Bryan Harry

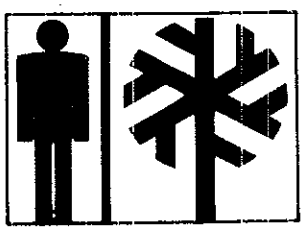
final
environmental statement

FES 74-28

NATURAL RESOURCES

MANAGEMENT PLAN

HAWAII VOLCANOES



NATIONAL PARK ● HAWAII

DEPARTMENT OF THE INTERIOR

FINAL
ENVIRONMENTAL STATEMENT

NATURAL RESOURCES MANAGEMENT PLAN

Hawaii Volcanoes National Park

Hawaii

FES 74-28

Prepared by

HAWAII VOLCANOES NATIONAL PARK
NATIONAL PARK SERVICE
DEPARTMENT OF THE INTERIOR

Joe Brown

Acting Associate Director

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SUMMARY

( ) Draft (X) Final Environmental Statement

Department of the Interior, National Park Service, Western Region

1. Type of Action: (X) Administrative ( ) Legislative

2. Brief Description of Action: This is a composite plan of biologic research, propagating rare and endangered plant species, reintroducing rare plants into former range, protecting rare endemic biota from depredation by feral goats and pigs, and re-establishing and nurturing remnants of endemic Hawaiian ecosystems. It is aimed at fulfilling applicable Congressional mandates for a natural category park.

3. Summary of Environmental Impact and Adverse Environmental Effects: The impact of this action is that the park's native Hawaiian organisms and ecosystems will operate under much less influence and destruction of the exotic species introduced by modern man. Forty-six miles of interior fences will be constructed to exclude goats.

4. Alternatives Considered: A. Conserve all species within park, including exotics. B. Goat Control: (1) reduction by local citizens (2) reduction by private contractors for profit (3) reduction by NPS personnel by any means possible (4) no fence construction (5) no action C. No reintroduction of rare plants.

5. Comments Have Been Requested From the Following:

*Advisory Council on Historic Preservation
Department of Agriculture
*Soil Conservation Service
Department of Defense
*U.S. Army
Department of the Interior
*Bureau of Indian Affairs
*Bureau of Mines
*Bureau of Land Management
*Bureau of Outdoor Recreation
*Bureau of Reclamation
*Bureau of Sport Fisheries and Wildlife
*Geological Survey
*Department of Transportation
Environmental Protection Agency
*State of Hawaii Clearinghouse
State Historic Preservation Officer
*County of Hawaii
Wilderness Society
Sierra Club
The Nature Conservancy
*University of Hawaii
*Bishop Museum
Society of American Foresters
Congress of the Hawaiian People
The Hawaiians
*Audubon Society
Life of the Land

6. Date Statement Made Available to CEQ and the Public:

Draft statement: October 36, 1973
Final statement: MAY 2 4 1974

*Comments received and attached.

DESCRIPTION OF THE PROPOSAL

The natural history resources of Hawaii Volcanoes National Park are an extensive and exceptional remnant of Hawaii's native biota. The island's isolated biologic life is duplicated nowhere else on earth. Though these ecosystems are well on their way to massive destruction with continuing extinctions of many Hawaiian species, there are opportunities at Hawaii Volcanoes National Park to preserve and restore a sample of natural Hawaiian biota including representative major vegetation communities from the 13,680-foot summit of Mauna Loa to the sea.

To that end, this resource proposal is a composite plan of biologic research, propagating rare and endangered plant and animal species, reintroducing rare species into former range, protecting rare endemic biota from depredation by species introduced by modern man, and providing avenues for public knowledge of these unique Hawaiian ecosystems.

The plan is also aimed at fulfilling applicable Congressional mandates for a natural category national park. Authority for the various aspects of the plan is found in the enabling legislation for Hawaii National Park, "National Park Service Administrative Policies" and Title 36, "Code of Federal Regulations."

The plan was also guided by and concurs with the concepts of resources management presented in the Hawaii Volcanoes National Park Master Plan. Pertinent to the park's natural history resources, the Master Plan states the following park objectives:

> Conduct and encourage natural history research focused upon (1) further definition and insight into the park's native island ecosystems, (2) developing life history and ecologic understanding of species facing extinction, and (3) developing management strategies for preserving endemic island ecosystems.
>
> Preserve the evolving natural scene by protecting outstanding geologic features, such as the calderas and rift zones, steam and sulphur banks, the profile of Mauna Loa, and the associated native ecosystems.
>
> Re-establish park's endemic species into former range, concentrating efforts on those species which are in danger of extinction, and those that are key components of major native ecosystems.
>
> Protect the park's remnant Hawaiian ecosystems--including endangered species--from further depredation and competition by those exotic animals and plants introduced by modern man.
>
> Seek legislation to identify the Olaa Tract as a detached portion of Hawaii Volcanoes National Park. Until that is accomplished, manage, preserve, and interpret the tract with objectives suitable for a natural area of the National Park System.

Develop an interpretive program predicated on the three themes of particular significance in Hawaii Volcanoes National Park. The primary story is the active volcanism from which the Island of Hawaii is evolving, as illustrated by the Mauna Loa and Kilauea Volcanoes. The story of the native ecosystems and the threats to their survival resulting from introduced plants and animals is second in importance to the geologic story. Another secondary theme will be prehistoric and historic events.

The natural resource actions now underway, and those proposed, are summarized under broad headings as follows:

I. Re-establish endemic Hawaiian species into former range.

A. Plants that are key components of major native ecosystems. Mamani, naio, ohia, and koa are raised from seed in greenhouses at Kilauea Headquarters and the Ainahou Ranch for use in plantings along such developed and spoil areas as road cuts, restored building sites, and damaged areas. Some 2,500 seedlings and transplants of these species are planted annually. Additionally, over a 5-year period about 50,000 seedlings of mamani are being planted on the recently acquired Ainahou Ranch and within goat-free exclosure units. Approximately 30,000 acres of potential lowland mamani forest are being planted on defined areas representing 25 percent of the potential lowland mamani shrub forest areas. Unplanted zones within the suitable potential sites are deliberate--to allow research opportunity to assess vegetation responses on goat-free areas without the variable of planting programs.

Pili grass seed is broadcast at specific lowland sites to restore damage by construction and fire suppression lines in an attempt to thwart invasions by exotic grasses. These have been ongoing projects for many years but have been expanded into the Ainahou Ranch and the newly constructed goat exclosures.

Table 1. Planted species that are key components of major native ecosystems.

Plant	
koa	Acacia koa
mamani	Sophora chrysophylla
ohia	Metrosideros collina
naio	Myoporum sandwicensis
pili grass	Heteropogon contortus

B. Rare plants known to occur (or to have occurred) within the park. The following plants are raised in greenhouses at Kilauea Headquarters and the Ainahou Ranch (see Table 2). Approximately 10,000 seedlings will be raised each year and planted on defined areas within exclosure units and other goat-free areas.

As former habitat of these plants is relieved from destruction by goats, excellent opportunity exists for native Hawaiian plant communities to re-establish themselves. However, in the case of the species listed, we doubt that a natural seed source still is present. Therefore, we propose to plant these species in park areas that by soil and climate conditions appear to fall within the species' former range. This is an ongoing program with a notable lack of success thus far; as fast as these species are transplanted, goats gobble them up. This program is totally dependent upon building fenced goat exclosures along the pali areas.

The number of plants managed in this manner will be reduced as species are successfully re-established and their survival appears secure. It will be expanded to include additional plants that continuing research identifies as rare and endangered, and for which suitable park seed sources are available.

C. Rare and endangered plants suspected of once occurring in the park. Four species of rare and endangered plants, in jeopardy in their present wild state, are suspected of once occurring within the park. These species are being raised from seed or cuttings for planting within the park. About 200 plants per year of each species are planted on mapped areas totalling 30 acres.

Reintroduction of rare plants into former ranges will not be done on a wholesale basis. A variety of local areas will receive plantings--enough to assure survival and potential seed sources of each species. Yet 80 percent of the park lands--adequate for scientific studies--will be left without plantings. In addition, these guidelines will lessen the possibility that the planting program will confuse scientific studies or upset Hawaiian ecosystems or their component species.

1. To prevent genetic alteration or hybridization of species, extreme caution shall be exercised to avoid introducing varieties or subspecies to areas in which it is known they do not naturally occur. When possible only propagating materials from the areas designated to be planted will be used. If a particular species to be planted can no longer be found in the planting area, then the nearest source shall

Table 2. Rare plants known to occur (or have occurred) in the park that are being raised and planted.

Plant		Typical Seed Sources[1/]	Approx. Acreage Subject to Planting
awikiwiki	*Canavalia kauensis (Fig. 13)	Kukalauula Pali	100
ohai	*Sesbania tomentosa (Fig. 14)	Apua Point, Halape Trail at 2,000 feet	1,000
hau-kuahiwi	*Hibiscadelphus giffardianus (Fig. 15)	Kipuka Puaulu	100
aiea[2/]	*Nothocestrum breviflorum (Fig. 17)	Napau Trail, Kipuka Ki	100
aiea	*Nothocestrum longifolium (Fig. 18)	Kipuka Ki	100
ahakea	*Bobea timonioides (Fig. 19)	Naulu Forest	1,000
naupaka	*Scaevola kilaueae (Fig. 20)	Hilina Pali Road	10
[2/]	**Stenogyne angustifolia var. angustifolia (Fig. 21)	None now	<10
hame	Antidesma pulvinatum (Fig. 22)	Naulu Forest	1,000
ohe makai	Reynoldsia hillebrandii (Fig. 23)	Poliokeawe Pali, Kamoamoa Pali	1,000
halapepe	Pleomele aurea (Fig. 24)	Poliokeawe Pali	1,000
kauila	*Alphitonia ponderosa (Fig. 25)	Kipuka Nene, Poliokeawe Pali	10,000
ae	*Zanthoxylum dipetalum var. geminicarpum (Fig. 26)	Kipuka Puaulu	100
ae[2/]	*Zanthoxylum hawaiiense var. citriodora	None now	100
kului	Nototrichium sandwicense var. macrophyllum (Fig. 27)	Hilina Pali	1,000

* Candidates for listing as endangered species.
** May already be extinct.
1/ For use only in planting areas close to the seed source.
2/ Not being raised now.

Table 2. Rare plants known to occur (or have occurred) in the park that are being raised and planted. (continued)

Plant		Typical Seed Sources[1/]	Approx. Acreage Subject to Planting
ohe mauka	Tetraplasandra hawaiiensis var. hawaiiensis (Fig. 28)	Naulu Forest mauka	5,000
papala	Charpentiera obovata (Fig. 29)	Kipuka Puaulu	100
holei	*Ochrosia sandwicensis (Fig. 30)	Kipuka Puaulu (not original seed source)	100
loulu palm	*Pritchardia beccariana	Olaa Tract	10
loulu palm	*Pritchardia affinis	Kaimu Beach[3/], Punaluu[3/]	100
sandlewood	Santalum ellipticum	Poliokeawe Pali, Pauahi Crater, Tree Molds	1,000
hoawa	*Pittosporum hosmeri (Fig. 31)	Kipuka Puaulu	1,000
wiliwili	Erythrina sandwicensis	Wahaula, Kamoamoa, Makahanu	1,000
hao	*Rauvolfia remotiflora (Fig. 35)	Poliokeawe Pali, Wahaula	1,000
silversword	*Argyroxiphium sandwicense (Fig. 32)	Mauna Kea[3/]	1,000
oloa[2/]	*Neraudia ovata (Fig. 33)	Halfway House 3,000 feet (?)	<10
ohelo[2/]	*Vaccinium pahalae (Fig. 36)	None now	10
kokoolau	*Bidens skottsbergii	Hilina Pali Road, Ainahou	1,000
pelea	*Pelea pualuensis	Kipuka Puaulu	10
pelea	*Pelea zahlbruckneri	Kipuka Puaulu	10
manena	*Pelea hawaiiensis var. gaudichaudii	Kipuka Puaulu	10
maua	Xylosma hawaiiensis var. hillebrandii	Naulu Forest	1,000
kou	Cordia subcordata	Halape	100

* Candidates for listing as endangered species.
1/ For use only in planting areas close to the seed source.
2/ Not being raised now.
3/ Seed source is not within Hawaii Volcanoes National Park; all others are.

be used. Planting seeds directly to locations near the source plant will be used in favor of greenhouse germination for species for which this technique proves to be effective. In any case, efforts will be made to obtain propagating material from as many plants of the same species as possible to preserve the natural genetic diversity of plant species.

2. Planting will be made only in areas that have been grossly disturbed by feral or domestic animals. Areas which have retained their native ecological integrity will not be planted.

3. A planting plan shall be prepared showing proposed planting areas and propagating material sources. This plan shall be available at park headquarters for review by interested persons. It shall be revised whenever deemed advisable, based on competent authority. Disagreements shall be resolved by requesting opinions from leading botanists in Hawaii.

4. Complete records shall be kept on all plantings. Locations shall be marked on topographic maps and aerial photos. These records shall be available to interested persons on request.

Table 3. Planting program involving rare plants suspected of once occurring within the park.

		Seed Source We Are Using	Approx. Acreage Subject to Planting
uhiuhi	*Mezoneuron kauaiense (Fig. 37)	Puuwaawaa, Kona[2/]	<10
kokio	*Kokia drynarioides (Fig. 38)	Kipukas Nene and Puaulu[3/]	<10
mao	*Gouania hawaiiensis	None now	<10
kauila	*Colubrina oppositifolia	Puuwaawaa, Kona	<10

D. Birds. Several birds on the Department of the Interior's endangered list occur--or did occur--within the park. These are Hawaiian dark-rumped petrel, Hawaiian hawk, nene, Hawaiian crow,

* asterisk indicates endangered species

2/ Seed source is not within Hawaii Volcanoes National Park; all others are.

3/ These plants probably were originally from Puuwaawaa.

Hawaii akepa, akiapolaau, and ou.1/ As endemic Hawaiian ecosystems recover--by the proposals to control exotics and restore endemic plants--there may be opportunity to re-establish rare endemic birds into former range. We propose the following actions related to these endangered bird species:

*Nene formerly bred throughout the park below alpine areas (Fig. 39). We propose to construct six 1-acre nene breeding pens on the pali areas in the vicinity of the Ainahou. Each pen (of woven wire 10 feet high) will be stocked with a pair of birds from Pohakuloa. At present 2,400-acre and 6,200-acre goat exclosures are under construction. Native plants are being reintroduced in both exclosures. With this habitat restoration, there is a possibility that offspring from the two breeding pens will survive and re-inhabit this former nene range. One pen is completed and stocked with a pair of nene; another pen is under construction.

*Dark-rumped petrel (Fig. 40) formerly bred in the Kau Desert and probably near Red Hill on Mauna Loa. We propose to study the feasibility and strategy for re-establishing breeding colonies in these vicinities. At present lava flows could easily obliterate the only dark-rumped petrel breeding areas on the Island of Hawaii.

The *Hawaiian hawk and the creeper will benefit from habitat restoration. Populations of these species are adequate to expand into suitable habitats; protection and restoration of environments for these species are crucial.

Populations of *ou, *akepa, and *akiapolaau are so low--and declining--that we propose priority efforts at habitat protection and restoration in areas near remnant populations of these species (Figs. 41 to 43). Studies aimed at life history knowledge and developing strategies for reintroducing birds into former ranges in the park as habitats are restored are programmed.

The remnant population of *Hawaiian crow is too far removed from the park to naturally repopulate this area even if we are able to restore park habitats. After habitats are well along to recovery we will seek assistance from endangered species biologists of Bureau of Sport Fisheries and Wildlife and the

---

* asterisks indicate endangered species

1/ Additionally, the Hawaii creeper is nearly as rare and as restricted in range as both the akiapolaau or Hawaii akepa. We expect it will be cited as "endangered" on the next revision of the Department's official endangered list. The Newell's Manx shearwater is "threatened."

Hawaii State Division of Fish and Game in developing remaining alternatives to restore crow populations to this former range, if the species is still surviving at that time.

II. Protect remnant Hawaiian ecosystems from exotics introduced by man.

A. Goats. We propose to reduce and control the numbers and distribution of goats to a degree that endangered Hawaiian plants can survive and become re-established on their former range within the park. Our actions to effect this are:

1. Reconstruct and maintain 70 miles of existing boundary and drift fences (Fig. 1) to prevent movement of goats into the park from adjacent ranch lands. We have begun this reconstruction and plan to complete it by 1974. This fence directly affects all other components of the proposed plan; other actions are fruitless if we do not prevent continual new infiltration of feral goats from outside the park.

   We propose to replace the existing fence with a 4-foot high hog-wire fence strung on T-type steel posts placed 15 feet apart.

   Fencing specifications are: woven wire fence, CF&I 1047-6-12½ and post T-type, painted hot rolled carbon or rail steel 1/8-inch thick. Between posts on uneven terrain anchor wires of #8 gauge wire will be installed. Fence must have less than a 4-inch gap with the ground. Fence right-of-way is not to be levelled or bulldozed. Fence is to follow the lay of the land so that the land surface remains undisturbed. Old fence is to be removed from the site.

2. Construct and maintain 46 miles of drift and exclosure fence (Fig. 1) to exclude goats from critical endemic plant areas and to assist in goat control measures. This work is ongoing and expected to be completed in 1976. These fences directly affect the success in saving remnant plant species from extinction and our efforts to reintroduce these species into their former range. Too, they will allow us to drive goats shorter distances for capture, which is more humane for the animals involved. The fencing is similar to item 1 above except that the vertical stays are 12 inches apart (CF&I 1047-12-12½).

3. In areas where effective, remove goats from the park by means that allow local citizen participation in the reduction and disposal of excess goats. This is ongoing and would continue as long as the people show interest by their participation. We deputize citizens as park rangers for

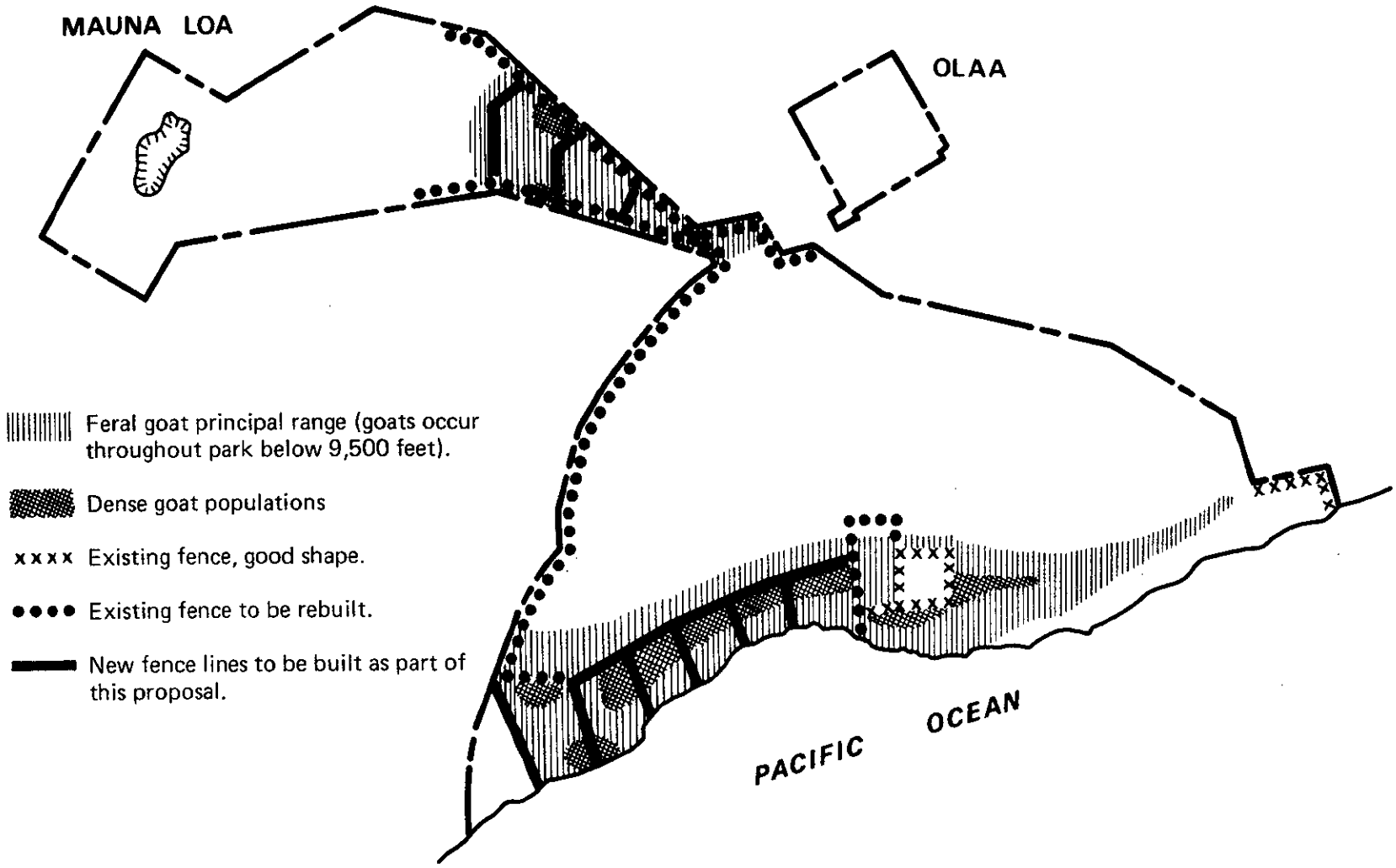


Fig. 1. Distribution of goats in the park and location of fences to be used in goat control proposals.

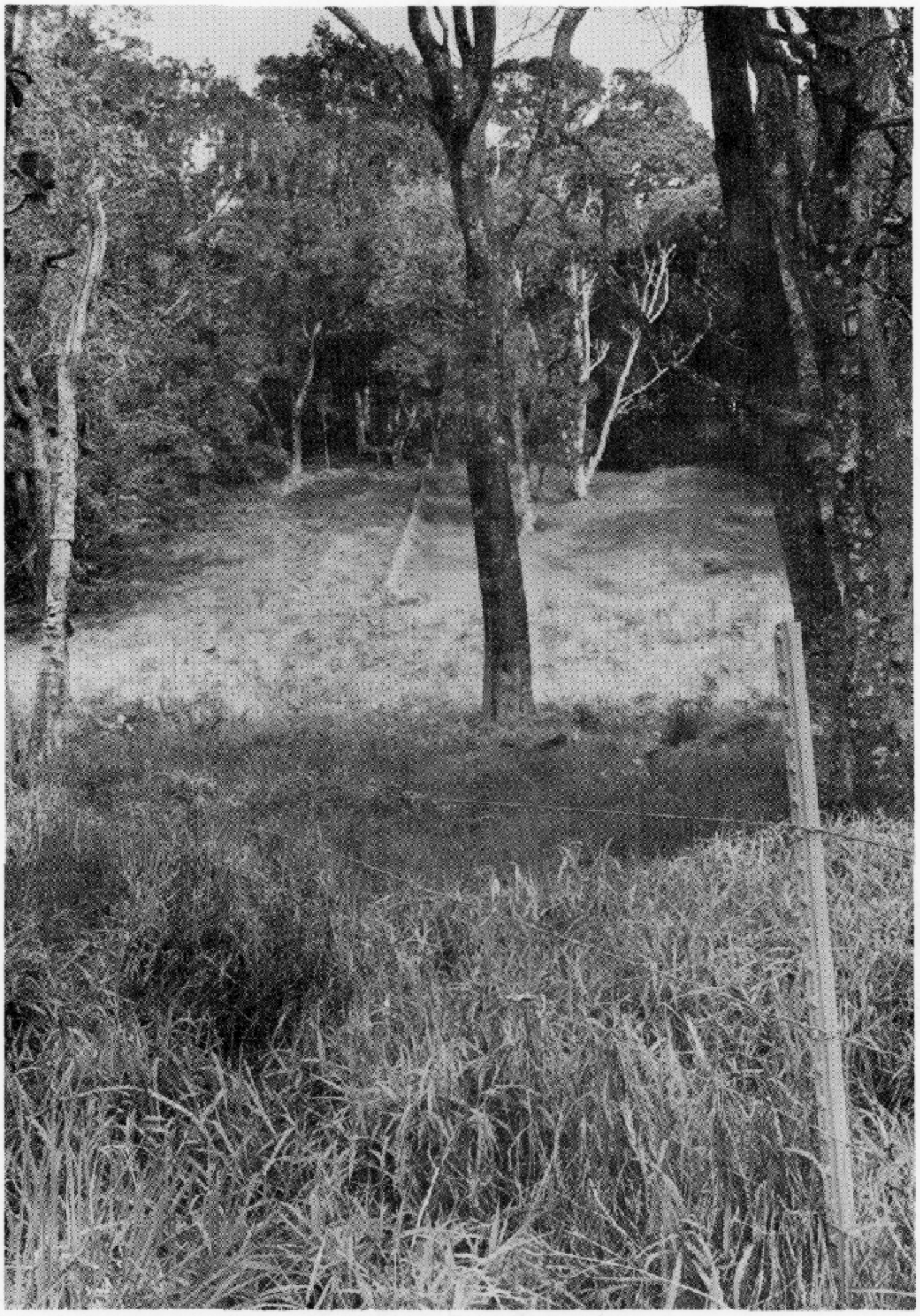


FIG. 2 Bird Park fence. This is the character of an interior drift and exclosure fence proposed for construction in this plan.

purposes of goat control. They kill or capture goats and at times are designated by the park superintendent, and act under control and direction of park rangers. Figures 3 and 4 show 1970-71 numbers of people participating and goats removed by areas. The data suggests that this program is popular and effective where goat populations are very high--but that public interest wanes where goat numbers are held at lower levels. We speculate that goat populations held to a low enough level for endemic Hawaiian plants to flourish will be too small to interest citizen goat hunters.

4. In areas where feasible, remove goats from the park by drives and roundups conducted by park personnel with trained goat dogs and using fences shown in Figure 1. Live goats so captured will be sold to public bidders.

5. Where other means are insufficient or impossible we will assign park rangers, using trained goat dogs, to hunt and kill excess goats.

Goat removal efforts (Fig. 5) by various methods have been an ongoing action for many years. However, lacking adequate internal fencing and adequate boundary fence maintenance--it has been impossible to maintain low goat populations. Goats have been the dominant factor in the continual destruction of native Hawaiian plants and ecosystems in the park (Fig. 12). Still, within the park goat reductions have been persistent; we still have remnants of endemic Hawaiian plant systems. Elsewhere on Hawaii goat control is nil; there, endemic systems are largely destroyed (note distribution maps of endangered plant species, Figures 13 to 38).

Goat control proposals listed here are key to the entire resources plan. Without this portion of the proposal, it is useless to transplant plants into former ranges--goats eat the plants. Efforts to restore endangered bird populations (nene, the drepanids, crow) are futile without restoration of Hawaiian plant habitats.

B. Pigs. We propose to reduce and control the numbers and distribution of pigs as best we can to a degree that their effect upon native Hawaiian vegetation is minimal. Our actions to effect this are:

1. In areas where effective, remove pigs from the park by a means that would include local citizen participation in the reduction and disposal of excess pigs. We deputize citizens as park rangers for purposes of pig control. Using dogs, they kill or capture pigs in areas and at times are designated

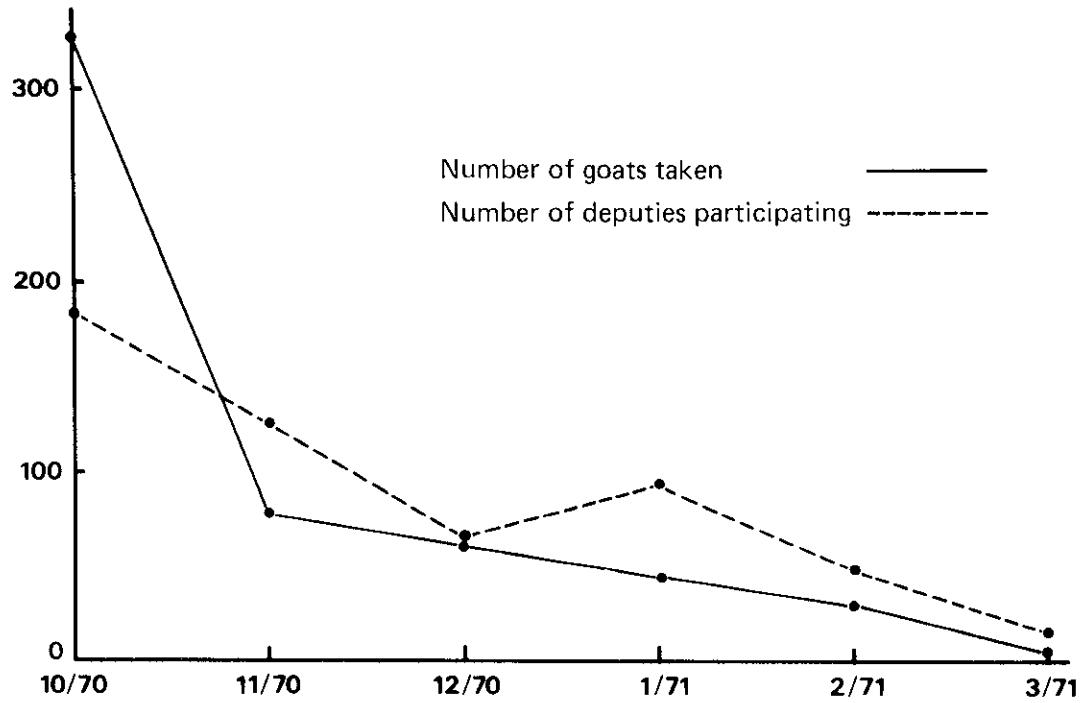


Fig. 3. Number of deputy rangers participating and number of goats taken during a 6-month period of the Holei Pali Deputy Ranger Program.

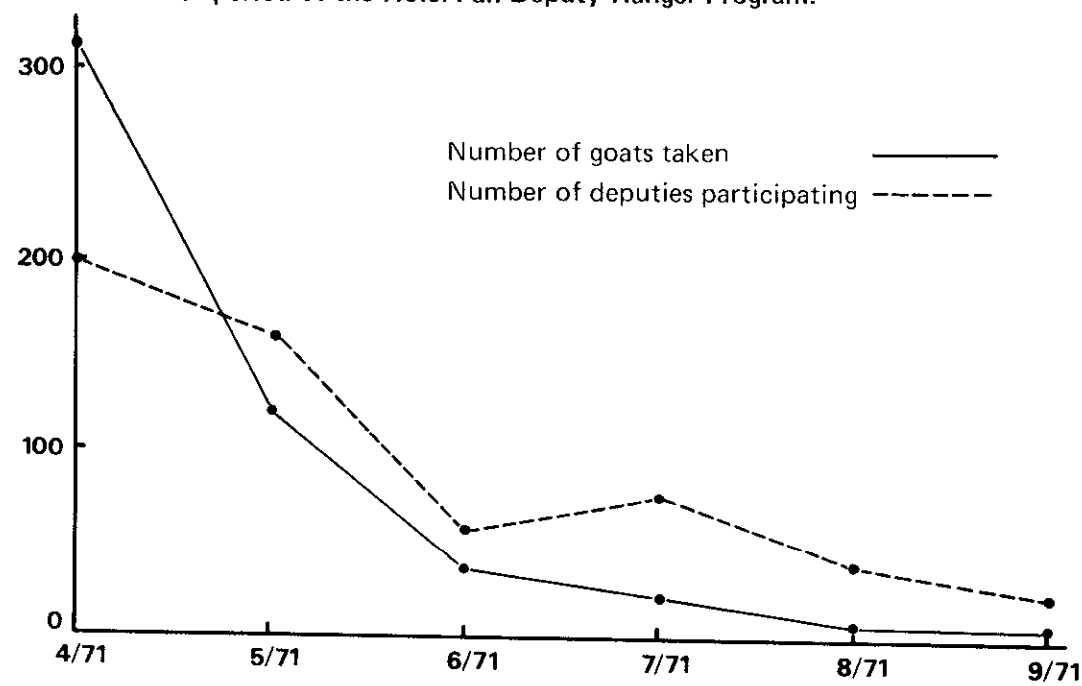


Fig. 4. Number of deputy rangers participating and number of goats taken during a 6-month period of the Kalapana Deputy Ranger Program.

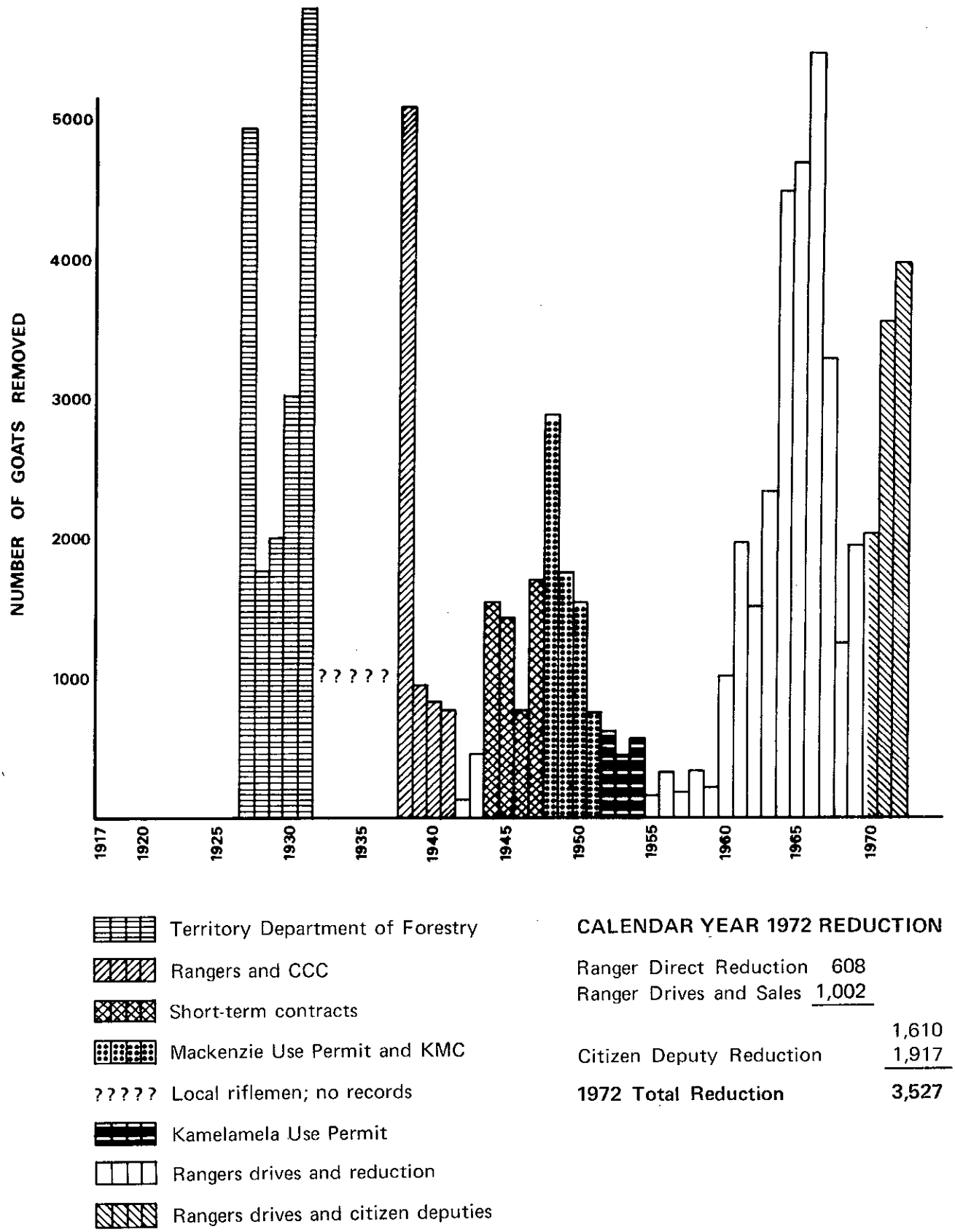


Fig. 5. Number of goats taken annually from Hawaii Volcanoes National Park.

by the park superintendent, and act under control and direction of park rangers. This program began in fall 1972 and will continue as long as people show interest by their participation.

2. Assign park rangers to hunt and kill excess pigs. This is ongoing and will continue.

3. Research in pig population control measures. Using the Mauna Loa Strip goat exclosure (about 5,000 acres now being fenced) as a research area, carefully controlled studies in pig populations and various pig control measures will be undertaken. This study will begin in F.Y. 1975, continue for 5 years, and should form the basis for a rational effort in pig population control.

Though pig removal efforts have been continuing for many years, they have been inadequate to prevent pigs from rooting and destroying native Hawaiian vegetation. Pigs eat and spread seeds of exotic plants. Guava is largely spread by pigs. Control of exotic plants and protection of rare native plants is impossible without greater control of feral pigs.

C. Rats and Mongooses. Rats and mongooses have done inestimable damage to endemic island biota. The destruction is continuing; yet, there is no present knowledge or technology available on which to base a park-wide plan of effective rat or mongoose population control. Therefore, no broad-scale control efforts are contemplated at this time.

The following management efforts are proposed:

1. Research aimed at better definition of the damage rats and mongooses are doing to native ecosystems (including rare species) and population control measures.

2. Specific control efforts at localized areas limited to nesting sites of dark-rumped petrel and Newell's Manx shearwater and in vicinity of the breeding pen experiments with nene. This control involves both live trapping and local, specific use of the poison Warfarin.

3. Control of back-country garbage disposal to reduce habitat for rats at such places as Red Hill Rest House (which is adjacent to a former nest site of dark-rumped petrel).

D. Other Exotic Mammals. Cattle, sheep, cats, dogs (and at times burros) pose a continuing problem in feral animal control. Populations are low (Table 4a) but require perpetual efforts

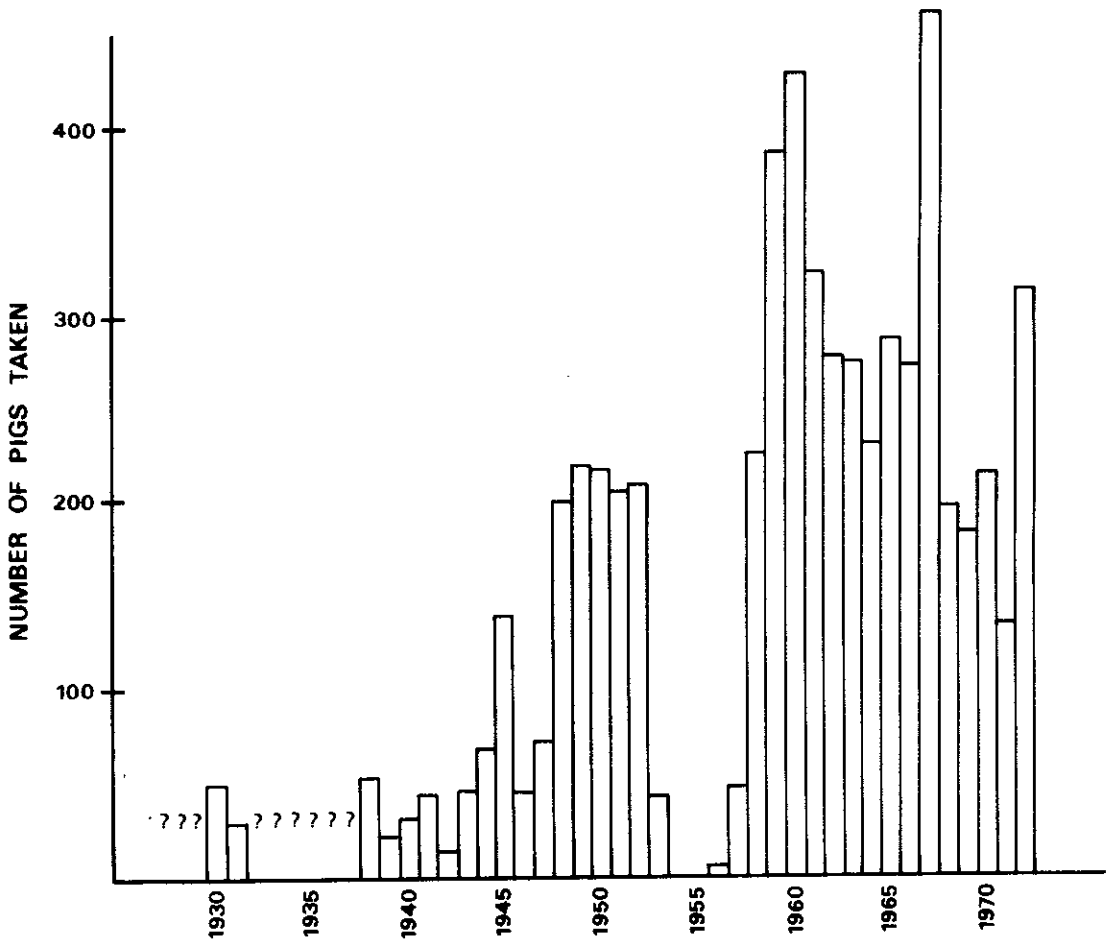


Fig. 6. Number of pigs taken by all methods in Hawaii Volcanoes National Park, 1927 to 1972.

at trapping, shooting, and fence repair to keep effects of these animals to a minimum.

E. Control of Exotic Plants. More than 400 exotic plants are recorded within Hawaii Volcanoes National Park. At present, several of these (Table 4) give cause for alarm because of their potential to take over widespread areas and cause major vegetation-type shifts away from native plant systems. This is particularly true in areas where goats and pigs eat the native plants. Two general techniques are used to control these plants:

1. Cut individual plants and apply approved herbicides such as Ammate-X, Karmex, or Dalpon to individual stems.

2. Cooperate with the State Department of Agriculture in finding natural biologic enemies for certain of the problem species. For example, State introduction of insects--lantana defoliater, Hypena strigata; leaf miner, Cremastobombycia lantanella; beetle, Octotoma scabripennis; and moth, Uroplata girardi--have been effective in impeding spread of the exotic shrub Lantana.

   We expect problems with exotic plants will be less when goat and pig populations are controlled.

3. Investigate effects of wildfire upon successional patterns of exotic plants.

   Hawaii Volcanoes' present wildfire management plan is to let fires ignited by lava flows run their natural course when such burning will contribute to the accomplishment of the park's vegetative management objectives, and when such burning can be contained within predetermined vegetation areas. Fire suppression techniques (such as bulldozed lines) which cause permanent soil disturbances that are avenues for exotic plant invasions are used only when other techniques would fail in keeping wildfires confined to broad predetermined management units.

   Yet, because browsing is disappearing, drastic changes in the park vegetative mosaic are underway altering the fire regime. Former areas of bare, unburnable lava are growing into brushlands of flashy fuels. On some sites the exotic broomsedge grass invades with vigor following hot fires whether or not goats are present. Studies are underway, and more are proposed, to evaluate these changes and, as needed, to modify the park's wildlife management policies to assure continuance of native plant associations.

Table 4. Exotic plants in Hawaii Volcanoes National Park that have high potential to take over Hawaiian ecosystems.

Name	Approximate Acreage Now Involved	Potential Acreage Involved	Control Technique Underway
Andropogon grass	25,000	60,000	No direct control
Guava	10,000	50,000	Cut and individually poisoned
Lantana	10,000	75,000	Biotic control; introduced insect enemy
Christmasberry	1,000	50,000	Cut and individually poisoned
Silky oak	500	50,000	Cut and individually poisoned
Ekoa	25	75,000	Cut and individually poisoned
Tibouchina	200	1,000	Cut and individually poisoned
Blackberry	scattered over 400	2,500	Spray or cut and individually poisoned
Faya tree	scattered over 25,000	75,000	Cut and individually poisoned
Wild olive	500	10,000	Cut and individually poisoned
Fountain grass	< 1	20,000+	Uprooted and poisoned when found
Cactus	<100	3,000	Individually cut and biological control
Banana poka	10	2,000	Cut and individually poisoned
Eucalyptus	10	3,000	Cut and individually poisoned. Large trees logged.

DESCRIPTION OF THE ENVIRONMENT

THE PARK [1]

Geology[2]

Hawaii Volcanoes National Park (Fig. 7) is geologically the youngest part of the Unites States. Its 220,000 acres extend from the Pacific shore to the dome-shaped tops of two active volcanoes, Mauna Loa (13,680 feet) and Kilauea (4,090 feet). During historic times, more years than not these mountains have been in eruption. New flows in the last few years cover 25 square miles of the park, are building a new mountain (Mauna Ulu), and are adding new lands to Hawaii where flows enter the sea. None of the park land surfaces are as old as Pliocene; some are as young as today.

Mauna Loa and Kilauea, the principal features of the park, are building layer after layer as the earth's magma extrudes from volcanic vents and solidifies as it flows toward the sea. Fundamental differences occur in the surface appearances of these volcanic deposits: (a) explosive eruptions cover areas with ash and rock fragments, (b) aa flows have rough clinkery surfaces and dense interiors, (c) pahoehoe flows have smooth surfaces and may have porous interiors and be dissected by cracks. Varying ages of rock surfaces occur. Kipukas--islands of older soils surrounded by younger lavas--often contain vegetation of older more mature successional stages.

The youthful land surfaces, particularly pahoehoe, are extremely porous. Water, even in areas of 100 inches annual rainfall, immediately percolates down to near sea level. Kilauea and Mauna Loa have no streams, lakes, or ponds--even intermittently.

1/ Based largely from:

Doty, M. S. and D. Mueller-Dombois. 1966. Atlas for Bioecology Studies in Hawaii Volcanoes National Park. Univ. of Hawaii. Hawaii Botanical Science Paper No. 2, 507 pp. mimeo.

2/ See also the excellent:

Macdonald, G. A. and A. T. Abbott, 1970. Volcanoes of the Sea; The Geology of Hawaii. Univ. of Hawaii Press. 441 pp.

Macdonald, G. A. and D. H. Hubbard. 1972. Volcanoes of the National Parks of Hawaii. Hawaii Natural History Assoc., 58 pp.

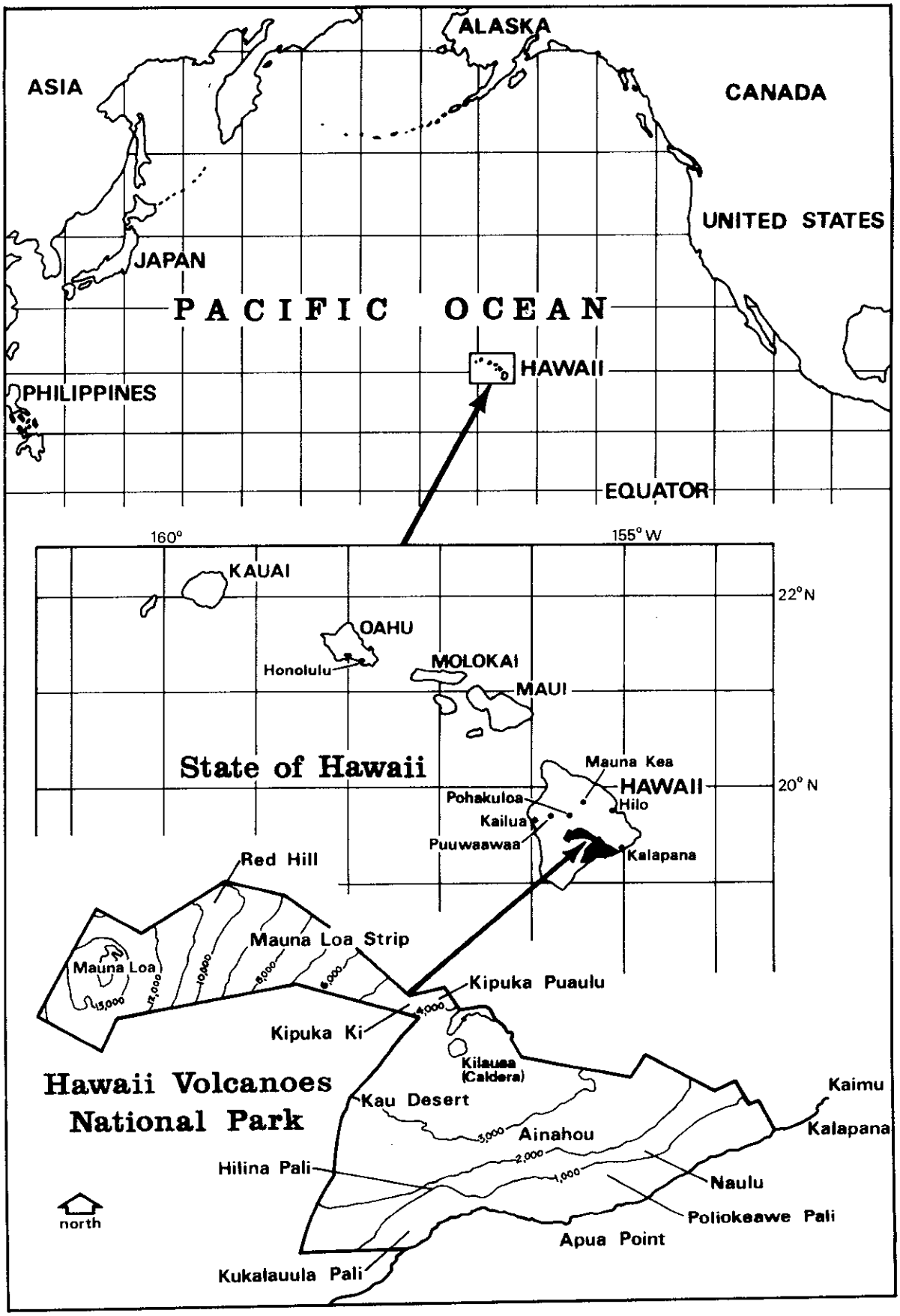


Fig. 7. The location of Hawaii Volcanoes National Park in reference to the State of Hawaii and the Pacific Basin. The Kilauea caldera, approximately circular, is about 3 miles in diameter.

The active volcanoes set repeated fires, and one senses that many native plants have adapted to this--by mechanisms such as sprouts or light, wind-blown seeds. But one also senses that a few newly arrived exotics--broomsedge, fountain grass--are even more successful fire species, and in proper soil and climate they will take over wholesale with repeated fires--shifting native dryland forests to exotic grasslands. Major research is needed to define the role of fire in relation to both native plants and newly arrived exotics.

Kilauea Volcano is also the site of the Hawaiian Volcano Observatory, the oldest and foremost research facility investigating volcanoes. It is a U. S. Geological Survey facility; all geological research projects in the park are coordinated by that agency.

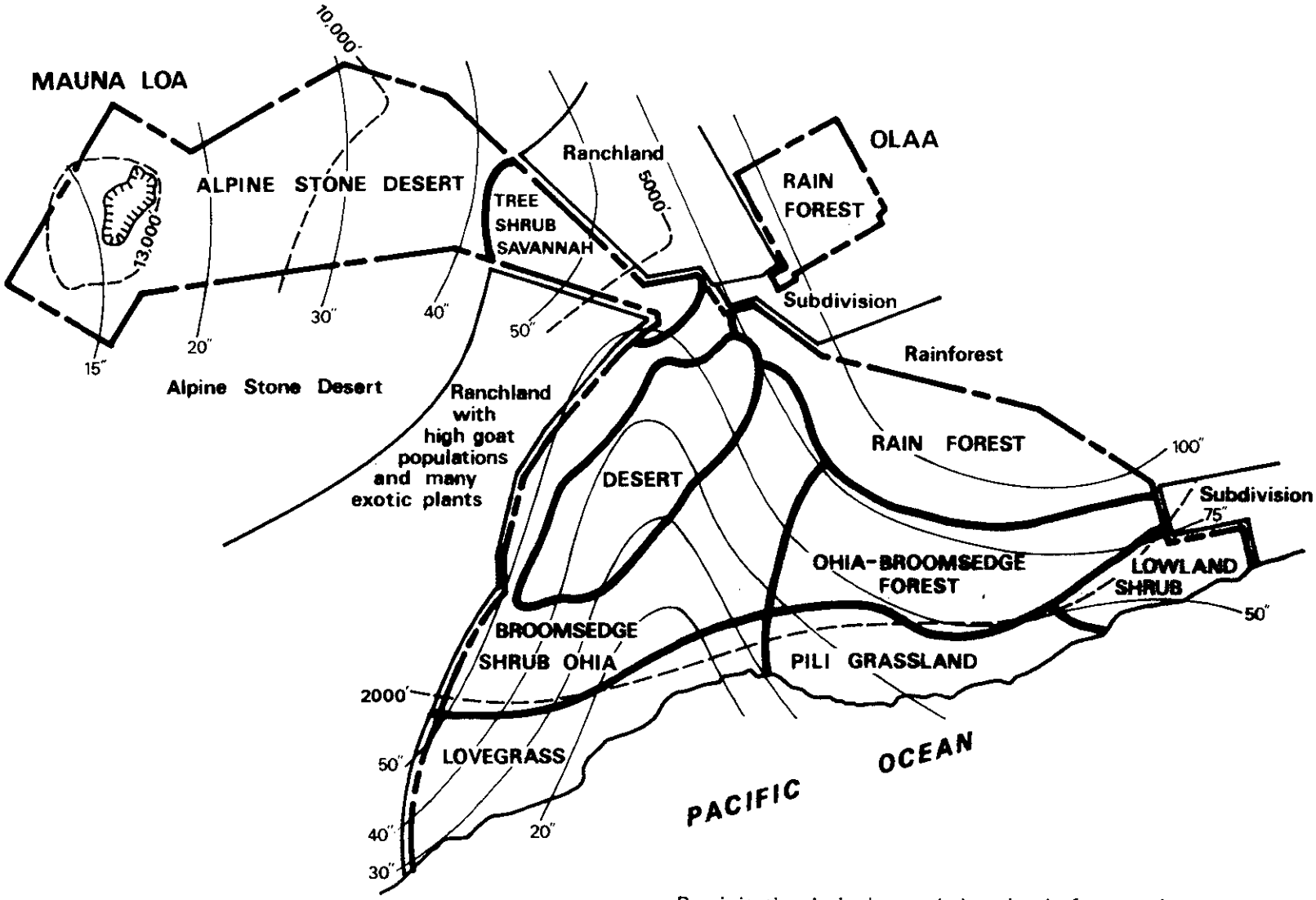
Climate

Steady, moisture-laden trade winds flowing across the topographical barrier formed by the Big Island are the principal cause of climatic variation within the park. In the park on Kilauea's windward side, trade winds dump more than 100 inches of rainfall annually; there rain forests of giant hapuu fern and ohia are luxuriant (Fig. 9a). After crossing Kilauea's summit, the trades are drying winds and the clear sunny skies suck up much of the Kau Desert's 20-inch rainfall. Infrequently, large Pacific storms disrupt the dominance of the trades. Then, for a time, the winds may blow the wrong way; such Kona winds drop the bulk of the rainfall in the lowland Kau. Too, the expected climatic gradient from the hot lowlands to the cold, 13,000 feet summit of Mauna Loa occurs. Treeline is about 7,800 feet.

Biology

> "Like a great museum of geology and island plant and animal life, the Hawaiian Islands lie isolated in the mid-Pacific. Over millions of years this isolation has permitted unique animal and plant phenomena to develop. Natural crossings of vast stretches of ocean by plants and animals in prehuman times are amazing feats of dispersal. After arrival, these organisms, isolated from mainland areas, have taken curious and unexpected courses of evolution, have presented us with the most exciting and astonishing flora and fauna to be found on an archipelago of oceanic islands. About 95 per cent of native Hawaiian plants and animals occur nowhere else in the world--a higher percentage than any comparable area in the world."3/

3/ Carlquist, S. 1970. Hawaii, a Natural History. American Museum of Natural History, 463 pp.



Precipitation in inches and elevation in feet are shown.

Fig. 8. Existing major vegetation systems. Lovegrass, broomsedge, and most lowland shrubs are exotic.

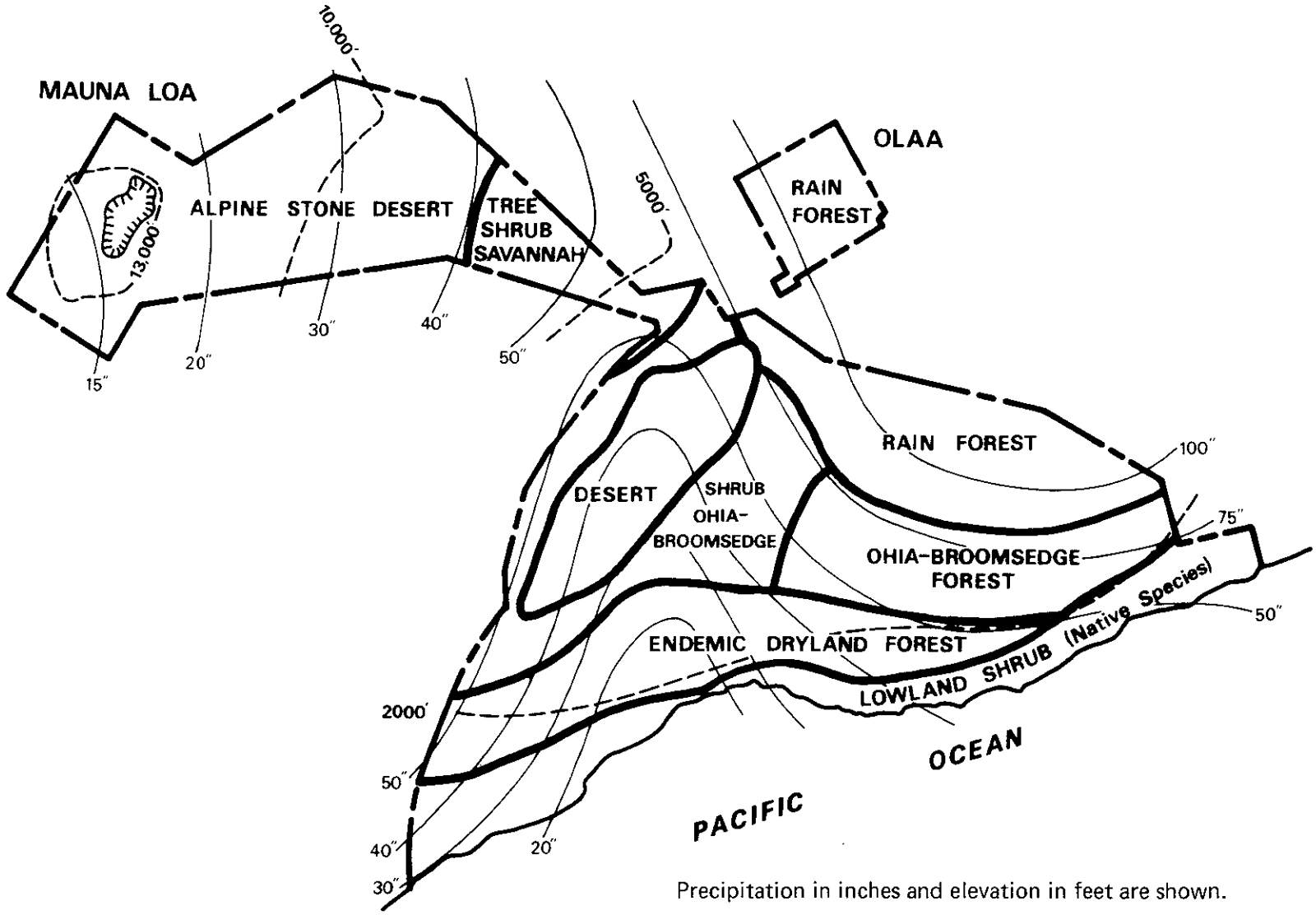


Fig. 9. General anticipated vegetation systems if this plan is followed (zones of lower elevation will largely be native species).

FIG. 9a. On the tradewind side of Kilauea Volcano are exceptionally fine ohia-fern forests.

Hawaii Volcanoes National Park contains an exceptionally fine remnant of this flora and fauna. Of species listed in the park's checklist[4/] of higher plants and vertebrates, 235 plants, 11 birds, and 1 mammal are found nowhere else but in Hawaii.

Research is only now identifying strange endemic invertebrate ecosystems peculiar to lava tubes and recent lava flows that include a bizarre blind big-eyed hunting spider, the cave tree cricket, and blind big-eyed water treader.

The park offers a substantial biological transect from the stone desert at Mauna Loa's 13,680-foot summit down through shrub and koa forest savannahs, ohia-fern forest, Hawaiian dryland forests, and low grasslands by the sea. On the Hilo side of this transect--facing the moist tradewinds--are exceptionally fine rain forests; the Kau side--shielded from the trades--is desert. Figure 8 and 9 show generalized plant zones. Detailed descriptions and vegetation-type maps are in the park's Atlas for Bioecology.[4/]

Despite being one of the largest and best preserved remnants of endemic Hawaiian natural history, the park has been--and is--suffering incredible biologic losses. The park area and its immediate environs has had twice as many extinctions of bird species as the entire mainland United States. Half the surviving forest birds on the Big Island are listed as "endangered" in the U.S.D.I. Red Book.[5/] If documented, the plant and invertebrate losses would likely appear equally disastrous.

The major cause of decline and extinctions on such a gigantic scale has been the mass introduction of continental species beginning with Captain Cook's release of goats on the Big Island in 1778. The effect of exotic introductions upon isolated island ecosystems is well documented and not peculiar to Hawaii alone. The Galapagos, New Zealand, Australia, and Madagascar share similar biologic tragedy. Hawaii is unique in that losses here are greater.

The number of exotic introductions is huge and continuing. Hawaii Volcanoes National Park has 427 known species of exotic plants--a hundred more than the number of native species. A few species, however, are the most destructive. Goats (Fig. 5) and pigs (Fig. 6) have caused major vegetation-type shifts (Fig. 12). The picture is graphic in illustrating the effect of goats on Hawaiian plants that have been isolated for so long without vegetarian mammals that they have lost all defenses against browsing or grazing. Hawaiian plants lack thorns, thick bark, bad taste, poisons; they are highly palatable, tender, nutritious--and vulnerable.

4/ See footnote 1 on page 18.

5/ U. S. Department of the Interior. 1973. Threatened Wildlife of the United States. Bureau of Sport Fisheries and Wildlife (Resource Publ. #114).

Rats and mongooses are predators that destroy populations of birds that evolved for aeons in the absence of predation. The unpalatable plants Andropogon, faya bush, ekoa, fountain grass, guava, and lantana invade widespread into lands denuded of native plants by goats; the new invaders provide no habitat for Hawaiian birds or invertebrates.

Table 4a. Status of non-native feral mammals in Hawaii Volcanoes National Park, July 1973.

Species	"Guess" Estimate Minimum Number In Park	"Guess" Estimate Maximum Number In Park
Goats	6,000	10,000
Pigs	2,000	6,000
Cattle	20	30
Sheep	20	30
Cats	200	400
Dogs	2	5
Black rats	1/acre	10/acre
Mongoose	1/100 acres	1/acre

Wilderness

Wild lands in the park now under study for classification as wilderness under the Wilderness Act are shown on the Wilderness Map, Figure 10. These have fine wilderness character only in the sense that they are unmarred by manmade developments; but they are profoundly scarred biologically--devastated by goats, pigs, cattle, rats, mongooses, and exotic grasses introduced on the island by modern man. Great acreages bear no resemblance to their pre-modern man wilderness character.

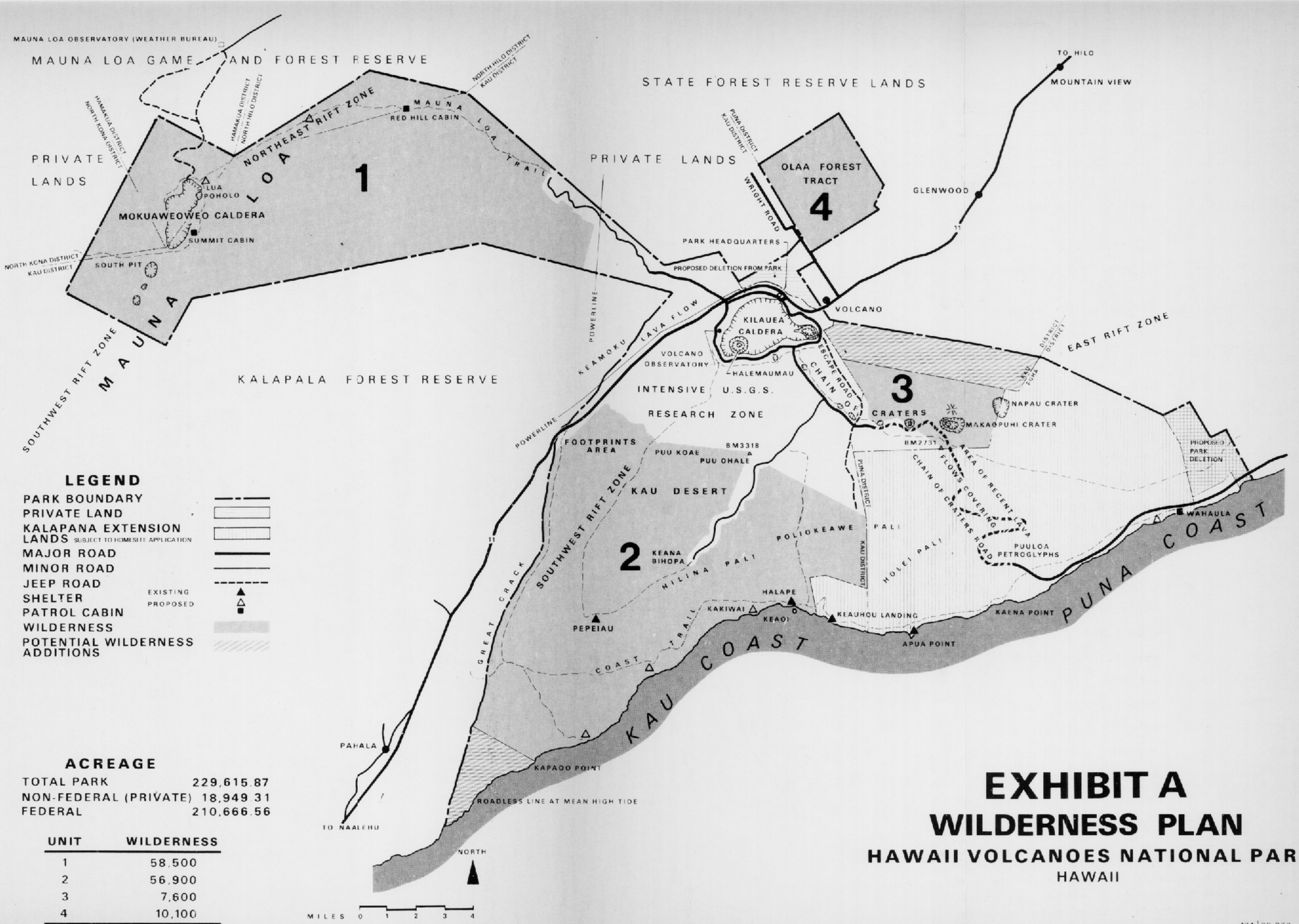
Archeology

The park preserves one of the largest single accumulations of stone structural remains in the Hawaiian Islands and, therefore, is a rich source of research material. Much of the stone remains are, however, unsuitable for the recovery of detailed information. Deposits of habitation material are rare. Only about 9 or 10 sites are regarded as potentially suitable for excavation. The extreme rarity of such sites requires that the utmost care be exercised in their investigation. In fact, it seems clear that some aspects of Hawaiian prehistory can best be investigated only within the park.

Table 5. Status of land birds native to the Big Island of Hawaii.

Species[1]	Distribution	Status of Rare Species
Nene	endemic; Big Island, Maui	"endangered"
Io or Hawaiian hawk	endemic; Big Island	"endangered"
Hawaiian rail	endemic; Big Island	extinct
Pueo or Short-eared owl	this ssp. is endemic to Hawaiian Islands	
Alala or Hawaiian crow	endemic; Big Island	"endangered"
Omao or Hawaiian thrush	endemic; Kauai, Molokai, Big Island	ssp. on Kauai and Molokai, "endangered"
Elepaio	endemic; main Hawaiian Islands	
Hawaii oo	endemic; Big Island	extinct
Kioea	endemic; Big Island	extinct
Amakihi	endemic; main Hawaiian Islands	
Greater Amakihi	endemic; Big Island	extinct
Creeper	endemic; main Hawaiian Islands	ssp. on Oahu, Molokai, and Hawaii[2], "endangered"
Akepa	endemic; main Hawaiian Islands	All remaining ssp except on Kauai, "endangered"
Akialoa	endemic; Oahu, Lanai, Big Island	extinct
Akiapolaau	endemic; Big Island	"endangered"
Ou	endemic; Big Island, Kauai	"endangered"
Palila	endemic; Big Island	"endangered"
Greater koa finch	endemic; Big Island	extinct
Lesser koa finch	endemic; Big Island	extinct
Grosbeak finch	endemic; Big Island	extinct
Apapane	endemic; main Hawaiian Islands	
Ula-ai-hawane	endemic; Big Island	extinct
Iiwi	endemic; main Hawaiian Islands	
Mamo	endemic; Big Island	extinct

1/ Common names of species as in Berger, A. J. 1972. Hawaiian Birdlife.
2/ The ssp. of creeper on the Big Island is in as great a danger of extinction as either the akiapolaau or akepa. We expect it to be cited as "endangered" on the Department's next official endangered species listing.



LEGEND

- PARK BOUNDARY
- PRIVATE LAND
- KALAPANA EXTENSION LANDS SUBJECT TO HOMESITE APPLICATION
- MAJOR ROAD
- MINOR ROAD
- JEEP ROAD
- SHELTER — EXISTING / PROPOSED
- PATROL CABIN
- WILDERNESS
- POTENTIAL WILDERNESS ADDITIONS

ACREAGE

TOTAL PARK	229,615.87
NON-FEDERAL (PRIVATE)	18,949.31
FEDERAL	210,666.56

UNIT	WILDERNESS
1	58,500
2	56,900
3	7,600
4	10,100
TOTAL	123,100

POTENTIAL WILDERNESS ADDITIONS 7,850 ACRES

EXHIBIT A
WILDERNESS PLAN
HAWAII VOLCANOES NATIONAL PARK
HAWAII

REVISION TO PRELIMINARY

124 | 20,020
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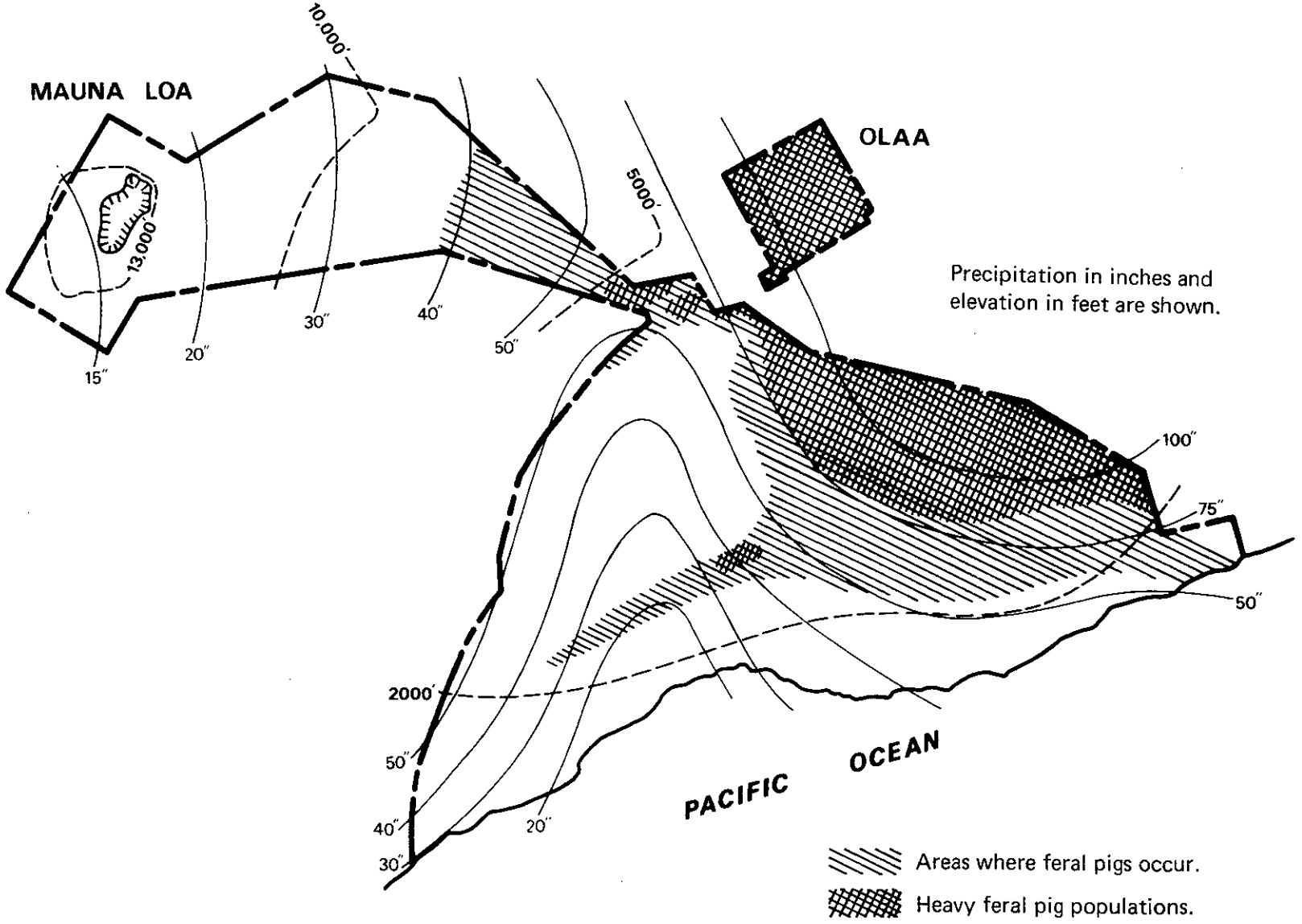
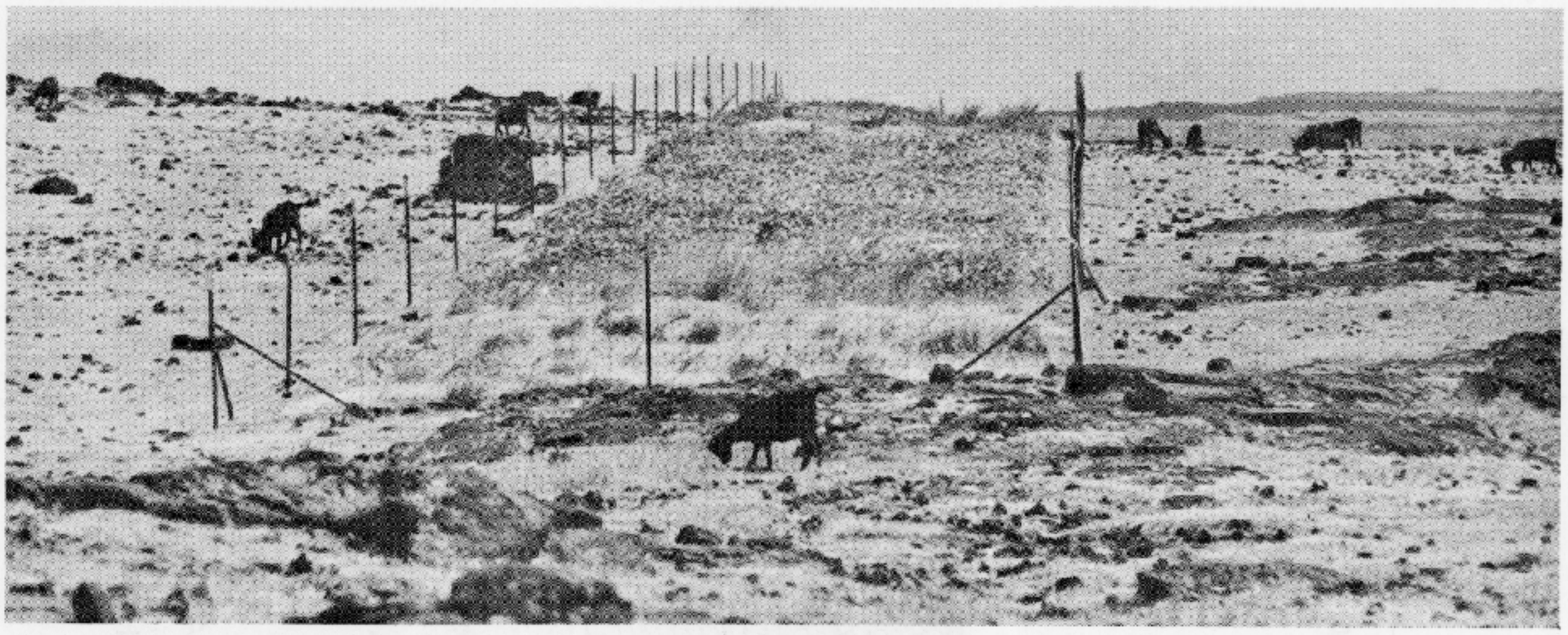


Fig. 11. Distribution of feral pigs in the park.



Species	% Cover OUTSIDE Exclosure	% Cover INSIDE Exclosure
PLANTS NATIVE TO HAWAII:		
Awikiwiki, *Canavalia (kauensis)*	None	45.0
Crabgrass, *Digitaria pruriens*	0.4	23.2
Pili Grass, *Heteropogon contortus*	None	1.2
Wild Portulaca, *Portulaca cyanosperma*	None	Trace
Total Ground Cover by Natives	0.4%	69.4%
EXOTIC PLANTS:		
Lovegrass, *Eragrostis tenella*	20.0	0.6
Burmuda Grass, *Cynodon dactylon*	17.2	18.8
Sedge, *Cyperus compressus*	4.4	None
Molasses Grass, *Melinis minutiflora*	1.6	None
Sedge, *Bulbostylis capillaris*	1.6	None
Three-flowered Beggarweed, *Desmodium triflorum*	0.4	1.2
Alaalapuloa, *Waltheria indica*	None	2.4
Partridge Pea, *Cassia leschenaultiana*	None	2.4
Total Ground Cover by Exotics	45.2%	25.4%
BARE SOIL AND ROCK	38.0%	None
LITTER	14.4%	None

FIG. 12. Comparison of plant cover inside and outside the Kukalauula Goat Exclosure. Data collected December 1971, 2 years after the exclosure was constructed. Photograph dipicts differences.

Data from Mueller-Dombois, D. and G. Spatz. 1972. The Influence of Feral Goats on the Lowland Vegetation in Hawaii Volcanoes National Park. Island Systems IRP, U.S. International Biological Program Techn. Rept. No. 13. 46 pp.mimeo.

FIG. 12a. Pig activity may stimulate the spread of guava, an exotic tree. The seeds are found in pig droppings.

The sections of the Puna and Kau coasts lying within the park are rich in remains of villages, temples, canoe landings, petroglyphs, shelter caves, heiaus, and other evidences of native life. They represent various aspects of ancient and historic Polynesian culture. Sites situated in widely scattered sheltered areas along the rugged Puna Coast were occupied from prehistoric times until the middle 1800's. This sparsely inhabited coast and adjacent upland benches required special adaptation to severe environmental conditions. The people who lived here were mainly fishermen and farmers, and in the uplands some were bird hunters.

Archeological field work was undertaken in 1959 when the Bishop Museum, under the direction of Dr. Kenneth P. Emory,[6/] made an extensive field survey. A second survey[7/] continued the assessment of the park's archeological resources and suggested avenues along which more detailed investigations might proceed. These surveys recorded 380 sites, but there are certainly many more. Between 1962 and 1968 several small sites were salvaged as part of the Chain of Craters Road project.

Wahaula Heiau--Red Mouth Temple--is one of the better known temple sites in the district of Puna. It is reported to have been established and constructed by the foreign chief Paao in A.D. 1275. Kailiili Village site adjoins Wahaula and probably supported the temple. Culturally speaking, it is probably the only uncontaminated ruin in the Puna area. It has the distinction of being the only place along the Puna coast where iliili, small water-polished stones used for paving the temple and the house sites, are found. Moreover, this complex is the most important archeological area in the park and one of the most significant in the Hawaiian Islands, as it is important in the story of Paao and the introduction of the heiau Luakini and the ritual worship of major Hawaiian gods. It is in remarkably fine condition and has an impressive appearance.

Site 911 is a small cave shelter west of Kailiili Village near the coast which was used by the ancient Hawaiians as a shelter and an occasional overnight campsite from about A.D. 1300 to modern times.

Kamoamoa Village site represents an area where two periods of time appear to be superimposed. The ancient village appears to

6/ Emory, K. P., et al. 1959. Natural and Cultural History Report of the Kalapana Extension of the Hawaii National Park. Bernice P. Bishop Museum, Part I, 126 pp. and Part II, 67 pp.

7/ Smart, C.D., et al. 1965. The Archeological Resources of Hawaii Volcanoes National Park. Dept. of Anthropology, Bernice P. Bishop Museum. Part I, 110 pp. and Part II, 48 pp.

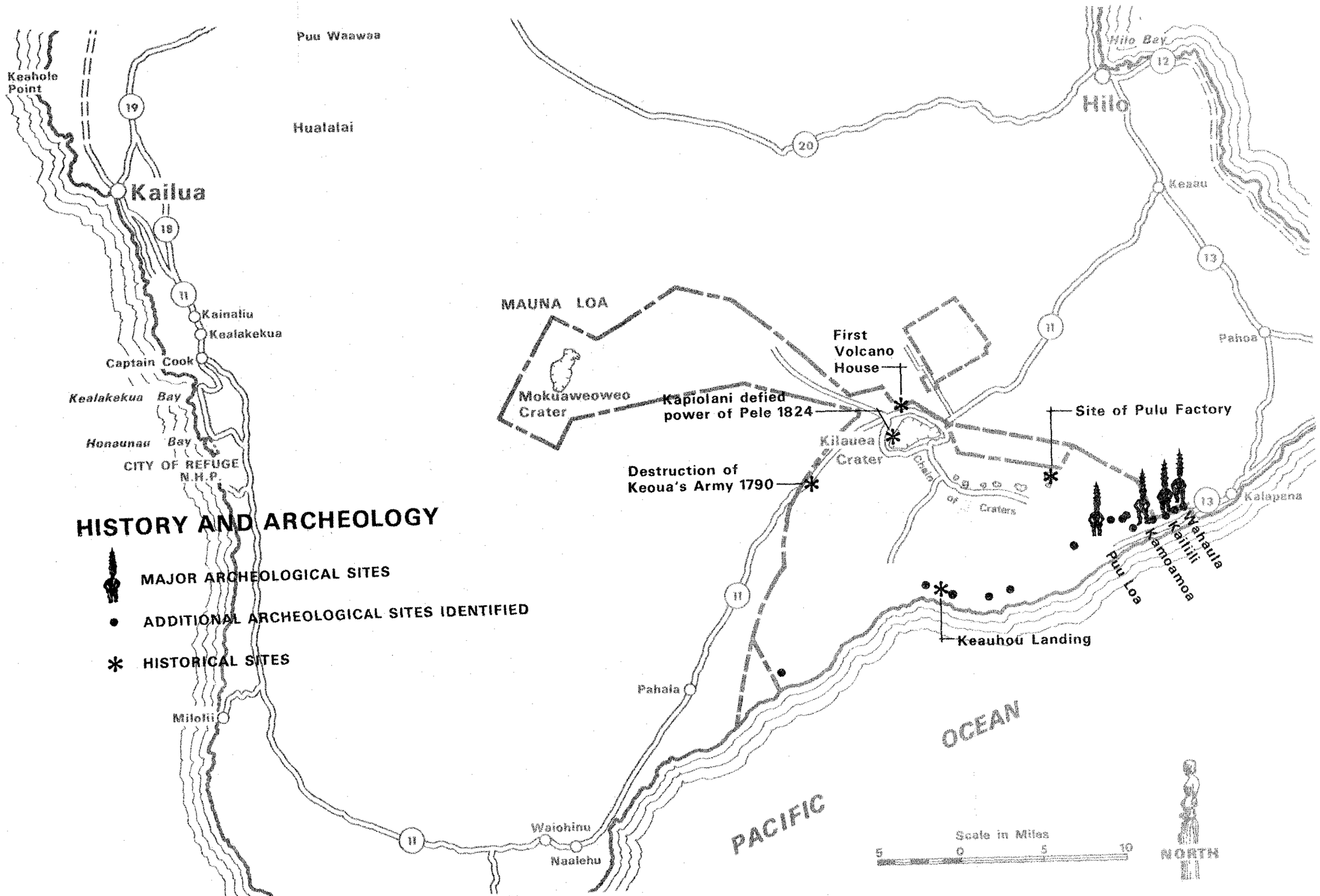


Figure 12b. Major Historic and Archeologic Sites

be farther back from the shore and the later (historic) development is toward the ocean.

The Puu Loa petroglyph field is the largest concentration of "rock carvings" in the park. It is located along an old Hawaiian trail inland from the village of Laeapuki. Many of the petroglyphs are ancient, as they have been almost completely obliterated by successive drawings and erosion. The petroglyph area is about one-half acre, one of the three largest in the Hawaiian Islands.

History

Captain James Cook, R.N., discovered Hawaii for the Western World in 1778 and died at Kealakekua Bay in 1779. His ships, the H.M.S. Discovery and H.M.S. Resolution, in 1779 navigated offshore from what is now Hawaii Volcanoes National Park, trading with the Hawaiians of Puna and Kau, exchanging nails, beads, and cloth for pigs, fruit, and salt.

The historic events that occurred within the park after Captain Cook first viewed the Puna-Kau coast are of value chiefly in their association with events that occurred elsewhere, and in the descriptions of the volcano and the coastal Hawaiian habitation recorded in accounts of early travelers. The destruction by a Kilauea explosive eruption of a portion of Keoua's Hawaiian Army in the Kau Desert in 1790, while on its way to battle the forces of Kamehameha, was a factor in the eventual rise of Kamehameha as ruler of all Hawaii. Fossil footprints of some of the Hawaiian warriors still remain today in the Kau Desert.

Kilauea first felt Western shoes in 1823 when a band of Christian missionaries found the summit active and wrote such vivid and widely read descriptions that thereafter Kilauea was of prime scientific interest as well as a desired visitor destination. By the 1840's, before Yosemite Valley had even been discovered, Kilauea Volcano had become a regular stop for tourists to Hawaii. They stayed in native-style huts until, in 1866, a commercial hotel, the Volcano House, was established on the rim. The Hawaiian Volcano Observatory was founded in 1912. Hawaiians held the Kilauea summit sacred, and it was at Halemaumau, the principal vent of Kilauea, that the image of Pele, the volcano goddess, was weakened by the High Chieftess Kapiolani. She was a convert to Christianity who defied Pele in 1824 by eating ohelo berries without the traditional offering while also proclaiming the Christian god supreme.

Several relatively recent historic sites have been identified as important. One is the "Old Volcano House" of 1877 which still stands. Another is the Keauhou Landing Site which for a time in

the middle 1800's was a landing for tourists coming to the Kilauea Volcano. The landing and village were virtually destroyed by the 1868 tsunami (tidal wave). A few coconut trees and remains of the old wharf are all that are left of what was once a fairly large village and steamship port.

A third historic site of some significance, a ruin of a factory for producing pulu (a fern product) is located on the trail between Makaopuhi and Napau Craters.

THE LOCAL AND REGIONAL ENVIRONMENT

Land Character

The Big Island--Hawaii--with an area of 4,038 square miles is almost twice the combined size of the other islands in the state. It has generally smooth and gently sloping topography related to the five volcanoes which created the island. The climate is largely the product of the prevailing trade winds, high mountain masses, and elevation. Annual temperature averages a balmy 75 degrees F. at sea level, but freezing winter weather is to be expected on the snowy summits of Mauna Loa and Mauna Kea where elevations exceed 13,000 feet.

The eastern side of Hawaii intercepts the moisture-laden trade winds and favors lush vegetation in humid rain forests and commercial sugar cane fields. The island's northwest coast protected from the trade winds presents a desert appearance with cactus-dotted range land.

Management and planning for Hawaii Volcanoes National Park are affected by the character, ownership, and use of surrounding lands. Barren lava flows at high elevations, and scrub forest below, border the Mauna Loa section. Grazing in the scrub vegetation is the only use of these lands. Grass and scrub range lie west of the park's Kilauea section. Forests are contiguous with most of the eastern boundary. Adjacent lands are primarily under trust estate and State ownership. Between the Kilauea section and the Olaa Forest Tract are estate lands leased for small homesites, agriculture, and a golf course. The balance of the tract is surrounded by forest and grazing lands. There is subdivision activity close to the boundary in the Kalapana section.

Population

The island's civilian resident population in 1971 was about 66,000. Hilo--with half the island's population--is the county seat and the fourth largest city in the State. It is a 40-minute drive from downtown Hilo to the park's center for visitor activities at Kilauea summit. In addition to Hilo, the four largest population

centers on the island are Papaikou (1 hour from the park), Honokaa (2 hours away), Pahala (45 minutes away), and Captain Cook (2½ hours away). The ethnic makeup of the resident population in 1970 was: Japanese, 38%; Caucasian, 29%; Filipino, 17%; Hawaiian, 12%; Chinese, 3%; and others, 1%.

Population trends are reflected in the following table:

Table 6. Island of Hawaii Resident Population

	1920	1930	1940	1950	1960	1970	Projected 1980	Projected 1990
Number of Residents	64,895	73,325	73,276	68,350	61,332	63,468	84,000-99,000	115,000-137,000

Mainland visitors swell the island's population. Trends in visitors are shown in Table 7.

Table 7. Westbound Visitors to the Island of Hawaii

Year	Total Number of Westbound Visitors
1962	75,305
1963	102,025
1964	126,330
1965	161,515
1966	177,665
1967	286,590
1968	369,509
1969	410,697
1970	462,777
1971	522,777

Economic Activity

The island's economic activity is based largely on sugar and tourism, though the island also produces 62% of the beef, 71% of the fruits (other than pineapple), and 36% of the vegetables raised in the State. An indication of the island economic activity is shown in Table 8 of Big Island employment:

Table 8. Big Island Employment 1971

Industry	Number of People in the Labor Force
Trade	5,540
State and local government	4,280
Service and miscellaneous (½ is hotel)	4,130
Unpaid self-employed, non-agricultural, family workers, and domestics	3,290
Agriculture (½ is sugar)	3,260
Manufacturing (includes 10 sugar mills)	2,800
Unpaid self-employed family workers, agriculture	2,260
Contract construction	1,820
Unemployed	1,740
Transportation, communication, utilities	1,390
Finance, insurance, real estate	910
Federal Government	370
Total Labor Force	31,790

PROBABLE FUTURE OF THE ISLAND'S ENVIRONMENT

Even with the proposal the outlook for surviving Hawaiian biota is not promising. Figures 13 through 38 show remaining distributions of 26 rare and endangered plant species. Figures 39 through 43 show remaining distribution of five rare and endangered birds.

Trends in spread of exotics and changing land patterns outside the park suggest a continuing decline in native ecosystems with gradual transitions from forest land to pasture land and from pure native forest to exotic or partially exotic forests. On the Big Island, areas of the State Department of Land and Natural Resources natural areas and the national park appear to be the only lands where actual management efforts are aimed at protecting native ecosystems.

The State's natural areas have a clear objective of preserving native Hawaiian ecosystems. The national park's mandate is expressed in the August 1, 1916 (39 Stat. 432) Act to establish a national park in the Territory of Hawaii--"Be it enacted that the tracts of land on the island of Hawaii . . . hereinafter described, shall be perpetually dedicated and set apart as a public park . . . that the said park . . . shall provide for the preservation from injury of all timber, birds, mineral deposits, and natural curiosities or wonders within said park, and their retention in their natural condition as nearly as possible."

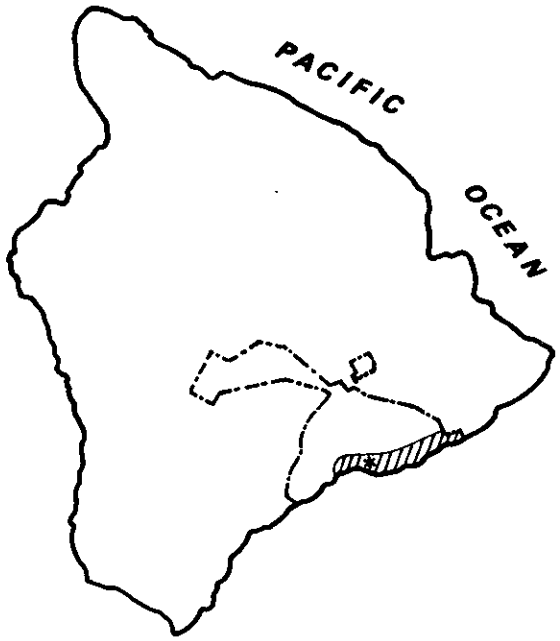
Without this proposal--or alternate proposals with similar goals and potential for success--there is little future for most of the Big Island's endemic biota. Hawaii Volcanoes--a large reserve with both good funding and excellent public support for nature preservation--would be abdicating its responsibility for managing native ecosystems. Conceivably, the Federal abandonment of managing these ecosystems would be contagious--and the State's nature reserves would have a more difficult time securing extensive funding for similar native resource management goals that depended partially upon concurrent actions on the large acreage national park.

If so, then dozens of endemic plant species on the Big Island would cease to exist as wild, dynamic populations. Hundreds of invertebrate species down the food chain and dependent upon those plants would disappear. Three-quarters of the remaining native forest birds would become extinct. Gradual, but final, vegetative type shifts would change the park's--perhaps the whole island's--plant communities from native Hawaiian forest and savannah lands to exotic, foreign plant associations. Extinction of species are final.

* Present known worldwide distribution.

▨ Anticipated distribution if this proposal is followed.

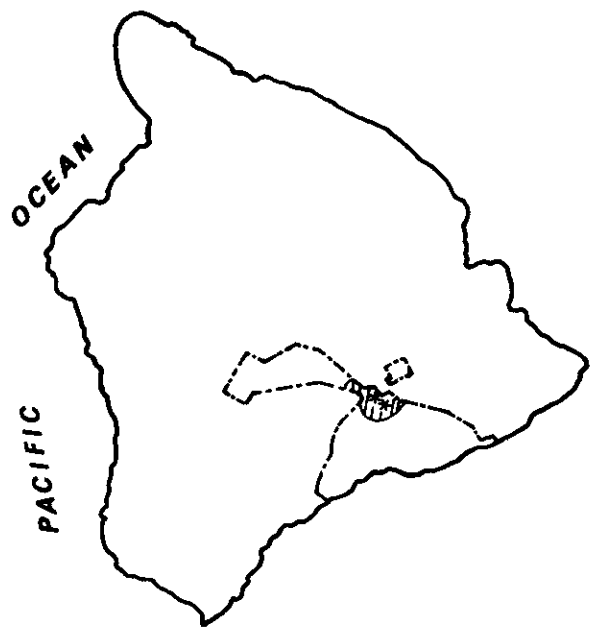
Fig. 13. Range of awikiwiki, *Canavalia kauensis.*



* Present known distribution on Hawaii.

▨ Anticipated distribution if this proposal is followed.

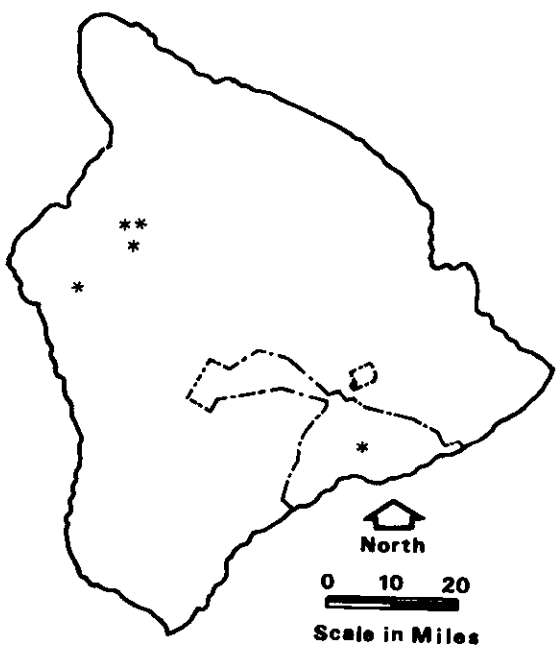
Fig. 14. Range of ohai, *Sesbania tomentosa.*



* Present known worldwide distribution.

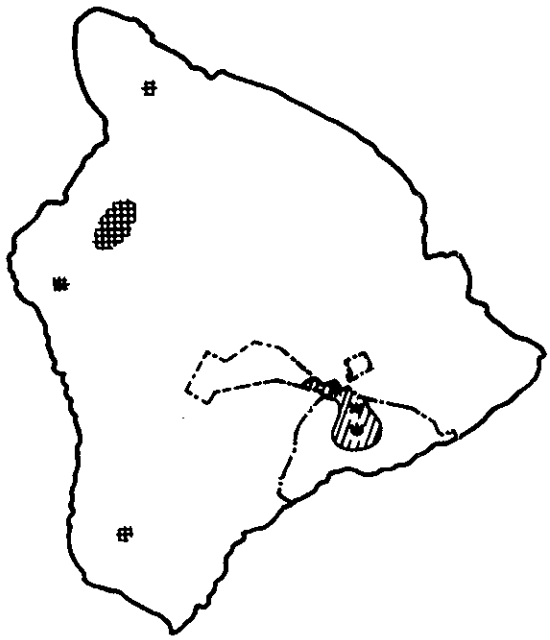
▨ Anticipated distribution if this proposal is followed.

Fig. 15. Range of hau–kuahiwi, *Hibiscadelphus giffardianus.*



* Present known worldwide distribution.

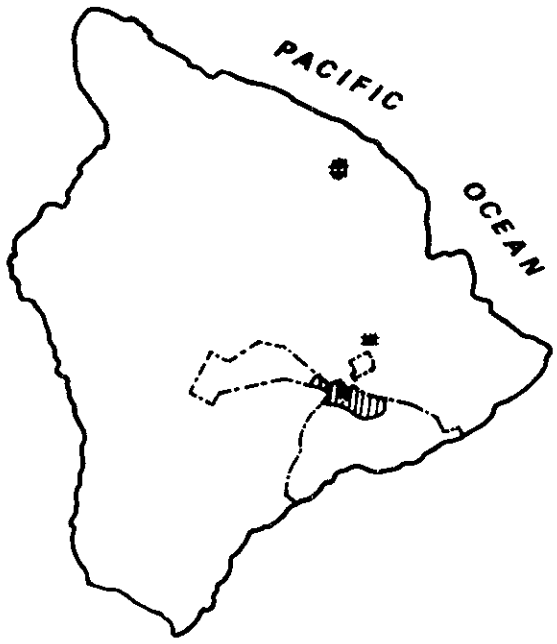
Fig. 16. Range of *Hibiscadelphus hualalaiensis.*



Present known worldwide distribution.

Anticipated distribution if this plan is followed.

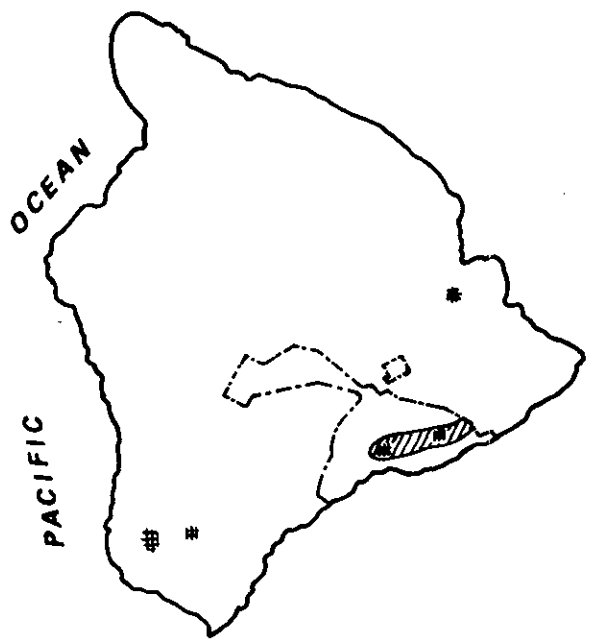
Fig. 17. Range of aiea, *Nothocestrum breviflorum.*



Present known worldwide distribution.

Anticipated distribution if this plan is followed.

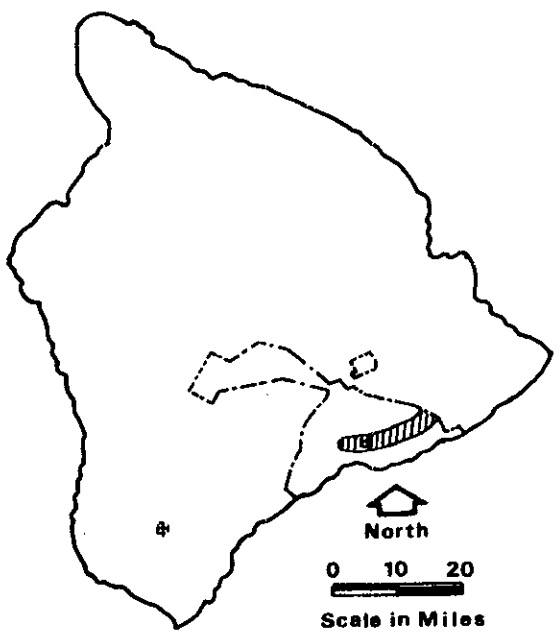
Fig. 18. Range of aiea, *Nothocestrum longifolium.*



Present known worldwide distribution.

Anticipated distribution if this plan is followed.

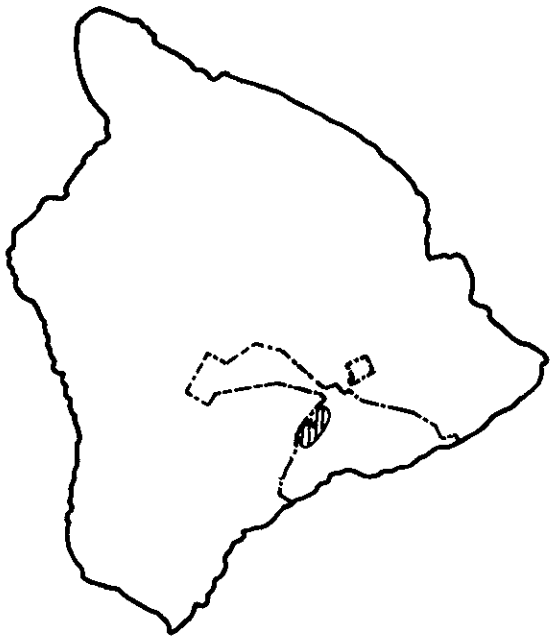
Fig. 19. Range of ahakea, *Bobea timonioides.*



Present known worldwide distribution.

Anticipated distribution if this pro- is followed.

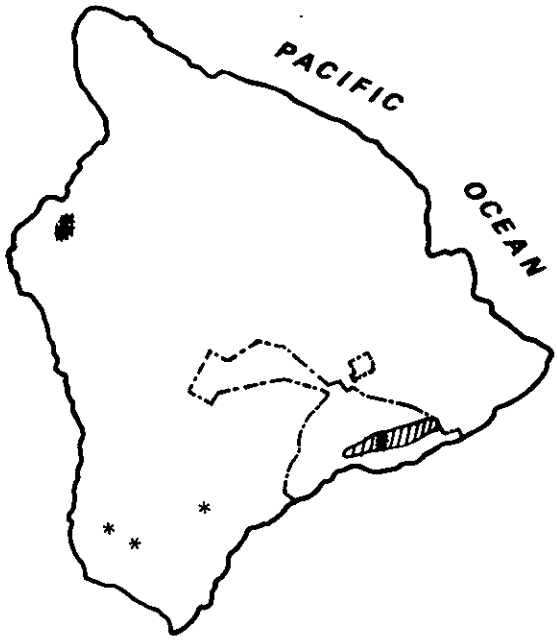
Fig. 20. Range of naupaka, *Scaevola kilaueae.*



* Present known worldwide distribution; known plants.

Anticipated distribution if this plan is followed.

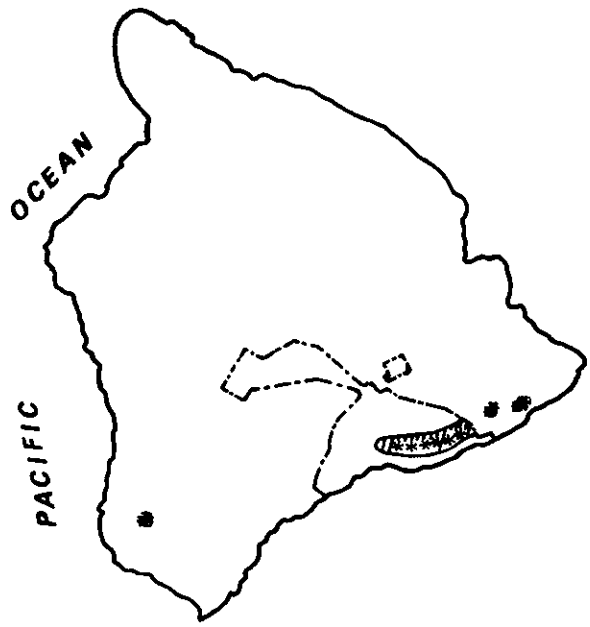
Fig. 21. Range of *Stenogyne angustifolia* var. *angustifolia.*



* Present known distribution on Hawaii (exists on Haleakala, Maui).

Anticipated distribution if this plan is followed.

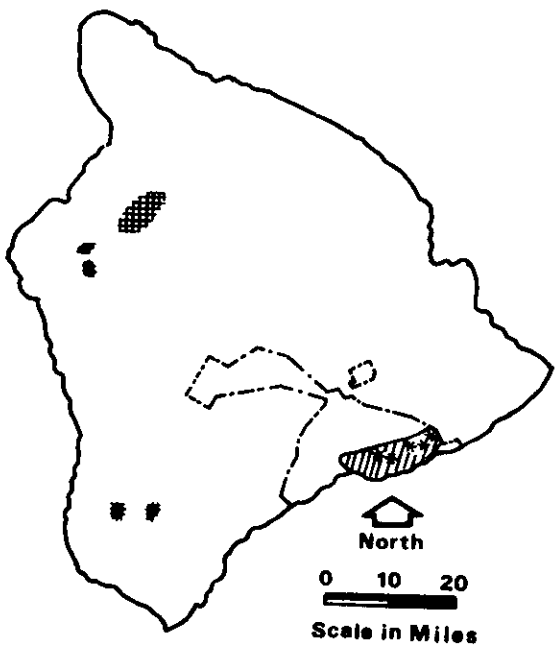
Fig. 22. Range of hame, *Antidesma pulvinatum* on Hawaii Island.



* Present known worldwide distribution.

Anticipated distribution if this plan is followed.

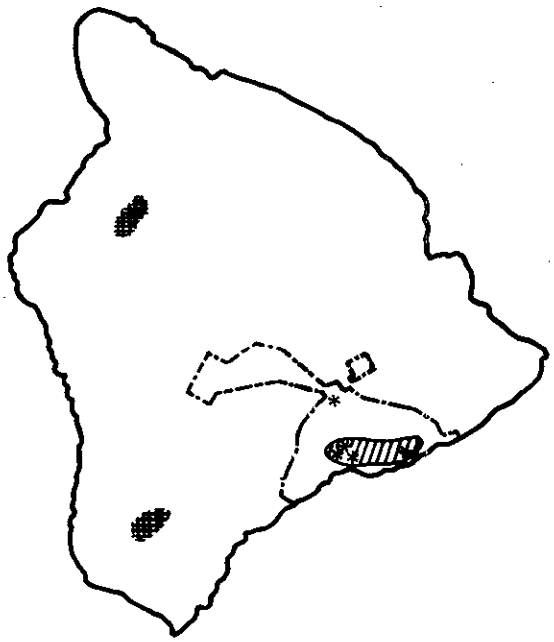
Fig. 23. Range of ohe makai, *Reynoldsia hillebrandii.*



* Present known distribution on Hawaii. Crosses are individual plants. (Exists on Kokee Park, Kauai.)

Anticipated distribution if plan is followed.

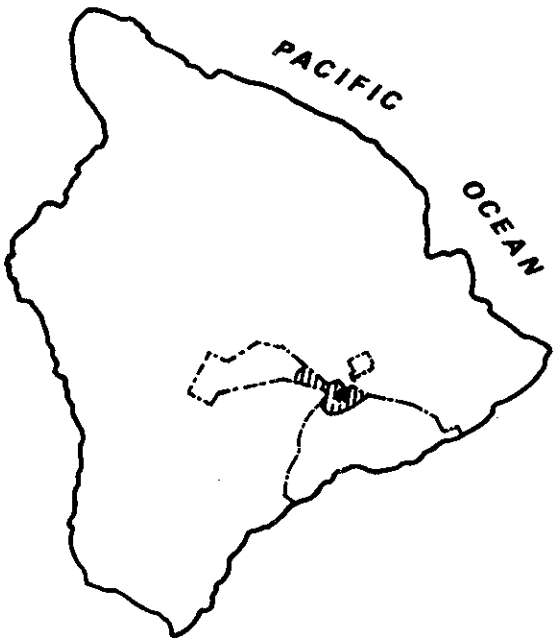
Fig. 24. Range of halapepe, *Pleomele aurea* on Hawaii Island.



* Known plants on Hawaii (occurs also at Kokee, Kauai, and Haleakala, Maui). Crosses are individual plants.

Anticipated distribution if plan is followed.

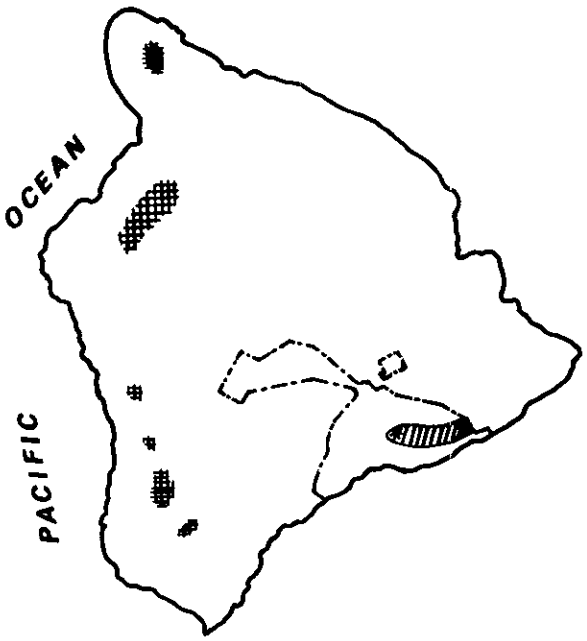
Fig. 25. Range of kauila, *Alphitonia ponderosa* on Hawaii Island.



Present known worldwide distribution.

Anticipated distribution if plan is followed.

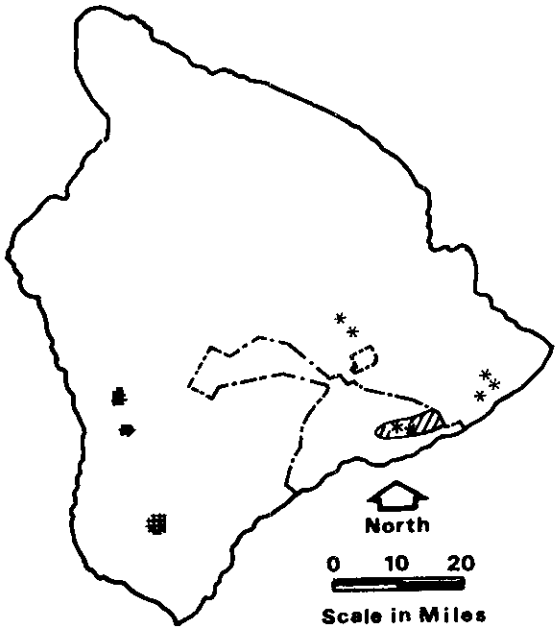
Fig. 26. Range of ae. *Zanthoxylum dipetalum* var. *geminicarpum.*



* Present known worldwide distribution.

Anticipated distribution if this plan is followed.

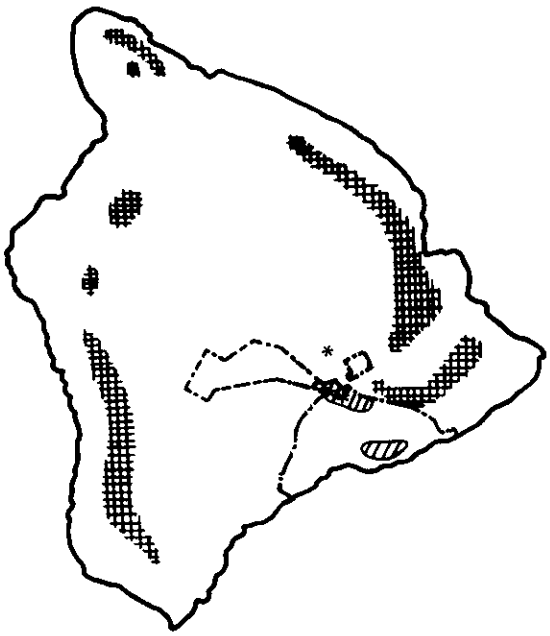
Fig. 27. Range of kului, *Nototrichium sandwicense* var. *macrophyllum.*



* Known plants on Hawaii.

Anticipated distribution if this plan is followed.

Fig. 28. Range of ohe mauka, *Tetraplasandra hawaiiensis* var. *hawaiiensis.*



* Known distribution (scattered) on Hawaii (still exists on other islands).

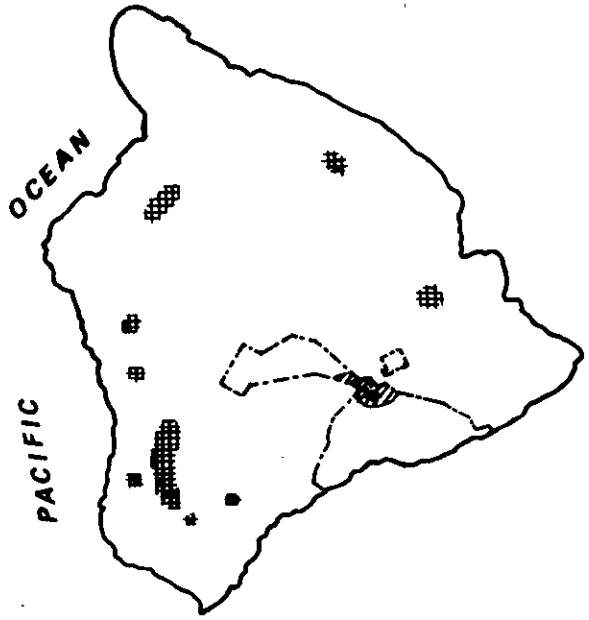
Anticipated added distribution in park if this plan is followed.

Fig. 29. Range of papala, *Charpentiera obovata* on Hawaii Island.

* Known individual plants on Hawaii (exists also on Haleakala and Kauai).

Anticipated distribution if this plan is followed.

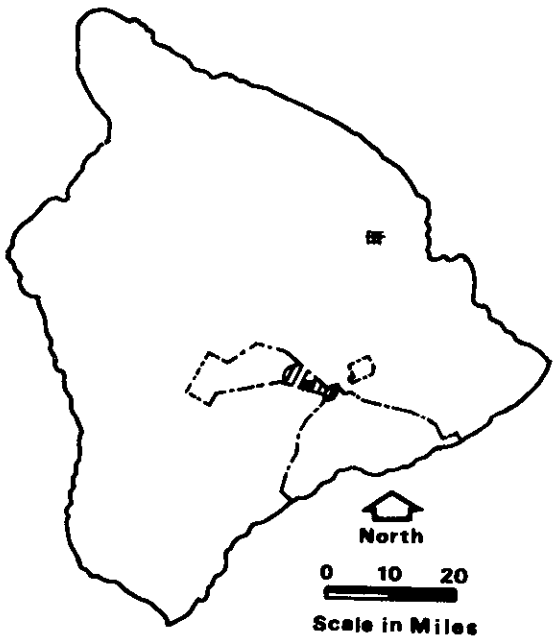
Fig. 30. Range of holei, *Ochrosia sandwicensis* on Hawaii Island.



Present known distribution.

Anticipated distribution if this plan is followed.

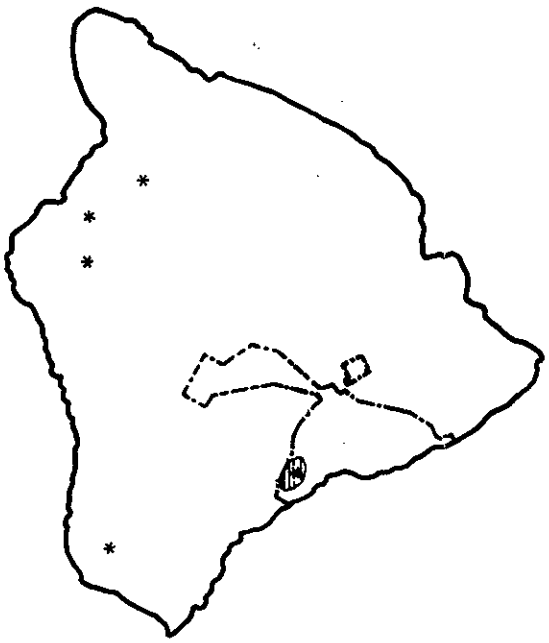
Fig. 31. Range of hoawa, *Pittosporum hosmeri*.



Present known distribution on Island of Hawaii.

Anticipated distribution on Island of Hawaii if this plan is followed.

Fig. 32. Range of silversword, *Argyroxiphium sandwicense*.



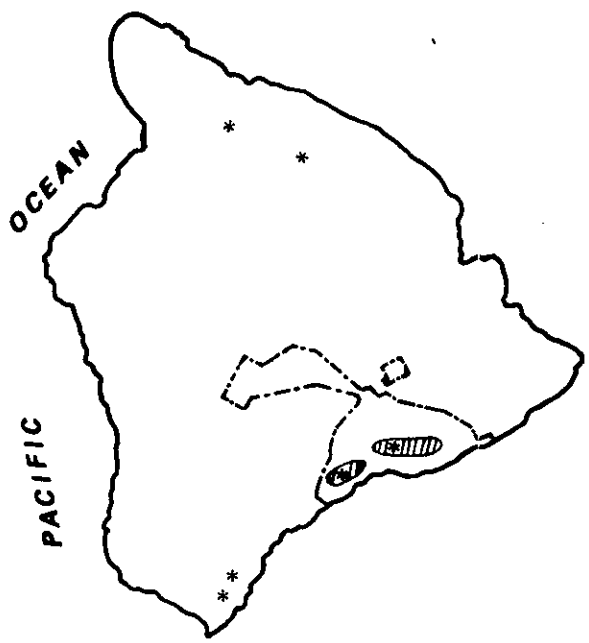
* Present known worldwide distribution (known individual plants).

Anticipated distribution if plan is followed.

Fig. 33. Range of oloa, *Neraudia ovata.*

* Present known worldwide distribution (known plants).

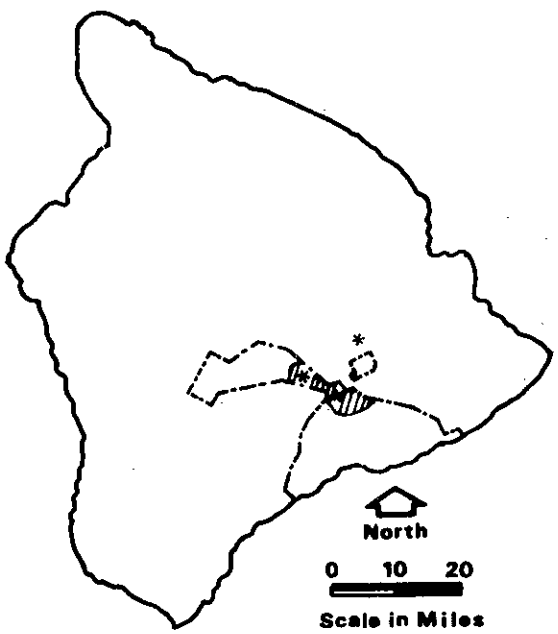
Fig. 34. Range of the tree fern, *Cibotium hawaiiense.*



* Present known worldwide distribution (known individual plants).

Anticipated distribution if plan is followed.

Fig. 35. Range of hao, *Rauvolfia remotiflora.*



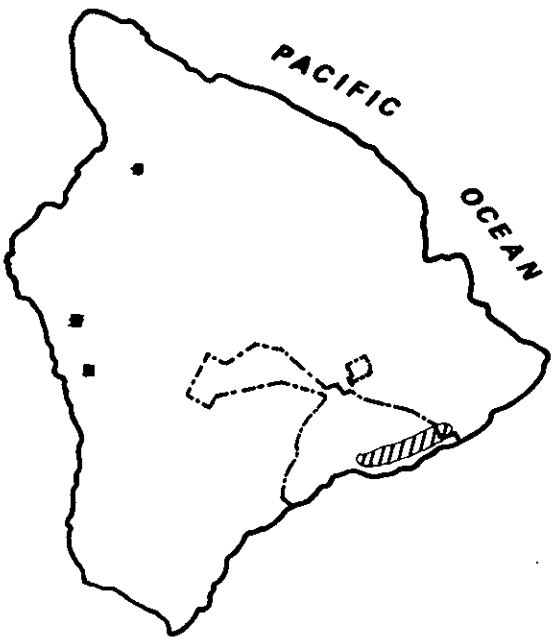
* Present known distribution on Island of Hawaii (known plants).

Anticipated distribution on Island of Hawaii if this plan is followed.

Fig. 36. Range of the ohelo, *Vaccinium pahalae.*

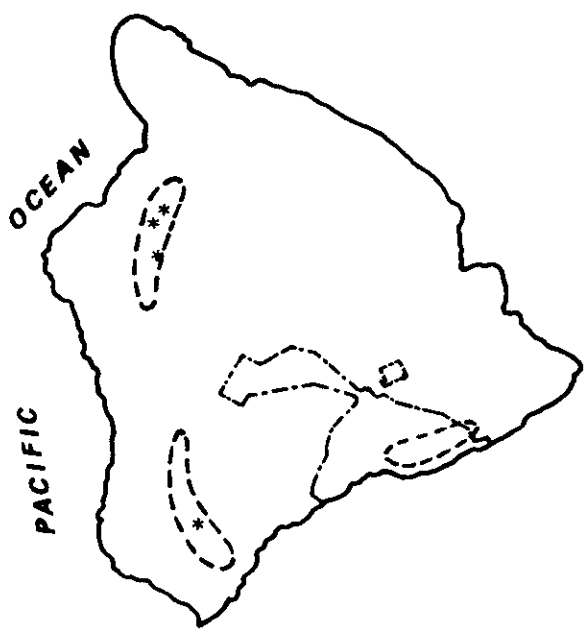
Present location of only known existing plants in the wild.

Speculated former distribution of uhiuhi before cattle and goats were introduced.



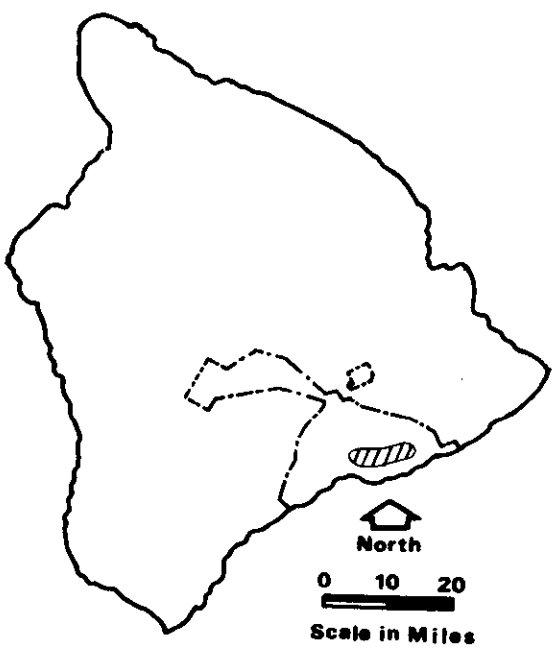
Anticipated wild distribution if this plan is followed.

Fig. 37. Range of uhiuhi, *Mezoneuron kauaiense.*



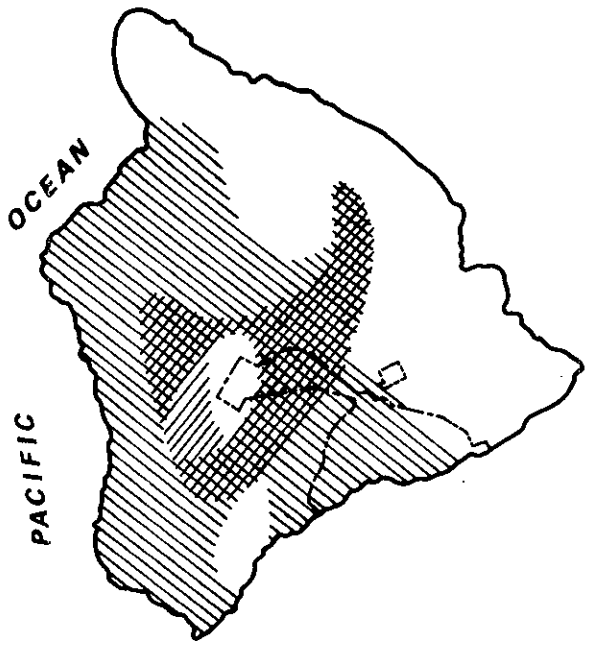
* Present worldwide distribution (known individual plants).

Speculated former distribution of kokio before cattle and goats were introduced.



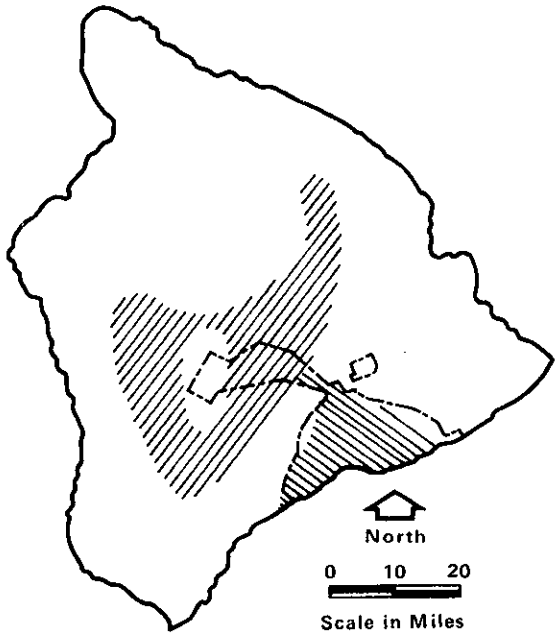
Anticipated distribution if this plan is followed.

Fig. 38. Range of kokio, *Kokia drynarioides.*



Present distribution

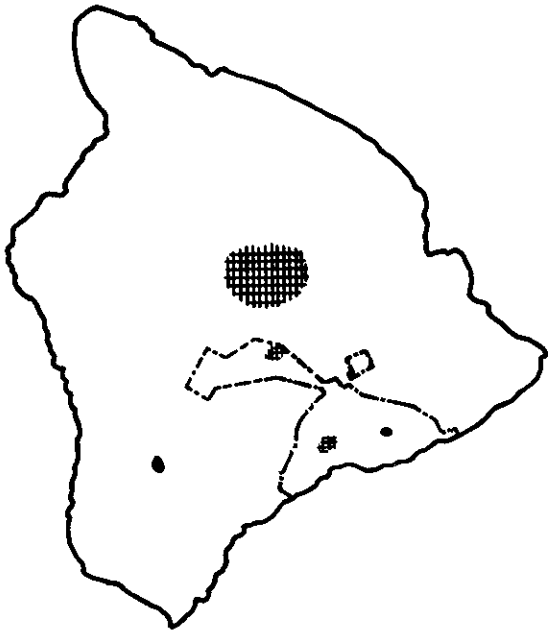
Former distribution



Likely future distribution without this plan.

Anticipated additional distribution if this plan is adopted.

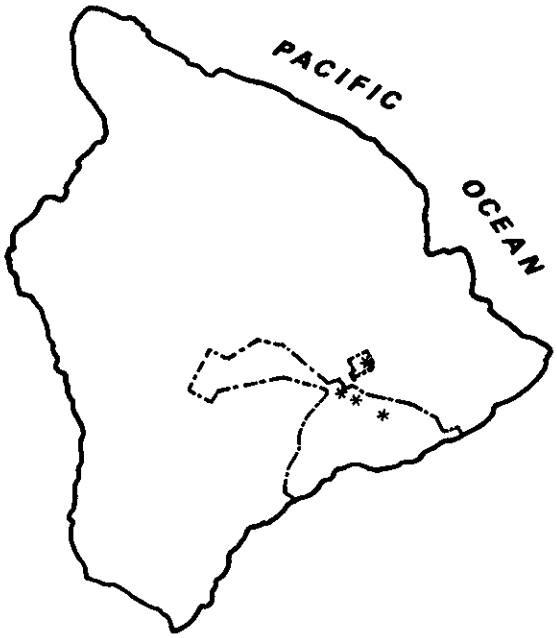
Fig. 39. Nene distribution on the Island of Hawaii. A small wild population (artificially supplemented) also exists on Haleakala, Maui. Together these are the extent of the worldwide wild population.



● Location of existing breeding sites on the Island of Hawaii.

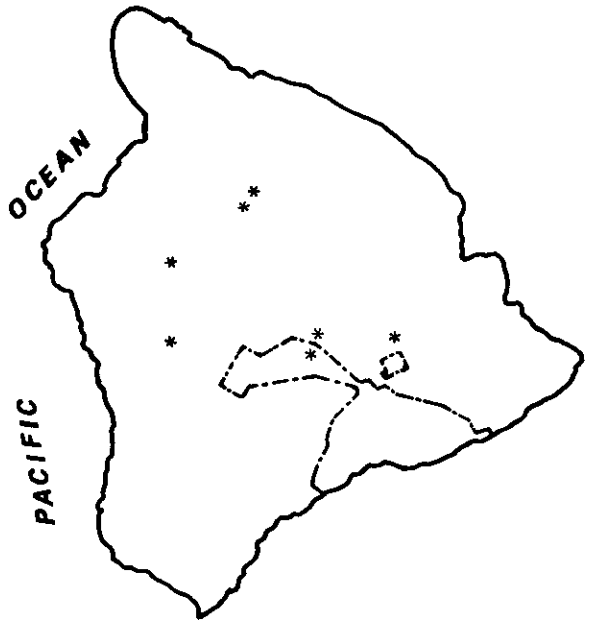
▓ Approximate location of former breeding sites.

Fig. 40. Hawaiian dark–rumped petrel



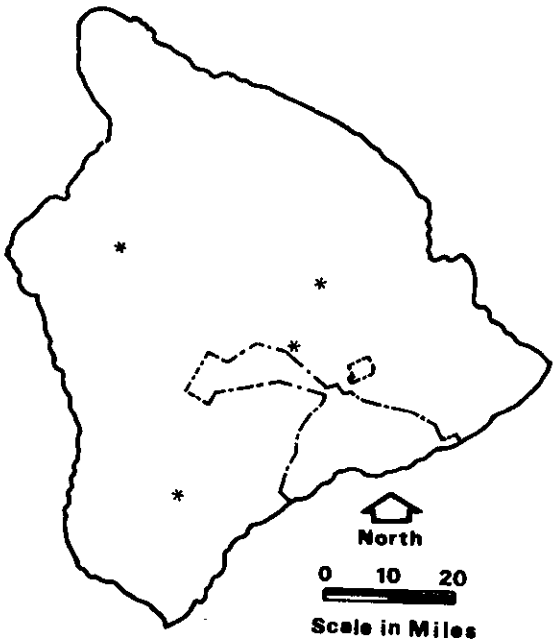
* Location of sightings on Island of Hawaii during last decade.

Fig. 41. Ou



* Location of sightings on the Island of Hawaii over the last decade.

Fig. 42. Akiapolaau



* Location of sightings on the Island of Hawaii over the last decade.

Fig. 43. Hawaii akepa

ENVIRONMENTAL IMPACT OF THE PROPOSED ACTION

The major consequence of this series of actions is that the park's native Hawaiian organisms and ecosystems will operate under much less influence and destruction of the exotic species introduced by modern man. The environment for many endangered plant species will be largely restored. Habitat for eight endangered birds can begin a recovery process--perhaps in time to save some of these species from extinction. The catastrophic effects of several exotic species--especially goats--introduced by modern man will be greatly reduced. Park visitors will encounter native Hawaiian forests and birds rather than exotic alterations of the environment resulting from pig and goat foraging. In the lowlands, hikers will traverse native savannah shrub lands rather than goat-created desert.

Other specific impacts vary according to the particular action:

REINTRODUCTION OF PLANTS

Planting operations will assure survival of the rare plants in Table 2 but can cause difficulty to researchers studying plant successions resulting from goat and pig removal--depending upon how widespread the plantings are in terms of acreage affected and species involved. Yet the plantings provide seed supplies for dozens of endemic species now so rare that they will likely never re-establish themselves unaided.

There is some risk of expanding the range of some rare species further than they naturally occurred. Because of their specialized niches, however, this risk should be minimal. The genetic integrity of those ecosystems where planting occurs will be reduced with the introduction of slightly different genetic stock. This effect is unavoidable where planting occurs. Its impact will be minimized by restricting planting to certain areas, and in some cases limiting the distribution of seed to the immediate proximity of the seed source. Records of all plantings detailing planting location and seed source will minimize confusion to botanical researchers. In this way, planting will preserve and restore to a high degree representative native ecosystems.

REINTRODUCTION OF NENE

The nene restorations require construction of six fenced pens, each 1 to 2 acres in extent. The pens then will involve 12 acres of the park's 220,000 acres. The pens are not along trails or in areas frequented by visitors; they are inconspicuous to the degree that they are not visible at distances greater than 200 yards from the pens.

CONTROL OF GOATS AND PIGS

Large numbers of goats (currently 4,000 per year) and pigs (500 per year) are taken by a variety of methods.

The Citizen Deputy Ranger Program to remove goats and pigs is offensive to many people who feel that any actions which might imply public hunting in the park should be prohibited.

Aspects of the reduction programs that involve professional park rangers shooting goats and pigs irritate many people who feel that if there is a surplus of goats and pigs, local people should be allowed to take them rather than have any "slaughtered" by rangers.

Commercial goat traders (who purchase live goats from the park at an average of $5/goat and market them at about $25/goat) object to any control effort that diminishes their trade or effectively reduces the herds to levels that threaten a continuing yield.

Fencing (46 miles of interior fencing and 104 miles of park boundary fencing) is permanent. About 30 miles of it lies in areas proposed as wilderness. The Wilderness Study for Hawaii Volcanoes National Park proposes a special provision in the park wilderness ". . . to provide for the use of whatever minimum fences, tools, and equipment that may be necessary to accomplish feral animal control."

Present fence maintenance techniques involve replacement of wire and posts on an average of 20 years--using an all-terrain vehicle (the "Coot" now used leaves no permanent scars on the land) to stretch wire, helicopter to drop in materials, generator-driven electric drill to drill 1-inch post holes in lava, and a 4 to 5-man maintenance crew living in tents. Wilderness designation will prohibit use of the all-terrain vehicle but will not deter us from using helicopter, electric drills, etc., because of the special provision in the wilderness proposal. Nonetheless, costs will double from the present fence replacement cost of $5,000/mile for fences in designated wilderness.

Gates are provided where trails intersect fences. Hikers in coastal areas could encounter as many as five fences on an extended trip; on the Mauna Loa Trail they would cross two fence lines. One trail--the Halape Trail--parallels a fence for 2 miles (this fence was built 40 years ago and the trail was worn in by people maintaining the fence; hikers now use it because it is the shortest route to Halape). Efforts to significantly and permanently reduce goat populations have failed repeatedly over the past half century; the simple reason is progress made in goat reductions could not be sustained without adequate boundary and internal fencing. Incredible

efforts involving removal of some 80,000 goats are negated when inadequate fencing allows herds to immigrate into goat-free areas.

Direct shooting as a control measure for goats and pigs has not been a safety hazard to visitors to date. Year-round open seasons on pigs and goats in the Deputy Ranger Control Program assure that there are no unsafe "opening day" crowds or "firing line" situations. As a result, our average number of deputies per day is only six--spread over 140,000 acres open on any given day to deputy control efforts. At an average density of one deputy per 22,500 acres there is little opportunity for conflict between deputies and park visitors. The maximum number of deputy rangers that participated on any given day during the last 6 months was 41.

Goat populations are low along trails, and the deputies generally seek animals off the regular visitor paths. We have the key Halape Trail, Thurston Lava Tube Trail, Puu Loa Petroglyph Trail, Bird Park Trail, and developed areas in safety zones closed to deputies.

Too, the number of pig deputy ranger parties (parties may not exceed 6 people; average is 2 to 3) is restricted to one party per management unit (average of 3,000 acres each). These parties sign up on a reservation basis to minimize conflicts.

Table 9 shows the accident record in calendar year 1972. It demonstrates that the impact on hunters' and visitors' safety will most likely be minimal if the same precautions are continued.

Table 9. Accident record at Hawaii Volcanoes National Park during 1972 related to the Deputy Ranger Program.

	No. of Injuries Related to the Deputy Ranger Program	No. of Injuries Not Related to the Deputy Ranger Program
Total injuries to all park visitors	0	37
Total injuries to visitors on trails or in back country	0	21*
Total injuries to National Park employees	0	2
Total injuries to deputy rangers engaged in control work	0	0

* 1 fatality

CONTROL OF RATS AND MONGOOSES

Rat and mongoose control efforts using traps and Warfarin have no side effects upon Hawaiian hawks, owls, or any native mammal (only the Hawaiian bat is native). Unfortunately--unless research discovers more effective measures--these control efforts have no widespread impact upon the rat and mongoose populations either. We are only successful in keeping rat and mongoose populations down in the two dozen acres involved in the nene breeding experiments. When, and if, research provides techniques that can be effective in lowering mongoose and rat populations, any proposed use of poisons will require relief from E.O. 11643.

CONTROL OF EXOTIC PLANTS

Exotic plant control is conducted by cutting and painting herbicides on individual stems. The chemicals are approved annually by the Department. The impact of the herbicides extends only to individual plants so treated. The overall effect on the park will be that visitors are more apt to encounter forests of native plants rather than exotics. Native Hawaiian birds will have more suitable habitats and the endangered birds will have greater chance of survival.

No known archeological sites and no properties listed on the National Register of Historic Places will be affected by the proposal.

MITIGATING MEASURES INCLUDED IN THE PROPOSED ACTION

Several measures are included in the proposed action to lessen any adverse impacts:

1. Large areas within the park will not be subject to the planting program and will remain untouched. By referring to park maps and records of plantings, these unaltered areas will be kept available for scientific studies. The planting program will be open to review by Hawaii botanists and interested persons on a continuing basis. Monitoring of planted sites by park personnel will serve as one means of investigating the possibility of hybrids and preventing any unnatural by-products of planting.

   No reestablishment of native vegetation is to be done in the 1959 Kilauea Iki Devastation Area or in the International Biological Program study transects that lie within the park. Control of exotic species in the Kilauea Iki Devastation Area will be limited to goats, pigs, and faya tree.

2. All participants in reduction programs will be closely supervised. In this way, any reduction in the park should be within Service objectives and policies; protection of all native animals will go hand-in-hand with the deputy role. Safety precautions will be continually observed to minimize on-duty injury and visitor hazard.

3. Design and character of the proposed interior fencing will assure that such fencing lies lightly and inconspicuously on the land (Fig. 2). We will avoid straight lines, clear no rights-of-way, and follow the lay of the land. Gates are provided where trails intersect fences.

4. Herbicides are used only by trained employees using biodegradable material given clearance annually by the Department. Poisons are used only in compliance with Executive Order 11643 assuring that any side effects to other organisms are fairly evaluated. (In fact, this is easier in Hawaii where all land mammals other than the bat are exotic.)

5. Current research is providing continuous feedback to modify aspects of the resource management efforts that are not effective or are destructive to other values, or to identify new or better approaches. At present Park Service research is concentrated upon determining the effect of pigs on native plants and birds, control of pigs, recovery of vegetation released from goat depredation, and propagation of rare Hawaiian plants. The Park Service also makes available housing to a Bureau of Sports Fisheries and Wildlife biologist studying native Hawaiian forest birds and to International Biological Program biologists studying all aspects of island ecosystems.

6. None of the actions will place manmade physical developments in the vicinity of archeological features. A professional archeologist has provided on-site clearance of the proposed 46-mile fenceline.

No additional fencing is contemplated in the entire Kalapana extension area. In the long run, the native and Polynesian plants favored in the plan are in closer character to the archeological ruins than recently introduced exotics. None of the historical structures that a Pacific historian has nominated to the National Register of Historic Places under EO 11593 lies within miles of any manmade physical developments proposed in this plan. One trail that was nominated as historic, the Mauna Loa Trail, is already crossed at right angles by two fences; no more are proposed. The State Historic Preservation Officer has been contacted and no comment was returned.

Should any archeological evidence be encounterd during manual planting, any further work will cease until the area is given onsite clearance by a professional archeologist.

ADVERSE EFFECTS WHICH CANNOT BE AVOIDED SHOULD THE PROPOSAL BE IMPLEMENTED

Though the effects of this series of actions are beneficial to the preservation of native Hawaiian biology, and regardless of the mitigating measures discussed previously, there are incidental adverse effects to other public values. These are:

1. Where rare plants of the species the park is propagating become established in the areas defined as planting zones, researchers will be unable to determine if these resulted from park operations or natural processes.

2. There is objection to the deputy ranger pig and goat control because of fears that this will evolve into a sport hunting program with an objective of sustained annual yield of goats and pigs from managed high goat and pig populations--at the expense of the native biota.

3. As numbers of pigs and goats are depressed to levels allowing survival of Hawaiian plants, the remaining pig and goat populations will be generally unproductive for deputy ranger harvest. Also, commercial goat traders (who purchase surplus live goats from the park at an average price of $5 and market them for an average price of $25) will find the park unproductive as a source of goats.

4. Forty-six miles of interior fences--however inconspicuous--will exist in the park. About 30 miles of this fence lies within areas proposed as wilderness. The Wilderness Study for Hawaii Volcanoes National Park proposes a special provision in the park wilderness ". . . to provide for the use of whatever minimum fences, tools, and equipment that may be necessary to accomplish feral animal control."

THE RELATIONSHIP BETWEEN SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The greatest benefits to be derived from an adequately managed Hawaii Volcanoes National Park are scientific in that if these disappearing endemic plant and animal communities can maintain even a semblance of their original integrity the information thus available can help indicate how other portions of our environment can be similarly maintained. This is especially significant in Hawaii because of the vulnerable nature of these ecosystems--complex insular biotic communities that developed somewhat independently of continental lifeforms but sensitive to competition from those same lifeforms.

If these resources can be maintained, the inspirational and educational opportunities for the public are legion. The dramatic displays of volcanism and their myriad opportunities for interpretation and research will continue despite man's operations. Many of the native birds and some rare plants, however, simply will not continue to exist without some positive management program that seeks to protect them.

The few adverse effects--undesirable aspects of goat and pig removal efforts, and visual intrusion of fences in wilderness--are far outweighed by long-term benefits to accrue to all people over all time by actions to preserve and restore the park's native biology.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES WHICH WOULD BE INVOLVED IN THE PROPOSED ACTION

The proposed actions are aimed at preventing irreversible and irretrievable losses of Hawaiian biota including the extinction of several birds and some two or three dozen higher plants.

The proposed actions can be halted at any time--fences removed; pig, goat, and exotic plant control abandoned--and the exotic pig, goat, guava, lantana, faya bush associations will quickly re-invade.

No non-renewable resources (landforms, archeological sites, historic sites) will be altered by this plan.

ALTERNATIVES TO THE PROPOSED ACTION

During long-standing natural history research efforts and management programs, many alternatives to the proposed actions have been considered and tried. Fundamental alternatives relate to the basic definition of objectives to be accomplished. Table 10 presents an evaluation of the park objectives compared to other possible alternative goals in preserving and managing the park's biotic resources.

If content with the statement of park purpose and objectives, there are many further alternatives to each facet of a resource management effort. Separate analysis by topic does not infer that these different components of the resource are unrelated. In fact, all aspects of the resource plan are as interdependent as a house of cards.

A. Alternatives in plant restoration are discussed in Table 11.

B. Alternatives related to methods for re-introducing rare and endangered birds (other than the nene) into recovering habitat must await continuing research. Present knowledge of the honeycreepers and the Hawaiian crow is inadequate to plan restoration efforts.

   The following alternatives were considered in planning re-introduction efforts with the nene:

   1. Do nothing. This is the most reasonable approach if the present proposal jeopardized the remaining population of nene. It does not. The number of birds involved with the program is a dozen; these are birds raised in the artificial breeding program at Pohakuloa.

   2. The proposed program disturbs very little area. It wastes no nene, and has a reasonable potential of raising young nene imprinted to a natural rather than a caged environment. It complements the State nene program at Pohakuloa by extending propagation efforts into native Hawaiian ecosystems.

   3. A greatly expanded propagation effort seems an unnecessary duplication of the State Department of Land and Natural Resource program at Pohakuloa.

C. Alternatives in goat control are discussed in Table 12.

D. Alternatives related to pig control are similar to those for goats except that pig-proof fences are not feasible, pig population control is much more difficult, and knowledge of pig ecology and population dynamics is more limited than for goats. Based upon present knowledge, the following pig control alternatives have been considered:

1. Do nothing about pigs. Research efforts now underway show that pigs are a major factor in the destruction of native plant environments.[1&2/]

2. The present program involving hunting pigs by both a citizen deputy ranger program and paid Park Service hunters does minimum environmental damage and depresses the pig populations. It is not lowering the pig population in remote rain forest areas to the extent that native plants are unaffected by pigs.

3. Expand the present program to use widespread poisoning and/or birth control chemicals. Our present knowledge is inadequate to evaluate if such techniques would really lower pig populations and if they would have side effects upon such species as the endangered Hawaiian hawk or affect domestic animals adjacent to the park. A research effort within the Mauna Loa Strip goat exclosure is planned to explore both pig control techniques and the ecological side effects. This research will allow better evaluation of this pig control alternative.

E. There are no known methods of rat and mongoose control that effectively limit populations to low levels over widespread wild lands and that may not cause biological damage to other organisms. Quite simply, this limits the available alternatives at hand now to the program of continuing intensive trapping and poisoning in very delimited acreages around the nene breeding enclosures and petrel nesting sites.

F. Alternatives to the present measures in exotic plant control include:

1. Expand the number of species involved. The list of species presently controlled is based upon evaluations of whether techniques are possible, the damage potential of the species, and cost/benefit anticipation of the control. The plants proposed for control seem the highest priority. Yet, there is good logic in expanding the number of species involved.

2. Do not control exotic plants. Such an approach would lead to dramatic type shifts in the case of ekoa, faya bush, fountain grass, and others. Perhaps in time, with a complete absence of

1/ Spatz, G. and D. Mueller-Dombois. 1972. Succession patterns after pig digging in grassland communities on Mauna Loa, Hawaii. Island Ecosystems IRP; U. S. International Biologic Program Technical Report #15, 44 pp.

2/ Mueller-Dombois, D. and C. H. Lamoureux. 1967. Soil-vegetation relationships in Hawaiian kipukas. Pacific Science 21(2): 286-299.

goats, natural succession might allow Hawaiian plants to replace these. The odds are slim when considering the potential of the exotic plants listed in Table 4.

Table 10. Alternatives related to the purpose and objectives in managing the park's natural history resources.

Alternatives within the framework of legal authority expressed in the Act of 1916	Effect upon the park's scenic beauty for public appreciation and enjoyment	Effect upon preserving geologic features for public appreciation and understanding	Effect upon preserving archeological features for public understanding and enjoyment	Effect upon endemic Hawaiian organisms and ecosystems	Dollar costs
A. This plan: The purpose and objectives of park management are to preserve and restore the park's organisms and ecosystems that are native to this park; i.e., that are typical of Hawaii prior to the environmental modifications attributed to modern man during the period beginning with the arrival of Captain Cook.	Scenery would be picturesque and unique. Vegetation would have the integrity of being native and typically Hawaiian. It would be an exceptional example of the natural Hawaiian scene.	No effect	Archeologic ruins would be associated with native Hawaiian species.	This alternative would allow preservation and restoration of the park's major Hawaiian vegetation types. Endemic Hawaiian species dependent upon these plant communities would have habitats.	Considerable but not impractical.
B. Modify the stated purpose and objectives of park management. Focus efforts to conserve all living things in an environment where natural processes (including new organisms' invasion of islands, natural selection, species extinctions, evolution of new vegetation communities) are dominant and free of man's intervention. With this objective we would allow any living thing--Hawaiian and introduced--to compete for a place in the park's space.	The scenery would be picturesque but the vegetation would not have the integrity of belonging to Hawaii. (An analogy--Yosemite Valley would still be beautiful with picturesque groves of eucalyptus rather than the natural groves of California black oak and ponderosa pine.)	No effect	Archeologic ruins would be associated with foreign plant communities and species.	This alternate would assure the destruction of the remaining Hawaiian communities in the park. It would allow extinction of some two dozen Hawaiian species within the next few decades.	Minimal

Table 11. Alternatives related to plant propagation and re-introduction into former range.
(Discussion of these alternatives is based upon the premise that exotic goats, pigs, and plants are controlled).

Alternative	Feasibility of this alternative	Effect of this alternative upon attaining the park objectives of preserving native ecosystems and re-establishing the park's endemic species into their former ranges.	Effect of this alternative upon saving the park's rare and endangered plants from extinction in a natural, wild state.	Effect of this alternative upon existing and potential studies relating to plant succession and distribution.
1. Make no plantings.	Feasible	Park ecosystems will probably always lack many of the species listed in Tables 2 and 3--as well as organisms dependent upon those specific plants.	Most species listed on Tables 2 and 3 will never become re-established as wild, dynamic populations.	Vegetation studies are uncomplicated by deliberate plantings.
2. Limit plantings to a few, small acreage, arboretum-type sites.	Feasible	Park ecosystems will probably always lack many of the species listed in Tables 2 and 3--as well as organisms dependent upon those specific plants. The opportunity for more widespread planting would not be lost--this alternative saves seed sources.	Most species listed on Tables 2 and 3 will never become re-established as wild, dynamic populations The opportunity for more widespread planting would not be lost--this alternative saves seed sources.	Vegetation studies are uncomplicated by deliberate plantings.
3. Limit plantings to only those seedlings that are individually marked or labelled and surveyed as to location.	This is an overwhelming task; it would not be feasible even with unlimited funding.	Park ecosystems will probably always lack many of the species listed in Tables 2 and 3--as well as organisms dependent upon those specific plants. The opportunity for more widespread planting would not be lost--this alternative saves seed sources.	Most species listed on Tables 2 and 3 will never become re-established as wild, dynamic populations The opportunity for more widespread planting would not be lost--this alternative saves seed sources.	Vegetation studies are uncomplicated by deliberate plantings.
4. This proposal; plant a delimited number of carefully selected species in areas recorded by mapped zones of plantings. (These zones comprise about 25% of the species' suitable range in the park.)	Feasible	Has a high chance of success in preserving ecosystems that include most rare Hawaiian plants that are natural components of the park's biota.	Has a high chance of success in preserving the species listed in Tables 2 and 3.	Studies are moderately complicated by planting programs on those areas mapped as planting sites.

Table 11. Alternatives related to plant propagation and re-introduction into former range. (Continued)
(Discussion of these alternatives is based upon the premise that exotic goats, pigs, and plants are controlled).

Alternative	Feasibility of this alternative	Effect of this alternative upon attaining the park objectives of preserving native ecosystems and re-establishing the park's endemic species into their former ranges.	Effect of this alternative upon saving the park's rare and endangered plants from extinction in a natural, wild state.	Effect of this alternative upon existing and potential studies relating to plant succession and distribution.
5. This proposal--except do not plant rare species suspected of once occurring in the park (listed in Table 3).	Feasible	Has a high chance of success in preserving ecosystems that include the rare Hawaiian plants listed in Table 2. Park ecosystems would lack rare plants listed in Table 3.	Has a high chance of preserving species listed in Table 2. Plants listed in Table 3 would not be found in this park; they might not survive elsewhere in as a wild population.	Studies are moderately complicated by planting programs on those areas mapped as planting sites.
6. This proposal, except expand the area of planting to include all suitable range.	Feasible	Has a high chance of success in preserving ecosystems that include most of the rare Hawaiian plants that are natural components of the park's biota.	Has a high chance of success in preserving the species listed in Tables 2 and 3.	Studies are highly complicated by the planting programs.
7. This proposal; plus expand the number of species planted to include several of the park's rare species, but that have puzzling or questionable taxonomy or distributions (Table 13).	Feasible	Has a high chance of success in preserving ecosystems that include most rare and endangered plants known to be native to the park. This alternative may spread several species well beyond their natural niches or cause unnatural hybridization of some species.	Has a high chance of success in preserving the species listed in Tables 2 and 3. This alternative may cause unnatural hybridization of some species (Table 13).	Studies are complicated by planting programs on those areas mapped as planting sites and by planting programs contributing to plant hybridization.

Table 11. Alternatives related to plant propagation and re-introduction into former range. (Continued)
(Discussion of these alternatives is based upon the premise that exotic goats, pigs, and plants are controlled).

Alternative	Feasibility of this alternative	Effect of this alternative upon attaining the park objectives of preserving native ecosystems and re-establishing the park's endemic species into their former ranges.	Effect of this alternative upon saving the park's rare and endangered plants from extinction in a natural, wild state.	Effect of this alternative upon existing and potential studies relating to plant succession and distribution.
8. This proposal, plus expand the number of species planted to include rare and endangered species that may never survive outside the park in wild populations--but that were never presumed to have occurred in the park (Table 13).	Feasible	Ecosystems began to be atypical of the park even though they involve endemic Hawaiian species--depending upon the number of species involved in the plantings that were never native to the park.	Has a high chance of success in preserving species in Tables 2 and 3 as well as rare species not native to the park but that now still exist in Kau and Kona districts of Hawaii (Table 13).	Studies are highly complicated by the planting programs.

Table 12. Alternative techniques in controlling goat populations at a low enough level to protect the park's remnant Hawaiian ecosystems from further depredation and competition by goats.

Alternative technique	Can this technique alone effectively reduce and maintain a low enough goat population that endemic plants are not affected by goats	If used with other techniques--can this help to effectively reduce and maintain a low enough goat population that endemic plants are unaffected	Effect upon scenic environment	Effect upon park wilderness designation	Social or other consideration
1. Do nothing to control goat populations.	No	No	Goats would browse the park's dryland habitats into sterile deserts. Great numbers of species would be lost. The changes would be irreversible and permanent.	Wilderness would be merely an area devoid of fences and roads; its natural ecology would be totally foreign to Hawaii.	Public who trust that the NPS will make every reasonable effort to preserve Hawaii's endangered species would be appalled at this approach.
2. Build and/or maintain 150 miles of boundary drift and exclosure fences as shown in this plan.	No; the existing goats within the fenced areas would still remain without actual goat reduction efforts.	Yes, this is a key to any plan to reduce goat populations; without fencing, goats constantly move into the park from adjacent ranch lands.	Fences on the landscape are inconspicuous--but they are present (a detracting aspect). Natural forests will become re-established--more than offsetting the presence of fences.	Fences proposed in this plan are technically compatible to "wilderness" in that they are the minimum necessary measure to protect the wilderness.	---
3. Control goats by a citizen deputy ranger program.	No; experience shows clearly that year-round hunting with no bag limits does not hold goat populations low enough for endemic plant survival.	Yes, but must be used with other reduction efforts and fencing.	There is some minor vandalism on the part of a very few citizen deputies.	None	Public are more inclined to support the goat control efforts when the goats killed are put to beneficial use. This does.

Table 12. Alternative techniques in controlling goat populations at a low enough level to protect the park's remnant Hawaiian ecosystems from further depredation and competition by goats. (Continued)

Alternative technique	Can this technique alone effectively reduce and maintain a low enough goat population that endemic plants are not affected by goats	If used with other techniques--can this help to effectively reduce and maintain a low enough goat population that endemic plants are unaffected	Effect upon scenic environment	Effect upon park wilderness designation	Social or other consideration
4. Control goats with park personnel conducting goat drives (sell live goats).	No; experience shows clearly that drives alone are inadequate to reduce and hold goat populations low enough for endemic plant survival.	Yes, but must be used with other reduction efforts and fencing.	Drift fences on the landscape are inconspicuous--but they are present.	None	Public are more inclined to support the goat control efforts if goats are live trapped, or are put to beneficial use. This does.
5. Control goats by private operators conducting goat drives and catching live goats for sale.	No; experience shows clearly that drives alone are inadequate to reduce and hold goat populations low enough for endemic plant survival.	It helps at very initial stages of reduction, but fails to cope with remote and difficult areas.	Drift fences on the landscape are inconspicuous--but they are present.	Commercial goat operations (that to some may border on goat ranching) are probably illegal.	Private operators, to remain in business, must operate on a sustained yield basis. Hence, this technique results in a continuously high goat population.
6. Control goats by rangers hunting goats with dogs and rifles.	Not alone; but this technique is effective in areas too remote or difficult to interest citizen deputies or to be susceptible to goat drives.	Yes, but must be used with other reduction efforts and fencing.	None	None	Public may be more agreeable to this technique than other killing techniques done by park rangers.

Table 12. Alternative techniques in controlling goat populations at a low enough level to protect the park's remnant Hawaiian ecosystems from further depredation and competition by goats. (Continued)

Alternative technique	Can this technique alone effectively reduce and maintain a low enough goat population that endemic plants are not affected by goats	If used with other techniques--can this help to effectively reduce and maintain a low enough goat population that endemic plants are unaffected	Effect upon scenic environment	Effect upon park wilderness designation	Social or other consideration
7. Control goats by poisons.	No; not without fencing to prevent constant infiltration of goats from outside the park.	Yes, but must be used with other reduction efforts and fencing.	Probably none	None	Poisoning as a technique may be repugnant to a large segment of the public. Too, would poison cause secondary poisoning of the Hawaiian hawk?
8. Control goats by birth control chemicals.	No; no known technology is available that is effective with a widespread, high populated area.	No; no known technology is presently available that is effective with a widespread, high populated area.	Probably none	None	---
9. Control goats by shooting from helicopters.	Not alone; it would have to be used with the fencing efforts to hold populations to low levels.	Yes, but must be used with other reduction efforts and fencing.	None	Probably none	Probably the general public is more agreeable to goat reductions by drives, citizen deputy ranger, and park ranger hunts than by mass shooting from helicopter.

Table 13. Plants considered for planting program but not included.

1. Not included because of inadequate knowledge regarding taxonomy, former distributions, or culturing techniques.

Cibotium hawaiiense

Clermontia hawaiiensis

Clermontia peleana

Cyanea carlsonii

Cyanea bryanii

Embelia pacifica

Eurya sandwicensis

Labordia sp.

Pelea clusiaefolia cuneata, alani

Pelea oblanceolata

Pelea radiata

Portulaca hawaiiensis

Portulaca sclerocarpa

Pseudomorus sandwicensis, aiai

Urera sandwicensis

2. Not included because we believe they were never native to Hawaii Volcanoes National Park.

Argyroxiphium kauensis, Kau silversword

Acacia koaia, koaia

Claoxylon sandwicensis, poola

Gardenia brighami, nau

Gardenia remyi, nahu

Platydesma remyi, pilo kea

Pterotropia dipyrema, ohe ohe

CONSULTATION AND COORDINATION

Consultation and Coordination in the Development of the Proposal and in the Preparation of the Draft Environmental Statement

During the preparation of the natural resources management plan, many sources outside the Park Service were consulted for their knowledge, suggestions, and recommendations. The following list is indicative of the types of sources contacted:

Rare endemic birds:	Mr. Winston E. Banko, U. S. Bureau of Sport Fisheries and Wildlife
Nene propagation:	Mr. Ernest Kosaka, Hawaii Division of Fish and Game Mr. Clinton H. Lostetter, U. S. Bureau of Sport Fisheries and Wildlife
Goat and pig control; fencing proposals; deputy ranger program:	Hawaii Audubon Society Hawaii Conservation Council Hawaii Island Fish and Game Association Hawaii State Division of Fish and Game
Rare endemic plants:	Mr. L. W. Bryan, Kailua-Kona, Hawaii Drs. Otto and Isa Degener, Volcano, Hawaii Dr. F. R. Fosberg, Smithsonian Institution International Biological Project scientists Dr. Charles H. Lamoureux, University of Hawaii Mr. Libert Landgraf, Hawaii Division of Forestry Mr. Russel K. LeBarron, Hawaii Division of Forestry Dr. Howard A. Powers, retired U. S. Geological Survey Mr. Ernest Pung, Hawaii Department of Natural Resources Dr. Harold St. John, Bernice P. Bishop Museum Mr. Tom K. Tagawa, Hawaii Department of Natural Resources

Beginning February 1972 the botanists listed above responded to a preliminary draft of proposals related to planting rare plants, development of species lists to be propagated, and to the sketch maps showing current distribution of plants and seed sources. Table 2 was developed from these consultations--though the table represents a conservative and delimited list of plants considered rare. As a result of these consultations substantial modifications were made in the proposed planting proposals including changes in species to be treated and in recognizing the need for adequate records of plantings. These consultations will continue. Smithsonian Institution is now developing species lists and

plans for rare endangered plants as required under the Rare and Endangered Species Act of 1973. Their proposals will bear significantly upon this park's rare plant program.

Coordination in the Review of the Draft Environmental Statement

On January 4, 1974, the draft was made available for review by other Federal agencies and interested organizations and individuals. Copies were distributed by Hawaii Volcanoes National Park to the following for comment:

Advisory Council on Historic Preservation

Department of Agriculture
- Coordinator, Environmental Quality Activities
- Soil Conservation Service

Department of Defense
- U. S. Army

Department of the Interior
- Bureau of Indian Affairs
- Bureau of Mines
- Bureau of Land Management
- Bureau of Outdoor Recreation
- Bureau of Reclamation
- Bureau of Sport Fisheries and Wildlife
- Geological Survey

Department of Transportation

Environmental Protection Agency

State of Hawaii
- State of Hawaii Clearinghouse
- State Liaison Officer
- Department of Land and Natural Resources
- State Historic Preservation Officer
- Department of Agriculture
- Department of Health

County of Hawaii

Wilderness Society

Sierra Club

The Nature Conservancy

University of Hawaii

Bishop Museum

Hawaiian Botanical Society

Society of American Foresters

Congress of the Hawaiian People

The Hawaiians

Hawaii Conservation Council

Audubon Society

Hawaii Island Fish and Game Association

Life of the Land

National Parks and Conservation Association

Dr. F. R. Fosberg, Smithsonian Institution

Drs. Otto and Isa Degener, Volcano, Hawaii

Mr. L. W. Bryan, Kailua-Kona, Hawaii

Dr. Howard Powers, Maui, Hawaii

Mr. James O. Juvik, Hilo, Hawaii

Written comments were received from the following:

Advisory Council on Historic Preservation

Department of Agriculture
- Soil Conservation Service

Department of Defense
- Department of the Army
- Department of the Army, Kilauea Military Camp

Department of the Interior
- Bureau of Indian Affairs
- Bureau of Land Management
- Bureau of Mines
- Bureau of Outdoor Recreation
- Bureau of Reclamation
- Bureau of Sport Fisheries and Wildlife, Portland Regional Office
- Bureau of Sport Fisheries and Wildlife, Mauna Loa Field Station
- Geological Survey

Department of Transportation

State of Hawaii
Department of Planning and Economic Development
Department of Land and Natural Resources, Division of Forestry
Department of Health Research Unit, Honokaa
Department of Agriculture, Weed Control Branch

County of Hawaii

National Parks and Conservation Association

Island Ecosystem Integrated Research Program

University of Hawaii, Department of Botany

University of Texas, Zoology Department

Hawaii Audubon Society

Hawaii Audubon Society, Island of Hawaii Representative

Bernice P. Bishop Museum

Hawaii Island Fish and Game Association

Conservation Council for Hawaii

The Anschutz Corporation

Drs. Otto and Isa Degener

Dr. Howard Powers

A copy of each of the above comments are included in the appendix of this statement. A resume of specific comments and responses follows:

ADVISORY COUNCIL ON HISTORIC PRESERVATION

Comment: To insure a comprehensive review of historical, cultural, archeological, and architectural resources, the State Historic Preservation Officer should be contacted.

Response: Copy of the draft statement was sent to Mr. Sunao Kido, Chairman of the Department of Land and Natural Resources, and no comments were received.

SOIL CONSERVATION SERVICE, HONOLULU OFFICE

Document reviewed and agreement noted.

DEPARTMENT OF THE ARMY

Document reviewed and no comment offered.

DEPARTMENT OF THE ARMY, KILAUEA MILITARY CAMP

Comment: Kilauea Military Camp personnel could be assigned to help with feral animal control to avoid criticism of sports hunting.

Response: KMC personnel may assist with control of feral animals through the deputy ranger program which is a closely supervised management activity.

Comment: Concern is expressed for exotic plant problems in the vicinity of Kilauea Military Camp. Help on the identification of target trees requested.

Response: Although several exotic trees are growing as ornamentals at KMC, the only species there now that is a threat to native ecosystems is faya tree. Known faya trees in the KMC area recently have been removed by park personnel.

BUREAU OF INDIAN AFFAIRS

Document reviewed and no inadequacies noted.

BUREAU OF LAND MANAGEMENT

Document reviewed and no comment offered.

BUREAU OF MINES

Document reviewed and no comment offered.

BUREAU OF OUTDOOR RECREATION

Document reviewed and no comment offered.

BUREAU OF RECLAMATION

Document reviewed and agreement noted.

BUREAU OF SPORT FISHERIES AND WILDLIFE

Comment: Document reviewed and agreement noted. Bird distribution maps are corrected.

Response: Correction to maps are incorporated.

BUREAU OF SPORT FISHERIES AND WILDLIFE, MAUNA LOA FIELD STATION

Document reviewed and agreement noted.

U. S. GEOLOGICAL SURVEY

Document reviewed and adverse impacts related to geology or hydrology of the area are not anticipated.

DEPARTMENT OF TRANSPORTATION

Document reviewed and no comment offered.

DEPARTMENT OF PLANNING AND ECONOMIC DEVELOPMENT, STATE OF HAWAII

Document reviewed and agreement noted.

HAWAII DEPARTMENT OF LAND AND NATURAL RESOURCES, DIVISION OF FORESTRY

Comment: Construction and maintenance of goat control fences will be costly, especially when exposed to volcanic fumes and lava flows.

Response: Fences are estimated to last a minimum of 20 years and they will have to be perpetually maintained and replaced, particularly along the park boundary. This is costly, but the degree of goat control necessary is not possible without adequate fences.

Comment: The policy to let natural wildfires run their course is unwise considering the resulting invasion of exotic plants and danger to adjacent lands. The park's fire protection policy should be clearly stated.

Response: A wildfire management plan is forthcoming, to be based upon further research of plant responses after release from goat browsing. There is little data now available on how Hawaii ecosystems react to varying intensities or seasons--or the absence--of fire. Certainly Hawaiian plants here have been subjected to volcano-caused fire since the birth of the island. This seems reflected in the sprouting and reseeding ability of many endemic plants as well as the vigor with which some grow following fire. National Park Service policy regarding natural fires in natural areas such as Hawaii Volcanoes National Park is:

> The presence or absence of natural fire within a given habitat is recognized as one of the ecological factors contributing to the perpetuation of plants and animals native to that habitat.

Fires in vegetation resulting from natural causes are recognized as natural phenomena and may be allowed to run their course when such burning can be contained within predetermined fire management units and when such burning will contribute to the accomplishment of approved vegetation and/or wildlife management objectives.

Until continuing research develops detailed knowledge of responses of Hawaiian plant systems to fire, park action is to suppress most fires. But some natural fires set by advancing lava flows are allowed to run their course. The percent of park area affected by such fires is small--it has never been more than 2 percent of the park acreage. In the 58-year history of the park, no wildfire has been allowed to spread to adjacent lands.

Comment: Restoring habitat may be only half the answer to increasing native birds. Avian diseases and predation by rats and mongooses are factors that also need attention.

Response: Without appropriate habitat, birds cannot survive even in the absence of avian diseases and predators. Habitat restoration is feasible at this time; in addition, this document gives recognition to other problems relating to native bird survival and supports research in these areas.

Comment: Forty percent of the Olaa Tract has been hit with "ohia decline" and this problem should be discussed.

Response: "Ohia decline" has been a problem in Hawaii since it was first noted in 1909. Recently the problem has become more severe, as the area of severe decline has tripled in recent years (Burgan, R.E. and R.E. Nelson 1972. Decline of ohia lehua forests in Hawaii. USDA Forest Service Gen. Tech. Rpt. PSW-3. Pacific SW Forest and Range Expt. Stn., Berkeley, Ca. 4 p.). Contributing to the problem is shoestring root rot (Armillaria mellea) as well as moisture stresses, insects, and other ecological factors. Until the cause of the decline is more thoroughly documented and feasible control measures can be developed, no action is proposed at this time. Research now underway by the State Department of Land and Natural Resources, the Forest Service, and the University of Hawaii will help determine management alternatives to deal with the problem.

STATE DEPARTMENT OF HEALTH, RESEARCH UNIT, HONOKAA, HAWAII

Document reviewed and agreement noted.

Comment: The feral cat may be a more important predator than is suggested in the plan.

Response: Mention of control of feral cats has been added to the plan (p. 14).

HAWAII DEPARTMENT OF AGRICULTURE, WEED CONTROL BRANCH

Comment: Karmex and Dalapon are not effective herbicides for cut stem treatment.

Response: Karmex and Dalapon may be used on fountain and Andropogon grass if uprooting is not practical. Ammate-X will be used for all others listed.

Comment: State agency responsible for bio-control work is the Department of Agriculture.

Response: Error corrected in this document. (See page 16)

Comment: Banana poka, eucalyptus, and mullein should also be controlled.

Response: Additions to the list include banana poka and eucalyptus; mullein is not known to occur in the park so it will not be included in this document.

Comment: Desmodium triflorum and Cassia leschenaultiana are commonly known as three-flowered beggar weed and partridge pea, respectively.

Response: These common names are included in this document. (See page 29)

COUNTY OF HAWAII, PLANNING DEPARTMENT

Comment: Control of exotic plant species by individually cutting and poisoning is commendable but costly, especially if vehicles are not allowed in wilderness areas.

Response: Funds are available to implement proposed actions in the plan and cost estimates are on park files for public review. In each case of resource management action, cost in dollars was found to be secondary to the cost to the environment if nothing was done.

Comment: What is the relationship of this management program to the statewide inventory of historic places or to the federal inventory program under EO 11593?

Response: In compliance with the Historic Preservation Act and EO 11593, the environmental statement has been subject to review by the State Historic Preservation Officer, the Advisory Council on Historic Preservation, a historian, and a professional archeologist.

Comment: Legislative action to permit hunting (which already exists) should be sought.

Response: The purpose of the deputy ranger program is to allow public participation in the park's pig and goat control efforts and to allow public use of these surplus animals. It is not a program for sustained yield of these animals to support a continuous recreation hunting program.

NATIONAL PARKS AND CONSERVATION ASSOCIATION

Comment: Elimination rather than control of feral animals to promote survival of Hawaiian plants should be the park's objective.

Response: Even if removal of every feral animal from the 220,000-acre park wildlands could be accomplished, those from adjacent lands would endlessly reinfect the park. This plan is based upon the realization that for as long as exotic animal populations exist on the Big Island, continuing fence maintenance and feral animal control will be necessary if native plant systems are to survive.

Comment: Citizen participation program for the control of feral animals should be fully supervised by employees of the National Park Service and should not result in extended hunting seasons.

Response: Citizen participation program during its 3 years of operation has been fully supervised by park employees; and thus far, it has not detracted from public use and enjoyment of the park. The program will be continued as an effective management tool to deal with feral animals. It is surmised that deputized citizen participation will decrease as feral animal populations decline.

ISLAND ECOSYSTEMS, INTEGRATED RESEARCH PROGRAM, U. S. INTERNATIONAL BIOLOGICAL PROGRAM

Comment: Data source for Kukalauula goat exclosure should be acknowledged.

Response: Source included in this document. (See page 29)

Comment: Is the park's policy to maintain low goat populations or to effect total eradication?

Response: This same comment is covered on page 75 under National Parks and Conservation Association.

Comment: The native plant propagation and reintroduction program needs to be carefully considered and precautions taken to prevent adverse effects on natural ecosystems. The intent to preserve rare and endangered species is good but the approach should be to establish botanical gardens or aboreta so designated. If species are planted throughout the park there will hardly be any natural ecosystems left.

Response: Additional explanation is given to the planting portion of the plan on pages 3 and 6 and to the impact section on page 47 to further define and delimit the number of plants and area involved, seed sources, and to provide means for Hawaii botanists to have knowledge of and to provide recommendations to the planting effort.

The suggested approach is discussed in Table 11, Alternative 2 on page 60. Native ecosystems of areas designated for native plant reintroduction have been degraded or destroyed by the long-term presence of feral animals. It is the park's objective to reintroduce native plants which are unlikely to re-establish on their own. This in turn will provide a habitat to support native birds and insects, some of which are on the brink of extinction. There will remain extensive unplanted areas within the park where ecosystems uninfluenced by any planting may be observed.

UNIVERSITY OF HAWAII, DEPARTMENT OF BOTANY

Comment: The re-establishment program for plants that are key components of native ecosystems should be conducted carefully to preserve the genetic integrity of Hawaiian plants.

The propagation of rare plants as proposed seems desirable as long as adequate records are kept and that seed sources are collected from within the park or at least immediately adjacent to the park.

Rare and endangered species only suspected of once occurring in the park should be introduced with great caution and extensive plantings avoided. Hybrids resulting from the crossing of plant species closely related must be avoided.

Response: Further details on the planting program are incorporated in the plan on pages 3 and 6 and to the impact section on page 47 specifying that seed sources will be in close proximity to planting areas, and that detailed records of the plantings will be kept.

Comment: Hibiscadelphus hualalaiensis has hybridized in the park with H. giffardianus.

Response: This may be true; we are evaluating the situation now. If so, and with consultation with you and other Hawaiian botanists, we may consider removal of all H. hualalaiensis plants mauka of Kilauea Caldera area. H. hualalaiensis has been removed from the plan (page 6) except to keep a stock of this species near the Ainahou Ranch where it has already been planted.

THE UNIVERSITY OF TEXAS, ZOOLOGY DEPARTMENT

Comment: Biological control of pests should be avoided because of potential risks to endemic species.

Response: Introduced biological control is subject to State Department of Agriculture regulations. Every other control method will be tried before the introduction of biological control agents is considered.

Comment: Transplants of artificially propagated plants should be done carefully to prevent hybridization with naturally occurring relatives.

Response: This same comment covered under University of Hawaii, Department of Botany, on pages 76 and 77 of this document.

Comment: Herbicides could be used to make fire lanes to help prevent fires in Andropogon grass. Also, long-range fire control shade out Andropogon grass.

Response: Planting native trees in exotic grass range is a more desirable method to lessen fire hazards. Unnatural fire lanes tend to encourage and perpetuate exotic plants.

Comment: Obtain advice on resource management activities from the scientific community. Perhaps a standing advisory committee composed of University of Hawaii faculty members could be established to help with decision making.

Response: In the preparation of this and preliminary documents, advice was sought broadly from the scientific community. Advice relating to ongoing or future actions will be continually requested and encouraged.

HAWAII AUDUBON SOCIETY

Comment: Opinion is expressed that any populations of exotic mammals will have adverse impacts on endemic island biota and wording should be used indicating that these animals, particularly goats and pigs, will be totally removed from the park.

Response: This same comment covered under National Parks and Conservation Association on page 75 of this document.

Comment: Biological control of exotic plants is less preferable to other methods because it adds additional exotic species to the park.

Response: This same comment covered under University of Texas on page 76 of this document.

Comment: It should be noted that the Smithsonian Institution under the direction of Dr. Raymond Fosberg is compiling a list of endangered plants in the Hawaiian Islands.

Response: The draft statement was prepared using the preliminary list of endangered plants prepared in 1970 by the Smithsonian Institution.

Comment: The lists of plants, and maps of plant and bird distribution need some revision in light of recent monographs.

Response: Cibotium hawaiiense has been deleted and distribution maps of birds and plants have been revised to reflect new information. Dr. Howard Powers reports Gouania hawaiiensis surviving on Lanai. Until the scientific community agrees upon revised nomenclature of certain Hawaii plants, current usage will be employed.

Comment: The Hawaiian bat should be added to the distribution maps since it is an endangered species.

Response: We agree but do not now have current information regarding bat distribution over the State. The Hawaiian bat occurs in the park. A study on the life history and distribution of the Hawaiian bat is presently proposed.

Comment: A new section on the biota of lava tubes should be added to "description of the environment" section.

Response: Summary of the lava ecosystems has been added (p. 24).

HAWAII AUDUBON SOCIETY, ISLAND OF HAWAII

Comment: Re-establishing endemic plants should be done carefully so as to avoid changing, upsetting, or creating new native Hawaiian ecosystems, or disturbing the genetic makeup of component species. It is extremely important to keep permanent records of plantings.

Response: A similar comment was covered under University of Hawaii. Department of Botany, on pages 76 and 77 of this document.

Comment: Propagating species not known to have occurred in the park should be confined to an arboretum.

Response: Four species suspected of once occurring in the park, based on opinion of Hawaii botanists, are proposed for planting in an area limited to 30 acres or less. Other than these, there are no plans to propagate species not known to have occurred in the park.

Comment: A park-appointed Scientific Council on Restoration of Native Ecosystems could assist in natural resource management planning for the park.

Response: See reply to University of Texas, Zoology Department, on page 78 of this document.

Comment: The nene program would be more successful if the experience of Hawaii Fish and Game personnel were utilized and if selected breeding stock were used.

Response: The park's six-enclosure program is a preliminary research project to ascertain the breeding, feeding, and predator problems that face nene at low elevations in the wild. National Park Service biologists are the principal investigators with two consulting biologists from the Hawaii Division of Fish and Game and the Bureau of Sport Fisheries and Wildlife.

Comment: Scientific names as well as common names for birds should be used to avoid confusing certain species.

Response: Document has been revised as you suggest, except that scientific names have not been added. We feel that adding scientific terminology tends to encumber the table and obscure the basic message that native birds on this island are in incredibly bad shape.

Comment: Opinion is expressed that additional exotic plants besides those listed should be the objects of control.

Response: Considering the large number of exotic plants in the park, those species considered the greatest threat to native ecosystems are given priority. Some of the species mentioned, however, have been included in the revised list (p. 17).

Comment: Exotic birds should also be the object of control because they compete and in other ways have adverse effects on native birds and their habitats.

Response: The park does not encourage the existence of exotic birds; but until research reveals the extent of the problem as well as feasible control techniques, no action is proposed.

Comment: Stray cattle and feral sheep should not be tolerated any longer than possible in the park.

Response: Adequate boundary fences as proposed are a must to keep cattle from entering the park. At this time about a dozen feral sheep remain in the park in areas of excellent cover; they are extremely wary.

BERNICE P. BISHOP MUSEUM

Comment: The document should include a statement against the release of axis deer or other game mammals on the island.

Response: The National Park Service opposes introduction of other game mammals to the island of Hawaii because of the potential threat of invasion into park ecosystems.

Comment: Exotic game birds may be a threat to park natural resources and, therefore, should be identified and methods for their removal proposed.

Response: This same comment covered on page 80 of this report under Hawaii Audubon Society, Island of Hawaii.

Comment: Biological controls should be used in preference to other means of exotic plant control.

Response: Others have expressed danger in the use of biological controls. See response given University of Texas, Zoology Department, on page 77 of this document. Techniques of exotic plant control need continuing critique and review to assure effective control of the plants without unforeseen side effects.

Comment: Propagation and reintroduction of native species should be carefully controlled to avoid adverse impact on Hawaiian ecosystems.

Response: Same comment covered under University of Hawaii, Department of Botany, on pages 76 and 77 of this document.

HAWAII ISLAND FISH AND GAME ASSOCIATION

Comment: The deputy ranger program is the most acceptable method for controlling feral animals.

Response: The deputy ranger program shall be a primary means of control wherever it is effective.

CONSERVATION COUNCIL FOR HAWAII

Document reviewed and general agreement noted.

THE ANSCHUTZ CORPORATION

Comment: Include in the plan provisions for the development of geothermal power.

Response: Geothermal leases may not be legally issued in National Park Service areas. The Geothermal Steam Act of 1970 (30 U.S.C. Section 1014c) states that, "Geothermal leases under this chapter shall not be issued for lands administered in accordance with (1) the Act of August 25, 1916 (39 Statute 535) as amended and supplemented . . ." Hawaii Volcanoes National Park is an area administered in accordance with this 1916 Act.

DRS. OTTO AND ISA DEGENER

Comment: Modify the wording "feral animals" to include "feral plants."

Response: Where used, the term feral animals is meant to define the problems and control techniques peculiar to animals, but not to imply a lack of concern regarding feral plants. A major objective of this park is to protect native ecosystems from both exotic animals and plants (page 1, next to last paragraph).

Comment: Exterminate rather than control goats, pigs, and sheep.

Response: This same comment covered under National Parks and Conservation Association on page 75 of this document.

Comment: To avoid scientific confusion that may be produced by the program to propagate and reintroduce native plants, it would be better to gather seeds and immediately plant them in the vicinity of the source tree instead of taking them to a central nursery for propagation.

Response: Clarified procedures on pages 3 and 6 of this document will help prevent confusion. The technique of immediate seed planting can be used for some species and has been included with planting procedures.

Comment: Scientific names for many of the plants listed are out of date and should be revised using more recent taxonomic literature.

Response: There appears to be much disagreement as to proper scientific nomenclature for Hawaiian plants. Many species are in need of further treatment by plant taxonomists.

By following suggestions to restrict seed sources of species to be planted to parent stock in close proximity to planting sites, and by keeping very careful documentation of the plantings, the relevance of problems over taxonomic disagreements will be greatly reduced.

DR. HOWARD POWERS

Document reviewed and agreement noted.

A P P E N D I X

Comments Received

Advisory Council
On Historic Preservation
1522 K Street N.W. Suite 430
Washington D.C. 20005

February 13, 1974

Mr. G. Bryan Harry
Superintendent
Hawaii Volcanoes National Park
National Park Service
U.S. Department of the Interior
Hawaii 96718

Dear Mr. Harry:

This is in response to your request of January 4, 1974, for comments on the environmental statement for the proposed Resources Management Plan at Hawaii Volcanoes National Park, Hawaii. Pursuant to its responsibilities under Section 102(2)(C) of the National Environmental Policy Act of 1969, the Advisory Council on Historic Preservation has determined that your draft environmental statement appears procedurally adequate. However, we have the following substantive comments to make:

> To insure a comprehensive review of historical, cultural, archeological, and architectural resources, the Advisory Council suggests that the environmental statement contain evidence of contact with the appropriate State Historic Preservation Officer and that a copy of his comments concerning the effects of the undertaking upon these resources be included in the environmental statement. The State Historic Preservation Officer for Hawaii is Mr. Sunao Kido, Chairman, Department of Land and Natural Resources, State of Hawaii, P.O. Box 621, Honolulu, Hawaii 96809.

Should you require any additional assistance, please contact Jordan Tannenbaum (202-254-3974) of the Advisory Council staff.

Sincerely yours,

Ann Webster Smith

Ann Webster Smith
Director, Office of Compliance

The Council is an independent unit of the Executive Branch of the Federal Government charged by the Act of October 15, 1966 to advise the President and Congress in the field of Historic Preservation.

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
440 Alexander Young Building, Honolulu, HI 96813

February 8, 1974

Mr. G. Bryan Harry
Superintendent
USDI National Park Service
Hawaii Volcanoes National Park
Hawaii, 96718

Dear Mr. Harry:

Subject: Draft Environmental Statement, Natural Resources Management Plan, Hawaii Volcanoes National Park

We have reviewed the above-mentioned draft as you requested.

It is well written and appears to be a comprehensive approach to the management of some important ecosystems in Hawaii.

We appreciate the opportunity to comment on the plan. Please let us know if we can be of further assistance.

Sincerely,

William H. Haun (Acting)
Francis C. H. Lum
State Conservationist

DEPARTMENT OF THE ARMY
OFFICE OF THE UNDER SECRETARY
WASHINGTON, D.C. 20310

22 FEB 1974

Mr. G. Bryan Harry
Superintendent, Hawaii Volcanoes
National Park
National Park Service
Department of the Interior
Hawaii 96718

Dear Mr. Harry:

We have reviewed your Draft Environmental Impact Statement for the Proposed Resources Management Plan at Hawaii Volcanoes National Park. From our review we have determined that the proposed action will have no impact on Army activities nor cause Army activities to impact on the environment.

However, the Civil Works Directorate of the Corps of Engineers is involved in parks and recreation planning, and will provide comments by separate correspondence.

Sincerely,

for Henry L. T. Koren
Deputy Under Secretary of the Army

G. E. BLAND
Colonel, GS
Executive, OSUSA

DEPARTMENT OF THE ARMY
HEADQUARTERS UNITED STATES ARMY SUPPORT COMMAND, HAWAII (PROV)
APO SAN FRANCISCO 96341
KILAUEA MILITARY CAMP

HCPCA-RK

7 January 1974

Mr. Bryan Harry
Hawaii Volcanoes National Park
Hawaii 96718

Dear Bryan:

Review of the Draft Environmental Statement for the Proposed Resources Management Plan at Hawaii Volcanoes National Park has been completed. No comments other than the following:

a. We will be happy to assist in the pig and goat control program if that will remove some of the potential criticism of what may "evolve into a sport hunting program." We will put people in uniform, if that helps.

b. I am concerned for our exotic plants at KMC. It might help if Don Reeser or some other qualified individual could identify for me the name and location of exotics at our camp. I would rather control these myself than have them taken out by another agency; there is also the possibility of saving those which present no real danger to the Park. I don't believe we have any of the serious ones shown at table 4, page 16, of the draft statement.

Otherwise, the Statement does not appear to have any effect on KMC, and we offer our help.

JAMES J. DORSEY
Major, FA
Commanding

United States Department of the Interior

BUREAU OF INDIAN AFFAIRS
WASHINGTON, D.C. 20242

IN REPLY REFER TO:
Trust Facilitation

FEB 7 1974

Memorandum

To: Superintendent, Hawaii Volcanoes National Park

From: Acting Director, Office of Trust Responsibilities

Subject: Draft Environmental Statement - Natural Resources Management Plan for Hawaii Volcanoes National Park, Hawaii (DES 73/67)

In response to your letter of January 4, 1974, it was found that the management plan does not conflict with the responsibilities or program operations of this Bureau. Our cursory review of the draft statement did not identify significant environment effects which were not adequately addressed.

Kenneth R. Payte

United States Department of the Interior

NATIONAL PARK SERVICE
HAWAII VOLCANOES NATIONAL PARK
HAWAII 96718

IN REPLY REFER TO:

N22

January 4, 1974

Mr. Burton W. Silock, Director
Bureau of Land Management
Department of Interior
Washington, D. C. 20240

Dear Sir:

Enclosed is a copy of the Draft Environmental Statement for the Proposed Resources Management Plan at Hawaii Volcanoes National Park. The statement has been prepared by the Department of the Interior, National Park Service in compliance with the National Environmental Policy Act of 1969, Public Law 91-190. This statement was filed with the Council on Environmental Quality on October 26, 1973, and assigned Control Number DES 73-67.

We would appreciate your review and comments on the draft statement. Please submit any comments to this office to arrive not later than February 18, 1974, for consideration in the final environmental statement.

Sincerely yours,

G. Bryan Harry
Superintendent

Enclosure

1/15/74

We have no comments.

A-7

DAN

OFFICE OF THE DIRECTOR

United States Department of the Interior

BUREAU OF MINES
WASHINGTON, D.C. 20240

February 19, 1974

In Reply Refer To:
EBM-MRED-MS
D-887

Mr. G. Bryan Harry
Superintendent
National Park Service
Hawaii Volcanoes National Park
Hawaii 96718

Dear Mr. Harry:

We have reviewed your draft environmental statement for the Proposed Resources Management Plan, Hawaii Volcanoes National Park. We appreciate the problems that lie ahead to accomplish restoration of the park's endemic ecosystems.

We can offer no help other than to commend your analysis of the many problems and what appear from here to be the best solutions.

Sincerely yours,

Assistant Director

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF OUTDOOR RECREATION
PACIFIC SOUTHWEST REGIONAL OFFICE
BOX 36062
450 GOLDEN GATE AVENUE
SAN FRANCISCO, CALIFORNIA 94102

IN REPLY REFER TO:
D72

February 15, 1974

Memorandum

To: Superintendent, Hawaii Volcanoes National Park

From: Regional Director

Subject: Review of October 26, 1973 Draft Environmental Impact Statement on the Natural Resources Management Plan for Hawaii Volcanoes National Park, State of Hawaii (DES 73--67).

We have reviewed the subject environmental statement submitted with your January 4, 1974 memorandum and have no comments to offer.

Frank E. Sylvester

cc: WASO

JOHNNY HORIZON '76
Let's Clean Up America For Our 200th Birthday

United States Department of the Interior

BUREAU OF RECLAMATION
WASHINGTON, D.C. 20240

IN REPLY
REFER TO: 739
125.

FEB 25 1974

Memorandum

To: Regional Director, Western Region
National Park Service, San Francisco, California

From: Commissioner of Reclamation

Subject: Review of Draft Environmental Statement for the Wilderness Study and the Proposed Resources Management Plan at Hawaii Volcanoes National Park, Hawaii (DES 73-66, 67, and 68)

This responds to your December 7, 1973, letter and the January 4, 1974, letter from the Superintendent, Hawaii Volcanoes National Park, Hawaii, requesting a review of subject environmental statements.

Although we have no specific comments, we concur with the aims and methods set forth by the National Park Service to attain its goals.

G. G. STAMM

cc:
Superintendent, Hawaii Volcanoes National Park
Director, National Park Service

CONSERVE AMERICA'S ENERGY

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE

1500 N. E. IRVING STREET
P. O. BOX 3737
PORTLAND, OREGON 97208

Reference: RB

February 28, 1974

To: Superintendent, Hawaii Volcanoes
National Park, Hawaii

From: Acting Regional Director, Bureau of Sport Fisheries and Wildlife
Portland, Oregon

Subject: Draft Environmental Statement for Proposed Natural Resources Management Plan at Hawaii Volcanoes National Park (DES 73/67)

We have reviewed subject draft environmental statement and provide the following comments for your consideration.

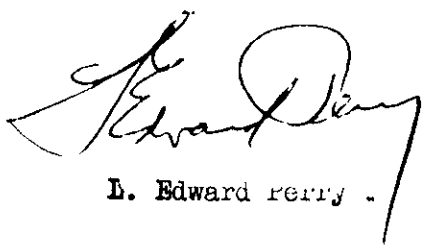
In the ordinary sense of land birds named in the title to Table 5a on page 25, fresh-water species are normally included. Your list should therefore be expanded to include the Hawaiian duck, (koloa) Hawaiian stilt, Hawaiian coot, and Hawaiian gallinule, which are all endemic to the major Hawaiian Islands. Of these, only populations of gallinules on the Big Island are extinct.

On page 44, Fig. 39, lower map, the solid shaded areas indicate likely future distribution of the Nene without this plan. We question the size of the areas as they are smaller than the existing distribution areas indicated in the upper map. It appears unlikely that Nene distribution, some distance from the park, would be greatly affected with or without the plan. However, the goat control program will undoubtedly benefit populations within and adjacent to the park.

The present distribution of Nene as indicated in the upper map in Fig. 39 is incorrect. The present distribution extends between the four solid shaded areas. The areas, as indicated on the maps, appear to represent the breeding areas of the Nene. We suggest the present distribution be outlined as indicated on the attached map.

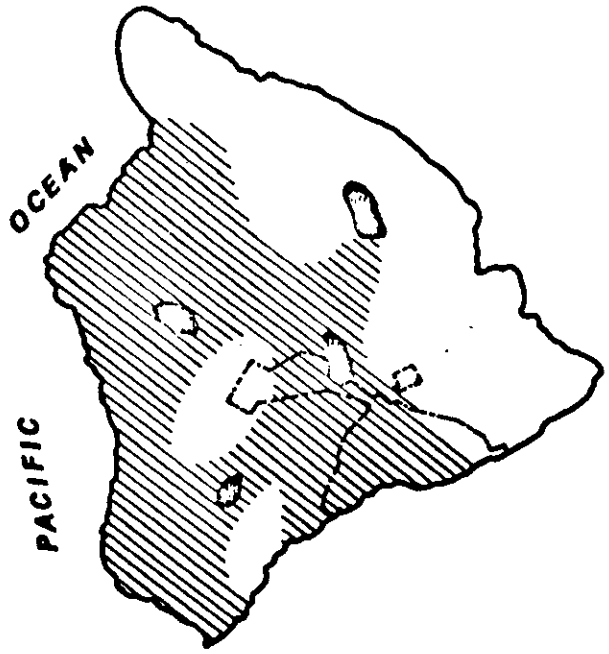
Page 45, Figs. 40, 41, 42 and 43 should include the additional known bird sightings, as indicated for these species by small circles and x's on the attached sheet.

In conclusion, we agree that the proposed plan will be a definite benefit to the fauna and flora of the area.



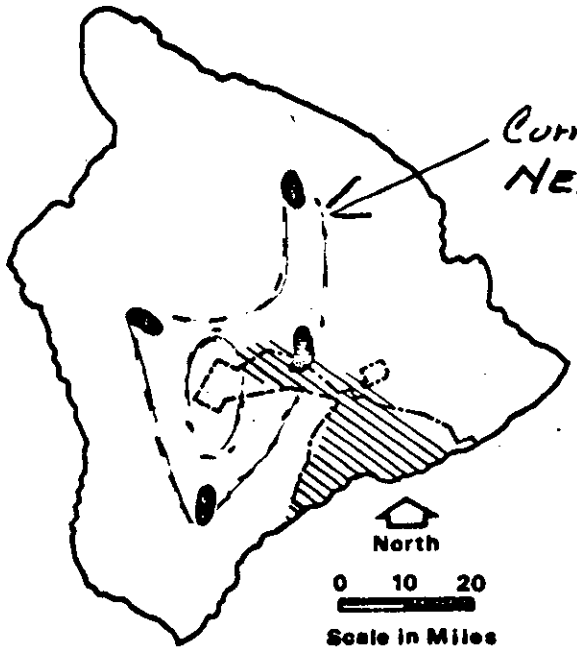
L. Edward Perry

Attachments



Present distribution

Former distribution



Likely future distribution without this plan.

Anticipated additional distribution if this plan is adopted.

Fig. 39. Nene distribution on the Island of Hawaii. A small wild population (artificially supplemented) also exists on Haleakala, Maui. Together these are the extent of the worldwide wild population.

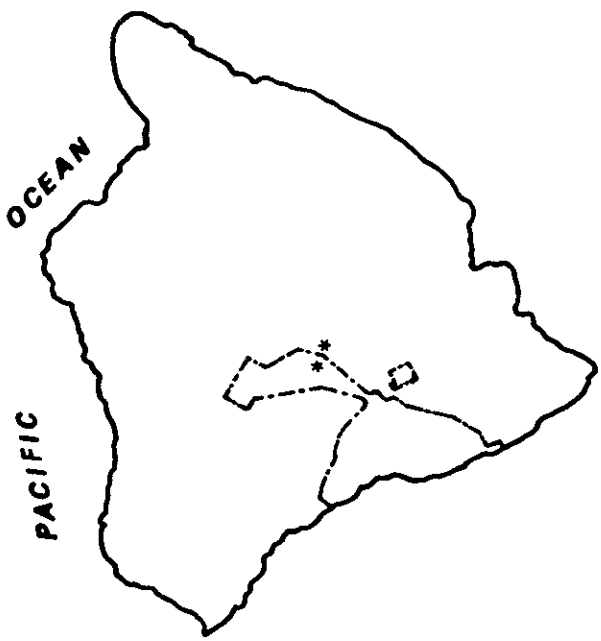
● Location of existing breeding sites on the Island of Hawaii.

▩ Approximate location of former breeding sites.

Fig. 40. Hawaiian dark–rumped Petrel

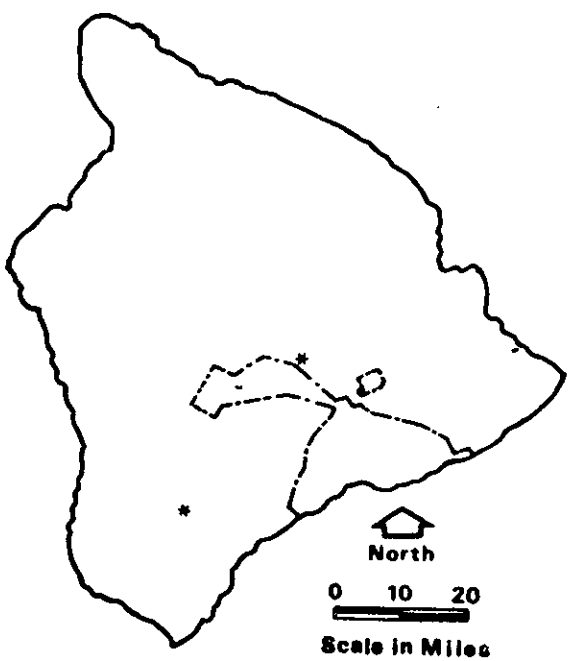
* Location of sightings on Island of Hawaii during last decade.

Fig. 41. Ou



* Location of sightings on the Island of Hawaii over the last decade.

. Akiapolaau



* Location of sightings on the Island of Hawaii over the last decade.

Fig. 43. Hawaii Akepa

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE

MAUNA LOA FIELD STATION
P. O. BOX 35, HAWAII NATIONAL PARK
HAWAII 96718

February 25, 1974

Mr. Bryan Harry, Superintendent
Hawaii Volcanoes National Park
Hawaii National Park, Hawaii 96718

Dear Mr. Harry:

Thank you for the opportunity to comment and make suggestions on draft of the environmental statement, Natural Resources Management Plan, Hawaii Volcanoes National Park.

As I read the Plan, the main emphasis is toward reduction of introduced plants and animals, and promotion of the natural ecosystem, insofar as this is feasible. I could not agree more enthusiastically with these goals!

Reduction of goats and area-exclusion by fencing is a logical first step. Control should be implemented for other introduced mammals as soon as goats are chiefly absent. There isn't much purpose in attempting to promote conservation of endagered species of birds, for example, unless the plants on which birds directly or indirectly depend for food are preserved.

Proposals for carrying out the goals in the Plan fall somewhat short, and follow practical rather than theoretical lines of action. Such deficiencies should be overlooked at this stage. Certainly they should not detract from initiating the Plan at the earliest possible date. Guidebooks to restoring ecosystems on oceanic islands have yet to be written. It is hoped that the Park Service will some day be in a position to author the first one.

You are to be commended on the action thrust of this initial document.

Sincerely,

Winston Banko

Winston Banko
Biologist-in-charge

United States Department of the Interior

GEOLOGICAL SURVEY
RESTON, VIRGINIA 22092

OFFICE OF THE DIRECTOR

February 27, 1974

DES 73-67

Memorandum

To: Superintendent, Hawaii Volcanoes National Park, Hawaii

Through: Acting Deputy Assistant Secretary--Energy and Minerals MAR 4

From: Director, Geological Survey

Subject: Review of draft environmental statement for the Proposed Resources Management Plan, Hawaii Volcanoes National Park

We have reviewed the subject draft environmental statement as you requested in a letter of January 4. Significant adverse environmental impact related to the geology and hydrology of the area of the proposed project is not anticipated.

Acting Director Henry W. Coulter

OFFICE OF THE SECRETARY OF TRANSPORTATION
WASHINGTON, D.C. 20590

JAN 31 1974

Mr. G. Bryan Harry
Hawaii Volcanoes National Park
National Park Service
Department of the Interior
Hawaii 96718

Dear Mr. Harry:

We appreciate the opportunity to review and comment on this draft environmental impact statement. We have no specific comments to offer on the statement.

Sincerely,

Martin Convisser, Director
Office of Environmental Affairs
Office of the Assistant Secretary
for Environment, Safety, and
Consumer Affairs

STATE OF HAWAII

DEPARTMENT OF PLANNING AND ECONOMIC DEVELOPMENT

P. O. BOX 2359 • HONOLULU, HAWAII 96804

JOHN A. BURNS
Governor

SHELLEY M. MARK
Director

EDWARD J. GREANEY, JR.
Deputy Director

February 25, 1974

Ref. No. 0468

Mr. G. Bryan Harry
Superintendent
Hawaii Volcanoes National Park
Hawaii 96718

Dear Mr. Harry:

SUBJECT: Draft EIS for Proposed Resources Management Plan for Hawaii Volcanoes National Park

We appreciate the opportunity to review the above subject draft statement.

The investigation for this statement appears to be quite complete. The material is well organized and the graphic illustrations adequately identify the issues and concerns.

As you know, the State of Hawaii, through the Commission for the Preservation of Natural Areas, is directly involved in designating certain natural areas in order to preserve representative native ecosystems. We feel that the type of management plan you propose for this particular area complements our efforts by promoting an action program for accomplishing this goal of preserving our native flora and fauna.

We appreciate this effort by the National Park Service to perpetuate preservation of Hawaii's natural, endemic ecosystems.

Sincerely,

E. J. Greaney, Jr.
for SHELLEY M. MARK

JOHN A. BURNS
GOVERNOR OF HAWAII

DIVISIONS:
CONVEYANCES
FISH AND GAME
FORESTRY
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF FORESTRY
1179 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

January 28, 1974

Mr. G. Bryan Harry, Superintendent
U. S. Department of the Interior
Hawaii Volcanoes National Park
Hilo, Hawaii 96718

Dear Mr. Harry:

Subject: Comments on Draft Environmental Statement -- Natural Resources Management Plan, Hawaii Volcanoes

Thank you for the opportunity to review and comment on the Natural Resources Management Plan, Hawaii Volcanoes.

Following are our comments:

1. The success of the entire proposed resource management plan hinges on the control of the goat population. To assist in achieving this prerequisite, there is a proposal for the reconstruction and maintenance of 70 miles of existing boundary and drift fences, and the additional construction and maintenance of 46 miles of drift and exclosure fences. Aesthetically, this would necessarily exert a negative impact, but it would be interesting to know the life expectancy of the erected fences, especially those that will be exposed to the corrosive sulfur fumes. It is apparent that the efficient maintenance of these fences would be very costly. This is not considering the unpredictable and destructive forces of flowing lava.

2. The attempt to re-establish endemic Hawaiian species into former ranges is distressing in the light of the "let burn" policy. The present park policy considers lightning and volcanic fires as a natural phenomenon which should be allowed to run its course, barring certain qualifying circumstances; i.e., danger to life and property, etc. The proposal to control or eradicate exotic

plants involve thousands of acres with a tedious "cut and individually poison" control methodology. In this light, a "let burn" policy in any conceivable aspect would be comic. Moreover, the aggressive and hardy exotic plant species would invade or reinvade any burned-over land. This would indicate a never-ending type conversion problem.

3. The proposal for native bird habitat restoration implies that the bird population can be increased or enhanced. This may be so and would be applicable, more so to water or wetland related birds. No reference is made to avian diseases and the fact that the "red book" (Threatened Wildlife of the United States, 1973 edition) indicates that the most probable cause for the extinction of many avian species were diseases spread by mosquitoes from introduced birds. To restore the habitat of native birds would only be half the solution. What about measures that would control avian diseases and is this in any way feasible? Predation by rats and mongooses is also listed as a probable (hypothetical) cause. We suspect that this is a strong possibility.

4. The Olaa Forest Tract is one of the hardest hit by the ohia decline. Our 1972 survey indicates nearly all the area has over 40 per-cent dead or dying trees. It is recommended problems and criticalness of the ohia decline be expounded in this management plan.

5. No mention is made on the recent fire protection policies of the National Park Services. The recent policy on natural fire (a natural phenomenon) in National Parks is to let the fire run their course when such burning can be contained within predetermined fire management units. This "let burn" policy will have an immense impact on our valuable watershed and ecosystem bordering the National Park boundaries. Therefore, the fire protection policy should be clearly indicated in this plan.

6. Page 15, D-2, delete State Department of Land and Natural Resources and insert State Department of Agriculture.

Very truly yours,

Much Aloha,

Tom

TOM K. TAGAWA
State Forester

A-20

cc: Hawaii District
G. Soh, Planning Office

RESEARCH UNIT
State of Hawaii
Department of Health
Honolulu, Hawaii, 96727

P. Quentin Tomich, Ph. D.
Animal Ecologist V

February 14, 1974

COMMENTARY

DES 73-67, Natural Resources Management Plan, Hawaii Volcanoes National Park, dated October 26, 1973.

General

The Draft Environmental Statement is a highly refreshing view of what is needed for rehabilitation of natural ecosystems in Hawaii Volcanoes National Park.

It is also a concise outline of the steps that are necessary to achieve rehabilitation. In some areas of the endeavor, details of considerable importance are not spelled out.

Vegetation

Segments of the vegetation that have been exposed to many generations of feral goats at maximum population densities bear little close resemblance to imputed original conditions. Obviously, whatever is done there is little liklihood for return to pre-Cook and pre-exotic conditions; these, of course, are unknown except as general interpretations from scanty evidence.

Expanding the ranges of species threatened by lava flows in an urgent task. This may be the only practical method to avert some possible extinctions. It is entirely proper in an ecological context to assist recovery of the Parks ecosystems, not only by the removal of goats and other exotics, but by a careful plan of local plantings based on extensive knowledge of the plants considered for local introduction.

Prominent botanists such as the Degeners, Fosberg, St. John and Lamoureux are acknowledged as resource persons for preparation of the plan. Guidance from such renowned systematists and ecologists, and from geneticists as well, should be continued. A particular need for their advice applies to geographic selection of seed sources, a program for labelling of introduced plants, and any actions which may result in the manipulation or hybridization of genetic stocks.

Animal Life

The hope for recovery of the Hawaiian goose and natural extension or reoccupation of range by forest birds will depend on revival of plant communities to a degree that will provide for their support. The plan covers these subjects very well, with the recognition that the pig and the smaller exotics require additional basic inquiry before management recommendations can be completed. The feral cat may be a more important predator than is suggested by the plan.

Alternatives

This section is particularly well organized. In addition, those alternatives which are ecologically sound are universally selected.

JOHN A. BURNS
GOVERNOR

FREDERICK C. ERSKINE
CHAIRMAN, BOARD OF AGRICULTURE

WILLIAM E. FERNANDES
DEPUTY TO THE CHAIRMAN

STATE OF HAWAII
DEPARTMENT OF AGRICULTURE
1428 SO. KING STREET
HONOLULU, HAWAII 96814
P. O. Box 226
Capt. Cook, Hawaii
96704

January 14, 1974

Mr. G. Bryan Harry, Superintendent
Hawaii Volcanoes National Park
Hawaii 96718

Dear Harry:

Thank you for giving me an opportunity to comment on DES 73-67.

I found the draft to be comprehensive and the few comments I have to offer are more in the nature of "nitpicking".

Page 15-D1 Karmex and dalapon are not known to be effective herbicides for cut stem treatments and probably should be delected.

D2 State agency reponsible for bio-control work is the Department of Agriculture.

Page 16 I am of the opinion that banana poka (Passiflora mollisima) poses a definite threat to the native tree species within the Park. Eucalyptus spp also appears to be worthy of note in this section.

Page 28 Desmodium triflorum is commonly called three flowered beggerweed. Cassia leschenaultiana is commonly called partridge pea.

Mr. David Woodsite, Wildlife Biologist of the State Fish and Game Division, once stated an opinion that the rapid spread of mullein (Verbascune thapsus) along the upper slopes of Hualalai was a threat to the nene flock in that area. His reasoning was that the dense, tall stalks of this species interfered in the landing and take-off of the bird. Mullein is now encroaching along the slopes of Mauna Loa and will eventually invade the upper sections of Park lands. Perhaps a control strategy should be considered for this weed species.

Yours truly,

A-22 Akira Kawasaki

Akira Kawasaki
Weed Specialist

cc: Mr. James Kim, Branch Chief

COUNTY OF HAWAII

PLANNING DEPARTMENT

25 AUPUNI STREET • HILO, HAWAII 96720

SHUNICHI KIMURA
Mayor

RAYMOND H. SUEFUJI
Director

February 13, 1974

Hawaii Volcanoes National Park
Volcano, Hawaii 96718

Re: Resource Management Program Draft Environmental Impact Statement

We have the following comments to offer on the subject draft environmental statement.

1. What is the cost estimate of these subprograms within the resource management plan? It seems that the control of exotic plant species which range over 75,000 by individually cutting and poisoning will require a tremendous amount of manpower and/or man hours. This is especially the case if vehicles are not allowed within the wilderness areas. While the intent of these programs is highly commendable, they do seem impractical from a logistics standpoint.

2. What is the relationship of this management program with other such as the statewide inventory of historic places or the federal inventory program under EO 11593?

3. Perhaps a request for legislative action to provide an exception to the no hunting rule should be sought. There could be limitations on species, bag limit, season and area. As it is, through circumlocution, hunting already exists. Such exception would be less confusing and perhaps a bit more honest.

Raymond Suefuji

RAYMOND H. SUEFUJI
Director

VG:RN:LR:lst

cc: State Clearing House Agency-DPED.

Approved:

Mayor

NPCA

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Pittsburgh, Pennsylvania
[illegible]

February 15, 1974

G. Bryan Harry
Superintendent
Hawaii Volcanoes National Park
Hawaii 96718

Dear Mr. Harry,

Thank you for sending NPCA the Draft Environmental Statement (DES 73-67) on the Natural Resources Management Plan for Hawaii Volcanoes National Park. We have reviewed the plan with interest and we commend your efforts in preparing a comprehensive and detailed report.

As in the past, we can only support a plan designed to eliminate destructive feral animals from this park. The present plan is inadequate in this respect since it proposes only to "reduce and control" feral animals to the point where endangered Hawaiian plants can survive. Without a program fully geared toward removal, instead of reduction and control of feral goats and pigs, this problem will persist and the park environment will continue to be threatened.

We further insist that participation by local citizens in control efforts be fully supervised by employees of the National Park Service. While citizen participation may provide a useful supplement to animal control efforts, such a program must be based on prompt elimination of feral animals, or the park will become involved in extended hunting seasons. This, of course, is not an acceptable management policy for national parks.

NPCA strongly urges you to strengthen your position on full elimination of feral goats and pigs. True, the possibility of reinfiltration by these animals will always exist, so that final elimination is difficult to achieve, but a firm position on your part will improve our understanding of your objectives.

National Parks & Conservation Association, 1701 Eighteenth Street, N.W., Washington, D.C. 20009
telephone (202) 265-2717

printed on recycled paper

Endangered plant and bird species rightfully occupy a priority position in your management policy. The first overall objectives are, and should be, protection and preservation of Hawaii's spectacular endemic ecosystems. However, as the environmental statement indicates, the key to restoring viable populations of endemics lies in effective elimination of feral animals. It is essential that this program be completed.

We appreciate your consideration of our views and we look forward to receiving the final plan.

Sincerely,

Toby Cooper

Toby Cooper
Administrative Assistant, Parks

cc. Russell E. Dickenson
Nathaniel P. Reed

IBP

ISLAND ECOSYSTEMS
INTEGRATED RESEARCH PROGRAM
ECOSYSTEM ANALYSIS STUDIES
U.S. INTERNATIONAL BIOLOGICAL PROGRAM

February 15, 1974

Mr. C. Bryan Harry
Superintendent
U.S. Department of the Interior
National Park Service
Hawaii Volcanoes National Park
Hawaii 96718

Dear Bryan:

Enclosed are my comments to the draft statement. I think you have done a tremendously fine effort, but there are a few points that need attention. Particularly, I am concerned about the details of the "rehabilitation" program. As you will remember from our earlier discussions, I consider it absolutely necessary to confine the planting into specially designated transplant gardens. The plan should be supplied with large-scale maps that show the areas individually and provide a separate program for each area.

The fencing program looks extremely good. On p. 28, I think you should acknowledge the data source, i.e., our Technical Report #13. I enclose a copy of the koa-goat paper that appeared in Ecology.

With best wishes.

Sincerely yours,

Dieter

Dieter Mueller-Dombois
Director, ISLAND ECOSYSTEMS IRP
Professor of Botany

DMD:la

Enclosures

DEPARTMENT OF BOTANY • UNIVERSITY OF HAWAII • PHONE (808) 944-8044 • HONOLULU, HAWAII 96822

February 15, 1974

Comments on draft environmental impact statement, Natural Resources Management Plan, Hawaii Volcanoes National Park, Hawaii, October 1973, 69 p.

1. The statement presents a great amount of very interesting information, and the spirit and effort with which this has been put together deserves a great deal of credit.

2. Although a number of management objectives are spelled out in the plan, there are primarily two that involve a major impact on the future development of the Park's biological resources:

a) the control of unwanted exotic species
b) the propagation of desired native species

3. The control program for unwanted exotic species is detailed under II on p. 7 to 15. The items singled out for control are: A. Goats, B. Pigs, C. Rats and mongooses, D. Exotic plants.

4. The goat control program involves the new idea of systematic exclusion by a fencing system that is mapped on Fig. 1 (p. 8). This effort is highly commendable. It is not quite clear, however, whether the Park Service policy aims at total eradication of the goats in the Park. The introductory statement under point A. GOATS (p. 7) is rather vague on this point. What is the policy: to maintain low levels of goat populations, or to eradicate them from the Park?

5. The pig control program likewise is commendable. Here, the policy is clear: to cut down the numbers to a low level. Total eradication would probably be an impossibility anyway, because the pigs are too well protected in the rain forest habitat. No control of mongooses and rats are contemplated for this plan, instead research is suggested. This seems wise under the conditions indicated.

6. The exotic plant control program is very generally treated (p. 15-16). Some interesting information is given in Table 4. Two control methods are mentioned: (a) cutting and use of herbicides, (b) introduction of biological controls. Both these methods may have considerable envrionmental consequences when applied. Nothing is said about the level or scale of use of these methods. Apparently, there is no well-established policy for plant control. Without further information, it is not possible to evaluate the consequences of the Park's plant control program.

7. The second major part of the draft statement involves the propagation of desired native species. This management aspect should receive some careful re-evaluation. According to the statements on p. 2-3, this "rehabilitation" program is well underway already. Basically, the intent to preserve rare, endemic Hawaiian plant species from extinction by planting of seedlings is highly commendable, but I sincerely question the scientific validity of the approach taken:

(1) If a species is rare, it does not mean that it was abundant at some earlier time. Most rare species are naturally rare.

(2) A species is not always a genetically homogeneous population. For example, we know for most wide-ranging species that they exist in several different races or ecotypes.

(3) Bringing species from higher elevations to lower elevations, or from outside the Park into the Park is not wrong as such. But it is wrong when the plants are propagated into existing natural ecosystems without proper precaution.

(4) This precaution would involve the setting up of specially designated transplant gardens or arboreta. A further precaution would be labelling of the plants as to their location of origin and establishment of a record system to check on their performance.

(5) It is not correct to assume from the climatic similarity of two places that a plant species should be distributed in the two locations, or to assume that the plant was formerly in the same climatic area where it is not found today. Species distribution is controlled also by the mechanisms of dispersal, by competition of a particular combination of plants and by soil factors.

8. The species range maps shown on pages 37-43 provide for a nice overview, but they are hardly sufficient as maps showing details of the planned rehabilitation program. From these maps one gets the impression that the entire Park will be affected by man's efforts of plant propagation. There will hardly be any natural ecosystems left in the Park. The influence of man as a regulator of plant and animal species composition will be the dominant factor in the future ecosystems of the Park.

9. Certainly, such an extensive rehabilitation program would be a misconception of the policy for Park managment. There is nothing against a large-scale program, but it should be intensive, i.e., small in area, done with proper care of recording, done with the proper knowledge that plant propagation establishes artificial conditions.

10. I strongly suggest, therefore, that "rehabilitation" areas be designated clearly on large-scale maps (at least 1 : 24,000 in size, better still, 1 : 10,000 or 1 : 5,000), that programs be worked out in detail for each area. The area itself should be treated as a transplant garden or arboretum of native plants and not as a native ecosystem. It should be very clear that such so-called "rehabilitation" areas can never become native ecosystems. Wherever such a transplant garden develops successfully, such a garden may serve as a seed source for the surrounding natural ecosystem. While the propagation from such artificially established seed sources is not natural either, it does not destroy the Park as a natural outdoor laboratory for studies in biogeography and ecology. At least one can later pin down the seed source. Wherever native plants become established in the surroundings from propagules of the transplant gardens, such surrounding areas may be more adequately referred to as "rehabilitated" ecosystems than the areas now so designated in the plan.

D. Mueller-Dombois

Dieter Mueller-Dombois
Professor of Botany
Director, ISLAND ECOSYSTEMS IRP

UNIVERSITY OF HAWAII

College of Arts and Sciences
Department of Botany

February 22, 1974

MEMORANDUM TO: Mr. G. Bryan Harry, Superintendent, Hawaii Volcanoes National Park

FROM: Charles H. Lamoureux, Professor of Botany, University of Hawaii

SUBJECT: Comments on Draft Environmental Statement for Natural Resources Management Plan

The objectives of the plan are stated as:

I. Re-establish endemic Hawaiian species into former range.

II. Protect remnant Hawaiian ecosystems from exotics introduced by man.

I am in full agreement with these objectives, and fully support the proposed actions indicated in the statement to accomplish objective II. However, I do have some reservations about certain actions proposed to accomplish objective I.

A. Plants that are key components of major native ecosystems. Current research which my students and I are doing in the park under the I.B.P. indicates that there are differences in morphology and phenology of such species as Acacia koa, Sophora chrysophylla, Metrosideros collina, and Myoporum sandwicensis from place to place within the park. These differences suggest that there are genetic differences between the various populations of these species within the park. If we are ever to understand the evolutionary biology of Hawaii's unique plants and animals we must have the genetic integrity of these populations preserved. Therefore, any large scale replanting schemes should be so designed that plants from different populations are not indiscriminately mixed. Consequently, I would recommend strongly against any replanting schemes which involve collecting mixtures of seeds from several populations of a plant such as mamane, and then scattering this seed mixture over wide areas of the park. It would be preferable to gather seed for planting any area only from the plants of the desired species growing closest to that area under similar environmental conditions. It is also necessary that careful records be maintained of all such plantings.

Plant Science Building · Room 101 · 3190 Maile Way · Honolulu, Hawaii 96822/Cable Address: UNIHAW

AN EQUAL OPPORTUNITY EMPLOYER

B. Rare plants known to occur (or to have occured) within the park.

This part of the project, as proposed, seems desirable from a biological standpoint, provided adequate records are kept. It would seem wise to identify, either on a detailed map or by means of labels attached to the plants, all plants which are set out in the park. I would recommend further that seed sources for these plants be from nearby areas within the park, or immediately adjacent to the park.

C. Rare and endangered species suspected of once occurring in the park.

I would advise great caution in this part of the project. One or more of the 5 species listed in Table 3 may well have occurred formerly in park areas from which dryland forest has disappeared. It might well be worth trying to grow some of these, under careful control, but it would seem unwise to undertake extensive plantings of any of them.

I have been informed that Hibiscadelphus hualalaiensis has hybridized in the park with H. giffardianus. This indicates that these two species were not sympatric in the recent past and suggests, in hindsight, that H. hualalaiensis should not have been planted in the park. In order to avoid losing H. giffardianus altogether, an effort should be made to remove all hybrid seedlings and trees of H. hualalaiensis from the park. Hybrids could be distributed to various botanical gardens within the state, and any plants of H. hualalaiensis which can be moved might be offered to forestry officials for replanting in Kona. Any trees which must be destroyed should be made available to scientists so that herbarium specimens, wood samples, and other collections can be made from them.

In all replanting programs it is essential that careful and detailed records be maintained so that scientists 5 or 50 years from now will be able to tell what has happened. Otherwise, in the future it will be impossible to conduct meaningful studies of evolutionary biology in the park, which is the only place in the world that many of these studies could be undertaken.

Thank you for your consideration of these comments.

CHL:dt

THE UNIVERSITY OF TEXAS AT AUSTIN
AUSTIN, TEXAS 78712

Department of Zoology

February 8, 1974

Superintendent Bryan Harry
Hawaii Volcanoes National Park
Hawaii 96718

Dear Bryan:

After our two brief conversations, I am reassured by your comments. I understand the difficulty of devising a plan for preserving and restoring the unique biosystem of the Park which will be consistent with scientifically sound principles, be supported by local citizens, meet the legal requirements of an Environmental Impact Statement, and gain a high priority for funding at the top administrative levels of the National Park Service. Your job is not easy and I hope I can make a few useful comments. From all our discussions, I have felt a need for further dialog, since there are many facets to the problem of which I am unaware, and to offer many positive comments, you have to continue filling in facts and points of consideration I need to know. It is with this knowledge that I summarize some of my comments, to make it easier for you to pick some to use, to consider others or to pursue some with me further.

First, I think we are in complete agreement that a "do nothing" approach is irresponsible and would certainly cost us, the public, one of the most geologically and biologically exciting, scientifically valuable, and one-of-a-kind possessions managed by the Department of Interior. Nowhere else can we see such biological activity resulting from the rapid geological perturbations. This system is the closest natural phenomenon to the impact of man on the biosphere, and we may learn by observation and analysis some of the long range consequences of disturbances to the biosphere. Of course, the natural beauty speaks for itself.

However, it is the similarities between man's impact on his biological surroundings and natural events on a young and active volcanic island which is at the root of the problem and demands serious evaluation of procedures designed to rebuild or preserve a natural community.

On such a young island many niches have not yet been naturally filled and the competition among species is still relatively mild. This means we can successfully introduce species to an area, but we run the risk of unexpected competition with the endemic inhabitants on the one hand, resulting in new selection pressures which will change the endemics and destroy them in their previous natural state. But on the other hand, the introductions are frequently made under the label of "biological control". When a parasite or predator is introduced to control a pest, the control organism may change and attack a non-pest. Indeed, in a community such as Hawaii where many niches are available, the predator or parasite, having no better competitor

or natural resistance of the endemic species eventually will shift hosts and attack some of the species we are interested in saving. Short run gain in control has a high long run price, and in my opinion should be avoided at all costs. There are other methods of control, indeed, biological control, where such risks are not taken. Control such as can be done through genetic methods rather than parasitism and predation are an example.

Second, to a population geneticist, the most striking aspect of the biological system in Hawaii is the extensive diversity among populations even in close proximity. Very closely related species have been found in Olaa Forest and Kipuka Puaulu, only three or four miles apart. I feel certain examples could be found much closer, since often we see species restricted to single kipukas, gulches, etc. The close relatives of such a restricted species may be indistinguishable except by cytogenetic, biochemical, or hybridization tests. To unwittingly hybridize them may result in exchange of incompatible gene combinations, the effects some times taking several generations to appear. Initial hybrid vigor may result eventually in poorly adapted forms even in eventual extinction of parents and hybrids alike. At the very least the original species is modified by gene exchange from a population adapted to a different environment, and thereby may be lost in a strict sense. (The latter need not be undesirable, but should not be assumed to be desirable.) As a consequence, any transplants, seeding, etc. should be made with careful consideration of the possibilities and consequences of subsequent hybridization with naturally occuring relatives. When such artificial propagation is done, it should ideally be conducted with considerable genetic study beforehand, but at the very least should be in a clearly documented fashion in a strictly confined area to allow observations and analyses to be made on subsequent effects. Furthermore, if the artificial propagation turns out to have been a mistake (as some surely will be), the introductions may be removed. If the naturally occurring population has been damaged or changed you should have "stored away" germplasm taken before the introduction (such as cuttings rooted and vegetatively propagated outside the experimental area and thereby uncontaminated). Without both being able to remove the unfortunate plantings and replace fresh original material, you do not have the option to back up an experiment.

Third, I've been thinking some more about the Andropogon and fire hazard you mentioned. The use of a selective herbicide for fire lanes and control near roads, trails, lava flows, etc. seems desirable. A lot of research has gone into selective herbicides, and there are knowledgeable specialists in this field who could be consulted. To the best of my knowledge, dalapon might be a chemical of choice, applied in the spring when the grass begins to grow. A longer range control of the grass could be initiated by planting some trees appropriate for the area and thereby begin to rebuild a forest. Shade tolerant understory plantings would logically follow at a later date.

Fourth, continuing advice and research from the scientific community could easily be obtained. One way as you are doing, is by encouraging research in areas related to development and selection of alternative means to the ends defined by the objectives of your program. I also feel if you could get several of the faculty at the University of Hawaii or elsewhere to serve on a standing advisory committee, the responsibility you could place on them to help at one level of your decision making process would greatly help them to see first hand where research was needed in order to give you valid advice. You would benefit by some prior digestion and consolidation of points of view, and you would not need to identify and push needed lines of research.

I think this sums up the ideas for the moment. I hope it is helpful. I feel we have much to learn, but time is short. Thereby immediate action is needed, but the high costs of failure require careful planning and subsequent alternatives to be tested in a preliminary fashion while there is time to lay plans for subsequent phases.

Let me know if I can be of help.

Sincerely,

R. H. Richardson

R. H. Richardson
Associate Professor

RHR:sjs

For the Better Protection of Wildlife in Hawaii

HAWAII AUDUBON SOCIETY

P. O. Box 5032
Honolulu, Hawaii 96814

18 February 1974

TO: G. Bryan Harry, Superintendent, Hawaii Volcanoes National Park

FROM: Wayne C. Gagne, President, Hawaii Audubon Society

SUBJECT: Comments on October 26, 1973, Draft Environmental Statement on the NATURAL RESOURCES MANAGEMENT PLAN, Hawaii Volcanoes National Park

The Society has examined the Plan and it was found to be generally satisfactory. We have some comments and questions which we think will help to improve the draft. In addition, Gagne has provided comment on this draft in his capacity as a staff member in the Entomology Department of the Bishop Museum. We will not reiterate all of the points raised in it but will expand our interpretation of a few subjects. The proposed alternatives are untenable.

There seems to be some confusion regarding one of the plant species listed in Table 3, page 6. Gouania hawaiiensis is almost certainly an extinct species. (see St John, Pacific Science 27(3): 269-73, 1973). Members of this genus are not known to have had hawaiian names. The mao usually refers to an Hawaiian cotton, Gossypium sandwicensis, an endemic species, or to Abutilon molle, an exotic species in the same plant family (Malvaceae).

Special mention should be made on the status of the ou discussed on page 7, paragraph. We consider this species to be in the most critical situation of the native birds on the Island of Hawaii, certainly more so than either the 'akepa or the akiapola'au. No sightinghas been reported in the last few years in spite of active searching by resident ornithologists there.

We are of the opinion that no population level of exotic mammals will be found to have "minimal" impact on the endemic island biota. The present practices would seem to run counter to the recommendations in the "Leopold Report" to the National Park Service. We would prefer wording to the effect that goats and pigs will be totally removed from the park and that there will be a continuing effort to exclude peripheral populations of these animals from re-entering the Park. We would prefer also that research be initiated towards the eventual elimination of the mongoose and the rodents. Following the same logic, there seems to be no ecological grounds to tolerate the presence of exotic birds. It could be argued that the exotic gallinaceous species, for example,arepossibly direct food competitors with the nene as well as having potential roles as vectors of diseases and parasites. Research needs to be initiated to better define the damage exotic birds are doing to native ecosystems and at population control measures.

Regarding CONTROL OF EXOTIC PLANTS (page 15), is Table 4a that on page 16? We regard the cut and individually poisoning technique to be preferable in all cases. Fountain grass needs to be uprooted, removed from the site where found, then burned. Biological control is less preferable because this adds additional exotic species to the park on a probably permanent basis. In certain instances these also attack native plants. A blackberry moth also attacks akala. This was probably predictable on hindsight. More importantly,

however, species introduced for biological control have the genetic potential of evolving the unexpected. For example, a lantana bug on Oahu attacks the entirely unrelated endemic naio as do the adults of the lantana leaf beetle on olopua in South Kona, Island of Hawaii. The function of biological control should be one wherein the pest is beyond the bounds of cultural control and the biological agent(s) would likely bring the pest population down to a level where cultural techniques could proceed toward the elimination of both the pest and its alien natural enemies.

With regard to DESCRIPTION OF THE ENVIRONMENT, page 23, paragraph 2, it should be noted that the Smithsonian Institution under the direction of Dr. Raymond Fosberg are compiling a list of the "endangered" plants in the Hawaiian Islands. The Hibiscadelphus species have been entered into the "Red Data Book" of the International Union for the Conservation of Nature and Natural Resources as endangered species.

In light of recent monographs, sightings and/or collections the distribution maps of the plants and birds need revision in some cases. The awikiwiki and ohai also occur at Soth Point. The aiea, Nothocestrum longifolium is now known from the Puu Makaala area. The holei is now known as Ochrosia compta and it is also known from Oahu. The meu, Cibotium hawaiiense is known from the Kohala Mountains (Richard Becker, personal communication). Mr. Win Banko of the U.S. Bureau of Sport Fisheries and Wildlife should be consulted regarding recent sightings of the akiapola'au and 'akepa. Recent reports indicate sporadic occurance in additional areas. The Hawaiian bat, another endangered species, should also be added to these distribution maps and Dr. P. Quentin Tomich of Honokaa should be consulted regarding its status with respect to this draft proposal.

Also in light of recent discoveries as to the presence and extent of a most remarkable biota in the lava tubes of Hawaii Volcanoes National Park and elsewhere in the State, a new section needs to be added under DESCRIPTION OF THE ENVIRONMENT. Mr. Francis Howarth of the Entomology Department of the Bishop Museum who made the initial discovery of this biota and who is continuing research on it under the International Biological Program (see Science reprint, enclosed) suggested the following wording:

"Lava Tube Ecosystem

A remarkable and significant ecosystem within the Park boundary is the lava tube ecosystem. More than 30 species of arthropods are endemic to caves on the Island of Hawaii. Most of these animals are found in Hawaii Volcanoes National Park and are worthy of protection. MMany, such as the blind big-eyed humting spider, the cave tree cricket and the blind terrestrial water treader are among the most bizarre cave animals known anywhere. The main energy source in Hawaiian caves is tree roots, mostly of ohia.

"The proposed park plan to preserve the above-ground ecosystems will not conflict with the integrity of the cave ecosystem. However, changes in the vegetation cover or the direct use of caves by visitors or for park facilities may jeopardize this ecosystem.

"Lava Flow Ecosystem

Recent lava flows, far from being biologically barren, harbor a unique assemblage of endemic arthropods which appear to scavenge on plant and animal detritus blown onto the flow. A newly discovered cricket, related to the Hawaiian cave cricket, lives on Mauna Ulu. The Hawaiian bat also forages over new flows."

(Comments on Draft NATURAL RESOURCES MANAGEMENT PLAN continued)

We have consulted Dr. D. Mueller-Dombois, Botany Department, University of Hawaii regarding the proposed re-establishment of endemic Hawaiian plant species into former range in Hawaii Volcanoes National Park. We generally concur with the remarks he has submitted to your office.

This concludes our comments.

ENCLOSURE

Cavernicoles in Lava Tubes on the Island of Hawaii

Abstract. *Cave-adapted arthropods have evolved in lava tubes in Hawaii. This is the first report of cavernicoles from the Hawaiian Islands. The specialization of the cavernicolous insects and the recent origin of the lava tubes suggest that subterranean connections between lava tubes regularly occur and provide dispersal routes. The discovery that lava tubes were colonized by representatives of the adaptively radiating native fauna offers significant potential for evolutionary studies.*

Troglobites (obligatory cavernicoles) have been reported almost exclusively from limestone caverns. In fact, Vandel (*1*) omits lava tubes entirely from his comprehensive monograph on biospeleology, and Poulson and White (*2*), in their article on the cave environment, limit their discussion to limestone caves, although a few troglobites have been reported from lava tubes in the United States (*3*) and Japan (*4*). Also, the few troglobites from tropical areas or from oceanic islands (*1*, p. 26) are, according to Barr (*3*), almost entirely aquatic. Consequently, it was surprising to discover a rich, specialized arthropod fauna in the relatively young lava tubes on the island of Hawaii (*5*).

The Hawaiian islands provide an extreme example of a disharmonic fauna on an isolated oceanic island chain and some of the most remarkable examples of adaptive radiation among those groups with early successful colonists (*6*). The biota are uniquely suited for evolutionary studies (*7*). Therefore, the discovery of lava tubes as a specific biotope for native fauna in the Hawaiian islands offers a significant potential for further insights into evolutionary processes and adaptive radiation.

During July 1971, I collected representatives of five groups of insects, in four orders, that have independently become specialized for life in lava tubes on Hawaii. All of these cave forms have been collected only in the dark zone of lava tubes. At least one of these, a cixiid plant hopper (Homoptera, Cixiidae) (Fig. 1), is a true troglobite (*8*). It has vestigial compound eyes, the antennal bases are remarkably enlarged, it is almost completely depigmented, and it is brachypterous. All its epigean relatives, a large endemic complex of species, are fully winged, eyed, and colored. All instars of the cave cixiid were taken on tree roots that hang in caves, and the last nymphal instars and adults were collected as they moved on the walls and floor far from tree roots.

Fig. 1. A specialized cave cixiid from Hawaii. Ventrad of the highlight on the head is the enlarged antenna. The lateral ocellus is visible as a diamond-shaped spot anterior and dorsad of the antenna. The compound eye consists of three vestigial ommatidia near the lateral ocellus and is visible only in slide mounts. The length of the body is 4.5 mm. [G. A. Samuelson, Bishop Museum]

Two groups of endemic crickets (Orthoptera, Gryllidae) have independently evolved cavernicolous species. One species can be placed in *Thaumatogryllus*, previously known only from an epigean form on the island of Kauai. It has markedly reduced eyes, elongation of legs and antennae, vestigal tegmina, and marked depigmentation of the integument compared to the surface species. The other is not related to anything in the known Hawaiian fauna and is possibly an apterous nemobiine cricket.

A terrestrial, apterous, and nearly eyeless water treader (Fig. 2) (Hemiptera, Mesoveliidae) was collected on the cave walls. It is the first representative of this family in the native Hawaiian fauna and may be related to *Speovelia maritima* Esaki, known only from a sea cave in Japan (*9*). I have also collected a species of ground beetle belonging to the widespread genus *Tachys* (Coleoptera, Carabidae). The latter is most closely related to *T. arcanicola* Blackburn, a native epigean species known only from Oahu. All of the above species from lava tubes may be troglobites, but further studies are necessary to confirm this. Other arthropods, including other insects, with reduced or absent eyes and depigmented integument that were collected in lava tubes are thysanurans, collembolans, spiders, isopods, and diplopods. Their status in the cave ecosystem is not yet clarified.

Many taxa common in caves in the continental tropics, for example, bats, cockroaches, and ants, are absent in the disharmonic native fauna of the Hawaiian islands. The resulting empty biotope in lava tubes has been colonized by representatives of the native groups in the process of adaptive radiation. The main source of energy input in the lava tubes appears to be the tree roots that penetrate the lava through cracks and dangle into the caverns. The roots, both living and decaying, serve as a direct food source, and they also form a path for percolating water carrying organic matter.

Two of the lava tubes visited in this study are on the Mauna Loa massif at 300 m and 1140 m, and the other is on the Kilauea massif at 480 m. The ages range from 90 years (Kaumana Cave) to less than 20,000 years (*10*). Lava caves, unlike limestone caves, tend to degrade and collapse in a brief geological time. It is not plausible that the specialized morphology of the species in the lava tubes could have evolved since these tubes were formed. In contrast to the opinions of Torii (*4*), I suggest that dispersal from one lava tube to another is a regular, though perhaps infrequent, occurrence in Hawaii. It may involve dispersal through aa clinker, extensive lava tubes, great earth cracks, fault lines, fissures, and perhaps the large gas bubbles in pahoehoe basalt. In that case, the fauna of a given volcanic massif may be similar in similar climatic regions, and there may be continuous evolution from the earliest occupation of lava tubes to the mature and eroded volcanic massif. Dispersal across sea gaps is much less easily envisioned than for the

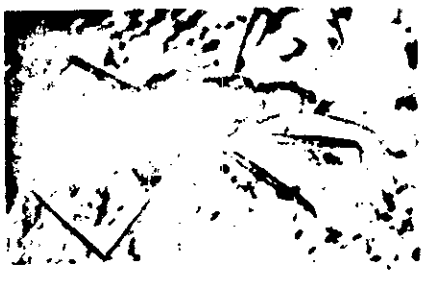

Fig. 2. A specialized cave mesoveliid. The remnant of the compound eye is visible near the posterior lateral corner on the right side of the head. It is not visible on the left side. The length of the body is 3.5 mm. [G. A. Samuelson, Bishop Museum]

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surface fauna, and studies have shown that the rate of such dispersal for epigean forms is low (*7*, pp. 534–535).

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References and Notes

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7. For example, see H. L. Carson, D. E. Hardy, H. T. Spieth, W. S. Stone, in *Essays in Evolution and Genetics in Honor of Theodosius Dobzhansky*, M. K. Hecht and W. C. Steere, Eds. (Appleton-Century-Crofts, New York, 1970), pp. 417–543.
8. Only one other cixiid is reported to be cavernicolous, *Typhlobrixia namorokensis* Synave from Madagascar. Vandel considered it a soil form accidental in caves (*1*, p. 183), but morphologically it is intermediate between epigean species and the Hawaiian cave cixiid. In Cixiidae, the adult is the dispersal stage, and most root-feeding cixiids molt to epigean adults. Field observation has shown that the nymphs of the Hawaiian cave cixiid feed on exposed tree roots in the caves and not on those roots within the soil and that the adults disperse entirely within lava tubes and associated cavities.
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10. G. A. MacDonald and A. T. Abbott, *Volcanoes in the Sea* (Univ. of Hawaii, Honolulu, 1970), p. 30; H. T. Stearns, *Geology of the State of Hawaii* (Pacific Books, Palo Alto, Calif., 1966), pp. 114–116.
11. This study was supported by NSF grant GB 23075 and is part of an integrated program of studies on island ecosystems, the International Biological Programme, Hawaii Subprogram. I thank F. J. Radovsky for his review and encouragement; G. A. Samuelson for identifying the carabid; and both of them and W. A. Steffan, W. C. Gagné, F. D. Stone, and N. C. Howarth for technical assistance. Contribution No. 1, Island Ecosystems IRP/IBP Hawaii.

31 August 1971; revised 15 October 1971

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For the Better Protection of Wildlife in Hawaii

HAWAII AUDUBON SOCIETY

P. O. Box 5032
Honolulu, Hawaii 96814

February 18, 1974

Mr. G. Bryan Harry
Superintendent
Hawaii Volcanoes National Park
Hawaii 96718

RE: Draft Environmental Statement for the NATURAL RESOURCES MANAGEMENT PLAN, Hawaii Volcanoes National Park, Hawaii

Dear Mr. Harry:

The Society is in full agreement with the two broad goals of the Natural Resources Management Plan to (1) Re-establish endemic Hawaiian species into former range and to (2) Protect remnant Hawaiian ecosystems from exotics introduced by man. It is most commendable that these objectives are clearly and unequivocably stated, that they are recognized as the official mandates for management of this Park's unique biological resources, and that these responsibilities remain in focus throughout the Statement.

The following comments and questions relate to research, techniques and actions in effective pursuit of these goals.

(1) Re-establishing endemic plants in areas freed of destructive exotic mammals. The Plan should give assurance that particular species selected for planting in specific vegetation zones are the same that occurred in that zone before disturbance by modern man -- or that match as closely as can be known.

After feral goats have been removed from some large areas, restoration efforts will be starting from scratch with only scant vegetative remnants of the native ecosystem present. The species components of the pre-goat ecosystem may be largely unknown. Restoration, in effect, could become just guessing what major species were there before and then planting on a large scale seeds of a few likely available candidates. What is needed before further planting proceeds is intensive research and planning in terms of the balanced diversity of species and their interaction in the whole ecosystem that is to be restored. To insure that plantings most closely approximate the endemic species make-up of the area, park records and scientific literature must be thoroughly researched and coordinated and several knowledgeable botanists and ecologists consulted on a continuing basis.

When the species components of an ecosystem are known, or carefully selected as the most likely components, the seeds or seedlings from immediately adjacent areas, or that most nearly match, should be used for planting. As much as possible, restoration managers must avoid creating new and different ecosystems from the wholesale planting of seeds taken from a single source in a divergent zone. When it is possible to approximate or replicate the native ecosystem that previously existed by judicious planting of species components in a balanced proportion, this must be done.

Hawaiian varieties tend to grade into different varieties even as the species itself extends in a continuous belt through one zone into another. Because some plant species vary considerably over short distances depending on climate, elevation and soil changes, the seed source should be as close as possible to the planted area.

It is essential that the park protect the genetic integrity of its endemic plants. To this end, the management Plan should recognize that the distinctive gene pool of a species, subspecies or variety is worth preserving. To avoid mixing gene pools, even of the same subspecies or variety, seeds from different vegetation zones and elevations should not be mixed together. Allied with this is the related recommendation that conscious effort be made to preserve the natural genetic diversity of a plant species in one ecosystem. This can be done by using many different parent trees in one area as the source for seeds or seedlings to be planted. In short, care must be taken not to mix two separate gene pools, but still to sustain the natural diversity within one specific gene pool. The Plan should acknowledge both the dangers of artificial hybridization and inbreeding in altering the composition of endemic species, and it should outline procedures to protect the natural genetic make-up of species to be re-established. (The writer is no more than a concerned layperson, but, undoubtedly, competent scholars will discuss this issue in precise scientific terms and provide relevant examples.)

Two additional points are raised in this section on planting endemic species in their former range. Kipuka Puaulu is listed in Table 2 as the seed source for many rare plants. It appears from other park records that some of these parent plants themselves were planted in that kipuka in the past, having been derived from sources far removed from that location both inside and outside the park. The question is whether such planted stock is a valid seed source for all species in restoration planting in a "former range," especially if a search can reveal stock growing naturally close to the restoration area.

Specific understory and groundcover plants should be recognized in the Plan as integral components of ecosystems in areas where only trees are presently scheduled to be re-established. Whenever possible, all of the plant components of the ecosystem should be identified, and, as frequently as possible, the understory and groundcover species should be planted to speed recovery of an area. Other native flora and fauna of the system, including ferns, mosses, insects and birds, are likely to reoccupy their niches at a faster rate when mid-level plants and some ground cover are planted along with trees.

(2) Maps and records of species planted.

For later workers to distinguish planted stock from growth and regeneration that occurs naturally, it is extremely important that permanent, accurate records be kept of the planted species. Such records are essential for productive evaluation of the degrees of success or failure of the restoration program. Some technique of recording on scaled maps with a grid system, with corresponding grid staking in the field where extensive planting occurs, will provide future managers with necessary and valuable data. If they exist, the record systems of the U.S. Forest Service in planting diversified native forests on the mainland may suggest a useful guide. If time and labor are expended in planting young trees, it would be a small additional cost to attach permanent metal tags with abbreviated data, as well as properly noting the plantings in the written record.

(3) The question of whether the park should propagate and maintain a stock of endangered Hawaiian plant species not known to have occurred previously in the park must be faced, although its resolution is difficult. This question is suggested from points raised in the Statement (pp.3-6,43,52, 59, 60,67).

Priority certainly must be given to restoring those native plants into the ecosystems it is known they occupied in pre-goat and pre-pig times. Second priority should be given to establishing those endemic plants that the most informed plant ecologists judge to have been likely residents of the park in the past. That leaves a third category of endangered endemic species of the Island of Hawaii that probably never occupied a park habitat. A convincing rationale and excellent arguments can be presented for the park not assuming the burden of saving these endemics.

The Society's position is that the foremost responsibility of the National Parks is the maintenance of park native ecosystems in their living process of natural selection and succession, with man manipulating the system [illegible] to remove exotics and to restore the destroyed native biota to their former park habitat. Thus the question of what the park should do, if anything, about non-resident, but endangered, endemic species on this island is troublesome.

Because of the lack of interest or concern by relevant State agencies, a number of additional unique Hawaiian plants are in imminent danger of extinction through habitat destruction. Their survival as living species may be assured only if the park propagates them. With the choice reduced to certain extinction or park propagation, we must opt for the latter. However, if this is a feasible park operation, such species maintenance must be kept separate, with lower priority, and be removed from the planting program. Such threatened Big Island species could be sustained in an arboretum environment until the time they could be returned to their former habitat.

An arboretum operation to save such plants can be justified on the basis of their unique value as distinctive Hawaiian species. The diversity of endemic Hawaiian biota has been reduced already by the extinction of hundreds of species, so it makes sense to save those that totter on the brink. They enrich the natural heritage of the nation as well Hawaii. Another consideration is that the natural range of these endemics may at some later time fall within the expanded boundaries of the park, or within a Natural Area Reserve or a Wilderness Preserve yet to be set aside.

Nevertheless, the Society finds instructive the development of park policy as written by David K. Morris, Park Ranger, The History of Native Plant Propagation and Re-introduction in Hawaii Volcanoes National Park, 1967. We are in accord with the policy as stated by Morris (pp.13-14): ". . . that propagating rare plant forms not originally found in the park is not consistent with the Service policy," and suggest an arboretum for those threatened plants with no planting directly onto open park lands.

(4) A park-appointed Scientific Council on Restoration of Native Ecosystems could provide park managers with useful biological information in depth and constructive counsel on aspects of natural resources management. These scientists, acting in a voluntary community service capacity, could supplement the present

dedicated and overburdened staff in offering skills in the specialized fields of botany, plant and animal ecology, plant and animal pathology, entomology, ornithology and vertebrate zoology. In choosing such advisers from among the scientific community in Hawaii, the most productive service may be given by those who have detailed knowledge of a segment of Hawaiian biota, an appreciation of Hawaii's insular ecosystems, who support the purposes of the National Park Service, and who would not be limited by a conflict of interest.

(5) Re-establishing endemic birds into former range.

The operation to restore a breeding population of Nene in the lower elevations of the park would have a better chance of success if park managers could draw upon the 23 years experience of the Division of Fish and Game at Pohakuloa. It was necessary to try out many experimental techniques over several years with a full-time staff of workers before a successful breeding program was established. Since the first objective is to establish productive breeding pairs, the long experience of Ah Fat Lee and David Woodside at Pohakuloa would be invaluable in reaching this goal.

Habitat restoration and a natural food source apparently are not enough to engender successful reproduction when working with just a few penned pairs that may not be well matched to begin with. The low reproduction observed in the hundreds of pen-reared Nene released at higher elevations in Hawaii and Maui suggests that the park's program will need a lot of help for some time. At a minimum, the park should start with Nene of sturdy stock that have already established records as successful breeders. Artificial feeding may be necessary if some reproduction is an early goal. To expect a fair breeding rate and self-sufficiency in food may be asking too much at once in a habitat new to these transplanted Nene.

For many years the State has been receiving an annual federal grant of $20,000 to support its Nene program. This is in addition to separate project funding under the Pittman-Robertson Act. Would it be possible, or desirable, for the park to coordinate its Nene program with the Division of Fish and Game to share the federal grant in restoring the State's official bird to its historic lowlands nesting grounds?

With the rapid decline in populations of Hawaiian birds on the U.S. List of Endangered Species, field studies of the park's endemic birds are desperately needed. With more knowledge of their feeding and breeding biology and knowledge of the impact of exotic birds, introduced diseases, and rats on endemic birds, sound habitat management would be enhanced. There are a number of mature graduate students in ornithology in Hawaii now with the time, enthusiasm and skills to undertake a project on endangered endemic birds. There are several private foundations in Hawaii and on the mainland that have been responsive recently to applications for grants in field research in Hawaii on native birds. If the park would sponsor such studies and provide housing, the opportunity does exist for foundation assistance to qualified researchers already resident in the State.

Table 5a. Status of land birds native to the Big Island of Hawaii (p.25) could be upgraded to provide the reader with more precise and accurate information. Scientific names should be given for all species. Hawaiian names should be added for the Hawaiian hawk ('Io) and Hawaiian short-eared owl (Pueo). Greater 'Amakihi is the present name in standard use for the

species formerly called "Green solitaire." 'Oma'o, the subspecies of thrush endemic to the Island of Hawaii (Phaeornis obscurus obscurus), is properly called the Hawaii thrush. Kauai should be omitted from the distribution column since the thrush resident on that island is a different subspecies and is on the Endangered List while the Hawaii thrush is not. The subspecies of 'Akialoa endemic to this island is properly called the Hawaii akialoa (Hemignathus obscurus obscurus). Since different subspecies are endemic to Oahu and Kauai, those islands should be omitted from the distribution column. It would be confusing not to make this change since there is a species of 'Akialoa on Kauai that is considered "endangered." The correct spelling of the Hawaiian name for Ciridops anna is Ula-ai-hawane. It can be confusing if the scientific name is not given since the Hawaiian name is the same for two different species in several cases. For example, in Table 5a, Kioea (Chaetoptila angustipluma) refers to the extinct forest bird endemic to the Island of Hawaii. The Hawaiian name for the Bristle-thighed curlew (Numenius tahitiensis) is also Kioea. The subspecies of 'Elepaio endemic to the Big Island is properly called the Hawaii elepaio (Chasiempis sandwichensis sandwichensis). The subspecies of 'Amakihi endemic to the Big Island is properly called Hawaii amakihi (Loxops virens virens).

Not treated in the Plan as natural resources are several categories of fauna that are native to the park and are distinctive and valuable assets. These include the seabirds that are not endangered that regularly visit park lands, the migratory shore birds resident in the park for 8-9 months of the year, and the amazing array of endemic insects with highly adapted forms that are a notable wonder in the scientific world.

(6) Protect remnant Hawaiian ecosystems from exotics introduced by man.

The emphatic position of the Society on the urgency of permanent and speedy removal of feral goats from park lands has been expressed previously to park managers and is strongly reiterated here! The most important and constructive action the park is taking today in natural resources management is the building of boundary, drift and exclosure fences to exclude the destructive goat. The Society is most grateful to the park administration for its commitment to this costly project. Fencing and the removal of goats by a variety of additional techniques will reap great rewards in a few years in the significant restoration of native ecosystems. Although chemical sterilants did not appear promising when the statement was written, this means of population control should be closely followed and investigated for a break-through in the near future. As much as possible, park rangers should be encouraged regularly to carry rifles for direct reduction of both goats and pigs. One useful incentive with the high meat prices, would be cooking demonstrations on how to prepare delectable goat and pig in a variety of ways. That incentive has one potential drawback for administrators. The satisfactions of such good "free" meat may lead to reduced and selective shooting to maintain a sustained-yield! The Society would not be in favor of the alternatives of private operators conducting goat drives or goat shooting from helicopters because of the overriding negative consequences of such actions that outweigh the goat reduction -- particularly when other suitable techniques are working effectively.

The Society gives its wholehearted support to operations for the removal of feral pigs from the park. We urge the park to investigate pig reduction through poison and chemosterilants. Trapping of pigs is not mentioned in the Plan but it would appear to be a promising control measure. We recommend that the park experiment with pig trapping in heavily infested areas.

In addition to the extensive damage done to native trees and other vegetation, rats are significant predators on both ground-nesting birds and on the nests of forest birds high in the canopy. We strongly support research on rat and mongoose damage and vigorous control of these pests.

The Society approves of the control measures proposed for agressive exotic plants -- unrooting, herbicides and biological control. The latter method requires careful testing of possible control insects against a broad spectrum of native plants to be sure that the insect agent is host-specific to the exotic plant. The State tests promising control insects against agricultural crops of economic importance and far less frequently against native plant species that have no economic value.

There are additional exotic trees and plants which should be removed from the park eventually. The stand of eucalyptus trees in Namakani Paio campground is a special eyesore to those Hawaii residents who know of the thousands of acres of prime native forests that were destroyed for the purpose of planting eucalyptus plantations. That lumber could be well used in fireplaces at the campgrounds.

At some time the exotic plantings at Volcano House and around park residences should be replaced with native ornamentals. The exotic fuschia along the park road to Thurston Lava Tube should be removed before it naturalizes further, as well as the exotic passion fruit vines in Kipuka Ki. The Jerusalem cherry is as unpleasing to the visitor's eye as it is to the goat's taste, but the exotic plants listed in Table 4 certainly have immediate priority in control efforts.

The control of exotic bird populations is not discussed in the Plan, but this problem warrants serious consideration in the management of resources. Introduced game birds have no place in the park's environment and should be shot or trapped whenever possible. The Society does not favor the retention of exotic bird populations in any park habitats. The control of exotic plants and the spread of native vegetation may also have the positive effect of reducing populations of some exotic bird species such as the Ricebird (Lonchura punctulata), House Finch (Carpodacus mexicanus frontalis), and House Sparrow (Passer domesticus). The aggressive White-eye (Zosterops palpebrosus japonicus), which exhibits flocking tendencies, is suspected of being a serious competitor with endemic honeycreepers for food and territory. The White-eye, a hardy survivor from Asia, may also be a factor in the potential transmittal of introduced disease and parasites to endemic birds.

The presence of stray cattle and feral sheep in park habitats, as indicated in Table 4b, must not be tolerated one day longer than is necessary to remove them. Feral sheep should be shot on sight. The park should adopt stricter measures in demanding the immediate removal of stray cattle on park lands by their owners from adjacent grazing lands. Fence maintenance and repair is an important preventive measure. When feral cats and dogs can be dispatched quickly by poison or trapping, it should be done.

The Hawaii Audubon Society appreciates the opportunity to review the Plan and Statement, and we request that careful consideration be given to the issues raised in this reply.

A-44

Sincerely yours,

Mae E. Mull Mae E. Mull

Island of Hawaii Representative

BERNICE P. BISHOP MUSEUM

P. O. Box 6037, Honolulu, Hawaii 96818 • Telephone 847-3511

13 February 1974

Mr. G. Bryan Harry, Superintendent
Hawaii Volcanoes National Park
Hawaii, Hawaii 96718

Dear Superintendent Harry,

We understand that comments on the Hawaii Volcanoes draft Environmental Impact Statement "Natural Resources Management Plan" (dated October 26, 1973) are requested by the National Park Service, and should be submitted to you before 19 February 1974.

In answer to this welcome request, we are enclosing here the official Bishop Museum position statement on this draft EIS.

You will note that this enclosure contains the Museum's comments on all three Hawaii Volcanoes draft EIS's issued on October 26, 1973, but that Part III is the portion directly pertinent to the Natural Resources Management Plan EIS. (Parts I:Proposed Master Plan and II:Proposed Wilderness Plan,will be presented as testimony at the National Park Service Meeting and Hearing on Oahu, 25 and 26 February, 1974.)

As we note in our comments, thanks for a great job on these draft Plans--and continued best of fortune to all of you there in the Park !

Sincerely,

Alan C. Ziegler
Vertebrate Zoologist

encl.

Xerox: Dr. R.W. Force,
Director, Bishop Museum

BERNICE P. BISHOP MUSEUM

P. O. Box 6037, Honolulu, Hawaii 96818 • Telephone 847-3511

DATE: 12 February 1974

TO: Hearings Officer, Western Region, U.S. National Park Service

FROM: Bernice P. Bishop Museum, Roland W. Force, Ph.D., Director

SUBJECT: Comments on October 26, 1973, draft Environmental Impact Statements for Hawaii Volcanoes National Park's:

I. PROPOSED MASTER PLAN
II. PROPOSED WILDERNESS AREAS
III. PROPOSED NATURAL RESOURCES MANAGEMENT PLAN

I. PROPOSED MASTER PLAN

The Bishop Museum considers the proposed Master Plan excellent in its overall intent, as well as in almost every one of its individual specific provisions. We strongly urge that a final Master Plan closely approximating that of the present draft EIS be adopted as soon as possible by the National Park Service.

We would like to submit the following comments on several specific goals and provisions of the presently proposed version of the Master Plan for consideration of the National Park Service and others.

Threefold Goal of Master Plan (see p. 55 of EIS).

(1) Increase in visitor-use opportunities: This aim is highly appropriate to the multi-use concept of the United States' National Park Program. The environmental impact which will result from the proposed new construction, development, and use of facilities of Hawaii Volcanoes National Park appears relatively limited in scope and intensity when considered in relation to the overall ecologic situation in this particular Park. And, this desirable increase in public use of specific areas in Hawaii Volcanoes will unquestionably lead to heightened public appreciation of the value and necessity of preserving the unique natural biotic and geologic environment of the Park.

(2) Maintenance and protection of Hawaiian native ecosystems: This aim reflects probably the most basic reason for the original establishment of the U.S. National Park System and, as such, should be considered of utmost importance in implementing the Master Plan for Hawaii Volcanoes. The attainment of complete control over introduced animals (especially goats and pigs) must initially receive the greatest effort in the program to preserve native ecosystems. Only in this way can any significant or lasting progress be made in other directions towards rehabilitating the Park's remaining native biota, now being progressively destroyed by unchecked numbers of, primarily, feral hoofed mammals.

(I. PROPOSED MASTER PLAN--cont.)

(3) Volcanic instrumentation and research: This aim is of great importance, not only because of its purely scientific aspects, but also because of the actual or potential application of the acquired knowledge to problems of human safety in all volcanically active areas of the world. These volcanic studies should be continued as proposed, with the same attention as currently given to minimizing visual and other impacts that would significantly detract from the Park's otherwise largely natural state.

Prospective Park Boundary Changes (see map on p. 3 of EIS).

All of the land additions and deletions proposed in this draft EIS seem reasonable and desirable. Of these various proposed changes, highest priority should be assigned to acquisition of three units, as follows: 1) the south coast offshore lands (to provide an essential--and the only Hawaiian--marine extension of a National Park); 2) the Olaa Forest Tract (as a natural ohia-tree fern preserve); and 3) the 420 acres of Tract 19 near Kalapana (for preservation of easily accessible historic and prehistoric archeological sites).

In addition, the Kilauea Forest Reserve (described in Alternative E on p. 86 of EIS), with a modest network of visitor trails to be developed in it, is strongly recommended for addition to the Park before its unique endemic ecosystem is forever destroyed by proposed lumbering and other commercial operations.

The 100,000-acre Hualalai-Mauna Loa addition (see p. 4 of EIS), although desirable, might be considered of lowest priority in the total list of proposed Park land acquisitions. This extensive area consists of only a few, relatively uniform, native ecosystems (for the most part already fairly well represented in present Park property); is in little danger of immediate commercial development; and would appear to entail considerable expense in terms of initial acquisition money and subsequent management manpower.

Chain of Craters Road Reconstruction (see p. 12ff of EIS).

Re-opening of this formerly heavily used scenic route is deemed highly desirable to provide visitor access and enjoyment of both a major volcanically active area and a significant archeological complex in the eastern portion of the Park. We fully endorse the proposed realignment and reconstruction of this road.

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II. PROPOSED WILDERNESS AREAS

The present Wilderness proposal appears most well considered. The Bishop Museum supports the designation of all four projected Wilderness Area Units, with Unit 4 (Olaa Forest Tract) rating special--and highest--priority (see map on p. 8 of EIS).

We also fully support the four proposed "special provisions" (see p. 2 of EIS) because they constitute reasonable and desirable exceptions to usual Wilderness Area use or policy.* These four special provisions are: 1) construction of the minimum number of trail shelters and rain-catchments necessary for use of the backcountry by hikers and Park maintenance and enforcement personnel; 2) continued use of the Mauna Loa north-side jeep road and other related operations essential to long-term volcanic scientific research; 3) recommendation that the Secretary of the Interior be authorized by legislation to designate two proposed Park additions (see map on p. 8 of EIS) as contiguous Wilderness Areas if eventually acquired; and 4) continued fence construction and maintenance activities concerned with the feral goat control program.

In fact, because finally attaining control over feral goat populations is so essential to preservation of the Park's native ecosystems, we would strongly recommend that the last-mentioned special provision be expanded to include use of four-wheel-drive vehicles by Park personnel in Wilderness Areas whenever found necessary in goat (or pig) control work.

A final special provision to similarly facilitate Park management work could also be added to allow relocation of the Chain of Craters Road to a different position within proposed Wilderness Area Unit 3 as may be found necessary following any future road destruction(s) by new lava flows.

The Bishop Museum especially wishes to recommend against the possible choice of any of the seven Alternatives listed in this draft proposal (see pp. 44-57 of EIS).

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* It appears that Park enactment of most or all of these "special provisions" may already be permissible under present U.S. Department of the Interior policy and guidelines for Wilderness Areas --see pp. 17-26 in the "Wilderness Study" booklet accompanying EIS. If this is correct, the proposed National Park Service request for special language in the enacting legislation to be passed by the Congress is unnecessary, and should be omitted in the final EIS.

III. PROPOSED NATURAL RESOURCES MANAGEMENT PLAN

In regard to this draft Plan, the Bishop Museum fully endorses the overall Park objective of "...conserving...endemic Hawaiian ecosystems...for visitor use and enjoyment." We state unequivocally that this objective must not be allowed to be subverted to "...conserving...all living things...for visitor use and enjoyment." (Page i of EIS.)

The four major components of the proposed Natural Resources Management Plan, as listed on p. i of the draft EIS, are:

(1) propagating rare and endangered plant species;

(2) reintroducing rare plants into former range;

(3) protecting rare endemic biota from depredation by feral goats and pigs; and (4) re-establishing and nurturing remnants of endemic Hawaiian ecosystems.

Among these, it should be self-evident that the complete control and eventual elimination of feral goats (and then pigs and any other feral mammals such as cattle and sheep which enter the Park) implied in (3) above must assume highest priority. None of the three remaining objectives is possible of attainment until at least the major portion of present goat populations in the Park is permanently removed. We consider the need to promptly eliminate these exotic hoofed mammals from Hawaii Volcanoes is of at least the same magnitude and urgency as the need to extinguish an extensive raging forest fire in a Mainland National Park. And no less time, effort, and equipment than would be devoted to controlling this Mainland blaze should be immediately devoted to the successful conclusion of goat control work in Hawaii Volcanoes National Park. As page 52 of the EIS most correctly states:

> "The few adverse effects--undesirable aspects of goat and pig removal efforts, and visual intrusion of fences in wilderness--are far outweighed by long-term benefits to accrue to all people over all time by actions to preserve and restore the park's native biology."

We agree, as proposed in this EIS (p. 10ff.), that public aid in the form of the deputized ranger program should be used whenever possible and feasible in decreasing goat and pig numbers. But, with or without this cooperation from hunters, Park personnel themselves must continue in these control measures until the environmental damage of these feral mammals becomes negligible or nil within the Park.

(III. PROPOSED NATURAL RESOURCES MANAGEMENT PLAN--cont.)

In this same matter of environmental destruction by introduced hoofed mammals, we strongly feel that the National Park Service should state in the final EIS the danger to Hawaii Volcanoes Park of the release of any additional game mammal species on the Island of Hawaii. The sporadic attempts by a few Hawaii hunters to have axis deer released into the wild on this island is a case in point. Experience with this introduced game species on the Hawaiian islands of Lanai and Molokai clearly indicates that Hawaii Volcanoes' presently used four-foot-high goat and pig control fences would serve as little or no barrier to deer movement into and within the Park. Thus, the time- and money-consuming work of years in controlling existing feral mammal populations in Hawaii Volcanoes would be undone if an exotic game species such as deer were ever to be released on the Island of Hawaii.

Several species of exotic game birds--introduced solely for hunting purposes--have now extended their ranges into Hawaii Volcanoes National Park, although no mention of these birds is made in the draft EIS. We suggest the final Plan should note the presence and identification of these introduced game birds, and propose actions that can be taken to control their populations within the Park. The ecological impact of these exotic avian species on native Hawaiian biota has been little studied, but it seems unquestionable that the continued presence of these alien forms is detrimental to the preservation and restoration of endemic Hawaiian ecosystems. And, one or more of the exotic gallinaceous game bird species now in the Park may well prove to be a partial ecological competitor of the Nene, an endemic bird which Park personnel are now attempting to re-establish at Hawaii Volcanoes.

As a suggested item of next-highest priority, we would submit that much more emphasis than presently seems apparent in the draft EIS needs to be placed on the necessity to effectively control exotic vegetation now continuing to invade vast reaches of the Park. Also, wherever possible, biological control (by host-specific insects, for example) of these introduced pest plant species would be preferable to control by chemical, mechanical, or other means.

Of the remaining major Natural Resource Management objectives, the continued process of propagation and reintroduction of rare and endangered plant species should be carefully re-examined to be sure that only seed or parental stock of plants from the immediate vicinity of areas proposed for replanting are being used in the program. To maintain as much as possible the scientific integrity of Hawaii Volcanoes' natural biota, it is essential that all such revegetation efforts be closely coordinated with competent Hawaii botanists

(III. PROPOSED NATURAL RESOURCES MANAGEMENT PLAN--cont.)

and island ecologists. This coordination will help assure that re-established biotic communities do correspond as closely as possible in both location and composition to original endemic ecosystems of various Park areas.

Any proposed artificial propagation projects involving endangered Hawaiian animal species (such as the Nene and possibly Hawaiian Crow, Hawaiian Hawk, etc. --see p. 6ff. of EIS) might be regarded as of lowest priority in comparison with the previously mentioned objectives envisioned by Park personnel. Protection and restoration of native plant ecosystems will, in itself, very likely prove a far more successful agent in the natural increase in distribution and population numbers of most endemic bird and other animal species on the Island of Hawaii.

##########

The Bishop Museum wishes to thank you very much for the opportunity to present this testimony. May we also express our appreciation to the Western Regional Director of the National Park Service and all other personnel concerned for the initiation and thorough preparation of all three of these far-sighted and generally excellent National Park proposals.

Bishop Museum Staff Members assisting in preparation of these comments:

Dennis M. Devaney, Ph.D., Head, Division of Marine Invertebrates
Wayne Gagné, Research Entomologist
Yoshio Kondo, Ph.D., Chairman, Department of Zoology
Frank J. Radovsky, Ph.D., Chairman, Department of Entomology
John E. Randall, Ph.D., Head, Division of Ichthyology
Yosihiko Sinoto, Ph.D., Chairman, Department of Anthropology
Pieter van Royen, Ph.D., Chairman, Department of Botany
Alan C. Ziegler, Ph.D., Head, Division of Vertebrate Zoology

Hawaii Isle Fish and Game Association
29 Akea Street
Hilo, Hawaii 96720

February 7, 1974

Mr. Bryan Harry
Superintendent
Hawaii Volcanoes National Park
Volcano, Hawaii 96785

RE: Environmental Statement - Natural Resources Management Plan

Dear Mr. Harry:

In reviewing your Natural Resources Management Plan, we recognize and understand your problems and concerns. Although we may not agree on all issues, and at times our objectives may differ, we agree that our indigenous and endemic plant, bird and animal lives must be protected.

Besides the exotic plants and trees, we recognize the affect the feral animals have on the native plants. The latter do help control some of the exotics to some degree, but great numbers do cause substantial damage to the native plants.

Our primary interest is in the humane approach to solving this problem and we are against any insemination program or mass eradication program. Rather, we would want to assist you with our present Deputy Ranger program, which has proven quite successful in accessible areas.

We would recommend that you use all the outlined methods with the Deputy Rangers providing time and labor in the safer, more accessible areas. Park rangers should then go into the more difficult areas, useing the most practical methods except insemination. As much as possible, in the fenced in areas, the goats should be driven out so the Deputy Rangers can assist.

We strongly feel that the above outlined methods would meet with stronger public acceptance. You and your Rangers have been most understanding and we trust that continued Park Service and Citizens' cooperation will result in a very fine controlled program.

Sincerely Yours,

Earl Pacheco
President

cc: Mr. Lloyd Koffman, Secretary

CONSERVATION COUNCIL FOR HAWAII
Windward Hawaii Chapter
SRC 18V
Keaau, HI 96749

February 14, 1974

DES-73-67

Statement of Windward Hawaii Chapter of the Conservation Council for Hawaii on Draft Environmental Statement, NATURAL RESOURCES MANAGEMENT PLAN, Hawaii Volcanoes National Park.

The Council favors the restoration of the natural ecosystems in the Park through (1) elimination of goats as the major destroyer of native plants, (2) the eventual control of pigs, rats and mongooses as they may affect the native flora and fauna either directly or indirectly, (3) the careful re-establishment of endemic plants in areas they formerly occupied, based on advanced scientific knowledge, (4) the concommitant control of exotic plants on a priority basis related to feasibility and need, with the assumption that many exotics are expected to be naturally controlled as successional changes occur in the absence of feral animals.

In our estimation, the plan will provide the means for accomplishing these very important objectives.

The acreages of lands subject to development and commercial exploitation on Hawaii Island are increasing, with attendant shrinkage of natural environments. For this reason we applaud the efforts of the Park Service to upgrade the degree of protection for Park lands that have been so shamefully neglected in the past, for one political reason or another.

Members of the Council do not think it is too late, even for areas of the Park that are heavily depleted, but rather we are sure that the healing process will advance at a reasonable rate when permanent protection is given to their natural biotic resources.

Accompanied by ecologically based management procedures aimed toward restoration of complete ecosystems, insofar as such restoration is possible, the plan should vastly strengthen and enliven natural values of the Park.

P. Quentin Tomich

P. Quentin Tomich
Vice-President, 1973-74

THE ANSCHUTZ CORPORATION

1110 DENVER CLUB BUILDING
518 SEVENTEENTH STREET
DENVER, COLORADO 80202
TELEPHONE 303 573-5685

November 14, 1973

Superintendent
Hawaii Volcanoes National Park
Hawaii 96718

Dear Sir:

In reference to the following:

1. Proposed Master Plan For Hawaii Volcanoes National Park, Hawaii - Draft Environmental Statement

2. Proposed Natrual Resources Management Plan, Hawaii Volcanoes National Park, Hawaii - Draft Environmental Statement

3. Proposed Wilderness Areas, Hawaii Volcanoes National Park, Hawaii - Draft Environmental Statement

I would appreciate it if you would consider the following comments.

Although the energy requirements for the State of Hawaii appear to be less demanding than those of the continental United States, Hawaii is now very dependant upon imported energy in the form of oil and gas. This source is rapidly dwindling and forecasts a severe inflation and potential depression of your local economy.

The major hope for a viable energy source in Hawaii is the development of geothermal energy.

I would strongly urge you to consider the human needs as part of your evaluation. Much of the land you are proposing as wilderness area has geothermal potential. It is possible to devise a plan that provides for the development of the geothermal potential along with: the development and control of exotic plant and animal species; the propagation of rare and endangered plant species, reintroducing rare plants into former range, protecting rare edemic biota from depredation from feral goats and pigs, and re-establishing and nurturing remnants of edemic Hawaiian ecosystems.

May I commend to you a course of action that considers both the human needs and the biota needs and puts them both in gear with each other. The establishment of wilderness areas does not accomplish this.

Sincerely yours,

THE ANSCHUTZ CORPORATION

Malcolm H. Mossman

MHM/sp

cc: John A. Love
Assistant to the President
for Energy Policy

Sen. Daniel K. Inouye
Senator for Hawaii

Congressman Don Brotzman
Second District, Colorado

Drs. Otto & Isa Degener
P. O. Box 154
Volcano, Hawaii 96785
U. S. A.

Feb. 13, 1974.

Dear Supt. Harry:

Mrs Degener & I have been living at our Mokuleia Beach home on Oahu for the last three months, and have just returned to Volcano. While on Oahu, I received a two-page alert from the Wilderness Society, of whivh we have been members for years, regarding the Proposed Natural Resources Management Plan. With that information available, I wrote my one-page comment approving of everything outlined excepting that the wording from "feral animals" be modified to include "feral plants." This recommendation with a copy of my "Caveat Emptor" report, I mailed to the Director in Washington and to the Hon., office.

Arriving at Volcano, Mrs. D. & I waded through 3 months accumulation of bears(Catalogues and other advertisements, reprints, Readers' Digests, Pac. Discoveries, Eetension Service Bulls., etc. AMONG THIS MATERIAL, we unearth your two thick franked envelopes, one including your Jan. 4 letter! Postmaster Kazuo Okamoto or staff, thinking the contents printed matter, I guess, never forwarded this first class mail. Perhaps in the future it should have written on it "First Class.". Anyway, I now have your informational material & hasten to add a few remarks that are too trivial for me to consider them a seond, official reply. One from me is enough.

Please read "Caveat Emptor," published sept. 1970. I ordered reprints and scattered about 800 among members of Congress, Nat. Park personnel in D.C., Nature Conservancy, Wilderness Society, etc. I hope that the seed scattered bears fruit.

To the two letters I mailed off, my ADDED remarks are:

1. Unless the word "control" is used to mollify a small but yappy group of local hunters, "exterminate" should be used regarding goats, pigs, sheep and, if we don't look out this year of 1974, axis deer The hunters have been passing around a petition for this introduction.

2. Except for areas where native ground nesting birds are concentrated, I would not waste acarce time and funds regarding mongoose, rats and an occasional feral cat. These three are more or less in biological control among themselves. They are hardly involved in the extermination of our plants. Indeed, the Haw. rat, even though feeding on seeds, in carrying them about may drop a goodly proportion and thus help in replanting. The ieie is certainly replanted by rats (and birds) which eat the fruit and the fleshy bracts.

3. Even if rangers and deputies have the high aim of extermination, I doubt they will have better luck than controlling many of the herbivores. The word "control" will tend to laxness, while "extermination" will not. The psychology would be better.

4. Except for a few outstanding species that Mr. Rieser is fortunately cultivating, I would allocate much of such time to the simple expedient of planting seeds. The seeds of the rarer endemics should be gathered on the spot, and planted within likely places WITHIN a 1,000 foot radius OF THE PARENT PLANTS. The collected seeds should not be taken back to the Administration Building and then planted in the future because of the probability that some one will forget the origin or perhaps save himself trouble and plant the lot elsewhere. This causes scientific confusion for the future. The planter in certain terrain may merely need to kick a little earth loose (as I did to revegetate Canton Atoll for FAA), drop a few seeds and step on the spot to cover them. Or the planter can walk over more stubborn terrain with a spiked walking stick to punch shallow holes for the dropping of seeds.

5. The planting of endemics far from where collected is the cause of scientific error. Some carpetbagger botanists with the gift of gab may come to the Islands and "identify" local plants, and then others uncritically swallow such statements as Gospel Truth. For example, because the Hawaii silversword was getting terrifically rare, some well-meaning person scattered seeds of the Maui s.s., on Hawaii. Now you have the likelihood of the Maui species crossing with the Hawaii one and exterminating it by sheer numbers. It is similar to the Hawaiian people becoming exterminated as a race by marrying out into other races.

Alvin Chock monographed the mamani, finding all manner of local kinds even on Hawaii. Will the mamani seedlings now available for transplanting, for example, by planted in the neighborhood of the parents or eventually elsewhere to hybridize with other strains to confuse the botanist? I hope the next monographer of the genus Ochrosia won't write a long article about how some bird flew from Maui all the way to Kipuka Puaulu with an Ochrosia seed in his beak or crop. The Hawaii Ochrosia grew in the kipuka formerly but as it petered out there, some well-meaning forester brought seeds from Maui and planted them as a replacement.

It would be a mistake to scatter naio seed from place to place because so many different kinds grow in different places in the Park. Similarly, giant Skottsberg's aalii grows in a Kauna Loa Strip Road kipuka. Why upset the applecart by planting its seeds near Puu Huluhulu?

6. Mrs. D., & I think it is a pathetic joke to pay so much attention listing by some old-fashioned name - too often based on Hillebrand's Flora (he left the Islands in 1871) or on Rock's Indig. Trees printed in 1912 - plants that are considered on the verge of extinction. To be sure, such treasures correctly or incorrectly identified, deserve help to survive. But this attitude lulls us into false security. The plants that really need help are not the 20 or so recognized and listed plants BUT THE 10,000 different kinds of algae, fungi, lichens, myxomycetes, mosses, ferns and Flowering Plants (I see my estimate is wrong - I should have upped the figure greatly) that are practically unknown.

I concentrated on the Haw., flora since 1922, and have had the confidence to describe only a couple of thousand flowering plants out of a potential total of 20,000 to 30,000. We have just scratched the surface. After 50 yrs., of concentration, I know hundreds of plants that are incorrectly identified and hence unknown; but I just don't know enough to correct the mistakes. I don't try to bluff with snap judgements.

As an example of the huge nos., of unknown local plants, it may interest you to know that a hundred or so species have been beautifully illustrated and described by St. John from the island of Oahu. In contrast, 6 are recorded from the Park in the pathetic taxonomy chapter of the "Atlas" and a couple more are recorded from outside the park elsewhere in publications. The discrepancy between numbers of small, 4,000 foot high Oahu and of huge, 13,000 feet high Hawaii is obviously false. The high number accredited to Oahu is that St. John & previous botanists and students lived in Honolulu and combed that island thoroughly; while Hawaii has had no resident botanist and was never much explored. Were I younger, had students and funds to comb Hawaii as well as Oahu has been combed, I am confident I could discover 50 new Cyrtandra species in spite of bulldozing and other forest destroying activities.

What I mention about Cyrtandra just about applies to all other groups of plants. In summary, it is fine to preserve plants recognized to be rare, but what is needed is blanket protection of the ENTIRE flora because of all the UNKNOWNS on the verge of extinction. Of course, all the above applies to the Animal Kingdom as well.

On page 23 of the tan brochure, it states that 235 higher plants exist in the Park. That figure is absurd!. You will come closer to the truth by multiplying by 10.

This hasty letter is for you, yourself to ponder - IT IS NOT A REPORT FOR THE MEETING.

Aloha,

Dr. Otto Degener

Collaborator in Haw. Botany, N.Y. Bot. Garden 1933-

HAWAIIAN BOTANICAL GARDENS FOUNDATION, INC
Gilmore 114, 2525 Varney Circle
University of Hawaii
Honolulu, Hawaii 96822

NEWSLETTER
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VOLUME IV Number 7 SEPT. 1970
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CAVEAT EMPTOR

Dr. Otto Degener /1

After criss-crossing the Hawaiian Islands since 1922 to collect their world famous flora for museums and botanical gardens, I have become familiar with their unique geological and biological features as well as the tragic deterioration of the latter in the past fifty years. Hence I was amazed when I read "The Island of Hawaii. A Resource Study and Master Plan. Preliminary Working Draft," dated June 1970 by Glenn O. Hendrix, Chief, Environmental Planning & Design. A copy is available for study at the public library in Hilo, Hawaii.

This 103 page study, among other features, deals with the Hawaii Volcanoes National Park, the City of Refuge National Historical Park, the Proposed Puukohola Heiau National Historic Site, and the Kealakekua Bay study. It is well illustrated with pertinent maps and diagrams. Though I am presently interested in the Hawaii Volcanoes National Park, I shall digress to comment first on the National Park on Maui.

The main feature of Haleakala National Park is its magnificent rift valley, incorrectly called a "crater", filled with colorful cinder cones and possessing prehistoric lava flows that had spilled down the Keanae Valley to the north and the Kaupo Valley to the south. Much of its access route is marred by both useful and obsolete astronomical and other scientific buildings with all their appropriate hardware. None have been even tastefully camouflaged as a courtesy to the Park Service.

Hawaii Volcanoes National Park as it now exists features the active shield volcanoes Mauna Loa and Kilauea. Most of the terrain consists of aa and pahoehoe lava, and numerous pit craters and cones of assorted sizes. Another extensive feature is the Kau Desert, which is flanked by the ocean. Unfortunately, both national parks in the Hawaiian Islands feature chiefly volcanic wonders and hence duplicate one another in many ways. Also, both are on the lee or arid side of their island, and above the "inversion layer" or cloudbelt. As rain, even in this Paradise of the Pacific falls downward, much of our present Maui and Hawaii parks are deserts or nearly so. They are conspicuously poor in plant life and in animals developed over the ages

/1 Dr. Degener has been the Hawaiian Botany collaborator with the New York Botanic Gardens since 1933. As a world-wide explorer he has made extensive plant collections for the important museums and botanical gardens of Europe and America. With his wife, Dr. Isa Degener, he wrote the "Flora Hawaiiensis" series. In addition he has taught botany at the University of Hawaii and served as ranger-naturalist at the Hawaii National Park.

to live on or with such plants. The master plan, as I understand it, would add additional features to our park, precisely the type of duplication that the National Park Service does not need if we are to follow the published yardstick of criteria for the choice of land for Park inclusion.

Both Parks, as now constituted, are conspicuous by the absence of lush jungle consisting of 99% of Flowering Plants found no other place on earth. In fact many of such plants are limited to a single kipuka or lava oasis, or to a little gulch or to an isolated hill. As animals of all kinds from "landshells" through insects and spiders to birds are dependent on these plants, the percentage of endemicity in the Animal Kingdom is correspondingly great. Truly, What Hath God Wrought in the Hawaiian Islands!

The Island of Hawaii is blessed with two "goldcoasts": 1) The tourist port and hotel complex in and about the clean city of Hilo, and 2) The tourist Mecca on the opposite side of the island roughly sixty miles distant as the crow flies, in and about Kailua, District of Kona. At present no direct road nor even a trail exists between these two tourist centers.

Some States are famous for selling wooden nutmegs, others for horse trading, and still others like Florida for land deals. According to front page articles presently appearing in our Hawaiian newspapers, the State of Hawaii now emulates Florida in this last activity.

As a loyal citizen of the State of Hawaii and one of the tax payers of its impoverished Island of Hawaii, I am most eager that the National Park Service take over ownership of a generously wide strip of land consisting mostly of additional aa and pahoehoe flows, volcanic ash and clinkers. Such land, I would estimate to be worth one dollar per acre, if that much. How wonderful if the State of Hawaii could foist these exuviae of the fire-goddess Pele upon the National Park Service. Perhaps we can then get the Service, with pride of ownership, to build for our use a 2- or 4- lane multimillion dollar highway across the middle of the island, no doubt with Federal Funds. I would expect the Service to finance all upkeep as well, an expensive duty every time a lava flow melts out a few miles of roadbed. I repeat, as a loyal citizen of the State I favor the plan as I do want direct access to Kona's south short for a pleasant morning dip without paying additional State taxes to help finance a highway.

As a loyal citizen of the United States and a friend of the National Park Service, however, I repudiate my approval of the above unless the master plan is modified in general as follows:

1. The corridor of lava waste with a tourist highway, also to be used by the few residents the underpopulated Island of Hawaii fortunately possesses, has in itself no justification being within a National Park System. It is monotonously repetitive of similar features far better represented about Haleakala and Kilauea-Mauna Loa. It is, however, a magnificent backdrop for the park-like transition forest that gradually melts downhill into the unexcelled tropical jungle of endmic plants and animals in the cloudbelt. This last is the unique feature found no other place in the United States, in fact in the World. It in itself is of high National Park standard.

2. The National Park Service should own the land from its highest elevation down to and including that part of the cloudbelt where the maximum rainfall occurs. To be sure, the proposed narrow Honaunau strip passes through a little of such cloudbelt land, but it is too skimpy in size and too mauled by past exploitation to be of any importance. The cloudbelt area on all islands, incidentally, is the least valuable for commercial use. Vegetables grown there are excellent for home consumption but are too juicy to withstand shipment to market; cane thrives but its juice is too watery to warrant boiling into sugar; cattle remain half-starved with bellies distended with soupy cud, and most exotic plants fail to thrive because the thick blanket of clouds deprives them of their higher requirement for sunlight. The cloudbelt terrain of the Island of Hawaii, in particular, consists of aa, ash, cinders, clinkers, pahoehoe and pumice, all in themselves porous. To aggravate the situation still more, all is interwoven with earthquake cracks and crevices; while here and there extend tunnel-like lava tubes.

A layer of spongy duff consisting of decayed treefern and other trunks, branches, leaves and roots, mixed with some muck, covers everything. A mass a foot thick would squash down to one inch; the same mass burned in a forest fire would leave but a thin film of ash. Whether one turns a bull or a bulldozer into such land to trample or to disturb it, the heavy rainfall washes the delicate layer of soil downhill or drives it straight down out of sight through crack, crevice and tubes. The watershed is gone forever, and only naked lava remains. With destruction of the rainforest, even fogdrip from leaves has ended. Though strictly of no concern with the Park issue now at hand, such tampering with the rainforest has dried up wells and springs. Streams that once could reach the ocean have been altered to dry steambeds that explode into dangerous flash floods during heavy downpours. Rainfall has been reduced at lower elevation farm lands that can ill afford to lose it.

3. Some of this scientifically and scenically precious and unique jungle is privately and State owned. Opposition to its inclusion obviously would come mainly from private owners and lessees who, by the discontinuance of leases held sometimes from generation to generation, would be financially harmed. This understandable feeling of antagonism should be soothed by generous rather than parsimonious or niggardly remuneration. How such financing can be accomplished is in the province of a banker, not of a retired naturalist. My amateurish ideas involve seeking aid from State and Federal agencies, and from the Nature Conservancy and like organizations. Furthermore, the coast to coast highway should be established as a turnpike road that would collect tolls for the eventual liquidation of a bond issue floated to repay injured ranchers, lumbermen, and others.

4. The Park area as a whole should not be fenced because because of the prohibitive expense and the futility of controlling animals by a fence. While the line might be patrolled by a ranger at one spot, a family of pigs may dig under it or a herd of goats, thanks to a fallen tree, may climb over it; and if some politician - may God have mercy on his Soul - should some day introduce axis deer to Hawaii, no practicable fence will prevent their jumping or climbing over it.

5. General Superintendent Robert L. Barrel, a 1950 geology graduate from Harvard and a trained Naturalist, has suggested a novel solution to curb the devastation caused by feral herbivores, be they pig, goat, sheep, mouflon or occasional cattle. He suggests calling upon sportsmen to help in their control within the Park areas. I do not know details of the plan. Perhaps he would assign several rangers as permanent game wardens and would deputize qualified applicants to hunt for such animals under strict supervision. The main danger here is the possibility of the appointment some day of a superintendent who might be lax in pushing toward the ultimate extermination of this scourge, and thus allow the Park to degenerate into a hunting preserve with game management.

In summary, I advise the National Park Service to ponder the saying: CAVEAT EMPTOR (Let the buyer beware). It already possesses more than enough duplicated volcanic features to want to burden itself with still more. On the other hand, it lacks unspoiled jungle adjacent to a stretch of aa, ash, cinders, clinkers and pahoehoe. If such jungle land can be purchased, the volcanic horizon would be an ideal frame. Only then should the Service get involved in more ownership of waste land and in helping to build and to maintain a multimillion dollar "Transgoldcoast Highway".

* * * * * * *

REMINDER

Dues for 1970 are now payable. Checks should be made payable to Hawaiian Botanical Gardens Foundation, Inc., and mailed to Dr. Constance E. Hartt, Secretary, 1527 Keeaumoku St., Honolulu, Hawaii 96822.

This Foundation is tax exempt under Federal and State regulations and contributions are tax deductible under the usual formulas.

Membership Dues

Annual	$ 10.00
Annual Contributing	25.00-99.00
Annual Sustaining	100.00-249.00
Annual Commercial	100.00 or more
Annual Sponsor	250.00 or more
Life	500.00 or more
Founder	1,000.00 or more
Research Endowments	5,000.00 or more

The HGBF Newsletter welcomes articles and news relating to botanical gardens, problems of environmental pollution, activities of garden groups etc. Black and white photographs are acceptable.

S. Goto, Editor

Dear Brian -

Thanks much for letting me read this - it is very good. I've made a few notes and comments - a few are catching typo errors - and none of the rest is a very important comment.

In other words - into good as it is.

I surely would like to have a copy if there is one to spare when it's official.

Best of success in the new year to you and your whole gang -

Howard