



Inventory & Monitoring Program

Pacific Island Network Monitoring Plan

Supporting Documents: Ala Kahakai National Historic Trail Resource Overview

Prepared by Page Else
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Pacific Island Network (PACN)

Territory of Guam

War in the Pacific National Historical Park (WAPA)

Commonwealth of the Northern Mariana Islands

American Memorial Park, Saipan (AMME)

Territory of American Samoa

National Park of American Samoa (NPSA)

State of Hawaii

USS Arizona Memorial, Oahu (USAR)

Kalaupapa National Historical Park, Molokai (KALA)

Haleakala National Park, Maui (HALE)

Ala Kahakai National Historic Trail, Hawaii (ALKA)

Puukohola Heiau National Historic Site, Hawaii (PUHE)

Kaloko-Honokohau National Historical Park, Hawaii (KAHO)

Puuhonua o Honaunau National Historical Park, Hawaii (PUHO)

Hawaii Volcanoes National Park, Hawaii (HAVO)

<http://science.nature.nps.gov/im/units/pacn/monitoring/plan/>

EXECUTIVE SUMMARY & INTRODUCTION

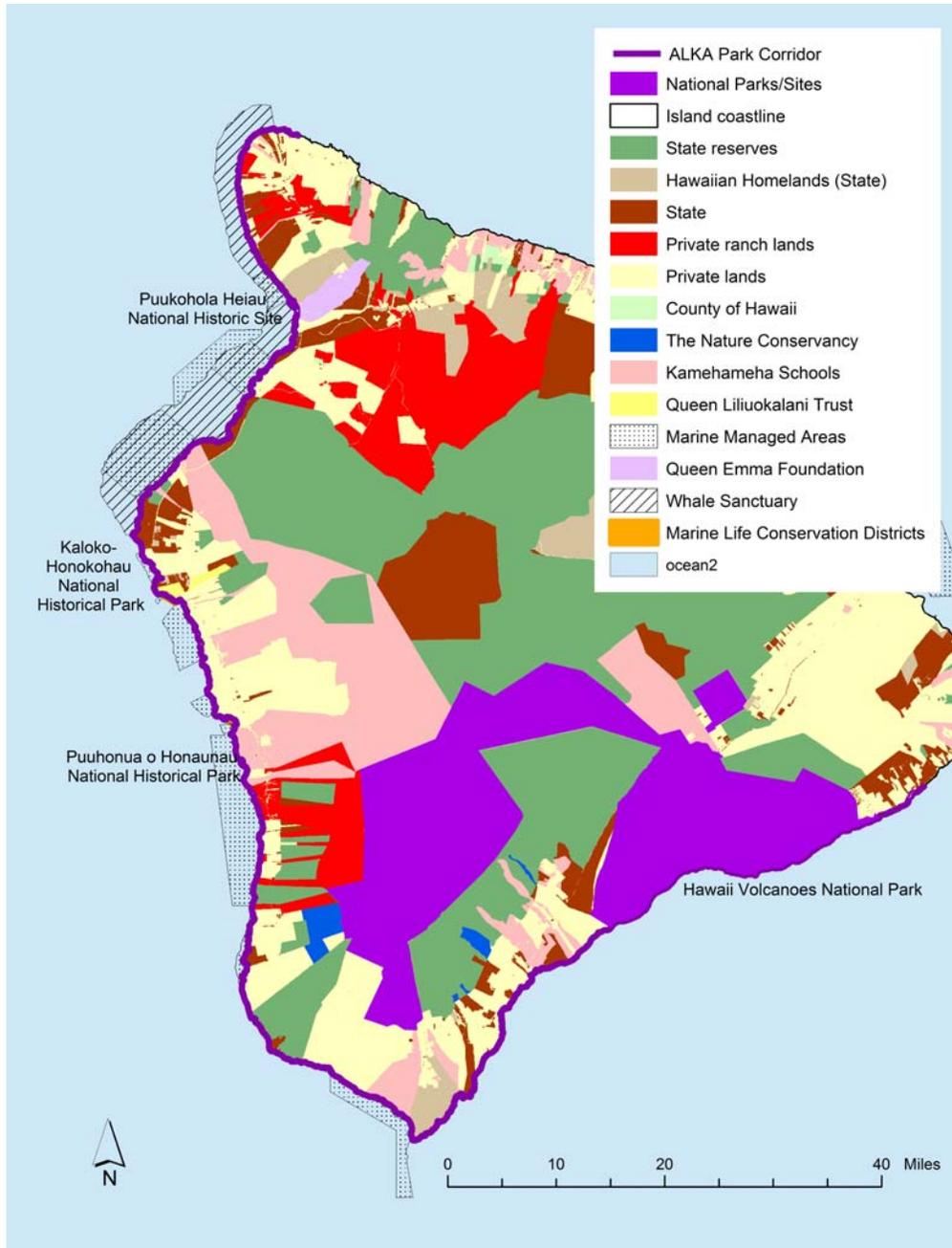
Enabling Legislation

Ala Kahakai National Historic Trail was designated in 2000 (Public law 106-509). As a trail system, the Park Service must rely heavily on cooperative agreements with the land owners outside of the federal government, and the enabling legislation recognizes that dynamic. The legislation states that “No land or interest in land outside the exterior boundaries of any federally administered area may be acquired by the United States for the trail except with the consent of the owner of the land. Trail management shall: (i) encourage communities and owners of land along the trail, native Hawaiians, and volunteer trail groups to participate in the planning, development, and maintenance of the trail; and (ii) consult with affected Federal, State, and local agencies, native Hawaiian groups, and landowners in the administration of the trail.

To find enabling legislation documents on-line follow the “Policy & Legislation” link from the Pacific Island Network website (www1.nature.nps.gov/im/units/pacn).

Geographic Setting

The Hawaiian phrase “Ala Kahakai” means "trail by the sea", a 175 mile long trail extending from 'Upolu Point on the north tip of Hawaii Island, down the west coast of the Island around the southern point to the east boundary of Hawaii Volcanoes National Park, ending at the ancient shoreline temple known as 'Waha'ula' (see map below). West Hawaii is the leeward or dry side of the Big Island, which is the youngest and most volcanically active island in the chain. In keeping with the Hawaiian traditional land management system of ahupua`a (from mountain to sea), the trail systems position along the coast clearly links its character and quality to land uses in the surrounding watersheds. Seventeen percent (17%) of the trail traverses all four NPS units on Hawaii Island, Hawaii Volcano National Park (HAVO), Pu'uhonua O Honaunau National Historic Site (PUHO), Kaloko-Honokohau National Historic Site (KAHO), up to Pu'ukohalā Heiau National Historic Site (PUHE) on the northwest. The remaining 83% of the trail is not owned by NPS and traverses other federal, state, county and private land holdings. Areas near the trail vary from developed resort and shoreline subdivisions to larger tracts of currently undeveloped or agricultural and grazing lands.



Significant Natural and Cultural Resources

Coastal strands, wetlands, anchialine pools, and fishponds provide habitat for endangered waterfowl, rare shrimp, native insects, plants and many organisms that are harvested for food. Threatened and endangered species and ecosystems occur in numerous locations along the corridor. Nearshore areas adjacent to the trail are pristine habitat for coral reefs and associated marine life.

This newest trail system in the Pacific islands cluster preserves and interprets ancient and historic trails called, ala loa (long distance trails), ala lawai'a (trails used for fishing and gathering) and, in historic times, ala aupuni (government roads also known as "King's Highway"). The trail is associated with Hawai'i island 's many prehistoric and historic habitation sites, nearly all the royal centers, and most of the major temples of the island; with battlefields and the movement of armies, and with annual taxation.

Resource Management Priorities

A combined Comprehensive Management Plan and EIS (CMP/EIS) is currently being developed for the trail. Given the potential impact of trail use on natural and cultural resources located within and adjacent to the trail's coastal corridor, current public scoping data results indicate a need to incorporate culturally appropriate shoreline management prescriptions for public use and resource protection. The trail system has included the identification of significant natural resources as a requirement in certification criteria for trail segments.

NATURAL RESOURCES

Focal Ecosystems and Processes

- Coastal Strand Communities, including intertidal areas and beaches
- Freshwater and Brackish systems: Streams, wetlands, fish ponds, and anchialine pools
- Groundwater dynamics and quality
- Traditional coastal harvesting and ethnobotanical resources
- Cave resources

This extensive coastal trail system encompasses several ecosystems supporting sensitive organisms which are a high priority for protection by the National Park Service. Beaches and inter-tidal areas provide foraging and resting areas for migratory shorebirds and recreational opportunities for humans. Adjacent to the shoreline, strips of coral sand support a unique ecosystem containing species adapted to salt spray, storm events, and a shifting substrate with limited water and nutrients. These coastal strand communities have aesthetic value and help prevent erosion of beach areas. Black and green sand beaches are also seen as unique and valuable aspects of this park. Birds, native bees, and damselflies utilize shoreline habitat and rely on many other protected or rare plants and animals associated with anchialine pools and wetland resources. Stream flow to the ocean is imperative to the reproduction of native gobies although, today, streams exist only intermittently in West Hawai'i and Ka'u. Fish ponds were constructed by native Hawaiians to grow and harvest desired fishes in a sustainable manner. `Aimakapa Pond and Kaloko Pond KAHO NP in North Kona are bounded by wetlands which provide critical habitat to two species of endangered waterbirds and several other resident or migrant species. Anchialine pools in Hawai'i have been historically used for drinking water and provide habitat to many endemic organisms.

Shoreline and spear fishing are common marine activities that provide food in addition to gathering of salt, various seaweeds, `opihi from rocky shorelines, and endemic shrimp from anchialine pools. Tide pools and the coral reef also harbor an assortment reef fish, sea urchins, crustaceans, gastropods, and seaweeds that are harvested for consumption.

The U.S. Fish and Wildlife Service (USFWS) lists as federally endangered one mammal (Hawaiian hoary bat, `Ope`ape`a, *Lasiurus cinereus semotus*), six birds, one reptile (Hawksbill turtle, honu'ea, *Eretmochelys imbricate*), and six plants which may occur along the Ala Kahakai corridor. The birds include the Hawaiian coot ('alae ke'ō ke'ō, *Fulica Americana alai*), Hawaiian crow ('alala, *Corvus hawaiiensis*), Hawaiian duck (kaloa maoli, *Anasi wyvilliana*), Hawaiian goose (Branta (*Nesochen*) *sandvicensis*), Hawaiian hawk ('io, *Buteo solitarius*), Hawaiian stilt (ae'ō, *Himantopus mexicanus knudseni*). The plants include the 'Aiea (*Northocestrum breviflorum*), Hilo ischaerum (*Ischaemum byrone*), Kauila (*Colubrina oppositifolia*), Ko'oko'aula (*Abutilon mensiesii*), 'Ohai (*Sesbania tomentosa*), and Na'u (*Gardenia brighamii*).

Endangered marine organisms include the humpback whales (*Megaptera novaeangliae*), hawksbill turtle (Honu`ea, *Eretmochelys imbricate*) and Hawaiian monk seals (*Monarchus schauinslandi*). Threatened species include one reptile (honu, *Chelonia mydas*) and species of concern include seven anchialine pool shrimps, one anchialine pool snail, and four plants.

Threats & Stressors

- Erosion leading to impairments in water quality or trail stability
- Pollution, point source and non-point source runoff damaging water quality
- Alien species overcoming native vegetation and wildlife
- Coastal habitat destruction
- Overharvesting of marine or plant resources
- Removal of sand from beaches
- Harbor operations leading to pollution and social impacts
- Unexploded ordinance and military hazards
- Natural events such as earthquakes and tsunami
- Motorized vehicles damaging the trail and creating user conflicts
- Light pollution affecting the visitor experience
- Vog (volcanic air pollution) threatening human health and comfort
- Development encroachment on public access, viewscales, and soundscapes

Beach and trail erosion is accelerated by motorized vehicles, foot traffic, feral goats, and construction activities together with natural geological processes. Unsanitary conditions are common in popular recreational areas due to the lack of restrooms, trash receptacles, and potable water, raising the likelihood of pollution and misuse of fresh water resources. Increased visitor access to the many anchialine pools located in Kaloko and Hawai`i Volcanoes National Park will degrade these sensitive systems. Predation by mongooses and feral cats diminish the opportunities for native birds to become reestablished in wetland habitats associated with anchialine pools and fishponds.

Land uses of the surrounding watershed may impact many aspects of this coastal park. Urban areas on Hawai`i Island are expanding rapidly, decreasing wildlife habitat by removing native vegetation, introducing alien species, and increasing groundwater withdrawal. This results in habitat quality being degraded by pollution, erosion, and runoff from road construction, industrial activities, golf courses, and residential cesspools upslope from water resources. Withdrawal and contamination of groundwater combine to affect connected water bodies including the marine environment. Fires on military lands could have significant erosional consequences, with attendant impacts on coastal water quality.

Fishing and collection of marine and shoreline organisms will increase in newly accessible areas adding to the strain on these resources. The removal of black and green sands from beaches in Punalu`u and Ka`u will contribute to the decline of these unique trail system features.

Industrial and recreational boat harbors in the region are slated for expansion in the near future which will increase impacts to marine resources from commercial diving and fishing charters. The presence of these facilities contributes to oil releases, illegal dumping, noise pollution, alien species, and physical damage to reef resources. Other types of pollution are present in coastal areas in the form of hazardous materials, abandoned equipment, and unexploded ordinance remaining from the sugar industry and WWII related military operations. Naturally occurring events such as wildfires, sea level rise and high surf will also impact the coastal resources of the trail system.

Water Quality

Water quality varies along the trail system. In places the trail meets urbanized areas, such as Kawaihae harbor near Pu'ukohala Heiau, Honokohau Harbor near Kaloko-Honokohau NPS, and the coastline between Kona and Kailua. Pelekane Bay, adjacent to PUHO and Kawaihae Harbor is listed as an impaired waterbody due to sedimentation. In these areas water quality indicators suggest risks to human bathers.

Water quality samples collected offshore of golf courses to assess the impact of nutrient loading have found that the effect of the input depends on the site, and sometimes cannot be distinguished from natural input from groundwater, which tends to be higher in nutrients than saltwater. Nutirent loading was more distinguishable in the shoreline anchialine ponds.

Although Hawaii does not have a designation category for outstanding natural resource waters, managers have identified the wetlands, anchialine pools, and coastal waters of KAHO as unique or pristine resources worthy of special attention. These inland surface waters are classified as 1a; prohibiting pollution by humans and requiring maintenance of their natural wilderness character. This same protection is extended to marine waters classed as AA and marine bottom ecosystems category II, which occur in park areas lying outside of a line drawn from Noia Point to Wawahiwa`a Point.

Marine waters and benthic ecosystems within this line and Honokohau Bay are classified as A and I respectively in order to allow for impacts from operations relating to Honokau Harbor.

CULTURAL ISSUES

- Protection of cultural sites from vandalism/looting/degradation
- Protection of traditional harvesting and recreational opportunities

The Ala Loa was the major land route connecting 600 or more communities of the island kingdom of Hawaii from 1400 to 1700. The trail is associated with many prehistoric and historic housing areas of the island of Hawaii, nearly all the royal centers, and most of the major temples of the island. Thus, the number of cultural features traversed by the trail is very high, with many

features likely to yet be discovered. The potential exists for visitors to have a huge impact on these cultural sites, either intentionally or through over-eager exploration.

Shoreline access for recreation and harvesting of marine resources is a traditional part of Hawaiian culture. Baseline data on resources is lacking in many cases. With increased access, the potential exists for over harvest.

MANAGEMENT ISSUES

Park Management

A combined Comprehensive Management Plan and EIS (CMP/EIS) is currently being developed for the trail. Given the potential impact of trail use on natural and cultural resources located within and adjacent to the trail's coastal corridor, current public scoping data results indicate a need to incorporate culturally appropriate shoreline management prescriptions for public use and resource protection. The park has included the identification of significant natural resources as a requirement in certification criteria for trail segments. As such, I&M protocols, appropriately adapted to non-NPS owned trail segments, will be an important resource management tool for ALKA and its non-NPS partners. Watershed issues will also play a role in determining management priorities.

Park management documents (General Management Plan, Resource Management Plan, etc.) are available on-line at the NPS intranet site (www1.nrintra.nps.gov/im/units/pacn/parks/mgmt_docs.htm). This website is available only from NPS computer networks. Inquiries about public access should be directed to the park.

INVENTORIES

Existing and Ongoing Inventories

Vegetation: Each of the 4 parks crossed by the trail system have had fairly extensive vegetation surveys. Private developers have also commissioned vegetation surveys as part of their planning documents. The parks tend to be dominated by exotic vegetation with coastal strand communities. The shoreline resorts generally have landscaping (often exotic plantings) along the shorelines, sometimes requiring irrigation, with sandy beaches, and lava rock outcroppings. There are areas of low density housing which may have landscaped grounds. The major urban developments are at Kawaihae and between Kona and Keauhou. Upper watersheds may still contain remanent natural forests, drylands, and cattle ranchers. Some of the forest sites have been surveyed by forest researchers.

A checklist of all plant species located within the Pu'ukoholā Heiau National Historic Site was compiled in 1975-1976 (Macneil and Hemmes, 1977). A total of 50 species from 21 Angiosperm families were recorded along with 2 ferns and 1 Basidiomycete. Of

the total number of species collected, 38 were introductions, 10 were indigenous, and 5 were endemic.

The PUHE plant community was surveyed again in 1996 (Pratt and Abbott, 1996). Results demonstrated that the current vegetation cover of PUHE is predominantly alien. Of 104 vascular plant species found in the survey, 67% were alien species. The checklist was further revised by Pratt in 1998 to include a total of 124 species documented in the Park (Pratt, 1998).

In 1989 an endangered fern study was initiated at PUHE on the pololei, (*Ophioglossum concinnum*).

KAHO vegetation was mapped by Canfield in 1987, using aerial photographs from 1959 and 1982, and was later surveyed by Pratt and Abbott (1996). 116 vascular plant species were found within Kaloko-Honokōhau in 1992-93. Eighty (69%) plant species were alien, four (3%) were Polynesian introductions, 27 (23%) were indigenous, and five (4%) were endemic. Fifty-six species (46 aliens, 9 indigenous, and 1 endemic) were additions to the known flora of the Park since the previous plant checklist (Canfield 1990). Three candidate endangered species were found in the Park: ko'oko'olau (*Bidens micrantha* subsp. *ctenophylla*), maiapilo (*Capparis sandwichiana*), and *Fimbristylis hawaiiensis*.

The invasive fountain grass (*Pennisetum setaceum*) was nearly ubiquitous in Kaloko-Honokōhau with highest estimated cover (>50%) in the northeastern and southern parts of the Park.

Yen conducted an ethnobotanical survey in 1971 at PUHO, including suggestions for restoration to historical conditions (Yen, 1971). Two vascular plant surveys have been completed. The first complete vascular plant checklist was published in 1986 as the result of surveys made in the Park during wet and dry periods over 3 successive years (Smith et al, 1986). New surveys were done in 1992-93 (Pratt and Abbot, 1996). Vegetation surveys carried out in the park have recorded a total of 134 vascular plant species. Nearly three-quarters of these, 96 species, were alien to Hawaii. About 17 percent, 23 species, are indigenous (native to Hawai'i, but occurring naturally outside of Hawai'i), four percent, six species, are endemic (occurring naturally in Hawai'i and found nowhere else), and 1.1 percent, 15 species, are Polynesian introductions (brought to Hawaii many centuries ago by the first Polynesian settlers).

Invasive plants such as Buffel grass (*Cenchrus ciliaris*), prickly pear cactus (*Opuntia ficinrs-indica*) and date palm (*Phoenix sp.*) are a high priority for removal at PUHO.

Terrestrial Vertebrates: Morin (1996) documented 16 bird species at PUHE in surveys conducted over four different months in 1992-1993. Sixteen bird species were detected during four surveys made during 1992 and 1993. Two of the species (12%) were indigenous migratory shorebirds and the other fourteen (88%) were introduced non-

native species. The paucity of indigenous avifauna and the complete absence of endemic species can be attributed directly or indirectly to human influences.

Morin (1996) documented 25 bird species out of 86 listed for KAHO including two endangered waterbirds. The Hawaiian Hoary Bat has been observed at KAHO

At PUHO, Morin (1996) documented 12 bird species from fall-winter and spring-winter surveys using 29 bird count stations located throughout the park. Species observations by park staff increase the total count to 26 species. The endangered Hawaiian hoary bat is known to frequent the park. A bat survey was done in April, 1993 by Mark Aeder and David Jacobs. Because of its heavily altered vegetation and other lowland characteristics (e.g. infestation with mosquitoes and other avian disease vectors, high numbers of mammalian predators, etc), Pu'u honua currently does not maintain endemic bird species (Morin, 1996). The Park is a likely site for detecting the spread of introduced bird species, or even the occurrence of newly introduced species.

An inventory of seabirds was conducted in 2001 using marine radar to identify seabird flight corridors within Hawaii Volcanoes National Park. Due to inaccessibility of coastal areas within HAVO only one station, Holei sea arch, at the end of Chain of Craters road was surveyed and found no evidence of Dark-rumped Petrel, Newell's Shearwater, and Band-rumped Storm Petrel colonies.

Terrestrial Invertebrates: A survey of the insect fauna at KAHO in 1992 found relatively few native terrestrial arthropods aside from flies breeding in the pools. Sporadic insect collections have been made since then. USGS has documented native bees in Kohanaiki to the north of KAHO.

Terrestrial and riparian invertebrate faunas were surveyed in 1992. About 100 species have been collected within PUHO out of a total of 609 insect species recorded for the Kona district. Of these, about 15 are considered native to Hawaii.

HAVO has the largest invertebrate specimen base than any other park in the PACN network. This is due to an intensive inventory of terrestrial invertebrates from 1971 to 1976 through the US International Biological Program Island Ecosystems Integrated Research Program. However, only a small fraction of its more than 332,800 acres have been surveyed for terrestrial invertebrates.

During the summer of 2004 an amphibian survey was conducted in the West Hawaii parks. The focus was on identifying what species are present, and collecting voucher specimens.

At PUHE, the blind snake (*Ramphotyphlops braminus*) is present in the park, along with the house gecko (*Hemidactylus frenatus*). The house gecko was far more dominant at PUHE than the other parks (Bazzano, 2004)

KAHO provides numerous habitats and anchialine pools favorable to amphibian establishment. Five species of gecko and one skink were found. The snake-eyed skink (*Cryptoblepharus peopcilopleurus*) was seen only at KAHO of the three West Hawaii

parks, near the anchialine pools. Only one house gecko, (*Hemidactylus frenatus*), which were dominant at PUHE, was observed at KAHO. One tree gecko (*Hemiphyllodactylus typus*) was observed. The gold dust day gecko (*Phelsuma laticauda*) appeared to be rapidly increasing in population at both KAHO and PUHO. The stump-toed gecko (*Gehydra mutilate*) and mourning gecko (*Lepidodactylus lugubris*) are less aggressive and were found in lower numbers.

There are no aliens of concern documented in West Hawaii parks yet. At KAHO and PUHO, the Jackson chameleon and coqui frog have been reported from locations close to the park.

Reptiles commonly found in PUHO include three species of geckos and three species of skinks, according to the PUHO site conception plan. In a recent survey (Bazzano, 2004), gold dust day gecko, (*Phelsuma laticauda*) was found to be rapidly increasing in numbers. The green anole (*Anolis carolinensis*) was found at the upper garden plot, which tends to be wetter. The stump-toed gecko (*Gehydra mutilate*) and mourning gecko (*Lepidodactylus lugubris*) are less aggressive, and were found in smaller numbers. The house gecko (*Hemidactylus frenatus*) was common at PUHO. A tree gecko (*Hemiphyllodactylus typus*) was observed and the metallic skink (*Lampropholis delicate*) was found at the upland gardens only.

Freshwater and Anchialine Pond Communities: In 1972, Maciolek, and Brock described 318 anchialine ponds along the Kona Coast and inventoried environmental and biological characteristics. The Natural Heritage Program of the Nature Conservancy of Hawaii published a biological database of rare species and natural communities in anchialine ponds in Hawaii in 1987

General biological surveys of the anchialine pools at KAHO were done by Brock and Kam (1997). USGS has documented the locations of anchialine ponds north and south of KAHO fishponds, inside and outside of KAHO boundaries. A preliminary inventory of anchialine resources was also a part of preparations for development of the Kohanaiki shoreline (Rutter/KW Kohanaiki 2003).

In 1999 Mitchell Chai took temperature, salinity, pH, tidal fluctuation, and made a list of species present in an anchialine pond in PUHO. The study found that the overall ecological health of the ponds is poor. The ponds are not viable habitat for fish traditionally stocked for ali`i because of degraded water quality and competitive tilapia. The ponds also are important from a biogeographical perspective since no other anchialine ponds are located between Kailua-Kona and Milolii.

At HAVO, an inventory of 19 anchialine pools was conducted in 1989 by Chai and colleagues, although other pools are known to exist. The only fish habitats in HAVO are these brackish water anchialine pools along the coast. Chai 's 1989 inventory found 7 fish species and 7 identifiable invertebrates in the anchialine pools. All the species were native except for an alien invasive species of prawn known to limit the populations of native shrimp species. One of the pool complexes (Waha`ula Wet Cave) has since been covered by lava. Since 2003, D. Foote has been monitoring pool-breeding damselflies and flies, as well as habitat, in the `Ola`a Pua unit.

A multi-park inventory of anchialine ponds is currently underway, through a cooperative agreement between the USGS and NPS. This survey includes insects present around the ponds, and the relationship between adjacent vegetation and the pond species. Accurate identification and mapping of these pools is another important component of these inventories.

Marine Communities: KAHO is unusual among the Hawaii parks in that marine waters are contained within the park boundaries. The enabling legislation for PUHO intended that the marine waters be included, as did PUHE's but the change in jurisdiction has never been made official.

A Cooperative Park Study Unit technical report on inventories of fish and invertebrates within KAHO was published by Brock and Kam in 1997. Research on spinner dolphins (*Stenella longirostris*) was conducted in 1989 by Jan Ostman (<http://www.kulanaia.org/research2.html>) which included research on the behavior, movement, and population dynamics of the parks "resident" pod. Recent data on fish in and near park waters are available from Hawaii DAR. Parrish et. al. (1990) documented 150 marine fish species within the KAHO Park boundaries.

Water Quality: At KAHO, there is very limited water quality information to provide a basis for listing, and so, no water bodies are listed as impaired. A baseline water quality data inventory has been conducted (NPS, 2000) Sampling stations surrounding the park have elevated indicator levels showing there may be risk to human bathers, but the parks waters are somewhat better.

Groundwater designations are being developed by the state of Hawaii, but are not yet available.

In 1999 the Water Resources Division of NPS conducted a baseline water quality inventory of PUHO. Waters in Honaunau Bay are deemed safe for swimmers.

A baseline water quality data inventory and analysis was conducted at Hawaii Volcanoes National Park (2002).

Air Quality: For a six months period particulate matter was measured at PUHO as part of VOGNET, which provided some information on input from volcanic emissions. Results of the study are not yet available.

Viewsheds: From May through June 2002 historic scenic viewsheds at various locations in HAVO were inventoried using a GPS and photography. Due to the natural processes of forest succession affecting the character of historic views, these historic views need to be managed to preserve visual access to historic scenic viewsheds.

Soundscapes: An inventory to characterize different acoustic environments at HAVO was conducted to provide baseline data for the development of the upcoming Air Tour Management Plan. As part of the acoustic survey, long term continuous 1/3 octave band sound levels, wind speed, and wind direction were collected at twenty two sites at HAVO.

Priorities for New Inventories

Vegetation: Status and trend data is needed on the health of native vegetation and the spread of invasives.

Terrestrial Vertebrates: An inventory of the Hawaiian Hoary Bat is to be conducted across a broad array of habitats in the Hawaii National Parks. The study will also evaluate bat habitat usage and relative abundance.

Shoreline areas for HAVO will be inventoried for seasonal waterfowl and shorebirds migrants along designated routes. Seabirds, raptors, and native waterbirds will also be recorded. The objective of this project is to inventory avian species diversity and relative abundance along the park's shoreline. This inventory will also be conducted in the other West Hawaii parks.

Rats, mice, mongooses, feral cats, rat, goats, and chickens are common introduced species all along the coastline. All pose threats to native species and habitat. No complete inventories of mammal species have been done for the parks along the trail system, and no vouchers of mammals for the park have been collected

Terrestrial Invertebrates: Biological inventories of terrestrial invertebrate species of concern (SOC) are in the planning stages in HAVO. The objectives of these inventories are to; 1) Compile specimen-level data for *Drosophila* and *Megalagrion* terrestrial SOCs, and use collection locality data in conjunction with vegetation and rainfall maps to delineate potential habitat for each species, (2) Survey these species along existing HAVO Resource Management transects,(3) Conduct focal searches in other likely habitat (i.e. microtopographic features such as Oloa Trench), and (4) Estimate search effort required to expand scope of inventory to include other rare or missing endemic species of *Megalagrion* and *Drosophila*.

Marine Communities: Analysis of baseline conditions is needed in order to ascertain the impacts of recreational use.

Water Quality: More data is needed on water quality baseline parameters and trends.

Visitor Use: The parks track the number of vehicles and people visiting the park. Data is available on the Internet at <http://165.83.32.36/mpur/> PUHE has received approximately 50,000 visitors as a yearly average recently, the second most visited West Hawaii park. PUHO has received almost half a million visitors annually in the past few years.

Buffer Zone Inventories

Marine Communities: Preliminary surveys of Pelekane Bay adjacent to PUHE and Kawaihae Harbor were initiated in the 1970's, with subsequent studies in the 1990's. Cheney et al (1977) documented a depauperate fish fauna of only 63 species. They also documented two alien fish species in anchialine pools in the park.

In 1996 Brian Tissot completed quantitative sampling of three 50-ft. transects on patch reefs in Pelekane Bay with a list of species and relative abundance of all species compiled for all habitats within the bay (Tissot, 1998). The study found a striking decrease in abundance of all plants and animals, associated with major changes in species diversity and composition since the Cheney surveys. Thirteen species of benthic algae were collected by a University of Hawai'i study team in 1976 (Ball 1977) offshore of PUHE. All but one was indigenous but no rare or unusual species were found.

Tissot attributes the faunal reductions to long-term sedimentation stress caused by chronic terrestrial runoff. An additional factor is the reduced ocean circulation in Pelekane Bay associated with massive historical deforestation in the Pelekane watershed and construction of the Kawaihae Harbor revetment. (Tissot, 1998).

Sharks are frequently seen in Pelekane Bay, offshore from the Heiau. Grey reef sharks, white tip sharks, and particularly black tip sharks use Pelekane Bay. Park personnel occasionally record shark sightings.

In 2003 research by NPS and collaborators began near PUHE and other W. Hawaii parks on the recruitment processes of key coral reef invertebrates and fishes (mainly aquarium species).

NPS Pacific Island Coral Reef Program (PICRP) started work in 2003 with USGS along with contractors for aerial photography, to produce high resolution coral reef habitat classification maps for the West Hawai'i parks and coast. A comprehensive marine GIS data base will be constructed to improve knowledge for monitoring and management of the West Hawai'i reef ecosystem structure. The database will also be used to track trends in ecological and oceanographic processes to detect ecological changes in coral reefs in space and time.

Echinoid fauna in Kealakekua and Honaunau Bays were surveyed in 1971 (Ebert, 1971) In 1968 Rhodes compiled field notes on observations of marine life near PUHO. Surveys of the fish fauna were conducted by Doty (1969 in Ludwig et al, 1980). Doty found 98 species and documented evidence of overfishing and commercial collection of corals. In comparison, Ludwig et al (1980) found greater fish abundance and species diversity (163 fish species) indicating potential recovery from earlier perhaps more intense human disturbance.

The PUHO Resource Management Plan provides the following information about the benthic communities: Visible algae is almost entirely intertidal; benthic seaweed populations are sparse. A single red alga, (*Tolpocladia glomerata*), is generally observed at depths greater than two meters. The coral, *Pocillopora meandrina* is found to a depth of five meters, castle coral (*Porites pukoensis*) extends to a depth of 15 meters, and finger coral extends to a depth of 20 m. Gastropods (cowries, cones, bivalves, clams and oysters) are present. *Echinometra mathaei* is the most abundant urchin in Honaunau Bay and the uncommon slate pencil urchin, *Heterocentrotus*, contributes greatly to biomass. The only larger crustacean seen in numbers is the cleaning shrimp, *Stenopus hispidus*. The most common fishes are yellow tang (*Zebrasoma flavescens*) and kole (*Ctenochaetus strigosus*).

Marine fish species were surveyed twice in waters just offshore of HAVO. Major (1976) produced an unpublished list of 54 fish species seen from reefs surveyed near the coastal backcountry campsite Halape. Ball (1976) recorded 25 (including 14 not recorded by

Major) fish species, 106 invertebrate species, and 89 species of algae in the tide pools near the Halape campsite.

Geology: Field work for the island of Hawaii soil survey was completed in 1957. The classification and map unit names were finalized in 1968, and the Island of Hawaii Soil Survey was published in 1973 at 1:24,000 scale. An evaluation was made of the soil survey in 1993, with the determination that soil map unit delineations were accurate. However, one additional map unit was added to the soil survey to reflect present day soil survey concepts, soil classification, and soil interpretations. Amendments to the correlation document reflecting these changes are on file at the NRCS Hawaii State Office.

Halbig et al, 1985, performed a baseline study of soil geochemistry in the Kawaihae area

Gardiner studied soils in the Kohala region (Gardiner, 1967), as did Giza (Giza, 1979)

Water Quality: The Pelekane Bay watershed was identified in Hawaii's Unified Watershed Assessment as a Category I watershed: placing it as one of the State's watersheds in most urgent need of restoration. Soil erosion from the watershed has impaired water quality of Pelekane Bay. Data on multiple parameters, including physical, organic, and metals, have been collected from 4 streams in the PUHE watershed by US Geological Survey.

MONITORING

Existing and Ongoing Monitoring along the trail system

Vegetation: Restoration, stabilization and outplanting efforts in coastal strands at HAVO have been monitored.

Terrestrial Vertebrates: Wetland bird populations are monitored at `Aimakapa Pond through an agreement with Ducks Unlimited. Ducks Unlimited has been monitoring the Hawaiian Stilts that have colonized a man-made wetland 4 miles to the North of KAHO at Keahole Point.

Invertebrates: Populations of damselfly *Megalagrion xanthomelas* breeding in the KAHO pools have been monitored for several years, but surveys for other important species have been sporadic.

Yellow jacket wasp populations are being monitored to understand timing and efficacy of insecticidal baits to control populations at HAVO. Mosquito monitoring at HAVO is being conducted in conjunction with a National Science Foundation Biocomplexity Project to understand vector relationships to avian disease and the decline of native forest birds. Other invertebrate monitoring projects have been conducted at HAVO including *Megalagrion* distribution, abundance, and potential breeding site surveys. In addition,

moths species variation during different times of the year is being investigated along with population numbers and community composition of *Drosophila*.

Marine Communities: KAHO has conducted cooperative green sea turtle monitoring with the National Marine Fisheries Service Marine Turtle Research Program and the Hawaii Preparatory Academy since 1999. The University of Hawaii at Hilo has recently began sea turtle forage studies and anchialine pool studies. Research on the recruitment processes of key coral reef invertebrates and fishes (mainly aquarium species) by NPS and collaborators began in 2003.

West Hawaii Aquarium Project has been studying aquarium fish in 23 sites along the West Hawaii coast since 1998. They are researching the effects of aquarium fish collecting by comparing results from Marine Protected Areas and Fish Replenishment Areas with those open to collection. Data collected include fish densities, recruitment patterns, coral cover, abundance, diversity, distribution, and rugosity (habitat relief/structure).

The marine soundscape is under analysis, with sensors recently placed to focus on low frequency sounds in the vicinity of Honokohau Harbor.

The annual Hawksbill turtle monitoring program (June-December) is the only marine monitoring program at HAVO, which began in 1989, to monitor nesting beaches in and outside the park. This project uses mainly volunteer help to collect field observations.

Geology: Volcanic activity monitoring is conducted by the Hawaiian Volcano Observatory, U.S. Geological Survey. Regular monitoring of eruption activity, seismic activity, ground deformation, and volcanic gases aid in the prediction of volcanic events

Water Quality: A two-year project funded by NPS Water Resources Division to monitor nutrient fluctuations in KAHO's wells, anchialine pools, Kaloko Fishpond and Aimakapa Fishpond will be implemented in 2004. This project will perform dye tracer studies to determine the residence time of water in the pools and ponds and will collect samples to analyze for biologically available nitrogen and phosphorus in the groundwater. Salinity, dissolved oxygen, silica, chlorophyll a and other pigments will also be monitored.

Ki'ilae Stream near PUHO was monitored for physical and chemical water quality parameters by the USGS from 1974 to 1982 when the stream was relatively perennial. The stream flow gauge is now inactive, and the stream is considered intermittent, due to upstream development and water diversions.

Air Quality: HAVO is classified as a Class I area, under the Clean Air Act, making monitoring for visibility, pollutant gases, and particulate matter mandatory. Monitoring of visibility, particulate matter, dry deposition, gaseous pollutants, wet deposition, cloud or fog water, solar radiation, meteorology, and climate is or has been conducted at Hawaii Volcanoes National Park. Monitoring stations are operated by the Environmental Protection Agency, the National Park Service, U.S. Geological Survey;

Hawaiian Volcano Observatory and the Pacific Island Ecosystem Research Center, and the University of Hawaii at Manoa.

Climate: Weather observations at PUHO and HAVO are recorded daily and reported to the National Weather Service. The Weather Service is the data repository, but hard copies of the observations are maintained at parks. Some of the data is available online from the National Weather Service. The weather data recorded is maximum and minimum temperature, temperature at time of observation, and precipitation from a rain gauge.

Soundscape: Beginning in approximately 1986, PUHE park maintenance personnel have recorded the presence of helicopters or other aircraft overhead. The concern is that sound vibrations could damage the un-mortared walls of the cultural sites, and impact visitors experience.

A management report dated 10/25/02 states that “No data on helicopter overflights was collected over the last 5-7 years. As an estimate however, compared to the previous reported number of 930 overflights, a significant decrease has been noticed and we would guess about 350 overflights are occurring annually.”

Priorities for New Monitoring

Vegetation: The spread of exotic species should be monitored, along with trends in native vegetation.

Terrestrial Vertebrates:

Bird populations should be monitored, along with trends in the populations of exotic mammals.

Invertebrates: Native bees and damselflies are in need of monitoring along the trail system. The spread of exotic insects and amphibians is important to track.

Freshwater Communities: Populations of candidate endangered insects should be monitored.

Water Quality: Groundwater quantity and quality are of primary concern as development around the trail system increase.

Soundscape: PUHE staff are no longer systematically monitoring overflights. Park staff have met with military and Federal Aviation officials to discuss Memorandums of Understanding for overflight issues. Agreements are in place for military pilots to keep a prescribed distance from the site. However, with increasing development in the population base, harbor, tourism traffic and military facilities, it could be important for the Park to have a system in place to note non-military overflights, and violations of the Memorandum of Agreement.

Buffer Zone Monitoring

Vegetation: The U.S. Fish & Wildlife Service collaborates with a variety of organizations on research projects such as the Kona Dryland Forest Project. The intent of this project is to restore one of the finest examples of dryland forest ecosystem remaining in Hawai'i. and research activities include restoration monitoring, invasive species eradication, and ungulate control. Collaborators in this project include the Hawai'i Forest Industry Association (HFIA); Hawai'i Division of Forestry and Wildlife (DOFAW); National Tropical Botanical Garden (NTBG); Kamehameha Schools Bishop Estate (KSBE); Potomac Investment Associates Kona Partnership (PIA); Hannah Springer and Mike Tomich of Kukui'ohiwai; Basil Hansen; Hualalai Ranch; The Nature Conservancy; U.S. Army Pohakuloa Training Area; Will and Judy Hancock from Kalopi; and the U.S. Forest Service.

Forest researchers from the University of Hawaii, as well as other academic institutions and from Volcano National Park (HAVO) have studied the cloud forests in which clouds supply significant nutrient and moisture inputs. There are several research plots located in the Kohala mountains, and along the slopes of Hualalai Volcano above Kona.

Marine Communities: George Balasz, of The National Marine Fisheries Service, and the Hawaii Preparatory Academy have been conducting green sea turtle monitoring in West Hawai'i since the 80s. Data is collected on turtle growth, food sources, and the existence of tumors. The population of green sea turtles in Hawaii has been recovering well from past levels, but the incidence of tumors seems to be on the rise.

West Hawaii Aquarium Project (WHAP) has been studying the distribution and abundance of aquarium fishes along the West Hawaii coast since 1998 and have found that marine reserves are helping depleted populations recover.

Kawaihae Coral Transplant and Monitoring Project: Corals have been collected and moved with hanging baskets to transplant the corals to new sites away from the "footprint" of the new breakwater. At each of the eight transplant sites, there are four sediment traps to monitor suspended matter settling on the reef (Jokiel et al, In Review). The project is a cooperative effort between: U.S. Army Corps of Engineers, National Marine Fisheries Service, U.S. Fish and Wildlife Service, State Division of Aquatic Resources (DLNR) and U.H. Institute for Marine Biology

Water Quality: Hawaii State Department of Health (DOH) monitors monthly for *enterococci* and *C. perfringens* at Kawaihae Harbor to the North and Spencer State Beach Park adjacent to the South boundary. Portable meters are also used at these collection sites to measure temperature, salinity, turbidity, dissolved oxygen, and percent dissolved oxygen.

The Hawaii State Department of Health monitors public swimming areas for human health parameters at Kailua Pier, 3 miles to the South of KAHO. The Natural Energy Laboratory of Hawaii has been performing a Comprehensive Environmental Monitoring

Program since the early 1980s that includes nearshore transects, surface and abyssal seawater, anchialine pools and groundwater.

Priorities for new Buffer Zone Monitoring

Marine Communities: Biologically, the natural gathering of sharks in Pelekane Bay represents an important biotic dynamic and presents a research opportunity to gather data on shark behavior. The relationships between shark concentrations, congregations of prey populations, watershed water quality, and sedimentation need to be studied. Better baseline data on shark presence and behavior is needed to monitor and manage impacts.

CONCLUSIONS

ALKA is the only trail system in the Pacific Island Network. As a trail system, it integrates and connects the other coastal parks. Culturally, the trail system can preserve traditional Hawaiian cultural uses of the land, and represent the traditional Hawaiian *ahu'pua* land management system, connecting mountains to sea. It provides an opportunity to link research on upper watershed health and ecosystem processes to those of the coast.

Hawaii has legislation to protect shoreline access for the public but clauses in the legislation have enabled locations where public shoreline access has been lost. This trail system presents an opportunity to preserve more public access. ALKA depends on cooperation between land owners and the Park Service. NPS needs to be able to identify ways that it will benefit land owners to cooperate with the Trail System.

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