

OLOKUI
NATURAL AREA RESERVE
MANAGEMENT PLAN

Natural Area Reserves System Program

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

March 1991

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Olokui Natural Area Reserve

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EXECUTIVE SUMMARY

This plan describes the management program for the Olokui Natural Area Reserve. The 1620-acre reserve, which was established in 1985 by Executive Order 3303, is located in an extremely remote portion of windward east Molokai. The reserve extends up from the bottom of sea cliffs, then along a plateau to 4602 feet elevation.

The reserve protects seven native communities including some of the most pristine wet forest communities in the state. Several types of rare plants, snails, and birds are present.

Management efforts will focus on retaining the ungulate free condition of the reserve. Feral goats and pigs are present in surrounding areas and recent survey work revealed ungulate damage along the northeast ridge leading up to the plateau. Since fencing is not feasible due to the extreme topography, aerial hunting is proposed to reduce ungulate populations along the surrounding ridges and pali areas.

Other management programs include: 1) monitoring to determine the effectiveness of nonnative animal and plant control programs; 2) nonnative plant control to limit the spread and where possible eradicate nonnative plant infestations; and 3) public education to build public understanding and support for the Olokui reserve and the Natural Area Reserves System.

Most of the lands surrounding the reserve are either Forest Reserve or managed by The Nature Conservancy of Hawaii. Control of nonnative plants and animals in these areas will help slow their influx into the Olokui reserve. Compatible management projects should be coordinated with adjacent landowners and managers. Due to the remote location and pristine condition of the reserve, use of the reserve should be limited to scientific research.

The four management programs discussed form an integrated strategy to protect the natural area resources of the reserve. A six year implementation schedule is proposed. Yearly budget estimates begin at \$34,000 in the first year and decrease to half that amount in years 3-6.

NATURAL AREA RESERVES SYSTEM PROGRAM

OLOKUI 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 Natural Area Reserves System (NARS). The NARS was established 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 Section 195-1). To date, there are 19 reserves on 5 islands, occupying more than 109,000 acres of the state's most biologically diverse ecosystems.

This plan describes the management program for the Olokui Natural Area Reserve on Molokai. The reserve, which was established in 1985 by Executive Order 3303, protects seven native communities including some of the most pristine wet forest communities in the state. Several types of rare plants, snails, and birds are present. This plan consists of five parts:

- o an **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.

Three major sources of information were used to prepare this plan. The first was The Nature Conservancy's Hawaii Heritage database on rare species and unique natural communities. The second was a field inventory conducted in March 1989, specifically designed to collect data relevant to management of the reserve's natural resources. The third was a review of this plan by managers, planners, and biologists familiar with the area and its management needs.

The reserve encompasses a plateau which is one of the few intact native areas remaining in the state. Feral ungulates, humans, and nonnative plants have little altered the area's pristine condition. For this reason, the field inventory conducted to gather information for this plan consisted mostly of aerial reconnaissance, with only one field day spent gathering data along a single transect (Figure 1). This transect was situated along a ridge between the reserve and neighboring Wailau Valley, thought to be a possible access point for ungulates into the reserve (Appendix 1). Detailed field forms were completed at sampling stations every 165 feet, noting the type of natural community and the presence of rare plants, native birds, feral ungulates, and nonnative plants (Appendix 2).

The survey was designed to gather management-oriented resource information over a large area in a short time period. It 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 plant species currently known from the reserve is in Appendix 3; a list of bird species is in Appendix 4.

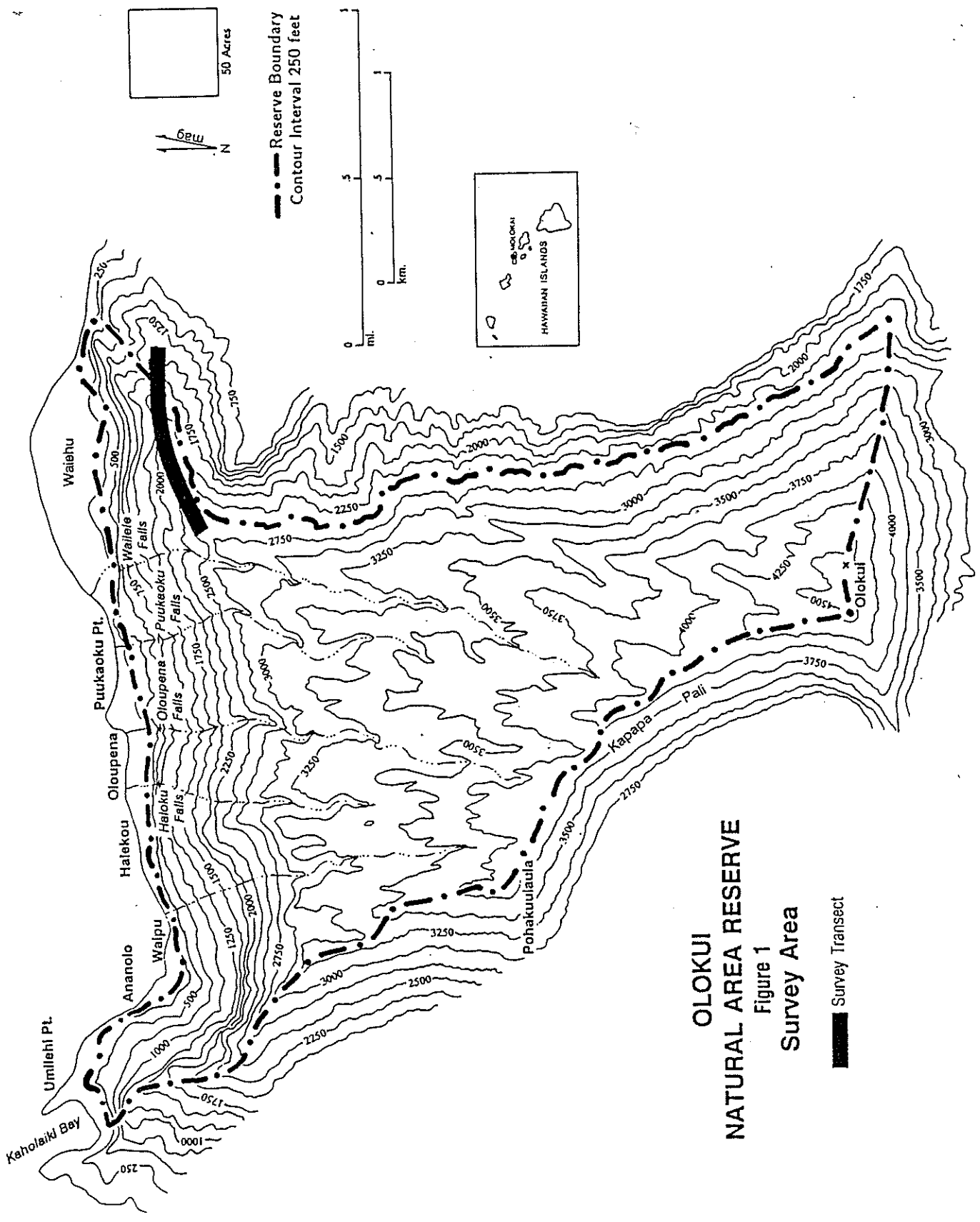
This plan is intended to establish long-range goals and describe specific programs and activities to be accomplished during the next six years. The plan will be updated biannually to incorporate new knowledge and refine management concepts.

II. RESOURCES SUMMARY

A. General Setting

The Olokui Natural Area Reserve occupies 1,620 acres in the Molokai District on the island of Molokai. The reserve is situated atop a plateau with very steep cliffs surrounding it. Elevations range from the top of the lowest sea cliffs, to 4,602 feet elevation at Olokui summit. Rainfall averages 80 - 120 inches per year, with March the wettest month (12 - 20 inches average) and June the driest month (3 - 6 inches) (Giambelluca, Nullet, and Schroeder 1986).

The Olokui reserve is bordered on the west by Pelekunu Valley (most of which is managed by The Nature Conservancy as a nature preserve), on the east by Wailau Valley, and on the north by the rugged Molokai north shore (Figure 1). Most of Wailau Valley and the area south of the reserve are state owned and designated as Forest Reserve, with some private landowners in the area. No roads or trails approach or cross the reserve. The reserve's natural inaccessibility has kept it one of the few pristine, native-dominated wet forest areas in the state. Surrounding valleys all contain feral pigs, goats, and deer,



**OLOKUI
NATURAL AREA RESERVE**

Figure 1
Survey Area

Survey Transect

which may eventually reach the plateau. Protecting this pristine area from invasion by nonnative ungulates is the top management priority for this reserve.

B. Flora

Two of the seven natural communities observed during the survey are described from information gathered during the survey on transect and from vegetation maps prepared for the island by J. Jacobi (1985). Information on the other five natural communities was derived from more than two hours of helicopter reconnaissance. Four communities were seen in the reserve's steeper sections, and three 'ohi'a (Metrosideros polymorpha)-dominated forests occupied the plateau (Table 1, Figure 2). Though none of the communities seen in Olokui are considered rare, the wet forests are arguably the most intact examples in the state.

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.

TABLE 1
NATURAL COMMUNITIES OF OLOKUI NATURAL AREA RESERVE

Natural Community	HHP Rank ¹	Acreage ²
Hawaiian Mixed Shrub Coastal Dry Cliff	3	304
Kawelu Coastal Dry Grassland	3	#
Lama/'Ohi'a Lowland Mesic Forest	3	+
Mixed Fern/Mixed Shrub Montane Wet Cliffs	3	108
'Ohi'a/'Olapa Montane Wet Forest	3	766
'Ohi'a/Mixed Shrub Montane Wet Forest	3	442
'Ohi'a/Uluhe Lowland Wet Forest	3	#

¹ Key to Hawaii Heritage Program Ranks:
3 Restricted range (typically 21-100 occurrences globally)

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.
acreage included in above community
+ acreages too small or scattered to measure accurately

At the reserve's western extension, adjacent to Pelekunu Valley, a Hawaiian Mixed Shrub Coastal Dry Cliff community was observed during aerial reconnaissance. This community is best represented on the sea cliffs of northern Molokai and the Na Pali region of Kauai. The particular shrub species vary by location, but often include representatives of Schiedea, Bidens and Sida. In Olokui, hinahina ku pali (Artemisia australis) and 'akoko (Chamaesyce celastroides) were common on the cliff faces. Kawelu (Eragrostis variabilis) grass grew from cracks in the lichen-covered basalt cliff face.

A sparse Kawelu Coastal Dry Grassland was seen on the driest and steepest portions of the sea cliffs. This heavily degraded grassland was observed during helicopter reconnaissance generally below 1,500 feet elevation. Coastal cliff shrubs included hinahina ku pali and 'akoko.

The Lama/'Ohi'a Lowland Mesic Forest was observed above the kawelu grassland on the south edge of the reserve's northeastern extension facing Wailau Valley. The proportion of lama and 'ohi'a in the canopy varied, with more 'ohi'a at higher, wetter elevations, and more lama in lower, drier areas. Mesic forest trees in the canopy included maua (Xylosma hawaiiense), kopiko (Psychotria marianiana), kolea (Myrsine lessertiana), and ho'awa (Pittosporum glabrum). The understory was generally sparse, but included Carex meyenii, kawelu, Elaphoglossum crassifolium, akia (Wikstroemia sp.), mamaki (Pipturus albidus), and maile (Alyxia oliviformis). Several individuals of a rare Hawaiian tree thistle, Hesperomannia arborescens, were seen. Above 1,800 feet elevation, the forest underwent a transition into 'Ohi'a/Uluhe Lowland Wet Forest.

A Mixed Fern/Mixed Shrub Wet Cliffs community was seen on the steep slopes surrounding the plateau region of the Olokui reserve. The dominant ferns and shrubs included 'ama'u (Sadleria sp.), uluhe (Dicranopteris linearis and Diplopterygium pinnatum), 'ohi'a, 'uki (Machaerina angustifolia), and pilo (Coprosma sp.).

'Ohi'a/Uluhe Lowland Wet Forest occupied the moderate to steep slopes both on the plateau and on the walls of the mountain, extending up from either nonnative vegetation or lama/'ohi'a forest. While best developed below 3,000 feet elevation, this community extended up into the montane zone on the north edge of the plateau and along the steep slopes east of Olokui summit. The canopy of the 'ohi'a/uluhe forest was dominated by 'ohi'a, but also included several other common wet forest tree species such as 'olapa, kawa'u (Ilex anomala), and 'ohi'a ha (Syzygium sandwicensis). The understory layers were dominated by uluhe, but where this was less well developed, other native shrubs and ferns such as 'ohelo kau la'au (Vaccinium calycinum), pu'ahanui (Broussaisia arguta) or na'ena'e (Dubautia

plantaginea ssp. plantaginea) were commonly seen. Native ferns were present, generally as epiphytes, including wahine noho mauna (Adenophorus tamariscinus), Elaphoglossum spp., and Grammitis tenella. Several rare land snails were seen in this forest type while on transect (see Fauna section).

In the plateau area, a pristine example of 'Ohi'a/Mixed Shrub Montane Wet Forest formed a complex mosaic with 'ohi'a/'olapa forest. Only an incomplete species list was compiled from the helicopter reconnaissance, but trees in the canopy included kawa'u and 'ohi'a ha. 'Olapa was very sparse or lacking altogether. Where the dense canopy was broken to permit views into the lower layers, ferns and shrubs such as hapu'u (Cibotium spp.), Elaphoglossum spp., pa'iniu (Astelia menziesiana), pu'ahanui, 'ohelo kau la'au, and Clermontia spp. were seen.

The 'Ohi'a/'Olapa Montane Wet Forest included kawa'u and mehame (Antidesma platyphyllum) in the canopy, besides the dominant 'ohi'a and 'olapa. The subcanopy layers contained a dense variety of native shrubs and ferns, including pu'ahanui, Clermontia spp., hapu'u tree ferns, and pa'iniu. Epiphytic growth was very thick.

A total of 26 rare plant taxa have been reported from the Olokui area. For the purposes of this plan, a species is considered rare and imperilled if it is known from 20 or fewer locations worldwide, or less than 3,000 individuals. Of the rare plants known to occur in the Olokui area, 12 taxa have been confirmed within the reserve boundary; it is likely that rare plants reported adjacent to the reserve from similar habitats could be found in the reserve during future surveys (Table 2). An additional 28 taxa have been reported in the literature for the general area, but not enough information is available to confidently depict them as in or adjacent to the reserve (Appendix 3).

As a result of changes in plant taxonomy, some taxa listed by the U.S. Fish and Wildlife Service as candidate species in the 1985 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. Hawaiian names, where available, are provided in Table 2.

Of the twelve taxa confirmed within the reserve, four were reported prior to 1948, but might be found with more in-depth surveys. The remaining eight plants were seen recently: five during the 1980 by the U.S. Fish and Wildlife Forest Bird Survey; two during this survey; and another during a 1989 survey of adjacent Pelekunu Valley (Figure 3).

TABLE 2
RARE PLANTS OF OLOKUI RESERVE

Scientific Name ¹ Former Name ² (Common Name)	Current (Historic) Occurrences ³	Federal Status ⁴	HHP Rank ⁵
<u>Cyanea solanacea</u> (`oha, haha, `ohawai)	1(0)	C1	?
<u>Cyrtandra biserrata</u> (ha`iwale, kanawao ke`oke`o)	0(1)	C2	2
<u>Cyrtandra halawensis</u> (ha`iwale, kanawao ke`oke`o)	1(0)	C2	2
<u>Cyrtandra hematos</u> (ha`iwale, kanawao ke`oke`o)	1(0)	-	1
<u>Eurya sandwicensis</u> <u>E. sandwicensis</u> var. <u>grandifolia</u> (anini)	1(0)	- C1	2
* <u>Hesperomannia arborescens</u> (-)	1(0)	C1	1
* <u>Hibiscus arnottianus</u> spp. <u>immaculatus</u> <u>H. immaculatus</u> (koki`o ke`oke`o)	1(0)	- C1	1
<u>Joinvillea ascendens</u> ssp. <u>ascendens</u> (`ohe)	2(0)	-	1
<u>Neraudia melastomifolia</u> (ma`aloa, ma`oloa, `oloa)	0(1)	C2	2
<u>Plantago princeps</u> var. <u>laxiflora</u> (ale)	0(1)	C1	1
<u>Pteris lidgatii</u> <u>P. lidgatei</u> (-)	0(1)	- C1	H
<u>Schiedea globosa</u> (-)	2(0)	-	2

* Observed during 1989 survey

Wagner and Wagner (1987)

Wagner et al. (1990), except Cyrtandra hematos (St. John 1987)

² Following taxonomy used in 1985 Federal Register

³ Current occurrences reported since 1972

⁴ Key to Federal Status (USFWS 1985):

C1 Candidate for endangered or threatened status

C2 Candidate for endangered or threatened status, information lacking

- No federal status. Recommended as rare by Hawaiian botanists and confirmed by Heritage data

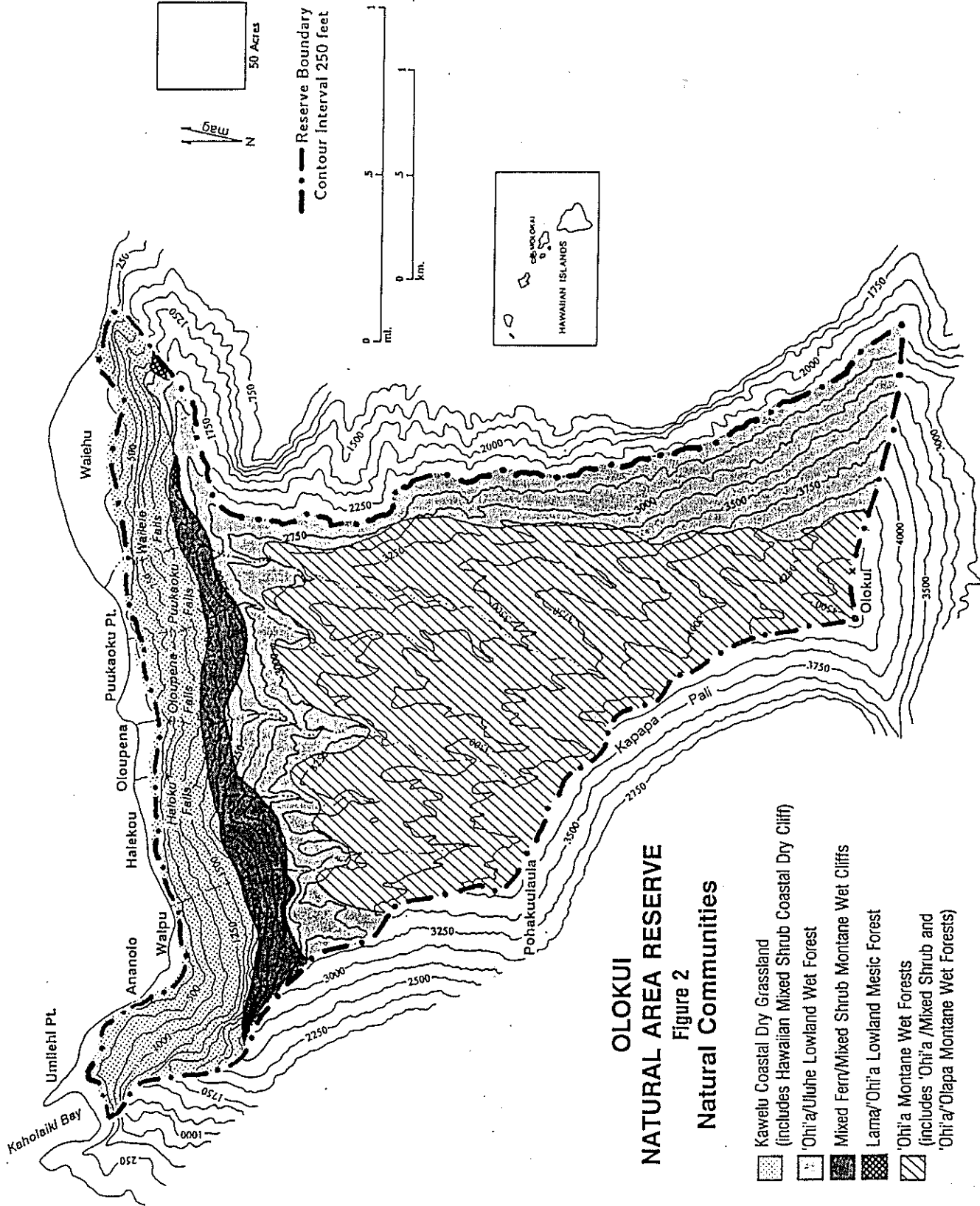
⁵ Key to Hawaii Heritage Program Ranks:

1 Critically imperilled globally (typically 1-5 occurrences)

2 Imperilled globally (typically 6-20 occurrences)

H Historically known (no observations since 1972 throughout its range)






? No more than 100 occurrences globally; rank not yet determined by HHP

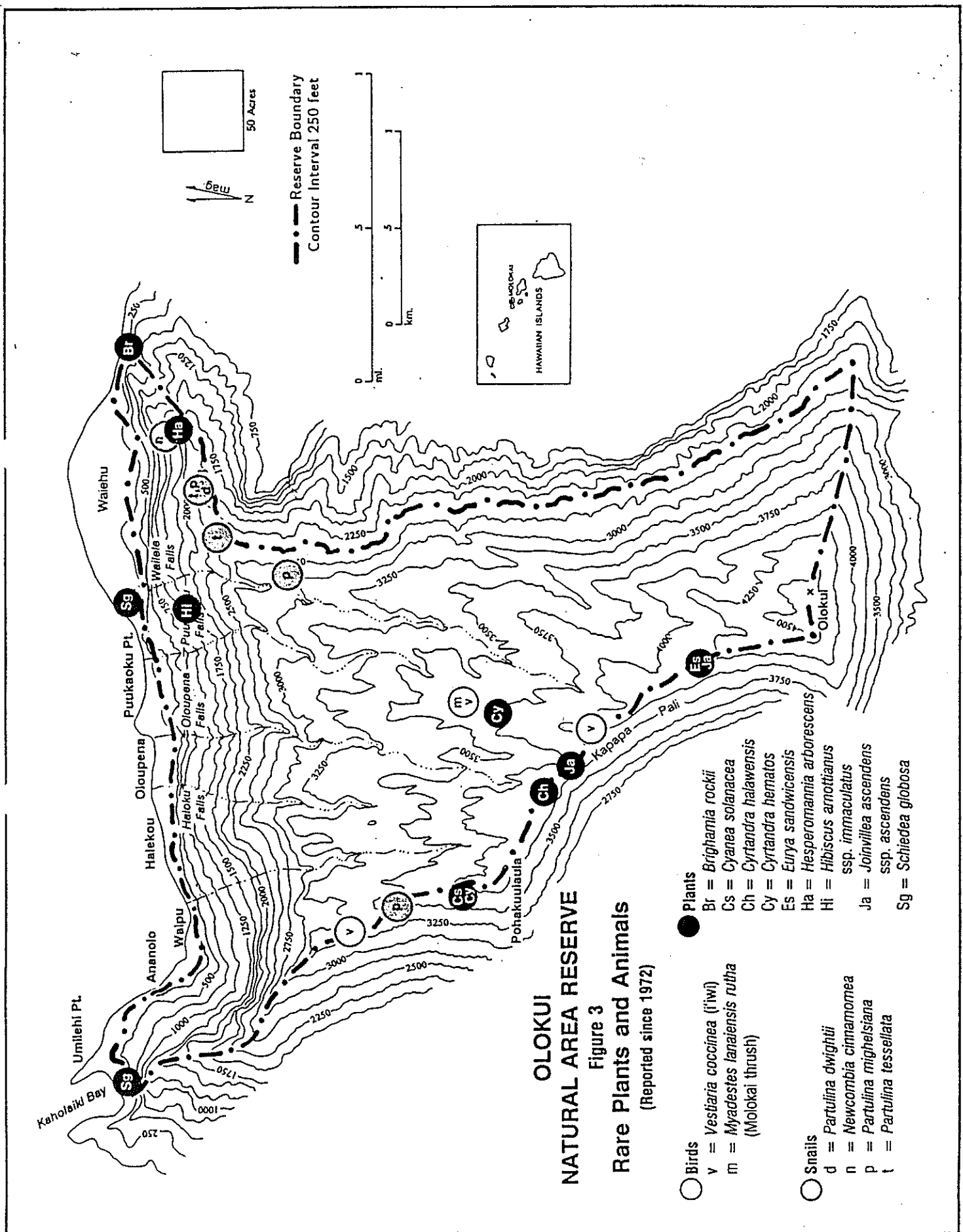


**OLOKUI
NATURAL AREA RESERVE**

Figure 2

Natural Communities

-  Kawelu Coastal Dry Grassland (includes Hawaiian Mixed Shrub Coastal Dry Cliff)
-  'Ohia'uluhe Lowland Wet Forest
-  Mixed Fern/Mixed Shrub Montane Wet Cliffs
-  Lama/'Ohia' Lowland Mescic Forest
-  'Ohia' Montane Wet Forests (includes 'Ohia'/Mixed Shrub and 'Ohia'/Olapa Montane Wet Forests)



**OLOKUI
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**Figure 3
Rare Plants and Animals
(Reported since 1972)**

- Birds
- v = *Vestiaria coccinea* (i'iwi)
- m = *Myadestes lanaiensis* rutha (Molokai thrush)
- Snails
- d = *Partulina dwightii*
- n = *Newcombia cinnamomea*
- p = *Partulina mighelsiana*
- t = *Partulina tessellata*

- Plants
- Br = *Brighamia rockii*
- Cs = *Cyanea solanacea*
- Ch = *Cyrtandra halawensis*
- Cy = *Cyrtandra hematos*
- Es = *Eurya sandwicensis*
- Ha = *Hesperomannia arborescens*
- Hi = *Hibiscus arnotianus*
ssp. *immaculatus*
- Ja = *Joinvillea ascendens*
ssp. *ascendens*
- Sg = *Schliedeia globosa*

Both rare plant populations were observed in Lama/'Ohi'a Lowland Mesic Forest during the survey. Two sterile trees and three saplings of Hesperomannia arborescens were observed from the transect on a sea cliff of Wailau Valley. This taxon is known only from this site, Pelekunu Valley and the Koolau Mountains of Oahu (Wagner et al. 1990). Typically, this tree bears clusters of attractive two-inch high erect flower heads containing small yellow flowers surrounded by purplish bracts (Neal 1965).

A population of Hibiscus arnottianus ssp. immaculatus, originally reported in 1912 from the sea cliff near Waiehu, was confirmed during aerial reconnaissance of this 1989 survey. Several of the 10 trees seen bore large white flowers. This taxon is known only from three valleys of northern Molokai (Wagner et al. 1990).

C. Fauna

Birds make up the native terrestrial vertebrate fauna on Molokai. Of the four endemic birds known from Olokui reserve, two are listed endangered (one federally and one by the state of Hawaii) (Table 3). Two rare marine birds have been reported from the area, though the reserve's importance to these birds is unknown. In addition to the endemic birds reported from the reserve, one indigenous marine bird and five nonnative birds have been reported (Appendix 4). Nonnative mammals are also known from the reserve area. Invertebrate fauna in the reserve includes beautiful land snails among the native invertebrates, as well as a few nonnative invertebrates.

Two of the more common native forest birds were seen on the single transect conducted during this survey. 'Apapane (Himatione sanguinea sanguinea) and 'Amakihi (Hemignathus virens wilsoni) were heard and seen frequently above 1,500 feet elevation. The indigenous White-tailed Tropicbird, or Koa'e kea (Phaethon lepturus dorotheae), was seen flying along the sea cliffs during this March survey. The nonnative Japanese White-eye (Zosterops japonicus) and Japanese Bush-Warbler (Cettia diphone) were seen frequently along the transect. The Northern Cardinal (Cardinalis cardinalis) was also heard, but only at the lower end of the transect around 1,500 feet elevation.

Two endangered forest bird species were last confirmed in the reserve during the 1980 U.S. Fish and Wildlife Forest Bird Survey (Figure 3). 'I'iwi (Vestiaria coccinea) was found on ridges and cliffs in Olokui Natural Area Reserve and other areas nearby during the 1979-80 U.S. Fish and Wildlife Forest Bird Survey. More recent sightings have been in Puu Alii Natural Area Reserve and near Wailau and Pelekunu valleys. Once more common, this bird is now listed as endangered by the state of Hawaii for the islands of Oahu, Molokai and Lanai (DLNR 1986).

TABLE 3
RARE BIRDS OF OLOKUI NATURAL AREA RESERVE

Scientific Name (Common Name)	Population Estimate (Molokai) ¹	Federal Status ²	HHP Rank ³
<u>Myadestes lanaiensis rutha</u> (Molokai Thrush or Oloma'o)	19 ± 38	LE	1
<u>Vestiaria coccinea</u> (`I`iwi)	80 ± 65	LE*	1

¹ Birds/km² with a 95% confidence interval. All estimates from Scott et al. 1986.

² Key to Federal/State Status:

LE Endangered (USFWS 1989)

LE* Molokai population listed endangered by the State of Hawaii only (DLNR 1986)

³ Key to Hawaii Heritage Program Ranks:

1 Critically imperilled globally (fewer than 1,000 individuals)

The Molokai Thrush, or Oloma'o (Myadestes lanaiensis rutha), was seen in the central part of the reserve during the Forest Bird Survey. Once common on Molokai, the Thrush's population decline and reduction in range began before the 1930s. The Molokai population appears to be a small remnant with a low probability of future survival (Scott et al. 1986). This species is listed as endangered by the U.S. Fish and Wildlife Service (USFWS 1989).

Two endemic seabirds, Newell Shearwater or `A`o (Puffinus newelli) and Dark-rumped Petrel or `Ua`u (Pterodroma phaeopygia sandwichensis), have been heard calling on east Molokai. Historically, they have been found on cliffs in Molokai valleys (Banko 1980a, 1980b). It is not known whether nesting occurs or if significant habitat exists in Olokui reserve for either species. Burrows are usually found in rugged terrain in forested areas and are very difficult to locate. The Dark-rumped Petrel is listed as endangered, and Newell Shearwater is listed as threatened (under Puffinus auricularis) in the Federal List of Threatened Species (USFWS 1989).

Two other endangered species have been historically reported near the reserve. The Molokai Creeper, or Kakawahie (Paroreomyza flammea), was last recorded nearby in Pelekunu Valley in 1936.

It is possible that this creeper is now extinct (Scott et al. 1986). The 'O'u (Psittirostra psittacea) was last seen in the Olokui area in 1907, and it is now presumed extinct on Molokai (Scott et al. 1986).

Evidence of other nonnative vertebrates was observed in the reserve during the survey. Goat browsing was evident at the start of the transect as high as 2,620 feet elevation, and increased down slope. At 1,500 feet elevation, fresh, heavy damage was evident, and both goats and deer were seen and heard below the transect. No ungulate damage of any sort on Olokui plateau was observed from the helicopter. The plateau remains one of the few wet forest locations in the state that has not been damaged by feral ungulates.

The only small mammal sign observed was of an unidentified species of rodent, probably Rattus sp. Predation on loulu (Pritchardia lowreyana) palm seeds and native tree snails was evident. Rats could pose a very serious threat to the tree snail population in the area.

The diversity of native invertebrates in the Olokui reserve is likely to be high, though no in-depth surveys have been conducted of the area's invertebrate fauna. Along the single transect, the survey crew observed several indicators of a diverse invertebrate fauna, including several species of spiders, native crickets and katydids, flies, and tree snails.

Four species of endemic achatinellid land snails have been reported in the reserve: Partulina mighelsiana; P. tessellata; P. dwightii; and Newcombia cinnamomea (Figure 3, Table 4). Although these species are considered rare, none are listed endangered by the U.S. Fish and Wildlife Service. Malacologists believe that virtually all of the larger endemic land snails are rare and in danger of extinction. It is likely that because of the pristine condition of the reserve and the lack of a comprehensive snail survey of the area, other rare species may be present. All of these species are extremely vulnerable to over collection.

Live Partulina tessellata, P. mighelsiana and P. dwightii were observed during this survey on the eastern coastal ridge of the reserve. Fresh, rat-eaten Partulina shells were observed at another location nearby; the genus was not confirmed, but it was thought to perhaps be P. virgulata. An unidentified species of tornatellinid snail was also observed in this area. P. mighelsiana has been reported recently (since 1980) in two other parts of the reserve. Newcombia cinnamomea was recorded in 1975 on the eastern coastal ridge.

A few nonnative invertebrates, including large flies typical of ungulate-infested areas and a few other conspicuous species such as nonnative isopods, were seen during the survey.

TABLE 4
RARE SNAILS OF OLOKUI NATURAL AREA RESERVE

Scientific Name	Current (Historic) Occurrences ¹	Federal Status ²	HHP Rank ³
<u>Newcombia cinnamomea</u>	1 (0)	-	1
* <u>Partulina dwightii</u>	1 (0)	-	1
* <u>Partulina mighelsiana</u>	3 (1)	-	1
* <u>Partulina tessellata</u>	2 (0)	-	1

* Observed during 1989 survey

¹ Current occurrences reported since 1972

² Key to Federal Status (USFWS 1989):
- No federal status. Recommended as rare by Hawaiian malacologists and confirmed by Heritage data.

³ Key to Hawaii Heritage Program Ranks:
1 Critically imperilled globally (typically 1-5 occurrences)

III. MANAGEMENT

A. Key Management Considerations

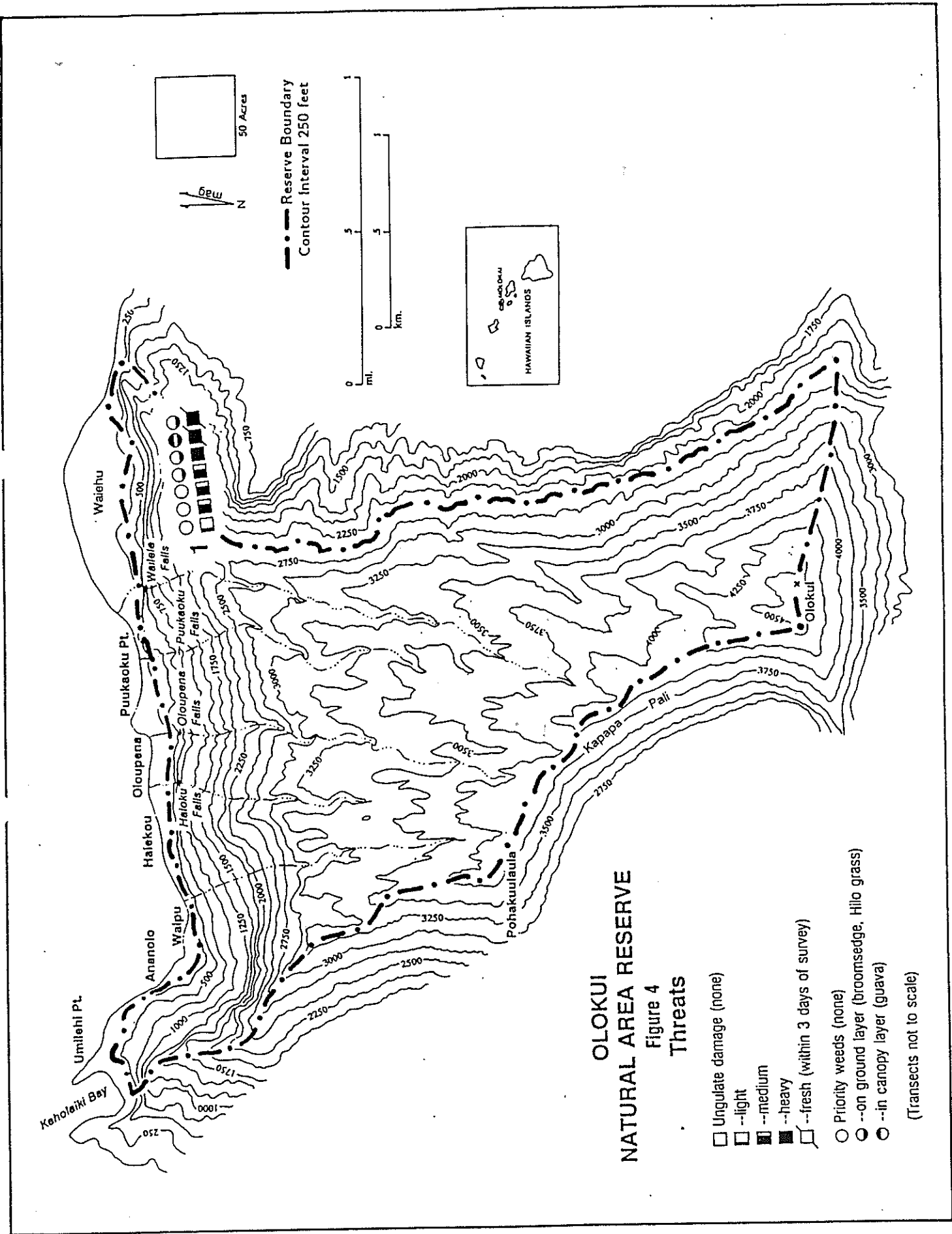
The overall management goal is to protect and maintain the reserve's native ecosystems. The following key points were considered in the development of management programs to achieve this goal:

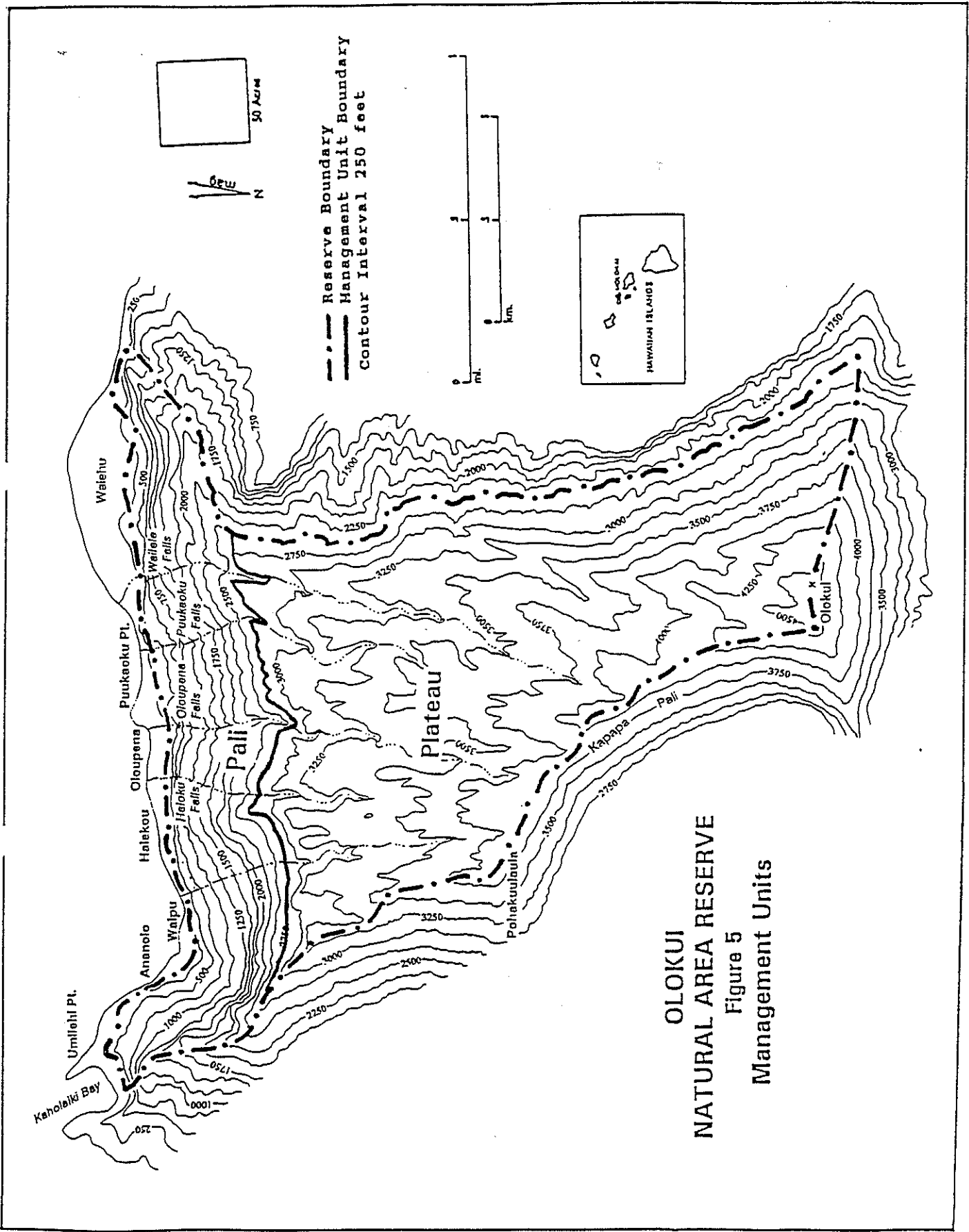
- 1) The Olokui Natural Area Reserve contains some of the most pristine native forests in the state. It has retained this remarkable status by virtue of its remoteness from human activity and its inaccessible position atop a high plateau surrounded on all sides by formidable cliffs. Feral ungulate populations are not yet established on the upper plateau, though some ungulate damage was observed along the single survey transect sampled for this plan on the northeast ridge leading up to the plateau (Figure 4). Feral animals disturb native vegetation, allowing soil to erode, and permitting weeds, and subsequently nonnative insects and birds to gain a foothold. Keeping ungulates from the surrounding valleys and ridges out of the reserve will be immediately and aggressively undertaken.
- 2) The aerially surveyed communities on the upper plateau in the Olokui reserve appear to be undisturbed and probably have little, if any, nonnative plant infestations. A single ground survey along the northeast corner of the reserve revealed a few limited nonnative plant infestations in the lower portions of the reserve.
- 3) Preventing encroachment of nonnative plants and animals from the surrounding areas will be critical to maintaining the pristine condition of the reserve. Both aerial and ground monitoring will be necessary to locate and control ungulates and weeds before they become established in the reserve.

B. Management Unit Descriptions

The reserve has been divided into two management units (Figure 5). Descriptions of each unit follow; threats, management priorities, and key management programs are outlined.

- 1) Plateau Unit - This 1150-acre unit encloses the plateau stretching from the top of the northernmost sea cliffs to the reserve's southern boundary. 'Ohi'a/Mixed Shrub and 'Ohi'a/'Olapa Montane Wet Forest communities and a large portion of the 'Ohi'a/Uluhe Lowland Wet Forest community are found in this unit. No recent ground surveys have been conducted in this unit. However, information obtained during aerial reconnaissance and past ground surveys indicates that the area is pristine. Preventing ungulate establishment in





**OLOKUI
NATURAL AREA RESERVE**
Figure 5
Management Units

this unit is the top management priority. Aerial hunting is proposed to control ungulate populations along the cliffs and ridges leading up to this unit.

- 2) Pali Unit - This 470-acre unit encloses the steep sea cliffs of the northern portion of the reserve. Natural communities found within this unit include the Kawelu Coastal Dry Grassland, Hawaiian Mixed Shrub Coastal Dry Cliffs, Mixed Fern/Mixed Shrub Montane Wet Cliffs, Lama/'Ohi'a Lowland Mesic Forest and portions of 'Ohi'a/Uluhe Lowland Wet Forest. Limited surveillance of these communities revealed some ungulate disturbance and nonnative plant invasion. Highest priority will be given to removing ungulates in this unit before they move into the Plateau management unit. Aerial hunting is proposed to control ungulates within and around this unit.

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 separately, they fit together to form an integrated management package.

UNGULATE CONTROL PROGRAM

GOAL: Prevent ungulates from entering the Plateau management unit by reducing animal populations on the surrounding pali areas and remove any ungulates currently present in the reserve.

Statement of the Problem: Information obtained during past ground surveys and more recently during aerial infrared reconnaissance along the plateau indicates that feral ungulates have probably not yet reached this area. However, some goat and deer damage was seen along the single survey transect on the northeast ridge leading up to the plateau. In addition, feral goats, deer and pigs are known to inhabit the valleys, steep slopes and cliffs surrounding the reserve. Left unchecked these animals will encroach upon the upper slopes and eventually gain access to the reserve, altering the native forest and disrupting the balance of native communities.

In some reserves, fencing can be an effective tool for preventing ungulate movement into certain areas. However, in the Olokui reserve, fencing is not considered feasible due to the extreme steepness of the terrain over such an extensive boundary.

Alternative Actions and Probable Impacts:

- 1) Institute staff ground hunting on the plateau in the reserve. This alternative is not consistent with reserve management goals due to the pristine nature of the communities on the plateau. The

disturbance created by increased human presence and path establishment would facilitate the ingress of nonnative organisms. In addition, hunting success on the steep slopes and cliffs surrounding the reserve is likely to be minimal, resulting in a continuous influx of feral ungulates onto the plateau from these areas.

2) Attempt to increase public hunting pressure in the lower areas surrounding the eastern and southern boundaries of the reserve, which are state-owned and designated as Public Hunting Unit B. This alternative would not prevent ungulate encroachment into the reserve for the following reasons:

a) Hunters do not visit this area in substantial enough numbers to control ungulate populations. Windward East Molokai is extremely remote. Overland access from leeward Molokai is long and arduous. Most hunters do not feel it worth their while to hike over the mountains, hunt, and then pack out the meat. In addition, access by sea is not feasible during much of the year due to high surf conditions.

b) Ungulates presently inhabit the sheer sea cliffs and extremely steep upper slopes of the plateau where hunters are unable to go or are only marginally successful at shooting animals and where they are usually unable to retrieve them once shot.

c) Hunting pressure in the lower areas could cause more animals to move up the sheer cliffs surrounding the reserve, placing the reserve in greater jeopardy to animal encroachment.

3) Institute an ungulate removal program utilizing staff aerial hunting along the upper slopes and cliffs within and around the reserve. This alternative offers the best means for preventing the ingress of feral ungulates into the reserve while avoiding unnecessary disturbance of the intact communities.

Recommended Action: Alternative no. 3 is recommended. Aerial hunting activities to date around the reserve have resulted in substantial ungulate population declines and native vegetation recovery along the surrounding slopes and ridges.

The areas that will continue to be hunted from aircraft are remote and have low stature vegetation which allow good visibility and use of infrared technology. The infrared spotter is heat sensitive and is used in the early morning when the landscape is still cool. The warmth of the ungulate's body shows up on the infrared screen and the aircraft can move directly to its location and make visual contact.

Detailed records of the locations and numbers of animals encountered during the aerial hunting missions will be kept to determine future management strategies. Ground monitoring for signs of ungulate presence along potential access sites will also be an integral part of the ungulate control program (see Monitoring Program). If monitoring reveals increased ungulate presence in the reserve, other ungulate control techniques such as staff hunting or strategic fencing along select ungulate access sites may need to be utilized. As ungulate populations are diminished, helicopter hunting missions will be reduced in frequency.

Cost/Workload: Two technicians will be needed on each hunting expedition, one for spotting and one for shooting. Required personnel time is listed; however, budget figures are not given as personnel costs are separately budgeted as part of the infrastructure costs necessary to run a statewide NARS program. Aerial hunting personnel is currently contracted out at a cost of \$200 per trip.

Year 1: Personnel
 2 Technicians 12 PD (monthly expeditions)
Supplies and Support
 Helicopter charter with IR spotting
 equipment (24 hours at \$800/hour) \$19,200
 Arms \$ 600
 Ammunition (3 cases at \$180/case) \$ 540
TOTAL \$20,340

Year 2: Personnel
 2 Technicians 12 PD (monthly expeditions)
Supplies and Support
 Helicopter charter with IR spotting
 equipment (24 hours at \$800/hour) \$19,200
 Ammunition (3 cases at \$180/case) \$ 540
TOTAL \$19,740

Year 3: Personnel
 2 Technicians 6 PD (bi-monthly expeditions)
Supplies and Support
 Helicopter charter with IR spotting
 equipment (12 hours at \$800/hour) \$ 9,600
 Ammunition (2 cases at \$180/case) \$ 360
TOTAL \$ 9,960

Years 4-6: Personnel
 2 Technicians 4 PD (quarterly expeditions)
Supplies and Support
 Helicopter charter with IR spotting
 equipment (8 hours at \$800/hour) \$ 6,400
 Ammunition (1 case) \$ 180
TOTAL \$ 6,580

MONITORING PROGRAM

GOAL: Monitor the effectiveness of management measures taken to prevent nonnative plant and animal encroachment into the reserve, 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 evaluated. Potential ungulate access sites will need consistent monitoring to determine whether ungulates and weeds are moving into the reserve. Monitoring by aircraft is useful in that it avoids disturbance of intact native communities; however, only limited information about the presence of nonnative plants and animals can be obtained in densely vegetated areas. Hence, ground monitoring will be necessary.

Alternative Actions and Probable Impacts:

- 1) Conduct ad hoc monitoring whenever possible. This is likely to be considerably less effective in the long run than a systematic approach.
- 2) Establish a systematic monitoring program. Increase monitoring intensity for select problems and areas as needed.

Recommended Action: Alternative no. 2 is recommended. Systematic monitoring at specific locations is necessary to accurately assess subtle signs of nonnative plant and ungulate invasion. The monitoring program will provide information needed to evaluate the effects of management activities and identify future management needs. Ground monitoring activities should be limited to potential ungulate access sites along the perimeter of the plateau. Ground monitoring in the pristine portions of the Plateau management unit should only occur if ungulate damage or nonnative weed invasion is suspected. Ground monitoring will require a minimum crew of two people for safety. Strict sanitary procedures will be followed to prevent introduction of weeds by management personnel on their boots, clothing, and equipment.

An annual overflight is recommended to inspect the canopy structure of the communities on the plateau and monitor ungulate presence along the steep slopes surrounding the reserve. Aerial reconnaissance trips should be increased as aerial hunting activities are decreased.

Specific goals of the program are to determine: 1) the effectiveness of aerial hunting in preventing ungulate access to the Plateau management unit, 2) the success of weed control activities, 3) the presence of new nonnative plant infestations, and 4) the status of native vegetation.

Cost/Workload: Costs outlined below are based on three ground monitoring trips during which nonnative plant control activities will also occur. Costs listed below represent the fraction of time spent on monitoring activities only. Required personnel time is listed; however, budget figures are not given as personnel costs are separately budgeted as part of the infrastructure costs necessary to run a statewide NARS program.

Years 1-2: Personnel
 Professional 2.5 PD
 Technician 2.5 PD
Supplies and Support
 Helicopter charter for crew transport
 (2 hours at \$600/hour) \$ 1,200
 Helicopter charter equipped with IR
 spotting equipment for reconnaissance
 (2 hours at \$800/hour) \$ 1,600
 Supplies and equipment \$ 500
 TOTAL \$ 3,300

Years 3-6: Personnel
 Professional 3 PD
 Technician 3 PD
Supplies and Support
 Helicopter charter for crew transport
 (2 hours at \$600/hour) \$ 1,200
 Helicopter charter equipped with IR
 equipment for reconnaissance
 (4 hours at \$800/hour) \$ 3,200
 Supplies and equipment \$ 500
 TOTAL \$ 4,900

NONNATIVE PLANT CONTROL PROGRAM

GOAL: To limit the spread and, where possible, eradicate populations of non-native plants.

Statement of the Problem: Threats from nonnative plants vary with the different communities in the reserve. Evidence from past ground surveys and more recent aerial surveys of the 'Ohi'a/Mixed Shrub Montane Wet Forest and the 'Ohi'a/'Olapa Montane Wet Forest communities on the upper plateau indicate that the vegetation is undisturbed, and therefore probably has limited, if any, weed infestation. Ground surveillance in the lower northeast corner of the reserve revealed some limited nonnative plant infestations within the Lama/'Ohi'a Lowland Mesic Forest and the 'Ohi'a/Uluhe Lowland Wet Forest communities.

Weeds encountered during the survey include: Hamakua pamakani (Ageratina riparia), Lantana camara, molassesgrass (Melinis minutiflora), sourbush (Pluchea symphytifolia), Hilo grass (Paspalum conjugatum), guava (Psidium guajava), and broomsedge

(Andropogon virginicus). The latter three are considered to be priority weeds for management control throughout the reserve (Figure 4).

The best strategy for preventing further weed invasion is to maintain intact native forests by limiting disturbance. Preventing ungulate caused disturbance and unnecessary human disturbance are essential first steps. However, since some weeds are already established in the lower elevations and others are spread by birds and the wind, weed removal will be necessary.

Recommended Action and Probable Impacts: Eradicate all known populations of nonnative plants and any new populations whenever they are encountered within the Plateau management unit. In the accessible regions of the Pali management unit, control and eradicate the above mentioned priority weeds and others that may be found to be equally invasive.

Nonnative plant removal should be undertaken during monitoring surveys. Special efforts should be made to locate and remove weeds that may be introduced during research and monitoring activities. Strict sanitary procedures will be followed to prevent introduction of weeds by management personnel on their boots, clothing, and equipment.

The use of manual and chemical weed control methods will be determined by the type of weed, the value and accessibility of the area it is invading, and the effectiveness of the control measure. Biocontrol is an important potential tool in the management of widespread nonnative plant infestations. The Natural Area Reserves System program should support interagency biocontrol projects.

Detailed records of the effectiveness of control measures used in the reserve will be kept. Careful monitoring and documentation of the results of plant control efforts is very important. Communication with the National Park Service and other agencies involved in plant control work will ensure that the best available control techniques are utilized.

Cost/Workload: Costs outlined below are based on three ground monitoring trips during which nonnative plant control activities will also occur. Costs listed represent the fraction of time spent on nonnative plant control activities only. Required personnel time is listed; however, budget figures are not given as personnel costs are separately budgeted as part of the infrastructure costs necessary to run a statewide NARS program.

Year 1:	<u>Personnel</u>		
	Professional	1 PD	
	Technician	1 PD	
	<u>Supplies and Support</u>		
	Helicopter charter for crew transport (1 hour at \$600/hour)		\$ 600
	Supplies (equipment, tools and herbicides)		\$ 500
		TOTAL	\$ 1,100
Years 2-6:	Same as year 1		TOTAL \$ 1,100

PUBLIC EDUCATION PROGRAM

GOAL: To build public understanding and support for the Olokui reserve and the Natural Area Reserves System.

Statement of the Problem: Most residents and visitors on Molokai are unaware that the Olokui reserve is one of the most pristine natural areas remaining in the state. The public needs to understand the existing threats and the rationale behind management actions being carried out to preserve this unique area. Management of this reserve will be a long term effort, and public support and cooperation is essential.

Recommended Action and Probable Impacts: Maintain a community outreach program to give public presentations and provide informational material. Inform the general public about resources within the reserve, current management activities, and the need to prevent the establishment of human access trails due to the potential damaging effects of human disturbance. Information could be presented through slide shows and talks to community groups, television, newspaper, and other local media outlets. This program could provide a local constituency that would support reserve management activities.

Cost/Workload: Required personnel time is listed; however, budget figures are not given as personnel costs are separately budgeted as part of the infrastructure costs necessary to run a statewide NARS program.

Year 1:	<u>Personnel</u>		
	Professional	5 PD	
	<u>Supplies and educational materials</u>		\$ 1,000
	<u>Brochure</u>		\$ 8,000
		TOTAL	\$ 9,000

Years 2-6:	<u>Personnel</u>		
	Professional	5 PD	
	<u>Supplies and educational materials</u>		\$ 1,000
		TOTAL	\$ 1,000

D. Boundary Administration

Participation and cooperation among adjacent landowners is an important factor for effective management of the Olokui reserve. Pelekunu Valley, to the west of the reserve, is currently managed as a preserve by The Nature Conservancy of Hawaii. Wailau Valley and the remaining lands around the southern and eastern boundaries of the reserve are primarily state owned and designated as Forest Reserve. Two private landowners own small parcels along the northeast and southwest boundaries of the reserve. Control of feral ungulates and nonnative plants in these surrounding areas will help slow their influx into the Olokui reserve. Compatible management projects should be coordinated with adjacent landowners or managers.

E. Recommended Uses

Due to the remote location and the pristine condition of the Olokui reserve, use of the reserve should be limited to scientific research. Research needs should be documented and appropriate proposals solicited from researchers in various scientific fields. Independent research projects should be coordinated in order to minimize disturbance to the intact communities.

IV. BUDGET SUMMARY

A six year implementation schedule is presented to accomplish management goals as efficiently as possible. Four management programs are proposed to achieve this, building upon each other to form an integrated strategy.

The budget summary shown is for the management of the Olokui reserve only. It does not include all the personnel, administrative, clerical, computer and facility expenses incurred in the operation of a state-wide NARS program. These infrastructure costs for the NARS will be identified and documented separately. Starting with year 3, a 5% inflation increase is incorporated into every annual total.

OLOKUI BUDGET SUMMARY

MANAGEMENT PROGRAM	* YR 1	* YR 2	* YR 3	* YR 4	* YR 5	* YR 6
Ungulate Control	20,340	19,740	9,960	6,580	6,580	6,580
Monitoring	3,300	3,300	4,900	4,900	4,900	4,900
Nonnative Plant Control	1,100	1,100	1,100	1,100	1,100	1,100
Public Education	9,000	1,000	1,000	1,000	1,000	1,000
TOTAL	33,740	25,140	17,808	14,938	15,617	16,296

PERSONNEL (PD = person days)

Years 1-2
 Professional 8.5 PD
 Technician 15.5 PD

Years 4-6
 Professional 9 PD
 Technician 8 PD

Year 3
 Professional 9 PD
 Technician 10 PD

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APPENDIX 1
Olokui Natural Area Reserve
Transect Specifications

Transect number	Transect length (ft)	No. of substations	Natural communities surveyed
1	2,952	19	Lama/'Ohi'a Lowland Mesic Forest 'Ohi'a/Uluhe Lowland Wet Forest

Survey Participants

The Nature Conservancy of Hawaii

Samuel Gon III, Ecologist

Steve Perlman, Botanist/Field Coordinator

State Division of Forestry and Wildlife, DLNR

Robert Hobdy, Maui County Deputy Forester

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

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	VERVSC	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: _____
 Description Line: _____ Photo #: _____
 INCIDENTALS OBSERVATIONS: _____
 CHK ITEM: _____

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	VERVSC	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: _____
 Description Line: _____ Photo #: _____
 INCIDENTALS OBSERVATIONS: _____
 CHK ITEM: _____

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	VERVSC	BOTTOM	>10 M	DRY
NO CHG	NO CHG	NO CHG	NO CHG	NO CHG	NO CHG

Additional notes: _____

APPENDIX 3
Olokui 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 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 '?'.
 Descriptions of natural communities are in the text. Taxonomy follows Wagner et al. (in press) and Wagner and Wagner (1987).

Status	Taxon	'Ohi'a/Uluhe Lowland Wet Forest	Lema/'Ohi'a Lowland Masic Forest	'Ohi'a/'Olapa Montane Wet Forest	'Ohi'a/Mixed Shrub Montane Wet Forest	Mixed Fern/Mixed Shrub Montane Wet Cliffs	Kawelu Coastal Dry Grassland
E	Adenophorus hymenophylloides				X		
# E	Adenophorus periens			?	?		
E	Adenophorus pinnatifidus			X			
E	Adenophorus tamariscinus	*					
E	Adenophorus tripinnatifidus			X			
N	Ageratina adenophora		*				
N	Ageratina riparia		*				
N	Ageratum conyzoides	*	*				
# E	Alectryon macrococcus var. macrococcus		?				
E	Alyxia oliviformis	*	*				
N	Andropogon virginicus		*				
E	Anoectochilus sandvicensis	*					
E	Antidesma platyphyllum	*		*			
E	Artemisia australis						*
E	Asplenium contiguum	*					
I	Asplenium lobulatum	*					
I	Asplenium nidus	*	*				
I	Asplenium normale			X	X		
E	Astelia menziesiana			*	*		

+ = Rare N = Non-native I = Indigenous E = Endemic
 * = Confirmed in NARS field study x = Cited in literature sources
 ? = Cited in literature sources; needs confirmation in natural community

Status	Taxon	'Ohi'a/Uluhe Lowland Wet Forest	Lama/'Ohi'a Lowland Mesic Forest	'Ohi'a/'Olapa Montane Wet Forest	'Ohi'a/Mixed Shrub Montane Wet Forest	Mixed Fern/Mixed Shrub Montane Wet Cliffs	Kawelu Coastal Dry Grassland
E	Athyrium arnottii	*					
E	Athyrium microphyllum	*					
E	Athyrium sandwichianum	*					
+ E	Bidens molokaiensis						?
+ E	Bidens wiebkei		?				
E	Bobea elatior	*					
E	Boehmeria grandis		*				
+ E	Brighamia rockii					?	
E	Broussaisia arguta	*		*	*		
N	Buddleia asiatica	*					
E	Callistopteris baldwinii			X			
+ E	Canavalia molokaiensis		?				
E	Carex meyenii		*				
E	Carex wahuensis	*					
# E	Centaurium sebaeoides						?
E	Chamaesyce celastroides						*
E	Cheirodendron trigynum	*		*			
E	Cibotium chamissoi	*					
E	Cibotium glaucum	*					
E	Cibotium splendens	*					
E	Clermontia grandiflora				X		
E	Clermontia kakeana	*					
E	Coprosma ochracea	*					
N	Cordyline fruticosa	*	*				
+ E	Cyanea grimesiana ssp. grimesiana	?					
# E	Cyanea horrida			?	?		
# E	Cyanea mannii	?					
# E	Cyanea procera	?					
# E	Cyanea profuga	?	?	?	?		
+ E	Cyanea solanacea			?	?		
+ E	Cyanea solenocalyx	?		?	?		
+ E	Cyrtandra biserrata	?		?	?		
+ E	Cyrtandra halawensis	?		?	?		
+ E	Cyrtandra hematos			?	?	?	
+ E	Cyrtandra macrocalyx	?		?	?		
E	Deschampsia nubigena				X		
I	Dicranopteris linearis	*				*	
+ E	Diellia erecta		?				
E	Diospyros sandwicensis	*	*				
+ E	Diplazium molokaiense			?	?	?	
E	Diplopterygium pinnatum	*				*	
# E	Dissochondrus biflorus						?
E	Dodonaea viscosa	*		X			
E	Doodia kunthiana	*					
N	Drymaria cordata var. pacifica	*					
E	Dryopteris acutidens	*					
E	Dryopteris fusco-atra			X			
E	Dryopteris unidentata			X			

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

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

Status Taxon

Status	Taxon	'Ohi'a/Uluhe Lowland Wet Forest	Lama/'Ohi'a Lowland Mesic Forest	'Ohi'a/'Olapa Montane Wet Forest	'Ohi'a/Mixed Shrub Montane Wet Forest	Mixed Fern/Mixed Shrub Montane Wet Cliffs	Kawelu Coastal Dry Grassland
E	Dubautia plantaginea ssp. plantaginea	*					
E	Elaphoglossum alatum	*			*		
E	Elaphoglossum crassifolium	*	*		*		
E	Elaphoglossum wawrae			X			
E	Embelia pacifica				X		
E	Eragrostis variabilis		*				
N	Erechtites valerianifolia	*	*				*
+ E	Eurya sandwicensis			X	X		
# E	Exocarpos gaudichaudii		?				
I	Freycinetia arborea	*	*				
E	Grammitis tenella	*					
E	Gunnera petaloidea			X			
# E	Haplostachys linearifolia	?					?
E	Hedyotis acuminata	*					
# E	Hedyotis littoralis						?
# E	Hedyotis mannii	?	?				
E	Hedyotis terminalis	*	*				
+ E	Hesperomannia arborescens	*	*				
+ E	Hibiscus arnottianus ssp. immaculatus	?	?				
+ E	Hibiscus kokio ssp. kokio				X		
I	Huperzia phyllanthum	*					
E	Huperzia serrata				X		
# E	Huperzia sulcinervia			?	?		
E	Ilex anomala	*		*	*		
+ E	Isachaemum bryone						?
E	Isachne distichophylla			X	X		
+ E	Joinvillea ascendens ssp. ascendens				X		
N	Kalanchoe pinnata	*	*				
E	Korthalsella cylindrica	*					
E	Korthalsella latissima			X			
N	Kyllinga brevifolia		*				
E	Labordia hedyosmifolia	*					
E	Labordia tinifolia		*				
N	Lantana camara	*	*				
E	Liparis hawaiiensis			X			
# E	Lobelia dunbarii ssp. dunbarii			?			
# E	Lobelia dunbarii ssp. paniculata			?			
# E	Lobelia hypoleuca				X		
I	Lycopodium cernuum				X		
# E	Lysimachia ternifolia	?	?	?	?		
I	Machaerina angustifolia	*				*	
E	Marattia douglasii			X			
E	Mecodium recurvum	*					
N	Melinis minutiflora		*				
E	Metrosideros polymorpha	*	*	*	*	*	
E	Metrosideros waialealae var.	*					

+ = Rare N = Non-native I = Indigenous E = Endemic
 * = Confirmed in NARS field study x = Cited in literature sources
 ? = Cited in literature sources; needs confirmation in natural community

Status	Taxon	'Ohi'a/Uluhe Lowland Wet Forest	Lana/'Ohi'a Lowland Mesic Forest	'Ohi'a/'Olapa Montane Wet Forest	'Ohi'a/Mixed Shrub Montane Wet Forest	Mixed Fern/Mixed Shrub Montane Wet Cliffs	Kawelu Coastal Dry Grassland
	fauriei						
I	Microlepia strigosa	*					
N	Musa xparadisiaca	*	*				
E	Myrsine emarginata				X		
E	Myrsine lessertiana	*	*				
I	Nephrolepis cordifolia				X		
I	Nephrolepis exaltata	*	*				
+ E	Neraudia melastomifolia		?				
I	Nertera granadensis					X	
E	Nestegis sandwicensis	*	*				
# E	Nothocestrum latifolium		?				
I	Odontosoria chinensis	*					
N	Paspalum conjugatum	*	*	*			
E	Pelea clusiifolia	*					
# E	Pelea hawaiiensis		?				
E	Pelea parviflora			?	?		
# E	Pelea reflexa	?		?	?		
E	Pelea sp.	*	*				
# E	Pelea wailauensis	?	?				
E	Peperomia latifolia	*					
E	Peperomia macraeana	*					
E	Peperomia tetraphylla	*					
E	Perrottetia sandwicensis	*					
# E	Peucedanum sanwicense					?	?
# E	Phyllostegia mannii			?	?		
# E	Phyllostegia mollis	?	?		?		
E	Phyllostegia stachyoides	?	?	?	?		
N	Phymatosorus scolopendria	?	?			?	
E	Pilea peploides				X		
E	Pipturus albidus	*	*				
E	Pittosporum glabrum	*	*				
+ E	Plantago princeps var. laxiflora			?		?	?
# E	Platanthera holochila		?				
E	Pleomele halapepe	*					
I	Pleopeltis thunbergiana	*					
N	Pluchea indica						?
N	Pluchea symphytifolia	*					
E	Polypodium pellucidum			X	X		
E	Pritchardia lowreyana	*					
N	Psidium guajava		*				
I	Psilotum complanatum	*					
I	Psilotum nudum				X		
E	Psychotria mariniana	*	*				
E	Psychotria mauiensis		*				
E	Psychotria sp.		*				
E	Pteridium decompositum	*					
+ E	Pteris lidgatii			?	?	?	
# E	Ranunculus mauiensis			?	?		
N	Rubus rosifolius	*	*				

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

Status	Taxon	'Ohi'a/Uluhe Lowland Wet Forest	Lama/'Ohi'a Lowland Mesic Forest	'Ohi'a/'Olapa Montane Wet Forest	'Ohi'a/Mixed Shrub Montane Wet Forest	Mixed Fern/Mixed Shrub Montane Wet Cliffs	Kawelu Coastal Dry Grassland
N	Sacciolepis indica	*	*				
E	Sadleria cyatheoides	*					
E	Sadleria pallida	*					
E	Scaevola chamissoniana	*					
+ E	Schiedea globosa					?	
# E	Schiedea pubescens var. pubescens	?	?				
E	Schizaea robusta			X	X		
E	Selaginella arbuscula	*					
# E	Sicyos cucumerinus	?		?	?		
I	Sida fallax		*				
E	Smilax melastomifolia	*					
E	Sphaerocionium obtusum	*					
+ E	Stenogyne bifida	?	?	?	?		
E	Stenogyne sp.			X			
E	Sticherus owhyensis	*					
I	Styphelia tameiameia	*					
E	Syzygium sandwicensis	*			*		
E	Tectaria gaudichaudii	*					
+ I	Tetramolopium sylvae					?	
E	Tetraplasandra hawaiiensis	*					
E	Tetraplasandra oahuensis	*					
E	Thelypteris cyatheoides	*					
N	Thelypteris parasitica	*	*				
E	Touchardia latifolia				X		
E	Trematolobelia sp.			X	X	*	
E	Urera glabra	*	*				
E	Vaccinium calycinum	*			*		
E	Vaccinium dentatum	*	*				
E	Vandenboschia davallioides	*		?	?		
+ E	Vandenboschia draytoniana						
E	Viola sp.			X	X		
E	Wikstroemia sp.	*	*				
E	Xiphopteris saffordii			X	X		
E	Xylosma hawaiiense		*				
N	Youngia japonica	*	*				

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APPENDIX 4
Olokui Area
Bird Species List

The birds listed have been reported from visual and audio identification in or near the Reserve. 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>Cardinalis cardinalis</u>	Northern Cardinal	*
N	<u>Cettia diphone</u>	Japanese Bush-Warbler	*
E	<u>Hemignathus virens wilsoni</u>	`Amakihi	*
E	<u>Himatione sanguinea sanguinea</u>	`Apapane	*
N	<u>Leiothrix lutea</u>	Red-billed Leiothrix	x
+E	<u>Myadestes lanaiensis rutha</u>	Oloma`o, Molokai Thrush	x
+E	<u>Pterodroma phaeopygia sandwichensis</u>	`Ua`u, Hawaiian Dark-rumped Petrel	?
I	<u>Phaethon lepturus dorotheae</u>	Koa`e kea, White-tailed Tropicbird	*
+E	<u>Puffinus newelli</u>	`A`o, Newell Shearwater	?
N	<u>Streptopelia chinensis</u>	Spotted Dove	x
+E	<u>Vestiaria coccinea</u>	`I`iwi	x
N	<u>Zosterops japonicus</u>	Japanese White-eye	*

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