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KUIA NATURAL AREA RESERVE
MANAGEMENT PLAN

Natural Area Reserves System
State of Hawaii

Department of Land and Natural Resources
1151 Punchbowl Street
Honolulu, Hawaii 96813

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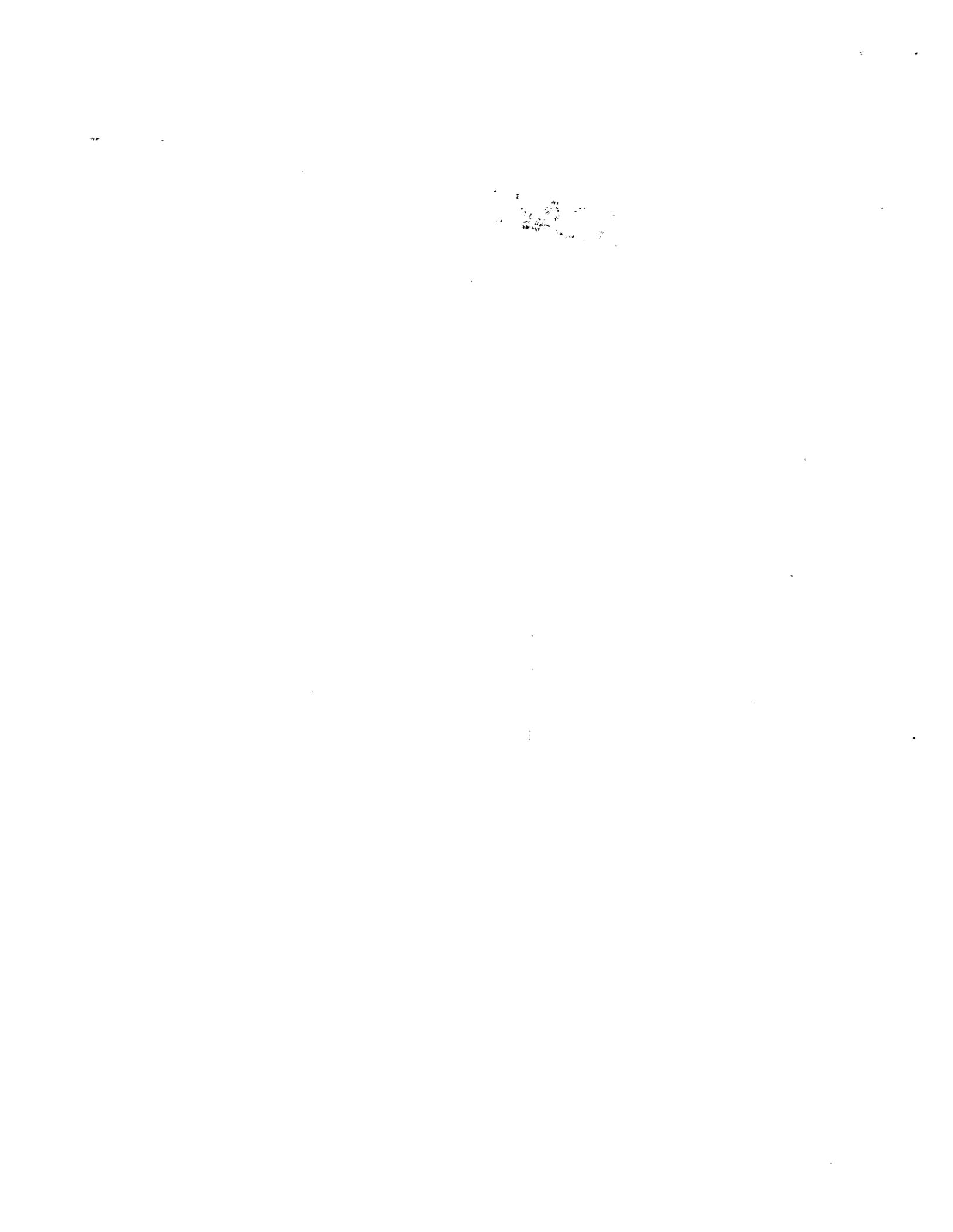


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 Management Plan

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HAWAII NATURAL AREA RESERVES SYSTEM
DEPARTMENT OF LAND AND NATURAL RESOURCES
KUIA NATURAL AREA RESERVE MANAGEMENT PLAN

I. INTRODUCTION

In 1970, Hawaii became one of the first states in the country to recognize the importance of its unique natural resources by establishing the State Natural Area Reserves System (NARS). The NARS is legally mandated to "preserve in perpetuity specific land and water areas which support communities, as relatively unmodified as possible, of the natural flora and fauna, as well as geological sites, of Hawaii" (HRS 195-1). To date, there are 18 reserves on 5 islands, occupying more than 108,000 acres of the state's most biologically diverse ecosystems.

Governor Waihee and the 1987 Legislature appropriated substantial new funding and legislative mandates to develop and implement management in the NARS. Directives were given to write comprehensive management plans for each reserve, based on the most current and relevant biological information available.

This plan describes the management program for Kuia Natural Area Reserve, established in 1981 by Executive Order 3097. The Reserve was established to protect mesic and wet native forest and shrubland ecosystems which include many rare plant taxa. The plan consists of five parts:

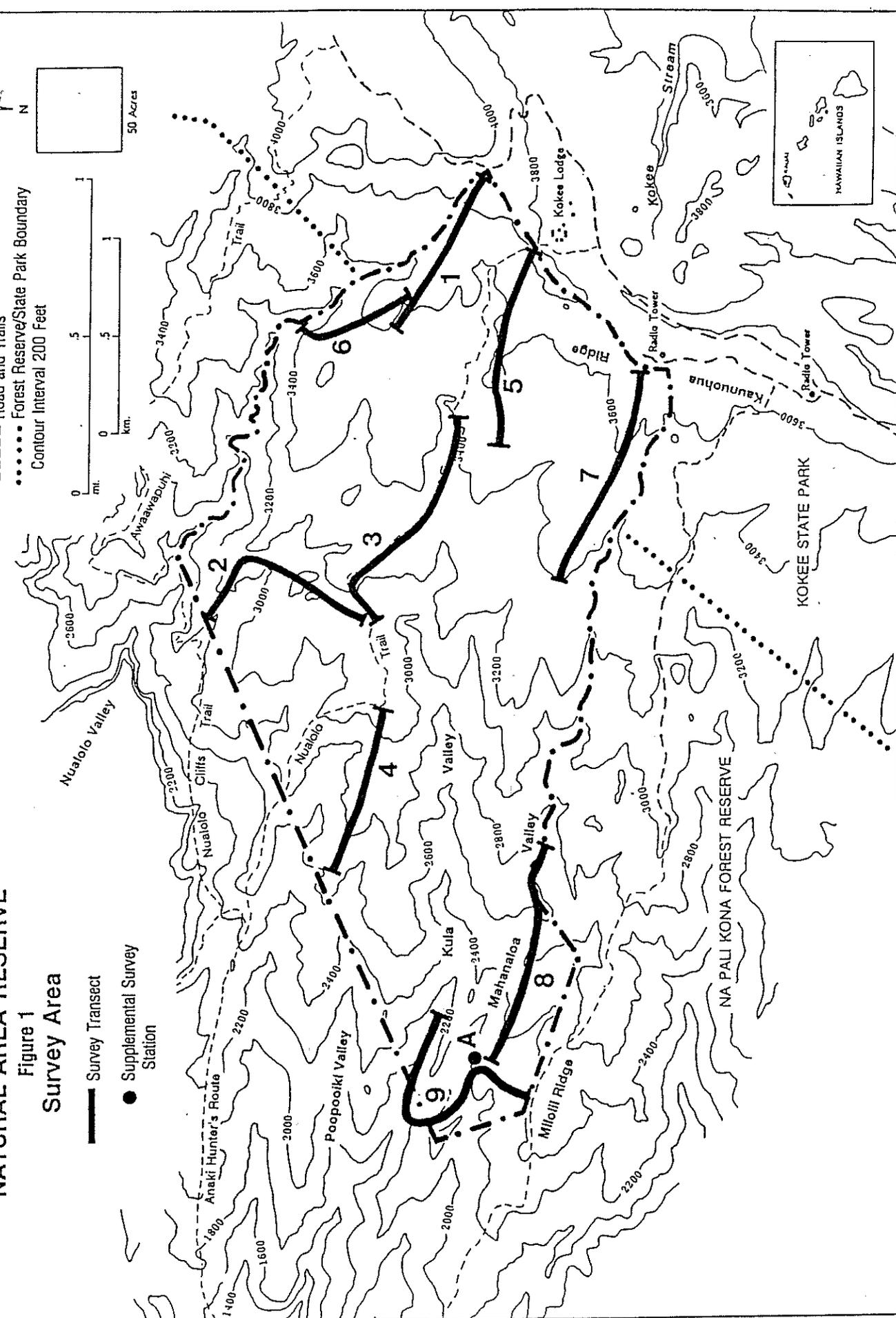
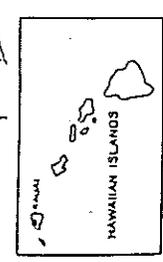
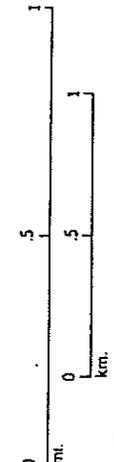
- o a brief Introduction to acquaint the reader with the project and how the plan was prepared;
- o a Resources Summary describing the Reserve's natural resources;
- o a Management plan describing programs recommended to maintain the Reserve's resources with an analysis of alternative actions and impacts;
- o a Budget Summary listing the funds necessary to carry out the management plan; and
- o Appendices describing resource information in more detail.

KUIIA NATURAL AREA RESERVE

Figure 1
Survey Area

-  Survey Transect
-  Supplemental Survey Station

-  Reserve Boundary
-  Road and Trails
-  Forest Reserve/State Park Boundary
-  Contour Interval 200 Feet



Three major sources of information were used to prepare this plan. The first was The Nature Conservancy's Hawaii Heritage database on natural communities and rare species. The second was a field inventory conducted in September 1988, specifically designed to collect data relevant to management of the Reserve's natural resources. The third was a review of this plan by qualified managers, planners, and biologists familiar with the area and its problems.

Survey crews spent nine field days gathering data along nine transects, ranging from 2,780-4,430 feet in length, and at one supplemental station (Appendix 1 and Figure 1). Transects were intended to sample the range of natural vegetation types as identified in aerial photographs. Detailed field forms were completed at sampling stations every 165 feet, noting the presence of natural communities, rare plants, native birds, feral ungulates, and weeds (Appendix 2).

This survey was designed to gather management-oriented resource information over a large area in a short time period, and was not intended to be a comprehensive biological inventory. Sampling of small mammals, birds, and invertebrates was incidental rather than systematic. Detailed survey methods are available upon request. A list of vascular plant species currently known from the Reserve is in Appendix 3; a list of bird species is in Appendix 4.

This plan is intended to establish long-range goals and management priorities at Kuia Natural Area Reserve, and to describe specific programs and activities to be accomplished during the 1989-1991 biennium. This plan will be updated biannually to incorporate new knowledge and refine management concepts.

II. RESOURCES SUMMARY

A. General Setting

Kuia Natural Area Reserve occupies 1,636 acres in the Waimea district of Kauai. Elevation ranges from 2,000 to 3,900 feet, encompassing lowland and montane vegetation types (communities). Many rare plant taxa are found within the Reserve's mesic and wet forests. Rainfall averages 40-80 inches annually; December is the wettest month, June the driest (Giambelluca, Nullet, and Schroeder 1986).

The Kuia Reserve lies partially within the Na Pali Kona Forest Reserve and adjacent to Kokee State Park (Figure 1). The Reserve is traversed by the Nualolo Trail; north of the Reserve is the Awaawapuhi Trail, and south is Milolii Ridge. Just outside the Reserve's eastern boundary are Kokee Lodge, museum, and cabins of Kokee State Park, accessed by the two-lane Highway 55. A NASA

tracking station, known as the Kokee Instrumentation Station, abuts the Reserve's southeastern boundary. Valleys and ridges cross the Reserve from west to east; Mahanaloa Valley crosses near the south boundary, then Kuia, Poopooiki, and Nualolo valleys further north. No roads cross the Reserve.

The Kuia Reserve protects important rare native communities and associated rare species. Two of the native natural communities are considered rare, as they are known from less than 20 locations worldwide. The Reserve is used by the public for hiking and hunting; Nualolo Trail is a frequently hiked trail. Hunters hunt pig and deer in the forests, and goats on the dry lower ridges.

B. Flora

Four native vegetation types were identified during the September survey of the Kuia Natural Area Reserve, with patches of non-native dominated vegetation occur throughout the Reserve, but are not recognized as a community. The Reserve's natural community map (Figure 2) is designed to show the general distribution of vegetation types in the Reserve, and the vegetation type boundaries are not meant to be absolute. The map does not reflect complex transitions between communities, or small patches of communities within others.

Two of the natural communities surveyed are considered rare: Koa/`Ohi`a (Acacia koa/Metrosideros polymorpha) Mixed Montane Mesic Forest, and Kauai Diverse Lowland Mesic Forest (known only from the west Kokee area of Kauai). Koa/`Ohi`a Lowland Mesic Forest was also surveyed, but is more widespread throughout the state and not considered rare. During aerial reconnaissance, patches of Kawelu (Eragrostis variabilis) Lowland Mesic Grassland were observed on drier, south-facing slopes below 3,000 feet elevation near the seaward (western) boundary of the Reserve (Figure 2).

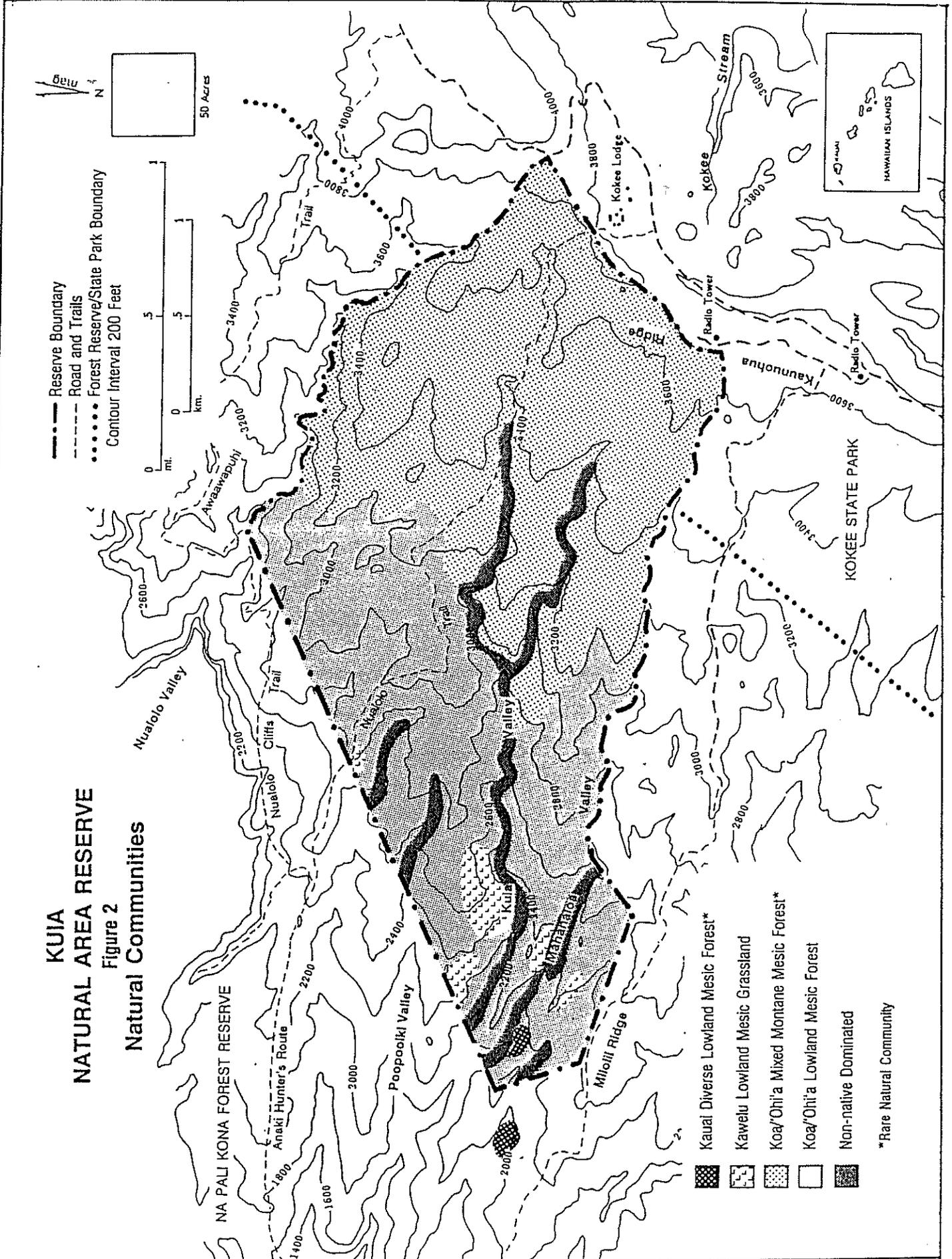
Non-native vegetation is found in Kuia Reserve at all elevations. In November of 1982, Hurricane Iwa severely damaged the forest canopy in Kuia, and contributed to an increase in cover of several non-native plants.

Lowland mesic forests containing a high diversity of native trees in which the dominant tree varies are known from Kauai, Oahu, and Lanai. Each island contains a different set of constituent tree species, and each geographical subtype is considered rare. The Kauai subtype, Kauai Diverse Lowland Mesic Forest, is known only from the 2,000 feet elevation in the Kokee area; the best known example is in the Reserve's Mahanaloa Valley area (Figure 2). Another intact patch is located just outside the Reserve boundary also in Mahanaloa Valley, and two heavily degraded patches are reported from Koaie Canyon, a tributary of Waimea Canyon east of

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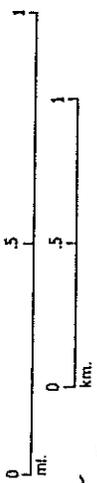
Figure 2

Natural Communities



- Kauai Diverse Lowland Mesic Forest*
- Kawelu Lowland Mesic Grassland
- Koa'Ohia Mixed Montane Mesic Forest*
- Koa'Ohia Lowland Mesic Forest
- Non-native Dominated
- *Rare Natural Community

- Reserve Boundary
- Road and Trails
- Forest Reserve/State Park Boundary
- Contour Interval 200 Feet



KOKEE STATE PARK

Kokee Lodge

Radio Tower

Radio Tower

Ridge

Kaunohua

Kokee Stream

Nualolo Valley

Nualolo Cliffs

Anaki Hunter's Route

Poopooliki Valley

Māhānalo Valley

Milioili Ridge

the Reserve. Subsequent surveys may discover other patches of the rare diverse mesic forest in the Reserve.

The canopy stature of the rare forest patch surveyed in the Reserve's Mahanaloa Valley ranged from about 15 feet to over 30 feet in height, and was generally dense. Several tree species were locally dominant in the canopy, including lama (Diospyros sandwicensis), papala kepau (Pisonia sandwicensis), the rare Euphorbia haeleeleana, mehame (Antidesma platyphyllum var. hillebrandii), 'a'ali'i (Dodonaea viscosa), alahe'e (Canthium odoratum), kalia (Elaeocarpus bifidus), olopua (Nestegis sandwicensis) and 'ohi'a. Other trees, while not as numerous, included another species of lama (Diospyros hillebrandii), as well as alani (Pelea ovata), kolea (Myrsine lanaiensis), maua (Xylosma hawaiiense), and koa.

The understory in the Kauai Diverse Lowland Mesic Forest was largely open. Seedlings and saplings of most of the canopy trees were present in the shrub layer, and ferns such as ho'i'o (Athyrium

TABLE 1
NATURAL COMMUNITIES OF KUIA NATURAL AREA RESERVE

Natural Community	HHP Rank ¹	Acreage ²
*Kauai Diverse Lowland Mesic Forest	1	10
Kawelu Lowland Mesic Grassland	3	47
*Koa/'Ohi'a Mixed Montane Mesic Forest	1	838
Koa/'Ohi'a Lowland Mesic Forest	3	587
Non-native Dominated	E	154

* = Rare Natural Community

¹ Key to Hawaii Heritage Program Ranks:
1 = Critically imperilled globally (typically 1-5 occurrences)
3 = Restricted range (typically 21-100 occurrences globally)
E = Exotic; non-native community

² Acreages are based on vegetation types mapped in Figure 2. Due to mapping and survey constraints, complex transitions between communities, or small patches of communities within others, are not accounted for.

sandwichianum), palapalai (Microlepia strigosa), `okupukupu lau`i`i (Doodia kunthiana), and moa (Psilotum nudum) were occasionally seen. Infrequent clumps of Carex wahuensis were also typical in this mesic forest; maile (Alyxia oliviformis) was a common liana.

Koa/`Ohi`a Mixed Montane Mesic Forests are known from the islands of Kauai, Maui and Hawaii, but are best developed on Hawaii. The community is often logged, and is therefore threatened throughout its range and considered rare. Especially good habitat for native forest birds, this forest type also contains rare plants. The diversity of trees in this forest is higher than almost any other forest type in the state.

In the Kuia Reserve, this tall-statured (greater than 30 feet in height), species-rich forest dominated by koa and `ohi`a was observed throughout about half of the Reserve, generally above 3,000 feet (Figure 2). In small patches it extended to as low as 2,600 feet (too small to be shown in Figure 2); below 3,000 feet the koa/`ohi`a canopy was not as tall, and graded into the simpler Koa/`Ohi`a Lowland Mesic Forest (description following).

The secondary layer of native tree species under the tall koa/`ohi`a canopy of the mixed montane mesic forest included `ahakea (Bohea brevipes), `ohe (Tetraplasandra kavaiensis), mehame, maua, po`ola (Claoxylon sandwichense), kawa`u (Ilex anomala), holio (Cryptocarya mannii), kopiko (Psychotria mariniana), kolea, kalia, ho`awa (Pittosporum gayanum and P. glabrum), `ala`a (Pouteria sandwicensis) and olopua.

Native shrubs identified in this community included Cyrtandra longifolia, Cyanea leptostegia, naupaka (Scaevola procera), akia (Wikstroemia furcata), the rare Platydesma rostrata, pilokea (Platydesma spathulata) and manono (Hedyotis terminalis and H. acuminata). Saplings of several tree species previously listed were also in the shrub layer. Several rare plants were observed in this forest, encompassing 10 genera. Ferns were not particularly well represented, but included such species as wahine noho mauna (Adenophorus pinnatifidus), ho`i`o, lo`ulu (Coniogramme pilosa), Elaphoglossum spp., uluhe (Dicranopteris linearis), `okupukupu lau`i`i, laukahi (Dryopteris glabra and D. wallichiana) and palapalai.

The transition of the rare koa/`ohi`a montane forest to a simpler Koa/`Ohi`a Lowland Mesic Forest was observed on the drier ridge tops below about 3,000 feet elevation. The understory of the koa/`ohi`a lowland forest was relatively simple, consisting primarily of pukiawe, `a`ali`i, `uki`uki (Dianella sandwicensis), Gahnia beechyi, and naupaka.

Severe damage to the forest canopy during Hurricane Iwa allowed an increase in several non-native plants, which were

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observed throughout the Reserve during this survey. The lower elevation gulch bottoms were kukui (Aleurites moluccana)-dominated riparian forest, while disturbed gulch bottoms in the higher elevations were occupied by a combination of Lantana (L. camara), banana poka (Passiflora mollissima), thimbleberry (Rubus rosifolius) and blackberry (Rubus argutus). Dry ridges below 2,800 feet were sometimes dominated by molasses grass (Melinis minutiflora), while forests at those elevations sometimes included a high percentage of silk oak (Grevillea robusta). Threats posed by specific weeds in the various natural communities are discussed in the management section on non-native plant control.

The Kuia Reserve has many rare plant species. For the purposes of this report, a species is considered rare if it is known from 20 or fewer locations worldwide, or less than 3,000 individuals. Due to changes in taxonomy, some taxa currently listed as candidate species in the most recent Federal Register may no longer be considered rare by the Hawaii Heritage Program, and their federal status is being reevaluated (Herbst pers. com.). Because many native plants lack unique Hawaiian or common names, scientific names are used throughout this section on rare plants. Hawaiian names, where available, are provided in Table 2.

Of the 50 rare plant taxa reported from the Kuia Reserve area, 28 have been verified within the Reserve boundary (Figure 3 and Table 2). The other 22 taxa are known from adjacent areas (Appendix 3). Six additional rare taxa, Alsinodendron viscosum, Diellia erecta, Gardenia remyi, Pelea degeneri, Phyllostegia wawrana, and Poa siphonoglossa, are reported in literature from the area, but location information is insufficient to definitively list as in the Reserve or immediately adjacent.

None of the 28 rare plant taxa reported to occur in the Kuia Reserve is officially listed as endangered by the U.S. Fish and Wildlife Service (1987). Four taxa, Chamaesyce remyi var. remyi, Hibiscus kokio ssp. saintjohnianus, Labordia helleri, and Peucedanum sandwicense, were on the Federal Register as candidates under previous taxonomic treatment. Due to new taxonomy, their federal status is being reevaluated (Herbst pers. com.). Sixteen taxa are candidates to be listed as endangered or threatened (Table 2), and their taxonomy has been maintained by Wagner et al. (in press).

Of the 28 rare plant taxa confirmed within the Reserve, 14 were seen during the survey (Table 2). Of the 14 not seen during the survey, 5 have been seen recently (since 1972) (Table 2). In the western section of the Reserve, several rare species were seen (Figure 3). Euphorbia haeleeleana was seen in two community types. The population in Poopooiki Valley was large (60-80 plants), and many seedlings and immature fruit were observed in the Koa/'Ohi'a Mixed Montane Mesic Forest. Southwest of the Poopooiki Valley

TABLE 2
RARE PLANTS OF KUIA NATURAL AREA RESERVE

Scientific Name ¹ Former Name ² (Common Name)	Current (Historic) Occurrences ³	Federal Status ⁴	HHP Rank ⁵
<u>Canavalia napaliensis</u> (`awikiwiki, puakauhi)	1(0)	-	1
<u>Chamaesyce remyi</u> var. <u>remyi</u> <u>Euphorbia remyi</u> (`akoko)	0(1)	- C1	1
<u>Delissea rhytidosperma</u> (`oha, haha, `ohawai)	0(1)	C1	1
<u>Diellia laciniata</u> (-)	0(1)	C1	1
* <u>Dubautia latifolia</u> (na`ena`e)	4(1)	C1	1
* <u>Dubautia microcephala</u> (na`ena`e)	2(1)	C1	2
* <u>Euphorbia haeleeleana</u> (`akoko)	2(0)	C1	1
<u>Hibiscus kokio</u> ssp. <u>saintjohnianus</u> <u>H. saint-johnianus</u> (koki`o`ula`ula)	1(0)	- C2	1
* <u>Isodendrion laurifolium</u> (aupaka)	3(0)	C1	1
<u>Joinvillea ascendens</u> ssp. <u>ascendens</u> (`ohe)	0(1)	-	1
* <u>Kokia kauaiensis</u> (koki`o)	2(0)	C2	1
* <u>Labordia helleri</u> <u>L. kaalae</u> var. <u>kauaiensis</u> (kamakahala)	1(0)	- C1	1
* <u>Lepidium serra</u> (`anaunau, naunau, kunana)	2(1)	C1	1
<u>Lindsaea repens</u> var. <u>macraeana</u> (-)	0(1)	-	1
* <u>Lobelia yuccoides</u> (panaunau)	1(1)	-	2
* <u>Lysimachia kalalauensis</u> (kolokolo huahiwi)	2(0)	C1	1
* <u>Neraudia kauaiensis</u> (ma`aloa, ma`oloa, `oloa)	1(0)	C1	2

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Scientific Name ¹ Former Name ² (Common Name)	Current (Historic) Occurrences ³	Federal Status ⁴	HHP Rank ⁵
<u>Neraudia melastomifolia</u> (ma`aloa, ma`oloa, `oloa)	1(1)	C2	2
<u>Nesoluma polynesianum</u> (keahi)	0(1)	-	1
<u>Nothocestrum peltatum</u> (`aiea)	0(1)	C1	1
<u>Peucedanum sandwicense</u> <u>P. sandwicense</u> var. <u>sandwicense</u> <u>P. kauaiense</u> (makou)	1(0)	- C2 C2	2
<u>Phyllostegia waimeae</u> (-)	0(1)	-	1
* <u>Platydesma rostrata</u> (pilo kea lau li`i)	1(1)	-	1
* <u>Psychotria hobdyi</u> (kopiko)	2(0)	-	1
* <u>Pteralyxia kauaiensis</u> (kaulu)	1(0)	C1	2
* <u>Remya kauaiensis</u> (-)	1(0)	C1	1
<u>Solanum sandwicense</u> (popolo-`ai-a-ke-akua)	1(1)	C1	1
<u>Xylosma crenatum</u> (maua)	0(1)	C2	1

* Observed during 1988 survey

¹ Wagner et al. (in press)
Wagner and Wagner (1987)

² Taxonomy used in 1985 Federal Register

³ Current occurrences reported since 1972

⁴ Key to Federal Status (USFWS 1985, 1987):
C1 Candidate for endangered or threatened status
C2 Candidate for endangered or threatened status, information lacking
- No federal status. Described as rare by Hawaiian botanists and confirmed by Heritage data

⁵ Key to Hawaii Heritage Program Ranks:
1 Critically imperilled globally (typically 1-5 occurrences)
2 Imperilled globally (typically 6-20 occurrences)

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population in Mahanaloa Valley, another large population (50-100 plants) with many seedlings, but no flowers or fruits, was observed in a patch of rare Kauai Diverse Lowland Mesic Forest. A small tree with inconspicuous flowers, this taxon is known from only a handful of locations in the Kuia area, Waimea Canyon, and two populations in the Waianae Mountains of Oahu (Wagner et al. in press).

Near the Euphorbia in the diverse mesic forest patch in Mahanaloa Valley, two deer-browsed Isodendrion laurifolium plants were observed. Another, larger population of 10-20 plants was observed north of the reserve boundary in Poopooiki Valley in koa/`ohi`a montane mesic forest. Isodendrion laurifolium is a shrub with small purple-green flowers, and is found on Kauai and Oahu (Wagner et al. in press).

Just inside the Reserve's western boundary, also in the rare diverse mesic forest, a mature tree and sapling of Pteralyxia kauaiensis were observed at the junction of Mahanaloa and Kuia valleys. This tree has dark shiny leaves and very small flowers. It is found on slopes and ridges in mesic and sometimes wet forests of Kauai (Wagner et al. in press). Schiedea membranacea was seen nearby, but just outside the Reserve boundary, on a shady streambank in a kukui-degraded example of the diverse mesic forest. Before Hurricane Iwa in 1982 this population was more extensive and healthy, but only 10 plants were seen during the survey, all of which were in very poor health. This perennial herb is known only from the Mahanaloa-Kuia area of Kauai (Wagner et al. in press).

Neraudia kauaiensis was observed southeast of the Pteralyxia near the Mahanaloa-Kuia junction in the Reserve on cliffs, also in a kukui-dominated section within the rare diverse mesic forest. Only two shrubs were seen, and neither was flowering nor fruiting. Male and female flowers are borne on separate trees, and are both inconspicuous. This taxon is known only from diverse mesic forests of Kauai (Wagner et al. in press).

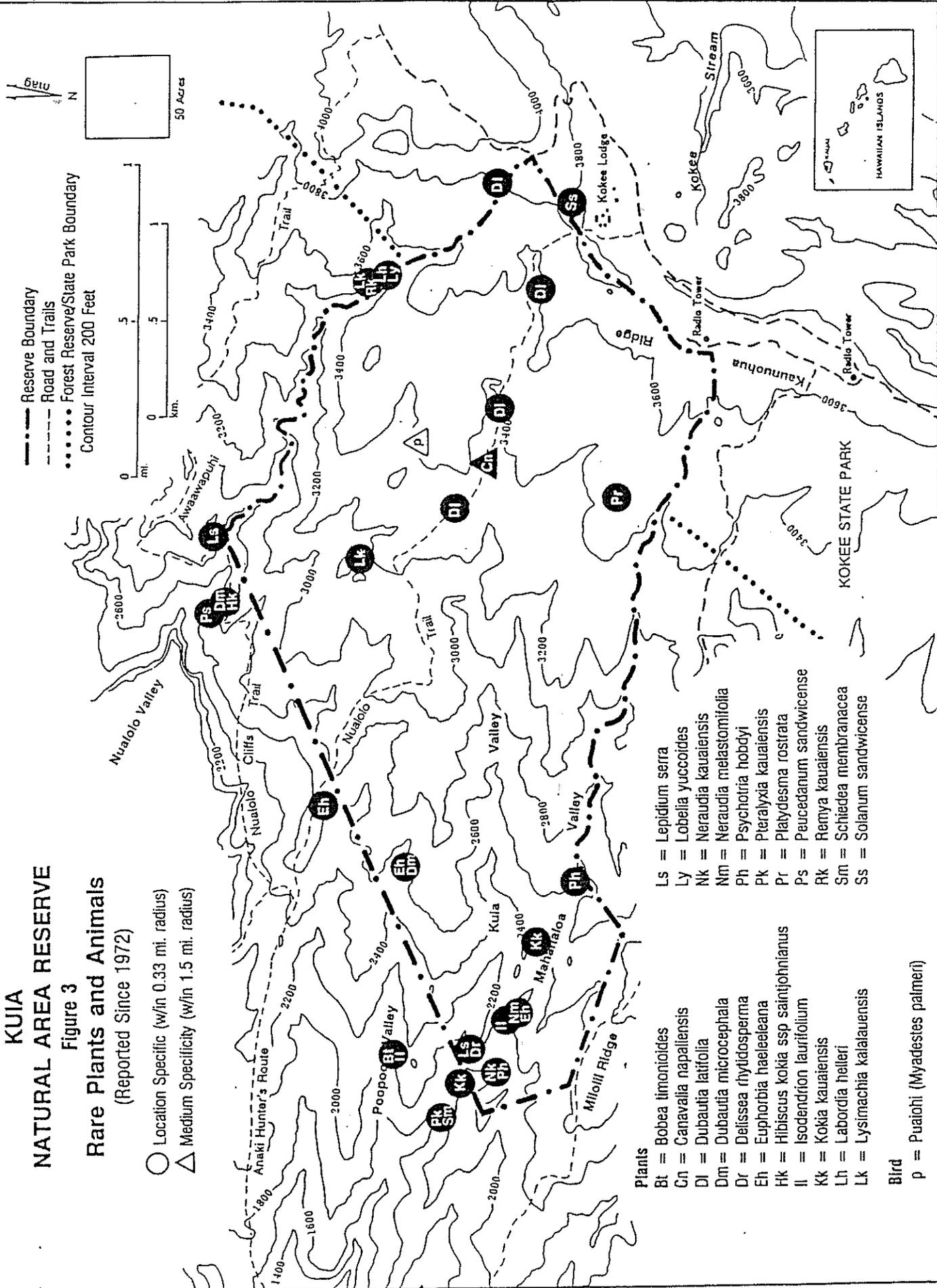
Psychotria hobdyi was observed during the survey in two separate locations of Mahanaloa Valley. One tree was seen at 2,000 feet near the Neraudia in a kukui-dominated streambed. Six flowering and fruiting trees, but no seedlings, were seen in the second population at the southern end of Mahanaloa Valley in the Reserve, in Koa/`Ohi`a Mixed Montane Mesic Forest. This tree has grayish brown bark and small unisexual flowers. Psychotria hobdyi is known only from the mesic forest of the Milolii-Kuia region of Kauai (Wagner et al. in press).

Also found in a non-native kukui-dominated gulch was Kokia kauaiensis, just north of the Neraudia and Psychotria observations. Kokia is a tree that has large, leathery reddish-orange flowers with papery bracts, which were seen during the survey. Originally

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Figure 3 Rare Plants and Animals (Reported Since 1972)

- Location Specific (w/in 0.33 mi. radius)
- △ Medium Specificity (w/in 1.5 mi. radius)



Plants

- Bt = *Bobea limonioides*
- Cn = *Canavalia napaliensis*
- DI = *Dubautia latifolia*
- Dm = *Dubautia microcephala*
- Dr = *Delissea rhytidosperma*
- Eh = *Euphorbia haeleleana*
- Hk = *Hibiscus kokia* ssp *saintjohnianus*
- Il = *Isodendron laurifolium*
- Kk = *Kokia kauaiensis*
- Lh = *Labordia helleri*
- Lk = *Lysimachia kalaiuensis*
- Ls = *Lepidium serra*
- Ly = *Lobelia yuccoides*
- Nk = *Neraudia kauaiensis*
- Nm = *Neraudia melastomifolia*
- Ph = *Psychotria hohdyi*
- Pk = *Pteralyxia kauaiensis*
- Pr = *Platydesma rostrata*
- Ps = *Peucedanum sandwicense*
- Rk = *Remya kauaiensis*
- Sm = *Schiedea membranacea*
- Ss = *Solanum sandwicense*

Bird

- P = Puaiohi (*Myadestes palmeri*)

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known as a single tree, it now occurs in diverse mesic forests of western Kauai (Wagner et al. in press).

Four individuals of Lepidium serra were seen near the Kokia, also in non-native kukui forest. This taxon is a small, many-branched shrub with small green flowers with white margins. It is generally found scattered on rocky ledges and cliffs in the mesic forests of Kauai (Wagner et al. in press).

Dubautia microcephala was observed in two populations, both in Koa/'Ohi'a Mixed Montane Mesic Forest. One was downslope of the Euphorbia in Poopooiki Valley. On a steep slope, the plants in Poopooiki Valley bore old inflorescences, but no flowers or seedlings. The other population, composed of only three shrubs, was seen in above Nualolo Trail on the Reserve's north-central boundary. This shrub has small yellow flowers borne in heads, and is known from only a few scattered locations on Kauai (Wagner et al. in press).

Two vines of Dubautia latifolia were seen in degraded Koa/'Ohi'a Mixed Montane Mesic Forest near the Reserve's eastern corner. No regeneration was evident. This species of Dubautia is a diffusely branched vine with small yellow flowers borne in heads.. It occurs in other mixed mesic forests of Kauai (Wagner et al. in press). A population of Platydesma rostrata was also observed in this natural community on the ridge between Mahanaloa and Kuia valleys in the south-central portion of the Reserve.

In Nualolo Valley on the Reserve's east boundary near the forest reserve/state park boundary, four rare plant taxa were seen near each other, in Koa/'Ohi'a Mixed Montane Mesic Forest. One Labordia helleri shrub with mature fruit and flower buds was seen. Typically this shrub bears 3-9 small white or pale greenish flowers in each inflorescence, and is found in the diverse mesic forests of valleys along the Na Pali Coast (Wagner et al. in press).

Lobelia yuccoides with immature fruits was seen near the Labordia. This taxon has a woody stem, with a dense rosette of leaves borne at the top and an unbranched inflorescence of curved blue or lilac flowers. Lobelia yuccoides occurs on dry ridges and canyons of Kauai and the Waianae Mountains of Oahu (Wagner et al. in press).

Remya kauaiensis was observed in Nualolo Valley, near the Lobelia and Labordia populations. Three small clumps with 10 plants total were seen in fruit. This sprawling shrub typically has creamy flowers borne in dense heads, and is known from only four populations in the Kokee area of Kauai (Wagner et al. in press).

One population of Lysimachia kalalauensis was seen in near

the Labordia, Lobelia, and Remya. Another population was seen northwest of there along the Nualolo Trail. Flowers of this sprawling shrub are green with a purplish base. Lysimachia kalalauensis is typically found in shady locations in the Kokee area, and Hanapepe Valley of Kauai (Wagner et al. in press).

Of the fourteen rare plant taxa observed in the Reserve during the survey, twelve are endemic to Kauai. Two taxa are endemic to Kauai and Oahu. Two other unidentified taxa, thought to be rare and possibly new species, were seen during the survey. One, a mint (Phyllostegia sp.) was observed on the ridge between Mahanaloa and Kuia valleys near the Platydesma. Ten spindly shrubs of the taxon, Schiedea sp. were observed on the ridge between Mahanaloa and Paaiki valleys which had been heavily browsed by deer. No flowers, which are needed for positive identification, were present on either taxa.

Twenty-two additional taxa have been reported near, but not in, the Reserve (Appendix 3). Of these, nine have not been seen recently (since 1972). One area that appears exceptionally rich in rare plant taxa is the Poopooiki-Mahanaloa valley region, both inside and out of the Reserve. Five rare taxa known from the Reserve occur here along with five additional taxa not found in the Reserve, all less than one-half mile outside the Reserve boundary. The five additional taxa are Bonamia menziesii, Dissochondrus biflorus, Flueggea neowawraea, Lipochaeta fauriei, and Schiedea membranacea. Additional surveys of the Reserve may uncover all of these taxa, as well as some new taxa, within suitable habitats of the Reserve.

C. Fauna

Forest birds were the only native vertebrates observed during this survey of Kuia Reserve. Several common species were observed in the Reserve's koa/`ohi`a forest along the survey transects, including `I`iwi (Vestiaria coccinea), `Apapane (Himatione sanguinea sanguinea), Kauai `Amakihi (Hemignathus virens stejnegeri), and `Elepaio (Chasiempis sandwichensis sclateri). Less frequently observed were `Anianiau (Hemignathus parvus), and Kauai `Akepa (Loxops coccineus caeruleirostris). Incidental sightings of the indigenous marine bird Koa`e kea (or White-tailed Tropicbird, Phaethon lepturus dorotheae), and the visiting shorebird Kolea (Pluvialis dominica), were made just outside of the reserve boundary. No rare birds were seen during this September survey.

Six native Kauai forest birds are listed endangered by the U.S. Fish and Wildlife Service, and are known from the Alakai Swamp, northeast of the Reserve. Many of the native bird species have contracted their ranges to remote areas of the swamp where they still outnumber introduced species and their habitat remains

intact (Scott et al. 1986). Kuia is separated from the swamp by a series of gulches and the complex of roads and buildings at Kokee State Park. The last bird surveys to cover the reserve area were the U.S. Fish and Wildlife Service single-man surveys of 1968-1973, during which two incidental sightings of rare species were recorded in and near Kuia (USFWS 1983).

Only Puaiohi (Myadestes palmeri) has been confirmed in the Reserve, though one other species has been seen within three-quarters of a mile from the Reserve recently (since 1972). Puaiohi had only been reported prior to 1900 in Kokee State Park until it was seen in 1973 east of the Nualolo trail during the USFWS single-man survey (Figure 3) (Banko 1980). Kauai Nuku-pu'u was seen as recently as 1988 east of Kuia's eastern-most boundary. Three other rare bird species known historically from the Reserve area are Kama'o (Myadestes myadestinus), Kauai 'O'o (Moho braccatus), and Kauai 'Akialoa (Hemignathus procerus). Kama'o was last seen in 1970 east of Kokee Lodge in the state park (Banko 1980). This species was also seen immediately north of Kuia in the Awaawapuhi Trail area during a 1968 USFWS single-man survey. The Kauai 'O'o and 'Akialoa were seen in the late 1800s south of the Reserve, and the 'O'o was last seen not far east of the Kokee Lodge area in 1946 (Banko 1981, 1984).

Non-native birds such as Japanese White-eye (Zosterops japonicus) and Hwamei or Melodious Laughing-thrush (Garrulax canorus) were common in the Reserve. Incidental sightings of the common myna (Acridotheres tristis) were made, particularly in the vicinity of Kokee Road. Red Jungle-fowl (Gallus gallus) were widespread in the Reserve. Because the Jungle-fowl are ground feeders, they may have impacted the snail population in the Reserve; no snail species were seen during the survey.

There was scattered evidence of small mammals, probably rat (Rattus sp.), which are likely widespread in the Kuia Reserve. Rodent predation on kukui and other plants was evident; the fruit of Passiflora edulis showed signs of rat predation. One large rat was seen in the drier koa/'ohi'a forest on transect 3, travelling arboreally along large branches in broad daylight. A metallic skink was seen in Kuia Valley, and is probably also widespread throughout the Reserve.

Three ungulate species were evident in the Kuia Reserve. Pig sign was common, especially in gulch bottoms and lower slopes at all elevations. Deer droppings, trails and damage was evident on ridge tops as high as 3,600 feet elevation, which is probably not the upper limit. Evidence of deer was observed in dense forest, but seemed to increase at lower elevations where more open forest was prevalent. Goats were not encountered on transect, but were seen from helicopter on open ridges near the lower boundary of the Reserve near the head of Nualolo Valley. Management of these

ungulates in the Reserve is discussed in the Ungulate Control section of this plan.

Because the Kuia Reserve contains a high diversity of plant species, the associated native invertebrate diversity is also high. Native insects and spiders were observed on all transects, and it is almost a certainty that the Kuia Reserve will yield new species of native arthropods if intensive surveys are conducted. The potential for invertebrate research in the Kuia Reserve is very high, because of a combination of good access, intact native forest stands, and a range of elevation.

Several non-native invertebrates were observed while on transect. In addition to the usual complement of non-native flies that accompany feral ungulates, and non-native honeybees that have spread throughout Hawaiian forest areas, there were several non-native species of concern to natural area management.

Mosquitos were encountered in gulches below 2,800 feet. These mosquitos are potential vectors of avian diseases thought to contribute to the decline of native birds. Yellow-jackets (Vespula sp.) were seen frequently at all elevations in the Reserve, and are probably widespread in the area. These ground-nesting predatory wasps pose a threat to native insects, and can disrupt pollination by competing with native pollinating species such as flies, moths and bees. Nest sites are probably concentrated in the lower, drier portions of the Reserve. Several control methods are being tested in both the Haleakala and Hawaii Volcanoes National Parks and may be applicable to Kuia Reserve.

Ants (unidentified Formicidae) were seen in drier situations below 2,800 feet elevation. Like Vespula, ants are generalist predators that can disrupt native invertebrate populations. Control of ants in the Reserve is probably not feasible, although several techniques are being developed in Haleakala National Park.

III. MANAGEMENT

A. Key Management Considerations

The management goal is to protect and maintain the Reserve's native ecosystems. The following key considerations were included in the management programs developed to achieve this goal:

- 1) Intensive management of the entire Kuia Reserve is not economically realistic at this time. Management of specific areas has been prioritized based on the biological resources they contain, the extent of current disturbances, the nature of other biological threats within and near the area, and the feasibility of management (e.g. topography and access).

Management activities will focus on intact pockets of native vegetation in the Reserve, protecting them from feral ungulates and aggressive weeds.

- 2) Pigs, goats, and deer constitute a severe threat currently affecting the Reserve (Figure 4). Pig rooting and wallowing destroy native plants and the forest floor cover. Such damage limits effective regeneration of native plants, and creates conditions favorable for certain non-native weeds throughout the Reserve. Deer and goats browse native plants and disperse seeds of non-native weeds. Control of the feral ungulates is an essential step in maintaining the Reserve's native plant communities. Management to achieve this is outlined in detail in the Ungulate Control Program.
- 3) Hurricane Iwa devastated the Reserve in 1982, blowing down much of the forest canopy, creating gaps and clearings in the forest. Noticeable reestablishment of koa seedlings and vigorous sapling growth has occurred within hurricane damaged stands of mature koa and koa-`ohi`a forests. Unfortunately, certain non-native species have formed monotypic stands and displaced native vegetation over large areas. Large-scale removal of these infestations is not cost effective and control activities will focus on certain invasive weeds within specific areas. Continuing and increased efforts to develop effective biologic control agents for aggressive weeds in the Reserve are needed.
- 4) Establishment of a volunteer field base in the Kokee area would enhance public involvement in the management of the Kuia Reserve. The Reserve, because of its accessibility and location for popular hiking trails, presents an important opportunity for exposure and public cooperation in natural area management in Hawaii.
- 5) Evidence of marijuana cultivation was seen in all parts of the Reserve. This illegal activity creates a hazard for people working in the Reserve. Increased enforcement presence is needed to curtail illegal growing activity within the Reserve.

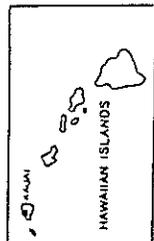
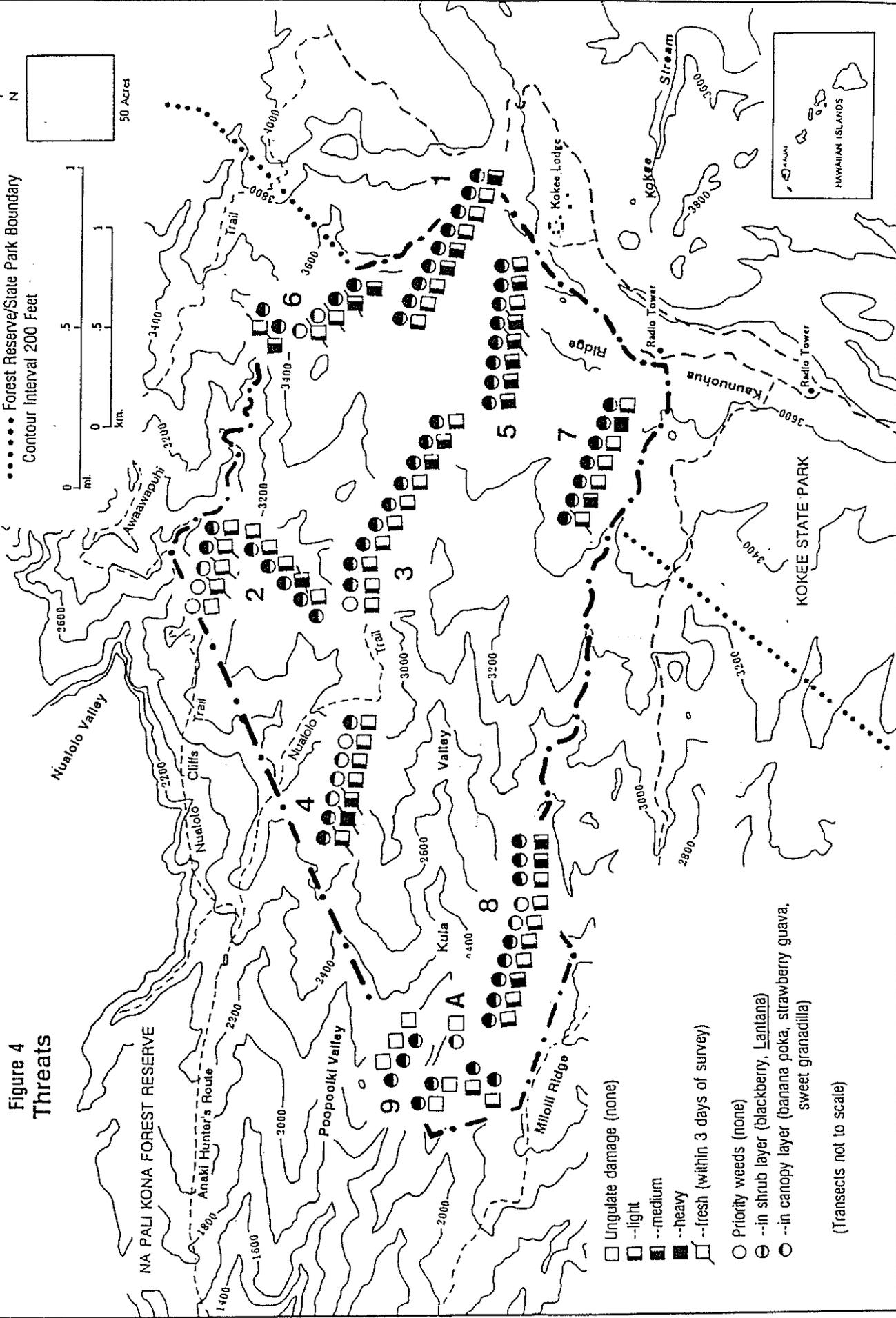
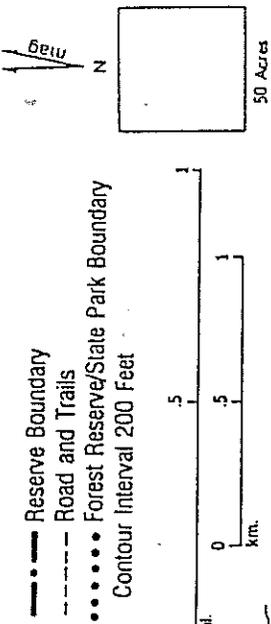
B. Management Unit Descriptions

The Reserve has been divided into three management units (Figure 5). Descriptions of each unit follow, and outline problems, key program features, and management priorities:

- 1) Kaunuohua Unit - This unit encompasses 573 acres, extending from the 3,400 foot elevation to the top of the Reserve along Kaunuohua Ridge. It includes koa/`ohi`a forests, rare plants, and the best native bird habitat in the Reserve. Serious

KUIJA NATURAL AREA RESERVE

Figure 4
Threats



- Ungulate damage (none)
 - ▤ --light
 - ▥ --medium
 - ▧ --heavy
 - ▨ --fresh (within 3 days of survey)
 - Priority weeds (none)
 - ⊖ --in shrub layer (blackberry, Lantana)
 - ⊙ --in canopy layer (banana poka, strawberry guava, sweet granadilla)
- (Transects not to scale)

threats include non-native plants and damage by feral mammals, particularly feral pigs and deer. The most important weeds observed were blackberry, banana poka, strawberry guava (Psidium cattleianum) and Lantana.

The unit has one of the best examples of a highly diverse mixed mesic forest between 3,700 and 3,800 feet, which extends into adjacent State Parks land on the hill above Kokee Lodge and cabins. The unit also has an intact stand of highly diverse forest with very large trees of koa, `ohi`a, and kawila (Alphitonia ponderosa) along the proposed Koa Trail at 3,500 elevation (See Figure 6). Both of these areas have a high priority for weed removal.

- 2) Kuia Unit - This 915-acre unit extends from the Reserve's lower boundary to 3,400 foot elevation along the proposed Kuia Trail. It includes mostly koa/`ohi`a lowland forests with some mixed montane forests above 3,200 feet. Threats include feral ungulates, and non-native plants, especially blackberry, lantana and strawberry guava. A firebush (Myrica faya) infestation in the northwest corner of the unit needs control.
- 3) Mahanaloa Unit - This small unit of 148 acres is in the southwestern corner of the Reserve and includes the best example of Kauai Diverse Lowland Mesic Forest found, with rare plants Euphorbia haeleeeleana, Pteralyxia kauaiensis, Neraudia kauaiensis, and the beautiful red flowered Kokia kauaiensis. Non-native plants, especially Lantana and kukui, have displaced Kauai diverse mesic forest in gulches. This unit has the highest priority for weed removal. Fencing around small pockets of intact stands of native flora may be needed for ungulate control. Further survey of the north-facing slopes in the unit is recommended to identify other intact pockets of native forest.

C. Management Programs

The following four management programs outline the long-term goals for the Reserve. A six-year implementation schedule is proposed. Although the programs are listed by priority, they fit together to form an integrated management package.

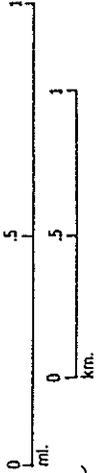
Priority #1 - Ungulate Control Program (KUI-RM-01)

GOAL: Eliminate feral ungulates in select areas of high biologic value. In the rest of the Reserve, reduce the impact of ungulates to a level that prevents further degradation of the Reserve's native ecosystems and allows the greatest possible recovery of the Reserve's native species.

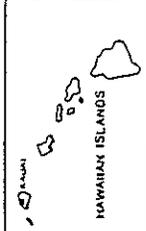
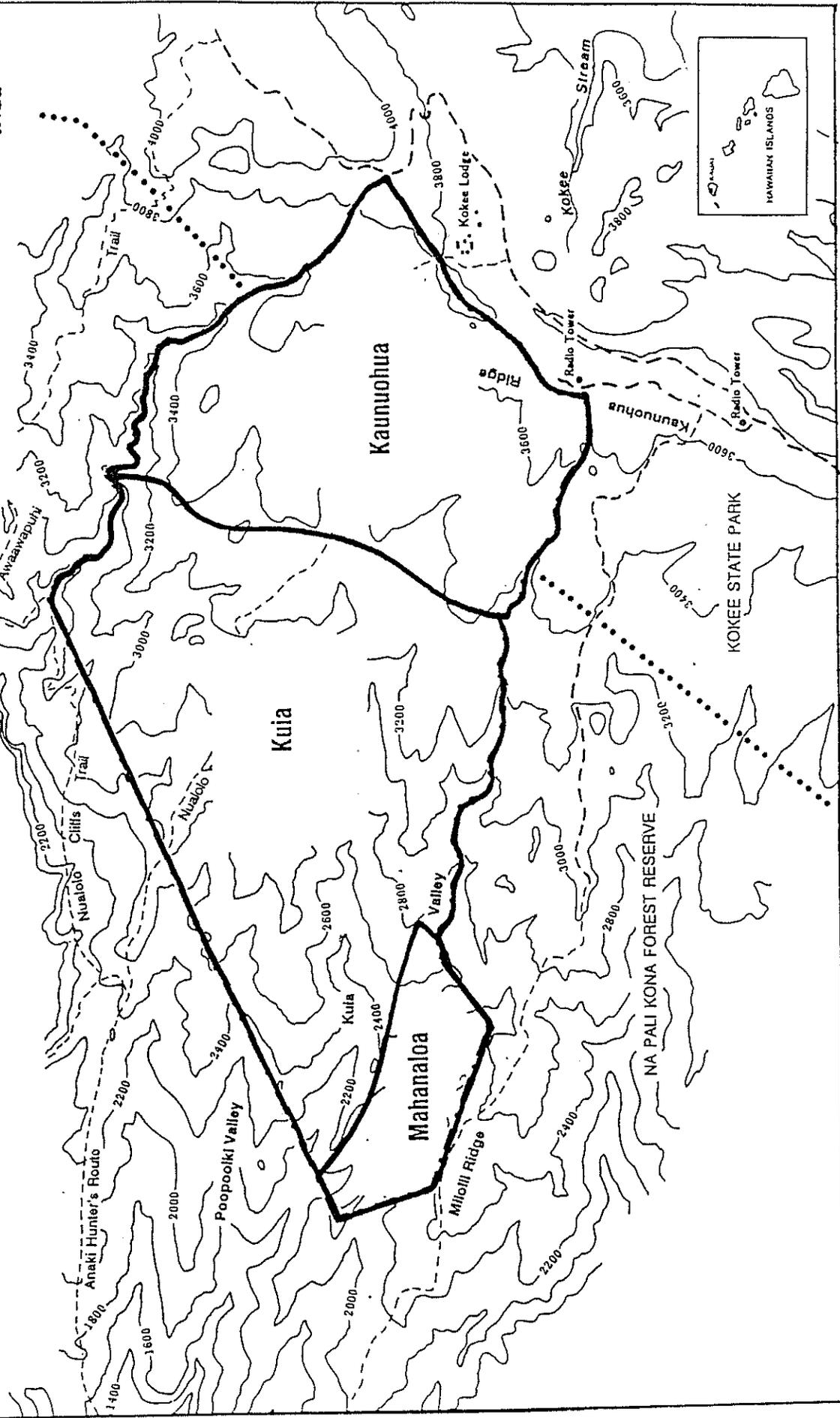
KUIA NATURAL AREA RESERVE

Figure 5
Management Units

- Reserve Boundary
- - - Road and Trails
- Forest Reserve/State Park Boundary
- Contour Interval 200 Feet



— Management Unit Boundary



Statement of the Problem: Feral ungulate control is critical to the survival of native ecosystems in the Reserve. There are many techniques for feral ungulate control. The NARS manager will need the flexibility to use all the tools available, as the Kuia Reserve presents different resource protection priorities and species requiring control. These tools include public and staff hunting, fencing, and snaring.

Black-tailed Deer (Odocoileus hemionus) were found throughout the Reserve. Although they are not congregating in any one area, deer tracks, browse, and scat were widespread from the upper elevation koa/`ohi`a forests to the lower, drier koa shrub forests. Deer browse native vegetation and spread seeds of banana poka and strawberry guava. Pigs are also prevalent, with some moderate to severe digging in some lower isolated valley draws and gulches (Figure 4). Goats were commonly seen on the lower dry slopes over Nualolo Valley. Steep terrain and poor access has limited hunting pressure.

Alternative Actions and Probable Impacts:

- 1) No action. Accept the continuing deterioration of Kuia's native resources. Without control, pigs, deer, and goats will degrade native communities, lower biological diversity, and increase non-native plant invasion.
- 2) Attempt control of feral ungulates using only public hunting. Do not attempt to use fences, staff hunting, or snaring within the Reserve. Impacts of ungulates under this alternative will probably be roughly the same as alternative #1, except for portions of the Reserve where increased hunting activity may keep populations down and protect small areas of forest.
- 3) Control feral ungulates with a liberal public hunting season supplemented by staff hunting, fencing, and snaring where necessary. Create and maintain access trails into priority management areas. Conduct special public hunts where appropriate to maintain hunting pressure within the Reserve. These activities will keep feral ungulate populations down, thus allowing recovery of native vegetation. The spread of non-native weed species by feral ungulates can be slowed. Native plant species surviving only as epiphytes because of feral ungulate disturbance can become re-established on the forest floor.

Recommended Action: Alternative #3 is recommended. Public hunting pressure will be increased by establishing and maintaining hunting trails. Because of limited accessible hunting areas on Kauai, public hunting pressure may be an effective tool for ungulate control in the Reserve, once access is improved and bag limits liberalized. Special hunts will also be used to concentrate hunters in specific portions of the Reserve. Horse travel,

strictly monitored and confined to Nualolo Trail, should be considered during special hunts to allow hunters to pack out animals in the lower portions of the Reserve.

A component of the feral ungulate control program is systematic monitoring. Monitoring will evaluate changes in levels of ungulate damage, the effectiveness of the management program in reducing damage, and the recovery of native vegetation (See Priority #3 - Monitoring Program). If monitoring indicates that public hunting is not effective in reducing ungulate damage, fencing and increased staff hunting may be necessary. At this time, fencing is not recommended.

Because of the windthrow and brushy conditions caused by Hurricane Iwa, foot travel within the Reserve is difficult. A 13.5 mile Reserve-wide management trail system is recommended to expedite work in the Reserve (Figure 6). These trails will not be developed and maintained for general recreational use but to allow easy and reliable access for NARS staff and hunters.

Two new ridge trails, running the length of the Reserve, are proposed to parallel the existing Nualolo trail. The new 2-mile Koa Trail, along the northern boundary of the Reserve, will pass through the Reserve's most intact koa stands, and connect into the existing Nualolo Cliffs Trail. An old portion of the Nualolo Trail (called the Old Trail-1 mile) will be reestablished to connect into the Koa Trail. The new 3-mile Mahanaloa Trail will run the length of the southern boundary of the Reserve with contours to connect into Milolii Ridge and the Nualolo Trail via the proposed 1.5-mile Poopooiki Trail. Two cross-contour trails will be established; the 1-mile Kaunuohua Trail along the top of the Reserve along Kaunuohua Ridge; and the 2-mile Kuia Trail along the 3,400 foot elevation dividing the Kaunuohua and Kuia management units. Volunteer groups can play an important role in establishing and maintaining forest trails in the Reserve (see Priority #4 - Volunteer Support Program).

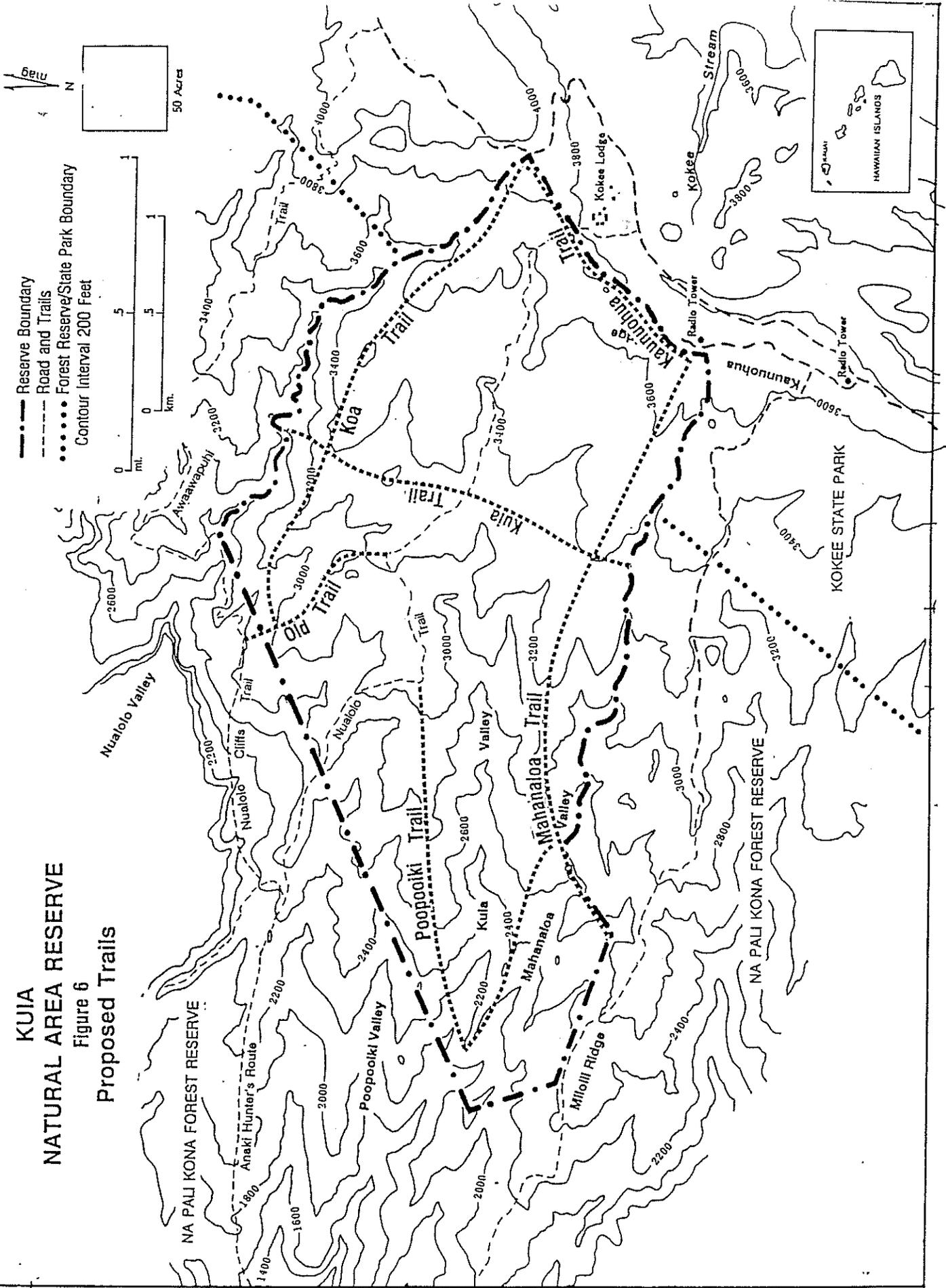
Cost/Workload: The following resources will be needed to conduct the ungulate control project:

Ungulate removal activities will consist of 10 days of staff hunting, and 20 days of special hunts for the general public (2 person crew for each) per year. Year-round public hunting seasons with no bag limits are recommended for the Reserve. Increased levels of staff hunting may be necessary if monitoring data indicate continued ungulate damage.

KUIA NATURAL AREA RESERVE

Figure 6

Proposed Trails



Year 1:	<u>Personnel</u>	
	Technician 50 person days (PD)	\$ 3,850
	Reserve Manager 10 PD	800
	<u>Materials and supplies</u>	
	Trail construction	21,000
	Staff hunting	1,000
	Special hunts	2,000
	Total	\$28,650
Year 2-6:	<u>Personnel</u>	
	Technician 50 PD	\$ 3,850
	Reserve Manager 10 PD	800
	<u>Materials and supplies</u>	
	Trail maintenance	6,750
	Staff hunting	1,000
	Special hunts	2,000
	Total	\$14,400

Supplies and support for a two-person crew for staff hunting (dogs, ammunition, etc.) and special hunts are estimated at \$100 per day. Management trail construction is estimated at \$2,000 per mile under contract. Trail maintenance is estimated at \$500 per mile per year under contract. Salaries are \$80 per day for a Reserve Manager and \$70 per day for technicians.

Priority #2 - Non-Native Plant Control Program (KUI-RM-02)

GOAL: To limit the spread and, where possible, eradicate non-native plant species which are already or may become invasive weeds in the Reserve.

Statement of the Problem: Many non-native plants have become established in Hawaii and their total removal from the Reserve is not feasible. The best control strategy is maintenance of intact native forests through limiting disturbance. While feral ungulate control will help, it is not completely effective in limiting weed spread, as many weeds are spread by birds and people.

After Hurricane Iwa severely damaged the canopy trees in the Kuia NAR in 1982, non-native plants, especially blackberry, banana poka, passion fruit (Passiflora edulis f. edulis), Lantana, strawberry guava, thimbleberry, and sweet granadilla (Passiflora ligularis) have successfully invaded the wind-thrown gaps in the canopy. This is especially true in valley bottoms, many of which are filled with one or more of the above species.

Blackberry is currently covering the forest in canopy openings and stream beds, mostly between 3,200-3,900 foot elevation.

Blackberry seeds are spread by birds and new plants also come up by root suckering. Blackberry has sharp thorns and forms dense thickets up to 10 feet high, forming a nearly impenetrable barrier. Banana poka and passion fruit are vining weeds which now smother much of the Kokee upper forest. Seeds are spread by birds and pigs with worst areas between 3,200-3,900 feet. Sweet granadilla is another related vine occurring in the lower drier regions between 2,000-3,000 feet elevation.

Strawberry guava is well established in the Reserve, especially in the southeast section near Milolii Ridge jeep road. Strawberry guava forms dense stands, spreading rapidly by seeds dispersed by birds and feral animals, as well as root suckering. Lantana is well established in the open drier areas and lower elevations of the Reserve. Lantana also has thorns and forms dense impenetrable mats often in stream beds, open valley bottoms, and south-facing slopes.

Special mention is the firebush (Myrica faya) population along the Nualolo loop trail. This plant spreads fast and its largest concentration in the Reserve is at this lower corner. Another non-native aggressive plant that is spreading over the drier slopes is molasses grass. Molasses grass, which is a fire hazard during dry periods, covers much of the slopes of upper Nualolo Valley.

This level of non-native plant invasion is beyond current control methods in areas of the Reserve. However, where native canopy was not as badly damaged, non-native plants are still absent, or present in low enough numbers to justify limited plant control measures. Vines can be cut from around the bases of selected large trees to free canopy trees from their stranglehold. Such preventative control may allow the forest to maintain sections with relatively intact understories while the canopy recovers..

Alternative Actions and Probable Impacts:

1) No non-native animal or plant control. This will lead to deterioration of native communities by blackberry, banana poka, lantana, strawberry guava and other aggressive species. Feral pigs, goats, deer, and birds will continue to disperse weed seeds. Disturbance of the forest floor by feral pigs will increase non-native plant establishment. Native plant regeneration in Hurricane Iwa damaged areas will be severely reduced by competition from aggressive non-native plant species.

2) Control ungulates, but do not attempt to control any priority weed species. This will reduce the spread of many ungulate-dispersed plant species, but will allow continued advance of weeds spread by birds and people. Decreased rooting and forest floor disturbance by feral pigs will slow down establishment of many non-native plants, but already established weeds may continue to spread unchecked. A few especially aggressive weeds could overwhelm large

areas.

3) Control priority non-native weed species in the key management areas before they become widely established. Set up monitoring transects to locate other incipient populations of priority weeds. Management measures would include selective use of approved herbicide and manual removal with hand tools.

4) Control all non-native plant species in the Reserve. This alternative would require substantial resources and may not be practical.

Recommended Action: Alternative 3 is recommended. The remaining intact pockets of native vegetation within the Reserve will be identified and weeds found within these areas removed. Selective cutting of Passiflora vines from around the bases of select large canopy trees is recommended to preserve this valuable seed source for future natural regeneration. The cut vines will decay in time and need not be removed. Control of the incipient population of fire bush is recommended. Monitoring and removal of new populations of priority weed species along trails will be necessary. Detailed records of the effectiveness of control methods used in the Reserve will be kept. Coordination between NARS and other involved agencies in plant control work will reduce management costs. Volunteer labor can play a major role in the non-native plant control program (See Priority #4).

Cost/Workload:

Year 1:	Reserve Manager 15 PD	\$ 1,200
	Technician 60 PD	4,200
	Supplies and support	4,000
	Total	\$ 9,425
Year 2-6: same as Year 1	Total	\$ 9,425/year

Salaries are \$85 a for reserve manager and \$70 a day for technician. Supplies and support include tools, herbicide, logistical support for volunteer and staff work crews.

Priority #3 - Monitoring Program (KUI-RM-03)

GOAL: Monitor the effectiveness of management projects and track significant ecological changes through long-term scientific monitoring.

Statement of the Problem: Management activities may not always achieve desirable results and management efficiency needs to be judged. Monitoring changes in non-native and native plant distribution, and animal species abundance entails recording

specific data at permanent points and transects in the Reserve. Monitoring also documents progress and facilitates refinement of management techniques employed in the Reserve.

Alternative Actions and Probable Impacts:

- 1) No monitoring program. This could lead to inefficient management resulting from poor understanding of the area's biological needs.
- 2) Conduct ad hoc monitoring whenever possible. This is likely to be considerably less effective in the long run than a systematic approach.
- 3) Establish systematic monitoring programs for ungulate damage, non-native weed invasion, native vegetation recovery, and status of rare species. Increase monitoring intensity for select problems and areas as needed.

Recommended Action: Alternative #3 is recommended. Develop monitoring programs to evaluate effects of management activities and identify future management needs. Specific goals of the program are to determine; 1) the effectiveness of staff and public hunting in reducing ungulate damage, 2) the success of priority weed species control, 3) the location of incipient populations of other priority weeds, and 4) status of known rare species. An annual overflight is recommended for photo documentation.

Cost/Workload: The following resources will be needed to conduct the monitoring project:

Year 1:	Reserve Manager 15 PD	\$ 1,275
	Technician 15 PD	1,050
	Helicopter (2 hours)	1,100
	Supplies	1,000
	Total	\$ 4,425
Year 2-6:	Same as year 1	Total \$ 4,425/year

Helicopter cost is \$550 per hour. Salaries are \$85 a day for reserve manager and \$70 a day for a technician. Supplies and support include film and development, software development, and office supplies.

Priority #4 - Public Education and Volunteer Program (KUI-RM-04)

GOAL: To build public understanding and support for the Reserve and the NARS in the local community. Educational opportunities will be provided for interested groups.

Volunteer labor to help staff in management activities will be recruited.

Statement of the Problem: Most residents and visitors are unaware of Hawaii's natural heritage. Even fewer realize that native resources and the benefits they provide are being threatened. Management of this Reserve will be a long-term effort, and public support is essential.

Concerned volunteer groups have proven successful in certain natural area management activities, especially in labor-intensive efforts such as fence construction, weed control, and trail maintenance. These groups tend to be extremely motivated, representing a valuable resource for the Reserve manager.

Alternative Actions and Probable Impacts:

1) Do not attempt to inform the general public about the resources protected in the Reserve or explain reasons for specific management actions. Do not use volunteer groups in management activities in the Reserve. The results of this alternative could include less public and legislative support for the NARS, misunderstanding among certain groups resulting in vandalism of capital improvements, and increased costs for overall NARS management, especially in plant control work.

2) Maintain community outreach program to give public presentations, provide informational material, and utilize concerned volunteer groups. This could result in cooperation with the general public in feral ungulate and non-native plant control programs and result in less expensive yet more effective management results. It could also provide a local constituency that would support Reserve management activities.

Recommended Action: Inform the general public about resources within the Reserve and management activities through television, newspaper, and other local media outlets. Utilize volunteer groups for Reserve management whenever feasible. Present slide shows and talks to community groups. Develop a brochure that describes the resources and ongoing management activities within the Reserve.

A lodging facility at Kokee is recommended for the volunteer work program. There are existing state-owned cabins in the Kokee State Park that would be ideally suited for this purpose. This idea was also proposed for the volunteer work program for the Hono O Na Pali NAR.

Cost/Workload:

Year 1 - Reserve Manager 10 PD

\$ 850

Technician 15 PD	1,050
Support and supplies	1,000
Total	\$ 2,900
Year 2 - Reserve Manager 20 PD	\$ 1,700
Technician 30 PD	2,100
Volunteer lodging facility upgrade	20,000
Brochure	6,000
Support and supplies	1,000
Total	\$30,800
Year 3-6 Reserve Manager 10 PD	\$ 850
Technician 20 PD	1,400
Support and supplies	4,000
Total	\$ 6,250

Salaries are \$85 per day for reserve manager and \$70 per day for a technician. Expenses for a volunteer lodging facility are for improvements of an existing state-owned cabin in Kokee. Supplies and support include brochures, audio-visual aids, and maintenance of volunteer facility.

D. Boundary Administration and Special Uses

Participation and cooperation between other DLNR Divisions and their respective land uses is an important factor for effective management of the Kuia Reserve. Reserve management plans should be reviewed and coordinated with the State Park's recreational program. Enforcement of hunting rules on adjacent Forest Reserve lands will be more difficult with liberalized hunting regulations within the Reserve and extensive posting of Reserve boundaries may be necessary.

As mentioned in the plan, Hurricane Iwa devastated the Kokee area and many portions of the Reserve are now dominated by aggressive non-native plants. If left strictly to natural succession, reestablishment of certain portions of the Reserve by native species is questionable. Site scarification and replanting of native species will probably be necessary. In this regard, the Kuia NAR represents a valuable outdoor laboratory for ecosystem restoration research. Guidelines for these activities will be needed from the NARS Commission. Cooperative management work such as monitoring and propagation of the Reserve's endangered plants should be considered with the Pacific Tropical Botanical Garden.

Lands adjacent to the Kuia Reserve, especially southward towards Milolii and Makaha ridge, contain koa-dominated forest with high biological value. Additionally, rare plant populations exist in Poopooiki and Paaiki valleys, just makai of the Reserve. NARS staff should monitor these natural communities and rare plants and work closely with the appropriate agencies to assure their

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maintenance and preservation.

IV. BUDGET SUMMARY

When this plan was prepared, the long-term funding and organizational structure of the NARS had not been settled. Coordination and implementation of priority projects among the 18 reserves may be affected by future organizational and funding decisions. This may require some revision in the priority projects described here.

A six-year implementation schedule is presented to accomplish management goals as efficiently as possible. Four management programs are proposed to achieve this. Although listed by priority, they build upon each other to form an integrated strategy.

The budget summary is based on a NARS integrated within the Division of Forestry & Wildlife. The budget summary shown is for the management of the Kuia NAR only. It does not include all the administrative, clerical, and facility support needed to run a state-wide NARS or to manage the other natural area reserve on the island of Kauai. These infrastructure costs for the NARS will be identified and documented separately.

Operations costs such as vehicles (a four-wheel drive truck with radio), two portable radios, and maintenance for vehicles and equipment are included in program KUI-OP-01. Starting with Year 3, a 1% inflation increase is incorporated into every annual total.

BUDGET SUMMARY
KUIA NATURAL AREA RESERVE

PROGRAM	YR 1	YR 2	YR 3	YR 4	YR 5	YR 6
KUI-RM-01	28,650	14,400	14,400	14,400	14,400	14,400
KUI-RM-02	9,425	9,425	9,425	9,425	9,425	9,425
KUI-RM-03	4,425	4,425	4,425	4,425	4,425	4,425
KUI-RM-04	2,900	30,800	3,250	3,250	3,250	3,250
KUI-OP-01	25,000	2,500	6,250	6,250	6,250	6,250
TOTAL (\$)	70,400	61,550	38,150	38,500	38,900	39,300

MANAGEMENT PROGRAMS

KUI-RM-01 - Ungulate Control (Priority 1)
 KUI-RM-02 - Non-native Plant Control (Priority 2)
 KUI-RM-03 - Monitoring (Priority 3)
 KUI-RM-04 - Public Education and Volunteer Support (Priority 4)
 KUI-OP-01 - Operating Expenses

PERSONNEL (PD = person days)

YR 1 -R. Manager 50 PD Technician 140 PD	YR 4 -R. Manager 50 PD Technician 145 PD
YR 2 -R. Manager 60 PD Technician 155 PD	YR 5 -R. Manager 50 PD Technician 145 PD
YR 3 -R. Manager 50 PD Technician 145 PD	YR 6 -R. Manager 50 PD Technician 145 PD

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3 August 1989
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APPENDIX 1
 Kuia Natural Area Reserve
 Transect Specifications

NUMBER	LENGTH	SUBSTATIONS	NATURAL COMMUNITIES SURVEYED ¹
1	3936	25	Koa/`Ohi`a Mixed Montane Mesic Forest
2	4428	28	Koa/`Ohi`a Mixed Montane Mesic Forest Koa/`Ohi`a Lowland Mesic Forest
3	4428	28	Koa/`Ohi`a Mixed Montane Mesic Forest Koa/`Ohi`a Lowland Mesic Forest
4	3116	20	Koa/`Ohi`a Mixed Montane Mesic Forest Koa/`Ohi`a Lowland Mesic Forest
5	3608	23	Koa/`Ohi`a Mixed Montane Mesic Forest
6	2788	18	Koa/`Ohi`a Mixed Montane Mesic Forest Koa/`Ohi`a Lowland Mesic Forest
7	2952	19	Koa/`Ohi`a Mixed Montane Mesic Forest
8	4428	28	Koa/`Ohi`a Mixed Montane Mesic Forest Koa/`Ohi`a Lowland Mesic Forest
9	3116	20	Koa/`Ohi`a Lowland Mesic Forest Non-native Dominated
A	n/a	1	Kauai Diverse Lowland Mesic Forest

¹Communities listed reflect survey data and do not necessarily coincide with the vegetation map depicted in Figure 2, as the resolution of Figure 2 is not great enough to show complex transitions between communities, or small patches of communities within others.

Survey Participants

Lyman Abbott, TNCH, Ecological Assistant
 Michael Buck, DOFAW, Survey Forester
 Samuel Gon III, TNCH, Ecologist
 Joel Lau, TNCH, Botanical Research Assistant
 Steve Perlman, TNCH, Field Coordinator/Botanist

DOFAW = State Division of Forestry and Wildlife, Department of Land and Natural Resources
 TNCH = The Nature Conservancy of Hawaii

Sample Field Forms

TRANSECT STATION FIELD FORM Time Start: _____ End: _____ Date: _____
 NC Name: _____ NAR Name: _____
 Observer(s): _____ Station#: _____ Elevation: _____ Bearing: _____
 Transect#: _____ Description Line: _____ Photo #: _____
 INCIDENTAL OBSERVATIONS: _____
 CHK ITEM: _____ REMARKS: _____

Birds Native Inverts Small Mammals Non-native Inverts Fire Erosion Human Influence Add'l Survey Needs		
--	--	--

ASPECT	SLOPE	CANOPY CLOSURE	TOPOGRAPHIC POSITION	CANOPY STATURE	SOIL MOISTURE
___ NORTH	___ FLAT	___ DENSE	___ CREST	___ <1 M	___ INUNDATED
___ EAST	___ GENTLE	___ CLOSED	___ UPPER SLP	___ 1-2.5 M	___ SATURATED
___ SOUTH	___ MOD	___ OPEN	___ MID SLP	___ 2.5-5 M	___ MOIST
___ WEST	___ STEEP	___ SCATTER	___ LOW SLP	___ 5-10 M	___ MOIST-DRY
___ ()	___ VERT	___ VERYS	___ BOTTOM	___ >10 M	___ DRY
___ NO CHG	___ NO CHG	___ NO CHG	___ NO CHG	___ NO CHG	___ NO CHG

Additional notes:

TRANSECT STATION FIELD FORM Time Start: _____ End: _____ Date: _____
 NC Name: _____ NAR Name: _____
 Observer(s): _____ Station#: _____ Elevation: _____ Bearing: _____
 Transect#: _____ Description Line: _____ Photo #: _____
 INCIDENTAL OBSERVATIONS: _____
 CHK ITEM: _____ REMARKS: _____

Birds Native Inverts Small Mammals Non-native Inverts Fire Erosion Human Influence Add'l Survey Needs		
--	--	--

ASPECT	SLOPE	CANOPY CLOSURE	TOPOGRAPHIC POSITION	CANOPY STATURE	SOIL MOISTURE
___ NORTH	___ FLAT	___ DENSE	___ CREST	___ <1 M	___ INUNDATED
___ EAST	___ GENTLE	___ CLOSED	___ UPPER SLP	___ 1-2.5 M	___ SATURATED
___ SOUTH	___ MOD	___ OPEN	___ MID SLP	___ 2.5-5 M	___ MOIST
___ WEST	___ STEEP	___ SCATTER	___ LOW SLP	___ 5-10 M	___ MOIST-DRY
___ ()	___ VERT	___ VERYS	___ BOTTOM	___ >10 M	___ DRY
___ NO CHG	___ NO CHG	___ NO CHG	___ NO CHG	___ NO CHG	___ NO CHG

Additional notes:

TRANSECT SUBSTATION FIELD FORM Time Start: _____ End: _____ Date: _____
 NC Name: _____ NAR Name: _____
 Observer(s): _____ Station#: _____ Elevation: _____ Bearing: _____
 Transect#: _____ Description Line: _____ Photo #: _____
 INCIDENTAL OBSERVATIONS: _____
 CHK ITEM: _____ REMARKS: _____

UNGULATES: PIGS GOATS CATTLE DEER CANOPY CHANGES: RARE PLANTS: BEARING		
---	--	--

NATURAL COMMUNITY FIELD OBSERVATION FORM

DATE: _____ TRANSECT#: _____ STATION#: _____ ELEVATION: _____ END: _____
 OBSERVER(S): _____ QUAD NAME: _____
 NC NAME: _____ ISLAND: _____
 SUBSTRATE: _____ QUAD NAME: _____ EOCODE: _____
 ADJ NCS: _____

DESCRIPTION LINE: _____

ASPECT SLOPE		CANOPY CLOSURE		TOPOGRAPHIC POSITION		CANOPY STATURE		MOISTURE		NC AREA	
N	FLAT	DENSE	<1M	CREST	<1M	INUNDATED	<1 AC				
E	GENTLE	CLOSED	1-2.5M	UPPER SLP	1-2.5M	SATURATED	1-5 AC				
S	MOD	OPEN	2.5-5M	MID SLP	2.5-5M	MOIST	6-10 AC				
W	STEEP	SCATTER	5-10M	LOW SLP	5-10M	MOIST-DRY	>10 AC				
()	VERT	VERY SC	>10M	BOTTOM	>10M	DRY	()				

*COVER CLASS CODES: 1 = <1% 2 = 1-5% 3 = 5-25%
 (FOR USE BELOW) 4 = 25-50% 5 = 50-75% 6 = 75-90% 7 = >90%

A. CANOPY DOMINANTS:

SPECIES	T	S	H	*COVER	DIA	REMARKS

B. SUBCANOPY DOMINANTS:

SPECIES	T	S	H	*COVER	REMARKS

* LITTER: _____ BARE GROUND: _____ SPECIES LIST ATTACHED: Y N
 THREATS: _____

PROTECTION/MANAGEMENT RECOMMENDATIONS: _____

ECORANK: _____ A = EXCELLENT B = FAIR-GOOD C = POOR D = DEGRADED
 EO BOUNDARIES MAPPED: Y N MAP ATTACHED: Y N PHOTO #:

PLANT FIELD OBSERVATION FORM
 NAR NAME: _____ QUAD NAME: _____
 DATE: _____ ISLAND: _____ SITE NAME: _____
 SPECIES NAME: _____
 OBSERVER(S): _____
 PHOTO TAKEN: _____ Y N
 SPECIMEN # COLLECTOR, REPOSITORY: _____
 DIRECTIONS: _____

ELEVATION: _____
 GENERAL DESCRIPTION OF AREA: _____

EODATA: _____

NATURAL COMMUNITY: _____
 ASSOCIATED NATIVE SPECIES: _____

ASSOCIATED WEED SPECIES: _____

THREATS: _____

PROTECTION/MANAGEMENT RECOMMENDATIONS: _____

COMMENTS: _____

ASPECT SLOPE		LIGHT		TOPOGRAPHIC POSITION		MOISTURE		DOMINANT SPECIES	
N	FLAT	DENSE	INUNDATED	CREST	INUNDATED				
E	GENTLE	CLOSED	SATURATED	UPPER SLP	SATURATED				
S	MOD	OPEN	MOIST	MID SLP	MOIST				
W	STEEP	SCATTER	DRY-MESIC	LOW SLP	DRY-MESIC				
()	VERT	VERY SC	DRY	BOTTOM	DRY				

HABIT		PHENOLOGY		STRUCTURE		VIGOR		FREQUENCY		POPULATION SIZE		POPULATION AREA	
TREE	IN LEAF	%SDILGS	DYING	COMMON	ACTUAL	1							
SHRUB	IN BUD	%IMM	FEEBLE	OCCAS	1-10	1-5							
HERB	IN FLOWER	%MAT	NORMAL	RARE	10-50	5-10							
VINE	IMM FRUIT	%SENEC	VIGOROUS	SOL	50-100	10-10							
PROST	MAT FRUIT				100-1000								
	DORMANT				1000+								

APPENDIX 3
 Kuia Area
 Vascular Plant Species List

This species list was compiled from available literature sources, personal communication with botanists familiar with the area (backed by specimen verification for rare plants), and field identification during this NARS field survey. Rare plants (less than 3,000 individuals, or known from fewer than 20 locations worldwide) with specific location information are noted by '+' and are either in the Reserve or its adjacent area (see the rare plants table for those confirmed in the Reserve). Rare plants thought to occur in the Reserve but which lack specific location information are noted by '#' in the status column.

Due to subjective location information, some plant species included on this list may not actually be present in the Reserve. Plants reported for the area without an associated vegetation type are assigned to the natural community they would most likely occur in with a '?'.
 ? = Cited in literature sources; needs confirmation in natural community

Descriptions of natural communities are in the text. Taxonomy follows Wagner et al. (in press) and Wagner and Wagner (1987).

Status	Taxon	Koa/Ohi'a Lowland Mesic Forest	Koa/Ohi'a Mixed Montane Mesic Forest	Non-native Dominated	Kauai Diverse Lowland Mesic Forest
E	<i>Acacia koa</i>	*	*		*
+ E	<i>Adenophorus periens</i>		?		
E	<i>Adenophorus pinnatifidus</i>		*		
I	<i>Adiantum capillus-veneris</i>			*	
N	<i>Ageratum conyzoides</i>		*	*	
N	<i>Aleurites moluccana</i>	*		*	
E	<i>Alphitonia ponderosa</i>	*	*		
# E	<i>Alsinidendron viscosum</i>	?	?		?
E	<i>Alyxia oliviformis</i>	*	*		*
N	<i>Andropogon virginicus</i>	*			
E	<i>Antidesma platyphyllum</i> var. <i>hillebrandii</i>	*	*		*
+ E	<i>Asplenium schizophyllum</i>		?		?
N	<i>Athyrium japonicum</i>		*		
E	<i>Athyrium sandwichianum</i>	*	*	*	?
N	<i>Axonopus fissifolius</i>	*	*		
E	<i>Bidens cosmoides</i>		*		
E	<i>Bidens forbesii</i>	*			

+ = Rare N = Non-native I = Indigenous E = Endemic

* = Confirmed in NARS field study

? = Cited in literature sources; needs confirmation in natural community

Status	Taxon	Koa/Ohi'a Lowland Mesic Forest	Koa/Ohi'a Mt Montane Mesic Forest	Non-native Dominated	Kauai Diverse Lowland Mesic Forest
N	<i>Blechnum occidentale</i>	*			
E	<i>Bobea brevipes</i>	*	*		
+ E	<i>Bobea timonioides</i>		?	?	?
E	<i>Boehmeria grandis</i>			*	
+ E	<i>Bonamia menziesii</i>	?	?	?	?
N	<i>Brachiaria mutica</i>		*		
+ E	<i>Canavalia napaliensis</i>			?	?
I	<i>Canthium odoratum</i>	*			*
I	<i>Carex meyenii</i>	*	*		
E	<i>Carex wahuensis</i>	*			*
E	<i>Chamaesyce atrococca</i>	*	*		
E	<i>Chamaesyce celastroides</i> var. <i>celastroides</i>		*		
+ E	<i>Chamaesyce halemanui</i>	?	?	?	?
+ E	<i>Chamaesyce remyi</i> var. <i>remyi</i>	?	?	?	?
E	<i>Charpentiera elliptica</i>	*	*	*	*
E	<i>Cheirodendron trigynum</i>	*	*		
E	<i>Cibotium splendens</i>		*		
E	<i>Claoxylon sandwicense</i>	*	*		
I	<i>Cocculus trilobus</i>	*			
E	<i>Coniogramme pilosa</i>		*		
E	<i>Coprosma kauensis</i>	*	*		*
E	<i>Coprosma waimeae</i>	*	*		*
N	<i>Cordyline fruticosa</i>	*		*	
N	<i>Corynocarpus laevigata</i>		*		
E	<i>Cryptocarya mannii</i>	*	*		
N	<i>Cuphea carthagenensis</i>		*		
E	<i>Cyanea leptostegia</i>		*		
N	<i>Cyperus</i> sp.		*		
E	<i>Cyrtandra kauaiensis</i>		*	*	
E	<i>Cyrtandra longifolia</i>		*		
I	<i>Cyrtomium caryotideum</i>		*		
+ E	<i>Delissea rhytidosperma</i>	?	?	?	?
N	<i>Desmodium triflorum</i>			*	
E	<i>Dianella sandwicensis</i>	*	*		
I	<i>Dicranopteris linearis</i>	*	*		
# E	<i>Diellia erecta</i>	?	?	?	?
+ E	<i>Diellia laciniata</i>	?		?	?
+ E	<i>Diellia mannii</i>	?	?	?	?
N	<i>Digitaria fuscescens</i>	*			
E	<i>Diospyros hillebrandii</i>		*		*
E	<i>Diospyros sandwicensis</i>	*	*		*
+ E	<i>Dissochondrus biflorus</i>	?	?	?	?
I	<i>Dodonaea viscosa</i>	*	*	*	*
E	<i>Doodia kunthiana</i>	*	*		*

+ = Rare N = Non-native I = Indigenous E = Endemic

* = Confirmed in NARS field study

? = Cited in literature sources; needs confirmation in natural community

Status	Taxon	Koa/Ohia Lowland Mesic Forest	Koa/Ohia Montane Mesic Forest	Non-native Dominated	Kauai Diverse Lowland Mesic Forest
E	<i>Dryopteris glabra</i>	*	*		
I	<i>Dryopteris wallichiana</i>	*	*		
+ E	<i>Dubautia knudsenii</i> ssp. <i>knudsenii</i>	?	?		
+ E	<i>Dubautia laevigata</i>	?	?		
+ E	<i>Dubautia latifolia</i>		*		
+ E	<i>Dubautia microcephala</i>		*		
E	<i>Elaeocarpus bifidus</i>	*	*		*
I	<i>Elaphoglossum alatum</i>		*		
E	<i>Elaphoglossum hirtum</i> var. <i>micans</i>		*		
N	<i>Elephantopus mollis</i>		*		
E	<i>Embelia pacifica</i>		*		
E	<i>Eragrostis variabilis</i>	*			
N	<i>Erechtites valerianifolia</i>	*	*		
N	<i>Erigeron karvinskianus</i>	*	*	*	
N	<i>Eucalyptus</i> sp.		*		
+ E	<i>Euphorbia haeleeleana</i>	*	*		*
+ E	<i>Flueggea neowawraea</i>			?	?
E	<i>Freycinetia arborea</i>	*	*		
E	<i>Gahnia beecheyi</i>	*	*		
# E	<i>Gardenia remyi</i>	?	?	?	?
N	<i>Grevillea robusta</i>	*			
N	<i>Hedychium gardnerianum</i>		*		
N	<i>Hedychium</i> sp.		*		
E	<i>Hedyotis acuminata</i>		*		
E	<i>Hedyotis knudsenii</i>		*		*
E	<i>Hedyotis terminalis</i>	*	*	*	*
+ E	<i>Hibiscus kokio</i> ssp. <i>saintjohnianus</i>	?		?	?
N	<i>Hydrocotyle verticillata</i>		?	?	
N	<i>Hypochoeris glabra</i>	*			
E	<i>Ilex anomala</i>		*		
N	<i>Ipomoea carica</i>		*		
N	<i>Ipomoea indica</i>			*	
+ E	<i>Isodendrion laurifolium</i>		*		*
+ E	<i>Isodendrion longifolium</i>	?	?	?	?
+ E	<i>Joinvillea ascendens</i> ssp. <i>ascendens</i>	?	?	?	?
N	<i>Kalanchoe pinnata</i>		*		
+ E	<i>Kokia kauaiensis</i>			*	
E	<i>Korthalsella remyana</i>	*			
+ E	<i>Labordia helleri</i>		*		
N	<i>Lantana camara</i>	*	*	*	
+ E	<i>Lepidium serra</i>			*	
+ E	<i>Lindsaea repens</i> var. <i>macraeana</i>	?	?		

+ = Rare N = Non-native I = Indigenous E = Endemic

* = Confirmed in NARS field study

? = Cited in literature sources; needs confirmation in natural community

Status	Taxon	Koa/Ohi'a Lowland Mesic Forest	Koa/Ohi'a Mj Montane Mesic Forest	Non-native Dominated	Kauai Diverse Lowland Mesic Forest
E	<i>Lipochaeta connata</i> var. <i>acris</i>		*		
+ E	<i>Lipochaeta fauriei</i>			?	?
+ E	<i>Lobelia yuccoides</i>		*		
N	<i>Lonicera japonica</i>		*		
N	<i>Ludwigia octovalvis</i>			*	
+ E	<i>Lysimachia glutinosa</i>	?	?		
+ E	<i>Lysimachia kalalauensis</i>		*		
I	<i>Mariscus javanicus</i>		*	*	
+ E	<i>Mariscus pennatifolius</i> ssp. <i>pennatifolius</i>	?	?	?	?
N	<i>Melaleuca quinquenervia</i>		*		
N	<i>Melinis minutiflora</i>	?		?	?
E	<i>Metrosideros polymorpha</i>	*	*		
I	<i>Microlepia speluncae</i>		*		*
I	<i>Microlepia strigosa</i>	*	*		*
N	<i>Musa</i> sp.			*	
N	<i>Myrica faya</i>	*	*		
E	<i>Myrsine alyxifolia</i>	*	*		
+ E	<i>Myrsine knudsenii</i>		?		
E	<i>Myrsine lanaiensis</i>	*	*		*
E	<i>Myrsine lessertiana</i>		*		
+ E	<i>Myrsine petiolata</i>	?	?		
N	<i>Nasturtium microphyllum</i>			*	
I	<i>Nephrolepis exaltata</i>	*	*		
+ E	<i>Neraudia kauaiensis</i>			*	
+ E	<i>Neraudia melastomifolia</i>	?	?	?	?
+ I	<i>Nesoluma polynesianum</i>	?			?
E	<i>Nestegis sandwicensis</i>	*	*		*
+ E	<i>Nothocestrum latifolium</i>	?	?	?	?
E	<i>Nothocestrum longifolium</i>	?	?	?	?
+ E	<i>Nothocestrum peltatum</i>		?		?
E	<i>Nototrichum sandwicense</i>			*	
I	<i>Odontosoria chinensis</i>	*	*		
N	<i>Oplismenus hirtellus</i>			*	*
N	<i>Oxalis corniculata</i>			*	
+ E	<i>Panicum napaliense</i>	?		?	?
N	<i>Paspalum conjugatum</i>	*	*		
N	<i>Paspalum urvillei</i>	*	*		
N	<i>Passiflora edulis</i> f. <i>edulis</i>	*	*		
N	<i>Passiflora ligularis</i>	*	*	*	*
N	<i>Passiflora mollissima</i>		*		
E	<i>Pelea anisata</i>	*	*		
E	<i>Pelea barbigera</i>	*	*		
E	<i>Pelea clusiifolia</i>		*		
# E	<i>Pelea degeneri</i>		?		

+ = Rare N = Non-native I = Indigenous E = Endemic

* = Confirmed in NARS field study

? = Cited in literature sources; needs confirmation in natural community

Status - Taxon

	Koa/Ohi'a Lowland Mesic Forest	Koa/Ohi'a Mix Montane Mesic Forest	Non-native Dominated	Kauai Diverse Lowland Mesic Forest
E		*	*	*
E		*		
E	*	*		*
N	*			
+ E	?			
? E		*		
+ E		?		?
# E	?	?		?
N		*		
N	*			
E			*	
E			*	*
E		*		
E	*	*		
N		*		
N	*	*		
+ E		*		
E		*		
E	*	*	*	*
N			*	
+ E	?	?		?
# E	?	?	?	?
E	*	*		
N	*	*	*	*
N	*		*	
I	*	*		*
+ E		?		
+ E		*		
E	*	*		
+ E			*	
E	*	*		
I		*		
E		*		*
N		*		
E	?	?		
+ E		*		
N	*	*		
N	*	*		
? Rumex sp.			*	
E		*		
E	*	*		
pyrularium				
E	*			
E	*	*		
+ E			*	

+ = Rare N = Non-native I = Indigenous E = Endemic

* = Confirmed in NARS field study

? = Cited in literature sources; needs confirmation in natural community

Status	Taxon	Koa/Ohi'a Lowland Mesic Forest	Koa/Ohi'a Mixed Montane Mesic Forest	Non-native Dominated	Kauai Diverse Lowland Mesic Forest
? E	Schiedea sp. indet.		*		*
N	Sechium edule		*		
E	Selaginella arbuscula		*		
N	Setaria gracilis	*	*		
+ E	Sicyos sp. A		?		
I	Sida fallax	*			
N	Solanum americanum		*		
+ E	Solanum sandwicense	?	?		?
E	Sophora chrysophylla		*		
N	Stachytarpheta jamaicensis	*			
E	Stenogyne purpurea		*		
E	Streblus pendulinus		*		*
I	Styphelia tameiameia	*	*		
E	Syzygium sandwicense	*	*	*	
E	Tectaria gaudichaudii		*		
E	Tetraplasandra kavaiensis		*		
E	Tetraplasandra waimeae		*		
N	Thelypteris dentata	*			
N	Thelypteris parasitica	*	*	*	
E	Thelypteris sandwicensis		*		
E	Touchardia latifolia			*	
E	Vaccinium dentatum	*	*		
E	Viola chamissoniana ssp. tracheliiifolia		*		
I	Waltheria indica	*			
E	Wikstroemia furcata	*	*		
E	Wilkesia gymnoxiphium	*		*	
+ E	Xylosma crenatum	?	?		
E	Xylosma hawaiiense		*		*
E	Zanthoxylum dipetalum var. dipetalum		*		

+ = Rare N = Non-native I = Indigenous E = Endemic

* = Confirmed in NARS field study

? = Cited in literature sources; needs confirmation in natural community

APPENDIX 4
 Kuia Area
 Bird Species List

The birds listed have been reported from visual and audio identification in or near the reserve (within three-quarters of a mile). The list includes information on rare birds, compiled from the literature. Taxonomy follows the Checklist of the Birds of Hawaii by Pyle (1988).

Status	Species	Common name	Source
N	<u>Acridotheres tristis</u>	Common Myna	*
N	<u>Cardinalis cardinalis</u>	Northern Cardinal	x
N	<u>Carpodacus mexicanus</u>	House Finch	?
E	<u>Chasiempis sandwichensis sclateri</u>	`Elepaio	*
N	<u>Copsychus malabaricus</u>	Shama Thrush	x
N	<u>Gallus gallus</u>	Red Jungle-fowl	*
N	<u>Garrulax canorus</u>	Hwamei	*
E	<u>Hemignathus lucidus hanapepe</u>	Kauai Nuku-pu`u	x
E	<u>Hemignathus parvus</u>	`Anianiau	*
+E	<u>Hemignathus procerus</u>	Kauai `Akialoa	?
E	<u>Hemignathus virens stejnegeri</u>	Kauai `Amakihi	*
E	<u>Himatione sanguinea sanguinea</u>	`Apapane	*
N	<u>Leothrix lutea</u>	Red-billed Leothrix	x
N	<u>Lonchura punctulata</u>	Nutmeg Mannikin	?
E	<u>Loxops coccineus caeruleirostris</u>	Kauai `Akepa	*
+E	<u>Moho braccatus</u>	Kauai `O`o, `O`o`a`a	?
+E	<u>Myadestes myadestinus</u>	Kama`o	?
+E	<u>Myadestes palmeri</u>	Puaiohi	x
I	<u>Phaethon lepturus dorotheae</u>	White-tailed Tropicbird	*
V	<u>Pluvialis dominica</u>	Lesser Golden-Plover, Kolea	*
N	<u>Streptopelia chinensis</u>	Spotted Dove	?
E	<u>Vestiaria coccinea</u>	`I`iwi	*
N	<u>Zosterops japonicus</u>	Japanese White-eye	*

+ = Rare
 E = Endemic

N = Non-native
 I = Indigenous

V = Visitor

x = Cited in literature * = Confirmed during NARS field study
 ? = Cited in literature; needs confirmation in Reserve