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STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF FORESTRY AND WILDLIFE
1151 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

June 15, 1998

Ms. Genevieve Salmonson
Office of Environmental Quality Control
220 South King Street, Fourth Floor
Honolulu, HI 96813

Dear Ms. Salmonson,

Subject: Finding of No Significant Impact (FONSI) for `Ola`a-Kilauea Management Area Natural Resources Management Plan;
`Ola`a, Puna, Hawaii, TMK: 9-9-01-7
Kilauea, Ka`u, Hawaii, TMK: 1-9-01-7
Waiakea, South Hilo, Hawaii, TMK: 2-4-08-25
Waiakea, South Hilo, Hawaii, TMK: 2-4-09-8

The State Department of Land and Natural Resources, Division of Forestry and Wildlife, on behalf of the `Ola`a-Kilauea Management Group (Department of Public Safety, U.S. Fish and Wildlife Service, National Park Service, Kamehameha Schools Bishop Estate, DLNR) has reviewed the comments received during the 30-day comment period which began on November 23, 1998 for the DEA, and April 8, 1999 for the Supplemental DEA. Please publish this notice in the July 23, 1999 OEQC Environmental Notice.

We have enclosed a completed OEQC Publication Form and four copies of the final EA. Please feel free to contact Tanya Rubenstein at 737-3246, or Bill Stormont of my staff in Hilo, at 974-4221, if there are any questions.

Sincerely,

MICHAEL G. BUCK
Administrator

Enclosures

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1999-07-23-HA-FEA-

FINAL ENVIRONMENTAL ASSESSMENT

for the

ʻŌLAʻA - KĪLAUEA MANAGEMENT AREA

Natural Resources Management Plan

in accordance with

Chapter 343, HAWAIʻI REVISED STATUTES

Proposed by:

Hawai'i Department of Land and Natural Resources - Natural Area Reserves Program
Hawai'i Department of Public Safety - Kūlani Correctional Facility
Kamehameha Schools Bishop Estate

In consultation with:

U.S. Fish and Wildlife Service
National Park Service - Hawai'i Volcanoes National Park
U.S. Geological Survey Biological Resources Division
U.S. Forest Service

June 1999

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I. Summary

CHAPTER 343, HAWAI'I REVISED STATUTES (HRS)
ENVIRONMENTAL ASSESSMENT

Project Name: 'Ōla'a – Kīlauea Management Area Natural Resources Management Plan

Proposing Agencies:

'Ōla'a – Kīlauea Management Group:

State Department of Land and Natural Resources
Division of Forestry and Wildlife

State Department of Public Safety
Kūlani Correctional Facility

Kamehameha Schools Bishop Estate
Department of Forestry and Natural Resources

Approving Agency: State Department of Land and Natural Resources

Project Location: 'Ōla'a – Kīlauea Management Area

Waiakea, South Hilo, Hawai'i, TMK: 2-4-08-25
'Ōla'a, Puna, Hawai'i, TMK: 1-9-01-7
Kīlauea, Ka'ū, Hawai'i, TMK: 9-9-01-7
Kūlani, South Hilo, Hawai'i, TMK: 2-4-08-9

Agencies Consulted During EA Preparation:

Federal: U.S. Department of Agriculture
Natural Resources Conservation Service

U.S. Department of Interior
Fish and Wildlife Service
Geological Service Biological Resource Division
National Park Service

State: Department of Land and Natural Resources
Division of Forestry and Wildlife-Hawai'i
Division of Land Management-Hawai'i
Historic Preservation Division
Natural Area Reserve System Commission

Department of Public Safety
Kūlani Correctional Facility

County: Department of Water Supply
Planning Department

Private: Bishop Museum
Conservation Council for Hawai'i
Hawaii Audubon Society
Kamehameha Schools Bishop Estate
Native Hawaiian Advisory Commission
Native Hawaiian Legal Corporation
Natural Resources Defense Council
The Peregrine Fund
Pig Hunters of Hawai'i
Sierra Club Legal Defense Fund
Sierra Club, Moku Loa Group
The Nature Conservancy of Hawai'i
Volcano Community Association
Wildlife Conservation Association of Hawai'i, Hilo Chapter

II. Project Description

This Final Environmental Assessment is for the project as described in a Draft Environmental Assessment (published in the November 23, 1998 OEQC Bulletin) as well as a Supplemental Draft Environmental Assessment (published in the April 8 OEQC Bulletin).

In an effort to better protect native biological resources, landowners and other interested parties established a partnership to cooperatively manage the 'Ōla'a - Kīlauea Management Area. The 'Ōla'a - Kīlauea Management Area includes lands owned or controlled by the Hawai'i Department of Public Safety's Kūlani Correctional Facility, the Hawai'i Department of Land and Natural Resources Pu'u Maka'ala Natural Area Reserve, the 'Ōla'a Tract of Hawai'i Volcanoes National Park, and Kīlauea Forest owned by Kamehameha Schools Bishop Estate (Management Plan, Figures 1 and 2).

The partnership cooperative agreement signed in 1994 includes the commitment to jointly develop a Natural Resources Management Plan to include, but not be limited to, feral animal and alien plant control measures, collaborative research projects, and habitat protection and restoration. A Management Group of landowners and managers of these project lands as well as representatives from U.S. Fish and Wildlife Service (USFWS), U.S. Geological Survey's Biological Resources Division (USGS-BRD) and U.S. Forest Service (USFS) developed a 5-year management plan.

The Natural Resources Management Plan (Appendix) presents background information on the project area's ecological setting, and provides both an overview of the management and research programs as well as more detailed project statements that identify current and proposed projects. The management and research programs outlined in the plan focus on the following areas:

- Removing or reducing impacts from feral animals, alien plants and non-native predators.

- Restoring native habitat and species to enhance diversity and stability of native ecosystems.
- Monitoring the response of native and alien species to management and using the results of monitoring to further refine management and research strategies.
- Providing information and education to the general public and work training and education to Kūlani Correctional Facility inmates.

III. Summary Description of Affected Environment

Location

The project area is located on the eastern slope of Mauna Loa, and it includes portions of South Hilo, Puna, and Ka'ū districts. The project area includes both public and private lands. The elevation ranges from a bit below 3,000 feet (900 m) in the east to nearly 6,300 feet (2000 m) in the northwest. Lands included in the Management Plan are Kūlani Correctional Facility (KCF), Pu'u Maka'ala Natural Area Reserve (NAR), the 'Ōla'a Tract, and Kīlauea Forest. The planning area totals approximately 32,000 acres, and contains natural communities that are notable for their high degree of diversity. Adjacent lands include the Upper Waiākea Forest Reserve, 'Ōla'a Forest Reserve and Keauhou Ranch.

Native Flora

The 'Ōla'a - Kīlauea Project area is vegetated by various combinations of three dominant structural plants: 'Ōhi'a (*Metrosideros polymorpha*), koa (*Acacia koa*), and hāpu'u or treefern (*Cibotium* spp.). Although different drainage characteristics of 'a'ā and pāhoehoe flows complicate local moisture regimes, the general trend is from a dry-mesic habitat at the upper western sections of the project area to wet forest at the lower elevations to the east. The project area is a mosaic of different aged lava flows and plant communities that vary according to lava flow type and age. Another factor contributing to current plant community composition is disturbance by man, feral and domestic ungulates, and aggressive non-native plants. The project area can be generalized into the following six native plant communities (Management Plan, Figure 3):

1) Wet 'Ōhi'a /Hāpu'u Forest - The largest portions of the project area contain 'ōhi'a with other native trees and a hāpu'u tree fern and native fern and shrub understory. Portions of the 'ōhi'a forest canopy have undergone defoliation and regeneration (a natural phenomenon known as "'ōhi'a dieback") at various times. The resulting openings are generally filled with younger 'ōhi'a, native trees and shrubs and hāpu'u.

2) Wet Koa/'Ōhi'a Forest - Most of Kīlauea Forest contains tall stature koa and 'ōhi'a with other native trees and a hāpu'u, native shrub and fern understory. The wet and mesic koa forest communities are generally found on older substrates.

3) Mesic Koa/'Ōhi'a Forest - Portions of KCF contain tall stature koa/'ōhi'a forest with other native trees and a hāpu'u tree fern, native shrubs and ground fern understory. This forest type differs from the wet koa/'ōhi'a in that wet forest tends to have higher densities of hāpu'u than mesic areas, which have more native trees and shrubs in the understory. Unless disturbed, both forest types have a diverse ground cover dominated by ferns.

4) Mesic ʻŌhiʻa Forest - Portions of KCF contain plant communities composed primarily of open to closed canopy ʻōhiʻa and an understory of native trees, shrubs, ferns and grasses without the prominent hāpuʻu component. This community can be found on intermediate aged lava flows as well as on young lava flows in association with other pioneer vegetation.

5) Dry Native Shrub with scattered ʻŌhiʻa - This plant community is found on younger lava flows, especially in the higher elevation, drier parts of KCF.

6) Dry ʻŌhiʻa Forest with mixed native trees and native shrub understory - This plant community is found on young to intermediate aged lava flows in the higher elevation, drier parts of KCF. This community is intermediate in successional development between the previous two communities.

The project area also contains additional, less geographically extensive plant communities. The upper elevation, drier parts of Kūlani, contains low stature ʻōhiʻa trees interspersed with native trees, shrubs and the native grass *Deschampsia nubigena*. Depressions in the lava flow surface collect water and have formed perennial "pocket bogs" containing native grasses and sedges. Other small wetlands composed primarily of the sedge *Carex alligata* are scattered in small distinct patches throughout the project area, and are typically found in cinder cones or other forest depressions. The largest patches occupy craters on Kūlani Cone and Na Lua Mahoe. The project area also has pockets of non-native communities including plantings of tropical ash, redwood and pine.

The ʻŌlaʻa - Kīlauea Management Area contains 11 plant species officially listed as endangered and 11 considered species of special concern (Management Plan, Table 2). Although portions of the project area have been surveyed for rare plants, large expanses have not been thoroughly searched and specific threats for many of these species are unknown.

Native Fauna

Bird and Mammals (Management Plan, Table 1)

The project area provides habitat for seven honeycreepers (Subfamily Drepanidinae) endemic to the Hawaiian Islands. These include four endangered species: Hawaiʻi creeper (*Oreomystis mana*), Hawaiʻi ʻākepa (*Loxops coccineus*), ʻākiapōlaʻau (*Hemignathus munroi*) and ʻōʻū (*Psittirostra psittacea),* a species which has not been sighted in the area since the mid-1980's. The non-endangered honeycreepers found in the project area are the ʻāpapane (*Himatione sanguinea*), ʻamakihi (*Hemignathus virens*), and ʻiʻiwi (*Vestiaria coccinea).*

Other native birds in the project area include the endangered Hawaiian hawk or ʻio (*Buteo solitarius*), ʻelepaio (*Chasiempis sandwichensis*), ʻōmaʻo or Hawaiian thrush (*Phaeornis obscurus*), nēnē (*Nesochen sandviceńsis),* Hawaiian owl or pueo (*Asio flammeus sandwichensis*) and Pacific golden-plover or kōlea. Additionally, the ʻuaʻu or dark-rumped petrel (*Pterodroma phaeopygia sandwichensis*) and the ʻakē ʻakē or band-rumped storm petrel (*Oceanodroma castro*) overfly the project area to and from nesting areas on the upper, eastern slopes of Mauna Loa.

The project area has some of the highest densities of native forest birds areas on the island. This relative abundance is due to large tracts of intact, upper elevation native forest. Native forest birds are primarily found in the upper elevations of the project area where lower numbers of mosquitoes reduce the incidence of diseases such as avian malaria and pox.

Hawai'i's only endemic land mammal, the 'ōpe'ape'a or endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*), also uses the project area.

Invertebrates

The project area's native insect fauna is predominantly native and relatively diverse. Researchers are developing monitoring procedures for several groups of endemic invertebrates in the project area, including soil microarthropods, *Megalagrion* damselflies, and picture wing *Drosophila* flies. Many insects now recognized as rare or candidate endangered species have evolved specialized habitats and require one or a very few native plant species to complete their life cycle. The decline of many groups of native plants has probably contributed to the loss of their associated native arthropod communities. Although the lava tube caves in the project area have not been investigated, research in adjacent areas has documented a well-preserved cave fauna. Endemic invertebrates appear to be particularly sensitive to changes in the microclimate (e.g. forest clearing, pig digging and invasion of alien plant species). Another serious threat to native invertebrates in the project area is the invasion of the alien yellowjacket wasp (*Vespula pennsylvanica*). These wasps are voracious predators of numerous species of native invertebrates, and they have been implicated in the local extinction of two species of endemic *Drosophila* in 'Ōla'a Tract.

Mollusks have not been studied in the project area, but the endemic tree snail *Succinia* is relatively common in the native wet and mesic forest and shrublands on the island.

Historical/Archeological and Cultural Sites

The history of the project area and use by Hawaiians is not well documented. Although the project area has not been surveyed for archeological sites, few features are known to exist in the area. Trails, small forest shrines, burial caves and lava tube shelters are the types of features that might be revealed in the area by intensive surveys. The area may have been used historically by Hawaiians for activities such as bird hunting and gathering forest plants for medicinal uses.

Current Land Use

The parcels contained in the partnership agreement have different land use histories and current uses. Current land uses include prison facility management, cattle ranching and domestic pig production, public hunting and biological conservation.

Pu'u Maka'ala NAR and 'Ōla'a Tract were both established with the primary purpose of protecting unique native ecosystems. The upper elevation half of 'Ōla'a Tract is designated for intensive management for the protection of native resources. Fencing, pig control, weed control and scientific research projects are ongoing in this portion of the park. Deputized public hunting is allowed in the lower half of 'Ōla'a Tract for pig control purposes. Pu'u Maka'ala NAR also has fenced units designated for intensive management, and public hunting is currently allowed

throughout the unfenced portions of the NAR as a means to assist with pig control. Public access is allowed in both the NAR and ʻŌlaʻa Tract for other recreational and cultural uses including gathering of plant material.

Kūlani Correctional Facility was built in 1946 as an honor camp for prison inmates. The facility currently houses about 220 minimum security inmates with approximately 90 people employed at the site as correctional officers and civilian workers. Approximately 900 acres of Kūlani property are used in prison operations and related activities, including a piggery and cattle ranching. The purpose of these activities is to provide job training in agricultural industries to KCF inmates and beef and pork to KCF and other state correctional facilities.

Kīlauea Forest is owned by Kamehameha Schools Bishop Estate (KSBE). KSBE is dedicated to managing its assets for the benefit of Kamehameha Schools and students of Hawaiian ancestry. KSBE has a license agreement for telecommunications uses on the summit of Kūlani Cone.

The entire project area is zoned Conservation District under Hawaiʻi Land Use law. Different parcels within the project area have different subzone designations. Kīlauea Forest and Puʻu Makaʻala NAR are designated Protective Subzone. ʻŌlaʻa Tract and most of KCF are designated Resource Subzone, and the portion of KCF immediately surrounding the administrative buildings and inmate quarters is designated General Subzone.

Sensitive Habitats

The entire project area can be considered sensitive habitat, particularly with regard to listed endangered plants and birds.

IV. General Description of the Action Including Environmental and Socioeconomic Characteristics

Management Goals

The Management Plan encompasses a wide variety of research and management activities that are planned for five fiscal years (Federal FY1999 – FY2004). The ʻŌlaʻa - Kīlauea Management Group will be responsible for coordinating and completing the research and management work. The Management Group will seek funding to implement the proposed projects from a variety of Federal, State and private sources.

The overall objective of management in the project area is the protection and recovery of native ecosystems to the point that they are self-sustaining, native-dominated communities with secure populations of native plant, invertebrate and forest bird species. Initial management efforts will primarily be directed at the control of feral pigs and alien plants, which are the greatest known threats to the project area's native ecosystems. Activities such as restoration of rare plant species and predator control are becoming higher priority as objectives for feral pig and alien plant control are achieved and large, pig-free areas become available for more intensive management.

The Management Plan includes the following proposed research and management programs:

Fencing/Pig Control

The highest priority management actions are fencing and feral pig control. The management goal for the feral ungulate program is to eliminate pigs from fenced management units, prevent pig ingress and minimize populations in unfenced areas.

The construction of ungulate proof fences to exclude pigs is the first step in habitat restoration. The ultimate goal of fencing is to control feral pig populations within management units to zero density and monitor subsequent forest recovery. The ʻŌlaʻa - Kīlauea Management Group has completed fences that form four management units enclosing over 5,000 acres. These units include Mauna Loa Boy's School Unit, Puʻu Kipu Unit, Kūlani Cone Unit, and Wright Road Unit. Other, previously completed fenced units in the project area that adjoin the units completed by the Management Group include five units in ʻŌlaʻa Tract (over 4,000 acres) and two units in Puʻu Makaʻala NAR (1,000 acres). The proposed fencing projects will create a large network of contiguous, fenced management areas which can be used as recovery areas for native ecosystems and rare and endangered species (Management Plan, Figure 4).

The two major units planned for construction in the next five years are the North Boundary Unit and South Boundary Unit (Management Plan, Figure 4). These new fences and a boundary road will run along the entire eastern boundary of KCF, with some fencing along roads within KCF. The total length of the proposed fence is approximately 8.5 miles. In addition, some fencing (an additional 2 miles) will run along previously existing roads within KCF to enclose the management units. The general progression of the fencing and subsequent pig control project is as follows:

1) The KCF boundary will be surveyed and the road/fence alignment will be marked with plastic flagging. Botanists will search for rare and endangered plants along the proposed alignment. If necessary, the alignment will be shifted to avoid individual plants and other sensitive features such as lava tubes.

2) The boundary road and fence will be constructed within the Kūlani boundary. The corridor will be cleared using heavy equipment, hand and small power tools. The fence corridor will be approximately 12-20 ft wide. The corridor will contain a narrow access road of approximately 12 ft with occasional pull-outs. The disturbance corridor including the road and fence will be approximately 20 ft. There may be occasional circumstances where the corridor is wider than 20 ft, but every attempt will be made to minimize the width of the corridor.

   Depending on the results of the boundary survey, portions of the fence/road corridor may be along old roads and bulldozer tracks. These already disturbed areas will require minimal clearing to create the alignment. Other portions of the corridor will require a greater degree of clearing because there are no previously existing roads.

3) Most of the fence materials will be driven to the fence line along existing roads, although helicopter airlifts may be necessary for some materials. All fence construction will be with hand tools. Construction involves driving galvanized steel fence posts into the ground along the corridor no more than ten feet apart, attaching one strand of galvanized barbed wire along the posts at ground level, and stretching 36 – 47 inch high galvanized

hog wire along the posts. Where necessary, anchor posts will be used along the fence, between the posts, to ensure the fencing is tight to the ground. Fence corridor clearing and fence installation will be done by a KCF inmate work crew.

4) Upon completion of the proposed fences, the National Park Service will control feral pigs using staff hunters. Control methods usually consist of repeated hunts with up to 18 dogs, but control efforts may also occasionally include trapping and/or snaring. Staff will also establish and regularly monitor pig activity transects to detect ingress, to determine the efficiency of the program, and to assess vegetation recovery.

Additional smaller fenced exclosures may be constructed to protect rare plant populations and other sensitive habitats. Staff will continue to monitor pig numbers and control pigs in existing management units. All pigs have been removed from the Mauna Loa Boy's School Unit, and this unit will be monitored every six months for pig ingress. Regular staff hunting for pig control purposes will continue in the Pu'u Kipu Unit, Kūlani Cone Unit, the two NAR units and the new 'Ōla'a Tract Unit. Staff will also inspect and maintain all fences on a monthly basis.

Alien Plant Control

The management goal for the alien plant control program is to protect the most intact native areas from disruptive alien plant species, and begin control efforts in these areas while alien species are still localized.

The problem of alien plants invasion in native habitats is a well-recognized management problem in Hawai'i's natural areas. Certain alien plants displace native plants and are capable of converting native ecosystems to alien dominated vegetation, altering soil moisture, nutrient and fire regimes and reducing habitat for native species. Alien plants species with small, localized populations should be controlled to preclude costly control programs in the future. This project will help prioritize alien plant control efforts, reduce the size of alien plant populations and slow or prevent alien plant encroachment into intact native ecosystems.

The alien plant control program will occur concurrently with fencing and pig control in both fenced and unfenced areas. The program will include the following:

- Distribution mapping of priority alien plants for control purposes.
- Development of a control strategy.
- Control using herbicide or manual methods.
- Follow-up monitoring to determine the effectiveness of control efforts.
- Long-term monitoring of alien plants.

Herbicides are needed to control most target species because manual or mechanical control methods are not feasible in native or semi-native communities; most target species resprout when cut; and effective biocontrol agents are not available. Herbicide use is strictly limited, and in full compliance with the state Department of Agriculture's pesticide branch. Additional techniques for alien plant control may be used in the future as these techniques are developed. These include aerial spraying of herbicides and biological control.

The greatest current threats to the project area, and the initial focus of mapping and control efforts are *Rubus ellipticus* (yellow Himalayan raspberry) and *Passiflora mollisima* (banana poka). The priority target species were selected on the basis of proven invasiveness in the ʻŌlaʻa - Kīlauea Management Area and/or similar habitats in other parts of the State. Additional species are likely to be added to this list in the future.

Priority Alien Plants

Anemone hupehensis (windflower)
Clidemia hirta (Koster's curse)
Ehrharta stipoides (meadow ricegrass)
Hedychium coronarium (white ginger)
Hedychium gardnerianum (kahili ginger)
Hedychium flavescens (yellow ginger)
Hypericum kouytchense
Myrica faya (faya tree)
Paspalum conjugatum (Hilo grass)
Paspalum urvillei (vasey grass)
Passiflora mollisima (banana poka)
Pennisetum clandestinum (kikuyu grass)
Psidium cattleianum (strawberry guava)
Pyracantha angustifolia (firethorn)
Rubus argutus (blackberry)
Rubus ellipticus (Himalayan raspberry)
Rubus glaucus
Rubus niveus (hill or mysore raspberry)
Setaria palmifolia (palm grass)
Tibouchina herbacea (glory bush)
Tibouchina urvilleana (Lasiandra)
Tritonia crocosmiflora
Verbascum thapsus (mullein)

Avian Disease and Vector Control

The management goal of avian disease and vector control research is to develop methods to control avian disease to improve habitat and populations of native birds.

Native Hawaiian forest birds, especially honeycreepers, are very susceptible to introduced vectored-disease such as avian malaria. Currently several species of honeycreepers survive in remnant populations restricted to elevations above the vector's distribution and common species suffer high mortality when foraging at lower elevations. Avian disease control is integral to native forest bird management and will rely on control of vector mosquito populations. Recent research in the ʻŌlaʻa - Kīlauea Management Area has focused on determining the distribution and disease vector potential of mosquitoes, the prevalence of pox and malaria in native and introduced birds at different elevations, and the effect of reducing feral pig numbers on mosquito populations.

USGS-BRD is planning to do additional research on the distribution of mosquito breeding sites and seasonal distribution and rate of movement of mosquitoes into higher elevation areas. While wide scale elimination of larval habitat may be economically and politically infeasible, selective larviciding may prove to be the most efficient form of wide scale mosquito control. USGS-BRD researchers and KSBE are planning work in KSBE's Kīlauea Forest to determine the feasibility of using granular B.t.i. (*Bacillus thuringiensis israelensis*) and methoprene larvicides for the control of *Culex quinquefasciatus* in forest ecosystems. This work will include research on the potential non-target effects larvicides may have on native soil and aquatic invertebrates. Both larvicides are relatively selective, and they provide effective control of mosquitoes in many mainland situations. Methoprene interrupts normal insect molting, and B.t.i. is a bacterium lethal to larval mosquitoes. All larvicide use will be in accordance with the registration requirements.

Predator Control

The management goal of predator control research is to develop more efficient methods for predator control for the protection of large areas of forest bird habitat.

Small alien mammalian predators, particularly rats (*Rattus rattus, R. exulans*), mongoose (*Herpestes aruopunctatus*) and cats (*Felis catus*) prey upon both ground and tree nesting birds. They also consume large quantities of insect prey, and vegetation: seeds, seedlings, and new growth on plants.

To control predators, the anti-coagulant diphacinone has been approved for use in natural areas in Hawai'i by the Environmental Protection Agency under a 24(c) registration. The current registration allows use of diphacinone bait in tamper-proof bait boxes. Additional research is needed to support a 24(c) registration of diphacinone in Hawai'i for broad area application, and to evaluate aerial method of predator control. The interagency Toxicant Working Group (USFWS, DOFAW, U.S. Department of Agriculture/Animal and Plant Health Inspection Service/Animal Damage Control/Denver Wildlife Research Center, USGS-BRD, and KSBE) working under the guidelines of the Environmental Protection Agency, continues to work together to coordinate research priorities. Future work planned for the 'Ōla'a - Kīlauea Management Area includes the following:

- Test Small Mammal Toxicants in Wet Forest – This USGS-BRD project planned for 'Ōla'a Tract (FY99 through FY01) has four major components: 1) evaluate control procedures, bait delivery systems and dosages of diphacinone in wet forest; 2) study recruitment and recovery of representative populations of rare plants and invertebrates, 3) evaluate non-target impacts of baits and toxicants on soil and litter invertebrates, and 4) prepare findings that can be used to support a 24(c) registration in Hawai'i for broad area application of diphacinone pellets or the use of other toxicants in natural areas.

- KSBE is planning experimental applications in Kīlauea Forest to support the registration of diphacinone for aerial application. Predator control will be conducted in pig-free areas using aerial broadcast methods if an experimental permit from the Environmental Protection Agency can be acquired. Numbers of rats, mongooses and cats will be monitored before and after predator control.

Additional use of toxicants for predator control may also be used for management and/or research purposes. All diphacinone and other toxicant use will be in accordance with the registration requirements.

Rare Plant Inventory, Monitoring and Recovery

The management goals for the recovery of rare plants is to protect large areas of native habitat by fencing and controlling pigs and alien plants.

Concurrently, as rare plants are located, representative genetic material is often able to be collected and maintained at the Volcano Mid-Elevation Rare Plant Facility. In some instances spot fencing is erected for interim protection from ungulates. The protection of large expanses of intact native habitat is crucial for the long-term survival and recovery of rare species. As broad-scale management actions are incrementally completed, the Management Group will spend more

time and effort on monitoring and implementing specific recovery actions for rare and endangered species.

Specific actions focused on rare plants will include additional searches and distribution mapping of individuals and populations, intensive monitoring of some species to assess potential threats such as rats and alien invertebrates, evaluation of forest stand structure and reproduction, and monitoring the results of management actions such as fencing and pig control. Some species may be adequately reproducing and require no further assistance while others may require human intervention to persist. Propagation and outplanting programs are being considered for some rare plant species that appear to be inadequately reproducing in the wild or for those in need to restoring genetic representation to the wild. The Volcano Mid-Elevation Rare Plant Facility is available for propagation efforts.

All necessary state and federal endangered species permits for collection and propagation of endangered plants have been or will be acquired and maintained. Federal permits are required for collection of material from or a specimen of an endangered plant on federal lands or by federal personnel, and the USFWS administers permits for this activity. Collection of a specimen or materials from plants in the National Park requires a collecting permit from the park (in addition to the USFWS permit). The National Park Service has an overall permit from USFWS covering NPS personnel on NPS lands. State permits are required for any collection of endangered plants on state land or by state personnel.

Other Ongoing and Proposed Research

Vegetation Inventory and Monitoring

The vegetation of an area is one of the best indicators of ecosystem health or stability. Detailed information on vegetation provides data on both the structure and composition of the plant communities, as well as the degree to which the area has been invaded by alien species and the status of rare native species. USGS-BRD and NAR staff are mapping vegetation, sampling plant community structure and composition, and monitoring the change in both native and alien plant species over time.

Bird Population Monitoring

Bird population trend information allows for an evaluation of changes in distribution and abundance over time which can be evaluated relative to active or inactive management programs. USGS-BRD is conducting surveys of endangered, native, and alien bird species once per year in Kūlani forest, and twice per year in Kīlauea Forest (with KSBE). A sharp decline in native species or an increase in alien bird species can be detected by this method, and may be an important indicator of need for additional management response to a new threat (e.g., increase in avian disease or predation) in an area.

Invertebrate Research

USGS-BRD has researched forest invertebrate communities in both ʻŌlaʻa Tract and Kūlani. Researchers are developing monitoring procedures for several groups of endemic invertebrates, including soil microarthropods, *Megalagrion* damselflies, and picture wing *Drosophila* flies.

These data are being used to evaluate forest recovery after removal of feral ungulates. USGS-BRD is also testing alien wasp control methods and studying the non-target impacts of wasp control on picture wing *Drosophila* flies.

Education and Public Outreach

Current efforts in the education and information program are focused on Kūlani Correctional Facility inmates. Inmates are being trained in fence building and other conservation projects as well as identification of native Hawaiian plants and animals they encounter in their daily work.. Future projects at Kūlani Correctional Facility may include native plant landscaping in the vicinity of facility buildings and the development of interpretive trails for use by inmates and staff.

Eventually, the Management Group plans to develop educational programs for the general public such as interpretive brochures and trails, and increase use of volunteers for conservation projects in publicly accessible portions of the project area. Pu'u Maka'ala NAR and 'Ōla'a Tract are ideal settings for these types of programs. KSBE lands could potentially be used for environmental education programs for Kamehameha Schools students, and KSBE is also considering ecotourism possibilities for their lands.

HVNP is currently developing an environmental education program for the Big Island in partnership with the Hawai'i Department of Education, Department of the Army, DLNR and USFWS. A full-time Environmental Education Specialist will be hired to teach teachers and high school students about Hawai'i's biodiversity and threats to native ecosystems. The 'Ōla'a - Kīlauea Management Area will be an important part of this program, and can provide numerous training opportunities for both teachers and students.

V. Summary of Major Impacts

Environmental Impacts

This project will benefit the environment by maintaining and enhancing native Hawaiian ecosystems and restoring rare and endangered native species. Increased research and management effort will allow for the tracking of biological resources in the project area, and evaluation of changes in those resources over time.

In the short-term, the actual clearing of road and fence lines will disturb plants cut or removed to create the corridor. Clearing can increase the introduction of non-native weed seeds along the fence corridor by personnel and vehicles traversing the site regularly, and pooling or congregating of feral animals as movement patterns may be disturbed. In addition, heavy equipment used in fence corridor clearing, helicopter airlifts of fence material and fence line construction will entail some ground and noise disturbance which may temporarily disturb forest birds. The proposed boundary road will have a long-term impact because it will serve as a corridor for the spread of alien weeds. However, fencing will also provide long-term benefits by allowing for effective control of feral pigs and restoration of acres of nearly pristine koa-ohia forest. Removal of feral pigs from existing and proposed fenced management units will promote the recovery of native vegetation and slow the establishment and spread of alien plants. Ample evidence exists to show that damage caused by feral pigs can lead to the eventual replacement of

unique Hawaiian vegetation by introduced weeds. If pigs are removed before disturbance becomes too severe, native vegetation is able to recover naturally and the spread of weeds slowed or even reversed.

Weed control and monitoring will reduce the numbers and range of certain habitat-modifying weeds, and help prevent the introduction of new problem weeds. Because herbicides are used for alien plant control, there is a remote possibility of localized soil contamination.

The development of management strategies and techniques for mammalian predators, mosquitoes and yellow jacket wasps will address other major known threats to native ecosystems and rare and endangered species. There is a small chance that diphacinone, other rodenticides, larvicides and/or toxic baits could potentially poison non-target animals.

Ongoing and proposed research projects will assess the health of the project area's ecosystems and species and will guide future management actions.

Socio-Economic Impacts

The fencing project will benefit KCF inmates by providing an opportunity to learn new skills such as fence construction, alien plant control, plant and bird identification, cultural values of native Hawaiian plants and animals, and management techniques to restore native Hawaiian ecosystems. This practical work experience and education may increase their employment opportunities upon release from KCF.

The eventual expansion of the education and information program will increase opportunities for public access to certain portions of the management area as well as increasing public awareness of native Hawaiian ecosystems.

There is general opposition to fencing and feral pig control from some portions of the hunting community. In early 1994, DOFAW formed the Natural Areas Working Group to discuss and solve differences among the hunting community, government land managers, and the environmental community. Also involved in the group are community associations, native Hawaiian interests, and a state legislator. The group's goal is to find solutions whereby each particular interest is met. It has been agreed that there should be areas where ungulate populations will be kept low, and conversely, other areas managed for high animal/hunting yields.

The ʻŌlaʻa - Kīlauea Management Group feels that the proposed new fenced units (North and South Boundary Units) are a high priority for protection and need active, sustained management. In addition, the area proposed for fencing is within KCF and is not available to public hunters. KCF does not permit public hunting because of security and liability concerns. Consequently, the group feels it appropriate to proceed with the proposed fences, while continuing to participate in the ongoing process designed to address community concerns within the project area and adjacent lands.

VI. Alternatives Considered

Although the 'Ōla'a – Kīlauea Management Group considered a variety of alternatives involving lower levels of management, we decided that the actions outlined in this assessment are all necessary to assure the continued protection of rare species and valuable habitat. Slowing the pace of management and research could jeopardize progress made in controlling feral pigs, weeds, and other serious threats. Similarly, a no-action alternative would promote the loss of rare Hawaiian ecosystems, plants and animals.

For the North and South Boundary Unit fencing project, the 'Ōla'a – Kīlauea Management Group considered the construction of a trail alongside the boundary fence instead of a road. However, the Department of Public Safety is concerned about unauthorized access into KCF along the fence and wants the ability to regularly patrol the entire facility boundary, as well as prosecute trespassers and escapees from KCF. The Group recognizes these concerns and has agreed the impacts of a road along the entire eastern boundary would be minimal and would be in the best interests of public safety. In addition, the road would increase the ease of fence construction, maintenance and pig control. Although the proposed road may increase the spread of weeds and entails a certain amount of forest clearing, the overall benefit of pig control and other management actions outweighs the impact of fence/road construction.

VII. Proposed Mitigation Measures

Negative impacts listed will be decreased by mitigation measures described in this section. These impacts will be far outweighed by the positive long-term benefits of this project.

Prior to clearing the fence corridor, endangered or rare plant species will be marked and identified to the crew and crew leader to ensure their protection. The alignment will be re-routed to avoid impacts to rare plants and other sensitive features such as lava tubes. Soil disturbance is expected to be minimal, and no changes in normal rainwater runoff or percolation are expected. Nor do we anticipate any adverse effects on avifauna and invertebrate fauna. Additionally, the use of heavy equipment for fence corridor clearing and helicopters to place the fencing materials on the line will be done during the period July through December to avoid any possible disturbance to nesting forest birds.

The introduction of new weed species as a result of human activity will be minimized by ensuring that equipment, tools and construction materials are clean. Regularly scheduled inspection and weed control trips along roads, fences and trails will be made to prevent further spread of noxious plants within the project area. Routine fence inspections will take place at no greater than two month intervals, and with each inspection, personnel will watch for new weed introductions along the road and fence. 'Ōla'a - Kīlauea Management Group members will follow a strict protocol for the prevention of alien species introduction and increase educational efforts for all those working in the area.

Pooling or congregating of animals along fences will be minimized because staff will be regularly monitoring transects throughout the project area and implementing control measures when needed during the pig control effort.

All herbicide use will be carefully monitored. Only small quantities are used and field staff are all trained in the safe application of approved herbicides. Any aerial spraying of herbicides will only be done in remote, uninhabited areas, and all spraying of herbicides and/or release of biological control agents will be in accordance with federal and state requirements. Similarly, any use of diphacinone and/or other pesticides for predator control will be in accordance with the registration. Research described in the plan will help develop effective predator control methods and determine if there are any non-target impacts to the ecosystem.

If any signs indicating the existence of archaeological sites or ruins are found, work on the project will halt immediately and the proper authorities notified. Work on the fence will resume only after an appropriate evaluation of the site is completed and a successful plan to avoid impacts to the site is accepted.

VIII. Determination

Having reviewed the comments received on the Draft Environmental Assessment and Supplemental Draft Environmental Assessment, the ʻŌlaʻa – Kīlauea Management Group has determined that no significant negative effects to the environment are expected as a result of this project.

IX. Findings, and Reasons Supporting the Determination

The intent of this project is to benefit native ecosystems and rare and endangered species in the project area. Because the project aims to better manage endangered ecosystems, it will not destroy or cause the loss of natural or cultural resources and will improve environmental quality. The project will increase the range of beneficial uses of the environment by increasing environmental education and public awareness as well as protecting native Hawaiian ecosystems for future generations.

The aim of this project is to protect ecosystems, or plant and animal communities, as opposed to particular species. If long-term viability of rare and endangered native organisms is to be achieved, protection of large tracts of land is essential. This is in keeping with the USFWS "ecosystem approach" policy which focuses on management of natural communities, and with the Hawaiʻi Natural Area Reserve Law, which states a system of reserves be established to "...preserve in perpetuity specific land and water areas which support communities, as unmodified as possible, of the natural flora and fauna..." (Chapter 195D, Hawaiʻi Revised Statutes). Protection and enhancement of endangered species is also mandated by both Federal and State Endangered Species Acts (16 U.S.C. 1531-1543, as amended; Chapter 195, Hawaiʻi Revised Statutes).

The project has a positive impact on the state's social welfare because it includes the training of correctional facility inmates in practical work skills. The project will probably not have a substantial impact on public health. However, by reducing numbers of pigs and small mammalian predators, the project may reduce the amount of leptospirosis and other diseases carried by these animals.

The project is focused on research, management and education. As such, the project has no growth inducing qualities and will only use a small amount of energy. The project is in an upland area and will not detrimentally affect any coastal areas or water bodies. It may improve watershed qualities by removing pigs and reducing the amount of erosion and water runoff. Although the project is in a geologically hazardous area, there will be no threat to public health, safety or welfare. Very little of the project are is visible from public viewing sites, and the project may improve visual qualities by increasing numbers of native species and restoring native habitat.

Helicopter and fence construction noise will be minor and short-term. The long-term benefits of fencing and complete feral pig removal far outweigh the limited short-term effects of fence construction. Installation of the proposed fences will help to more efficiently and effectively control feral pigs (*Sus scrofa*) in the project area. Feral pigs pose the greatest threat to existing intact native wet forest areas. Pigs consume and trample understory plants, create conditions for non-native plant infestation and establishment, prevent the establishment of ground-rooting native plants, serve as vectors for the dispersal of non-native plants, and disrupt soil nutrient cycling. Their wallows create habitat for mosquitoes, which transmit avian malaria and pox to native forest birds. The cumulative effects are the decline of intact native forest ecosystems, including the decline of threatened and endangered forest birds, plants, and invertebrates. Removal of feral pigs has been proven to result in the recovery of native vegetation, particularly understory plants and tree ferns. Pig removal also inhibits or suppresses the spread of alien plants.

The possibility for introduction of new weed species as a result of human activity exists. This can be minimized by ensuring that equipment, tools and construction materials are clean. Regularly scheduled inspection and weed control trips along roads, fences and trails will be made to prevent further spread of noxious plants within the project area.

X. EA Preparation Information

This Final Environmental Assessment was prepared on behalf of the ʻŌlaʻa – Kīlauea Management Group by:

Tanya Rubenstein, ʻŌlaʻa – Kīlauea Project Coordinator
P.O. Box 52
Hawaii National Park, HI 96718
(808) 985 - 6197

XI. Appendix

Comments received on Draft Environmental Assessment and Supplemental Draft Environmental Assessment and Responses to comments

ʻŌlaʻa – Kīlauea Management Area Natural Resources Management Plan

To: Ola'a Kilauea Working Group 12/20/98

From: Steven Araujo

RE: Comments on Ola'a Kilauea Working Group Management Plan

Aloha. After reviewing the Management Plan proposal of this Group and reviewing the Ola'a Kilauea Forest Cooperative Agreement, this new 5 year project plan should not be implemented. When reviewing both Plan and Agreement, it is noted that the Agreement expires in June of 1999, which is only 6 months away. Before reviewing the Management Plan, a review of the Agreement and the concerned entities of the Agreement should be conducted.

Concerned Entities

In the second Whereas in the agreement-
The DLNR portion of this area is Pu'u Maka'ala NARS. This upper portion (Wright Rd section) should be declassified from the NARS program. As stated in the Pu'u Maka'ala Area Reserve Management Plan, this area is an Ohia/Hapu'u forest. According to chapter 195 and the NARS criteria this is not a unique representative sample of Hawaiis flora and fauna. The only parcel that is unique in this area is the Anunu unit consisting of 300 acres in the Army Rd. section. Also in the Management Plan this area is better to be monitored because of excellent access and public hunting control of feral pigs.

In the fourth Whereas in the agreement-
USFWS- The USFWS and its agencies should not be part of this group, for as I understand the USFWS has no jurisdiction on state property. Which brings to mind, how can the State cooperate with an entity that does not conform with its own criteria as stated in the Management Plans for the Islands by downlisting and/or delisting species? On the Endangered Species List there are numerous plant species that are extinct. there are also numerous species that can and should be downlisted. Also, isn't the Volcano Rare Plant Facility experiencing financial difficulties?

In the fifth Whereas in the agreement-
Kulani Correctional Facility- This area should not be included in this agreement. This parcel of the land has a special use zoning. The mandate for rhe corrections facility is to provide subsistance food for the prison system of Hawaii. Removing the ranching portion of this area and engaging in ecosystem protection should not be, by any means, be desirable. This area should be put to full use to meet the growing need of subsistence. This would help the State save on spending and educate the inmates on more practical avenues of rehabilitation.

In the sixth Whereas in the agreement-
Hawaii Volcano National Park (HVNP)_ The HVNP service owns 219,000 acres. This acreage has been almost fully eradicated for many years. The Park service has not, from then until now, been able to manage their own land to eliminate alien weed species nor have they adequate rodent and pest control. All that the Park service is good at is killing

feral animals and leaving them to rot. These accounts can also be found in the Upper Puna-Volcano Regional Group memory.-(Bill Stormont)

In the eighth Whereas in the agreement-
To my knowledge, the only area that is designated to the (UNESCO) is the HVNP. I, and many, if not the majority of the public, have no idea that any or part of this area is continguous to the Park. I would then suggest that any and all of this information be made public. This does concern all of the people of Hawaii.

In the ninth Whereas in the agreement-
This forest has had an impact from feral ungulates from pre 60's. To address degradation from wild pigs and trespassing cattle, one must not overlook the history of this area. For one, goats were also present in the late 60's and early 70's. Another thing, and the most devastating occurrence that happened in this area, was when the U.S. Military used the entire area as a testing site for mustard gas and defoliants. So, to say wild pigs and cattle degrade the forest, one must also take all facts and history into account. And given a little history on this area, to say what is written is absurd. The formal complaint filed with video of no compliance with the fenceline EA showed more damage than decades of animals.

In the tenth Whereas in the agreement-
As stated in the Pu'u Maka'ala Management Plan. This area does not have an impact of weeds due to the covering (shade) of the hapu'u.

In the eleventh Whereas in the agreement-
Management is best done by realistically evaluating the situation. Not by entering into a partnership to have a large land mass and not manage it correctly or realistically.

In the twelfth Whereas in the agreement-
Public hunting, as we know, is limited in these fenced off areas. We are hunters. Not eradicators. We conserve our resource. Not eliminate it.

In Therefore #5 of the agreement-
No plan was developed with the hunting community. Hunters (Pig Hunters Of Hawaii) went on one monitoring excursion. Bill Stormont said that the hunters had sufficient time to remove the pigs,so he implemented still ongoing staff hunting. The Ola'a Kilauea Working Group could not even work with the Div. of Forestry and Wildlife staff to remove 90% of the pigs from Kulani area. Not even half of the numbers were trapped and relocated. The others were staff hunted and left to rot. (Refer to Upper Puna-Volcano Regional Group memory.-Bill Stormont

In Therefore #11 of the agreement-
If no member or delegate to Congress, or Resident; Commissioner shall be admitted to any share or part of this agreement, then is there or has there been legitimacy to this Group, or has this Group just done what it wanted to do for the past 5 years and asking to do more of the same for the next 5 years?

In light of what is written within, this Group should not be re-organized and the Ola'a Kilauea Management Plan should not, by any means, be implemented. A copy of the Ola'a Kilauea Cooperative Agreement is enclosed.

Thank You,

Steven Araujo

c.c.
Ola'a Kilauea Working Group Members (via Bill Stormont)
Gov. Benjamin Cayetano (via Al Castro)
Al Castro, East Hawaii Liason
Mike Wilson
Mike Buck
Jon Giffin
Ted Sakai
Cora Lum
Sen. Dan Inouye
Sen. Dan Akaka
Robert Smith
Upper Puna/Volcano Regional Group (via Bill Stormont)
Lloyd Case
Thomas Medeiros Sr.
Steve Hurt
All other interested persons (via Bill Stormont)

Hawai'i Dept. of Land & Natural Resources
Kamehameha Schools Bishop Estate
Hawai'i Dept. of Public Safety
Hawai'i Volcanoes National Park
U.S. Fish and Wildlife Service

`Ola`a - Kilauea Management Group
P.O. Box 52
Hawai`i National Park, HI 96718
(808) 985-6197
FAX (808) 985-6029

March 22, 1999

Steven Araujo
PO Box 637
Kurtistown, HI 96760

Subject: Draft Environmental Assessment for the Olaa – Kilauea Management Area Natural Resources Management Plan

Dear Steven,

We have prepared a Supplemental Draft EA (enclosed) which addresses a new component of the project which you provided comments on earlier. This Supplemental Draft EA will be published in the April 8, 1999 Office of Environmental Quality Control Bulletin and public comments are due by May 8, 1999.

Thank you for your comments on the Olaa – Kilauea Cooperative Agreement and the Draft Environmental Assessment (EA) for the Olaa – Kilauea Management Area Natural Resources Management Plan. The Draft EA does not address the Cooperative Agreement but I have attempted to respond to some of your points in any case.

- Puu Makaala Natural Area Reserve (NAR) was set aside to protect high quality ohia-hapuu montane wet forest, and the Wright Rd. section does qualify for inclusion in the NAR. Bill Stormont has proposed removing the lower one-third of the NAR (Ihope Rd. Section - 4,000 acres) from NAR status because it no longer meets the NAR criteria.

- The U.S. Fish and Wildlife Service is responsible for the recovery of threatened and endangered animals and plants, and is required to work with other state and federal agencies as well as private landowners to improve the overall status of these species.

- Kulani Correctional Facility is on land zoned as state Conservation District. One of the objectives for land in the conservation district is to sustain important natural resources. Kulani also has an interest in participating in the cooperative agreement because inmates can gain valuable work training by working on resource management activities.

- Hawaii Volcanoes National Park participates in the cooperative agreement because protection and management of lands outside the park can assist in the protection and management of park lands. For example, control of alien weed species outside the park will reduce the establishment and spread of the weed within the park. The park is also interested in restoring certain rare bird and plant species found in the Olaa-Kilauea Management Area to the park

and wants to ensure continued survival of these rare species. The park has spent a great deal of time and effort managing their lands, and have been relatively successful controlling feral ungulates and alien plants within portions of the park (Special Ecological Areas).

- Hawaii Volcanoes National Park is designated by the United Nations as an International Biosphere Reserve and a World Heritage site. The rest of the project area (Kulani, Kilauea Forest and Puu Makaala NAR) is contiguous with portions of the National Park (Olaa Tract).

- We agree that the forest has had long-term impact from feral ungulates. This impact can be stopped by implementing the fencing, animal and alien plant control programs proposed in the management plan. The short-term impact from fence construction is minimal in comparison.

- The entire project area is threatened by alien weeds. Even areas with hapuu are being invaded by weeds such as yellow Himalayan raspberry.

- Members of the Olaa – Kilauea Management Group are trying to develop a regional plan for public hunting with the hunting community through the discussions of the Upper Puna Volcano Regional Group. Although the project area is not available for long-term sustainable game management, the Management Group has cooperated with hunters in trying to remove animals before initiating staff hunting. Bill Stormont worked with the hunting community for several years to get animals removed from NAR management units before staff hunting was implemented. The Olaa – Kilauea Management Group worked with DOFAW on a six month trapping and relocation effort in another management unit.

The Management Group is planing on reviewing the cooperative agreement before it is renewed in June. Initial plans for renewal of the agreement include expansion to include two new agencies - U.S. Geological Survey Biological Resources Division and the U.S. Forest Service. These agencies will assist the rest of the cooperators in developing and implementing research and monitoring of native and alien species as well as potential reforestion projects. The other agencies involved in the agreement are all interested in continuing or expanding their participation in the agreement.

Please call me if you have any additional comments and/or questions.

Sincerely,

Tanya Rubenstein

Tanya Rubenstein, Olaa – Kilauea Partnership Coordinator

Sunrise, Mt. McKinley Ansel Adams

SIERRA CLUB LEGAL DEFENSE FUND, INC.
EARTHJUSTICE

The Law Firm for the Environmental Movement

(On August 1, 1997, we officially became Earthjustice Legal Defense Fund)

223 South King Street, 4th Fl., Honolulu, HI 96813 (808) 599-2436 FAX (808) 521-6841

December 31, 1998

Via Facsimile Transmittal (808) 967-6029

Tanya Rubenstein
`Ōla`a-Kīlauea Project Coordinator
P.O. Box 52
Hawai`i National Park, Hawai`i 96718

Dear Tanya:

Earthjustice Legal Defense Fund appreciates the opportunity to comment on the Draft Environmental Assessment for the `Ōla`a-Kīlauea Management Area Natural Resources Management Plan. On May 8, 1997, we submitted written comments in support of the proposed fencing in the Kīlauea Forest and at the Kūlani Correctional Facility. We maintain that ecosystem and watershed management is the highest and best use of this area, and we appreciate the efforts of government agencies and the private landowner involved in this project.

The proposed natural resources management plan will increase protection for native ecosystems and watershed, and will enhance the likelihood of recovering endangered species in the project area. This area includes relatively intact native forest and essential habitat identified by the United States Fish and Wildlife Service for four endangered forest birds: Hawai`i `ākepa, Hawai`i creeper, `akiapōlā`au, and `ō`ū.[1] The project area also has been identified as potential important habitat for the recovery of several endangered plant taxa.[2] The endangered dark-rumped petrel, endangered `io, endangered `ōpe`ape`a, endangered nēnē, and less imperiled plants and animals have been reported from the project area. In short, the `Ōla`a/Kīlauea/Kūlani region is a biological treasure and deserves special protection and management.

The removal of destructive feral pigs and aggressive alien plants is essential to maintaining the project area for future generations. We are particularly concerned about the presence of feral pigs, mosquitoes, and avian diseases in Hawaiian natural areas. Unless intact native ecosystems and essential habitat are secured, captive breeding of birds and plant propagation are pointless.

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[1] Hawai`i Forest Bird Recovery Plan, 1983.

[2] Draft Recovery Plan for the Multi-Island Plants, September 1998.

State and federal agencies in Hawai`i must take a more aggressive approach to eliminating introduced species from natural areas. If not, endangerment and extinction will certainly continue. The `Ōla`a-Kīlauea working group, with its proposed management plan, is an excellent example of what can and should be done for the few remaining natural areas in the Hawaiian islands.

The proposed management plan is consistent with the actions necessary to reverse Hawai`i's extinction crisis, as identified by the United States Fish and Wildlife Service, Hawai`i Department of Land and Natural Resources, and The Nature Conservancy of Hawai`i:[3]

- ◊ Protect essential habitat for native species;
- ◊ Fund active, long-term stewardship of essential habitats in publicly owned natural areas, National Parks and Refuges, State Forest Reserves, Natural Area Reserves, and Sanctuaries;
- ◊ Provide strong incentives for private landowners to protect endangered species and native ecosystems on their property; and
- ◊ Further integrate government and private citizen conservation efforts.

The proposed management plan is consistent with necessary recovery actions for endangered forest birds on Hawai`i:[4]

- ◊ Preserve habitat for endangered forest birds, and reduce effects of factors limiting forest bird use of habitat;
- ◊ Apply prescribed management practices in areas of essential habitat;
- ◊ Reduce feral pig populations in essential habitat and adjacent areas;
- ◊ Reduce breeding sites for mosquitoes in areas adjacent to and within essential habitat;
- ◊ Promote practices to enhance the use of private lands by endangered forest birds;
- ◊ Reduce breeding sites for *Culex* in essential habitat and adjacent areas; and
- ◊ Create a habitat mosaic in historic range of upper montane koa forest so as to guarantee long-term survival of this essential habitat.

---

[3] Hawai`i Extinction Crisis: A Call to Action, 1992.

[4] Hawai`i Forest Bird Recovery Plan, 1983.

The proposed management plan is consistent with necessary recovery actions for endangered plants in the project area:[5]

- ◊ Consider eradication program for control of ungulates;
- ◊ Construct and maintain fences, wherever possible;
- ◊ Conduct alien plant control;
- ◊ Control rodents.
- ◊ Secure Kīlauea, Keauhou, and Kūlani portions of essential habitat;
- ◊ Expand existing wild populations, and create new populations within historic range, as necessary; and

The proposed management plan is consistent with DLNR's program for threatened and endangered plants and animals:[6]

- ◊ Protect, manage, develop, and maintain existing and future habitats to improve condition, long-range viability;
- ◊ Control noxious animals (herbivores) damaging to habitat; and
- ◊ Control noxious plants (exotics) damaging to habitat.

Fencing and actively managing the project area for native Hawaiian species and ecosystems is also consistent with the Natural Area Working Group's (NAWG's) guiding principle that some areas on the Big Island should be managed for few or no pigs/ungulates so that native ecosystems can thrive, and that other areas should be managed for game animals so that hunting opportunities are enhanced. Given the species richness and ecological integrity of the Kīlauea Forest and Kūlani, there is no question the area should be managed for native species and ecosystems.

Mahalo for the opportunity to comment on this important project.

Sincerely,

Marjorie Ziegler

Marjorie Ziegler

---

[5] Recovery Plan for the Big Island Plant Cluster, September 1996; Big Island II: Addendum to the Recovery Plan for the Big Island Plant Cluster, May 1998; Final Recovery Plan for Four Species of Hawaiian Ferns, April 1998; and *Vicia menziesii* Recovery Plan, May 1984.

[6] Threatened & Endangered Species Plan for Wildlife, Plants & Invertebrates, 1988.

BENJAMIN J. CAYETANO
GOVERNOR

GARY GILL
DIRECTOR

STATE OF HAWAII
OFFICE OF ENVIRONMENTAL QUALITY CONTROL
235 SOUTH BERETANIA STREET
SUITE 702
HONOLULU, HAWAII 96813
TELEPHONE (808) 586-4185
FACSIMILE (808) 586-4186

November 24, 1998

Jon Giffin
Department of Land & Natural Resources
Forestry & Wildlife
PO Box 4849
Hilo, HI 96720

Attn: Tanya Rubenstein

Dear Mr. Giffin:

RE: Draft Environmental Assessment (EA) for Olaa-Kilauea Management Area Plan

We have the following comments to offer:

1. Unbound documents: Please note that unbound copies of the EA are not permitted. Bind or staple attachments to all copies of the final EA.

2. Permits: In the final EA please discuss more fully the federal endangered species permits that will be required for collection and propagation of rare plants.

If you have any questions call Nancy Heinrich at 586-4185.

Sincerely,

Gary Gill
Director

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION
P.O. BOX 621
HONOLULU, HAWAII 96809

DEC 30 1998

AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
LAND DIVISION
STATE PARKS
WATER RESOURCE MANAGEMENT

Ref: PS:EH

Ms. Tanya Rubenstein
Olaa Kilauea Project Coordinator
P.O. Box 52
Hawaii National Park, HI 96818

Dear Ms. Rubenstein:

Subject: Ola'a Kilauea Management Area Draft Natural Resources Management Plan

Thank you for the opportunity to review the subject document.

As identified on page 7 of the Management Plan, the entire project area is located within the State Conservation District, with various parcels designated in different subzone categories. As specific land use elements are framed to implement the Management Plan (e.g. fencing), please contact the Planning Section of the Land Division, to ensure that provisions of Chapter 183C HRS and Chapter 13-5 Hawaii Administrative Rules are addressed.

Should you have any questions, or require further assistance, please contact staff planner Ed Henry at 587-0380.

Very truly yours,

Dean Uchida,
Administrator

c.c. Hawaii District Land Office

Hawai'i Dept. of Land & Natural Resources
Kamehameha Schools Bishop Estate
Hawai'i Dept. of Public Safety
Hawai'i Volcanoes National Park
U.S. Fish and Wildlife Service

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March 22, 1999

Dean Uchida
Administrator - Land Division
Department of Land and Natural Resources
P.O. Box 621
Honolulu, HI 96809

Subject: Draft Environmental Assessment for the Olaa – Kilauea Management Area Natural Resources Management Plan

Dear Mr. Uchida,

Thank you for your comments on the Draft Environmental Assessment (EA) for the Olaa – Kilauea Management Area Natural Resources Management Plan.

Your letter stated we should contact the Planning Section of the Land Division to ensure that provisions of Chapter 183C HRS and Chapter 13-5 Hawaii Administrative Rules are addressed as various parts of the management plan are implemented.

We have prepared a Supplemental Draft EA (enclosed) which addresses a new component of the project. This Supplemental Draft EA will be published in the April 8, 1999 Office of Environmental Quality Control Bulletin and comments are due by May 8, 1999.

Please call me if you have any comments and/or questions.

Sincerely,

Tanya Rubenstein

Tanya Rubenstein, Olaa – Kilauea Partnership Coordinator

Stephen K. Yamashiro
Mayor

Virginia Goldstein
Director

Russell Kokubun
Deputy Director

County of Hawaii

PLANNING DEPARTMENT

25 Aupuni Street, Room 109 • Hilo, Hawaii 96720-4252
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December 15, 1998

Ms. Tanya Rubenstein
Olaa Kilauea Project Coordinator
`Ola`a-Kilauea Management Group
P. O. Box 52
Hawai`i National Park, HI 96718

Dear Ms. Rubenstein:

Olaa - Kilauea Management Area
Resources Management Plan - Draft EA
TMK: 2-4-8:9 & 25, 1-9-1:7, & 9-9-1:7

We have received your letter of November 9, 1998, which transmitted a the Draft EA and Draft Natural Resources Management Plan for this Management Area.

Although the affected land area is excluded from the County's administrative authority, we applaud your joint effort in the habitat protection and restoration.

Thank you for the opportunity to review these documents.

Sincerely,

VIRGINIA GOLDSTEIN
Planning Director

RKN:pak
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LIFE OF THE LAND

Ua Mau Ke Ea O Ka `Aina I Ka Pono
Hawai`i's own Community Action Group
Protecting our Fragile Environment through
Research, Education, Advocacy and Litigation

Tanya Rubenstein
Ola`a-Kilauea Management Group
P. O. Box 52
Hawai`i National Park, Hawai`i 96718

Bill Stormont
Department of Land and Natural Resources
Division of Forestry and Wildlife
P. O. Box 4849
Hilo, Hawai`i 96720

re: Ola`a-Kilauea Management Area Plan Draft Environmental Assessment

Aloha,

Environmental Assessments and Environmental Impact Statements are often written in technical terms not easily understood by the lay person. In addition, some fail to cover obvious issues, mitigations and alternatives. It is a pleasure to read a thorough and well written document.

This looks like a great plan and we support it.

Henry Curtis

Henry Curtis
Executive Director

1111 Bishop Street * Suite 503 * Honolulu, Hawai`i 96813 * phone (808) 533-3454 * fax (808) 533-0993

STATE OF HAWAII

DEPARTMENT OF LAND AND NATURAL RESOURCES

HISTORIC PRESERVATION DIVISION
Kakuhihewa Building, Room 555
601 Kamokila Boulevard
Kapolei, Hawaii 96707

December 22, 1998

LOG NO: 22678
DOC NO: 9812PM09

Ms. Tanya Rubenstein
`Ola`a-Kilauea Management Group
P.O. Box 52
Hawai`i National Park, Hawaii 96718

Dear Ms. Rubenstein:

SUBJECT: Draft Environmental Assessment (Natural Resources Management Plan for the `Ola`a-Kilauea Management Area) Waiakea and Kulani, South Hilo; `Ola`a, Puna; and Kilauea, Kau, Hawaii Island, TMK: 2-4-08:25; 2-4-08:9; 1-9-01:7 and 9-9-01:7

Thank you for your letter of November 9, 1998 and the opportunity to review and comment on the above referenced draft environmental assessment, which proposes a natural resources management plan for the `Ola`a-Kilauea Management Area.

According to our records the management area has not been surveyed for archaeological sites. Thus, there are no known or recorded sites in this area. We would predict that few sites would be found in this forested area, which is well inland of the zone of pre-contact Hawaiian permanent settlement. The draft assessment notes some of the kinds of activities that might have been pursued in the area and types of archaeological sites that might be found.

We believe that the proposed projects will have "no effect" on significant historic sites. If such sites should be found in the course of fencing or other activities, we would appreciate notification so that our staff could have the opportunity to properly record and evaluate the findings.

If you should have any questions or need in the future to report any archaeological findings please contact either Marc Smith (933-0482) or Patrick McCoy (692-8029).

Aloha,

DON HIBBARD, Administrator
State Historic Preservation Division

PM:amk

BENJAMIN J. CAYETANO
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF PUBLIC SAFETY
919 Ala Moana Boulevard, 4th Floor
Honolulu, Hawaii 96814

CORA K. LUM
ACTING DIRECTOR

TED SAKAI
ACTING DEPUTY DIRECTOR

JEFF YAMASHITA
DEPUTY DIRECTOR

MARK K. OTO
DEPUTY DIRECTOR

No. _____

November 19, 1998

Ms. Tanya Rubenstein
Ola'a-Kilauea Partnership Coordinator
Ola'a-Kilauea Management Group
P.O. Box 52
Hawaii National Park, Hawaii 96718

Dear Ms. Rubenstein:

Thank you for providing our Department with an opportunity to respond to the proposed boundary fencing project. The strong working relationship between the Ola'a-Kilauea Management Group and Corrections is obviously mutually beneficial.

Your proposed fencing project meets most of the needs of Kulani Correctional Facility in terms of detail and scope. However, it is our preference to construct a narrow one-lane access road adjacent to the fenceline. Such a road would allow security a wider range for searching when there is an escape. The perimeter road would also provide for a more timely response when hunters are penetrating our boundaries, when there is a workline related accident or when there is a range fire. Conversely, a trail along the fenceline offers little more than an unauthorized access for hunters and other civilians. The construction of a narrow road on the perimeter of Kulani Correctional Facility would be in the best interest of public safety and security.

We appreciate your willingness to assist us and to request our input. If you have additional questions, please contact Warden Peter Mac Donald at Kulani Correctional Facility.

Very truly yours,

Cora K. Lum

CORA K. LUM
Acting Director

Hawai'i Dept. of Land & Natural Resources
Kamehameha Schools Bishop Estate
Hawai'i Dept. of Public Safety
Hawai'i Volcanoes National Park
U.S. Fish and Wildlife Service

`Ola`a - Kilauea Management Group
P.O. Box 52
Hawai'i National Park, HI 96718
(808) 985-6197
FAX (808) 985-6029

March 22, 1999

Ted Sakai
Director
Department of Public Safety
919 Ala Moana Blvd., Room 400
Honolulu, HI 96814

Subject: Draft Environmental Assessment for the Olaa – Kilauea Management Area Natural Resources Management Plan

Dear Director Sakai,

Thank you for your comments on the Draft Environmental Assessment (EA) for the Olaa – Kilauea Management Area Natural Resources Management Plan (letter from Cora Lum 11/19/98).

Your letter stated the Department of Public Safety's preference for a narrow one-lane access road adjacent to the proposed boundary fence.

We have prepared a Supplemental Draft EA (enclosed) which addresses the construction of such a road. This Supplemental Draft EA will be published in the April 8, 1999 Office of Environmental Quality Control Bulletin and comments are due by May 8, 1999.

Please call me if you have any questions and/or comments.

Sincerely,

Tanya Rubenstein

Tanya Rubenstein, Olaa – Kilauea Partnership Coordinator

BENJAMIN J. CAYETANO
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF PUBLIC SAFETY
KULANI CORRECTIONAL FACILITY
HC 01 Stainback Highway
Hilo, Hawaii 96720

TED SAKAI
DIRECTOR

MARIAN TSUJI
DEPUTY DIRECTOR

SIDNEY A. HAYAKAWA
DEPUTY DIRECTOR

PAULINE NAMUO
DEPUTY DIRECTOR

No. _____

Mary 20, 1999

Ms. Tanya Rubenstein
Ola'a-Kilauea Partnership Coordinator
Ola'a-Kilauea Management Group
P.O. Box 52
Hawaii National Park, Hawaii 96718

Dear Ms. Rubenstein:

Thank you for providing our Department with an opportunity to respond to the supplemental environmental impact assessment relative to the continued extension of enclosures surrounding our facility. The strong working relationship between the Ola'a-Kilauea Management Group and Corrections is obviously mutually beneficial.

We appreciate the inclusion of a boundary road in your plans for future pig fencing. As previously mentioned, a road that is adjacent to the proposed fencing would permit a more timely response to hunters who are penetrating our perimeters and allow us to more effectively find lost inmates or apprehend escapees. The planned road will also assist Kulani in repairing and maintaining a fenceline that will predictably suffer damages and erosion over time.

We appreciate your willingness to appreciate our requirements. Hopefully, Kulani is equally as important in meeting the needs of the Ola'a-Kilauea Group.

Sincerely,

Peter Mac Donald
Warden

PMD:gn

c: Ted Sakai, Director
Marian Tsuji, DEP-C
Clayton Frank, IDA

ʻŌLAʻA - KĪLAUEA MANAGEMENT AREA

Natural Resources Management Plan

Prepared by the ʻŌlaʻa – Kīlauea Management Group

U.S. Fish and Wildlife Service
Kamehameha Schools Bishop Estate
Hawaiʻi Department of Land and Natural Resources - Natural Area Reserves Program
Hawaiʻi Department of Public Safety - Kūlani Correctional Facility
National Park Service - Hawaiʻi Volcanoes National Park

June 1999

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I. EXECUTIVE SUMMARY

Landowners and managers realize large-scale ecosystem protection is difficult without a concerted effort to manage lands across land management and ownership boundaries. The cooperatively managed ʻŌlaʻa - Kīlauea Management Area on the island of Hawaiʻi offers an unparalleled opportunity to preserve a significant portion of a large, functioning native ecosystem and the endangered species that depend on it for survival. Additionally, this joint management program can serve as a model for future biological resource conservation efforts.

The ʻŌlaʻa - Kīlauea Management Area contains a diversity of native habitats and numerous rare and endangered species. The project area includes the Hawaiʻi Department of Public Safety's Kūlani Correctional Facility, the Hawaiʻi Department of Land and Natural Resources Puʻu Makaʻala Natural Area Reserve, the ʻŌlaʻa Tract of Hawaiʻi Volcanoes National Park, and Kīlauea Forest owned by Kamehameha Schools Bishop Estate. Managers of these project lands as well as representatives from U.S. Fish and Wildlife Service, U.S. Geological Survey's Biological Resources Division, and U.S. Forest Service meet regularly to make decisions about the direction of the project.

The overall goals of the ʻŌlaʻa - Kīlauea Management Group include enhancing long-term survival of native plant and animal communities and natural processes, maintaining a healthy forest ecosystem, protecting and managing a large contiguous area across ownership boundaries, and recovering rare and endangered species. At the same time, the group plans to continue certain existing land uses such as prison facility management and achieve other objectives compatible with ecosystem protection, such as public education, developing ecotourism opportunities, and providing correctional facility inmates with education and work training. Although the agencies and private organization that make up the partnership have different mandates, they all agree protection of this ecosystem can best be accomplished cooperatively.

This Natural Resources Management Plan describes the cooperative agreement that serves as the foundation of this management partnership, presents background information on the project area's ecological setting, and provides both an overview of the management and research programs as well as more detailed project statements that identify current and proposed projects. The management and research programs focus on the following areas:

- Determining ecosystem parameters that can serve as targets for management, and evaluating the current status of project area ecosystems relative to these parameters.
- Removing or reducing impacts from feral animals, alien plants and non-native predators.
- Restoring native habitat and species to enhance diversity and stability of native ecosystems.
- Monitoring the response of native and alien species to management and using the results of monitoring to further refine management and research strategies.
- Providing information and education to the general public and work training and education to Kūlani Correctional Facility inmates.

II. INTRODUCTION

A. Project Background and Objectives

The Natural Resource Management Plan for the ʻŌlaʻa - Kīlauea Management Area focuses on lands owned or controlled by the Hawaiʻi Department of Public Safety's (DPS) Kūlani Correctional Facility (KCF), the Hawaiʻi Department of Land and Natural Resources (DLNR) Puʻu Makaʻala Natural Area Reserve (NAR), the ʻŌlaʻa Tract of Hawaiʻi Volcanoes National Park (HVNP), and Kīlauea Forest owned by Kamehameha Schools Bishop Estate (KSBE) (Figures 1 and 2). The planning area totals approximately 32,000 acres (12,950 ha), and contains natural communities that are notable for their high degree of diversity.

The project area is considered essential habitat for four species of endangered forest birds, and the area also supports the endangered ʻio (*Buteo solitarius*), nēnē (*Nesochen sandvicensis*), Hawaiian hoary bat (*Lasiurus cinereus semotus*) and twenty-two rare plant species (Tables 1 and 2). Land uses include prison facility management, cattle ranching and domestic pig production, silviculture, public hunting and biological conservation. As a result, the native ecosystems are politically, and to some degree physically and biologically fragmented. Significant populations of feral pigs, alien plants and other introduced organisms are causing severe damage to many of the native forest communities.

In an effort to better protect the native biological resources of this area, landowners and other interested parties established a partnership to cooperatively manage the forest ecosystems. KSBE, DLNR, DSP, U.S. National Park Service (NPS), and U.S. Fish and Wildlife Service (USFWS) developed a cooperative agreement for the protection of the project area's public and private land as habitat for rare and endangered plants and animals. The partners held a signing ceremony in Honolulu on July 6, 1994, to celebrate completion of the cooperative agreement (see Appendix for the ʻŌlaʻa - Kīlauea Cooperative Agreement). The agreement includes the following commitments:

- To jointly develop a Natural Resources Management Plan to include, but not be limited to, feral animal and alien plant control measures, collaborative research projects, and habitat protection and restoration.
- To seek funding for cooperative efforts to implement planned activities.
- To exchange relevant information and research findings.
- To develop a plan for public hunting in selected areas as a management tool in monitoring and controlling feral pigs.

A Management Group of landowners and managers of these project lands as well as representatives from U.S. Geological Survey's Biological Resources Division (USGS-BRD) and U.S. Forest Service (USFS) meets regularly to discuss management strategies and make decisions about the direction of the project.

Figure 1. `Ola`a - Kilauea Project Area Location

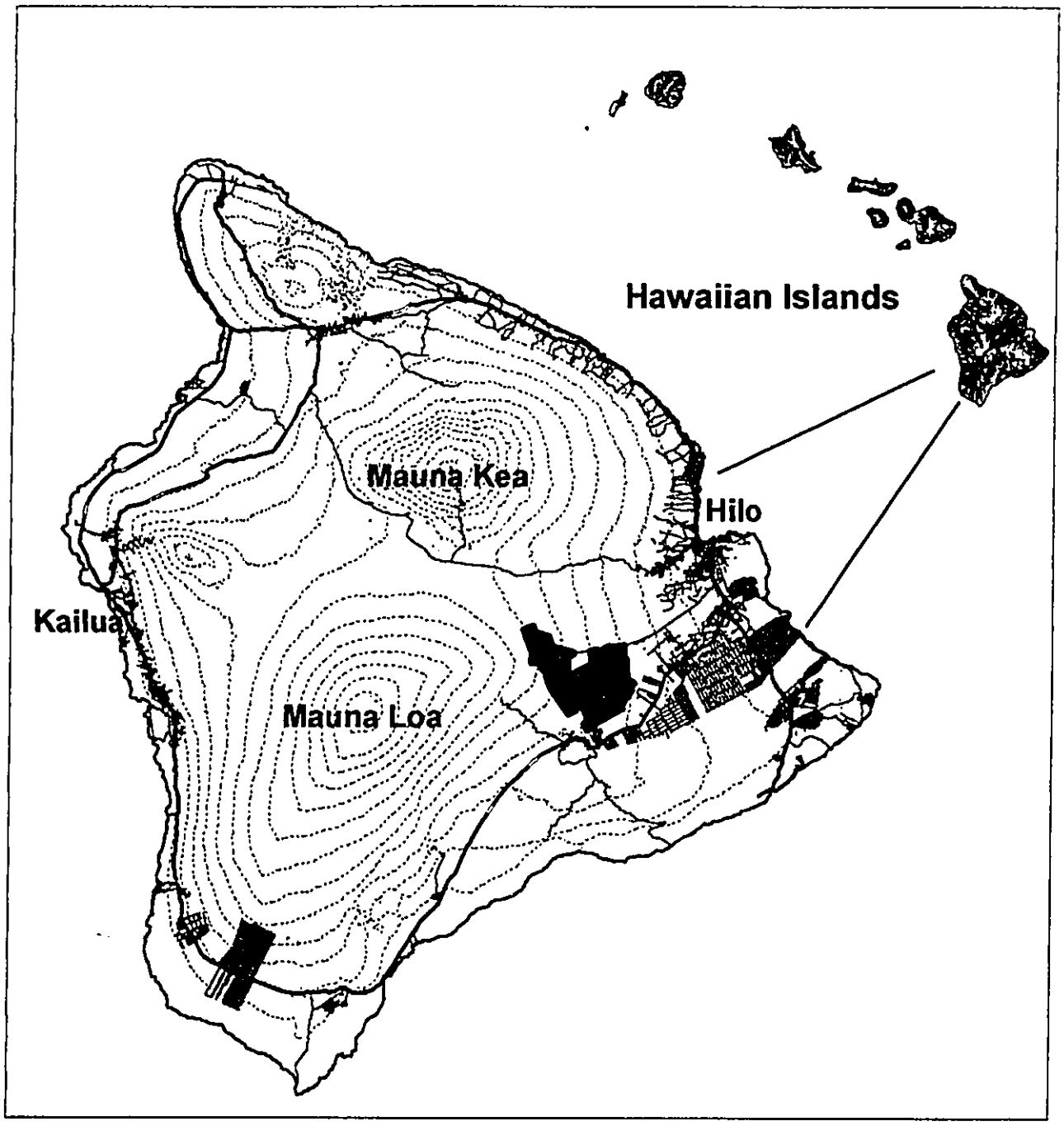
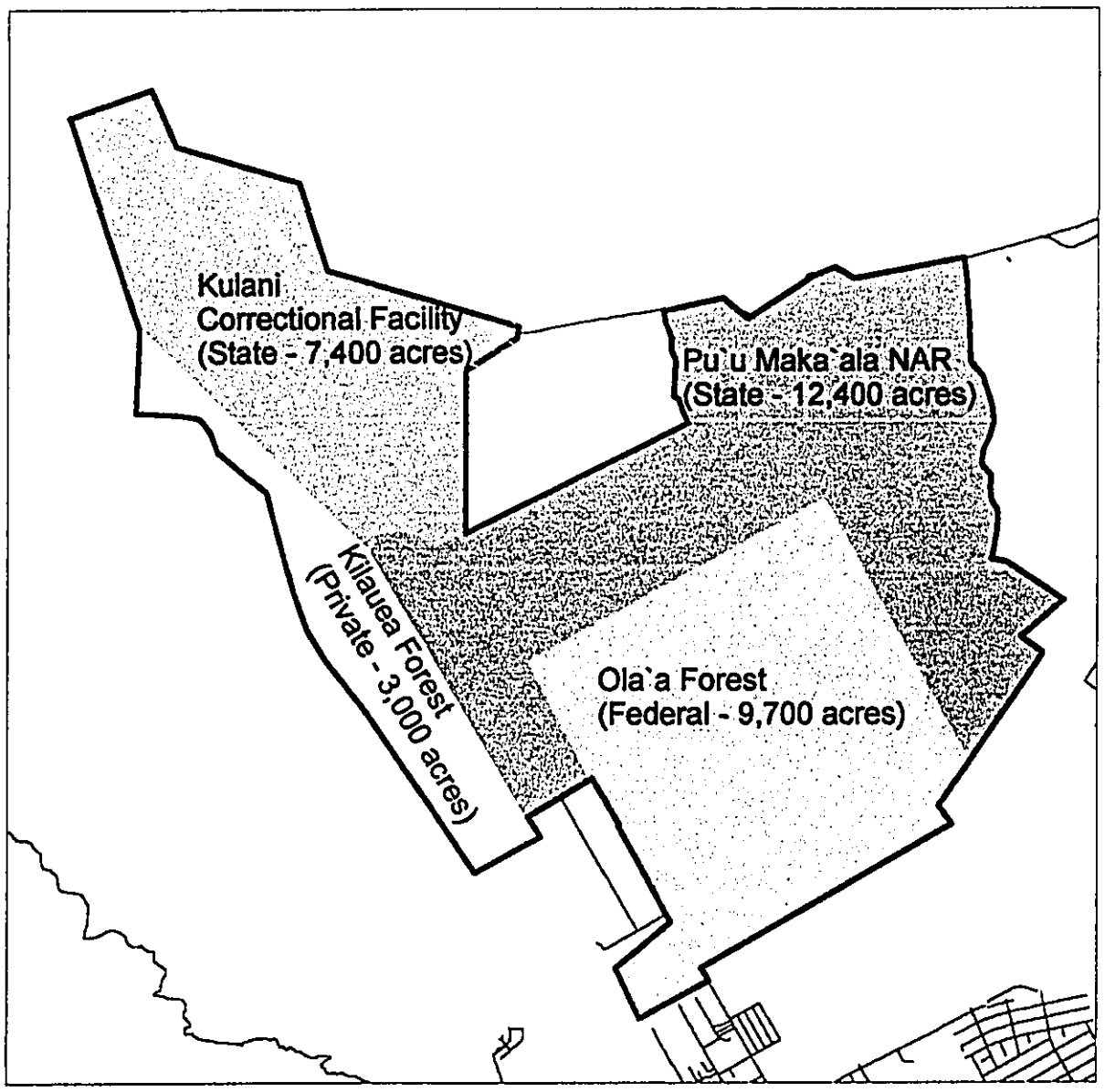


Figure 2. `Ola`a-Kilauea Project Area
Land Ownership and Boundaries



Map Legend

- Hawai`i Volcanoes National Park
- Kamehameha Schools Bishop Estate
- Hawai`i Div. of Forestry and Wildlife
- Kulani Correctional Facility
- Secondary Roads
- Ola`a-Kilauea Boundary

N

0 1 2 3 4 Miles

0 2 4 6 Km

B. Management Objectives

The overall objective of management in the project area is the protection and recovery of native ecosystems to the point that they are self-sustaining, native-dominated communities with secure populations of native plant, invertebrate and forest bird species. Long-term goals include perpetuation of natural evolutionary and ecological processes (e.g. speciation, colonization, succession), and maintenance of biological and genetic diversity.

To achieve this vision, management will generally follow a process of problem identification, management and evaluation. The Management Group will identify problems affecting native species stability based on past experience as well as a resource inventory of the current status of vegetation and native and alien species populations. Once critical problems are identified, the Group will determine possible management options and how to implement them. Management actions will help reduce or alleviate problems, and monitoring and evaluation will help us determine if we have reached our management objectives and/or how management should be changed.

Although the project was started in large part because of high numbers of rare and endangered species in the project area, management work will initially focus on a larger, ecosystem-level scale rather than intensive management of individual species. This ecosystem management approach is more cost effective and has potential for positive results on a large number of native species, both common and rare. Portions of the project area will be prioritized for management based on the quality of the native ecosystem because the probability of success is higher and costs are lower when the most intact and diverse resources are managed first. This approach is based on HVNP Special Ecological Areas (SEA) (Tunison and Stone 1992, HVNP 1996).

The management and research program will focus on the following five major areas:

- Determining ecosystem parameters that can serve as targets for management, and evaluating the current status of project area ecosystems relative to these parameters.
- Removing or reducing impacts from feral animals, alien plants and non-native predators.
- Restoring native habitat and species to enhance diversity and stability of native ecosystems.
- Monitoring the response of native and alien species to management and using the results of monitoring to further refine management and research strategies.
- Providing information and education to the general public and work training and education to Kūlani Correctional Facility inmates.

Initial management efforts will primarily be directed at the control of feral pigs and alien plants, which are the greatest known threats to the project area's native ecosystems. The highest priority management action is feral pig control. Fencing management units and eradicating pigs within those units has been shown to result in dramatic recovery of native vegetation, particularly

understory plants and tree ferns. Recovery of native vegetation improves habitat for native invertebrates and forest birds. Pig control also reduces mosquito breeding sites, decreasing the spread of avian malaria, one of the greatest threats to native birds. Pig control is a prerequisite to successful alien plant control in relatively pristine environments, because removal of feral pigs slows the establishment and spread of most alien plants. Unfortunately, some alien plants spread throughout native habitat and can completely alter native ecosystems even after pigs are removed. These disruptive species will be targeted for initial control efforts (HVNP 1996).

Other planned management projects are currently lower priority, either because they are focused on particular species or management techniques are still in the experimental stage (e.g. predator control). Activities such as restoration of rare plant species and predator control are becoming higher priority as objectives for feral pig and alien plant control are achieved and large, pig-free areas become available for more intensive management.

Current efforts in the education and information program are focused on Kūlani Correctional Facility inmates since inmates are providing most of the labor for large-scale fencing projects. Inmates are being trained in fence building and other conservation projects as well as identification of native Hawaiian plants and animals they encounter in their daily work. Eventually, the Management Group plans to develop educational programs for the general public such as interpretive trails, and increase use of volunteers for conservation projects in publicly accessible portions of the project area.

Most management activities will require ongoing effort in order to succeed. For example, feral pigs, alien plants and predators such as rats are likely to always remain external threats and will require continuing management to prevent ingress from surrounding areas. However, once major known threats to the ecosystem are controlled, the intensity of management activity and human intervention can be reduced. Healthy native ecosystems will be more resilient and capable of recovery after disturbance. Ongoing research and monitoring will assess the success of management and provide direction for future actions. Criteria for evaluating the success of management will include ecosystem structure (e.g. expected population structure of dominant and co-dominant plant species, vegetation layers dominated by native species, and a high diversity of woody and non-woody native plant species), self-sustaining populations of common and rare native plant and bird species, and alien species absent from the project area or at population levels that are not affecting native species.

Successful response of the ecosystem to management will be indicated by stable and increasing populations of rare and endangered species as well as maintenance of the more common plant and animal species that comprise the ecosystem matrix. As research and monitoring helps us gain an understanding of what constitutes a healthy native ecosystem, we will further refine our management activities. The Management Plan will be a dynamic document, and the ʻŌlaʻa - Kīlauea Management Group will reassess goals and objectives of the plan and success of specific projects on an annual basis.

III. DESCRIPTION OF NATURAL RESOURCES

A. Project Area Location, Climate, Geology and Soils

The project area is located on the eastern slope of Mauna Loa, along the volcano's active Northeast Rift Zone. It includes portions of South Hilo, Puna, and Ka'ū districts. Although the project area is on the windward side of the island, the area contains a broad range of habitats due to the elevational extent, range of moisture conditions, and mosaic of geologic ages and types. This variety of environmental conditions supports a high diversity of native plants and animals.

The elevation ranges from a bit below 3,000 feet (900 m) in the east to nearly 6,300 feet (2000 m) in the northwest. Annual median rainfall generally declines with rising elevation from about 190 inches (5000 mm) in the east to about 75 inches (2000 mm) in the west (DLNR 1982). Condensation from ground-level clouds (fog drip) contributes additional moisture at higher elevations. The moist side of an ecotone (a transition to drier conditions) runs along the western edge of the project area; otherwise the project area contains all wet habitats. Only the uppermost areas are subject to some seasonal nighttime freezing.

The area's geology is the greatest influence on environmental conditions. The project area contains a mosaic of over fifty surface flows, predominately originating from Mauna Loa. These flows range in age from 1942 to those over 10,000 years old. Pāhoehoe and 'a'ā flows, cinder cones, and tephra deposits (volcanic ashfalls) are surface types which provide a suite of different substrate conditions, especially with regard to drainage and soil type. Tephra deposits from Kīlauea volcano blanket about a quarter of the project area flows, and beneath that layer a small portion in the southwest has also been covered with Kīlauea flows. The northeast rift zone of Mauna Loa extends through the central half of the project area, along which are found at least ten Mauna Loa eruptive vents, usually evident by cinder cones or troughs (Wolfe and Morris 1996).

The range in soil conditions reflects the geologic parent material. Pāhoehoe, 'a'ā, cinders, and weathered ash provide differing contributions of minerals and drainage characteristics. Accumulations of organic matter in the soil and ground litter is the most important factor in soil development on these relatively young substrates. Naturally impaired drainage on some pāhoehoe flows or highly weathered ash deposits tend to further influence the vegetation type or dynamics in certain areas. In general, soil age and composition has considerable influence over plant community composition.

B. History and Current Land Use

The history of the project area and use by Hawaiians is not well documented. Although the project area has not been surveyed for archeological sites, few features are known to exist in the area. Trails, small forest shrines, burial caves and lava tube shelters are the types of features that might be revealed in the area by intensive surveys (USFWS 1990). The area may have been used

historically by Hawaiians for activities such as bird hunting and gathering forest plants for medicinal uses.

The parcels contained in the partnership agreement have different land use histories and current uses. Pu'u Maka'ala NAR and 'Ōla'a Tract of HVNP were both established with the primary purpose of protecting unique native ecosystems. The upper elevation half of 'Ōla'a Tract is designated for intensive management for the protection of native resources. Fencing, pig control, weed control and scientific research projects are ongoing in this portion of the park. Deputized public hunting is allowed in the lower half of 'Ōla'a Tract for pig control purposes. Pu'u Maka'ala NAR also has fenced units designated for intensive management, and public hunting is currently allowed throughout the unfenced portions of the NAR as a means to assist with pig control. Public access is allowed in both the NAR and 'Ōla'a Tract for other recreational and cultural uses including gathering of plant material.

Kūlani Correctional Facility was built in 1946 as an honor camp for prison inmates. The facility currently houses about 220 minimum security inmates with approximately 90 people employed at the site as correctional officers and civilian workers. Approximately 900 acres of Kūlani property are used in prison operations and related activities, including a piggery and cattle ranching. The purpose of these activities is to provide job training in agricultural industries to KCF inmates and beef and pork to KCF and other state correctional facilities. Other activities in the forest and pasture surrounding the facility include firewood cutting and maile collecting. The growing population of prison inmates in Hawai'i has lead to discussions of possible expansion of KCF.

Kīlauea Forest is owned by KSBE. The Estate is dedicated to managing its assets for the benefit of Kamehameha Schools and students of Hawaiian ancestry. KSBE has a license agreement for telecommunications uses on the summit of Kūlani Cone.

The entire project area is zoned Conservation District under Hawai'i Land Use law. Different parcels within the project area have different subzone designations. Conservation District rules restrict certain land uses (e.g. construction, harvesting or mining) and require DLNR approval or permits for other identified uses within particular subzones. Within the project area, Kīlauea Forest and Pu'u Maka'ala NAR are designated Protective Subzone. This designation is the most restrictive in terms of land use, with the primary objective being to protect valuable resources. 'Ōla'a Tract and most of KCF are designated Resource Subzone. The objective of this subzone is to ensure sustained use of the natural resources. The portion of KCF immediately surrounding the administrative buildings and inmate quarters is designated General Subzone. The objective of this subzone is to designate open space where specific conservation uses may not be defined, but where urban use would be premature (DLNR 1994).

Adjacent lands include the Upper Waiākea Forest Reserve, 'Ōla'a Forest Reserve and Keauhou Ranch, and adjacent land uses include watershed, hunting, residential and agricultural development, ranching and forestry.

C. *Plant Communities*

The ʻŌlaʻa - Kīlauea Project area is vegetated by various combinations of three dominant structural plants: ʻōhiʻa (*Metrosideros polymorpha*), koa (*Acacia koa*), and hāpuʻu or treefern (*Cibotium* spp.). Although different drainage characteristics of ʻaʻā and pāhoehoe flows complicate local moisture regimes, the general trend is from a dry-mesic habitat at the upper western sections of the project area to wet forest at the lower elevations to the east. The project area is a mosaic of different aged lava flows and plant communities that vary according to lava flow type and age. Another factor contributing to current plant community composition is disturbance by man, feral and domestic ungulates, and aggressive non-native plants (Jacobi and Warshauer 1996).

For the purposes of this plan, the project area is generalized into the following six native plant communities (adapted from Hawaiʻi Heritage Program 1989; Jacobi 1989; Gagne and Cuddihy 1990; Jacobi 1990) (Figure 3):

1) Wet ʻŌhiʻa /Hāpuʻu Forest - The largest portions of the project area contain ʻōhiʻa with other native trees and a hāpuʻu tree fern and native fern and shrub understory. Portions of the ʻōhiʻa forest canopy have undergone defoliation and regeneration (a natural phenomenon known as "ʻōhiʻa dieback") at various times. The resulting openings are generally filled with younger ʻōhiʻa, native trees and shrubs and hāpuʻu.

2) Wet Koa/ʻŌhiʻa Forest - Most of Kīlauea Forest contains tall stature koa and ʻōhiʻa with other native trees and a hāpuʻu, native shrub and fern understory. The wet and mesic koa forest communities are generally found on older substrates.

3) Mesic Koa/ʻŌhiʻa Forest - Portions of KCF contain tall stature koa/ʻōhiʻa forest with other native trees and a hāpuʻu tree fern, native shrubs and ground fern understory. This forest type differs from the wet koa/ʻōhiʻa in that wet forest tends to have higher densities of hāpuʻu than mesic areas, which have more native trees and shrubs in the understory. Unless disturbed, both forest types have a diverse ground cover dominated by ferns.

4) Mesic ʻŌhiʻa Forest - Portions of KCF contain plant communities composed primarily of open to closed canopy ʻōhiʻa and an understory of native trees, shrubs, ferns and grasses without the prominent hāpuʻu component. This community can be found on intermediate aged lava flows as well as on young lava flows in association with other pioneer vegetation.

5) Dry Native Shrub with scattered ʻōhiʻa - This plant community is found on younger lava flows, especially in the higher elevation, drier parts of KCF.

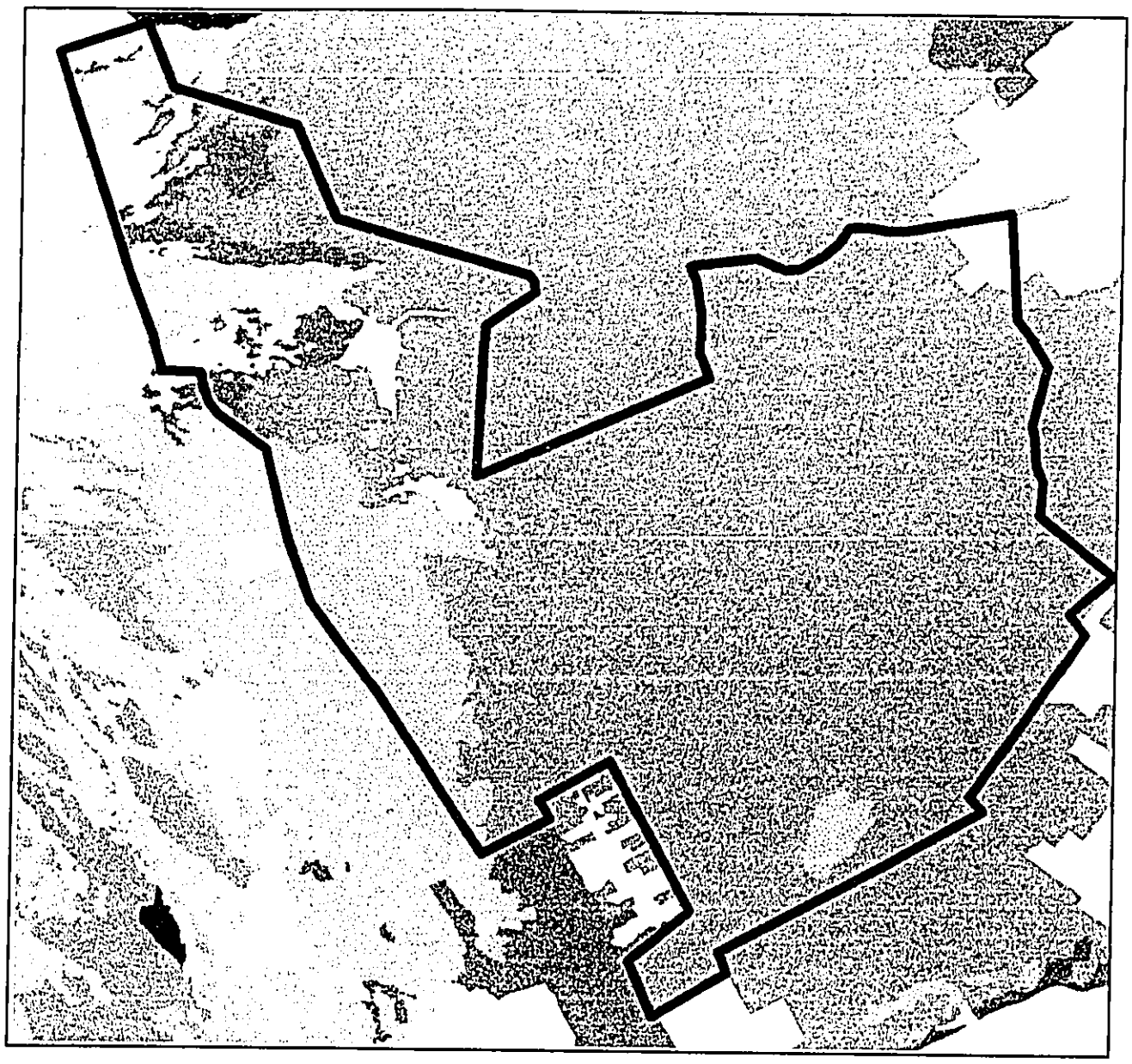
6) Dry ʻŌhiʻa Forest with mixed native trees and native shrub understory - This plant community is found on young to intermediate aged lava flows in the higher elevation, drier

parts of KCF. This community is intermediate in successional development between the previous two communities.

These six main plant communities tend to intergrade, as they are points along a successional continuum of maturing plant communities that develop in wet, mesic and dry conditions. Younger communities tend more to resemble drier communities than the older ones immediately adjacent. Older communities disperse propagules into nearby younger communities, hastening their successional development.

The project area also contains additional, less geographically extensive plant communities. The upper elevation, drier parts of Kūlani, particularly the Mauna Loa Boy's School area, contains low stature 'ōhi'a trees interspersed with native trees, shrubs and the native grass *Deschampsia nubigena*. Depressions in the lava flow surface collect water and have formed perennial "pocket bogs" containing native grasses and sedges (Jacobi and Warshauer 1996). Other small wetlands composed primarily of the sedge *Carex alligata* are scattered in small distinct patches throughout the project area, and are typically found in cinder cones or other forest depressions. The largest patches occupy craters on Kūlani Cone and Na Lua Mahoe. The project area also has pockets of non-native communities including plantings of tropical ash, redwood and pine (Hawai'i Heritage Program 1989).

Figure 3. `Ola`a -Kilauea Project Area
Vegetation Types



Map Legend

- Olaa Kilauea Project Area Boundary

Habitat Types Within Project Area

- Dry Native Shrub w/Ohia
- Dry Ohia Forest
- Mesic Koa/Ohia Forest
- Mesic Ohia Forest
- Wet Koa/Ohia Forest
- Wet Ohia/Hapuu Forest
- Other (Forestry Plantings, Kulani Facility)

0 2 4 6 Miles

0 2 4 6 8 Km

N

Scale 1:110,000

D. Native Fauna

Bird and Mammals

The project area provides habitat for seven honeycreepers (Subfamily Drepanidinae) endemic to the Hawaiian Islands. These include four endangered species: Hawai'i creeper (*Oreomystis mana*), Hawai'i 'ākepa (*Loxops coccineus*), 'ākiapōla'au (*Hemignathus munroi*) and 'ō'ū (*Psittirostra psittacea*), a species which has not been sighted in the area since the mid-1980's. The non-endangered honeycreepers found in the project area are the 'āpapane (*Himatione sanguinea*), 'amakihi (*Hemignathus virens*), and 'i'iwi (*Vestiaria coccinea*) (Scott et al. 1986; Jacobi and Warshauer 1996; and USGS-BRD, unpublished data).

Other native birds in the project area include the endangered Hawaiian hawk or 'io (*Buteo solitarius*), 'elepaio (*Chasiempis sandwichensis*), 'ōma'o or Hawaiian thrush (*Phaeornis obscurus*), nēnē (*Nesochen sandvicensis*), Hawaiian owl or pueo (*Asio flammeus sandwichensis*) and Pacific golden-plover or kōlea (*Pluvialis fulva*) (Scott et al. 1986; Jacobi and Warshauer 1996; and USGS-BRD, unpublished data). Additionally, the 'ua'u or dark-rumped petrel (*Pterodroma phaeopygia sandwichensis*) and the 'akē'akē or band-rumped storm petrel (*Oceanodroma castro*) overfly the project area to and from nesting areas on the upper, eastern slopes of Mauna Loa (USGS-BRD, unpublished data).

The project area has some of the highest densities of native forest birds areas on the island. This relative abundance is due to large tracts of intact, upper elevation native forest. Native forest birds are primarily found in the upper elevations of the project area where lower numbers of mosquitoes reduce the incidence of diseases such as avian malaria and pox.

The project area also contains a number of alien bird species. Alien birds may threaten native birds through direct competition, spread of disease and parasites and habitat alteration (spread of alien plants). The most common species in the project area include the red billed leothrix (*Leiothrix lutea*), northern cardinal (*Cardinalis cardinalis*), Japanese white eye (*Zosterops japonicus*), mynah (*Acridotheres tristis*), spotted dove (*Streptopelia chinensis*), kalij pheasant (*Lophura leucomelanos*), and house finch (*Carpodacus mexicanus*) (Jacobi and Warshauer 1996; USGS-BRD, unpublished data).

Hawai'i's only endemic land mammal, the 'ōpe'ape'a or endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*), also uses the project area (USFWS and USGS-BRD, unpublished data).

Invertebrates

The insect fauna of the canopy trees within Kīlauea Forest is predominantly native (over 75%) and relatively diverse. Hawai'i's native insects are especially interesting because certain groups

fill vacant ecological niches by adaptive shifts. For example, a suite of wet forest caterpillars, *Eupithecia* spp., are predaceous rather than herbivorous, making it different from most other caterpillar species in the world. Althought the lava tube caves in the project area have not been investigated, research in adjacent areas has documented a well-preserved cave fauna. Lava tube caves harbor specialized invertebrate species dependent on native forests above the caves (Mueller-Dombois et al. 1981).

Many endemic arthropods are not well studied or described, although may species face extinction with the rapid changes in their environment. (Mueller-Dombois et al. 1981). USGS-BRD has researched forest invertebrate communities in both ʻŌlaʻa Tract and Kūlani. Researchers are developing monitoring procedures for several groups of endemic invertebrates, including soil microarthropods, *Megalagrion* damselflies, and picture wing *Drosophila* flies. These data are being used to evaluate forest recovery after removal of feral ungulates (Foote and Carson 1995, HVNP 1996).

The project area's native insect fauna is intimately associated with native vegetation. The high diversity of native plants infer a correspondingly rich insect fauna, given the host specificity of many species. Many insects now recognized as rare or candidate endangered species have evolved specialized habitats and require one or a very few native plant species to complete their life cycle. The decline of many groups of native plants has probably contributed to the loss of their associated native arthropod communities. Endemic invertebrates also appear to be particularly sensitive to changes in the microclimate (e.g. forest clearing, pig digging and invasion of alien plant species). Another serious threat to native invertebrates in the project area is the invasion of the alien yellowjacket wasp (*Vespula pennsylvanica*). These wasps are voracious predators of numerous species of native invertebrates, and they have been implicated in the local extinction of two species of endemic *Drosophila* in ʻŌlaʻa Tract (HVNP 1996).

Mollusks have not been studied in the project area, but the endemic tree snail *Succinia* is relatively common in the native wet and mesic forest and shrublands on the island.

Table 1. Summary of Native Birds and Native Mammals Known From the Project Area

COMMON NAME	SCIENTIFIC NAME	STATUS*
Band-rumped storm petrel (ʻakēʻakē)	(*Oceanodroma castro*)	Uncommon
ʻĀkepa	*Loxops coccineus*	Endangered
ʻĀkiapōlaʻau	*Hemignathus munroi*	Endangered
ʻAmakihi	*Hemignathus virens*	Common
ʻĀpapane	*Himatione sanguinea*	Common
ʻElepaio	*Chasiempis sandwichensis*	Common
Hawaiʻi Creeper	*Oreomystis mana*	Endangered
ʻIʻiwi	*Vestiaria coccinea*	Common
Hawaiian Hawk (ʻIo)	*Buteo solitarius*	Endangered
Pacific golden-plover or kōlea	*Pluvialis fulva*	Common
Nēnē	*Nesochen sandvicensis*	Endangered
ʻŌmaʻo	*Myadestes obscurus*	Common
ʻŌʻū	*Psittirostra psittacea*	Endangered
Hawaiian Owl (Pueo)	*Asio flammeus sandwichensis*	Common
Dark Rumped petrel (ʻUaʻu)	*Pterodroma phaeopygia sandwichensis*	Endangered
Hawaiian Hoary Bat (ʻŌpeʻapeʻa)	*Lasiurus cinereus semotus*	Endangered

* Endangered means the species is officially listed as endangered by both the Federal and State governments.

IV. OVERVIEW OF PAST AND CURRENT MANAGEMENT AND RESEARCH ACTIVITIES

A. Past Research in the ʻŌlaʻa - Kīlauea Management Area

The biological resources of the ʻŌlaʻa - Kīlauea Management Area have been studied by a number of research programs over the past 20 years. This work has included projects conducted under the International Biological Program between 1970-1975, which included studies of vegetation composition and structure studies, bird populations, invertebrate populations, mammal populations, as well as the collection of detailed climatological information (Mueller-Dombois et al. 1981). The forest bird populations of these and adjacent areas were surveyed during the Hawaiʻi Forest Bird Survey in 1977 (Scott et al. 1986). Studies of habitat use and foraging behavior by native forest birds were conducted by the USFS during the late-1970's to mid-1980's (Sakai 1988; Ralph and Fancy 1994a, b, c, 1995, 1996). The Hawaiʻi DLNR conducted rare plant surveys in the Kīlauea Forest and Kūlani sections of the Management Area in 1979-1981 (State of Hawaiʻi 1983) and are currently monitoring native and alien plant

populations and pig impacts within the Pu'u Maka'ala Natural Area Reserve (Dunn 1992; NAR, unpublished data). Additionally, the NPS has conducted studies of the distribution and status of native and alien plant species, and impacts of feral pigs within 'Ōla'a Tract (HVNP 1996; Pratt and Abbott 1996; Pratt and Abbott 1997).

B. Threats to Native Ecosystems

Management in the 'Ōla'a - Kīlauea Management Area is currently primarily focused on major threats to the native ecosystem. The primary threats are invasion of non-native or "alien" plants and animals, including ungulates (hoofed animals), small mammals, alien birds, and pest insects. Alien species threaten the unique biota and biological diversity in Hawai'i with extinction, and they jeopardize natural evolutionary processes.

Hawai'i is besieged by an invasion of alien organisms. Although Polynesians introduced a few species when they arrived in Hawai'i, settlers from Europe, America and Asia greatly accelerated the colonization rates of species starting in the late eighteenth century. In recent years, rapid human population growth, large numbers of overseas visitors, and inadequate quarantine regulations contribute to the many deliberate and/or unintentional species introductions (HVNP 1996).

Alien species are particularly successful in Hawai'i because island organisms evolved in isolation from many of the strong selective forces that continually affect continental ecosystems. For example, the Hawaiian flora did not coevolve with ungulates and consequently lacks defenses against trampling, digging and browsing. Therefore, ungulates are particularly damaging to native vegetation and soils, and further create ideal conditions for establishment of alien plants. Moreover, Hawaiian biota did not evolve in the presence of ecologically important groups such as ants, colonial wasps, mammalian carnivores, and rats. These groups have been particularly disruptive in Hawai'i (HVNP 1996). Ongoing research in the project area is aimed at assessing the presence and impacts of the most damaging alien organisms.

The project area is also threatened by external development and its associated threats. Portions of the project area are surrounded by agricultural lots and subdivisions. Increased human population growth and associated development will decrease the forested buffer zone around the project area, bringing an increased influx of invasive alien pests such as feral cats, mosquitoes and alien plants (HVNP 1996).

Rare and endangered species are also threatened by the very fact that they exist in small numbers. Small numbers of populations and small population sizes reduce genetic variability making populations increasingly susceptible to inbreeding depression. Small populations are also more vulnerable to extinction from alien species damages as well as natural disturbances such as lava flows or storms (USFWS 1996).

C. *Fencing and Feral Ungulate Control*

The management goal for the feral ungulate program is to eliminate pigs from fenced management units, prevent pig ingress and minimize populations in unfenced areas. Feral pigs are found throughout the ʻŌlaʻa - Kīlauea Management Area in a variety of habitat types including rainforest, shrubland, native grassland, lava flows, and pasture. Populations are most dense in the remote rain forests with population densities of approximately 80 to 125 pigs per square mile. Although pigs are currently the most critical ungulate threat in the project area, another ungulate, the mouflon sheep is expanding its range toward the project area and is a potential future problem. Additionally, small numbers of feral goats are found in the drier habitats east of the project area and occasionally on the 1942 lava flow north of KCF.

Impacts of Feral Pigs - Feral pigs are the greatest current threat and main modifiers to existing native rain forest areas within the project area. Pigs consume and trample understory plants and soil invertebrates, create conditions for non-native plant infestation and establishment, prevent the establishment of native plants, serve as vectors for the dispersal of non-native plants (Smith 1985), and can change the large-scale functioning of native ecosystems (Vitousek 1992). Dispersal of seeds of banana poka (*Passiflora mollissima*) and strawberry guava (*Psidium cattleianum*) can be directly attributed to pigs. The spread of most other non-native species are enhanced by the disturbance of surface litter and soil, vegetation cover, and opening of the tree fern subcanopy. Pigs also create pockets of standing water through tree fern feeding and wallowing. Standing water provides breeding places for mosquitoes, enabling the transmission of avian malaria carried by mosquitoes to native birds. The cumulative effect of pigs is the decline of intact native forest ecosystems, including the decline of suitable habitat for threatened and endangered forest birds, plants, and invertebrates (Cooray and Mueller-Dombois 1981; Loope and Scowcroft 1985; Stone 1985; Stone et al. 1992; HVNP 1996).

Results of Pig Control – Wherever native vegetation has been subject to the removal of feral pigs, the result has been the recovery of native plants, particularly understory plants and tree ferns (Katahira 1980; Loope and Scowcroft 1985; Stone 1985). At HVNP, the recovery of native vegetation has been dramatic after pig removal, especially in areas with low weed densities at the time of pig control. Pig removal can also inhibit or suppress the spread of weed species. If pig control occurs in relatively pristine area, as represented in the ʻŌlaʻa - Kīlauea forests, cover or frequency of many weed species remains stable or actually declines. This has been demonstrated in several fenced pig-free units in ʻŌlaʻa Tract of the National Park (Pratt and Abbott 1997). In contrast, where pigs are not controlled, the cover of most weed species increases, particularly banana poka and yellow Himalayan raspberry (*Rubus ellipticus*) (LaRosa 1992; Stratton 1996). In addition, the presence of mosquito breeding sites decreases in pig-free fenced units (Lease et al. 1996).

Fence Construction - The construction of ungulate proof fences to exclude pigs is the first step in habitat restoration. The ultimate goal of fencing is to allow for control of feral pig populations within management units to zero density and monitor subsequent forest recovery.

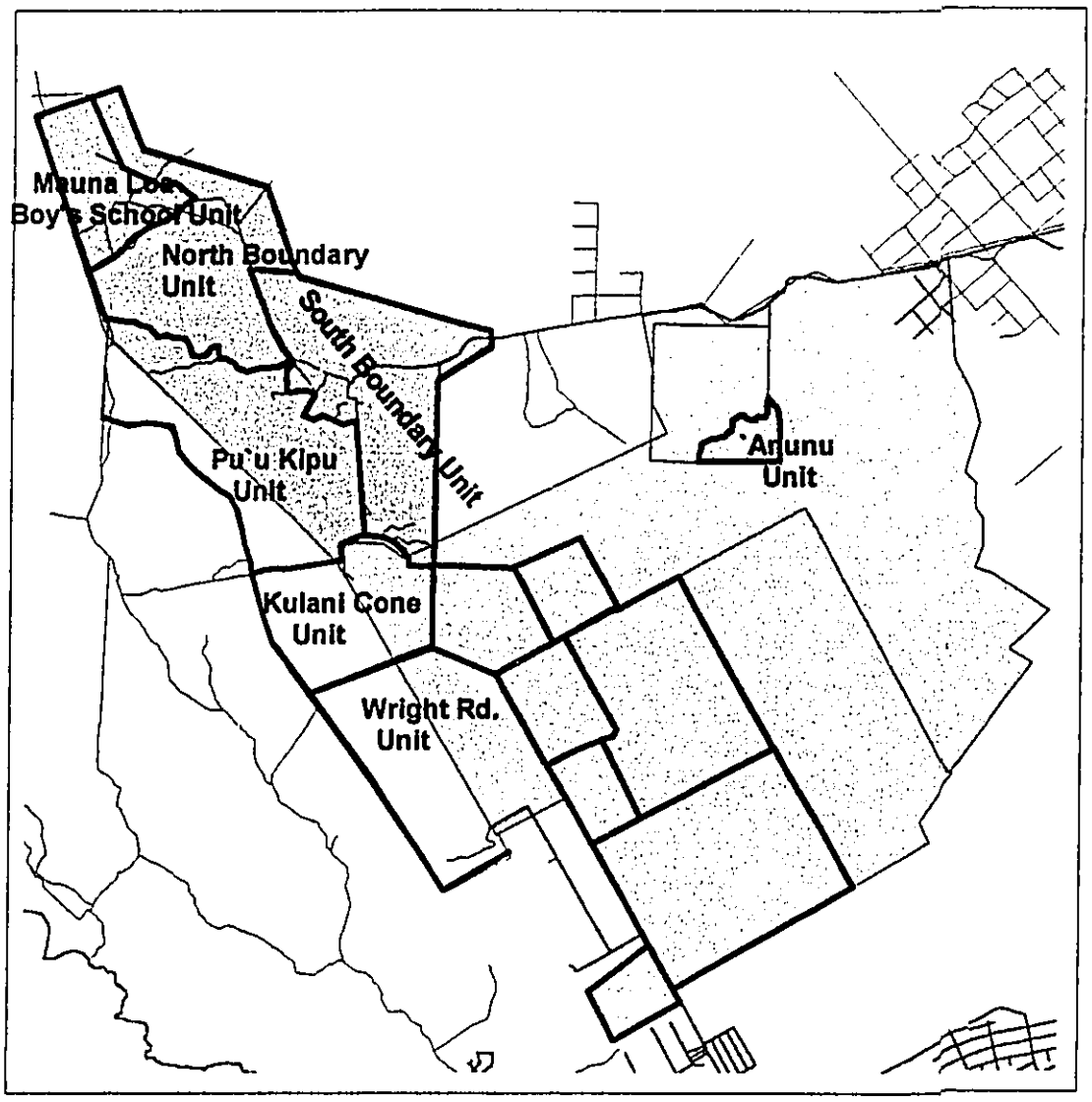
The proposed fencing projects will create a large network of contiguous, fenced management areas which can be used as recovery areas for native ecosystems and rare and endangered species (Figure 4).

The ʻŌlaʻa - Kīlauea Management Group has completed four major fencing projects to protect native habitat in the management area. These projects formed four management units that enclose over 5,000 acres. The units completed by the Management Group include Mauna Loa Boy's School Unit, Puʻu Kipu Unit, Kūlani Cone Unit, and Wright Road Unit. Other, previously completed fenced units in the project area that adjoin the units completed by the Management Group include five units in ʻŌlaʻa Tract (over 4,000 acres) and two units in Puʻu Makaʻala NAR (1,000 acres).

Pig Control Program - The pig control program is very costly, requiring establishment and monitoring of transects, intensive control efforts, and indefinite follow-up to detect ingress. Research in Hawai'i on pig control methods, except for methods which use toxicants, is complete and is largely published. Since 1981, HVNP has been successful in eliminating pigs from ten fenced units in the park totaling 19,000 acres. Control methods usually consist of repeated hunts with up to 18 dogs, intensive snaring, and occasionally trapping.

As the pig population is reduced, the cost of removing remnant animals increases significantly. However, due to the high reproductive rate (a population of pigs can potentially double every 4 months) it is necessary to eliminate all animals. Selection of control methods and strategies is based on transect monitoring, scouting, and necropsy data. Pig activity transects are monitored regularly to detect ingress, to determine the efficiency of the program, and to assess vegetation recovery. The presence or absence of pigs is detected by looking for signs such as droppings, rubs, tracks, vegetative damage, and wallows along the transect. In addition, staff analyze necropsy and aging data to gain insight on the population structure and habitat use of remnant pigs (HVNP 1996). All these measures are costly and require indefinite follow-up.

Figure 4. `Ola`a-Kilauea Management Area Existing and Proposed Management Units



D. Public Hunting Issues

The ʻŌlaʻa - Kīlauea cooperative agreement includes a commitment to develop a plan for public hunting in selected areas as a management tool in monitoring and controlling feral pigs. The Management Group is currently working with community groups and DLNR to develop a plan for hunting, ecosystem protection and other forest uses over a large geographic area, including areas outside of the ʻŌlaʻa – Kīlauea Management Area (e.g. Upper Waiākea Forest Reserve).

In early 1994, the DLNR's Division of Forestry and Wildlife (DOFAW) formed the Natural Areas Working Group (NAWG) to discuss and solve differences among the hunting community, government land managers, and the environmental community. Issues surrounding the use and management of forest resources on the island of Hawaiʻi have been a source of conflict for different interest groups for a number of years. These issues involve ungulate hunting, plant gathering, native ecosystem and species protection, management of ungulates for sustained hunting, and community involvement in land use planning. One of the key recommendations of the NAWG was to develop Regional Forest Management Advisory Councils (RFMACs). The RFMACs would allow communities to participate in discussions regarding the management, protection, and use of forested lands in their region. These regional councils have the potential of becoming effective vehicles for mobilizing communities, addressing community concerns, incorporating community ideas, generating support for projects, and developing and reviewing management plans. Another important goal of these groups is to inform and educate the community about the natural resources in their area (NAWG 1995). DOFAW organized the Upper Puna Volcano RFMAC, which encompasses the ʻŌlaʻa - Kīlauea Management Area, and ʻŌlaʻa – Kīlauea Management Group members currently participate in the meetings and planning effort. One of the primary goals of the Upper Puna Volcano RFMAC is to determine which lands should be used as public hunting areas and which lands should be set aside for ecosystem protection. Most native ecosystem managers acknowledge both the mutually exclusive nature of these conflicting land use priorities and the difficulty in deciding which lands are prioritized for each use.

The ʻŌlaʻa - Kīlauea Management Group feels portions of the project area are high priority for ecosystem protection and need active sustained management attention. Current fencing and pig control projects are taking place in these priority areas. The Management Group also feels some portions of the project area could sustain some degree of public hunting, and perhaps even be incorporated into a sustained yield game management area.

Areas currently available for public hunting within the project area include portions of Puʻu Makaʻala NAR and the lower elevation half of ʻŌlaʻa Tract. There are no plans to change the public hunting status of most of the NAR and of lower ʻŌlaʻa Tract. In fact, it has been suggested that lower elevation portions of Puʻu Makaʻala NAR are no longer of sufficient quality to be included in the NAR and should have an alternative designation, perhaps as an area for enhanced, sustained yield game management. Other areas have been open for public hunting

following fencing and prior to staff control efforts. These areas include the two fenced units in Pu'u Maka'ala NAR and the newest unit in 'Ōla'a Tract. The 'Ōla'a - Kīlauea Management Group is also open to discussions on alternative methods for pig control such as trapping. DOFAW trapped pigs for release in public hunting areas from both the Mauna Loa Boy's School and Pu'u Kipu Units prior to staff control, and the 'Ōla'a - Kīlauea Management Group is willing to work with DOFAW to develop plans for trapping in other areas designated for future pig control.

E. Alien Plant Distribution Mapping, Control and Monitoring

Management Goal - Protect the most intact native areas from disruptive alien plant species, and begin control efforts in these areas while alien species are still localized and manageable by conventional methods (e.g. manual control or control with herbicides).

Impacts of Alien Plants - The problem of alien plants invasion in native habitats is a well-recognized management problem in Hawai'i's natural areas. Certain alien plants displace native plants and are capable of converting native ecosystems to alien dominated vegetation, altering soil moisture, nutrient and fire regimes and reducing habitat for native species. Generally, the sustained pressure of ungulates is necessary for such ecosystem collapse, but a few alien plants appear to be able to seriously degrade native ecosystems alone once dispersed into an area (Smith 1985; Vitousek 1992).

Alien Plant Mapping, Control and Monitoring Program - Removal of ungulates from fenced units is a critical first step in alien plant control because it stimulates the recovery of native vegetation and slows or prevents the establishment of alien plants. It is also important to avoid and/or reduce the introduction and spread of alien plants by Kūlani staff, inmates, visitors and researchers and managers working in the 'Ōla'a - Kīlauea Management Area. 'Ōla'a - Kīlauea Management Group members will follow a strict protocol for the prevention of alien species introduction and increase educational efforts for all those working in the area.

Kūlani Correctional Facility and Kīlauea Forest will be the initial focus of alien plant mapping, and control. Pu'u Maka'ala NAR and the 'Ōla'a tract of HVNP already have personnel and funding designated for alien plant control work and have established monitoring and control programs. In addition, populations of the disruptive alien plant species at Kūlani and Kīlauea Forest are at relatively low levels, are localized in their distribution and can be controlled with less effort than widespread weeds prevalent in other areas. It is crucial to control these alien plants before they become more widespread via dispersal.

The alien plant control program will occur concurrently with fencing and pig control in both fenced and unfenced areas. The program will include distribution mapping of priority alien plants for control purposes, development of a control strategy, control using herbicide or manual methods and follow-up monitoring to determine the effectiveness of control efforts. Much of the research into effective mapping, control and monitoring techniques has already been done by HVNP and NAR

personnel (Tunison 1992), and members of the 'Ōla'a - Kīlauea Management Group will cooperate in sharing of techniques to avoid duplication of effort. Additionally, USGS-BRD plans to monitor the distribution of all alien plants species along transects in the Kūlani and Kīlauea portions of the project area to detect long-term change over time, assess overall health of the ecosystem, and help determine future management actions.

Herbicides are needed to control most target species because manual or mechanical control methods are not feasible in native or semi-native communities; most target species resprout when cut; and effective biocontrol agents are not available. Even species targeted for eventual biological control will be managed using other methods because considerable and possibly irreversible ecological damage may occur in the interim and because biocontrol has seldom been effective in Hawai'i.

The priority target species were selected on the basis of proven invasiveness in the 'Ōla'a - Kīlauea Management Area and/or similar habitats in other parts of the State. Additional species are likely to be added to this list in the future. The greatest current threats to the project area, and the focus of mapping and control efforts are *Rubus ellipticus* (yellow Himalayan raspberry) and *Passiflora mollisima* (banana poka).

Priority Alien Plants

Anemone hupehensis (windflower)
Clidemia hirta (Koster's curse)
Ehrharta stipoides (meadow ricegrass)
Hedychium coronarium (white ginger)
Hedychium gardnerianum (kahili ginger)
Hedychium flavescens (yellow ginger)
Hypericum kouytchense
Myrica faya (faya tree)
Paspalum conjugatum (Hilo grass)
Paspalum urvillei (vasey grass)
Passiflora mollisima (banana poka)
Pennisetum clandestinum (kikuyu grass)
Psidium cattleianum (strawberry guava)
Pyracantha angustifolia (firethorn)
Rubus argutus (blackberry)
Rubus ellipticus (Himalayan raspberry)
Rubus glaucus
Rubus niveus (hill or mysore raspberry)
Setaria palmifolia (palm grass)
Tibouchina herbacea (glory bush)
Tibouchina urvilleana (Lasiandra)
Tritonia crocosmiflora
Verbascum thapsus (mullein)

F. Avian Disease Assessment and Vector Control

Mosquito-vectored avian disease is believed to be the major cause for extinctions of some Hawaiian bird species and the continued decline of native Hawaiian forest bird populations (Scott et al. 1986). The vector mosquito is *Culex quinquefasciatus* and control strategies for avian malaria will need to be directed at this species. Recent research in the 'Ōla'a - Kīlauea Management Area by USGS-BRD researchers has focused on determining the distribution and disease vector potential of mosquitoes, the prevalence of pox and malaria in native and

introduced birds at different elevations, and the effect of reducing feral pig numbers on mosquito populations. Researchers mist-netted birds and sampled blood and collected mosquitoes in the Mauna Loa Boys School exclosure at Kūlani Correctional Facility from 1992-1994. They have also sampled mosquitoes inside and outside fenced, pig free exclosures in the 'Ōla'a Tract. The conclusions of the research are as follows (Atkinson et al. 1995; Lapointe 1996):

- Distribution of pox and malaria is dependent on elevation and mosquito abundance. Higher prevalences occur at lower elevations where susceptible hosts overlap with mosquito populations. At higher elevations, cool temperatures limit number of mosquitoes and inhibit development of malarial parasites in the vector. Transmission of both diseases is seasonal, with peaks during warmer months of the year between August and December when numbers of mosquitoes are highest.

- Primary reservoir hosts are native species, particularly 'ākepa. 'I'iwi have low prevalences of infection because of their high susceptibility to malaria, i.e. most die before they can be captured.

- Outbreaks are epizootic in nature, involving large numbers of susceptible birds. Researcher documented outbreaks in 1992 and 1994. Factors controlling these outbreaks are complex, involving rainfall, temperature and abundance of uninfected, susceptible hosts.

- Preferred breeding sites for mosquitoes are associated with fallen tree ferns that have been hollowed by pigs. Starch in the core of trees ferns is a major food source for pigs. Feral pig control can be an effective tool in reducing breeding sites and numbers of mosquitoes, but managed areas need to be as large and unfragmented as possible.

G. Predator Control

Small alien mammalian predators, particularly rats (*Rattus rattus, R. exulans)*, mongoose (*Herpestes aruopunctatus*) and cats (*Felis catus*) prey upon both ground and tree nesting birds. They also consume large quantities of insect prey, and vegetation; seeds, seedlings, and new growth on plants. These animals did not evolve with Hawai'i's endemic flora and fauna and since their introduction have been implicated in the extinction of many species. Their existence in native Hawaiian forests continues to threaten our native species (Stone 1985; HVNP 1996).

Following the New Zealand example, USFWS, DOFAW, U.S. Department of Agriculture/Animal and Plant Health Inspection Service/Animal Damage Control/Denver Wildlife Research Center (USDA/APHIS/ADC/DWRC), USGS-BRD, and KSBE obtained the registration of Eaton's Bait Blocks containing .005% diphacinone for use in conservation. This registration uses bait stations for predator control and is used throughout the islands with many different agencies. An increase in the number of young birds fledged in a season as a result of predator control is suggested by several studies, including DOFAW's work on the Oahu 'elepaio (VanderWerf 1997) and USGS-BRD work at Hakalau National Wildlife Refuge (USGS-BRD, unpublished data).

More efficient methods for predator control are needed if large areas of forest bird habitat are to be protected. Further research for management is needed to evaluate New Zealand's aerial method of predator control. The interagency Toxicant Working Group, working under the guidelines of the Environmental Protection Agency, continues to coordinate research priorities. Tests on palatability of a new 8-gram pellet are underway. Initial bucket tests for aerial application have been conducted with success, and further work needs to be completed on how well the new pellet penetrates forest canopy. Other needed research includes determining effective size of treatment area, reinvasion rates of predators, frequency of treatment intervals, and toxicant effect on the ecosystem. All diphacinone and other toxicant use will be in accordance with the registration requirements.

Continuing bird surveys in Kīlauea Forest will provide additional baseline information to determine success of future predator control work, and additional invertebrate and vegetation data would also be extremely valuable.

H. Vegetation and Plant Inventory and Monitoring

The vegetation of an area is one of the best indicators of ecosystem health or stability. Detailed information on vegetation provides data on both the structure and composition of the plant communities, as well as the degree to which the area has been invaded by alien species and the status of rare native species. Plant studies within the 'Ōla'a - Kīlauea Management Area will be directed toward three major objectives:

- Establish a baseline of the composition and structure of the major plant communities within the project area.

- Using the vegetation baseline, assess the condition of the plant communities within the project area and develop optimal parameters of crucial components of the vegetation (e.g., population structure of the dominant plant species, native ground cover species composition and diversity) that can be used as target criteria to evaluate the success of management actions upon.

- Monitor the response of the vegetation to management actions relative to these target criteria.

Studies under this topic to be conducted within the 'Ōla'a - Kīlauea Management Area include vegetation mapping, sampling of plant community structure and composition, and monitoring the change in both native and alien plant species over time. Some of this information is already available for portions of the project area. For example, the vegetation of the entire area has been mapped by Jacobi (1990) as part of the Hawai'i Forest Bird Survey. Additional maps have been prepared for portions of the project area including the National Park lands (Rhonda Loh, in preparation), and the distribution of ōhi'a canopy dieback (Jacobi 1993). A detailed investigation of the composition and structure of the vegetation in Kīlauea Forest Reserve was

done as part of the Hawai'i program of the International Biological Program (Mueller-Dombois et al., 1981). Studies of the distribution of rare species and selected alien plant species have also been conducted in the 'Ōla'a Tract and Pu'u Maka'ala sections of the project area (Dunn 1992; Pratt and Abbott 1996, 1997; NAR, unpublished data; NPS, unpublished data), and recently initiated in the Kūlani section (USGS-BRD, unpublished data).

The development of target ecosystem criteria is initially one of the most important components of this program. Using baseline data collected on the structure and composition of the vegetation, we can predict what the optimal values should be for critical components of these plant communities and use these values to develop target criteria that can be used to measure the success of management actions within the project area. For example, criteria are being developed for the necessary population structure of dominant plant species that will ensure their maintenance of dominance within the community over time. Additionally, we will develop targets for alien plant species within the management area. However, some alien plants (e.g., *Rubus ellipticus, Passiflora mollissima, Myrica faya, Hedychium* spp., and *Miconia calvescens*) pose such a great threat to the integrity of the ecosystems that every effort will be made to exclude them entirely from the project area.

l. Bird Population Monitoring

Many of the endemic forest bird populations have continued to decline over the past 50 years. Although most of the loss of native birds has occurred below 4,000 feet elevation, we are now seeing declines in populations of some species (e.g., 'i'iwi, 'elepaio, and 'ākiapōla'au) up to 5,000 feet elevation. It appears that two major causes of this decline in birds has been the upward expansion of the range of mosquitoes, and increases in the density and impacts of predator populations, particularly rats.

Information on population status and trends of Hawaiian forest bird populations is an extremely important tool for developing recovery strategies for rare bird species and overall conservation programs for the remaining Hawaiian ecosystems. The USFWS conducted an extensive survey of Hawaiian forest bird populations during 1976-1981 (Scott et al.). Since this survey, several bird surveys have been continued, but many of these have represented opportunistic sampling in selected areas. An integrated, long-term program of inventory and monitoring to determine population size and trends for Hawaiian forest birds does not currently exist. The 'Ōla'a - Kīlauea forests have been sampled through a variety of different project headings since 1991 (Earth Watch, Rare Bird Search and Survey Project, Audubon Christmas Bird Counts). These data provide valuable baseline information to evaluate the long term trends of native species to proposed management actions (feral ungulate removal, avian disease vector control, predator removal, and alien plant removal).

Currently, USGS-BRD is conducting surveys of endangered, native, and alien bird species once per year in Kūlani forest, and twice per year in Kīlauea Forest (with KSBE). Bird population trend information allows for an evaluation of changes in distribution and abundance over time which can be evaluated relative to active or inactive management programs. A sharp decline in

native species or an increase in alien bird species can be detected by this method, and may be an important indicator of need for additional management response to a new threat (e.g., increase in avian disease or predation) in an area.

J. Rare Plant Inventory, Monitoring and Recovery

The ʻŌlaʻa - Kīlauea Management Area contains 11 plant species officially listed as endangered and 11 considered species of special concern (Table 2). USFWS has prepared recovery plans for a number of these species (USFSW 1994, 1995,1996). Although portions of the project area have been surveyed for rare plants, large expanses have not been thoroughly searched and specific threats for many of these species are unknown.

Various portions of the project area have been surveyed for rare plants by researchers in the past. Botanists with the USFWS Hawai'i Forest Bird Survey went through the project area in 1977, locating a number of rare plants. NPS researchers systematically searched managed units of ʻŌlaʻa Forest, HVNP for rare plants in 1992-1994 and summarized information from previous search efforts and other miscellaneous observations (Pratt and Abott 1996). Puʻu Makaʻala NAR has been partially surveyed for rare plants by The Nature Conservancy and NAR staff (Hawai'i Heritage Program 1989). NPS and USFWS researchers have surveyed portions of Kīlauea and Kulani during bird surveys, fencing work and other incidental observations (Mueller-Dombois et al. 1981; State of Hawai'i 1983; Scott et al. 1986; USGS-BRD, unpublished data). USGS-BRD researchers are compiling data on current and historic distribution of rare plants in the project area in a GIS database.

The primary strategy for management of rare plant populations in the project area is to first protect large areas of native habitat by fencing and controlling pigs and alien plants. Concurrently, as rare plants are located, representative genetic material is often able to be collected and maintained at the Volcano Rare Plant Facility. In some instances spot fencing is erected for interim protection from ungulates. The protection of large expanses of intact native habitat is crucial for the long-term survival and recovery of rare species. As broad-scale management actions are incrementally completed, the Management Group will spend more time and effort on monitoring and implementing specific recovery actions for rare and endangered species.

Specific actions focused on rare plants will include additional searches and distribution mapping of individuals and populations, intensive monitoring of some species to assess potential threats such as rats and alien invertebrates, evaluation of forest stand structure and reproduction, and monitoring the results of management actions such as fencing and pig control. Some species may be adequately reproducing and require no further assistance while others may require human intervention to persist. Propagation and outplanting programs are being considered for some rare plant species that appear to be inadequately reproducing in the wild or for those in need to restoring genetic representation to the wild. The Volcano Mid-Elevation Plant Facility is available for propagation efforts.

All necessary state and federal endangered species permits for collection and propagation of rare plants have been or will be acquired and maintained.

Rare plants known from the project area are shown in Table 2. This list will be expanded as awareness of rare plants grows. Other depleted plants in the area are also expected to be used in restoration work.

Table 2. Rare and Endangered Plants (currently found or suspected to have previously occurred within the Project Area)

TAXON	COMMON NAME	STATUS *	LOCATIONS
Argyroxiphum kauense	ʻāhinahina, Kaʻu silversword	Endangered	Upper Waiakea Forest Reserve
Asplenium fragile var.*insulare*	No common name	Endangered	Kūlani
Asplenium schizophyllum	No common name	Species of Concern	ʻŌlaʻa
Clermontia lindseyana	ʻōhā	Endangered	Kūlani, Kīlauea
Cyanea shipmanii	hāhā	Endangered	Kūlani, Upper Waiakea Forest Reserve
Cyanea stictophylla	No common name	Endangered	Kūlani, Kīlauea
Cyanea tritomantha	ʻakū	Species of Concern	Puʻu Makaʻala, ʻŌlaʻa
Cyrtandra giffardii	No common name	Endangered	Kīlauea, ʻŌlaʻa, Puʻu Makaʻala, Kūlani
Eurya sandwicensis	ʻānini	Species of Concern	Puʻu Makaʻala
Joinvillea ascendens ssp. *ascendens*	ʻohe	Species of Concern	Puʻu Makaʻala, ʻŌlaʻa
Phyllostegia floribunda	No common name	Species of Concern	Puʻu Makaʻala, ʻŌlaʻa, Kīlauea
Phyllostegia racemosa	kīponapona	Endangered	Kūlani
Phyllostegia velutina	No common name	Endangered	Kūlani, Kīlauea
Plantago hawaiensis	laukāhi	Endangered	Kūlani
Phytolacca sandwicensis	pōpolo kū mai	Species of Concern	Kūlani, Kīlauea, ʻŌlaʻa
Rubus macraei	ʻākala	Species of Concern	Kūlani, Kīlauea
Sicyos alba	ʻānunu	Endangered	Puʻu Makaʻala, ʻŌlaʻa
Stenogyne macrantha	mōhihi	Species of Concern	Puʻu Makaʻala, ʻŌlaʻa, Kīlauea, Kūlani
Stenogyne scrophularioides	mōhihi	Species of Concern	Puʻu Makaʻala, ʻŌlaʻa
Tetraplasandra kavaiensis	ʻohe ʻohe	Species of Concern	Kūlani, ʻŌlaʻa
Trematolobelia grandifolia	koliʻi	Species of Concern	ʻŌlaʻa
Vicia menziesii	Hawaiian vetch	Endangered	Kīlauea

* Endangered – Listed as Endangered by both Federal and State governments. Species of Concern are considered rare and requiring further survey to determine status.

K. *Education and Public Outreach*

Current efforts in the education and information program are focused on Kūlani Correctional Facility inmates. Inmates are being trained in fence building and other conservation projects as well as identification of native Hawaiian plants and animals they encounter in their daily work. This program has been relatively informal, with scientists and managers from the Management Group leading field workshops for the Kūlani Conservation Workline. In the future, the Management Group envisions an expanded program for Kūlani Correctional Facility. This program would include classroom and field-based work in the scientific and cultural aspects of native Hawaiian ecosystems as well as practical, work-related training (e.g. training in horticultural and reforestation techniques for native plants, and training in the safe use of herbicides for alien plant control projects). An expanded program could include Kūlani Correctional Facility staff and additional inmates who are not on the Conservation Workline. Future projects at Kūlani Correctional Facility may include native plant landscaping in the vicinity of facility buildings and the development of interpretive trails for use by inmates and staff.

Eventually, the Management Group plans to develop educational programs for the general public such as interpretive brochures and trails, and increase use of volunteers for conservation projects in publicly accessible portions of the project area. Pu'u Maka'ala NAR and 'Ōla'a Tract are ideal settings for these types of programs. KSBE lands could potentially be used for environmental education programs for Kamehameha Schools students, and KSBE is also considering ecotourism possibilities for their lands.

HVNP is currently developing an environmental education program for the Big Island in partnership with the Hawai'i Department of Education, Department of the Army, DLNR and USFWS. A full-time Environmental Education Specialist will be hired to teach teachers and high school students about Hawai'i's biodiversity and threats to native ecosystems. The Education Specialist will work with land management agencies to provide 7th-12th grade students and their teachers with hands-on field research and management opportunities to educate them about Hawai'i's natural resources. The Education Specialist will also coordinate teacher workshops and community outreach projects on various Hawaiian ecosystems and environmental issues. The 'Ōla'a - Kīlauea Management Area will be an interegal part of this program, and can provide numerous training opportunities for both teachers and students.

V. PROJECT STATEMENTS

Project Statements describe specific ongoing and proposed management, research and education projects for the ʻŌlaʻa – Kīlauea Management Area and summarize project accomplishments.

This section includes two types of Project Statements - detailed one-page statements, and shorter descriptions of relevant projects done by NPS in ʻŌlaʻa Tract, NAR in Puʻu Makaʻala, as well as multi-island or island-wide projects with an ʻŌlaʻa - Kīlauea research component. This section also includes lists of potential future projects. All Project Statements will be updated on a yearly basis with a summary of accomplishments.

The Management Group will prioritize projects for funding on a case-by-case basis. Overall priorities follow the management objectives. Initial management efforts will primarily be directed at the control of feral pigs and alien plants, which are the greatest known threats to the project area's native ecosystems. Activities such as restoration of rare plant species and predator control will become higher priority as objectives for feral pig and alien plant control are achieved and large, pig-free areas become available for more intensive management. Research, particularly with management applications for alien plant control and other major ecosystem threats is also high priority.

A. *Summary of Ongoing and Proposed Management, Research and Education Projects*

MANAGEMENT PROJECTS				
ʻŌlaʻa – Kīlauea Project Coordination and Inmate Crew Supervision	NPS and KCF (CPSU)	Funded (FY98)	USFWS and NPS	$100,000
Feral Pig Monitoring and Control – Mauna Loa Boy's School Unit, Puʻu Kipu Unit, Kūlani Cone Unit and Wright Road Unit	NPS	Funded (FY98)	USFWS and NPS	$60,000
Fence Inspection and Maintenance for Mauna Loa Boy's School Unit, Puʻu Kipu Unit, and Kūlani Cone Unit	NPS	Funded (FY98)	USFWS and NPS	$12,000
Kūlani Boundary Fence Survey and Construction	NPS, KCF	Unfunded	–	$100,000 (total cost)
Puʻu Makaʻala Fence Construction – ʻĀnunu Unit	NAR	Funded	USFWS	$19,484 (total cost)
Alien Plant Mapping, Control and Monitoring for Kūlani and Kīlauea Forest	NPS (CPSU)	Funded (FY98)	NPS and USFWS	$55,000
Kūlani Bog and Open-forest Restoration: Rare Plants	USGS-BRD, DOFAW	Unfunded	–	To be Determined
ʻŌlaʻa - Kīlauea Management Area Rare Forest Plant Restoration	USGS-BRD, DOFAW	Unfunded	–	To be Determined
Feral Pig Control and Monitoring in ʻŌlaʻa Tract, HVNP	NPS	Funded (FY99 –FY01)	NPS special and base funds	$46,000
Fence Inspection and Maintenance in ʻŌlaʻa Tract, HVNP	NPS	Funded (FY98)	NPS base funds	$15,600
Manage ʻŌlaʻa Tract Special Ecological Areas (SEAs) for Feral Pigs and Alien Plants	NPS	Funded (FY98)	NPS special and base funds	$30,000

Monitor Vegetation in ʻŌlaʻa Tract SEAs	NPS	Funded (FY98)	NPS base funds	$30,000
Restore Kaʻū Silversword in HVNP	NPS	Funded (FY98-FY02)	NPS base funds	$15,000
Feral Pig Monitoring and Control in Puʻu Makaʻala NAR	DLNR-NAR	Funded (FY98)	DLNR-NAR base funds	$7,000
Alien Plant Monitoring and Control in Puʻu Makaʻala NAR	DLNR-NAR	Funded (FY98)	DLNR-NAR base funds	$7,000
RESEARCH AND INVENTORY PROJECTS				
Study Forest Bird Population Distribution and Abundance Over Time in Selected Portions of the ʻŌlaʻa - Kīlauea Project Area.	USGS-BRD	Funded (FY98)	USGS-BRD	$28,485
Study and Management of Small Mammalian Predators in Kīlauea Forest.	KSBE	Unfunded	_	$70,000
Test Alien Wasp Control Methods, and Study Non-Target Impacts of Control on *Drosophila* and Other Native Diptera.	USGS-BRD	Funded (FY98)	NPS and USFWS	$10,000
Breeding Ecology, Bionomics and Control of *Culex* Mosquitoes in Hawaiian Forest Bird Habitat.	USGS-BRD	Funded (FY98)	USGS-BRD and USFWS	$10,000
Efficacy and Non-target Effects of Aerial Applications of Larvicides to Control Mosquitoes in Forest Bird Habitat.	USGS-BRD	Funded (FY98)	USGS-BRD and USFWS	$23,031
Develop and Implement a Native and Alien Species Database for Kūlani and Kīlauea Forest.	USGS-BRD	Partially Funded (FY98)	USGS-BRD and USFWS	$15,000
Assess Alien Plant Distribution along Transects within Kūlani and Kīlauea Forest	USGS-BRD	Partially Funded (FY98)	USGS-BRD and USFWS	$30,000
Evaluate the Composition and Structure of Plant Communities within Kūlani and Kīlauea Forest with Emphasis on Assessing Changes Relative to Management.	USGS-BRD	Partially Funded (FY98)	USGS-BRD and USFWS	$65,000
Growth and Survival of Trees in a Hawaiian Montane Rain Forest.	USGS-BRD	Funded (FY96-FY00)	USGS-BRD and Nat. Geo.	$8,000

Loss of Invertebrate Diversity Associated with Rare Plants.	USGS-BRD	Funded (FY98)	NPS special funds	$35,000
Response of Vegetation, Soil and Litter Invertebrates to Pig Removal.	USGS-BRD	Funded (FY98)	NPS	$40,000
Weeds initiative - ʻŌlaʻa Tract Projects.	USGS-BRD	Funded (FY98)	USGS-BRD	$32,000
Test Small Mammal Toxicants – Wet Forest.	USGS-BRD	Funded (FY99-FY01)	NPS special funds	$70,000
Long-term Vegetation Monitoring in Puʻu Makaʻala NAR.	DLNR-NAR	Funded (FY98)	DLNR-NAR base funds	$5,000
Study Biocontrol of Himalayan Raspberry.	USGS-BRD	Unfunded	–	
Demography Studies and Breeding Success of the ʻIo (Buteo solitarius).	*USFWS*	Funded	USFWS	Not Available
Determining Short, Medium and Long-term Forest Health in the ʻŌlaʻa – Kīlauea Project Area Using Appropriate Measurement, Monitoring and Modeling Tools.	Proposed Project	Unfunded	–	To be Determined
EDUCATION AND INFORMATION PROJECTS				
Educational Program for Kūlani Correctional Facility Inmates and Staff.	NPS and KCF (CPSU)	Funded (FY98)	USFWS	$5,000
Develop an Interpretive Trail and Brochure for a Selected Area in Puʻu Makaʻala NAR.	Proposed Project	Unfunded	–	To be Determined
Native Plant Landscaping of Kūlani with an Educational Focus.	Proposed Project	Unfunded	–	To be Determined

B. *Management Projects*

1. ʻŌlaʻa – Kīlauea Project Coordination and Inmate Crew Supervisor.

2. Feral Pig Monitoring and Control – Mauna Loa Boy's School Unit, Puʻu Kipu Unit, Kūlani Cone Unit and Wright Road Unit.

3. Fence Inspection and Maintenance for Mauna Loa Boy's School Unit, Puʻu Kipu Unit, and Kūlani Cone Unit.

4. Kūlani Boundary Fence Survey and Construction.

5. Puʻu Makaʻala Fence Construction – ʻĀnunu Unit.

6. Alien Plant Mapping, Control and Monitoring for Kūlani and Kīlauea Forest.

7. Kūlani Bog and Open-forest Restoration: Rare Plants.

8. ʻŌlaʻa - Kīlauea Management Area Rare Forest Plant Restoration.

9. Feral Pig Control and Monitoring in ʻŌlaʻa Tract, HVNP

10. Fence Inspection and Maintenance in ʻŌlaʻa Tract, HVNP.

11. Manage ʻŌlaʻa Tract Special Ecological Areas (SEAs) for Feral Pigs and Alien Plants.

12. Monitor Vegetation in ʻŌlaʻa Tract SEAs.

13. Restore Kaʻū Silversword in HVNP.

14. Feral Pig Monitoring and Control in Puʻu Makaʻala NAR.

15. Alien Plant Monitoring and Control in Puʻu Makaʻala NAR

ʻŌLAʻA - KĪLAUEA MANAGEMENT GROUP - PROJECT STATEMENT

Project Title: ʻŌlaʻa – Kīlauea Project Coordination and Inmate Crew Supervision

Lead Individuals and Agency: Tanya Rubenstein (NPS-Cooperative Park Studies Unit) and Al Galimba (KCF-Cooperative Park Studies Unit)

Project Location: Hawai'i Volcanoes National Park and Kūlani Correctional Facility

Start Date: 1997
Completion Date: *Ongoing*
Project Status: Ongoing
Funding Status: Funded FY98 (USFWS and NPS)

Problem Statement: The ʻŌlaʻa – Kīlauea Project is a complex interagency project involving multiple landowners and numerous research and management projects. This project requires a biologist/coordinator for overall coordination to accomplish project and management objectives. In addition, a well-trained work crew is necessary to achieve significant on-the-ground conservation results. The Kūlani Correctional Facility Conservation Workline can provide a hard-working crew at very low cost provided a supervisor is available to train and supervise this crew.

Description of Recommended Project or Activity: The Project Coordinator develops and implements a natural resources research, monitoring and management program for the project area with the involvement of project partners. This includes drafting project plans to be included in the management plan, coordinating with agency and contractor participants in carrying out projects, monitoring species and habitat response to management actions, developing education programs for the inmate work crew and general public, and preparing reports summarizing the results of the projects. The Kūlani Conservation Workline Supervisor supervises and instructs a crew of 10-15 inmates in conservation projects such as fencing, alien plant control, reforestation and environmental education. This position is based at KCF.

Budget and Positions: This project has been primarily funded by USFWS ($204,000 in FY95-FY98) with administrative and additional operating support provided by NPS ($16,000 in FY98). Additional funds will be needed in FY99 to continue the project. Estimated annual cost for this project is as follows:

Salaries	$84,000
Operating	$16,000
TOTAL	$100,000

ʻŌLAʻA - KĪLAUEA MANAGEMENT GROUP - PROJECT STATEMENT

Project Title: Feral Pig Monitoring and Control – Mauna Loa Boy's School Unit, Puʻu Kipu Unit, Kūlani Cone Unit and Wright Road Unit

Lead Individuals and Agency: Larry Katahira, NPS

Project Location: Kīlauea Forest, Kūlani Correctional Facility and Puʻu Makaʻala NAR.

Start Date: September 1993
Completion Date: September 2001
Project Status: Ongoing
Funding Status: Funded – 1998 (USFWS and NPS)

Problem Statement: Feral pigs damage the native biota through rooting and wallowing, consuming tree ferns, displacing native understory plants, creating mosquito breeding sites, and causing conditions favorable for the spread and establishment of alien plant species. Removal of feral pigs will result in the recovery of native vegetation, an increase in native species diversity, reduction in the spread of alien plant species and reduction in mosquito breeding sites.

Description of Recommended Project or Activity: NPS staff will control and monitor feral pigs in the fenced Mauna Loa Boy's School, Puʻu Kipu and Kūlani Cone Units. NPS will establish transects for baseline sampling, semi-annual monitoring and follow-up monitoring to increase the success of control efforts. No active pig control by staff is anticipated in the Wright Road unit because pig activity appears low due to the close proximity of a public hunting area.

Summary of Accomplishments:

- 1995 – All pigs were removed from the 900 acre Mauna Loa Boy's School Unit. NPS will continue semi-annual monitoring to detect ingress and control pigs if necessary.
- 1997 – The Puʻu Kipu Unit fence was completed. DOFAW trapped and translocated pigs to a public hunting area during fence construction, and NPS is currently controlling pigs and monitoring this unit. It will take approximately three years to eradicate pigs in this unit.
- 1998 – The Kūlani Cone Unit fence was completed. NPS crews will monitor transects in this unit and control pigs. It will take approximately three years to eradicate pigs in this unit.

Budget and Positions: This project has been funded by USFWS ($150,000 in FY93) and NPS ($76,000 in FY97-FY98). Additional funds will be needed in FY99 to continue the project. Estimated annual cost for this project is as follows:

Salaries	$48,000
Operating	$12,000
TOTAL	$60,000

'ŌLA'A - KĪLAUEA MANAGEMENT GROUP - PROJECT STATEMENT

Project Title: Fence Inspection and Maintenance for Mauna Loa Boy's School Unit, Pu'u Kipu Unit, and Kūlani Cone Unit

Lead Individuals and Agency: Larry Katahira, NPS

Project Location: Kīlauea Forest and Kūlani Correctional Facility lands.

Start Date: September 1993
Completion Date: Ongoing
Project Status: Ongoing
Funding Status: Funded – 1998 (USFWS)

Problem Statement: Maintaining the integrity of existing fences is a high priority activity. Substantial amounts of money, time and effort have gone into building these fences and controlling pigs within fenced units. Maintaining pig-proof fences requires monthly fence maintenance and repairs. In addition, frequent emergency fence inspections and repairs are needed due to high winds, heavy rains and earthquakes. Neglecting these fences would lead to eventual pig ingress, neutralizing progress in pig control.

In addition to ongoing maintenance, fences must be completely replaced every 7-15 years due to deterioration caused by acidic volcanic fumes and high rainfall. NPS follows a long range fence replacement schedule to replace a few miles of fence each year. This is based on when fence was installed, type of material used, exposure to corrosive conditions, and ungulate threats.

Description of Recommended Project or Activity: Inspect and repair ungulate-proof fences every month (Mauna Loa Boy's School Unit, Pu'u Kipu Unit and Kūlani Cone Unit). These units contain approximately 20 miles of fence which requires two staff 3 days/month to inspect and maintain.

Budget and Positions: Funding for this project has been provided by USFWS, and NPS staff are doing regular fence inspections and maintenance. Annual cost includes personnel and operating equipment (vehicles, chainsaws, miscellaneous fencing supplies and materials). Additional funds will be needed in FY99 to continue this project. Estimated annual cost for this project is as follows:

Salaries	$9,600
Operating	$2,400
TOTAL	$12,000

'ŌLA'A - KĪLAUEA MANAGEMENT GROUP - PROJECT STATEMENT

Project Title: Kūlani Boundary Fence Survey and Construction

Lead Individual and Agency: Larry Katahira, NPS and Peter MacDonald, KCF

Project Location: Kūlani Correctional Facility

Start Date: September 1998 Completion Date: September 1999
Project Status: New Project Funding Status: Unfunded

Problem Statement: Additional fences need to be constructed to create new management units to protect the project area's remaining high quality native forest from the devastating impacts of feral pigs. Following fencing, pig and alien plant control need to be implemented immediately.

Description of Recommended Project or Activity: The following fencing projects are the final phases of a comprehensive pig control program for KCF. These projects will enclose the remaining pig habitat in Kūlani allowing alien plant and pig control activities to proceed.

- Survey Kūlani Boundary - Prior to construction, the eastern KCF boundary of approximately 10 miles need to be surveyed. The survey will allow for the construction of two fenced management units. In addition, this survey and fence alignment will delineate a physical land boundary for KCF and provide KCF access for security purposes. Two options are proposed to survey approximately 10 miles. The first option is for licensed State surveyors to conduct this project. The second option is for trained field biologists to determine boundaries using a hand-held GPS from known boundary survey stakes.

- Construct North KCF Boundary Unit - This is the highest fencing priority because this unit contains greater diversity and greater numbers of rare and endangered plants and birds. Approximately 5 miles of fence are needed to enclose approximately 2,000 acres of forest. This unit will connect with the Mauna Loa Boy's School and Pu'u Kipu Units.

- Construct South KCF Boundary Unit - This unit will be fenced following completion of the North unit. KCF inmates will construct the 5 miles of fence to enclose approximately 2,000 acres of forest. This unit will connect with the North Boundary and Pu'u Kipu Units.

Budget and Positions: KCF inmates will provide labor for clearing and fence construction. USGS-BRD personnel are available to survey the KCF boundary using GPS, and can also survey the fence corridor for rare plants. Cost for fencing materials (10 miles) is $100,000

ʻŌLAʻA - KĪLAUEA MANAGEMENT GROUP - PROJECT STATEMENT

Project Title: Puʻu Makaʻala Fence Construction – ʻĀnunu Unit

Lead Individual and Agency: Bill Stormont, DOFAW-NAR

Project Location: Puʻu Makaʻala NAR

Start Date: September 1998 Completion Date: December 1998
Project Status: In Preparation Funding Status: Funded (USFWS)

Problem statement: Feral pigs pose one of the greatest threats to existing intact native wet forest areas. The area proposed for fencing is home to one of three known remaining individuals of the endangered ʻānunu, or *Sicyos alba*, a native member of the cucumber family, as well as several other very rare plant species. Additionally, this fence will surround a pocket of forest characterized by taller statue ʻōhiʻa trees, high species diversity, and higher densities of plants such as olonā (*Touchardia latifolia*) and loulu palm (*Pritchardia beccariana*), not commonly found in other areas of the NAR.

Description of Proposed Project or Activity: This project is part of ongoing efforts to protect native forest ecosystems, and rare and endangered flora and fauna. This project will incorporate a pocket of unique forest as well as protect an extremely rare plant. In addition to the biological value of this proposed unit, this project is supported by the Upper Puna Volcano RFMAC, a community group consisting of representatives from hunting organizations, the environmental community, government land management agencies, community associations, landowners, the forest industry, and cultural practitioners and gatherers. This fenced area also has the potential to be a valuable area for environmental education and interpretation of natural resources for the general public.

This 16,700 ft fence will run along existing four-wheel drive roads (two-thirds of line) and through a portion of undisturbed forest, creating a 290 acre fenced area. The proposed fence is approximately one mile south of Stainback Highway, adjacent to a four-wheel drive road named both "Army" and "Disappointment" road. The ultimate goal of the project is to completely exclude feral pigs from within the fenced area.

Budget and Positions: Fence corridor clearing and construction will be done by NAR Program staff, volunteers and the KCF inmate work crew. USFWS provided $19,484.00 to purchase fencing materials.

'ŌLA'A - KĪLAUEA MANAGEMENT GROUP - PROJECT STATEMENT

Project Title: Alien Plant Mapping, Control and Monitoring for Kūlani and Kīlauea Forest

Lead Individual and Agency: Tanya Rubenstein, HVNP-Cooperative Park Studies Unit

Project Location: Kūlani Correctional Facility and Kīlauea Forest

Start Date: January 1997
Project Status: Ongoing

Completion Date: Ongoing
Funding Status: Funded – 1998 (NPS)

Problem Statement: Kūlani and Kīlauea Forest are currently relatively free of native-habitat altering alien plant species. Localized alien plants (species with small, localized populations) should be controlled to preclude costly control programs in the future. This project will help prioritize alien plant control efforts, reduce the size of alien plant populations and slow or prevent alien plant encroachment into intact native ecosystems.

Description of Recommended Project or Activity: Distribution mapping of priority alien plant species is needed to develop control strategies, and to locate all populations of a target species to assure that every plant is treated once a control program starts. An overall control strategy and prioritization of species and areas for control will be developed using distribution mapping information. Manual/mechanical and herbicidal means will be used to control alien plants. Species targeted for immediate control include yellow Himalayan raspberry (*Rubus ellipticus*) and banana poka (*Passiflora mollissima*). Target alien plant populations and associated vegetation will be monitored to determine the effectiveness of control treatments and the possible need for follow-up control. The rate of spread of some alien species and their impacts on other vegetation will also be monitored to determine the need for control.

Summary of Accomplishments: NPS funded part-time technicians and crew for *Rubus ellipticus* mapping and control in 1997 and 1998. Personnel mapped portions of Kūlani and Kīlauea and controlled plants in priority areas.

Budget and Positions: The 'Ōla'a – Kīlauea Project Coordinator, technicians and volunteers will carry out most work with assistance from NPS and NAR staff . The Kūlani inmate crew will also work on particular alien plant control projects. Funding needed for this project is for technicians, field crew and operating costs. Additional funds will be needed in FY99 to continue this project. Estimated annual cost for alien plant control is as follows:

Salaries	48,000
Operating	7,500
TOTAL	$55,500

ʻŌLAʻA - KĪLAUEA MANAGEMENT GROUP - PROJECT STATEMENT

Project Title: Kūlani Bog and Open-forest Restoration: Rare Plants.

Lead Individuals and Agency: Rick Warshauer and Jim Jacobi, USGS-BRD;
Lyman Perry, DLNR-DOFAW.

Project Location: Kūlani Correctional Facility

Start Date: To be Determined
Completion Date: To be Determined
Project Status: New Project
Funding Status: Unfunded

Problem Statement: Extended pig activity has damaged the pocket bogs of upper Kūlani and a few bog-associated plants have been totally eliminated or depleted. Now that feral pigs have been removed from the Mauna Loa Boys School Unit, recovery of the numerous pocket bogs is under way. Experimental management can accelerate recovery by replacing some of the depleted species and controlling certain alien plants. Restoration activities can assist in the recovery of two endangered bog species and several other rare bog plants.

One of the most important species to restore into the Kūlani pocket bogs is the Mauna Loa silversword (*Argyroxiphium kauense*). This species formerly extended around windward Mauna Loa in patches of upper elevation habitat. The species is now on the verge of extinction, and is known only from three sites. In addition to the recent threats from feral pigs and mouflon sheep, the plants are threatened by volcanic activity. Multiple recovery sites will be necessary to mitigate likely future lava flow coverage of some of the restored populations.

Exclosure fences are vital to silversword survival and recovery. In addition to Kūlani's fenced habitat, HVNP will be expanding their upper fences and starting outplanting, and DOFAW will be expanding the small upper Waiākea exclosure that has prevented the loss of that population. Recovery efforts could start at both large exclosures and should be extended elsewhere as more sites become ungulate free. Recovery efforts are being designed and implemented by the interagency Silversword Working Group.

Description of Proposed Project or Activity: Proposed restoration activities at selected pocket bogs and open-forest areas at Kūlani would involve (a) removal of certain alien plants (hand weeding, heat treatments, and/or shadecloth), (b) representative field collection of seeds or other propagules of various depleted native bog species; (c) growing of seeds, cuttings, and other propagation material at the Volcano Rare Plant Facility (VRPF) of the plants to supply seeds and seedlings for planting; (d) direct seeding back into selected bogs, especially to still-barren pig damaged soil; (e) direct transplanting from the VRPF and/or original wild field sites, especially into barren pig damaged or weed-cleared soil; (f) monitoring the pace of recovery, and watching for unforeseen complications to recovery.

Budget and Positions: To be determined

ʻŌLAʻA - KĪLAUEA MANAGEMENT GROUP - PROJECT STATEMENT

Project Title: ʻŌlaʻa - Kīlauea Management Area Rare Forest Plant Restoration.

Lead Individuals and Agency: Rick Warshauer and Jim Jacobi, USGS-BRD;
Lyman Perry, DLNR-DOFAW.

Project Location: ʻŌlaʻa - Kīlauea Management Area lands.

Start Date: To be Determined
Completion Date: To be Determined
Project Status: New Project
Funding Status: Unfunded

Problem Statement: The project area has a range of forest habitats and rare plant species, including *Cyanea shipmanii, Cyanea stictophylla, Cyanea tritomantha, Clermontia lindseyana, Vicia menziesii, Phyllostegia racemosa, Phyllostegia velutina, Sicyos alba, Asplenium fragile var. insulare, Asplenium schizophyllum, Tetraplasandra kavaiensis, Stenogyne scrophularioides, Stenogyne macrantha, Urera glabra, Joinvillea ascendens* ssp. *ascendens, Eurya sandwicensis,* and *Rubus macraei.* Depleted species identified so far as candidates for supplemental planting include *Phytolacca sandwicensis, Rumex giganteus, Peperomia macraei, Cyrtandra lysiosepala,* and *Labordia hedyosmifolia.* Most of these taxa have some individuals or populations already located, and most have trial individuals in cultivation at Volcano Rare Plant Facility (VRPF). There is an opportunity to initiate recovery efforts for these plants in the project area's fenced management units. Some species may not recover without such active recovery efforts.

Description of Proposed Project or Activity: Initial activities involve the location of rare species to define their habitat types and to identify specific locations appropriate for their recovery. Additionally, collections of propagation material from as many of populations and individuals as possible will ensure maximum remaining genetic material is included in recovery actions. Collection of genetic material should be expanded beyond the project area to increase its effectiveness.

Propagation and outplanting will include various experimental applications of simple technology in strategic manner and in alliance with several cooperators. Studies may be needed to determine additional limiting factors (e.g., predation by slugs or rats, impaired pollination), and to test if such threats might be overcome in different outplanting densities. Studies should be able to be incorporated into the design and implementation of the recovery efforts. Such applications can be supplemented by more complex technologies (e.g., DNA analyses of remnant and outplant genetic variability) if needed on a species by species basis. Labeled plantings within outplant populations could be used for demographic monitoring in order to assess long-term recovery potential, for optional manual pollination if needed, and for seed collection should additional stock be desired. The recovery efforts could also include management recommendations aimed at setting up self-sustaining outplanted populations.

Budget and Positions: To be determined

ʻŌLAʻA - KĪLAUEA MANAGEMENT GROUP - PROJECT STATEMENT

This section contain shorter project statements for ongoing projects done by NPS in ʻŌlaʻa Tract, NAR in Puʻu Makaʻala, as well as multi-island or island-wide projects with an ʻŌlaʻa - Kīlauea component. This section also includes lists of potential future projects.

NPS MANAGEMENT PROJECTS

Feral Pig Control and Monitoring in ʻŌlaʻa Tract, HVNP – Pigs have been removed from four ʻŌlaʻa Tract units (Small Tract, Puʻu Unit, Ag Unit and Koa Unit) totaling 3,420 acres. In 1998, NPS completed the last fence planned for construction in ʻŌlaʻa Tract enclosing a 2,000 acre unit. The four older units are regularly monitored for pig ingress once per year. Control work in the new unit will begin in FY99, and eradicating pigs from the new unit will take approximately three years. This project is completely funded by NPS base funding and Natural Resource Protection Program (NRPP) funds ($40,000 for the first year of pig control in the new unit). Estimated annual costs for salaries and operating expenses are as follows:

Monitoring	$ 6,000
Pig Control	$40,000
TOTAL	$46,000

Fence Inspection and Maintenance in ʻŌlaʻa Tract, HVNP –ʻŌlaʻa Tract contains five fenced units. These fences are inspected and maintained once per month. This project is completely funded by NPS base funding. Estimated annual costs for salaries and operating expenses are as follows:

Salaries	$12,600
Operating	$ 3,000
TOTAL	$15,600

Manage ʻŌlaʻa Tract Special Ecological Areas (SEAs) for Feral Pigs and Alien Plants – SEAs are portions of HVNP selected for their intactness, uniqueness, species richness, presence of rare species and manageability. In SEAs, all disruptive feral ungulates and alien plants are controlled. Several fenced portions of ʻŌlaʻa Tract are currently designated as SEAs by HVNP and are actively managed for alien plants (Small Tract, Puʻu Unit and the western half of Koa Unit). The other ʻŌlaʻa Tract units are potential future SEAs. Control of priority alien plants involves setting up search blocks, systematically searching the area and treating priority alien plants every 3-4 years. In most cases this results in declining weed populations and workloads. Follow-up treatments are needed indefinitely because of recruitment from the seed bank and dispersal from outside areas. Alien plants have been controlled in Small Tract since 1985, and control efforts for Puʻu Unit and Koa Unit will begin in FY98. This project is completely funded by NPS base funding (follow-up treatments) and Natural Resource Protection Program (NRPP) funds ($80,000 for the initial treatment of Puʻu Unit and Koa Unit). Estimated annual costs for salaries and operating expenses are as follows:

Initial treatment – Pu'u Unit and Koa Unit	$80,000 ($20,000/year follow-up)
Follow-up treatment- Small Tract	$10,000
TOTAL	$100,000

Monitor Vegetation in 'Ōla'a Tract SEAs – This project will quantify the spread of key alien plant species and their effects on native plant communities along transects in fenced units of 'Ōla'a Tract. This information will help future alien plant control efforts. In addition, permanent plots in the Koa Unit have been set up for long-term monitoring of vegetation changes after pig removal. In FY98, NPS staff did baseline monitoring of transects in the new 'Ōla'a Tract unit for alien plants. Native and alien vegetation in permanent plots in the Koa Unit were also monitored as part of a long-term monitoring program. These plots will be monitored every five years. Estimated annual costs for salaries and operating expenses are as follows:

Alien Plant Monitoring	$20,000
Permanent Plots	$3,000 (every 5 years)
TOTAL	$23,000

Restore Ka'ū Silversword in HVNP – NPS is working with State, Federal and private partners to restore Ka'ū silversword. HVNP plans to establish at least two large populations of outplanted Ka'ū silversword in HVNP in protected habitat, monitor outplanted and wild plants and work with partners to protect remaining individuals to preserve genetic variability. Outplanting is planned for FY99. Estimated costs in FY98 include $14,500 in operating costs and protective fencing. Estimated annual costs for this project are $75,000 (for five years starting in FY98).

NAR MANAGEMENT PROJECTS

Feral Pig Monitoring and Control in Pu'u Maka'ala NAR - NAR staff have monitored feral pig activity for five years along a series of 18 transects that cover all areas of the reserve. Transects are regularly monitored, and monitoring intensity will increase once pig control begins. Staff will begin pig control in the two fenced units – Na Lua Mahoe Unit and Lava Flow Unit (totaling 1,000 acres) in the NAR in 1998 with assistance from NPS. NAR staff will also regularly inspect and maintain fences. Estimated annual NAR staff and operating cost for monitoring, pig control and fence inspection in this reserve is $7,000.

Alien Plant Monitoring and Control in Pu'u Maka'ala NAR - NAR staff have monitored alien plants for five years along a series of 18 transects that cover all areas of the reserve. Transects are monitored every three years, and priority alien plants are controlled. Additional alien plant control work will be initiated in the two fenced units once pigs are removed from those units. Estimated annual NAR staff and operating cost for monitoring and alien plant control in this reserve is $7,000.

C. *Research and Inventory Projects*

1. Study of Forest Bird Population Distribution and Abundance Over Time in Selected Portions of the ʻŌlaʻa - Kīlauea Project Area.

2. Study and Management of Small Mammalian Predators in Kīlauea Forest.

3. Test alien wasp control methods in the ʻŌlaʻa- Kīlauea Management Area, and Study Non-Target Impacts of Yellowjacket Wasp Control on Hawaiian *Drosophila* and Other Native Diptera.

4. Breeding Ecology, Bionomics and Control of *Culex* Mosquitoes in Hawaiian Forest Bird Habitat.

5. Efficacy and Non-target Effects of Aerial Applications of Larvicides to Control *Culex* Mosquitoes in Hawaiian Forest Bird Habitat.

6. Develop and Implement a Native and Alien Species Database for the Kūlani and Kīlauea Forest Sections of the ʻŌlaʻa – Kīlauea Project Area.

7. Assess Alien Plant Distribution along Transects within the Kūlani and Kīlauea Forest Sections of the ʻŌlaʻa- Kīlauea Management Area.

8. Evaluate the Composition and Structure of Plant Communities within Kūlani and Kīlauea Forest with Emphasis on Assessing Changes Relative to Management.

9. Growth and Survival of Trees in a Hawaiian Montane Rain Forest.

10. Loss of Invertebrate Diversity Associated with Rare Plants.

11. Response of Vegetation, Soil and Litter Invertebrates to Pig Removal.

12. Weeds initiative - ʻŌlaʻa Tract Projects.

13. Test Small Mammal Toxicants – Wet Forest.

14. Long-term Vegetation Monitoring in Puʻu Makaʻala NAR.

15. Demography Studies and Breeding Success of the ʻIo (*Buteo solitarius*).

16. Study Biocontrol of Himalayan Raspberry.

17. **Determining Short, Medium and Long-Term Forest Health in the ʻŌlaʻa – Kīlauea Project Area Using Appropriate Measurement, Monitoring and Modeling Tools.**

ʻŌLAʻA - KĪLAUEA MANAGEMENT GROUP - PROJECT STATEMENT

Project Title: Study of Forest Bird Population Distribution and Abundance Over Time in Selected Portions of the ʻŌlaʻa- Kīlauea Project Area.

Lead Individual and Agency: Michelle Reynolds and James D. Jacobi, USGS-BRD

Project Location: Kīlauea Forest and three sections of forest in the Kūlani Correctional Facility.

Start Date: January 1997 Completion Date: December 1999
Project Status: Ongoing Funding Status: Funded 1998 (USGS-BRD)

Problem Statement: Endemic forest bird populations have continued to decline over the past 50 years. Information on population status and trends of Hawaiian forest bird populations is an extremely important tool for developing recovery strategies for rare bird species and overall conservation programs for the remaining Hawaiian ecosystems.

Description of Proposed Project or Activity: This project focuses on continuing to conduct bird surveys within the ʻŌlaʻa - Kīlauea management area, and to complete analysis of previous bird survey data collected there. Surveys will be conducted of endangered, native, and alien bird species along existing or new transects located in Kūlani Correctional Facility and Kīlauea Forest. These surveys use the variable circular plot technique to determine the birds' distribution, density, and status.

The results will provide information on the annual distribution and density of both native and introduced bird species throughout the study area. We will additionally reanalyze raw data from all of the previous surveys conducted in these areas. Survey information allows for an evaluation of changes in distribution and abundance over time which can be evaluated relative to active or inactive management programs. A sharp decline in native species or an increase in alien bird species can be detected by this method, and may be an important indicator of need for additional management response to a new threat (e.g., increase in avian disease or predation) in an area. An annual report will be prepared by October 31 each year summarizing the results of the various bird surveys.

Summary of Accomplishments: Counts have been conducted once per year (January - February) in Kūlani, and twice per year (January and June) in Kīlauea Forest.

Budget and Positions: This project is currently funded by USGS-BRD. It is part of a larger project that includes forest bird surveys and analysis of previous data for locations throughout the state. Estimated annual cost for the ʻŌlaʻa- Kīlauea portion of this project are as follows:

Salaries	$23,485
Operating	$ 5,000
TOTAL	$28,485

'ŌLA'A - KĪLAUEA MANAGEMENT GROUP - PROJECT STATEMENT

Project Title: Study and Management of Small Mammalian Predators in Kīlauea Forest.

Lead individual and Agency: Tonnie Casey, KSBE

Project location: Kīlauea Forest

Start date: July 1998
Project status: Ongoing

Completion date: June 2003
Funding status: Unfunded

Problem Statement: Further research on the effects of rat, mongoose and cat predation of both ground and arboreal birds will aid in continued registration of Eaton's bait blocks for conservation uses in Hawai'i. New Zealand has shown that endangered bird species can show population increases and juvenile recruitment when predators are controlled and eradicated. The New Zealanders use both bait stations and aerial distribution of rodenticides to curb rats, mustelids (similar to our mongoose), and feral cats.

Description of Proposed Projects and Activities: KSBE will do initial tests on a toxic aerial bait for Keauhou Reforestation Area, in the "control" area for original tests of diphacinone in bait stations. If these tests are successful, portions of Kīlauea Forest can be used for further applications to support the registration of diphacinone for aerial application.

Numbers of rats, mongooses and cats will be monitored before and after predator control. Predator control will be conducted in pig-free areas using aerial broadcast methods if an experimental permit can be acquired. Bird numbers will continue to be measured. Numbers of nests and young birds produced would provide excellent information on the usefulness of predator control. Vegetation plots will be set up, measured and monitored yearly. Other data including invertebrate numbers and any changes over time would be valuable information. To measure rat numbers, tracking tunnels will be set up on a 100 x 150 meter grid, between transects 291 and 292 in the Pu'u Kipu Unit. Data will be gathered semiannually.

Through continued applications of rodenticides we should see a marked increase in species threatened by small mammal predation. These may be direct benefits: i.e. numbers of individuals of a species increases. There will also be indirect benefits. For instance, less mammals may decrease competition for food resources or enable the flowering and fruiting of a plant. We hope to see an increase in overall diversity. Small mammals may be vectors for alien plant invasions, and predator control may help curtail the spread of certain weeds.

Budget and Positions: Salary for the KSBE Biologist is provided by KSBE. Estimated annual operating cost for this project is $70,000. Funding is being sought for FY98-99.

ʻŌLAʻA - KĪLAUEA MANAGEMENT GROUP - PROJECT STATEMENT

Project Title: Test alien wasp control methods in the ʻŌlaʻa- Kīlauea Management Area, and Study Non-Target Impacts of Yellowjacket Wasp Control on Hawaiian *Drosophila* and Other Native Diptera.

Lead individual and Agency: David Foote, USGS-BRD

Project location: Kūlani, ʻŌlaʻa Tract, and other portions of HVNP

Start date: September 1997
Completion date: May 1999
Project status: Ongoing
Funding status: Funded – NPS and USFWS

Problem Statement: Western Yellowjacket Wasps (*Vespula pennsylvanica*) became established in Hawaiʻi in the late 1970's. Their ability to develop very large social colonies that subsist on a prey-base of native arthropods has resulted in ecosystem-level changes, including the reduction of invertebrate food for forest birds and pollinators of native plants. Within the last decade, alien Yellow-jacket wasps have become voracious predators of native invertebrates in Hawaiian ecosystems. Research suggested that the yellow-jackets can be controlled in local areas using poison baits, supplemented in certain instances with nest site detection and removal. However, the impact of yellow-jackets on native prey was difficult to evaluate because of the limited data on population trends of the native arthropods. Since 1991, monitoring methods for several groups of sensitive native insects are being tested in SEAs within HVNP and at Kūlani Correctional Facility. Research has reached the stage where the impact of yellow-jackets on native arthropods can be evaluated and control measures standardized for different areas. Control of local populations of yellow-jacket wasps should have a positive impact on communities of native arthropods.

Description of Proposed Projects and Activities: This project statement includes two projects.

- NPS funded work ($70,000/two years) includes monthly surveys in Kūlani and ʻŌlaʻa Tract and other areas of HVNP to monitor wasp and select prey populations, and to evaluate the effectiveness of augmenting poison baiting with nest site detection and removal. Following this study, USGS-BRD will continue a long-term monitoring program for yellow-jackets and sensitive native invertebrates in SEAs using NPS base funding.

- USFWS funded research ($48,000/one year) on the non-target impacts of yellowjacket wasp control on Hawaiian *Drosophila* and other native Diptera. Hawaiian *Drosophila* have been attracted to the This study will evaluate alternative wasp baits and determine which ones are least attractive to native flies while still attracting the wasps.

Budget and Positions: The estimated annual cost of the ʻŌlaʻa - Kīlauea Management Area portion of both projects is approximately $10,000 for salaries and operating costs. These two projects have been funded by NPS and USFWS.

ʻŌLAʻA - KĪLAUEA MANAGEMENT GROUP - PROJECT STATEMENT

Project Title: Breeding Ecology, Bionomics and Control of *Culex* Mosquitoes in Hawaiian Forest Bird Habitat.

Project location: Multi-island project including portions of the ʻŌlaʻa - Kīlauea Management Area.

Lead Individuals and Agency: Dennis A. LaPointe and Carter T. Atkinson, USGS-BRD

Start Date: October 1, 1996 Completion Date: Sept. 30, 1999
Project Status: Ongoing Funding Status: Funded (USFWS, USGS-BRD)

Problem Statement: Mosquito-transmitted avian pox and malaria are acting as major limiting factors in native Hawaiian forest bird populations. These diseases have their most significant impacts below elevations of 5,000 ft. where they interact with other environmental stresses such as habitat degradation, predation, and competition with disease-resistant non-native species. Only a few native species appear to be developing natural resistance to pox and malaria. It is likely that control of these diseases will be dependent on reduction of mosquito populations through elimination of breeding sites and use of highly specific, environmentally compatible larvicides such as BTI or methoprene. These management actions require detailed knowledge about vector biology and genetics to target specific breeding sites and to develop an integrated approach that will prevent development of resistance to control agents in the vector population.

Description of Proposed Project or Activity: This project will target remaining mid- and high elevation forest habitats on Hawaiʻi, Maui, and Kauai to prevent further spread of *Culex* mosquitoes into high elevation habitats and to help restore bird populations in mid-elevation forests where many native species have disappeared during the past 50 years.

- Conduct surveys to locate primary *Culex* breeding sites, characterize breeding sites to identify conditions that hasten the establishment and spread of mosquito populations, and determine the association of breeding sites and feral pig activity.

- Determine seasonal distribution and rate of movement of mosquitoes into higher elevation areas.

- Collect and freeze mosquitoes from a variety of different islands and habitats for future characterization of genetic diversity in the vector population.

- Develop and test strategies for controlling mosquitoes and the spread of avian disease.

Budget and Positions: This project is completely funded by USGS-BRD and USFWS. Estimated annual cost for the ʻŌlaʻa - Kīlauea portion of this research is $10,000.

ʻŌLAʻA - KĪLAUEA MANAGEMENT GROUP - PROJECT STATEMENT

Project Title: Efficacy and Non-target Effects of Aerial Applications of Larvicides to Control *Culex* Mosquitoes in Hawaiian Forest Bird Habitat.

Project location: Kīlauea Forest

Lead Individuals and Agency: Dennis A. LaPointe, USGS-BRD and Tonnie Casey, KSBE

Start Date: October 1, 1997
Project Status: *New* Project

Completion Date: Sept. 30, 1999
Funding Status: Funded (USFWS, USGS-BRD, KSBE)

Problem Statement: *Culex quinquefasciatus* has been demonstrated to be an extremely efficient vector of avian malaria. This mosquito also has a wide geographical and elevational distribution in the Hawaiian Islands making it the primary vector of avian malaria in Hawaiʻi. Native Hawaiian forest birds, especially honeycreepers, are very susceptible to introduced vectored-disease such as avian malaria. Currently several species of honeycreepers survive in remnant populations restricted to elevations above the vector's distribution and common species suffer high mortality when foraging at lower elevations. Avian disease control is integral to native forest bird management and will rely on control of vector mosquito populations. While wide scale elimination of larval habitat may be economically and politically infeasible, selective larviciding may prove to be the most efficient form of wide scale mosquito control.

Description of Proposed Project or Activity: This project will determine the feasibility of using a granular B.t.i. (*Bacillus thuringiensis israelensis*) and methoprene larvicides for the control of *Culex quinquefasciatus* and the potential non-target effects it may have on native soil and aquatic invertebrates. Both larvicides are relatively selective, and they provide effective control of mosquitoes in many mainland situations. Methoprene interrupts normal insect molting, and B.t.i. is a bacterium lethal to larval mosquitoes. Specific project objectives include the following:

- Determine appropriate application rates for inert carriers in forested areas of varying vegetative cover.
- Determine efficacy of selected compounds against field populations of *Culex quinquefasciatus* larvae.
- Determine the duration of control (residual nature) in the field for selected compounds.
- Determine the effect of these compounds to native aquatic and soil invertebrates.

Budget and Positions: This project is funded by USGS-BRD, USFWS and KSBE. Estimated annual cost of this research is $23,031.

ʻŌLAʻA - KĪLAUEA MANAGEMENT GROUP - PROJECT STATEMENT

Project Title: Develop and Implement a Native and Alien Species Database for the Kūlani and Kīlauea Forest Sections of the ʻŌlaʻa - Kīlauea Project Area.

Lead Individuals and Agency: James D. Jacobi and Rick Warshauer, USGS-BRD

Project Location: Kīlauea Forest and Kūlani Correctional Facility lands.

Start Date: January 1997
Completion Date: October 1998
Project Status: New Project
Funding Status: Funded - 1998 (USFWS and USGS-BRD)

Problem Statement: The development of successful management programs for conserving native species and ecosystems requires detailed information on the distribution, habitat requirements, and status of native and selected alien plants and animals. With global positioning system (GPS) and geographical information system (GIS), data collected on plant and animal locations can easily and accurately be accumulated into an interactive database that can greatly assist with directing management. For example, by determining habitat characteristics (vegetation type, substrate, rainfall, etc.) from rare plant species locations, searches for additional individuals can be made more efficient, and potential reintroduction sites can be identified.

Description of Proposed Project or Activity: This project will result in the development and implementation of a GIS database for locations of rare native plant species, selected alien plant species, plant communities, and bird populations from data collected by USGS-BRD biologists. Additionally, data from other surveys (e.g., pig monitoring, avian disease, predator control, invertebrate data, fence locations, transect locations) could easily be incorporated. Other data, including elevation, rainfall, geological substrate, roads/trails, and property boundaries are also available and will be included as basemap information. During this project we will setup the GIS, input available data, produce maps needed by the ʻŌlaʻa - Kīlauea group, and begin to explore the interactions between the various data layers to aid with planning and implementing management actions in this area. With adequate information in a GIS, the production of maps for reports, presentations, and planning becomes relatively routine. Additionally, it is possible to determine habitat characteristics, distribution patterns, and potential range of species of interest, and to identify ecological interactions between the biological and environmental data.

Budget and Positions: This project is funded by USGS-BRD and USFWS. The work covered in this project statement is part of a larger project funded by USFWS to develop a native plant species database from USGS-BRD data. Estimated cost for the ʻŌlaʻa - Kīlauea portion of this project are as follows:

Salaries	10,000
Operating	5,000
TOTAL	15,000

ʻŌLAʻA - KĪLAUEA MANAGEMENT GROUP - PROJECT STATEMENT

Project Title: Assess Alien Plant Distribution along Transects within the Kūlani and Kīlauea Forest Sections of the ʻŌlaʻa- Kīlauea Management Area.

Lead Individuals and Agency: James D. Jacobi, USGS-BRD

Project Location: Kīlauea Forest and Kūlani Correctional Facility lands.

Start Date: January 1997
Project Status: New Project

Completion Date: October 1999
Funding Status: Funded 1998 (USFWS, USGS-BRD)

Problem Statement: Although the fenced management units within the project area are dominated by native plants, they also contain many alien species. Most of the alien plants probably do not pose a major threat to the integrity of the native ecosystems. However, a few species, including banana poka (*Passiflora mollissima*), Himalayan raspberry (*Rubus ellipticus*), and Kahili ginger (*Hedycyium gardnerianum*), have the potential to seriously alter the composition and structure of the native ecosystems if they become well established.

Description of Proposed Project or Activity: The objectives of the project are to:

- Determine distribution of alien plant species throughout the Kūlani and Kīlauea Forest sections of the OK Project Area, with specific emphasis on a select group of species.
- Compare alien species distribution and frequency between different management areas.
- Evaluate change in alien species distribution and frequency over time.

Biologist will collect data along transects established in Kūlani and Kīlauea Forest on the presence of all alien plant species, as well as record a Braun-Blanquet cover estimate for particularly threatening species. Sampling will be repeated at 1 year intervals during the first two years, and the sampling schedule will be reevaluated at the end of that time. The results of the surveys will be helpful in determining management actions that may need to be taken to reduce or eliminate the impacts of selected alien plants within the project area.

Budget and Positions: The work covered in this project statement is part of a larger project funded by USFWS and USGS-BRD to assess rare plant and alien weed distributions in Kūlani and Kīlauea Forest, and to evaluate the response of the plant communities to on-going management actions. Estimated cost for the alien plants assessment is as follows:

Salaries	$25,000
Operating	$ 5,000
TOTAL	$30,000

'ŌLA'A - KĪLAUEA MANAGEMENT GROUP - PROJECT STATEMENT

Project Title: Evaluate the Composition and Structure of Plant Communities within Kūlani and Kīlauea Forest with Emphasis on Assessing Changes Relative to Management.

Lead Individuals and Agency: James D. Jacobi, USGS-BRD

Project Location: Kīlauea Forest and Kūlani Correctional Facility lands.

Start Date: January 1997 Completion Date: October 1999
Project Status: New Project Funding Status: Funded 1997 (USFWS, USGS-BRD)

Problem Statement: The vegetation of an area is one of the best indicators of ecosystem health or stability. Detailed information on vegetation provides data on both the structure and composition of the plant communities, as well as the degree to which the area has been invaded by alien species and the status of rare native species.

Description of Proposed Project or Activity: Plant studies within the 'Ōla'a- Kīlauea Management Area will be directed toward three major objectives:

- Establish a baseline of the composition and structure of the major plant communities.
- Using the vegetation baseline, assess the condition of the plant communities within the project area and develop optimal parameters of crucial components of the vegetation (e.g., population structure of the dominant plant species, native ground cover species composition and diversity) that can be used as target criteria to evaluate management.
- Monitor vegetation response to management actions relative to these target criteria.

Specific objectives of this project include assessing changes in the ground cover vegetation relative to ungulate removal within the Kūlani and Kīlauea Forest sections of the 'Ōla'a- Kīlauea Management Area, collecting baseline data on plant community composition and structure throughout Kūlani and Kīlauea Forest, and remapping the vegetation of the 'Ōla'a- Kīlauea Management Area and compare changes with similar maps prepared in 1982.

Budget and Positions: This project is part of a larger project that was initially funded in 1997 by USFWS and USGS-BRD to access rare plant and alien weed distributions in Kūlani and Kīlauea Forest, and to evaluate the response of the plant communities to on-going management actions, particularly feral pig control. Due to funding restrictions from the USFWS in 1998, we are attempting to continue this project with a limited amount of USGS-BRD funding. Estimated annual cost for full implementation of the current vegetation sampling within the 'Ōla'a- Kīlauea Management Area is as follows:

Salaries	50,000
Operating	15,000
TOTAL	$65,000

ʻŌLAʻA - KĪLAUEA MANAGEMENT GROUP - PROJECT STATEMENT

Project Title: Growth and Survival of Trees in a Hawaiian Montane Rain Forest.

Lead Individual and Agency: Jeff S. Hatfield, USGS-BRD

Project Location: Puʻu Kipu section of Kūlani Correctional Facility.

Start Date: July 22, 1996
Project Status: Ongoing

Completion Date: Dec 31, 1999
Funding Status: Funded – 1999 (USGS-BRD, National Geographic Society)

Problem Statement: Hatfield *et al.* (1996) found that competition between koa and ʻōhiʻa probably was occurring in the Kūlani Forest on Mauna Loa. They used a mathematical model to show that the two species probably are able to coexist where they are sympatric (between 1450 and 2050 m elevation) because of differences in dispersal abilities into large gaps created by lava flows, and also because of probable differences in seedling recruitment variability. However, these conclusions depend on the assumption that koa grows at a much faster rate than ʻōhiʻa. Although this is probably true given the growth rates of these two species reported in the literature, their growth rates have never been measured at the same time in mature, primary rain forest to verify this assumption.

Description of Proposed Activity: This study will measure growth and survival rates of koa and ʻōhiʻa by tagging and monitoring a sample of trees for 3.5 years in the same study area as Hatfield *et al.* (1996). In addition, the growth and survival rates of seven species of subcanopy trees and shrubs also will be measured in this study.

The product expected from this research will be at least one manuscript comparing the growth and survival of trees and shrubs within the Kūlani Forest. In particular, growth rates of koa and ʻōhiʻa will be compared, but growth and survival of all nine species of trees and shrubs will be measured and submitted for publication. Furthermore, a long-term objective will be to use the growth and survival rates of each species of tree or shrub for the eventual development and parameterization of a forest simulation model to describe succession and regeneration of Hawaiian montane rain forest. This forest simulation model also could be used to evaluate management options for restoration of degraded tropical forests on the island of Hawaiʻi.

An annual report will be submitted by October 1 each year. The data will be analyzed and a final manuscript will be written by December 31, 1999.

Budget and Positions: This is a five year project (FY96-FY00). USGS-BRD is funding salary and operating costs and the National Geographic Society is funding airfare. Annual cost is approximately $8,000.

ʻŌLAʻA - KĪLAUEA MANAGEMENT GROUP - PROJECT STATEMENT

This section contain shorter project statements for ongoing projects done by NPS in ʻŌlaʻa Tract, NAR in Puʻu Makaʻala, as well as multi-island or island-wide projects with an ʻŌlaʻa - Kīlauea research component. This section also includes lists of potential future projects.

USGS-BRD RESEARCH PROJECTS IN ʻŌLAʻA TRACT

Loss of Invertebrate Diversity Associated with Rare Plants – USGS-BRD has established plots in ʻŌlaʻa Tract and other HVNP SEAs and is taking data on stand structure, the population dynamics of certain *Drosophila* host plants and *Drosophila* populations. This project is funded $70,000/year through FY99 (USGS-BRD NRPP funds). The estimated annual cost for work in the ʻŌlaʻa- Kīlauea Management Area is $35,000/year.

Response of Vegetation, Soil and Litter Invertebrates to Pig Removal – USGS-BRD is taking data on tree fern density, stand structure of certain species, and the long-term population trends for certain invertebrates (*Collembola* and other soil invertebrates, *Megalagrion* damselflies and native moths) in areas before and after pig removal. This reasearch is being done in Kūlani, ʻŌlaʻa Tract and other HVNP SEAs. The project has $50,000/year funding through FY99 (NPS base funds). The estimated annual cost for work in the ʻŌlaʻa- Kīlauea Management Area is $40,000/year.

Weeds Initiative - ʻŌlaʻa Tract - USGS-BRD researchers will research historical changes in weed distribution and the role of weeds in supporting alien invertebrates. The project has $32,000 in funding (USGS-BRD funds). The estimated annual cost for work in the ʻŌlaʻa- Kīlauea Management Area is $20,000.

Test Small Mammal Toxicants – Wet Forest – This USGS-BRD project has four major components: 1) evaluate control procedures, bait delivery systems and dosages in wet forest; 2) study recruitment and recovery of representative populations of rare plants and invertebrates, 3) evaluate non-target impacts of baits and toxicants on soil and litter invertebrates, and 4) prepare findings that can be used to support a 24(c) registration in Hawai'i for broad area application of diphacinon pellets or the use of other toxicants in natural areas. This work is being done in coordination with the interagency working group on toxicants. The wet forest portion of the project will be done in ʻŌlaʻa Tract, and it has $70,000/year funding from FY99 through FY01 (USGS-BRD NRPP funds).

NAR RESEARCH PROJECTS

Long-Term Vegetation Monitoring in Puʻu Makaʻala NAR – NARs staff monitored vegetation in circular plots along 15 of the main monitoring transects established throughout the reserve. This long-term monitoring included recording the structure and composition of species groups and dominant species, as well as measurement of canopy and understory species. Data

from this monitoring is currently being analyzed. Plots will be re-monitored every six years. Estimated annual cost for NAR staff time to analyze data and prepare a report is $5,000.

OTHER ONGOING OR PROPOSED RESEARCH

Demography Studies and Breeding Success of the 'Io (*Buteo solitarius*) – USFWS has funded a graduate student project to do an island-wide survey of 'io. The demography studies and survey includes portions of the 'Ōla'a- Kīlauea Management Area. Funding information on the 'Ōla'a- Kīlauea portion of this research is not available.

Study Biocontrol of Himalayan Raspberry - Himalayan raspberry threatens the integrity of the project area's native ecosystems by forming thick, rapidly growing, impenetrable thickets of canes that displace native vegetation and suppress native seedling recruitment. Biological control is one potential control option. However, insect and pathogen work is needed to determine potential biocontrol agents. Promising agents need to be thoroughly tested on non-target organisms before they are released to reduce probability that native plants, invertebrates, or species of economic importance may be affected. Whereas no economically important blackberry and raspberry species occur in Hawai'i, protection of the two endemic species of *Rubus* is of concern. Entomological biological control research is established in HVNP, under an interagency agreement among NPS, USFS, and DLNR. The University of Hawai'i Cooperative Park Studies Unit and the State Department of Agriculture are interested parties. Pathogenic biological control research is undertaken by a USGS-BRD Research Scientist. This project is currently unfunded.

Determining Short, Medium and Long-term Forest Health in the 'Ōla'a – Kīlauea Project Area Using Appropriate Measurement, Monitoring and Modeling Tools – Proposed project

D. Education and Information Projects

1. Educational Program for Kūlani Correctional Facility Inmates and Staff.

2. Develop an Interpretive Trail and Brochure for a Selected Area in Pu'u Maka'ala NAR.

3. Native Plant Landscaping of Kūlani with an Educational Focus.

ʻŌLAʻA - KĪLAUEA MANAGEMENT GROUP - PROJECT STATEMENT

Project Title: Educational Program for Kūlani Correctional Facility Inmates and Staff.

Lead Individual and Agency: Peter MacDonald, Kūlani Correctional Facility and Tanya Rubenstein, Project Coordinator

Project Location: Kūlani Correctional Facility

Start Date: September 1997 Completion Date: Ongoing
Project Status: Ongoing Funding Status: Funded 1998 (USFWS)

Problem Statement: Kūlani Correctional Facility contains unique Hawaiian ecosystems, and staff and inmates have not have not had the opportunity to learn about Native Hawaiian flora and fauna. Educational efforts for KCF inmates will increase employment and educational opportunities for the inmates once they are released from KCF. These efforts will also assist on-the-ground management by providing a well-educated, trained work crew for the Conservation Work Line.

Description of Proposed Project or Activity: The intent of the education program is to provide cultural and environmental information to staff and inmates at the Kūlani Correctional Facility. Additionally, the program aims to promote an awareness and appreciation of Hawaiʻi's delicate ecosystems in pursuit of protecting native species of flora and fauna. Class scheduling and curriculum shall be offered primarily to approximately forty (40) inmates assigned to the conservation, woodline and ranch/farm work crews. A minimum of four (4) workline supervisors for those crews shall also attend classes. Instructors would be drawn from the ʻŌlaʻa -Kīlauea Management Group and would be selected on the basis of expertise and background within a given area of the curriculum.

Courses will include information on Hawaiʻi's cultural heritage as it pertains to the native ecosystems, native and introduced flora and fauna and the impact of man of native species. eradication, control and monitoring programs that promote the survival of native Stress practical application as a means to that end. Classroom and practical field-based instruction.

Budget and Positions: This project is organized and implemented by the ʻŌlaʻa – Kīlauea Management Area Project Coordinator with the assistance of Kūlani Correctional Facility. The Project Coordinator and Conservation Workline Supervisor positions were funded for FY98 by USFWS. The estimated annual cost of staff time to implement this project is $5,000. Additional funds will be needed in FY99 to continue this program.

'ŌLA'A - KĪLAUEA MANAGEMENT GROUP - PROJECT STATEMENT

PROPOSED EDUCATION AND INFORMATION PROJECTS

Develop an Interpretive Trail and Brochure for a Selected Area in Pu'u Maka'ala NAR.

Native Plant Landscaping of Kūlani with an Educational Focus.

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VII. APPENDIX

A. ʻŌlaʻa - Kīlauea Forest Cooperative Agreement

OLAA-KILAUEA FOREST COOPERATIVE AGREEMENT
BETWEEN THE
TRUSTEES OF THE ESTATE OF BERNICE PAUAHI BISHOP
HAWAII DEPARTMENT OF LAND AND NATURAL RESOURCES
HAWAII DEPARTMENT OF PUBLIC SAFETY, CORRECTIONS DIVISION
UNITED STATES FISH AND WILDLIFE SERVICE
AND
NATIONAL PARK SERVICE

THIS MASTER COOPERATIVE AGREEMENT ("Agreement"), made and entered into on the 6 day of July 94, among the above agencies and organizations hereinafter referred to as "parties", to participate in cooperative management activities.

WHEREAS, the contiguous native forest area of Kilauea and Olaa Forest are owned by the State of Hawaii, The National Park Service and the Trustees of the Estate of Bernice Pauahi Bishop (hereinafter referred to as "Bishop Estate"), as indicated on the attached map, and

WHEREAS, the State Department of Land and Natural Resources manages a portion of the subject area as the Puu Makaala Natural Area Reserve and the Olaa and Upper Waiakea Forest Reserve, and

WHEREAS, Bishop Estate owns the Kilauea Forest and desires to actively manage the area in order to preserve and enhance its natural and cultural resources in cooperation with surrounding landowners, and

WHEREAS, the U.S. Fish and Wildlife Service operates a research center in the Hawaii Volcanos National Park and is actively involved in scientific research, monitoring, and protecting the biological and botanical resources in the Olaa-Kilauea Forest area. and

WHEREAS, the State of Hawaii, Department of Public Safety, Corrections Division operates the Kulani Prison facility in the Olaa Forest and has an interest in participating in the active preservation of natural habitat in the area and providing meaningful employment for its inmates, and

WHEREAS, the National Park Service manages the adjacent 219,000 acre Hawaii Volcanos National Park for purposes of natural and cultural resource protection and public education and recreation, and

WHEREAS, the subject properties provide habitat for many native species, including several species of rare and endangered forest birds and plants, and

WHEREAS, the subject properties are part of or contiguous to, the area designated by the United Nations (UNESCO) as both an International Biosphere and World Heritage Site for its global uniqueness and significance for future generations of mankind, and

WHEREAS, the Olaa-Kilauea Forest is subject to degradation from introduced factors such as wild pigs and trespassing cattle, non-native plants, rodents and other predators and

WHEREAS, active management is needed to control the impact of introduced factors and to enhance the vitality of the native ecosystems within the Olaa-Kilauea Forest area, and

WHEREAS, effective management is best achieved through the coordinated actions of all major landowners and agencies in the region;

WHEREAS, the parties to this Agreement acknowledge the interest of members of the public to access public lands for hunting purposes and wish to include such use as part of a comprehensive management program for the resource area, and

NOW THEREFORE, the parties hereto deem it mutually advantageous and desirable to cooperate and hereby agree in principle as follows:

1. To develop jointly an Olaa-Kilauea Forest management plan to include, but not be limited to, feral animal and non-native plant control measures, collaborative research projects and habitat protection and restoration. The plan will be reviewed and updated by the signatories of this agreement annually and will document the Olaa-Kilauea Forest resource values and identify priority management objectives.

2. To seek funding within our respective authorities, and to seek funds for cooperative efforts to implement the habitat restoration and enhancement protection plans.

3. To exchange relevant information needed to compile and implement the management plans and apply the results of scientific research to management action.

4. To develop specific agreements and working plans for individual projects considered by all or some of the parties hereto to have mutual interest. Such agreement and working plans will be developed whenever deemed appropriate by the relevant parties.

5. To develop a plan, with input from the local hunting community and interested persons to use public hunting in selected areas of the Olaa-Kilauea forest area as a management tool in the monitoring and control of feral pigs.

6. To consider entering into specific agreements between all or some of the parties and/or third parties, as occasion demands, for the use of specialized equipment, hiring and supervision of personnel, transfer of funds, purchasing of supplies, and other matters pertaining to the general purposes of management agreed upon by all or some of the parties hereto. Any allocation of responsibilities and liabilities, including limitation of expenditures under this Agreement will be set forth in specific working agreements entered into by the relevant parties.

7. That any partner may terminate its participation in this Agreement by providing 60 days written notice to the others.

8. Nothing contained in this Agreement shall be deemed to create a partnership or joint venture relationship and no party shall be liable for any expense or cost incurred by any other party without its express written agreement.

9. This Agreement shall not surrender any interest in any land held by any party, nor shall it be deemed to constitute a grant or demise of any Bishop Estate lands or a grant of access by any party to any other party to this Agreement, or authorize the expenditure of any funds by any party.

10. Term of Agreement

Unless terminated earlier, this Memorandum of Understanding shall continue in effect for a period of five (5) years from the date of the last signature hereto, and shall, on or before the termination date, be reviewed by all parties to determine if the Agreement should be renewed, modified, or terminated.

11. Required Clauses

During the performance of this Agreement, the participants agree to abide by the terms of Executive Order 11246 on non-discrimination and will not discriminate against any person because of race, color, religion, sex, or national origin. The participants will take affirmative action to ensure that applicants are employed without regard to their race, color, religion, sex, or national origin.

No member or delegate to Congress, or resident; Commissioner, shall be admitted to any share or part of this Agreement, or to any benefit that may arise therefrom, but this provision shall not be construed to extend to this Agreement if made with a corporation for its general benefit.

This instrument has been executed by the Trustees of the Estate of Bernice Pauahi Bishop in their fiduciary capacities as said Trustees, and not in their individual capacities. No personal liability or obligation under this instrument shall be imposed or assessed against said Trustees in their individual capacities.

IN WITNESS WHEREOF, the parties hereto have executed this Agreement as of the first date above written.

STATE OF HAWAII
DEPARTMENT OF LAND AND
NATURAL RESOURCES

By: _____
Title:

Date: _____

HAWAII VOLCANOES NATIONAL
PARK

By: _____
Title:

Date: _____

STATE OF HAWAII
DEPARTMENT OF PUBLIC SAFETY

By: _____
Title:

Date: _____

U.S. FISH AND WILDLIFE
SERVICE - PACIFIC REGION

By: _____
Title:

Date: _____

Legal Group

TRUSTEES OF THE ESTATE OF
BERNICE PAUAHI BISHOP

Richard Sung Hong Wong

Oswald Kofoad Stender

Myron Bennett Thompson

Date: July 6, 1994

B. *Preliminary Plant List for the Kīlani and Kīlauea Forest Sections of the ʻŌlaʻa - ʻKīlauea Management Area*

C	SPECIES	FAMILY	ORIGIN	Select
1	FERNS			1
2	Adenophorus hymenophylloides	GRAMMITACEAE	N	1
2	Adenophorus tamariscinus	GRAMMITACEAE	N	1
2	Adenophorus tamariscinus montanus	GRAMMITACEAE	N	1
2	Adenophorus tripinnatifidus	GRAMMITACEAE	N	1
2	Amauropelta globulifera	THELYPTERIDACEAE	N	1
2	Asplenium adiantum-nigrum	ASPLENIACEAE	N	1
2	Asplenium contiguum	ASPLENIACEAE	N	1
2	Asplenium lobulatum	ASPLENIACEAE	N	1
2	Asplenium macraei	ASPLENIACEAE	N	1
2	Asplenium monanthes	ASPLENIACEAE	N	1
2	Asplenium polyodon	ASPLENIACEAE	N	1
2	Asplenium rhipidoneuron	ASPLENIACEAE	N	1
2	Asplenium schizophyllum	ASPLENIACEAE	N	1
2	Asplenium unilaterale	ASPLENIACEAE	N	1
2	Athyrium microphyllum	ATHYRIACEAE	N	1
2	Christella cyatheoides	THELYPTERIDACEAE	N	1
2	Cibotium chamissoi	DICKSONIACEAE	N	1
2	Cibotium glaucum	DICKSONIACEAE	N	1
2	Cibotium hawaiense	DICKSONIACEAE	N	1
2	Coniogramme pilosa	HEMIONITIDACEAE	N	1
2	Ctenitis rubiginosa	ASPIDIACEAE	N	1
2	Dicranopteris linearis	GLEICHENIACEAE	N	1
2	Diplazium sandwichianum	ATHYRIACEAE	N	1
2	Diplopterygium pinnatum	GLEICHENIACEAE	N	1
2	Dryopteris fusco-atra	ASPIDIACEAE	N	1
2	Dryopteris glabra	ASPIDIACEAE	N	1
2	Dryopteris hawaiiensis	ASPIDIACEAE	N	1
2	Dryopteris unidentata	ASPIDIACEAE	N	1
2	Dryopteris wallichiana	ASPIDIACEAE	N	1
2	Elaphoglossum hirtum micans	ELAPHOGLOSSACEA	N	1
2	Elaphoglossum wawrae	ELAPHOGLOSSACEA	N	1
2	Grammitis hookeri	GRAMMITACEAE	N	1
2	Hypolepis punctata	HYPOLEPIDACEAE	N	1
2	Lycopodium cernuum	LYCOPODIACEAE	N	1
2	Lycopodium polytrichoides	LYCOPODIACEAE	N	1
2	Lycopodium venustulum	LYCOPODIACEAE	N	1
2	Marattia douglasii	MARATTIACEAE	N	1
2	Mecodium recurvum	HYMENOPHYLLACEA	N	1
2	Microlepia strigosa	DENNSTAEDTIACEA	N	1
2	Pleopeltis thunbergiana	POLYPODIACEAE	N	1
2	Pneumatopteris sandwicensis	THELYPTERIDACEAE	N	1
2	Polypodium pellucidum	POLYPODIACEAE	N	1
2	Pseudophegopteris keraudreniana	THELYPTERIDACEAE	N	1
2	Psilotum complanatum	PSILOTACEAE	N	1
2	Pteridium aquilinum decompositum	HYPOLEPIDACEAE	N	1
2	Pteris cretica	PTERIDACEAE	N	1
2	Pteris excelsa	PTERIDACEAE	N	1
2	Sadleria pallida	BLECHNACEAE	N	1
2	Sadleria souleyetiana	BLECHNACEAE	N	1
2	Sadleria sqarrosa	BLECHNACEAE	N	1
2	Sphaerocionium lanceolatum	HYMENOPHYLLACEA	N	1
2	Sphenomeris chinensis	LINDSEACEAE	N	1
2	Sticherus owhyhensis	GLEICHENIACEAE	N	1
2	Xiphopteris saffordii	GRAMMITACEAE	N	1
2	Nephrolepis multiflora	NEPHROLEPIDACEA	X	1
3	DICOTS			1
4	Acacia koa	FABACEAE	N	1
4	Alyxia oliviformis	APOCYNACEAE	N	1
4	Bobea elatior	RUBIACEAE	N	1

C	SPECIES	FAMILY	ORIGIN	Select
4	Broussaisia arguta	HYDRANGEACEAE	N	1
4	Cheirodendron trigynum	ARALIACEAE	N	1
4	Clermontia hawaiiensis	CAMPANULACEAE	N	1
4	Clermontia lindseyana	CAMPANULACEAE	N	1
4	Clermontia montis-loa	CAMPANULACEAE	N	1
4	Clermontia parviflora	CAMPANULACEAE	N	1
4	Coprosma ernodeoides	RUBIACEAE	N	1
4	Coprosma montana	RUBIACEAE	N	1
4	Coprosma ochracea	RUBIACEAE	N	1
4	Coprosma rhynchocarpa	RUBIACEAE	N	1
4	Cyanea degeneriana	CAMPANULACEAE	N	1
4	Cyanea pilosa longipedunculata	CAMPANULACEAE	N	1
4	Cyanea pilosa pilosa	CAMPANULACEAE	N	1
4	Cyanea shipmanii	CAMPANULACEAE	N	1
4	Cyanea stictophylla	CAMPANULACEAE	N	1
4	Cyrtandra lysiosepala	GESNERIACEAE	N	1
4	Cyrtandra platyphylla	GESNERIACEAE	N	1
4	Dodonaea viscosa	SAPINDACEAE	N	1
4	Dubautia ciliolata	ASTERACEAE	N	1
4	Dubautia scabra	ASTERACEAE	N	1
4	Embelia pacifica	MYRSINACEAE	N	1
4	Geranium cuneatum	GERANIACEAE	N	1
4	Gnaphalium sandwicensium kilaueanum	ASTERACEAE	N	1
4	Gouldia terminalis	RUBIACEAE	N	1
4	Ilex anomala	AQUIFOLIACEAE	N	1
4	Labordia hedyosmifolia	LOGANIACEAE	N	1
4	Lythrum maritimum	LYTHRACEAE	N	1
4	Melicope clusiifolia	RUTACEAE	N	1
4	Melicope pseudoanisata	RUTACEAE	N	1
4	Melicope radiata	RUTACEAE	N	1
4	Melicope volcanica	RUTACEAE	N	1
4	Metrosideros polymorpha	MYRTACEAE	N	1
4	Myoporum sandwicense	MYOPORACEAE	N	1
4	Myrsine lessertiana	MYRSINAEAE	N	1
4	Myrsine sandwicensis	MYRSINACEAE	N	1
4	Nertera granadensis	RUBIACEAE	N	1
4	Nothocestrum longifolium	SOLANACEAE	N	1
4	Peperomia cookiana	PIPERACEAE	N	1
4	Peperomia hypoleuca	PIPERACEAE	N	1
4	Peperomia macraeana	PIPERACEAE	N	1
4	Peperomia membranacea	PIPERACEAE	N	1
4	Perrottetia sandwicensis	CELASTRACEAE	N	1
4	Phyllostegia velutina	LAMIACEAE	N	1
4	Phytolacca sandwicensis	PHYTOLACCACEAE	N	1
4	Pipturus albidus	URTICACEAE	N	1
4	Pittosporum confertiflorum	PITTOSPORACEAE	N	1
4	Plantago hawaiensis	PLANTAGINACEAE	N	1
4	Psychotria hawaiiensis	RUBIACEAE	N	1
4	Psychotria hawaiiensis hillebrandii	RUBIACEAE	N	1
4	Rubus hawaiensis	ROSACEAE	N	1
4	Rubus macraei	ROSACEAE	N	1
4	Rumex giganteus	POLYGONACEAE	N	1
4	Solanum americanum	SOLANACEAE	N	1
4	Sophora chrysophylla	FABACEAE	N	1
4	Stenogyne calaminthoides	LAMIACEAE	N	1
4	Stenogyne macrantha	LAMIACEAE	N	1
4	Stenogyne scrophularioides	LAMIACEAE	N	1
4	Stenogyne sessilis	LAMIACEAE	N	1
4	Styphelia tameiameiae	EPACRIDACEAE	N	1
4	Tetraplasandra kavaiensis	ARALIACEAE	N	1

C	SPECIES	FAMILY	ORIG	N	Select
4	Touchardia latifolia	URTICACEAE	N		1
4	Trematolobelia grandifolia	CAMPANULACEAE	N		1
4	Urera glabra	URTICACEAE	N		1
4	Vaccinium calycinum	ERICACEAE	N		1
4	Vaccinium reticulatum	ERICACEAE	N		1
4	Vicia menziesii	FABACEAE	N		1
4	Viola maviensis	VIOLACEAE	N		1
4	Ageratina adenophora	ASTERACEAE	X		1
4	Ageratina riparia	ASTERACEAE	X		1
4	Anemone hupehensis	RANUNCULACEAE	X		1
4	Arenaria serpyllifolia	CARYOPHYLLACEAE	X		1
4	Buddleia asiatica	BUDDLEIACEAE	X		1
4	Chrysanthemum leucanthemum	ASTERACEAE	X		1
4	Cirsium vulgare	ASTERACEAE	X		1
4	*Epilobium ciliatatum*	ONAGRACEAE	X		1
4	Erechtites valerianifolia	ASTERACEAE	X		1
4	Fragaria vesca	ROSACEAE	X		1
4	Fraxinus uhdei	OLEACEAE	X		1
4	Geranium homeanum	GERANIACEAE	X		1
4	Gnaphalium japonicum	ASTERACEAE	X		1
4	Hydrocotyle bowlesioides	APIACEAE	X		1
4	Hypericum kouytchense	CLUSIACEAE	X		1
4	Hypericum mutilum	CLUSIACEAE	X		1
4	Hypericum parvulum	CLUSIACEAE	X		1
4	Hypochaeris radicata	ASTERACEAE	X		1
4	Lonicera japonica	CAPRIFOLIACEAE	X		1
4	Lotus uliginosus	FABACEAE	X		1
4	Ludwigia palustris	ONAGRACEAE	X		1
4	Myosotis discolor	BORAGINACEAE	X		1
4	Passiflora mollissima	PASSIFLORACEAE	X		1
4	Physalis peruviana	SOLANACEAE	X		1
4	Phytolacca octandra	PHYTOLACCACEAE	X		1
4	Plantago australis	PLANTAGINACEAE	X		1
4	Pluchea symphytifolia	ASTERACEAE	X		1
4	Polygonum capitatum	POLYGONACEAE	X		1
4	Prunella vulgaris	LAMIACEAE	X		1
4	Psidium cattleianum	MYRTACEAE	X		1
4	Pyracantha angustifolia	ROSACEAE	X		1
4	Ranunculus plebeius	RANUNCULACEAE	X		1
4	Rubus argutus	ROSACEAE	X		1
4	Rubus ellipticus	ROSACEAE	X		1
4	Rubus rosifolius	ROSACEAE	X		1
4	Rumex acetosella	POLYGONACEAE	X		1
4	Rumex crispus	POLYGONACEAE	X		1
4	Senecio sylvaticus	ASTERACEAE	X		1
4	Sonchus asper	ASTERACEAE	X		1
4	Tibouchina herbacea	MELASTOMATACEAE	X		1
4	Tropaeolum majus	TROPAEOLACEAE	X		1
4	Veronica plebeia	SCROPHULARIACEA	X		1
4	Veronica serpyllifolia	SCROPHULARIACEA	X		1
5	MONOCOTS				1
6	Astelia menziesiana	LILIACEAE	N		1
6	Carex alligata	CYPERACEAE	N		1
6	Carex echinata	CYPERACEAE	N		1
6	Carex macloviana	CYPERACEAE	N		1
6	Carex montis-eeka	CYPERACEAE	N		1
6	Carex thunbergii	CYPERACEAE	N		1
6	Carex wahuensis	CYPERACEAE	N		1
6	Deschampsia nubigena	POACEAE	N		1
6	Dicanthelium hillebrandianum	POACEAE	N		1

C.	SPECIES	FAMILY	ORIGIN	Select
6	Freycinetia arborea	PANDANACEAE	N	1
6	Gahnia gahniiformis	CYPERACEAE	N	1
6	Luzula hawaiiensis	JUNCACEAE	N	1
6	Machaerina angustifolia	CYPERACEAE	N	1
6	Oreobolus furcatus	CYPERACEAE	N	1
6	Panicum tenuifolium	POACEAE	N	1
6	Pycreus polystachyos	CYPERACEAE	N	1
6	Rhynchospora chinensis spiciformis	CYPERACEAE	N	1
6	Rhynchospora rugosa lavarum	CYPERACEAE	N	1
6	Sisyrhinchium acre	IRIDACEAE	N	1
6	Smilax melastomifolia	SMILACACEAE	N	1
6	Trisetum glomeratum	POACEAE	N	1
6	Uncinia uncinata	CYPERACEAE	N	1
6	Agrostis stolonifera	POACEAE	X	1
6	Andropogon virginicus	POACEAE	X	1
6	Anthoxanthum odoratum	POACEAE	X	1
6	Axonopus fisifolius	POACEAE	X	1
6	Crocosmia x crocosmiiflora	IRIDACEAE	X	1
6	Cyperus halpan	CYPERACEAE	X	1
6	Dactylis glomerata	POACEAE	X	1
6	Ehrharta stipoides	POACEAE	X	1
6	Eragrostis brownei	POACEAE	X	1
6	Hedychium coronarium	ZINGIBERACEAE	X	1
6	Hedychium gardnerianum	ZINGIBERACEAE	X	1
6	Holcus lanatus	POACEAE	X	1
6	Juncus effusus	JUNCACEAE	X	1
6	Juncus ensifolius	JUNCACEAE	X	1
6	Juncus planifolius	JUNCACEAE	X	1
6	Juncus tenuis	JUNCACEAE	X	1
6	Kyllinga brevifolia	CYPERACEAE	X	1
6	Paspalum urvillei	POACEAE	X	1
6	Pennisetum clandestinum	POACEAE	X	1
6	Sacciolepis indica	POACEAE	X	1
6	Schizachyrium condensatum	POACEAE	X	1
6	Setaria gracilis	POACEAE	X	1
6	Sporobolus africanus	POACEAE	X	1