relating to the shrines, and all the park's cultural resources for that matter, could provide a means of educating visitors.

Caves also exist throughout the park, especially in the backcountry, and they pose a challenge to managers. Native Hawaiians used caves for habitation, water collection, burial, and refuge. The park needs to survey all caves, which should include an inventory of artifacts within them, assessments of their condition and historical significance, and a plan to monitor them. Staff are taking steps in this direction. Each year

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The park's museum collection and archives include more than 390,000 items, such as this 10-inch stone weapon, used to shatter war canoes in battles at sea.

since 2003, staff have monitored 23 caves located near roads and trails where visitors are likely to encounter them. During 2006, staff mapped and inventoried 50 caves. As of 2008, no more funding is available to continue monitoring caves or to complete further inventories of caves. Staff hope that additional funding will be received in 2012.

Limited funding has forced staff to concentrate their interpretation and evaluation of archaeological sites to high-profile areas in the park such as Crater Rim Drive and the Kīlauea Caldera region. Even so, interpretation of these areas could be improved with additional funding and higher prioritization of such projects.

#### MUSEUM COLLECTION AND ARCHIVES— CATALOGING BACKLOG AND LIMITED ACCESS PREVENT FULL USE OF ITEMS

The park's museum collection and archive include historic paintings of the volcanoes, rolls of *kapa* (a traditional cloth made from pounded bark), park management documents, plant specimens, and artifacts such as stone tools and fishhooks. In sum, the collection and archive include nearly 390,000 items, though fewer than half have been cataloged. The museum objects represent the history of the island, native culture, scientific research in the region, and the history of the park, but limited accessibility and a large backlog of uncataloged items prevent park staff and researchers from fully using the collection. Staff have worked to create finding aids for specific collections; establishing a comprehensive finding aid for the whole collection and entering this information into a database would enhance research opportunities.

The park's new system for storing historic paintings provides better protection for the collection.

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Most of the museum collection is housed in the basement of the visitor center, where it is relatively safe from earthquakes but vulnerable to floods. Additional storage space is needed to fully protect fragile items such as the *kapa*. The park recently added new storage for the historic paintings collection, which is comprised of work by both Native Hawaiians and other artists. In the past, paintings were either stacked on top of one other or placed in storage facilities that were difficult to access. The new system employs rolling shelves where the paintings are hung individually and suspended away from one another to prevent touching. In addition to being stored more safely, the paintings are easily accessible to staff and researchers. A historic study of these paintings—their acquisitions, history, subject matter, and historical context—is the subject of the current curator's Master of

Arts degree. Her work on the subject will soon be posted to the park's website and will provide a valuable resource to future curators and researchers.

Future plans for the museum program include the use of an existing historic building as the replacement for the cultural museum at Waha'ula, which was buried under lava in the late 1980s. The 'Ōhi'a wing, which was built in the 1930s to house the administrative offices of the park and is currently being used as part of the Volcano House Hotel, will provide additional exhibit space for the museum collection and make it more accessible to visitors and staff. The 'Ōhi'a wing will include a major rotating exhibit, which will allow different artifacts and collection objects to be displayed and interpreted according to various themes. Planning for this project is scheduled to begin in 2011.

The park's large archival collection is not being used to its full potential, largely because the park does not have an archivist on staff to create finding aids and inventory resources. Early park documents such as maps and surveys are often unused because access to them is limited. These kinds of historic documents would provide valuable information for staff involved in cultural landscape and historic structure preservation. Additionally, park staff believe that there are many documents in the park that are potentially valuable as archival resources, but little is known about the location of these documents, what information they might contain, their ties to historical or interpretive themes, or their current relevance. A park-wide inventory of these potential resources and a comprehensive finding aid are needed.



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## STEWARDSHIP CAPACITY

### FUNDING AND STAFFING—PROJECTS AWAIT FUNDS; STAFF NEEDED TO CARE FOR RESOURCES

In fiscal year 2007, Hawai'i Volcanoes National Park had an operational budget of \$13.6 million, which was insufficient to fund all projects. As a result of funding and staffing shortfalls, many science and resource management projects could not be conducted. Projects that are still awaiting funds include setting up operations in Kahuku; boosting core interpretive content to support rangers and visitors; monitoring and restoring threatened and endangered

species; monitoring and combating invasive species; and furthering cultural resource management programs in historic preservation, museum collections, and archaeological site interpretation. In addition to resource management projects, funds are needed to upgrade the park's telephone system, radios, computer hardware and software, facilities, and other infrastructure.

Existing staff positions remain vacant at the park because there are no funds to hire people to fill them. For example, the park has lost a wildlife biologist and a pest controller within the last two years but has not yet filled the positions. New staff are also needed to boost

Since 1980 the park has hosted a cultural festival that allows visitors to learn more about Native Hawaiian traditions by listening to Hawaiian music, watching demonstrations of activities such as fishing and canoe building, eating foods such as taro and breadfruit, and learning traditional crafts such as making a lei or Hawaiian bark cloth.

natural resources and cultural resources management programs as well as visitor services and law enforcement. A park-wide shortfall of about 63 full-time equivalent employees was cited in the park's 2004 business plan—about 24 of these fell within the park's resource management division. More staff are needed to manage cultural resources, set up operations in Kahuku, analyze and integrate resource information, restore ecosystems, combat invasive species, manage fires, provide interpretive services, staff the Kilauea Visitor Center and Jaggar Museum, maintain trails, and provide law enforcement support, among a host of other resource management and park operations duties. To exemplify the current shortfalls, law enforcement at the park is at a minimum, with only six officers on staff. At this level, rangers only patrol the Kahuku portion of the park about once every two weeks. In the absence of sufficient staffing,

current staff have taken on more responsibilities in order to get projects done without reducing services to the public.

#### PLANNING—OUTDATED PLANS NEED REVISION

Several key management plans for Hawaii Volcanoes National Park are seriously outdated and need revisions. For example, the park's general management plan was produced in 1975 and does not include issues associated with wilderness areas, which were designated in 1978, or the recent acquisition of Kahuku, which expanded the park by 116,000 acres. It also pre-dates the current volcanic activity along the east rift of Kilauea. The park is currently working on a new general management plan that will include these important topics. The park's resource management plan, originally written in 1974, was last revised in 1999 and needs to be

The park's fire management plan is updated annually. In some areas, fire is used as a tool to restore native ecosystems.



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updated to address new invasive species and the acquisition of Kahuku.

Other park planning documents are more current and relevant to management actions. A 2006 interim operating plan for Kahuku identifies resources that require protection, inventory goals, and general management actions. A backcountry management plan was drafted in 1995 and details goals for visitor access and needed staff. A cave management plan, updated in 1999, discusses the need for an inventory of all caves in the park and a standardized system of monitoring. Due to budget and staff limitations, however, management and inventory of park caves is not a priority. The park's fire management plan, created in 2005, is updated annually. The park's land protection plan identifies

lands for future acquisition, and requests for funding are submitted annually. Internal scoping for an updated non-native ungulate management plan began in March 2007. And finally, the park is working with the Federal Aviation Administration on an air tour management plan.

Several cultural resources plans are needed, including cultural landscape reports for landscapes that have already been inventoried. Preservation plans for historic structures are also a top priority.

The park's interpretive program is charged with conveying the significance of the park's natural and cultural resources to visitors. The comprehensive interpretive plan, currently in draft form, helps guide those efforts. Once the new general management plan is complete,

Ensuring visitors have safe and enjoyable experiences at the park is an important role for staff at the visitor center. Providing enriching interpretive experiences that teach visitors the significance of park resources and the importance of protecting them is also critical.

The park provides educational programs to thousands of school children each year, but limited numbers of interpretive staff have forced the park to deny these opportunities to some groups.



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the park will create a long-range interpretive plan. Work is needed to ensure interpretive programs are accessible to all visitors and to determine how best to interpret Native Hawaiian heritage and connect visitors with park resources, with a goal of instilling a sense of stewardship responsibility within visitors. Funds are needed to support these planning and interpretation efforts.

#### *RESOURCE EDUCATION— INTERPRETATION IS CRITICAL TO CONVEYING PARK MESSAGES*

For many children and young adults, a formal educational program is the highlight of their visit to Hawai'i Volcanoes National Park. In 2006, 5,269 students and teachers participated in educational programs in the park. Unfortunately, more than 1,200 students were denied this opportunity because the park lacked the staff needed to accommodate them. In addition, the number of educational programs provided by the park has decreased by 45 percent in the last decade, and it is only

with the help of volunteers that current levels are maintained.

The park has only one visitor center—the Kīlauea Visitor Center—located on Crater Rim Drive. While the visitor center contains new interpretive exhibits, installed in 2005, it is not large enough and does not employ enough staff to handle the number of people it services. After internal review by the Park Service, the 1,700 square feet of space in the building were considered sufficiently large for a lobby, but not for an entire visitor center.

Many interpretive exhibits in the park need to be updated or replaced. All of the park's wayside exhibits date back to the early 1970s, and the majority of these have been badly damaged by volcanic acid, rendering them illegible. Geologic displays in the Jaggar Museum are more than 20 years old and do not interpret the remarkable changes and human drama that have occurred since the 1983 eruption cycle of Kīlauea began. This eruption cycle is still occurring today. No interpretive rangers currently service the Jaggar

Museum or the active lava flow site; an increase of 5.5 full-time equivalent employees is needed to service the 1.6 million recreational visitors that use the visitor center and museum each year. An additional 3.3 full-time equivalent employees are needed at the active lava flow site.

More than 100 commercial tour guides provide trips to Hawai'i Volcanoes National Park. The park would like to be able to certify, train, coach, and mentor these tour operators to help ensure the most rewarding visitor experience for their clients. At current staffing levels, however, the park does not have enough interpretive staff to provide training to ensure that the interpretation provided by tour guides meets professional standards, aligns with the park's mission and themes, reflects current science, and is sensitive and supportive of Hawaiian heritage.

#### EXTERNAL SUPPORT—VOLUNTEERS AND RESEARCHERS PROVIDE ESSENTIAL CONTRIBUTIONS

Hawai'i Volcanoes National Park benefits from a large and dedicated volunteer workforce. In fiscal year 2006, 471 volunteers and interns contributed 35,195 hours to resource management projects—the equivalent of 17 full-time employees. Almost two-thirds of the volunteer hours contributed towards operation of the hawksbill turtle recovery program, while the remainder contributed largely towards native plant restoration and endangered nēnē recovery efforts. Additional volunteer hours that amount to the equivalent of ten full-time employees contributed towards visitor center operations, reforestation, backcountry patrols, and interpretation. Under the Centennial Initiative, the park is hiring a volunteer coordinator to direct this vital workforce.

Strong partnerships with other agencies and organizations also benefit the park. In 2005, the park entered into a partnership with the adjacent community of Ocean View to combat the

spread of invasive fountain grass, a highly aggressive, fire-promoting ornamental species. The park also participates in the Three Mountain Alliance (formerly the 'Ōla'a-Kīlauea partnership) with Kūlanī Correctional Facility, Pu'u Maka'ala Natural Area Reserve, Kamehameha Schools, U.S. Fish and Wildlife Service, U.S. Geological Survey, U.S. Forest Service, and The Nature Conservancy. The largest cooperative land management effort in the state and considered one of the most successful multi-agency partnerships in the country, this project protects 500,000 acres of forest habitat. The goal is to manage long-term sustainability of fragile Hawaiian ecosystems. As of 2006, members of the alliance had collaborated on developing goals for management of the top three threats to the region—feral ungulates, invasive plants, and fire. Accomplishments include using inmate work crews to install fencing to keep out non-native ungulates; removal of feral pigs from portions of Kūlanī; assistance with highway paving; and completed bird surveys for the Kīlauea, Keauhou, and Kūlanī areas.

The park also supports the Three Mountain Alliance by providing technical assistance on cultural resources management, oversight of staff working on partnership projects, and by reviewing all archaeological inventory surveys and overviews for projects on partnership lands. This model of cooperative land management needs to be extended to involve the education and interpretation of the greater ecosystem. Continuous habitats are essential to ensure the perpetuation of the living culture, its heritage, and its legacy.

The park is also a member of the Big Island Invasive Species Committee (BIISC). Established in 2000, BIISC is a voluntary partnership among private citizens, community organizations, businesses, landowners, universities, and state and federal government agencies focused on addressing invasive species issues on the island of Hawai'i. In 2006, the park coordi-

A park staff member shows a group of children a hawksbill turtle hatchling. Educating visitors—especially children—about the significance of natural and cultural resources helps instill a sense of stewardship responsibility.



nated with other BIISC members to conduct invasive species surveys and control work on lands adjacent to the park.

Scientific research has a long history within the park. The U.S. Geological Survey operates the Hawaiian Volcano Observatory on the summit of Kilauea, recording seismic activity and providing daily summaries on their website. The park also benefits from strong research partnerships with the University of Hawai'i—Mānoa, the U.S. Geological Survey Pacific Island Ecosystems Research Center, and Stanford University. The research relationship with the University of Hawai'i—Mānoa currently operates under a cooperative agreement as part of the Hawai'i—Pacific Islands

Cooperative Ecosystem Studies Unit (CESU). Recent collaborations with CESU and Pacific Island Ecosystems Research Center scientists include work on the population dynamics of invasive mouflon sheep, avian disease vectors, and rare plant limiting factors. Ecosystem processes are the focus of the Stanford studies, which use Hawai'i as a model system for nutrient cycling and the impacts of non-native plants on ecosystem processes. The park also has research and education partnerships with the National Oceanic and Atmospheric Administration, U.S. Fish and Wildlife Service, U.S. Forest Service, and other federal agencies.

The Friends of Hawai'i Volcanoes National Park, the park's nonprofit partner organization,

offers an annual series of small, high-quality educational seminars that complement the park's educational mission. Among the grant projects administered by the group are the National Park Service's "Parks as Classrooms" program; Hawai'i Tourism Authority grants for annual cultural festivals; and Hawai'i Council for the Humanities funds for the publication of oral histories of 'Āinahou Ranch. In 2005, the friends group raised the requisite matching funds for a \$15,000 grant from the National Park Foundation to revise and produce updated educational materials for the park's Junior Rangers Program. The group raised another \$3,000 to purchase tents for public events at Kahuku. The park also works with the friends group on bi-monthly service projects to remove non-native weeds and plant native species in areas on the Mauna Loa Strip, in the Kīlauea summit area, and in Kahuku. The friends group is also currently working on developing an educational institute for Hawai'i Volcanoes National Park.

Other groups and organizations work with the park, including the Hawai'i Natural History Association and the Volcano Art Center. For 75 years, the Hawai'i Natural History Association has operated bookstores in the park, selling educational and interpretive materials to visitors in the Kīlauea Visitor Center and Jaggar Museum. The association contributes funds to support interpretation, education, and resource management and protection projects. For example, the association has provided funds to support work to protect hawksbill turtles, Hawaiian geese, and Hawaiian petrels. The Volcano Art Center provides visitors authentic cultural experiences by sponsoring and supporting *hula kahiko* presentations by local *halau* (schools, academies, or groups). They also provide Elderhostel programs that link together all eight of the national parks in Hawai'i.

## WHAT YOU CAN DO TO HELP:

- **Participate in park planning efforts:** The public is invited to provide input on all park plans and studies. Public scoping for a non-native ungulate management plan began in April 2008. Visit [www.nps.gov/havo](http://www.nps.gov/havo) for information.
- **Support or become a member of groups helping to protect the park:** The Friends of Hawai'i Volcanoes National Park ([www.fhvn.org](http://www.fhvn.org)), the Hawai'i Natural History Association ([www.hawaiinaturalhistory.org](http://www.hawaiinaturalhistory.org)), the Trust for Public Land ([www.tpl.org](http://www.tpl.org)), NPCA ([www.npca.org/support\\_npca/](http://www.npca.org/support_npca/)), and other regional organizations.
- **Volunteer in the parks.** Many parks are looking for dedicated people who can lend a helping hand. To learn about opportunities for volunteering at Hawai'i Volcanoes National Park, contact the park at 808.985.6000.
- **Become an NPCA activist and learn about legislative initiatives and protection projects affecting parks.** When you join our activist network, you will receive *Park Lines*, a monthly electronic newsletter with the latest park news and ways you can help. Join by visiting [www.npca.org/takeaction](http://www.npca.org/takeaction).





## APPENDIX: METHODOLOGY

To determine the condition of known natural and cultural resources at Hawai'i Volcanoes National Park and other national parks, the National Parks Conservation Association developed a resource assessment and ratings process. The assessment methodology can be found online at NPCA's Center for State of the Parks® website ([www.npca.org/stateoftheparks/](http://www.npca.org/stateoftheparks/)).

Researchers gather available information from a variety of research, monitoring, and background sources in a number of critical categories. The natural resources rating reflects assessment of more than 120 discrete elements associated with environmental quality, biotic health, and ecosystem integrity. Environmental quality and biotic health measures address air, water, soils, and climatic change conditions as well as their influences and human-related influences on plants and animals. Ecosystems measures address the extent, species composition, and interrelationships of organisms with each other and the physical environment.

The scores for cultural resources are determined based on the results of indicator questions that reflect the National Park Service's own *Cultural Resource Management Guideline* and other Park Service resource management policies.

Stewardship capacity refers to the Park Service's ability to protect park resources, and includes discussion of funding and staffing levels, park planning documents, resource education, and external support.

For this report, researchers collected data



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Parts of the park are covered by dense rainforest.

and prepared a paper that summarized the results. The draft underwent peer review and was also reviewed by staff at Hawai'i Volcanoes National Park.

NPCA's Center for State of the Parks® program represents the first time that such assessments have been undertaken for units of the National Park System. Comments on the program's methods are welcome.

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For more information about the **Center for State of the Parks®** and this and other program reports, contact:

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Lewis and Clark National Historic Trail (various)  
Little Bighorn Battlefield National Monument (MT)  
Longfellow National Historic Site (MA)  
Missouri National Recreational River (NE)  
Mojave National Preserve (CA)  
Nez Perce National Historical Park (WA, ID, MT, OR)  
Olympic National Park (WA)  
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Point Reyes National Seashore (CA)  
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San Juan Island National Historical Park (WA)  
Santa Monica Mountains National Recreation Area (CA)  
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San Antonio Missions National Historical Park (TX)  
Sleeping Bear Dunes National Lakeshore (MI)  
Virgin Islands National Park  
Virgin Islands Coral Reef National Monument  
Waterton-Glacier International Peace Park (MT-Alberta)  
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