HANAWI NATURAL AREA RESERVE

MANAGEMENT PLAN

Natural Area Reserves System

State of Hawaii

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

February 1989

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EXECUTIVE SUMMARY

In 1970, Hawaii became 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). Governor Waihee and the 1987 Legislature appropriated substantial new funding and legislative mandates to develop and implement a NARS management program. This plan describes the NARS management program for the 7,500-acre Hanawi Natural Area Reserve, established in 1986 by Executive Order 3351. The Reserve protects a diversity of native ecosystems and is one of the most important habitats for endangered forest birds in Hawaii.

The Reserve is in the Hana District of Maui County, and ranges from 2,000 to 7,500 feet in elevation. Rainfall varies from 120 inches in the upper grasslands to 300 inches per year in the rainforests. There were nine native vegetation communities identified in the Reserve. The Reserve provides a crucial habitat link between Haleakala National Park on its south border and the state-owned Koolau Forest Reserve on its east and west borders. Within the Reserve are rare plants and birds; one bird species, the Po`ouli, is found nowhere else in the world. The Reserve gets little public use due to its remote location, especially in the higher elevations.

Because of its size and inaccessiblity, intensive management of key areas within the Reserve are proposed and prioritized based on the biological resources they contain and the threats to those resources. Management activity will begin in the upper elevation forests above 5,000 feet to protect the endangered forest bird habitat and forest watershed from the impact of feral pigs. Pigs constitute the most severe threat affecting the Reserve, as their rooting and wallowing destroy native plants and disturb the ground cover on the forest floor. Severe erosion is occurring as a result of this disturbance.

A progressive fencing strategy is recommended to create smaller pig control units and restrict pig movements. Intensive control activities using snares and staff hunting are proposed for the upper elevation forests. A forest trail system and improved access to increase public hunting pressure in the lower portion of the Reserve is planned. Other program areas are:

1) Monitoring to evaluate the effectiveness of management work and track significant ecological changes,
2) Non-native Plant Control of priority weeds that threaten to invade large portions of the Reserve, and
3) Public Education and Volunteer Support to provide educational and work opportunities for schools and other concerned groups.

A six-year implementation schedule is proposed to accomplish management objectives. An annual budget of $200,000 will be needed to manage the Reserve over this time period. The remoteness of the Reserve necessitates extensive helicopter use. Once the pig threat is reduced, annual management costs should decrease. Considerable benefit and monetary savings can be accrued to both the NARS and Haleakala National Park by participating in joint management activities.

ACKNOWLEDGEMENTS

Several organizations and individuals contributed information, guidance, and review for this management plan. Their cooperation and support is deeply appreciated. In particular, thanks to Barri Morgan, Steve Perlman, Sam Gon, Alan Holt, Audrey Newman, and all the other hard working and dedicated professionals at The Nature Conservancy of Hawaii who helped me prepare this plan; Division of Forestry and Wildlife staff Andy Engilis, Thane Pratt, Ron Walker, Wes Wong, and Bob Hobdy; Deputy DLNR Chairperson Libert Landgraf; Robert Lee and members of the Natural Area Reserves Commission; Jim Jacobi, Cameron Kepler, and Al Marmelstein of the U.S. Fish and Wildlife Service; Ron Nagata, Betsy Gagne, and Peter Connally of Haleakala National Park; and Chuck Stone, Larry Katahira, Steve Anderson, and Linda Cuddihy of Hawaii Volcanoes National Park.

This plan is dedicated to all the biologists and researchers who have spent thousands of wet and cold hours in the Hanawi area. Their efforts in communicating the importance of the biological resources and the urgent need for aggressive management have been heard.

Finally, sincerest thanks to Governor John Waihee, the State Legislature, and DLNR Chairperson William Paty for their desire and vision to preserve Hawaii's unique natural resources, and for their support of the Natural Area Reserves System.

Michael G. Buck
Natural Area Reserves System Coordinator

HAWAII NATURAL AREA RESERVES SYSTEM

DEPARTMENT OF LAND AND NATURAL RESOURCES

HANAWI 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 a management program for 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 NARS management program for the 7,500 acre Hanawi Natural Area Reserve, established in 1986 by Executive Order 3351. The Reserve was established to protect a diversity of native ecosystems and is considered one of the most important habitats for endangered forest birds in Hawaii. The plan consists of five parts:

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

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

Ground survey crews spent 10 days collecting data on natural communities, rare plants, native birds, feral ungulates, and non-native weeds during March 1988. Helicopter reconnaissance was used to provide information on the reserve's remote sections, especially the areas below 5,000 feet elevation. Sampling stations, ranging from 1,150 - 5,575 feet in length, sampled all upper elevation vegetation units as described by Jacobi (1983), at 165-foot intervals along six transects (Figure 1, appendices 1 and 2). Much of the reserve's lower elevation forest was not surveyed on the ground.

The 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. Sighting of small mammals and invertebrates were incidental, though systematic bird counts were conducted in the Hanawi reserve by a trained ornithologist who accompanied the field crew. Detailed survey methods are documented in the NARS field manual. Lists of plant and bird species currently known from the reserve are in appendices 3 and 4.

II. RESOURCES SUMMARY

A. General Setting

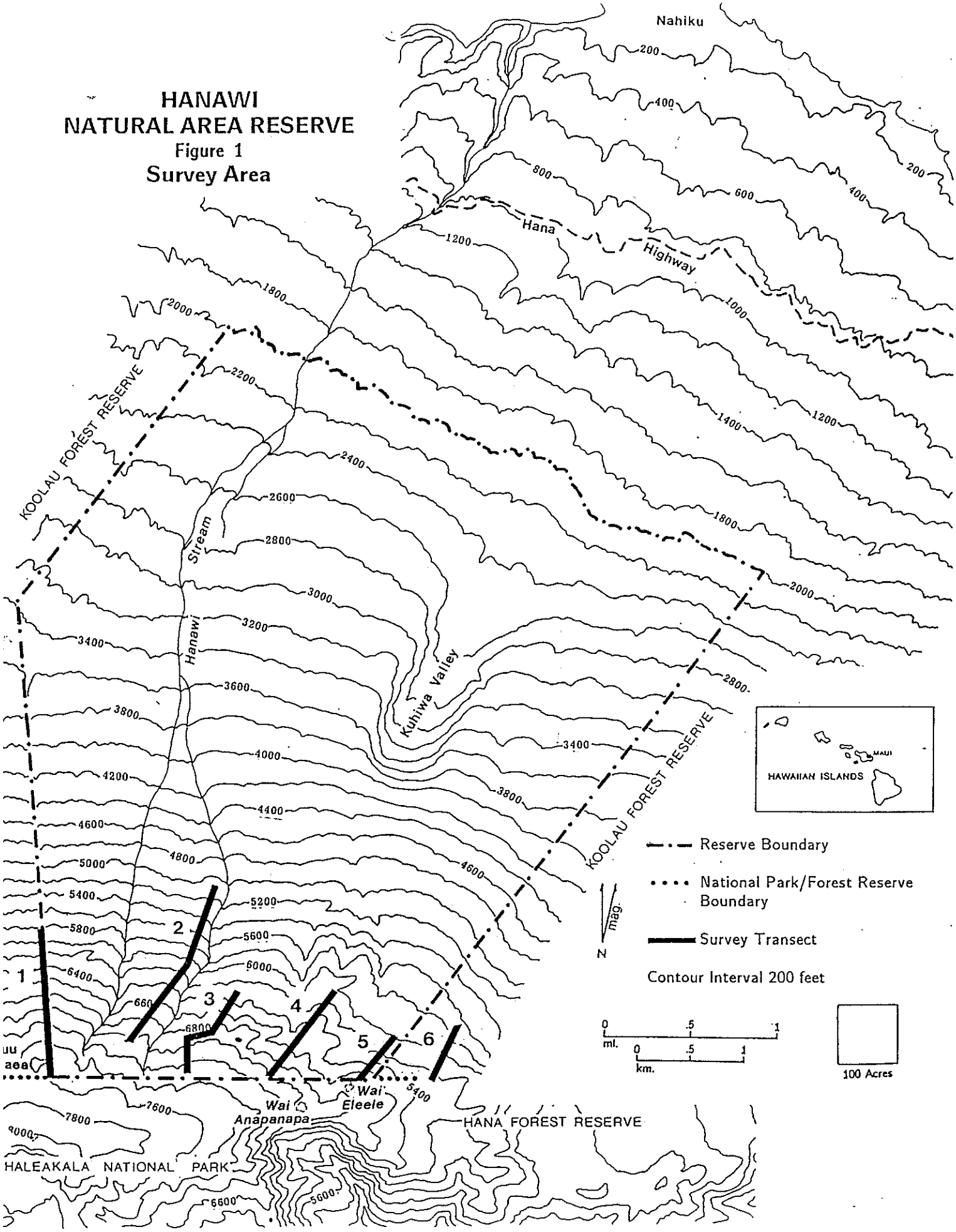
Hanawi Natural Area Reserve occupies 7,500 acres in the Hana District of Maui. Elevation ranges from 2,000 feet above Nahiku to 7,500 feet on the outer slopes of Haleakala Crater. Rainfall varies from 120 inches per year in the grasslands to 300 inches per year in the rainforests (DLNR 1986). Within the forests are rare plants and birds; one bird species, the Po`ouli (Melamprosops phaeosoma), is found nowhere else in the world.

The Hanawi Reserve lies within the Koolau Forest Reserve, state-owned land leased to East Maui Irrigation Company (EMI). Most streams on the windward side of East Maui are utilized by EMI's flume system which supplies water for sugarcane irrigation on the island's isthmus. Haleakala National Park (HALE) borders the Hanawi Reserve on the south and includes Wai Anapanapa and Wai Eleele lakes. Other landmarks in the area include Puu Alaea and Kuhiwa Valley. To the west (but not immediately adjacent) lies Keanae Valley; beyond the east boundary near the coast lies the town of Hana. North of the Reserve near the coast lies Nahiku and the Hana Highway. No roads cross the Reserve.

The Hanawi Reserve is an important parcel for conservation regionally. It has the highest number and density of endangered forest birds in the state. The Reserve furthers efforts to establish a protected watershed and reserve system in the upper elevation East Maui forests, as it provides a habitat link between Haleakala National Park on its south border and the state-owned Koolau Forest Reserve on its east and west borders. The Koolau Forest Reserve contains excellent native forests and shrublands, which also support endangered birds and key forest watersheds. The Nature Conservancy's Waikamoi Preserve is located just west of the reserve.

HANAWI NATURAL AREA RESERVE

Figure 1
Survey Area



The reserve gets little public use due to its remote location, especially in the higher elevations. Occasionally a hiker traverses Hanawi from the Nahiku-Hana area, or from Haleakala Crater near Wai Anapanapa. Hunters may reach the lower areas of Hanawi, but very few go above 3,000 feet elevation. The area is mostly used by research teams studying endangered bird life. Biologists from the State Division of Forestry and Wildlife, U.S. Fish and Wildlife Service, and the National Park Service have spent hundreds of field hours in the Hanawi area.

B. Flora

The nine native vegetation communities in the Hanawi Natural Area Reserve show generally well-defined altitudinal limits and relatively abrupt boundaries where dominant species and physiognomy change (Table 1 and Figure 2). One of these communities, Deschampsia nubigena Subalpine Mesic Grassland, is rare, known only from a few places on Maui and the Big Island. For the purposes of this management plan, a species or community is considered rare if it is known from 20 or fewer locations worldwide, or has 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. comm.).

At the Reserve's highest elevation (7,500 feet), there were 15 acres of Deschampsia nubigena grassland (the majority of the community is in adjacent Haleakala National Park). Deschampsia nubigena grows in tussocks, reaching a height of about 2.5 feet on a substrate of cinder. While scattered native shrubs such as `ohelo (Vaccinium spp.), kukaenene (Coprosma ernodeoides), pilo (C. montana) and pukiawe may occur among the tussocks, much of the community is represented by nearly pure stands of Deschampsia. At the boundary with the adjacent pukiawe shrubland, the diversity and cover of native shrubs increases, until the Deschampsia is reduced to isolated patches within the shrubland.

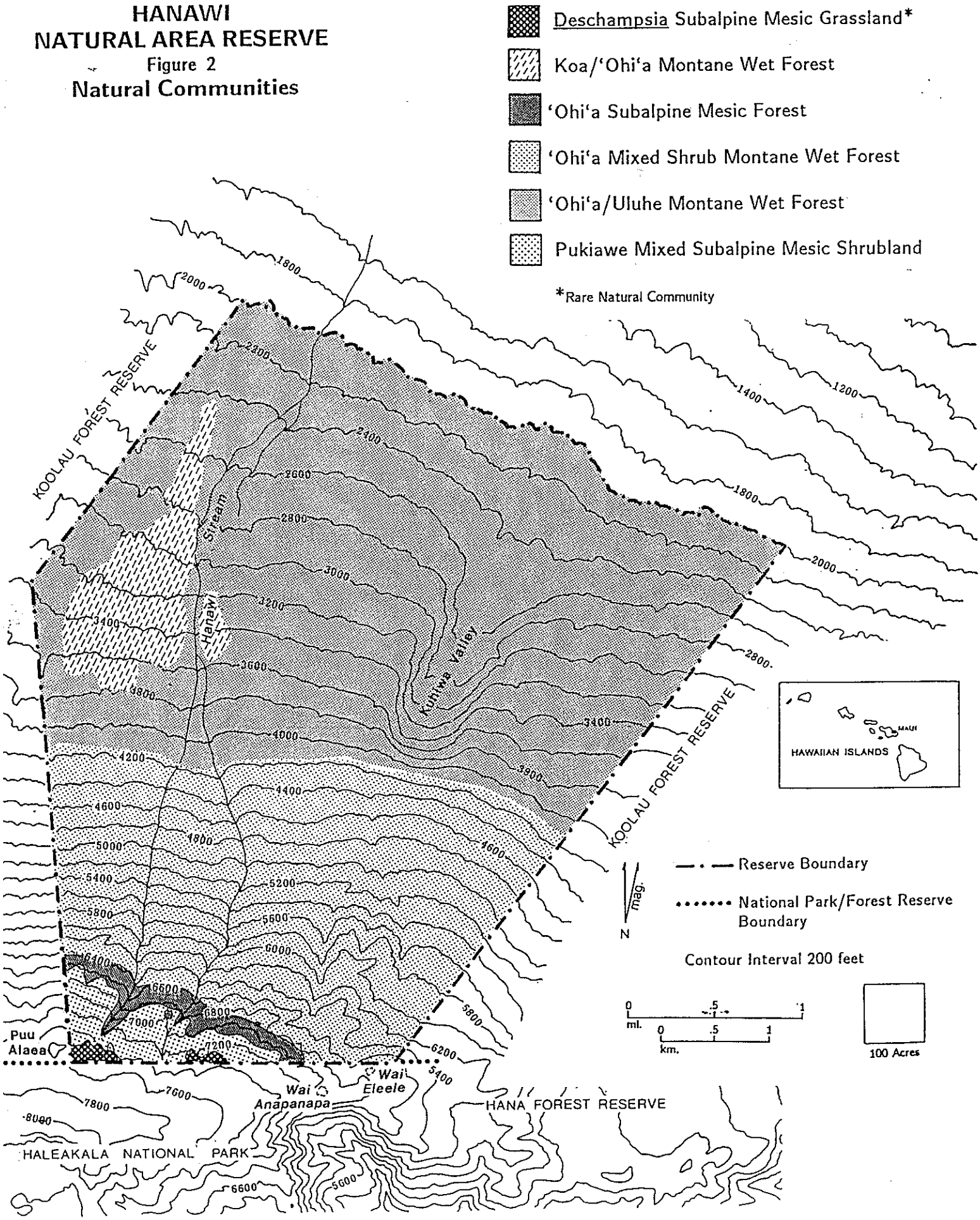
At approximately 7,400 feet in elevation, the Pukiawe Mixed Subalpine Mesic Shrubland begins and covers approximately 190 acres. Pukiawe is the dominant element, but other species such as `ama`u fern (Sadleria cyatheoides), `ohelo and pilo can assume dominance, especially as the shrubland increases in diversity near the boundary with `ohi`a (Metrosideros polymorpha) forest. Patches of Deschampsia occur within the shrubland, and other species include nohoanu (Geranium multiflorum), kukaenene, `akala (Rubus hawaiiensis and R. macraei), Dryopteris ferns and na`ena`e (Dubautia spp.). As the shrubland approaches tree line, scattered low `ohi`a and `olapa (Cheirodendron trigynum) trees emerge from the shrub layer, and the stature of pukiawe, pilo and nohoanu increases.

The pukiawe shrubland diversity increased downslope, grading rather abruptly into a narrow belt of `Ohi`a Subalpine Mesic Forest, which covers 105 acres of the reserve. This community extends from tree line, at approximately 7,200 feet elevation, down to approximately 6,700 feet. The canopy consists of dense, low-stature (9-15 feet) `ohi`a. In gaps, `olapa, alani (Pelea clusiifolia), kolea (Myrsine lessertiana), or larger shrub species such as another pilo (Coprosma ochracea) or pukiawe share the canopy. Several other species

HANAWI NATURAL AREA RESERVE

Figure 2

Natural Communities



characterize the subalpine forest, including the fern Dryopteris wallichiana, an arborescent na`ena`e (Dubautia reticulata), and the mesic sedges Carex wahuensis and Uncinia uncinata. Conspicuously lacking are wet forest species such as manono (Hedyotis terminalis), pu`ahanui (Broussaisia arguta), ho`i`o (Athyrium sandwichianum), and other ferns. In less disturbed areas, a well-developed litter of `ohi`a leaves overlies a thick mat of humus and fine roots. Epiphytes include a larger number of lichens than in the wet forest at lower altitudes, and are low in fern and moss diversity. Laukahi (Elaphoglossum alatum) is the prevalent epiphytic fern.

This relatively simple mesic forest increased in diversity downslope, becoming an `Ohi`a Mixed Shrub Montane Wet Forest that dominated down to approximately 4,000 feet elevation. This community covers 2,370 acres or 32 percent of the reserve. The stature of `ohi`a increases to over 30 feet with an association of native trees below the `ohi`a canopy including `olapa, kawa`u (Ilex anomala), kolea and alani. Ferns and bryophytes are diverse, and trees and shrubs are thickly covered with epiphytic species; the ground fern layer is well-developed. On larger trees, epiphytes might also include pa`iniu (Astelia menziesiana), `ohelo, and seedlings of `ohi`a and `olapa. Common shrub species include pu`ahanui, manono, `ohelo, alani, pilo, `akala, na`ena`e and `ohawai (Clermontia arborescens). On slopes or in draws, species such as olomea (Perrottetia sandwicensis), `ape`ape (Gunnera petaloidea), the rare Cyanea aculeatiflora and C. horrida, `ama`u, and uluhe (usually Sticherus) were found.

`Ohi`a continued to dominate the forest canopy, and from roughly 4,000 feet elevation to the Reserve's lower boundary, mat ferns such as Dicranopteris, Sticherus and Diplopterygium (collectively referred to as uluhe) assumed dominance in the understory, forming the `Ohi`a/Uluhe Montane Wet Forest. This is the largest community in the reserve, covering over 4,430 acres, or almost 60 percent of the reserve's area. Trees associated with the `ohi`a canopy in this elevation range include some species that do not extend to higher elevations, such as loulu (Pritchardia sp.) and `ohe (Tetraplasandra kavaiensis). Kopiko (Psychotria hawaiiensis) also appears, and hapu`u (Cibotium glaucum and C. chamissoi) become noticeable elements. Steeper slopes within this community were dominated by uluhe, with scattered trees and shrubs.

A patch of Koa (Acacia koa)/`Ohi`a (Metrosideros polymorpha) Montane Wet Forest (390 acres), grows at approximately 3,600 feet elevation near the Reserve's western boundary, surrounded by `ohi`a/uluhe forest. Aerial reconnaissance of the koa/`ohi`a area indicated that other associated trees include `ohe, kopiko, alani and `olapa, but koa cover is high, and in places exceeds 80 percent. Shrub species such as pu`ahanui, pilo and manono were present in the understory's 3 to 12 foot layer of uluhe (largely Sticherus sp.).

Three other natural communities in the Hanawi Reserve occupied scattered patches less than one-acre in size, and were consequently not shown in Figure 2. Distribution of these communities is determined more by topographic characteristics than altitude. Occasional patches of Carex alligata Montane Wet Grassland occur in the flatter and wetter portions of the Reserve, especially east of Kuhiwa Valley. Above 4,000 feet elevation, the steepest portions within the `ohi`a mixed shrub montane wet forest were occupied by Mixed Fern/Shrub Montane Wet Shrublands, with `ama`u or uluhe as the dominant ferns, and `ape`ape frequently codominant. Smaller gulches near tree line and in the upper `ohi`a forests are often occupied by `Akala (Rubus hawaiiensis) Montane Wet Shrublands.

TABLE 1
NATURAL COMMUNITIES IN THE HANAWI NATURAL AREA RESERVE

Community Name	HHP Rank[1]	Acreage[2]
`Akala (Rubus hawaiiensis) Montane Wet Shrubland	3	x
Carex alligata Montane Wet Grassland	3	x
Deschampsia nubigena Subalpine Mesic Grassland	1*	15
Koa/`Ohi`a (Acacia koa/Metrosideros polymorpha) Montane Wet Forest	3	390
Mixed Fern/Shrub Montane Wet Shrubland	3	x
`Ohi`a Subalpine Mesic Forest	3	105
`Ohi`a Mixed Shrub Montane Wet Forest	3	2,370
`Ohi`a/Uluhe Montane Wet Forest	3	4,430
Pukiawe (Styphelia tameiameiae) Mixed Subalpine Mesic Shrubland	3	190

[1]Key to Hawaiian Heritage Program Ranks:
1 Critically imperilled globally (typically 1-5 occurrences).
2 Imperilled globally (typically 6-20 occurrences).
3 Restricted range (typically more than 20 occurrences globally).
* Rare natural community

[2]Community acreages based on Figure 1
x small scattered patches

There were numerous non-native plants found within the natural communities described. The priority weed species are discussed in the Non-native Plant Control program. Appendix 3 has a complete species list of all non-native plants found within the Reserve.

Of the twelve rare plant taxa reported from the Hanawi area, eight have been verified within the Reserve's boundary (Table 2 and Appendix 3). The other four taxa may well occur in the Hanawi Reserve; all are known from adjacent areas. None of the eight rare plant taxa verified in the Hanawi reserve is officially listed as endangered by the U.S. Fish and Wildlife Service Federal Register of Endangered and Threatened Species (1985). Two of these taxa, nohanu (Geranium multiflorum), and `ala`ala wai nui (Peperomia expallescens) were on the Federal Register as candidates under their previous taxonomic treatment. Due to new taxonomy, their federal status is being reevaluated (Herbst pers. comm.). Platanthera holochila is a candidate that may be listed as endangered or threatened. The remaining five, Calamagrostis expansa, two types of `ohawai (Cyanea aculeatiflora and C. horrida), Phyllostegia bracteata, and Schiedea diffusa, have not been accorded any federal status, but are considered rare by the Hawaii Heritage Program.

TABLE 2
RARE PLANTS IN THE HANAWI NATURAL AREA RESERVE

Scientific Name[1] Former Name[2] (Common Name)	Current (Historic) Occurrences[3]	Federal Status[4]	HHP Rank[5]
*Calamagrostis expansa (-)	2(0)	-	2
*Cyanea aculeatiflora (`ohawai, `oha, haha)	1(0)	-	?
*Cyanea horrida (`ohawai, `oha, haha)	1(0)	-	?
*Geranium multiflorum Geranium multiflorum var. multiflorum (nohanu, hinahina)	4(0)	- C1	?
Peperomia expallescens Peperomia expallescens var. brevipilosa (`ala`ala wai nui)	0(1)	- C2	2
Phyllostegia bracteata (-)	0(1)	-	H
Platanthera holochila (-)	0(1)	C1	1-2
Schiedea diffusa	1(1)	-	?

* Observed during 1988 survey

[1] Wagner et al. (in press)

[2] Taxonomy used in 1985 Federal Register

[3] Current occurrences were reported in the reserve since 1972

[4] Key to Federal Status (1985 Federal Register):
C1 Candidate for endangered or threatened status
C2 Candidate for endangered or threatened status; information lacking
\- No federal status.

[5] Key to Hawaii Heritage Program Ranks:
1 Critically imperilled globally (typically 1-5 occurrences).
2 Imperilled globally (typically 6-20 occurrences).
? No more than 100 occurrences globally; rank not yet determined by HHP
H Historically known (no observations since 1972 throughout its range).

Four of the eight rare plant taxa confirmed within the Reserve boundary recently (since 1972) were seen during the survey (Table 2). The two `ohawai taxa were both seen on the eastern boundary of the reserve near Wai Eleele lake. Approximately five to ten scattered clumps of Calamagrostis expansa were seen on the north slopes below Kalapawili Ridge. Nohanu is found only on East Maui, and during the survey, hundreds of 3 - 10 foot tall plants were seen in a band between 6,600 and 7,200 feet. In addition, a greensword (Argyroxiphium spp.) located at the beginning of transect 1 in a fenced exclosure near Puu Alaea built by Haleakala National Park to protect this population from ungulates, may be the rare Argyroxiphium virescens, but further botanical confirmation is needed.

Ala`ala wai nui, Phyllostegia bracteata, and Platanthera holochila were last collected in 1937 within the Reserve, though where exactly is unknown. The four rare taxa that have been found near, but not in, the Reserve are Asplenuim schizophyllum, nanu (Gardenia remyi), a rare pilo (Hedyotis elatior), and `ohe (Joinvillea ascendens var. ascendens). All records for these four taxa are prior to 1950, and their exact localities are uncertain.

C. Fauna

The Hanawi Reserve is one of the richest native bird areas in the state, containing nearly all of the native forest and upland birds found on Maui, including the Po`ouli, a species found nowhere else in the world (Appendix 4). Though the field inventories of the Natural Area Reserves are not intended to be comprehensive, special effort was made during this survey to document Hanawi's special avifauna. Systematic bird counts were conducted on all transects by a trained ornithologist who had worked in the reserve previously and was intimately familiar with its avifauna.

Of the nine species of endemic honeycreepers known from the Hanawi reserve, five are listed as endangered by the U.S. Fish and Wildlife Service (1987) (Table 3). Maui `Akepa (Loxops coccineus ochraceus), Po`ouli (Melamprosops phaeosoma), Maui Parrotbill (Pseudonestor xanthophrys) and Crested Honeycreeper (Palmeria dolei) were observed during the field survey. Maui Nuku-pu`u (Hemignathus lucidus affinus) was not observed on this survey, but was seen in the Reserve as recently as 1986.

Nuku-pu`u is one of the rarest forest birds known to exist on Maui, where sightings have been reported from the northeast slopes of Haleakala and in Kipahulu Valley (east of the reserve), in wet `ohi`a and koa-`ohi`a forests with well-developed native understories (Figure 3). It was thought that the Maui Nuku-pu`u was extinct until three birds were sighted in Kipahulu Valley in 1967, where it was again seen in 1978 and 1979. The second observation of this rare bird after its rediscovery on Maui was made during the 1973 Hana Rain Forest Project, when two birds were observed in the Hanawi reserve. It has since been observed in the Reserve during the 1980 Forest Bird Survey, and again in 1985 and 1986.

Maui `Akepa is among the rarest forest birds known from the Hanawi Reserve, and occurs in very low numbers in East Maui. This bird has a patchy distribution, ranging from 3,600 - 6,890 feet elevation in `ohi`a and koa/`ohi`a

forests (Scott et al. 1986). A Maui `Akepa was heard singing near Kuhiwa at 6,350 feet on transect 3, the first observation of Maui `Akepa in the reserve since 1975. A male `Akepa was observed west of transect 6, outside the southeast corner of the Reserve on the boundary of Haleakala National Park. Other observations of Maui `Akepa, all west of the reserve area, were recorded during the 1980 Forest Bird Survey.

TABLE 3
RARE BIRDS IN THE HANAWI NATURAL AREA RESERVE

Scientific Name (Common Name)	East Maui Population Estimate[1]	Federal Status[2]	HHP Rank[3]
Hemignathus lucidus affinus (Maui Nuku-pu`u)	28 ± 56	LE	1
*Loxops coccineus ochraceus (Maui `Akepa)	230 ± 290	LE	1
*Melamprosops phaeosoma (Po`ouli)	140 ± 280	LE	1
*Palmeria dolei (Crested Honeycreeper)	3800 ± 700	LE	2
*Pseudonestor xanthophrys (Maui Parrotbill)	500 ± 230	LE	1

* Observed during 1988 survey

[1] Birds/km^2 with a 95% confidence interval (Scott et al. 1986)

[2] Key to Federal Status (USFWS 1987):
LE = Endangered

[3] Key to Hawaii Heritage Program Ranks:
1 = Species and/or subspecies critically imperilled globally (fewer than 1,000 individuals)
2 = Species and/or subspecies imperilled globally (typically 1,000 - 3,000 individuals)

Po`ouli is another of the Reserve's very rare species. Discovered in 1973, it is known only from the reserve. Records exist from as low as 4,600 feet to 6,800 feet. Though five different observations of Po`ouli were made during this survey, reports over the last decade suggest that the population is declining. The birds feed on snails and insects found in foliage and bark (Scott et al. 1986). Small heavily vegetated gulches seem to be a favorite area for Po`ouli (Engilis unpublished).

The Crested Honeycreeper, or `Akohekohe, (Palmeria dolei), is locally common in the Hanawi area. Restricted to East Maui, this species is generally found

only at upper elevations (4,250 7,550 feet), with the population's highest density at 4,900 - 6,900 feet (Scott et al. 1986). During this survey, `Akohekohe were observed on every transect in moderate numbers, and on transect 1 approximately 26 individual birds were seen. A few young birds were reported from transects 1 and 2, and several pairs were viewed defending territories. Observations during the survey indicate that `Akohekohe favored areas with mature flowering `ohi`a, but they were also observed foraging in `olapa and `akala.

The Maui Parrotbill, known only from East Maui, is thought to have a continuous distribution from the upper Waikamoi watershed west of the Reserve to upper Kipahulu in the southeast, with the population reaching its highest density in the Hanawi watershed area (Scott et al. 1986). This species was observed on all transects in low numbers.

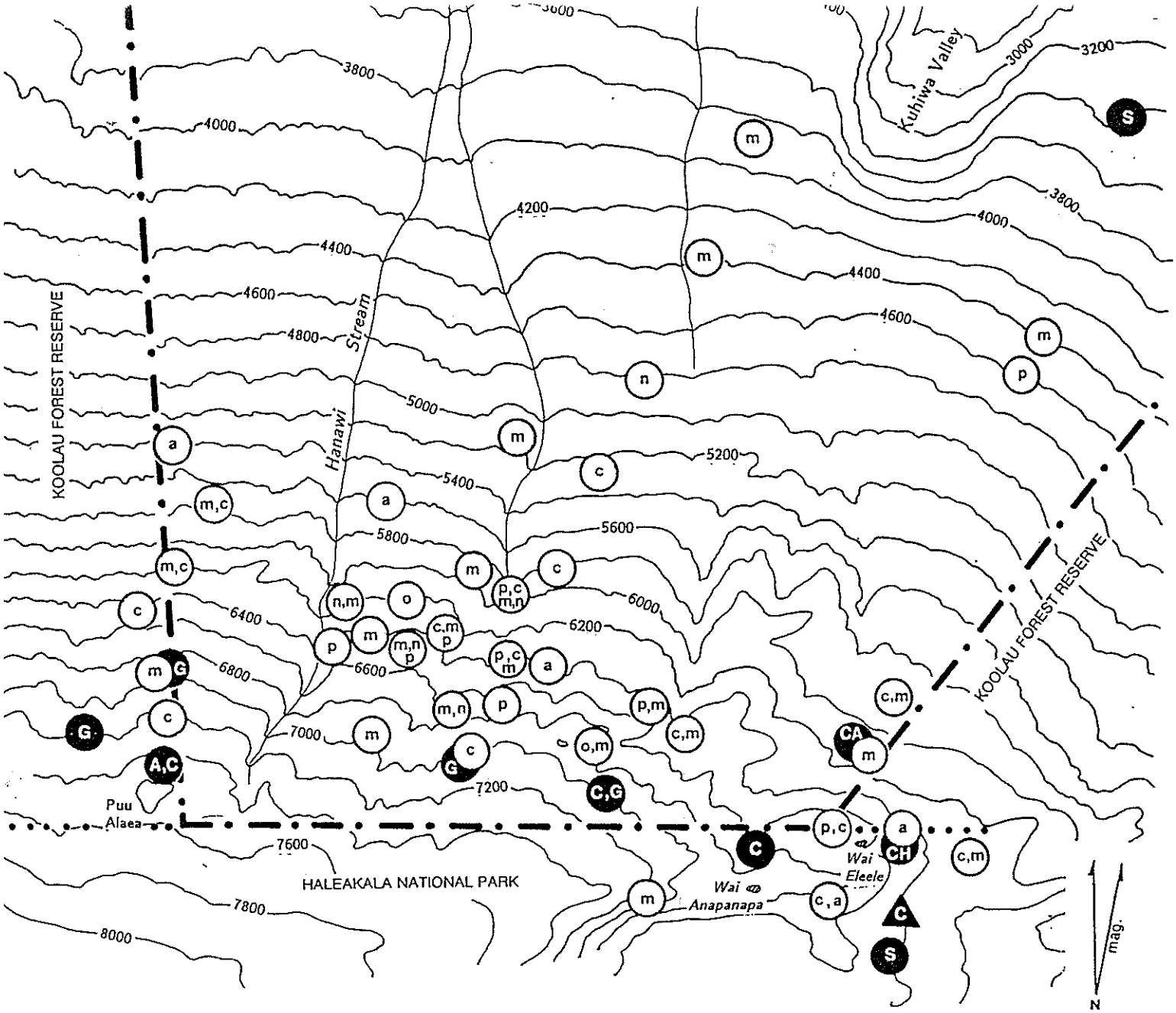
Throughout the years there have been sightings of unidentified black birds on Maui. It has been speculated that these black birds may be `O`o (Moho sp.). This mysterious bird has been reported from Maui since 1828 (Banko 1981), but most notable are recent observations made in the Hanawi Reserve during 1980 and 1985. These observations has been tentatively identified as Bishop's `O`o (Moho bishopi), though until a specimen or photograph is obtained the specific identity of the "Maui `O`o" remains debatable (Scott et al. 1986).

Five common native birds have been reported from the Hanawi Reserve, and were all seen during the survey. Four are forest birds: Maui `Amakihi (Hemignathus virens wilsoni); `Apapane (Himatione sanguinea sanguinea); Maui Creeper (Paroreomyza montana newtoni); and `I`iwi (Vestiaria coccinea). The Hawaiian Owl, or Pueo (Asio flammeus sandwichensis), was seen hunting in the upper grasslands.

The most common non-native species seen above 5,000 feet were Japanese White-eye (Zosterops japonicus) and Red-billed Leiothrix (Leiothrix lutea). Melodious Laughing-thrush (Garrulax canorus) and Northern Cardinal (Cardinalis cardinalis) were also present, but in lower numbers. Common Barn-owls (Tyto alba) were reported from the upper forests (Engilis unpublished). The upper grasslands provide habitat for many gamebirds; most common are Ring-necked Pheasant (Phasianus colchicus) and Chukar (Alectoris chukar).

In all of the natural communities visited, native invertebrates were observed. Spiders were extremely common, including several species of thomisids, salticids, tetragnathids, theridiids and araneids. Wasps and flies were seen on vegetation or in flight. Moths were seen very often by day and night. Aquatic insects were seen in pools and streams, and other native insects such as leafhoppers, beetles, psocids and psyllids were common. Native succinid and tornatellinid snails were also locally common on foliage.

The non-native component of the invertebrate fauna was marked by incidental species such as the cabbage butterfly (Pieris rapae), small syrphids and the like. The most noticeable introduced insects were large sarcophagid flies associated with feral pigs. These were common in all but the most pristine areas. During the survey, slugs were noticed only a few times. Ants were looked for in the more mesic grassland, shrubland and upper forest regions, but not found. Vespula were also looked for, but not seen.



HANAWI NATURAL AREA RESERVE

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)

Reserve Boundary

National Park/Forest Reserve Boundary

Contour Interval 200 feet

0 .5 1 mi.

0 .5 1 km.

50 Acres

Birds
- a = 'akepa
- c = crested honeycreeper
- m = Maui parrotbill
- n = nuku–pu'u
- o = o'o
- p = po'ouli

Plants
- A = Argyroxiphium virescens
- C = Calamagrostis expansa
- CA = Cyanea aculeatiflora
- CH = Cyanea horrida
- G = Geranium multiflorum
- S = Schiedea diffusa

II. MANAGEMENT

A. Key Management Considerations

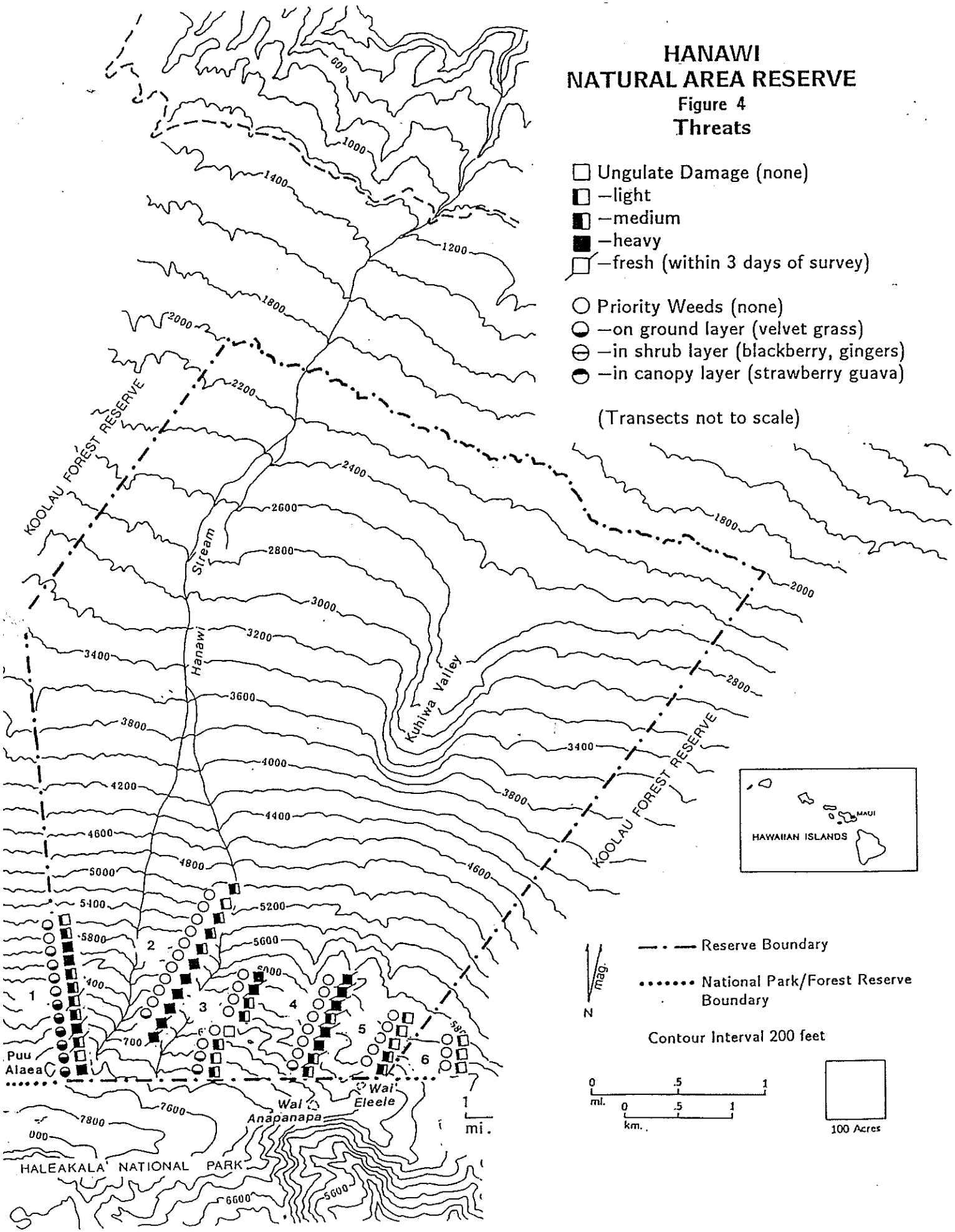
The overall goal of management is to protect and maintain the Reserve's native character. Some of the key considerations behind the management programs proposed to achieve this are as follows:

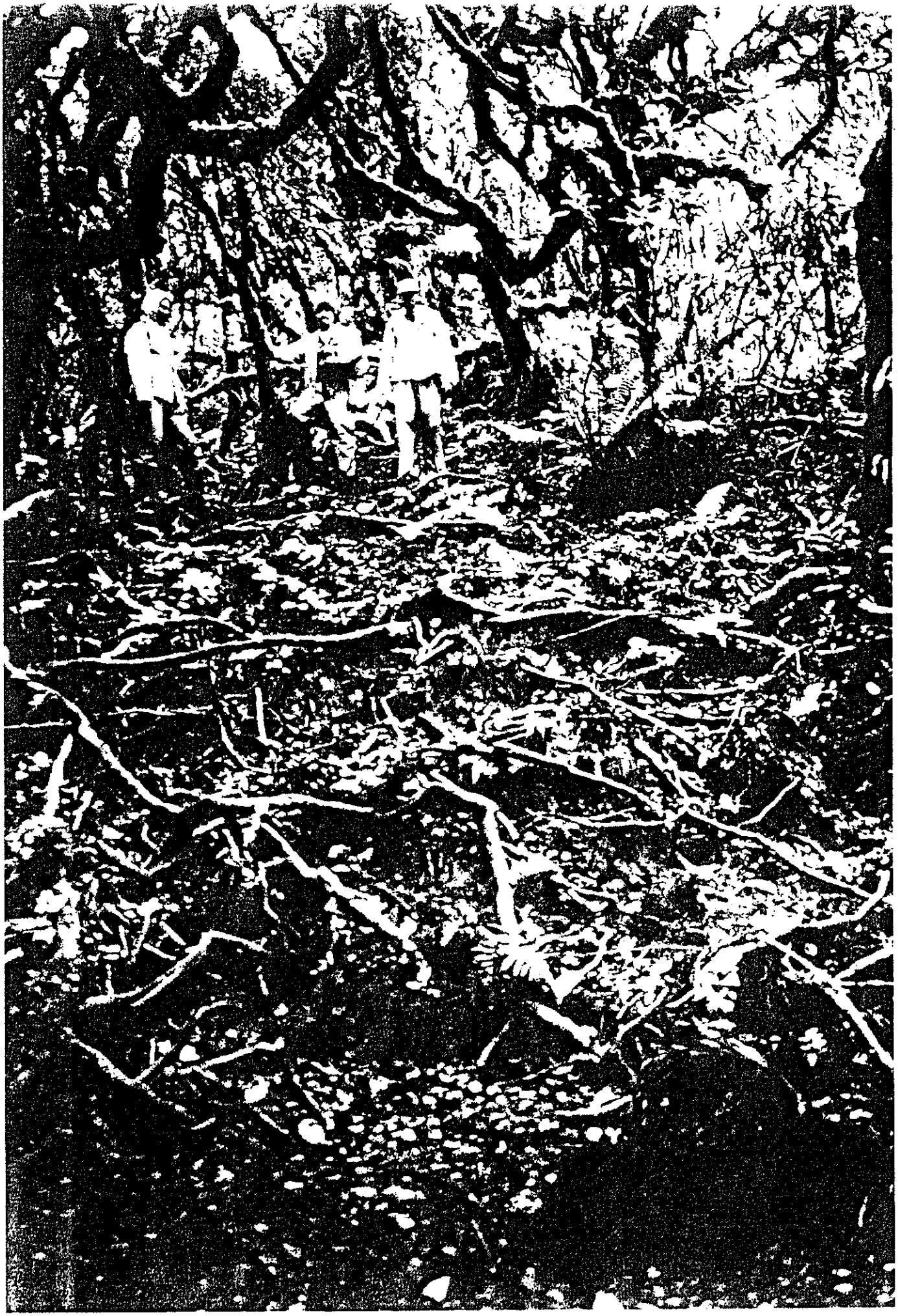
(1) Hanawi is a very large and relatively inaccessible reserve. At this time it is not economically realistic to intensively manage the entire Reserve. Intensive management of key areas are proposed and prioritized based on the biological resources they contain, the extent of current disturbance, the nature of the other biological threats within and near the area, and the feasibility of management (e.g. topography and access). Management activity should begin in the upper elevation forests above 5,000 feet, because of the presence of endangered forest birds and the impact of feral pigs on their habitat. This area also contains important watershed forests.

(2) Pigs constitute the most severe threat currently affecting the Reserve (Figure 4). Their rooting and wallowing destroy native plants and disturb the ground cover on the forest floor (Plate 1). Such damage limits effective regeneration of native plants, and creates conditions favorable for certain weeds throughout the reserve. This in turn degrades the quality and integrity of the native plant communities, threatening the existence of species that rely on the forest for survival. Destruction of plant roots and large wallows on several ridges have caused severe surface soil erosion which has degraded downslope water quality. Pig distribution and movements are discussed in more detail in the Ungulate Control program.

Control of the feral pig population is the essential first step in the maintenance and restoration of native plant communities in the Reserve. A strategic fencing and aggressive ungulate control program are critical for effective long-term reduction of the pig population. A progressive fencing strategy is recommended to create smaller pig control units and restrict pig movement. Fortunately, non-native plant invasion in heavily disturbed areas is minimal at this time. The native vegetation should recover by itself, once feral pigs are controlled. The few areas left in the Reserve that have escaped pig disturbance need to be protected to insure a seed source for natural regeneration in pig-disturbed areas as well as a refugium for endangered fauna.

In the upper Reserve, vegetation in areas with older pig damage is recovering, though the recovering communities are much simpler in structure and species numbers. Forest conditions in these areas were open with more air circulation beneath the canopy. There was considerably less epipyhte growth, probably a result of a change in localized microclimatic conditions. This may be having a negative effect on microhabitat in sites critical to native land snails, other invertebrates, and the bird species that feed on them, such as the Po`ouli and Maui Parrotbill. Information from this survey indicates that Po`ouli may now be restricted to the rectangle of land between East Hanawi and West Kuhiwa Gulch (Engilis unpublished). Severe pig damage is threatening the last remnant of this portion of Po`ouli habitat.


HANAWI
NATURAL AREA RESERVE
Figure 4
Threats
Ungulate Damage (none)
—light
—medium
—heavy
—fresh (within 3 days of survey)
Priority Weeds (none)
—on ground layer (velvet grass)
—in shrub layer (blackberry, gingers)
—in canopy layer (strawberry guava)
(Transects not to scale)
KOOLAU FOREST RESERVE
Hanawi Stream
Kuhiwa Valley
Puu Alaea
Wai Eleele
Wai Anapanapa
HALEAKALA NATIONAL PARK
HAWAIIAN ISLANDS
MAUI
Reserve Boundary
National Park/Forest Reserve Boundary
Contour Interval 200 feet
mag.
N
mi.
km.
100 Acres



Increased public hunting is an essential component of a reserve-wide control program. Access into the lower portion of the Reserve needs to be improved. Arrangements with EMI to increase public access should be pursued and a forest trail system needs to be developed and maintained to increase effectiveness of public hunters in the lower portions of the Reserve.

(3) `Ohi`a dieback impacts the Reserve, especially its lower elevations. Dieback is a natural successional phenomenon in which older stands die synchronously, leaving gaps in the forest canopy. These gaps provide openings for subsequent `ohi`a regeneration. However, invasion of aggressive non-native weeds, accelerated by feral pig damage, hampers native plant regeneration and is a management concern.

(4) Many non-native plants observed in the Reserve are shade intolerant and pose no major problem as long as the canopy and ground cover remain intact. There are several non-native weed species in the Reserve, however, which form monotypic stands and displace native vegetation over large areas, making them priority weeds for management. Weed control activities will focus on these invasive weeds within priority management areas, and on localized populations of priority weed species.

(5) Signs of marijuana cultivation were seen in the lower elevation forests in Kuhiwa Valley. This illegal activity creates a hazard for people in the reserve. Growers destroy native plants in order to create patches for cultivation, introducing new weeds to the forest and spreading others.

B. Management Unit Descriptions

The Reserve has been divided into seven management units, four of which are located in the upper elevation forests above 5,000 feet (Figure 5). Descriptions of each unit follow, and outline key features, problems, and priorities for management:

**Po`ouli Unit** - 420 acres, highly diverse, grasslands, shrublands, mesic and wet `ohi`a forests, endangered birds including Po`ouli, Maui Parrotbill, Crested Honeycreeper, Nuku-pu`u, and rare plants. Forest has been heavily impacted by feral pigs. This unit has highest priority for feral pig control.

Wai `Ele`ele Unit - 340 acres, mostly `ohi`a forests with small scattered bogs. A pristine area containing the reserve's most intact forest and habitat for rare birds including Parrotbill, Crested Honeycreeper, and Akepa. Addition from the Koolau Forest Reserve is included. This unit has high priority for feral pig control.

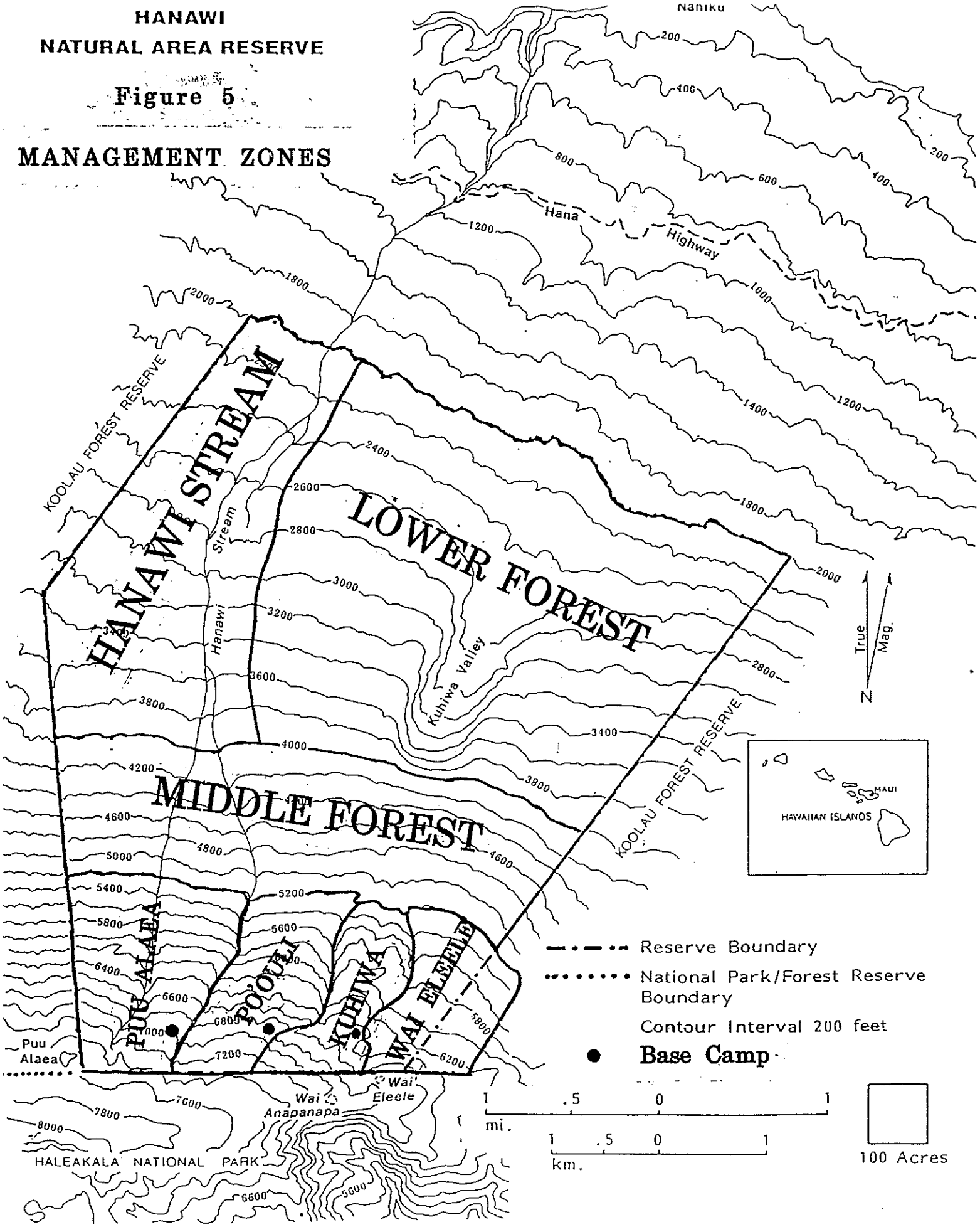
Kuhiwa Unit - 290 acres, a mix of native vegetation with rare plants and birds, severe pig activity along ridge flats, high priority for feral pig control.

Puu Alaea Unit - 490 acres, includes good examples of subalpine grassland, shrubland, rare forest plants and birds. The forest has been heavily impacted by feral pigs along ridge flats, high priority for feral pig control.

HANAWI
NATURAL AREA RESERVE

Figure 5

MANAGEMENT ZONES



Middle Forest Unit - 1,267 acres, contains excellent `ohi`a forest from 4,000 to 5,200 feet. Little survey work was done in unit. There is severe pig disturbance south of Kuhiwa valley at 4,200 to 5,000 foot elevation. This unit has highest priority for monitoring and further survey work.

Hanawi Stream Unit - 1,532 acres, contains koa/`ohi`a forests and lower portions of the Hanawi Stream. Little survey work was done in the unit, high priority for future survey work.

Lower Forest Unit - 3,161 acres, with `ohi`a forests, some exhibiting moderate to severe dieback, Kuhiwa Valley walls have intact native flora. Non-native weed problems exist. High priority for monitoring.

C. Management Programs

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.

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

GOAL: To reduce the impact of ungulates to a level that prevents further degradation of the Reserve's native elements and allows the greatest possible recovery of the Reserve's native character.

Statement of the Problem: Hanawi presents a worst case scenario for an aggressive pig control program. The topography is steep but not quite steep enough to prevent pig movement. The upper Reserve area is accessible only by helicopter during good weather, which is the exception, as wet, windy conditions normally prevail. Effective methods for pig control must not demand intensive and constant maintenance.

Techniques available for pig control in the Reserve include hunting with or without dogs, snaring, baiting and trapping. Current pig control research recommends use of passive control (e.g. snares and traps) before actively controlling with dogs when possible, unless hunting is already established. There is less investment initially, less upkeep, and it is more cost effective in remote areas. The use of snares necessitates control areas being closed to public hunting.

Reduction is the necessary first phase of a control effort. Fence construction, pig control and fence maintenance are essential components of a successful ungulate control program. Attempts to reduce pig populations to remnant levels in similar terrain without the use of fences have not been effective due to unimpeded ingress of animals into areas where population densities were reduced. Funds spent on feral pig control will be ineffective unless populations can be reduced to critical levels and not allowed to build back up to damaging levels. Ongoing research on snaring effectiveness and subsequent vegetation recovery within and outside fenced areas will help determine the need for extensive fence construction in remote natural areas.

Alternative Actions and Probable Impacts:

1) No action. Accept the continuing deterioration of Hanawi's forest watershed and native resources. Pigs destroy native plants, alter the structure of native vegetation, and contribute to the spread of non-native plants. Without control, pigs can be expected to degrade native communities, converting most of the reserve to less diverse assemblages of native plants with nonnative weeds. Extinction of rare bird species, such as Po`ouli, whose range is restricted and and habitat is threatened by pig disturbance, could occur.

2) Attempt control of feral animals without installation of any fences. Damaging impacts of feral pigs under this alternative will probably be roughly the same as alternative #1, except for portions of the reserve where increased hunting activity may protect small areas of forest. Management resources used for pig control will be less effective without fences to keep new populations from moving into the reserve.

3) Control feral pigs with the aid of fences. This method has proven successful in both Hawaii Volcanoes and Haleakala National Parks. Initial cost is high, but benefits in preservation of native ecosystems are great. Recovery of native vegetation can occur if feral animals are controlled. The advance of non-native weed species can be slowed and at times reversed. Native plant species surviving only as epiphytes because of feral pig disturbance can become reestablished on the forest floor.

Recommended Course of Action: Alternative #3 is recommended incorporating three projects; fence construction, pig control, and fence maintenance. Better hunter access into the lower portions of the Reserve is planned. Priority management units proposed for intensive pig control comprise only one-fifth of the Reserve. Some negative reaction to intensive pig control in the Reserve is expected but public hunting in priority management units is negligible.

Project 1 - Fence Construction

The project will construct a progressive network of barrier fences to create four smaller pig control units in the upper portions of the Reserve. Goals of the fencing project are to cut off pig access routes into pristine areas and direct movement within intensive control areas. Aggressive pig control activities are essential in conjunction with the fencing project to take advantage of induced pig movements and to avoid creation of "pig pens".

A six year program for progressive fencing in the four upper elevation management units is proposed. This progressive strategy will allow time for monitoring pig movements and scouting routes to determine the most effective locations for fence construction. After six years a total of 10.4 miles of fence would be constructed (Figure 6). If monitoring indicates vegetation recovery from pig control efforts is occurring, construction of sections of expensive contour fences may not be necessary.

Natural topographic features combined with knowledge of pig movement will be utilized to chose fence locations. Observed patterns seen during the survey indicate that pigs move on to new areas after causing heavy localized damage. The upper grasslands are used as access routes for pig movement into lower forested ridges. The general trend of movement seems to be from west to east.

The area between the east and west forks of Hanawi Stream had moderate to heavy damage, much of which was old. Ridges above Kuhiwa Stream showed heavy, fresh damage. The southeast corner of the reserve near Wai Eleele and the area east of the boundary appeared nearly pristine.

Three types of fences are recommended, differing in order of construction, topographic location, and cost. The first are short fences (T fences) through the upper grass and shrublands connecting the existing HALE fenceline to plunge pools along steep ravines within the reserve. These will disrupt the west to east movement of the pigs through the area into the lower forested ridges and begin to induce predictable movement. The second are stream and boundary fences (B fences) which will run mauka-makai along ridgelines and along side drainages. These fences will further restrict and define pig movement patterns and begin to isolate pig populations.

The third type of fences are the lower contour fences (C fences), which will be the most expensive to construct and maintain. They will complete the fencing of the units. Aggressive control activities within the fenced areas will be necessary to bring pig populations to remnant levels within the fenced units. Special tearaway sections across many of the drainages will be necessary. Extensive scouting for fence location will be required for the boundary and contour fences.

Pig control fences will consist of 39-inch high galvanized woven-wire supplemented along the ground surface by one strand of barbwire stretched tightly across the ground. Woven-wire and barbwire will be secured to steel posts placed no more than 10 feet apart. Concreted galvanized pipe posts may be required to secure the fenceline at certain corners. One-way gates will be installed at strategic points to allow pigs within the fenced units to leave on their own accord.

<u>Year 1</u> - Construct E. Kuhiwa T fence (0.7 mi.)
W. Kuhiwa T fence (0.3 mi.)
E. Hanawi T fence (0.3 mi.)

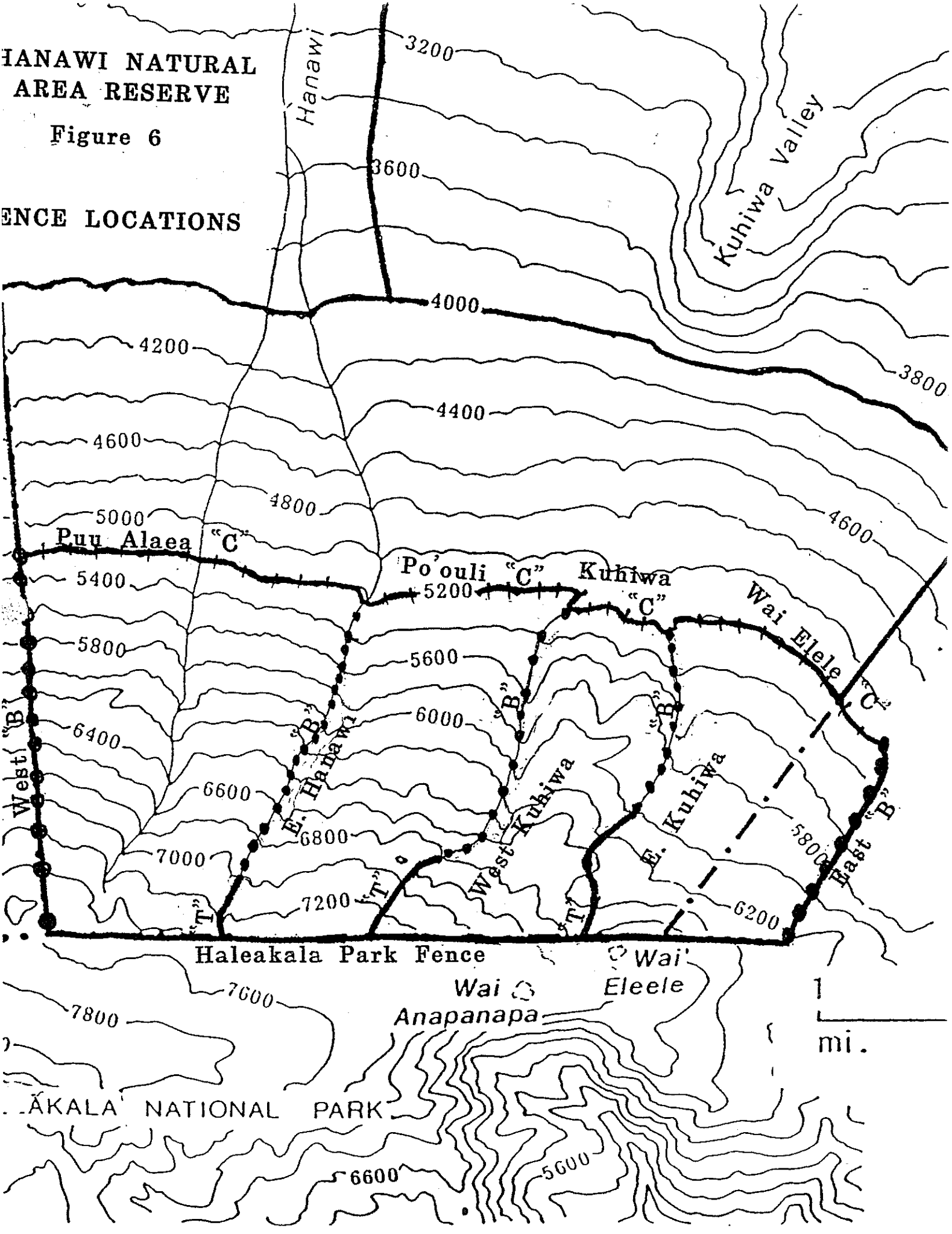
Objectives:
- disrupt movement of pigs in the upper grassland
- protect pristine Wai Eleele unit from pigs moving from Kuhiwa unit
- restrict pig activity to the Kuhiwa unit

Ongoing activities in conjunction with the fence construction include:
1) radio track pig movements in the Kuhiwa unit.
2) establish Kuhiwa base camp
3) snaring along all T fencelines
4) scouting E. and W. Kuhiwa boundary fence routes

HANAWI NATURAL AREA RESERVE

Figure 6

ENCE LOCATIONS



Year 2 - Construct E. Kuhiwa Boundary Fence (0.4 mi.)
W. Kuhiwa Boundary Fence (1.0 mi.)

Objectives: - isolate active pig population in Kuhiwa unit
- refine boundary fence technology

Ongoing activities in conjunction with the fence construction include:
1) snaring along all fencelines and within Kuhiwa unit
2) establish Po`ouli and Puu Alaea base camps
3) scout East Boundary, E. Hanawi Boundary and Kuhiwa Contour fence routes
4) expand radio tracking to Po`ouli and Wai Eleele units

Year 3 - Construct E. Hanawi Boundary fence (0.9 mi.)
East Boundary fence (0.7 mi.)
Kuhiwa Contour fence (0.6 mi.)
4 one-way gates in Kuhiwa fence

Objectives: - close off Kuhiwa unit
- begin to close off Wai Eleele and Po`ouli units

Ongoing activities in conjunction with the fence construction include:
1) snaring along all fencelines and within Kuhiwa, Po`ouli, and Wai Eleele units
2) refine contour fence technology
3) scout Po`ouli and Wai Eleele Contour fence routes

Year 4 - Construct Po`ouli Contour fence (1.0 mi.)
Wai Eleele Contour fence (1.4 mi.)
4 one-way gates in each fence

Objective: - close off Po`ouli and Wai Eleele units

Ongoing activities in conjunction with the fence construction include:
1) snaring along all fencelines and within Kuhiwa, Po`ouli and Wai Eleele units
2) scout West Boundary fence route

Year 5 - Construct West Boundary fence (1.4 mi.)

Objective: - begin to close off Puu Alaea unit

Ongoing activities in conjunction with the fence construction include:
1) snaring along all fencelines and within all four upper management units
2) scout Puu Alaea Contour fence route

Year 6 - Construct Puu Alaea Contour fence (1.7 mi.)

Objective: - close off Puu Alaea unit

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

Year 1 - 1.3 miles of T fence Total $ 65,000

Year 2 - 1.4 miles of B fence	Total	$105,000
Year 3 - 1.6 miles of B fence		$120,000
0.6 miles of C fence		60,000
4 one-way gates		2,000
	Total	$182,000
Year 4 - 2.4 miles of C fence		$240,000
8 one-way gates		4,000
	Total	$244,000
Year 5 - 1.4 miles of B fence	Total	$105,000
Year 6 - 1.7 miles of C fence		$170,000
4 one-way gates		2,000
	Total	$172,000

Cost are based on an estimated $50,000 per mile for T fences, $75,000 for B fences and $100,000 per mile for C fences. Contracting for fence construction is recommended. Costs include materials, supplies, logistics for the contractor, and labor for fence preconstruction (brushing and clearing of proposed fenceline) and actual construction. They do not include personnel costs for fenceline layout and assessment, contract preparation and monitoring. Strict procedures for clearing fence routes will be established to minimize disturbance. A botanist will walk flagged fences routes to search for rare plants to be avoided by the brushing crew.

Project 2 - Fence Maintenance

The project will inspect and maintain all fencelines (and after major storms) on a monthly schedule. Inspections will be done in conjunction with other resource management activities such as pig control, monitoring, and non-native plant control along fence corridors.

Cost/Workload: The following annual workload is projected for monthly fence inspection:

Year 1 - 1.3 miles of T fence		
Personnel 6 Person Days (PD)		$ 420
Supplies and Support		2,000
	Total	$ 2,420
Year 2 - 1.3 miles of T fence, 1.4 miles of B fence		
Personnel (19 PD)		$ 1,330
Supplies and Support		5,500
	Total	$ 6,830
Year 3 - 1.3 miles of T fence, 3.0 miles of B fence		
0.6 miles of C fence		$ 3,080
Personnel (44 PD)		11,150
Supplies and Support	Total	$14,230

Year 4 - 1.3 miles of T fence, 3.0 miles of B fence		
3.0 miles of C fence		
Personnel (90 PD)		$ 6,300
Supplies and Support		22,400
	Total	$28,700
Year 5 - 1.3 miles of T fence, 4.4 miles of B fence		
3.0 miles of C fence		
Personnel (127 PD)		$ 8,890
Supplies and Support		27,950
	Total	$36,840
Year 6 - 1.3 miles of T fence, 4.4 miles of B fence		
4.7 miles of C fence		
Personnel (156 PD)		$10,920
Supplies and Support		35,000
	Total	$45,920

Costs are based on a two person crew able to inspect and fix 3 miles of T fence/day, or 2 miles of B fence/day, or 1 mile of C fence/day. Supplies for fence maintenance include $1,000/mi./yr. for T fences, $2,000/mi./yr. for B fences, and $3000/mi./yr. for C fences. Helicopter is $500/hr (one round trip), salaries are $70/day, and perdiem is $90/person/week. Already constructed fences will be inspected 12 times/yr and fences constructed during the year will be inspected six times/yr.

Project 3 - Pig Control

The project will initiate an active pig control program using snaring in the upper reserve. The goal is to reduce feral pig populations to remnant levels in 1540 acres of the Reserve. Snaring is msot effective in areas with a combination of well-defined pig trails, features that will channel the pigs' movements, and trees to anchor the snares. The most effective approach is to set snares in a good location and leave the area unattended to minimize the effect of human presence, returning to assess the success and condition of the snares. Fence construction should disrupt normal pig movement in the reserve and create good snaring opportunities along fence corridors. Certain pigs are "snare shy" and some staff hunting will be necessary. Snaring areas will need to be posted and public access closed off. Accumulating data on health, sex and age of pigs captured will provide important data on the effectiveness of the control program.

Snare numbers will increase over time to continue to catch pigs as their densities decrease. The greatest effort is initially setting up the snare groups. These snare groups are left in place, as pigs habitually return to previously used areas. When new areas are found with fresh sign, additional snare groups are set out. Snares in rain forests last six months to a year.

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

Year 1	Personnel (16 PD)		$ 1,240
	Supplies and Support		3,750
		Total	$ 4,990
Year 2	Personnel (36 PD)		$ 2,790
	Supplies and Support		6,150
		Total	$ 8,940
Year 3	Personnel (86 PD)		$ 6,665
	Supplies and Support		11,100
		Total	$17,765
Year 4	Personnel (108 PD)		$ 8,370
	Supplies and Support		14,250
		Total	$22,620
Year 5	Personnel (142 PD)		$11,000
	Supplies and Support		19,300
		Total	$30,305
Year 6	Personnel (160 PD)		$12,400
	Supplies and Support		21,350
		Total	$33,750

Costs are based on a two-person crew able to establish 50 snares/day and check 250 snares/day. Snares ($5 each) will be replaced every year and inspected five times/year. Snaring densities will be approximately every 40 feet along fenceline corridors and 100 snares/250 acres within the management units. Helicopter is $500/hr (one round trip), salaries are $85/day for a biologist and $70/day for technician, and perdiem is $90/person/week.

Monitoring Program (HAN-RM-02) - Priority #2

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

Statement of the Problem: Scientific monitoring must be established to track changes in key non-native and native plant and animal species in the Reserve. Another monitoring function is to determine the effectiveness of operational management plans and techniques, so that progress can be documented and methodologies refined. Monitoring data are also needed to develop long range plans.

Alternative Actions and Probable Impacts:

1) No monitoring program. This could lead to inefficient management as a result of poor understanding of the area's biological needs.

2) Conduct ad hoc monitoring whenever possible. This is likely to be considerably more expensive and less effective in the long run than a systematic approach.

3) Establish a systematic monitoring program that covers the current and potential resource management problems in the reserve at least once a year. Increase monitoring intensity for select problems as needed.

Recommended Action: Establish a systematic monitoring program that covers the current and potential resource management problems in the reserve at least once a year (Alternative #3). Monitoring is recommended in intensive pig control units twice a year to evaluate levels of pig activity and vegetation recovery. Transects should be established along strategic ridges, drainages, and snare lines. More systematic monitoring transects can be established once the home range for pigs is determined. Monitoring in the Middle Forest unit will be done at least once a year. Most transects will require a two-person crew for safety. Some monitoring activities can be done in conjunction with fence inspection. Only annual aerial monitoring with subsequent ground checks are suggested at this time for the Hanawi and Lower Forest units because of size, poor access, and lower priority for management.

Goats were not observed during this survey, but are known historically from Kalapawili Ridge and the grassland areas above Hanawi. The fence built by Haleakala National Park along the reserve's southern boundary prevent goats from entering the reserve from adjacent grasslands. Goat movement in response to hunting pressure in the National Park west of the reserve warrants close monitoring.

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

Year 1	Personnel (100 PD)		$ 7,750
	Radio receiver (3 at $2000)		6,000
	Radio collars (20 at $300)		6,000
	Perdiem (20 weeks at $90/week)		1,800
	Helicopter (10 trips, and recon)		6,500
		Total	$28,050
Year 2	Personnel (100 PD)		$ 7,750
	Perdiem and Helicopter		8,300
		Total	$16,050
Year 3-6	same as year 2	Total	$16,050

Non-native Plant Control Program (HAN-RM-03) - Priority #3

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 naturalized in Hawaii and their total removal from the reserve is not feasible. The best strategy for control is to maintain intact native forests by limiting disturbance to existing native vegetation. While feral pig control will help in this regard, many weeds are spread by birds and control of priority weed species in key management units will be necessary. Weed seeds are also spread by people on their boots or in their equipment.

Manual and chemical control of weeds is costly and should be prioritized by the nature of the weed, the value of the area it is invading, and the effectiveness of the control measure. Biocontrol is an important tool in the management of wide-spread priority weed species and the NARS should support ongoing interagency biocontrol projects.

Strawberry guava (Psidium cattleianum) and gingers (Hedychium spp.) are currently the most invasive weeds in the Reserve's 2,000 to 3,000 foot elevation range. These weeds are spreading throughout much of the state. Strawberry guava grows as a shrub or tree forming dense stands. Kahili ginger (Hedychium gardnerianum) appears most common, but yellow ginger (Hedychium flavescens) and white ginger (Hedychium coronarium) also occur.

Threatening weeds in the upper elevation grasslands are velvet grass (Holcus lanatus) and blackberry (Rubus argutus). Blackberry is currently expanding its population near Puu Alaea into the lower shrublands, probably spread by birds such as the Ring-necked Pheasant, which eat the fruit. This fast-spreading weed could become a major pest in the rainforest. Velvet grass spreads rapidly in grasslands where pigs have disturbed clumps of native Deschampsia as well as the adjacent, lower-elevation pukiawe shrublands.

Alternative Actions and Probable Impacts:

1) Control pigs, but do not attempt to control any aggressive non-native plant species. This will reduce the spread of many pig-dispersed plant species, but will allow continued advance of plants spread by birds. Decreased rooting and forest floor disturbance by feral pigs will slow down establishment of many non-native plants, but already established plants may continue to spread unchecked. Native plant regeneration in `ohi`a dieback areas could be severely reduced by competition from aggressive non-native plant species.

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

3) Control all non-native weed species in the Reserve. This alternative would require extensive resources and is not practical.

Recommended Course of Action: Alternative #2 is recommended. Remove blackberry from the upper grasslands in the Puu Alaea area. Utilize existing plant control research conducted at HAVO and HALE. Conduct non-native plant removal along fenceline corridors as part of periodic maintenance. Establish monitoring transects for other priority weeds. Establish strict sanitary procedures to prevent introduction of weed seeds by management personnel on their boots and equipment.

Detailed records of the effectiveness of control methods used in the Reserve will be kept. Careful monitoring and documentation of results of plant control efforts is very important. Coordination between NARS and other involved agencies in plant control work will reduce management costs.

Cost/Workload:

Year 1 - Personnel (60 PD)		$ 4,200
Supplies and support		9,100
	Total	$13,300
Year 2-6 same as Year 1	Total	$13,300

Cost are based on helicopter at $500/hr (one round trip), salary is $70/day, and perdiem is $90/person/week.

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

GOAL: To build public understanding and support for the reserve in the local community. To provide educational opportunities, where appropriate, for interested groups. To provide volunteer labor to help staff in management activities.

Statement of the Problem: Most residents and visitors are unaware of Hawaii's natural heritage. Even fewer realize that this resource is being threatened. Management of this reserve will be a costly and long term effort and public support is essential. The upper portions of the Reserve are invaluable for research and public use needs to be controlled. Public education through appropriate media coverage is important but encouragement of unrestricted public visitation in the upper reserve must be avoided.

Concerned volunteer groups have proven successful in certain natural area management activities, especially in labor intensive efforts such as trail building and maintenance. They tend to be extremely motivated and represent a valuable resource for the reserve manager.

Recommended Course of Action: Inform the general public about the Reserve's resources and management activities through television and newspaper coverage. Utilize volunteer groups for development and maintenance of a trail system in the lower portion of the Reserve. Present slide shows and talks to community groups.

Cost/Workload:

Year 1 - Personnel (40 PD)		$ 2,800
Support and supplies		2,000
	Total	$ 4,800
Year 2-6 same as Year 1	Total	$ 4,800

D. Boundary Administration and Special Uses

A cooperative management agreement should be formalized with Haleakala National Park. Costs of resource management in the reserve and the park will decrease with cooperation and communication between NARS and HALE. Savings could be incurred by sharing fence maintenance (especially after storms), remote base camps, research data, and by coordinating other management activities.

A 170 acre portion of the Koolau Forest Reserve is included within the Wai Eleele management unit. This portion of the Forest Reserve is pristine. Areas which have escaped pig disturbance need to be protected to insure a seed source for natural regeneration in pig-disturbed areas as well as a refuge for endangered fauna. An additional management unit in the Koolau Forest Reserve could be fenced to link the Hanawi reserve to the Kipahulu section of HALE, if funds are available.

The reserve has been used by research teams studying endangered bird life. Biologists from the State Division of Forestry and Wildlife, U.S. Fish and Wildlife Service, and the National Park Service have spent hundreds of field hours in the Hanawi area, establishing transects, trails, and base camp areas. As management activity increases, the demand for research will also increase. A formal research plan should be written for the reserve that specifically identifies research needs and procedures. All research proposals should be evaluated within the context of this plan and closely monitored to insure that the resources within the reserve are not damaged.

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. Three 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 program integrated within the existing structure of the Division of Forestry & Wildlife. The budget summary shown is for the management of the Hanawi Reserve only. It does not include all the administrative, clerical, and facility support needed to run a state-wide NARS or to manage the other two natural area reserves on the island of Maui. These infrastructure costs for the NARS will be identified and documented separately.

Initial costs of starting up a management program in a reserve the size of Hanawi are high, especially fence construction. Annual maintenance costs will decrease, once feral pig and non-native plant threats are under control. Operations and maintenance costs such as four portable radios, and establishment/maintenance of three base camps are included in program HAN-OP-01. Starting with year 3, a 1% inflation increase is incorporated into every yearly total.

HANAWI BUDGET SUMMARY

PROGRAM	YR 1	YR 2	YR 3	YR 4	YR 5	YR 6
HAN-RM-01						
Proj. 1	65,000	105,000	182,000	244,000	105,000	172,000
Proj. 2	2,450	6,850	14,250	28,700	36,850	45,950
Proj. 3	5,000	8,950	17,800	22,650	30,300	33,750
HAN-RM-02	28,050	16,050	16,050	16,050	16,050	16,050
HAN-RM-03	13,300	13,300	13,300	13,300	13,300	13,300
HAN-RM-04	4,800	4,800	4,800	4,800	4,800	4,800
HAN-OP-01	22,000	21,000	4,000	4,000	4,000	4,000
[1]TOTAL($)	140,600	175,950	252,950	338,400	214,800	299,650

MANAGEMENT PROGRAMS

HAN-RM-01 - Ungulate Control
- Project 1 - Fence Construction
- Project 2 - Fence Maintenance
- Project 3 - Feral Pig Control

HAN-RM-02 - Monitoring
HAN-RM-03 - Non-native Plant Control
HAN-RM-04 - Public Education and Volunteer Support
HAN-OP-01 - Infrastructure Expenses

PERSONNEL (PD = person days)

YR 1 -Biologist 93 PD
Technician 114 PD

YR 2 -Biologist 103 PD
Technician 137 PD

YR 3 -Biologist 128 PD
Technician 187 PD

YR 4 -Biologist 139 PD
Technician 244 PD

YR 5 -Biologist 156 PD
Technician 298 PD

YR 6 -Biologist 165 PD
Technician 336 PD

[1] Starting with year 3, a 1% inflation increase is incorporated into every yearly total.

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APPENDIX 1
Hanawi Natural Area Reserve
Transect Specifications

Transect number	Transect length (ft)	No. of substations	Natural communities surveyed*
1	5,576	35	*Deschampsia* Grassland Pukiawe Shrubland `Ohi`a Mixed Forest
2	5,412	34	Pukiawe Shrubland `Ohi`a Mixed Forest `Ohi`a Subalpine Forest
3	3,772	24	*Deschampsia* Grassland Pukiawe Shrubland `Ohi`a Mixed Forest
4	3,772	24	*Deschampsia* Grassland Pukiawe Shrubland `Ohi`a Mixed Forest `Ohi`a Subalpine Forest
5	2,132	14	`Ohi`a Mixed Forest
6	1,148	8	`Ohi`a Mixed Forest

*See Table 1 for full natural community names.

SURVEY PARTICIPANTS

Steven Perlman - Botanist
Sam Gon - Ecologist
Andy Engilis - Ornithologist
Michael Buck - Management Specialist

Hanawi Natu. Area Reserve
Sample Field Forms

NATURAL COMMUNITY FIELD OBSERVATION FORM TIME START: _____ END: _____
DATE: _____ TRANSECT#: _____ STATION#: _____ ELEVATION: _____
OBSERVER(S): _____
NC NAME: _____ EOCODE: _____
NAR NAME: _____ QUAD NAME: _____
SUBSTRATE: _____
ADJ NCS: _____

DESCRIPTION LINE: _____

ASPECT	SLOPE	CANOPY CLOSURE	TOPOGRAPHIC POSITION	CANOPY STATURE	MOISTURE	NC AREA
___N	__FLAT	__DENSE	__CREST	__<1M	__INUNDATED	__<1 AC
___E	__GENTLE	__CLOSED	__UPPER SLP	__1-2.5M	__SATURATED	__1-5 AC
___S	__MOD	__OPEN	__MID SLP	__2.5-5M	__MOIST	__6-10 AC
___W	__STEEP	__SCATTER	__LOW SLP	__5-10M	__MOIST-DRY	__>10 AC
__( )	__VERT	__VERY SC	__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	AVE DIA	REMARKS

B. SUBCANOPY DOMINANTS:

SPECIES	T	S	H	*COVER	REMARKS

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

PROTECTION/MANAGEMENT RECOMMENDATIONS: _____

EORANK: _____ 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	%COV
___N	__FLAT	__DENSE	__CREST	__INUNDATED		
___E	__GENTLE	__CLOSED	__UPPER SLP	__SATURATED		
___S	__MOD	__OPEN	__MID SLP	__MOIST		
___W	__STEEP	__SCATTER	__LOW SLP	__DRY-MESIC		
__( )	__VERT	__VERY SC	__BOTTOM	__DRY		

HABIT	PHENOLOGY	AGE STRUCTURE	VIGOR	FREQUENCY	POPULATION SIZE	POPULATI AREA (M
__TREE	__IN LEAF	__%SDLGS	__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	__%SENESC	__VIGOROUS	__SOL	__50-100	__10-100
__PROST	__MAT FRUIT				__100-1000	__100+
	__DORMANT				__1000+	

Hanawi Natu[illegible] Area Reserve
Sample Field Forms

TRANSECT STATION FIELD FORM Time Start: _____ End: _____ Date: _____
NC Name: _____ NAR Name: _____
Observer(s): _____
Transect#: _____ Station#: _____ Elevation: _____ Bearing: _____
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	__ VERYSC	__ 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): _____
Transect#: _____ Station#: _____ Elevation: _____ Bearing: _____
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	__ VERYSC	__ 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: _____ Transect#: __
Observer(s): _____
*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

STATION NUMBER:

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

APPENDIX 3
Hanawi Area
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 non-rare species included on this list may not actually be in the reserve. Plants and their associated vegetation types reported from literature for the area, but not confirmed during this survey, are noted with an 'x'. Plants reported for the area without an associated vegetation type are assigned to the natural community they would most likely occur in with a '?'.

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

STATUS	TAXON	`Ohi`a Subalpine Mesic Forest	`Ohi`a/Uluhe Wet Forest	`Ohi`a Mixed Shrub Wet Forest	Carex Wet Grassland	`Akala Wet Shrubland	Koa/`Ohi`a Wet Forest	Deschampsia Mesic Grassland	Pukiawe Subalpine Mesic Shrubland
E	Acacia koa						*		
E	Adenophorus tamariscinus			*			x		
E	Adenophorus tripinnatifidus			*					
N	Ageratina adenophora		*						
N	Ageratum conyzoides	?	?	?	?	?	?	?	?
E	Alyxia oliviformis			*					
N	Andropogon virginicus	?	?	?	?	?	?	?	?
N	Anthoxanthum odoratum			*					
E	Argyroxiphium grayanum	*		*	x				
+E	Argyroxiphium cf. virescens				x				*
E	Asplenium acuminatum			?		?	?		
E	Asplenium contiguum	*		*					
E	Asplenium lobulatum	*		*					
I	Asplenium normale			*					
+E	Asplenium schizophyllum			?			?		
?	Asplenium sp.			*					

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

* = Confirmed in NARS field survey x = Cited in literature sources
? = Cited in literature; needs confirmation in natural community

STATUS	TAXON	'Ohi'a Subalpine Mesic Forest	'Ohi'a/Uluhe Wet Forest	'Ohi'a Mixed Shrub Wet Forest	Carex Wet Grassland	'Akala Wet Shrubland	Koa/'Ohi'a Wet Forest	Deschampsia Mesic Grassland	Pukiawe Subalpine Mesic Shrubland
E	Asplenium subcaudatum			x					
E	Asplenium trichomanes								x
E	Asplenium unilaterale			*					
E	Astelia menziesiana	*		*					
E	Athyrium microphyllum			*				x	*
E	Athyrium sandwichianum			*					*
E	Bidens campylotheca ssp. pentamera		?	?			?		
E	Boehmeria grandis			*					
E	Broussaisia arguta			*			*	*	
+E	Calamagrostis expansa								*
N	Cardamine flexuosa			*					
E	Carex alligata	*		*	*			x	*
E	Carex echinata				x				
E	Carex macloviana								x
E	Carex montis-eeka				x			x	
E	Carex wahuensis	*		*					x
N	Cerastium fontanum ssp. triviale		?	?			?	?	
E	Cheirodendron trigynum	*		*	*		*	*	*
E	Cibotium chamissoi		*						
E	Cibotium glaucum		*						
E	Cibotium spp.		*	*					
E	Clermontia arborescens			*					
E	Clermontia sp.								
E	Coniogramme pilosa	*		*					
E	Coprosma ernodeoides			*				*	*
E	Coprosma montana	*		*				*	*
E	Coprosma ochracea	*		*		*			*
E	Coprosma sp.					*	*	x	
E	Ctenitis rubiginosa			?	?	?	?		
+E	Cyanea aculeatiflora	*		*					
+E	Cyanea horrida			*					
N	Cyperus halpan		?	?	?	?	?	?	?
E	Cyrtandra spp.			*					
E	Deschampsia nubigena	*		*	x			*	*
I	Dicranopteris linearis		*						
I	Diplopterygium pinnatum		*	*					
E	Dryopteris fusco-atra			*					
E	Dryopteris glabra	*		*	x				*
E	Dryopteris hawaiiensis	*		*				*	*
E	Dryopteris wallichiana	*		*				x	*
E	Dubautia menziesii								*
E	Dubautia menziesii x scabra	*		*					*
E	Dubautia plantaginea ssp. plantaginea	*		*					

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

* = Confirmed in NARS field survey x = Cited in literature sources
? = Cited in literature; needs confirmation in natural community

STATUS	TAXON	'Ohi'a Subalpine Mesic Forest	'Ohi'a/Uluhe Wet Forest	'Ohi'a Mixed Shrub Wet Forest	Carex Wet Grassland	'Akala Wet Shrubland	Koa/'Ohi'a Wet Forest	Deschampsia Mesic Grassland	Puklawe Subalpine Mesic Shrubland
E	Dubautia reticulata	*		*		*			
E	Dubautia scabra								*
E	Dubautia spp.			x					*
I	Elaphoglossum alatum	*		*					*
E	Elaphoglossum hirtum	*		*					*
E	Elaphoglossum spp.			x					
N	Epilobium ciliatum			*				*	*
N	Erechtites valerianifolia		*						
N	Epilobium sp.								*
I	Fragaria chiloensis ssp. sandwicensis							*	*
+E	Gardenia remyi	?							
+E	Geranium multiflorum			*					*
E	Grammitis hookeri			*					
E	Gunnera petaloidea			*					
N	Hedychium coronarium		*						
N	Hedychium flavescens		*						
N	Hedychium gardnerianum		*		*				
N	Hedychium spp.		*						
+E	Hedyotis elatior		?	?					
E	Hedyotis spp.			x					
E	Hedyotis terminalis			*					
N	Holcus lanatus			*				*	*
N	Hypochoeris radicata			*				*	*
E	Ilex anomala	*		*					
+E	Joinvillea ascendens ssp. ascendens		?	?			?		
N	Juncus bufonius							x	
E	Korthalsella complanata	*		*					*
E	Labordia hedyosmifolia			*					
E	Labordia sp.			*					*
E	Labordia venosa			*					
N	Lapsana communis								x
E	Lobelia gloria-montis		?	?					
E	Lobelia grayana			*					
N	Ludwigia octovalvis		?	?		?	?	?	
E	Luzula hawaiiensis			*					
I	Lycopodium cernuum			*					x
I	Lycopodium venustulum	*		*				*	*
E	Lysimachia sp.	*							*
E	Machaerina gahniformis			*				*	*
E	Marattia douglasii			*					
E	Metrosideros polymorpha	*	*	*	*		*	*	*
E	Microsorium spectrum		?	?	?	?	?	?	?
E	Myrsine lessertiana	*		*				*	*
I	Nertera granadensis			*					

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

* = Confirmed in NARS field survey x = Cited in literature sources
? = Cited in literature; needs confirmation in natural community

STATUS	TAXON	`Ohi`a Subalpine Mesic Forest	`Ohi`a/Uluhe Wet Forest	`Ohi`a Mixed Shrub Wet Forest	Carex Wet Grassland	`Akala Wet Shrubland	Koa/`Ohi`a Wet Forest	Deschampsia Mesic Grassland	Pukiawe Subalpine Mesic Shrubland
E	Oreobolus furcatus			*	x			x	
E	Pelea clusiifolia	*		*					
E	Pelea sp.						*		
+E	Peperomia expallescens		?	?					
E	Peperomia globulanthera	*		*					*
E	Peperomia kipahuluensis			*					
E	Peperomia spp.			*					
E	Perrottetia sandwicensis			*					
+E	Phyllostegia bracteata		?	?			?		
#E	Phyllostegia macrophylla	x		x					
E	Phyllostegia sp.			*					
I	Pilea peploides			*					
E	Pipturus albidus			*		*			
E	Pittosporum argentifolium	?							
E	Pittosporum confertiflorum	*		*					x
E	Plantago pachyphylla	*						*	x
+E	Platanthera holochila		?	?	?	?	?		
I	Pleopeltis thunbergiana	*		*					*
E	Polypodium pellucidum	*		*				x	*
E	Polystichum haleakalense			x					
E	Pritchardia sp.		*						
N	Prunella vulgaris			*				*	*
N	Psidium cattleianum		*						
N	Psidium guajava		*						
E	Psychotria hawaiiensis		*						
E	Psychotria spp.		*	*			*		
E	Pteridium decompositum	*		*				x	x
I	Pteris excelsa	*		*					
N	Rubus argutus							*	*
E	Rubus hawaiiensis	*		*	*	x		*	*
E	Rubus macraei			*				*	*
N	Rubus rosifolius		*	*					
N	Rumex acetosella			*				*	*
E	Rumex giganteus								x
N	Sacciolepis indica	?	?	?	?	?	?	?	?
E	Sadleria cyatheoides	*		*				*	*
E	Sadleria pallida			*					
E	Sanicula sandwicensis								x
E	Scaevola chamissoniana			*					
+E	Schiedea diffusa			?					
E	Schizaea robusta				?				
E	Selaginella deflexa			?	?	?			
N	Senecio spp.			*				*	*
E	Sisyrinchium acre								x
E	Smilax melastomifolia	*		*					
E	Sophora chrysophylla								x

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

* = Confirmed in NARS field survey x = Cited in literature sources
? = Cited in literature; needs confirmation in natural community

STATUS	TAXON	'Ohi'a Subalpine Mesic Forest	'Ohi'a/Uluhe Wet Forest	'Ohi'a Mixed Shrub Wet Forest	*Carex* Wet Grassland	'Akala Wet Shrubland	Koa/'Ohi'a Wet Forest	*Deschampsia* Mesic Grassland	Pukiawe Subalpine Mesic Shrubland
E	Stenogyne kamehamehae			*					
E	Stenogyne rotundifolia	*		*					
E	Sticherus owhyensis		*	*			*		
E	Styphelia tameiameiae	*		*	x			*	*
N	Syzigium jambos		*						
N	Syzigium cumini		*						
E	Tetraplasandra kaviensis		*	*			*		
E	Tetraplasandra oahuensis		?	?					
E	Thelypteris sandwicensis			*					
E	Touchardia latifolia			*					
E	Uncinia uncinata	*		*				x	*
E	Urera glabra			?					
E	Vaccinium calycinum	*		*		*		*	*
E	Vaccinium reticulatum	*		*	x			*	*
E	Vandenboschia draytoniana			?		?			
E	Viola maviensis				?				
N	Vulpia bromoides			*				x	*

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

* = Confirmed in NARS field survey x = Cited in literature sources
? = Cited in literature; needs confirmation in natural community

APPENDIX 4
Hanawi Natural Area Reserve
Bird Species List

The birds listed were reported from visual and audio identification in the reserve. Nine natural community types have been recognized in the Hanawi reserve, but only three are designated as habitat types for birds in this appendix.

GS: **Grass and shrublands**
Deschampsia Subalpine Mesic Grassland, Pukiawe Mixed Subalpine Mesic Shrubland, and `Akala Montane Wet Shrubland (southern section of the reserve).

UO: **Upper elevation `ohi`a forests**
`Ohi`a Subalpine Mesic Forest and `Ohi`a Mixed Shrub Montane Wet Forest (ca. 4,200-7,000 feet).

LO: **Lower elevation `ohi`a forest**
`Ohi`a/Uluhe Montane Wet Forest (ca. 4,200 feet to the lowest reserve boundary)

Mixed Fern/Shrub Montane Wet Shrubland and `Uki Montane Wet Grassland are not included here as they constitute only occasional patches. Koa/`Ohi`a Montane Wet Forest was not sampled during this field survey, and is not represented here.

Status	Species	Common Name	GS	UO	LO
N	Alauda arvensis	Eurasian Skylark		?	
N	Alectoris chukar	Chukar	x	x	
E	Asio flammeus sandwichensis	Pueo, Hawaiian Owl	x	*	?
N	Cardinalis cardinalis	Northern Cardinal		*	x
N	Carpodacus mexicanus	House Finch		x	
N	Garrulax canorus	Melodious Laughing-thrush		x	x
+E	Hemignathus lucidus affinus	Maui Nuku-pu`u		x	
E	Hemignathus virens wilsoni	Maui `Amakihi	*	*	x
E	Himatione sanguinea sanguinea	`Apapane	*	*	*
N	Leiothrix lutea	Red-billed Leiothrix	*	*	x
N	Lonchura punctulata	Nutmeg Mannikin, Ricebird		x	x
+E	Loxops coccineus ochraceus	Maui `Akepa		*	
+E	Melamprosops phaeosoma	Po`ouli		*	
N	Mimus polyglottos	Northern Mockingbird		?	
+E	Palmeria dolei	Crested Honeycreeper	x	*	
E	Paroreomyza montana newtoni	Maui Creeper	x	*	x
N	Phasianus colchicus	Ring-necked Pheasant	x	*	
V	Pluvialis dominica	Lesser Golden-plover			*
+E	Pseudonestor xanthophrys	Maui Parrotbill	x	*	x
N	Tyto alba	Common Barn-owl		x	
E	Vestiaria coccinea	`I`iwi	x	*	x
N	Zosterops japonicus	Japanese White-eye		*	*

+ = Rare N = Non-native V = Visitor E = Endemic
x = Cited in literature * = Confirmed during NARS field study
? = Cited in literature; needs confirmation in reserve