

Draft Environmental Assessment

for

Population Reestablishment of the `Alala

Hawaii County, Hawaii



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State of Hawaii

Department of Land and Natural Resources



United States Department of the Interior

Fish and Wildlife Service

December 1999

DRAFT ENVIRONMENTAL ASSESSMENT

Population Reestablishment of the 'Alalā
Corvus hawaiiensis

U.S. Fish and Wildlife Service
Pacific Islands Fish and Wildlife Office
Pacific Islands Ecoregion

Hawai'i Department of Land and
Natural Resources
Division of Forestry and Wildlife

Authorities for Action:

NATIONAL ENVIRONMENTAL POLICY ACT OF 1969
U.S. ENDANGERED SPECIES ACT OF 1973, as amended
HAWAI'I ENVIRONMENTAL IMPACT STATEMENT LAW (HRS 343)
HAWAI'I ENDANGERED SPECIES LAW (HRS 195D)

Prepared jointly by:

U.S. Fish and Wildlife Service
Pacific Islands Fish and Wildlife Office
Pacific Islands Ecoregion
Honolulu, Hawai'i

Hawai'i Department of Land and Natural Resources
Division of Forestry and Wildlife
Honolulu, Hawai'i

December 1999

Summary Information

Title: Draft Environmental Assessment for Population Reestablishment of the 'Alalā (*Corvus hawaiiensis*), Hawai'i County, Hawai'i.

Proposed Action: 'Alalā (*Corvus hawaiiensis*) Recovery Actions

Proposing Agencies: Department of Land and Natural Resources (DLNR)
Division of Forestry and Wildlife (DOFAW)
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United States Department of the Interior (USDI)
U.S. Fish and Wildlife Service (USFWS)
Pacific Islands Fish and Wildlife Office
300 Ala Moana Blvd., Room 3-122
Honolulu, Hawai'i 96850

Location: North Kona, South Kona, Ka'ū, and South Hilo districts, Island of Hawai'i. Portions of Tax Map Key numbers (District 3) 2-4-8:009, 2-9-5:005, 7-1-1:001, 8-6-1:001, 8-6-1:003, 8-9-1:002, 9-7-1:001, 9-8-1:004, 9-8-1:010, 9-9-1:007.

Determination: Anticipated Finding Of No Significant Impact

Approving Agency: DLNR-DOFAW and USDI-USFWS

Permits Required: Federal Endangered Species Permit
Conservation District Use Permit

AGENCIES AND ORGANIZATIONS CONSULTED OR CONTACTED IN PREPARING THE DRAFT ENVIRONMENTAL ASSESSMENT

Federal: U.S. Geological Survey, Biological Resources Division
National Park Service, Hawai'i Volcanoes National Park
National Zoological Park, Conservation and Research Center

State: Hawai'i Division of Forestry and Wildlife, Hawai'i District, and
Administrative Office

Others: Kamehameha Schools/B.P. Bishop Estate
The Peregrine Fund
‘Ōla‘a-Kīlauea Partnership Group
‘Alalā Partnership Group

Federal Recovery Teams:

‘Alalā Recovery Team
‘Io Recovery Working Group

PUBLIC LIBRARIES WHERE DOCUMENT WILL BE AVAILABLE:

O‘ahu: Hawai‘i State Library, Honolulu
Hawai‘i: Thelma Parker Memorial Public & School Library, Waimea
Kealakekua Public Library, Kealakekua
Pāhala Public & School Library, Pāhala
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Mountain View Public & School Library, Mountain View
Laupāhoehoe Public & School Library, Laupāhoehoe
Kailua-Kona Public Library, Kailua-Kona

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Executive Summary

The U.S. Fish and Wildlife Service (USFWS) and State of Hawai'i Division of Forestry and Wildlife (DOFAW) are considering the reestablishment of populations of the Hawaiian crow, or 'alalā, in suitable areas on the island of Hawai'i. The USFWS and DOFAW have prepared a Draft Environmental Assessment (DEA). It presents a historical review of the 'alalā population and conservation efforts, examines a variety of alternative reintroduction sites, and analyzes possible environmental effects of the alternatives, one or more of which could be selected. The DEA serves as the basis for a decision by the USFWS and DLNR on which alternatives, if any, to implement, and if multiple sites are selected, what should be the order of utilization. Actions proposed in the DEA would take place on privately owned and publicly owned lands in the districts of North Kona, South Kona, Ka'u, and South Hilo on the island of Hawai'i.

Summary of proposed alternatives

The recovery actions being presented in this DEA are intended to establish multiple reproducing populations of 'alalā in the wild. The alternatives being proposed are:

- | | |
|---------------|---|
| Alternative 1 | Release 'alalā at Pu'u Wa'awa'a Forest Bird Sanctuary while continuing releases at Kona Forest/McCandless Ranch |
| Alternative 2 | Release 'alalā at Honomalino Section, South Kona Forest Reserve while continuing releases at Kona Forest/McCandless Ranch |
| Alternative 3 | Release 'alalā at Kapāpala Forest Reserve while continuing releases at Kona Forest/McCandless Ranch |
| Alternative 4 | Release 'alalā at Kūlani Correctional Facility/Keauhou Ranch while continuing releases at Kona Forest/McCandless Ranch |
| Alternative 5 | Release 'alalā at Hakalau Forest National Wildlife Refuge while continuing releases at Kona Forest/McCandless Ranch |
| Alternative 6 | No Action: Continue 'alalā releases at Kona Forest/McCandless Ranch only |

Agency determination

At this time, the agencies do not have a preferred alternative. None of the alternatives being proposed are expected to cause significant, irreversible impacts to the environment, pursuant to the significance criteria established by the Environmental Council (Hawai'i Administrative Rules, Section 11-200-12); therefore, the anticipated determination is a Finding of No Significant Impact (See Chapter 5: Summary of significance criteria).

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DRAFT ENVIRONMENTAL ASSESSMENT FOR POPULATION REESTABLISHMENT OF THE ‘ALALĀ

CHAPTER 1. PURPOSE AND NEED FOR THE ACTION

1.1 INTRODUCTION

The U.S. Fish and Wildlife Service (USFWS) and State of Hawai‘i Department of Land and Natural Resources (DLNR), Division of Forestry and Wildlife (DOFAW), are considering accelerating the recovery of the ‘alalā (*Corvus hawaiiensis*), a native Hawaiian forest bird from the island of Hawai‘i, by establishing multiple populations. This Draft Environmental Assessment (EA) was prepared by the USFWS and DOFAW. It presents a historical review of the conservation efforts to recover the ‘alalā, examines a range of alternative reintroduction sites, analyzes the possible environmental effects of the alternatives, and serves as the basis for a decision by the USFWS and DOFAW on which alternatives, if any, to implement. At this time the agencies do not have a preferred alternative. This Draft EA also provides an opportunity for public involvement.

1.2 BACKGROUND INFORMATION

1.2.1 ‘Alalā population history

The endangered ‘alalā or Hawaiian crow is the only native Hawaiian corvid (member of the crow family) still in existence. Two other species, once found on O‘ahu and Maui, became extinct sometime after Polynesian settlement (James and Olsen 1991). The ‘alalā differs from the crows of continental regions in its requirement for a forested habitat and its dependence on fruit for a large part of its omnivorous diet. More detailed discussions of ‘alalā biology, including life history, habitat use, and reproduction, may be found in the ‘Alalā Recovery Plan (USFWS 1982), Banko and Banko (1980), Giffin (1983), Giffin *et al.* (1987), and Duckworth *et al.* (1992).

The ‘alalā is endemic to the island of Hawai‘i, and historically inhabited a V-shaped belt of dry woodlands, ‘ōhi‘a (*Metrosideros polymorpha*) forests, and moist ‘ōhi‘a-koa (*Acacia koa*) forests at elevations of 340-1800 meters (m) (1100- 6000 feet [ft]) in the Kona and Ka‘ū districts (Fig. 1; see Perkins 1893, Banko and Banko 1980). In common with many Hawaiian birds, the ‘alalā has experienced a severe decline in numbers and range. Large changes in the forest ecosystems of Hawai‘i, beginning with Polynesian arrival and increasing after Western contact, have contributed to the decline and disappearance of many species of endemic birds (Scott *et al.* 1986, Cuddihy and Stone 1990). For example, of the 21 native bird species living in the forests of Kona and Ka‘ū at the time of Western contact roughly 200 years ago, over half (12 species) are now extinct or extirpated (Berger 1972, Pratt *et al.* 1987).

Figure 1

As recently as 1900, the 'ālalā occupied all of its historic range. It was considered “numerous” and occurred in “flocks” from the mid-elevation forests and parklands of the Kona and Ka‘ū districts to the higher slopes of the mountains (Munro 1944). Estimates of the historical population numbers are not available; however, by the 1930s and 1940s the 'ālalā population was greatly reduced and was becoming fragmented in distribution. By 1978, the wild 'ālalā population was restricted to four distinct areas between 850 and 1700 m (2800 and 5700 ft) in elevation (Scott *et al.* 1986), and the total population was estimated to be 76 birds. By 1983, Giffin (1983) estimated the species to consist of 29 individuals. In 1992 only one population of 11 birds remained on privately owned lands in South Kona, in addition to a single individual believed to persist on Hualālai (Duckworth *et al.* 1992).

Populations decline when, on average, the death rate exceeds the birth rate. The precise reasons for the decline of the 'ālalā remain uncertain, but some combination of factors in the environment must have directly or indirectly affected one or both rates. Both increases in direct sources of mortality and a gradual loss of habitat quality and extent are probably to blame for the decline of the 'ālalā.

Direct mortality factors reported historically are shooting (Munro 1944), avian disease (Banko and Banko 1980, Jenkins *et al.* 1989), and predation on nests and young by mammals (Banko 1976). Disease and predation, at least, are still direct threats to 'ālalā. Mosquitoes, which transmit avian malaria, avian pox, and other diseases, are alien to Hawai‘i but are now found throughout the 'ālalā’s historic range. Alien birds are now common throughout the historic range of the 'ālalā, and can carry parasites and diseases such as avian pox and avian malaria, compete with the 'ālalā for food, and provide a prey base for large populations of predators. Recent data from the release program shows that the endangered ‘io or Hawaiian hawk (*Buteo solitarius*) prey upon juvenile and adult 'ālalā, a previously unreported source of mortality. Rats (*Rattus* spp.) are known predators on 'ālalā eggs and nestlings, as are mongoose (*Herpestes auro-punctatus*; Banko 1976). Feral cats (*Felis catus*) are also suspected predators on fledglings and adults (USFWS, unpubl. data). In addition to direct predation on 'ālalā, feral cats carry a parasite (*Toxoplasma gondii*) which infects a variety of potential 'ālalā prey and causes toxoplasmosis, now known to be often fatal to 'ālalā in the wild (B. Rideout, San Diego Zoo, unpubl. data; Work *et al.* in prep.). Bacterial and fungal infections have also caused mortality to 'ālalā in the wild (Work *et al.* 1999; T. Work, BRD, unpubl. data).

Indirect effects on birth and death rates are probably also implicated in the decline of the 'ālalā. Because 'ālalā feed extensively on fruits of native understory plants, it is reasonable to assume that the gradual but massive loss of those plants within native forest (Cuddihy and Stone 1990) has strongly reduced habitat quality. This could have reduced adult survival during lean years, the ability of pairs to raise chicks, and the total number of 'ālalā that could subsist in a given area. Understory plant numbers and diversity have been affected over time by the loss of pollinators and dispersers such as nectar-feeding and fruit-eating birds, and direct consumption and trampling by alien cattle (*Bos taurus*), sheep (*Ovis aries*), goats (*Capra hircus*), pigs (*Sus scrofa*) and rats. The strong negative effect of feral cattle and pigs on forest quality was noted

over a century ago (Anon. 1856, in Cuddihy and Stone 1990) and the cumulative effects of alien mammals on 'ālalā habitat has continued to the present. Opening of the previously dense (Menzies 1920) forest by grazing and forest clearing may have made 'ālalā more vulnerable to 'io predation, as well as directly eliminating habitat. Fragmentation of the forest belt for agriculture may have led to the isolation of 'ālalā subpopulations observed in the last few decades (Duckworth *et al.* 1992), making them more susceptible to chance events that reduce population size.

Seasonal elevational movements of 'ālalā were noted by early observers in response to fruit availability and weather (Banko and Banko 1980). The advent of coffee agriculture at the lower margin of the native forest in Kona made 'ālalā vulnerable to farmers' guns as the birds exploited this seasonal fruit (Berger 1972). Conversion of mid- and low-elevation native forest to agriculture may have led to the retreat of 'ālalā to higher elevations (Berger 1972), and possibly to reduced survival or fecundity during seasons of poor fruit availability at higher elevations.

1.2.2 'Alalā habitat requirements and behavior

Hawaiian crows are associated with native forests with a closed to semi-open canopy (Scott *et al.* 1986). The habitat with the highest breeding densities of 'ālalā during the 1970-1982 period was relatively undisturbed koa-'ōhi'a forest (Giffin *et al.* 1987). Giffin also found that 'ālalā occupied virtually all of the undisturbed and none of the heavily disturbed koa-'ōhi'a forests in Kona, suggesting that some feature of forest disturbance makes forest unsuitable for 'ālalā. 'Alalā generally nest in mature mesic koa-'ōhi'a forest in central Kona, and they appear to prefer mature 'ōhi'a for nest sites in both mesic and dry forests (USFWS, unpubl. data; Berger 1972). Rainfall levels within historic range vary from 600 to about 2500 millimeters (mm) per year or 24 to 98 inches per year (in/yr). Although collectors in the 1890s noted 'ālalā as low as 340 m (1100 ft; Berger 1972), all recorded nests have been between 1040 and 1770 m (3400-5800 ft).

'Alalā need a diversity of food resources from native understory fruit trees and shrubs. They also depend heavily on forest bird eggs and nestlings during the breeding season, as well as on arthropods found year-round in decaying and healthy overstory and mid-canopy trees. The 'ālalā seems to require significant protective understory cover as a means of shelter from 'io (USFWS, unpubl. data).

The 'ālalā uses a wide range of habitat types, often moving from wet 'ōhi'a forest into mesic koa-'ōhi'a and finally into the dry 'ōhi'a forest on a seasonal basis in south Kona (USFWS, unpubl. data). On Hualālai, where lower-elevation native forests have been largely eliminated, 'ālalā were historically seen moving seasonally from the montane dry forest on the north side of Hualālai to the wet west side of Hualālai in response to changing food resources (Giffin 1983).

In the central Kona forests, established pairs of 'ālalā have home ranges of approximately 200 hectares (ha) or 500 acres (ac; USFWS, unpubl. data) and are normally permanent residents of their territory. These home ranges contract slightly during the breeding season (March-July), as

the pair stays closer to the nest. Movements within these home ranges appear to be influenced heavily by quality of habitat (food resource availability and protective cover), proximity and distribution of other 'alalā, and proximity of territorial 'io. Limited studies with other crow species (Yom-Tov 1974) suggest that sizes of breeding territories are not influenced by food supply, at least in the short term, but are more likely set by social interactions among pairs. Losses of established pairs from a population can lead to several-fold increases in the home ranges of the remaining 'alalā, apparently due to the need of the birds to locate adjacent 'alalā (USFWS, unpubl. data).

'Alalā appear to prefer staying within forested habitat wherever possible. They will traverse small pasture areas surrounded by native forest but rarely cross large areas that provide them with little in the way of food resources or protection from 'io (D. Ball, USFWS, pers. obs.). One such landscape barrier, a large piece of pasture land constituting Kealakekua Ranch, occurs between the north and central Kona forests. The deforestation of this area may have led to the separation of the north and central Kona 'alalā populations prior to the 1970s.

1.2.3 Recovery actions to date

The 'alalā was protected by Territorial and later State of Hawai'i law beginning in 1931, and was added to the Federal and State lists of endangered species in 1967. A captive propagation program for the 'alalā was initiated in 1970 by DOFAW in partnership with the USFWS. This program was initially based on birds collected as fledglings from the wild in 1970. Between 1970 and 1981, a total of 12 'alalā were brought into captivity. However, the program suffered due to inadequate facilities and a low rate of successful reproduction. In 1986 the program, with nine captive 'alalā, was transferred from Pohakuloa, Hawai'i, to Olinda, Maui. Three fledglings were produced from 48 eggs laid at Pohakuloa between 1977 and 1986, and an additional nine young resulted from 80 eggs laid at Olinda from 1987 to 1995 (TPF 1995).

In 1984 a State Wildlife Sanctuary was established at Pu'u Wa'awa'a on Hualālai for the protection of the 'alalā and other forest birds. In 1991, the USFWS commissioned the National Academy of Sciences' National Research Council (NRC) to undertake a review of the status of the 'alalā and recommend appropriate recovery actions. That same year, Hawai'i Audubon Society and National Audubon Society filed a lawsuit (Hawai'i Audubon Society v. Lujan, U.S. District Court No. 91-00191 DAE) alleging that, due to a lack of progress in the recovery of the 'alalā, the USFWS and the owners of the land in South Kona on which the last remaining 'alalā population resided were in violation of the U.S. Endangered Species Act of 1973, as amended (ESA). The NRC released its report in 1992 and the lawsuit was settled in 1993. These two events resulted in the reestablishment of a Recovery Team for the 'alalā and a formalized cooperative partnership between the USFWS and the private landowners.

Since 1993, USFWS, DOFAW, The Peregrine Fund, Inc. (TPF), the Biological Resources Division of the U.S. Geological Survey (BRD), and the owners of Kealia and McCandless Ranches and Kuaola Refuge (the private portion of the former Kai Malino Ranch) have been

operating a program of active management to increase the size of both the wild and captive populations of the 'ālalā. The captive flock, presently numbering 26 'ālalā, is maintained by TPF at the Maui Bird Conservation Center at Olinda, and at the Keauhou Bird Conservation Center near Volcano, Hawai'i. The captive flock is projected to consist of 10 breeding pairs for the indefinite future. Offspring from breeding pairs in the wild and captivity are used for the release program and to augment the captive flock.

The Peregrine Fund was contracted to manage the 'ālalā captive propagation effort in 1993. Since that time, productivity of the captive 'ālalā has steadily improved, with an increase in fledging success among current breeding pairs (A. Leiberman, TPF, pers. commun., 1998). Captive rearing of young, transfers to field aviaries, releasing of young birds to the wild ("hacking"), and weaning onto wild foods are being refined but are now relatively routine tasks (P. Harrity, TPF, pers. commun., 1998). Released birds seem to exhibit appropriate fear responses to 'io, forage on wild foods, and interact appropriately with peers (P. Harrity and D. Ball, pers. commun., 1998). Avian malaria and avian pox infect the released birds but do not appear to be fatal or induce serious illness when supportive care is available. Determining locations and gaining observations of transmittered birds, while arduous, is relatively straightforward. Much has been learned about food plant use, foraging patterns, and behavioral interactions by observation of released and wild birds.

The release program has not resulted in the reproduction of released birds to date, although a pair of five year-old birds formed a pair bond and attempted to nest in a field aviary in 1998. 'Alalā are known to become reproductively mature at two to three years of age. Some behavioral interactions among and within release groups and wild 'ālalā may be delaying breeding of released birds and disrupting nesting of wild 'ālalā. There is little positive interaction or mentoring between the remaining wild individuals and the released 'ālalā, although harassment by adults is probably a normal and necessary learning experience for young 'ālalā. The mortality rate of released 'ālalā has not declined with age as in most birds (e.g., Flegg and Cox 1975). As of October 1999, 27 captively-reared 'ālalā have been released at the current release site. Of these, 21 have died or disappeared. Of the 21 known or suspected mortalities, the cause of eight is unknown, seven 'ālalā have been killed or scavenged by 'io, five have died from toxoplasmosis, bacterial or fungal infections, and one was killed or scavenged by a mammal (perhaps when weakened by disease). Of the remaining six birds, one has recovered from toxoplasmosis acquired in the field, and all six are now being held in captivity.

The wild population, numbering 11 in 1992, has fallen to three birds as of October 1999, including one known breeding pair. No breeding in the wild has occurred since 1996, possibly because of advanced age or other health issues within the remaining pair. The causes of death of the wild birds are not known.

Improvements continue to be made to the release program, based on new information regarding behaviors and risk factors. Hacking procedures have been simplified and refined. Knowledge of foraging habits will shape the precise location of future hacking sites. The threat of 'io predation

on 'ālalā of all ages has focused renewed attention on vegetation density within the habitat and on the optimum health of 'ālalā in the field. The need for expansion and intensification of habitat management, especially mammalian predator control, has resulted in acquisition by the USFWS of the Kona Forest Unit of the Hakalau Forest National Wildlife Refuge, a 2150 ha (5300 ac) parcel adjacent to the current release site at McCandless Ranch. Management of significant forest areas for ecosystem integrity has been identified as a key 'ālalā recovery action for many years (Banko 1976, Duckworth *et al.* 1992, USFWS 1993).

1.2.4 Factors limiting 'ālalā recovery

In order to maximize the chances for establishment of reproducing, wild populations of 'ālalā in the near future, the number of birds released to the wild will need to increase and the limiting factors present in the historic and potential habitat of the species need to be determined and controlled. Releases in central Kona have revealed previously unknown interactions and mortality factors that must be addressed during a release program in order for 'ālalā to survive and reproduce in the wild. Risk factors, and thus the potential for successful reintroduction, probably vary across the island, but can only be determined by releasing 'ālalā at additional sites. Multiple release sites will increase the rate of learning and thus the probability of recovery.

Most of the factors suggested to be responsible for the decline and near extinction of the 'ālalā in the wild still exist in most of the historic range of the species. Populations of mammalian predators (rats, feral cats, mongoose) are essentially uncontrolled, although control methods exist and can be effective over relatively large areas (Mansfield 1996). Populations of 'io appear to be robust in most areas of native forest (USFWS, unpubl. data). Avian pox and avian malaria exist island-wide, although some areas have low prevalence of malaria (C. Atkinson, BRD, unpubl. data). Toxoplasmosis can be expected to be present wherever there are feral cats (Wallace 1973), which apparently includes most areas below 3000 m (10,000 ft) elevation (G. Lindsey, BRD and D. Hu, National Park Service, pers. commun., 1999).

Except for fenced enclosures within protected areas, feral and domestic ungulates (pigs, cattle, sheep, goats) occur widely within former 'ālalā habitat. The native vegetation within these areas, especially the understory and mid-canopy plants that produce most of the fruits eaten by 'ālalā, has therefore declined over time and continues to do so (DLNR 1998a, Cuddihy and Stone 1990, Jacobi 1989). The logging of large koa trees, which has occurred in much of the upper-elevation forests of Kona, has created canopy gaps and fragmentation of key nesting habitat for 'ālalā. Regeneration of koa is occurring in many of these areas, but early-successional koa forests have low understory diversity, provide little protective cover, and are probably of low habitat value for 'ālalā.

Establishment and persistence of reintroduced populations of 'ālalā will require control of the most significant mortality factors over long time periods and extensive areas. In order for a population of 'ālalā to maintain itself in the wild, mortality rates of juveniles and adults must be much lower than those observed in wild (and reintroduced) populations over the last 30 years

(Duckworth *et al.* 1992). Ongoing studies at the current Kona Forest/McCandless Ranch release site are revealing previously unsuspected causes of direct mortality, but other, more indirect limiting factors remain conjectural. Some potentially important factors, such as the reduced elevational range and increasing fragmentation of native forest, may not be amenable to control.

‘Alalā have extensive home ranges, and so a self-sustaining population would occupy a substantial area of forest. Populations of ‘alalā, like most wild species, will tend to lose genetic diversity and become inbred if they remain small (e.g., less than 100 individuals) for several generations (Duckworth *et al.* 1992). In addition, smaller populations are more likely to disappear over time due to severe environmental events or other random factors than are larger, more spatially extensive populations. For this reason, areas with more potential habitat for ‘alalā are preferable as reintroduction sites, all else being equal.

1.3 THE PROPOSED ACTION

The USFWS and DOFAW propose to expand the ongoing program of releasing captive-reared ‘alalā (*Corvus hawaiiensis*) from the current single site to multiple sites on the island of Hawai‘i. The proposed releases will help achieve the recovery goals for the ‘alalā as outlined in the ‘Alalā Recovery Plan (USFWS 1982), “The Scientific Bases for the Preservation of the Hawaiian Crow” (Duckworth *et al.* 1992), the “Long-Term Management Plan for the ‘Alalā” (USFWS 1993), and the revised ‘Alalā Recovery Plan (USFWS in prep.). These plans envision an eventual population of ‘alalā larger than the habitat capacity of the single current release site. The above plans also encourage the establishment of multiple populations to reduce the threat to the species due to a catastrophic environmental event.

1.4 PURPOSE OF THE PROPOSED ACTION

The overall goal of the proposed action is to achieve the recovery of the ‘alalā. The specific goal is to attain a self-sustaining ‘alalā population size sufficient to reclassify the ‘alalā as threatened. The framework for accomplishing this goal is provided in the revised Recovery Plan for the ‘Alalā (USFWS in prep.).

1.5 NEED FOR THE PROPOSED ACTION

The original ‘Alalā Recovery Plan (USFWS 1982) required a self-sustaining population of at least 400 birds as a prerequisite to reclassification of the species from its endangered status. Because of the home range sizes of the ‘alalā, this would require a substantial reoccupation of the historic range. The revised Recovery Plan (USFWS in prep.) calls for three to four self-sustaining wild populations of ‘alalā within its historic range. Because the long-term genetic viability of a species can only be sustained in a relatively large population (Duckworth *et al.* 1992), maintenance of the ‘alalā at the present very low population size for many more generations is expected to reduce the chances of eventual recovery. The entire species now

numbers 29 individuals, approximately the population size in 1980 (Giffin 1983). There have been no releases to date outside the current project site.

Despite the lack of population growth at the current release site, a clearer picture of the mortality factors and habitat requirements of the 'ā'alā has been gained. The agencies believe that with habitat restoration and more intensive predator control, the mortality factors presently restricting 'ā'alā survival can be reduced enough to allow survival and reproduction in many areas of forest on Hawai'i in addition to the current site. However, the time lags inherent in site preparation and habitat recovery impose a need to identify and dedicate alternative release sites as soon as possible, so that the 'ā'alā population can begin expanding and recovering in the wild.

1.6 RELATED AGENCY ACTIONS

1.6.1 U.S. Fish and Wildlife Service 'ā'alā management activities

The USFWS, together with public and private partners, has conducted numerous actions aimed at recovery and management of the 'ā'alā and its habitat. Between 1976 and 1983, the Service sponsored forest bird surveys (Scott *et al.* 1986) which determined the distribution and approximate numbers of the wild population. Additional surveys were conducted in 1995 as part of an effort to assess habitat suitability at potential release sites (USFWS, unpubl. data).

The 'ā'alā captive propagation program, ongoing since 1970, has been jointly supported by USFWS and DOFAW. Currently, the USFWS Pacific Islands Office funds construction of facilities at the Keauhou Bird Conservation Center (KBCC), provides \$500,000 per year for operation of that facility, and an additional \$64,316 per year for the services of the State Avian Veterinarian and operation of the Maui Bird Conservation Center (MBCC).

The USFWS also provides Federal funds to the State of Hawai'i for the protection and recovery of endangered and threatened species under the provisions of section 6 of the Endangered Species Act. Through a section 6 cooperative agreement with the DOFAW, the USFWS' Federal Aid Program provides approximately \$300,000 per year for operation of MBCC.

The release program in Kona has required funding and logistical support for four to six staff and temporary biologists from 1993 to the present. Partial funding for an ungulate enclosure being constructed by McCandless Ranch in the core of the 'ā'alā's present habitat was provided by the Partners for Fish and Wildlife program of the USFWS.

In 1997, USFWS purchased the majority of Kai Malino Ranch as an additional unit (the Kona Forest Unit) of Hakalau Forest National Wildlife Refuge (NWR), in order to manage the habitat for the maximal benefit of native forest organisms, including the 'ā'alā. Substantial habitat restoration activities, including fencing and feral ungulate control, are planned for this area but have not yet commenced.

In 1991, the USFWS commissioned the National Academy of Sciences' National Research Council to undertake a review of the status of the 'alalā and recommend appropriate recovery actions. Meetings of the 'Alalā Recovery Team have occurred at least annually since 1993, at which management options are discussed and recommendations are made for program improvement. All of these meetings and reviews have been supported by the USFWS.

1.6.2 Other U.S. Fish and Wildlife Service activities

Other activities by USFWS may benefit the 'alalā recovery effort if one or more of the alternative release sites proposed in this document are chosen for action. The purchase and ongoing habitat management and restoration activities at Hakalau Forest NWR would benefit the 'alalā if releases were to occur there (see USFWS 1985, 1996). This management involves fencing, ungulate control, outplanting of forest plants, and experimental predator control.

Continued funding has been provided through the Biodiversity Joint Venture program to help support habitat restoration and management in the 'Ōla'a-Kīlauea Partnership area near Volcano, Hawai'i (OKMG 1998a,b). Ongoing actions in concert with other partners include fencing, weed control, and feral ungulate control.

The USFWS administers the appropriation of Federal funds from the Pittman-Robertson Federal Aid to Wildlife Restoration program. These funds, derived from a Federal excise tax on the manufacture of arms and ammunition, are apportioned to DOFAW for use in game management and other wildlife programs. The Pittman-Robertson funds have been used for periodic forest bird surveys in the State of Hawai'i, including 1990 and 1991 surveys of the Pu'u Wa'awa'a Forest Bird Sanctuary.

1.6.3 Actions by the Division of Forestry and Wildlife and other agencies

DOFAW conducts programs and management activities that support recovery of 'alalā and their habitat on much of the 600,000 acres of land it manages on Hawai'i. Programs that support 'alalā recovery include protection and management of wildlife and plant Sanctuaries, Natural Area Reserves, and Forest Reserves. Some of the important areas under DOFAW management that may contribute to the recovery of 'alalā in the future include Pu'u Wa'awa'a Forest Bird Sanctuary; Kipāhoehoe, Manukā, Kahauale'a, and Pu'u Maka'ala Natural Area Reserves; the Honua'ula, South Kona, Honomalino, Ka'ū, Kapāpala, Waiākea, Upper Waiākea, 'Ōla'a, Hilo and Mauna Loa Forest Reserves and various smaller plant sanctuaries.

Other DOFAW programs that directly or indirectly support recovery of 'alalā and their habitat include the operation of the public hunting program, wild fire control, weed control, predator control, captive propagation of endangered birds, forest bird monitoring and surveys, avian disease research, propagation and outplanting of native and endangered plants, and development of new management techniques. Some of the specific management actions conducted at Pu'u Wa'awa'a Forest Bird Sanctuary that support 'alalā recovery include removal of cattle; fencing

of the Sanctuary boundary; control of pig, sheep and goat populations; development of a staff cabin; control of invasive weeds; surveys of native birds, plants and insects; surveys for mosquitoes; koa restoration activities; outplanting of endangered and rare native plants; predator control; fire suppression; and forest bird reintroduction. Common, rare and endangered plants, many of which provide food for ‘*alalā*, have been outplanted in Honua‘*ula*, Honomalino, Ka‘*ū* and South Kona Forest Reserves. DOFAW is an active member of the ‘*Ōla‘a-Kīlauea* Partnership and manages a portion of the ‘*Ōla‘a-Kīlauea* Management Area as the Pu‘*u Maka‘ala* Natural Area Reserve. The partnership participates in cooperative management activities and implements management actions such as feral animal and non-native plant control measures, collaborative research projects, and habitat and species protection and restoration. DOFAW also provides facilities, funding and support to TPF to operate the captive propagation program for ‘*alalā* at the MBCC in Olinda, Maui.

Veterinary support for the ‘*alalā* captive propagation and release program is provided by DLNR’s staff veterinarian. Crucial research on disease and other mortality factors for ‘*alalā* has been conducted by scientists from the BRD’s Pacific Island Ecosystems Research Center in Volcano, Hawai‘*i*, and National Wildlife Health Research Center in Honolulu.

1.7 DECISIONS TO BE MADE

U.S. Fish and Wildlife Service (USFWS): The USFWS must determine

- A. Whether to release ‘*alalā* at a location in addition to the current release site in the near future, and if so, which of the alternative sites are appropriate for release and in what order they should be implemented.
- B. Whether this is a major Federal action with significant effects on the human environment, and thus requires an Environmental Impact Statement (EIS), or whether an Environmental Assessment (EA) will satisfy the requirements of the National Environmental Policy Act of 1969, as amended (NEPA).

The State of Hawai‘*i* Department of Land and Natural Resources (DLNR): DLNR must determine

- A. Whether it will authorize use of Forest Reserves, State lands, and Conservation District lands for the purpose of ‘*alalā* recovery activities.
- B. Whether that action will have a significant impact, requiring the preparation of a State EIS, or whether an EA will satisfy the requirements of HRS 343.

USFWS and DOFAW consider all of the alternatives to be potential release sites and have not selected one or more preferred alternatives. The agencies are soliciting input from adjacent landowners, the scientific community and the general public.

1.8 OVERVIEW OF THE PLANNING PROCESS

NEPA and Hawai'i's Environmental Impact Statement Law (HRS 343) mandate a series of steps that ensure that projects which may potentially affect the human environment are adequately described and publicly reviewed prior to decision-making. The following steps briefly outline the process followed for this project involving an Environmental Assessment:

1. Action is proposed and defined
2. Scoping of issues through informal meetings
3. Analysis of potential environmental effects
4. Preparation of a preliminary Draft Environmental Assessment (DEA)
5. Meetings with cooperators, landowners and other affected parties
6. Completion of DEA
7. Public notice of DEA availability in the *Bulletin* of the State of Hawai'i Office of Environmental Quality Control (OEQC) and *Federal Register*
8. Circulation of the DEA to interested parties and the public, solicitation of comments
9. Public meetings held if needed/requested
10. Receipt and acknowledgement of comments by agencies
11. Revision of DEA based on comments received
12. Selection of preferred alternatives and determination of significance of impact
13. Preparation of a Finding of No Significant Impact (FONSI) or initiation of EIS preparation if no FONSI
14. Circulation of draft final EA to agencies
15. Public notice of EA publication in OEQC *Bulletin* and *Federal Register*
16. Implementation of action

1.9 SCOPING THE ISSUES AND CONCERNS

The USFWS and DLNR, in cooperation with the 'Alalā Recovery Team and the 'Alalā Partnership, is making a concerted effort to solicit input from potentially affected parties and to adequately address the concerns presented. Pursuant to this effort, the USFWS has solicited comments from owners of large landholdings near potential release sites, the scientific community, the general public, and State and Federal agencies. The primary means of scoping were direct contacts with individuals and entities with an expressed interest in the proposed action.

1.10 ISSUES AND CONCERNS

The following issues and concerns were identified by a preliminary analysis of responses received during the scoping process described above. The potential effects of each alternative are analyzed with respect to these issues in Chapter 4: Environmental Consequences.

1. Effect of the proposed action on the recovery effort for the ‘alalā
 - ! Biological suitability of the site (site characteristics and food availability)
 - ! Risks to ‘alalā from predators and disease
 - ! Risks to ‘alalā from illegal shooting and accidental poisoning

2. Ability to implement management actions to reduce factors limiting ‘alalā recovery
 - ! Existing management actions and infrastructure
 - ! Accessibility of the site
 - ! Cooperation of adjacent landowners
 - ! Potential for control of non-native species

3. Effect of ‘alalā releases and associated activities on existing land uses and human activities.
 - A. Agricultural land use
 - ! Grazing on public and private land
 - ! Logging on private land
 - ! Third-party lawsuits alleging degradation of ‘alalā habitat on private land
 - B. Hunting
 - ! Public hunting opportunities on State land

4. Effects of ‘alalā releases on other species present in the release area
 - ! Endangered, threatened or candidate species
 - ! Native bird populations
 - ! Alien plant species

1.11 AUTHORITIES AND REGULATORY COMPLIANCE

1.11.1 Authorities

This action is consistent with the USFWS mandate for promoting long-term conservation and recovery of the nation’s endangered and threatened species (the U.S. Endangered Species Act of 1973, as amended (16 U.S.C. 1531-1544, 87 Stat. 884) and DLNR’s mandate to promote long term conservation and recovery of Hawai‘i’s endangered and threatened species (Hawai‘i’s Endangered Species Law (HRS 195D)).

1.11.2 Compliance

The proposed action will be completed in compliance with Federal and State policies and the following laws and regulations: NEPA; Executive Order 12372 (Intergovernmental Review of Federal Programs); ESA; HRS 195D; and HRS 343.

CHAPTER 2. ALTERNATIVES

2.1 IDENTIFICATION OF THE ALTERNATIVES

NEPA requires that all reasonable alternatives for a proposed action be rigorously explored and objectively evaluated. The alternatives described below were identified jointly by the USFWS and DOFAW, along with the 'Alalā Recovery Team (ART; a scientific advisory body to the USFWS), and representatives of BRD and TPF.

To be a viable alternative, a potential release area must contain a native-dominated ecosystem of sufficient quality, diversity and extent to support survival and reproduction of a population of 'alalā. In addition, the potential must exist for significant control of factors, such as alien predators, associated with unnaturally high mortality of 'alalā. Finally, the agencies must have sufficient access to the site and its surroundings to release 'alalā, monitor their movements, and retrieve injured or dead birds.

In this document, release site refers to an area within which releases of juvenile 'alalā might take place. These are areas of native-dominated forest, within all or part of which predatory mammals and ungulates could be reduced or removed. Potential release sites were evaluated through site visits, examination of existing data and photo imagery, discussions with landowners, agency personnel, the ART and others familiar with the sites. Potential 'alalā release sites were assessed for suitability using a standard set of criteria (Appendix A).

Maps of potential 'alalā habitat were prepared using the most complete and detailed data available. Vegetation data from 1976 (Jacobi 1989) were used, combined with 'alalā location records (Scott *et al.* 1986, HNHP 1998) and nest site records (DOFAW and USFWS, unpubl. data). The vegetation data used are over 20 years old, however, and reflect conditions that existed when 'alalā were extirpated or declining throughout almost all of their range. In many cases, later photoimagery has shown that substantial deforestation has occurred since 1976. Due to the widespread distribution of feral ungulates and invasive alien plants, most areas without active management of such species can be assumed to have declined in native forest integrity since 1976. Therefore, due to both the age of the vegetation data and uncertainties regarding which features of the environment determine habitat suitability for 'alalā, these maps should be interpreted with caution.

Two types of potential habitat were delineated: nesting and foraging (Fig. 2). Nesting habitat refers to all vegetation types matching those known to have contained an 'alalā nest. Based on the known elevational range of 'alalā nests in recent decades, only such vegetation above 915 m (3000 ft) elevation was included. Two subtypes of potential nesting habitat were defined: native nesting habitat, having a native tree canopy and mostly native understory, and invaded nesting habitat, having a native tree canopy but a partially or completely non-native understory. Because the objective of releasing 'alalā is to establish breeding populations, only sites with significant

areas of nesting habitat are being considered. It should be noted that most such areas within the 'alalā's historic range did not sustain a population of 'alalā by the 1980s, due to a variety of known and unknown habitat characteristics.

The area of habitat needed to support a breeding pair of 'alalā was assumed to be fixed by social factors rather than food supply within the habitat, similarly to other crows (Yom-Tov 1974). Historical data on nest spacing (USFWS 1998) and current data from direct observations in the McCandless area since 1993 (USFWS, unpubl. data) suggest a breeding territory size of approximately 200 ha (544 ac). Because of uncertainties in habitat quality assessments for the various proposed alternative sites, and because long-term variations in food supply may require larger territories, a median breeding territory size of 400 ha (988 ac) was used in calculations of habitat carrying capacity.

Foraging habitat was defined as all vegetation classes in which 'alalā have been observed since 1970, excluding roadside and coastal sightings of wandering birds. Native-dominated, invaded, and alien-dominated areas were included. Based on current observations of 'alalā foraging, in which birds only rarely venture below 610 m (2000 ft) elevation, only foraging habitat above that elevation was mapped. Although foraging areas may be important to 'alalā as seasonal sources of food, they appear to lack some attributes that are necessary for a successful reproductive territory. Again, the areas of foraging habitat shown on maps represent conditions in 1976, and may have changed in nature or extent since that time.

2.2 FEATURES COMMON TO ALL ALTERNATIVES

Establishing and operating a release program at any of the alternative sites would take place in several stages. These are pre-release preparation of the site including habitat management actions and infrastructure, the release of 'alalā, and tracking, monitoring and manipulation of the released birds. Because reintroduction sites are intended to help establish and maintain a population of 'alalā in the long term, habitat management activities, as well as 'alalā management, can be considered ongoing activities once initiated.

This section gives an overview of the activities that would be carried out at any of the alternative release sites. The exact scale, extent and cost of these activities cannot be specified in advance because they will be partly determined by the site itself (e.g., topography, vegetation, predator density) and partly by features of the release program (e.g., number of 'alalā available for release per season, foraging range of release cohorts, mortality rates and causes). Site characteristics that would affect a release program, as well as actions that would be specific to each of the proposed alternative sites, are described in Section 2.3: Alternatives Under Consideration. Features of each site that would potentially be affected by the activities of a release program are presented in Chapter 3: Affected Environment.

Figure 2

2.2.1 Pre-release site preparation

Pre-release preparation of a site is intended to establish a safe working environment for the field crew, to prepare the area for habitat restoration activities, and to reduce the number of mammalian predators in the area. Preliminary activities would include flagging and mapping trails, mapping prominent landmarks and vegetation types, and identifying territories of 'io. Establishment of a primitive campsite would be necessary if no nearby shelter exists.

Hacking locations would be chosen in appropriate, dense vegetation, and one or more hack towers would be constructed. These are temporary, movable wooden and steel structures that allow young 'alalā to gradually acclimate to the forest and that serve as feeding stations until the birds are weaned to available wild foods.

Because the 'alalā has disappeared from all but one small part of its former range, it would be imprudent to release 'alalā back into formerly occupied areas without attempting to control the factors suspected of causing that decline and extirpation. Habitat management activities at the release site would attempt to reduce the risks to 'alalā of predation and disease, and to halt and reverse the decline of plant community integrity. Similar, wider-scale efforts in areas adjacent to the release sites would increase the probability of a released population's survival and growth.

To be maximally effective these habitat management activities should begin well before the release of 'alalā. For example, to reduce the prevalence of toxoplasmosis in an area probably requires that cats be absent for many months, due to *Toxoplasma gondii*'s persistence in tissues of potential 'alalā prey (T. Work, BRD, pers. commun., 1999). Similarly, restoration of understory vegetation damaged by feral ungulates is a slow process which is impeded while significant disturbance by ungulates continues (Stone *et al.* 1992).

Although 'io predation appears to have been a significant mortality factor in the release program to date, the agencies consider it impractical and potentially counterproductive to attempt to reduce local 'io populations at release sites. Experimental relocation of territorial 'io has been attempted, did not succeed, and in one case actually increased local 'io density (DOFAW and USFWS, unpubl. data). Reduction of 'alalā mortality from 'io will be attempted through careful site selection, maintenance of good physical condition in released 'alalā, forest restoration activities, and potentially through behavioral modification of 'io resident near the release site. Temporary capture and holding of resident 'io might be considered in order to protect an 'alalā nest during the breeding season. A long-term possibility is to reduce the prey base for 'io (e.g., rats, kalij pheasant [*Lophura leucomelana*]) and thus to reduce the density of 'io in the release area. This would ideally occur prior to 'alalā release to avoid a shift to 'alalā as prey.

Alien predator control

Cats and mongoose could be controlled in a limited area with a grid of baited traps centered on the hack site, with additional cat traps located along roads and trails into the area. Based on

previous studies in Hawai'i (G. Lindsey, and T. Casey, Kamehameha Schools/B.P. Bishop Estate, unpubl. data), a grid appropriate for predator control around an 'alalā release site would be 600 meters square (36 ha, 89 ac), and consist of 16 cat and 8 mongoose traps. Because feral pigs often disturb these traps (K. Clarkson, USFWS, pers. commun., 1999), removal of these ungulates from a trapping area is necessary for a successful trapping program, in addition to being needed for forest understory recovery.

If approval is obtained for use of toxic baits within 'alalā habitat, more effective and efficient rat and mongoose control would be possible, either through the use of bait stations, which is less labor-intensive than maintaining a grid of traps, or through hand or aerial broadcast techniques. Rat control using live or kill traps is not feasible over large areas of Hawaiian forest (G. Lindsey, pers. commun., 1998), so without approval to use poison bait stations, rat control would probably be limited to areas around nest trees and other small areas where 'alalā are vulnerable.

Efforts to develop the best possible methods for controlling introduced mammalian predators in Hawai'i's forests have been underway for several years. The Toxicant Working Group, made up of members of several governmental agencies, private conservation organizations, and private landowners in Hawai'i, gained approval in 1994 for the use of diphacinone bait blocks in bait stations in Hawai'i's forests. However, the baits have not been used in 'alalā territories due to the fear of secondary poisoning (i.e., 'alalā consumption of poisoned carrion). Studies conducted since that time indicate that there is little to no risk of such secondary poisoning in crows (Massey *et al.* 1997) and steps are underway to gain approval for the use of bait stations in current and potential 'alalā release sites. While the use of bait blocks in bait stations has been proven very effective in many areas of Hawai'i, there is an urgent need for the development of better methods for toxicant dispersal over larger areas.

With limited financial resources for endangered species conservation, better and more efficient methods of expanded habitat management are currently being developed. A broad-scale delivery of rodenticide is currently being examined as the most cost effective and efficient method for controlling predators over large remote areas. Preliminary studies have been conducted (T. Casey, unpubl. data.), and are continuing (USDA 1999), to determine the potential of this strategy for use in Hawai'i. The aerial broadcast of rodenticides is a strategy that has been used in New Zealand for the past 20 years with outstanding success in eliminating predation on ground nesting birds (Morris and Smith 1988). The estimated minimum time that it will take to complete the field studies needed to support an application for aerial broadcast of rodenticide and for the United States Environmental Protection Agency's processing and approval of the application is two years.

Habitat restoration

Restoration of understory plants needed by 'alalā for food and shelter would require site-specific strategies, and cost estimation would require a detailed analysis. In general, restoration would require control of feral ungulates to low levels, control of aggressive alien weeds, and possibly

propagation and outplanting of selected plants native to the area. In some of the proposed release sites, fencing, feral ungulate control and weed control are already in place or planned, while in others appropriate areas would have to be identified, fenced, and ungulates driven out or otherwise removed. Pigs and sheep are known to be important reservoirs for *Toxoplasma gondii* (Dubey 1994), so any lethal control of feral ungulates within a release area should be conducted prior to beginning the release program in order to insure that 'alalā will not feed on infected carrion. Ungulate carcasses are also a source of bacterial infections that have proven fatal to released 'alalā. Because ungulate-disturbed areas are often invaded by weedy alien plants when ungulates are removed, some ongoing investment in weed control will probably be necessary to improve the habitat for 'alalā.

Hunting could cause mortality of 'alalā directly, by accidental shooting, or indirectly if 'alalā scavenge the carcass of a shot bird or mammal. Scavenging could expose 'alalā to toxoplasmosis or pathogenic bacteria from infected tissue, or to toxic lead from bullet fragments or shot, known to cause mortality in other scavenging birds. To inform hunters about the 'alalā and the program, educational materials would be provided to hunting clubs and would be available at check-in stations. Later in a release program, when 'alalā have set up breeding territories, temporary closures of sensitive areas during breeding season might be necessary because gunfire near active nests could cause nest abandonment (P. Banko, BRD, pers. commun., 1999).

2.2.2 Release activities

Release of 'alalā involves transport of young birds to the release site, acclimating them in hacking towers, the actual hacking or release, and weaning the released birds onto the natural foods they find by foraging. Current practice is to release 'alalā in small groups of three to five birds. The process takes approximately 8 weeks, usually beginning in October or November (P. Harrity, pers. commun., 1998). Natural food plants are collected near the hack site and fed as a supplement to the birds in the hack boxes prior to release. Released 'alalā usually stay together as a group, or cohort, as they forage and become familiar with the habitat. Home range sizes for released cohorts at McCandless Ranch have been as small as 250 ha (620 ac) and as large as 1500 ha (3700 ac; USFWS, unpubl. data), depending on time since release, season, and other factors.

If more than one group of 'alalā were to be released at a site during a season, they would probably be hacked at well-separated locations so that the foraging areas of the birds would overlap less and the groups would be less likely to compete for food or space.

The frequency of releases at a site and the number of 'alalā released per season cannot be specified at this time. Timing and size of releases at a particular site would depend on output of the captive breeding facilities and wild nests, number of release sites available, and available habitat capacity at each release site. Releases at a site would likely continue until natural reproduction of 'alalā was sufficient to offset mortality, and the local 'alalā population was either growing or stable at a level that was viable over the long term.

2.2.3 Tracking, monitoring and manipulation of released ‘alalā

All released ‘alalā are currently given unique leg bands and fitted with backpack radio transmitters that allow the birds to be periodically located and observed. The ability to locate and identify foraging birds and recover sick or dead birds, at least in the initial stages of population establishment, is crucial to determining management priorities and corrective actions. For example, the major roles of ‘io, toxoplasmosis and opportunistic infections in ‘alalā mortality would be unknown without radio tracking. Because the causes of ‘alalā population decline may be different in different habitats, sick or dead ‘alalā must be recovered in order to generate the information needed for reestablishment of populations, as well as to maximize individual survival. When release cohorts become large, or significant natural reproduction occurs, the proportion of birds carrying transmitters may be reduced. At approximately yearly intervals, released ‘alalā have been recaptured, given a health check, and fitted with a fresh battery-powered transmitter.

Supplemental feeding is a potential management tool that could be used to enhance the physical condition of ‘alalā during periods when wild food is not abundant, and possibly to keep ‘alalā resident in an area of managed habitat that they might otherwise temporarily abandon in the search for seasonal food resources. Feeding stations, if established, could also be used to lure ‘alalā to a scale so their weight and physical condition could be monitored.

When released ‘alalā form pairs and begin nesting, if broader scale predator control has not yet been implemented, such measures would be established within the territory in order to minimize losses of eggs or young. To increase the reproductive output of ‘alalā pairs, at least the first clutch of eggs is usually collected for incubation and rearing in a captive propagation facility. ‘Alalā will then typically lay another clutch. This nest manipulation and “double-clutching” will be needed in the foreseeable future in order to generate the maximum number of young ‘alalā for release.

2.2.4 Involvement of neighboring landowners

The areas of forest that will be used for foraging, and eventual nesting, by released ‘alalā cannot be predicted with certainty. At most of the proposed alternative release sites, monitoring and observation of wide-ranging released ‘alalā, as well as recovery of dead or injured ‘alalā, will be greatly facilitated if field personnel have access to private lands beyond the limit of the publicly owned release area. For this and other reasons, landowners adjacent to potential release sites are considered key partners in the proposed action and in the recovery of the ‘alalā. A formal cooperative agreement could be used to specify the terms and conditions of access to the lands of the private partner. Safe Harbor Agreements (SHAs), discussed in more detail in Chapter 4, are a potential vehicle for such public-private cooperation, and remove much of the regulatory burden from landowners who choose to participate in endangered species recovery.

2.3 ALTERNATIVES UNDER CONSIDERATION

Six alternatives are currently under consideration for the proposed action. Five of these alternatives represent possible release sites on the island of Hawai'i (Fig. 3) in addition to the current release site; the sixth is a "no action" alternative that would involve no 'alalā releases outside of the current release area in central Kona.

2.3.1 Alternative 1: Release of 'alalā at the Pu'u Wa'awa'a Forest Bird Sanctuary.

Physical and biological characteristics of the area

The 1541-ha (3806-ac) Pu'u Wa'awa'a Forest Bird Sanctuary is located in the North Kona district between 1200 and 1900 m (4000 to 6200 ft) on the northern slope of Hualālai (Fig. 4). The Sanctuary is characterized by steep (30% slope), undulating topography beginning at about 1200 m (4000 ft) with a dry to mesic forest of 'ōhi'a and koa and is dominated by an understory of grass and native shrub. The Sanctuary extends upward to approximately 1950 m (6400 ft), becoming a dry native shrub/'ōhi'a forest. Average rainfall for the area ranges from 1200 mm (47 in) per year at low/mid elevation and decreases to 750 mm (29 in) per year in the drier high elevations (Fig. 5). The understory is dominated by alien grasses with small native shrubs and trees ('ōlapa, *Cheirodendron trigynum*; māmaki, *Pipturus hawaiiensis*; pilo, *Coprosma* spp.; 'ōhā wai, *Clermontia* spp.) beginning to recover after protection following several decades of cattle grazing (J. Giffin, DOFAW, pers. commun., 1999). A complete description of the area, including a checklist of native plants and animals, is available (DLNR 1996).

Portions of Pu'u Wa'awa'a have been used for cattle grazing for over 100 years. The State of Hawai'i removed the Sanctuary from grazing lease in 1984 for the conservation of forest birds, including 'alalā. Cattle were removed from the Sanctuary in 1985 in order to increase its habitat value for native birds and plants. Parts of the Sanctuary were logged for koa by the former tenant prior to 1984 (J. Giffin, pers. commun., 1999). The eastern one-quarter of the Sanctuary was burned by wildfire in 1995 (P. Conry, DOFAW, pers. commun., 1999), reducing its carrying capacity for native forest birds.

Hualālai represents the northern limit of the historical range of the 'alalā, and the Sanctuary area was the core of the population on the mountain in 1978 (Scott *et al.* 1986). In the past, wild 'alalā were known to move seasonally from the dry north side of Hualālai near the Sanctuary to the wetter west and south sides of the mountain in response to changing food resource availability (Giffin *et al.* 1987). In addition, 'alalā observed at Kīpuka 'Alalā in the Hualālai-Mauna Loa saddle in the late 1970s were assumed to have been Hualālai residents (Scott *et al.* 1986). In the 1970s, nests were recorded on both the north and southwest sides of the mountain. 'Alalā last nested in the Sanctuary in 1982. No 'alalā have been reliably reported from Hualālai since 1991 (Duckworth *et al.* 1992).

The Sanctuary was surveyed for forest birds in 1978 (Scott *et al.* 1986), 1990 and 1991 (DLNR 1996). Several native forest birds (amakahi, *Hemignathus viriens viriens*; 'apapane, *Himatione sanguinea*; i'iwi, *Vestiaria coccinea*; 'elepaio, *Chasiempis sandwichensis sandwichensis*) are common within the Sanctuary. A small population (less than 50 individuals) of 'ōma'ō (*Myadestes obscurus*) now occur within and adjacent to the Sanctuary as a result of reintroductions undertaken by TPF and researchers from BRD in 1996 (J. Nelson, BRD, pers. commun., 1998) and subsequent reproduction. Numbers of endangered birds (Hawai'i creeper, *Oreomystis mana* and 'ākepa, *Loxops coccineus coccineus*) are apparently declining (DLNR 1996).

The Sanctuary was also examined for suitability as a release site in 1995 by members of the ART. Overall, it was characterized as having a heavily disturbed understory and mid-canopy, and a poor diversity of foraging plants of the proper age structure. Based on native vegetation qualities, native invertebrate densities were similarly assumed to be low, although collections show at least 95 endemic insect species are present (J. Giffin, unpubl. data.). Much of the food available to 'alalā within the Sanctuary (estimated over 75%; J. Giffin, J. Klavitter, USFWS, pers. commun., 1998) is the fruit of banana poka (*Passiflora mollissima*), an invasive alien vine that is the target of control measures throughout the island and can be spread by frugivorous birds. Banana poka is found throughout the area and in some cases is smothering the 'ōhi'a canopy as well as the understory plants (J. Giffin, pers. commun., 1998). Banana poka produces fruit year round with a minor peak in production during the wetter winter months (LaRosa 1984). Due to the current lack of food plant diversity, banana poka is likely to become an important food resource for any released 'alalā. Biocontrol agents for banana poka have been released in the Sanctuary, and other control actions for this vine, as well as for invasive silk oak (*Grevillea robusta*), are ongoing within the Sanctuary.

High numbers of alien predators (rats and mongoose) were trapped within the Sanctuary during the 'ōma'ō translocation by BRD in the spring and fall of 1996 (J. Nelson, pers. commun., 1998). Feral cats were not trapped or seen within the area during the time the study was conducted, although cats are associated with residences in the Kaloko Mauka subdivision to the south. State personnel report seeing feral cats often within the Sanctuary (J. Giffin, pers. commun., 1998). Approximately 25 'io are thought to be resident within a 7000 ha (17,000 ac) area which includes the Sanctuary, and tend to hold territories near the lower boundary of the forest (USFWS, unpubl. data).

Feral pigs are abundant within the Sanctuary (J. Burgett, USFWS, pers. obs.). Moderate densities of game birds (kalij pheasant; Erkel's francolin, *Francolinus erkelii*; turkey, *Meleagris gallopavo*) are found within the Sanctuary (J. Giffin, pers. commun., 1998).

Figure 3

Figure 4

Figure 5

Avian disease levels were monitored within the Sanctuary in January and November of 1994. Of 206 blood samples drawn from native forest birds only two (<1%) were found to be positive for malaria and three (1%) were found with active pox lesions. Based on these findings it is believed that avian disease levels are very low within the Sanctuary area (G. Massey, DLNR, pers. commun., 1998).

The proposed release site is in the core of the Sanctuary (Fig. 4) and includes the most intact koa-‘ōhi‘a forest on Hualālai. The boundaries of the proposed release site encompass approximately 200 ha (490 ac). The area previously was chosen as a release site for ‘ōma‘o because it contained the best vegetation structure in the Sanctuary (J. Nelson, pers. commun., 1999). As shown in Figure 5, in 1976 most of the Sanctuary consisted of potential nesting habitat, although invaded by alien vegetation to some extent. Potential foraging habitat surrounds the Sanctuary and is widely distributed on Hualālai and in the Hualālai-Mauna Loa saddle area, although much of this habitat is heavily invaded with alien vegetation.

Based on the food resources and size of the unburned contiguous forest in and adjacent to the Sanctuary (Table 1), it is estimated that 4 pairs of ‘alalā could hold territories there. The release site itself is too small to contain a nesting pair. The ultimate potential number of breeding pairs in North Kona is difficult to estimate due to uncertainties regarding the present and future extent and quality of nesting habitat. For example, recent reassessment of the Honua‘ula Forest Reserve indicated substantial alien plant invasion since 1976, to the extent that some areas depicted as native-dominated in the 1976 data are now dominated by non-native plants (DLNR 1998a). Other areas have been more visibly altered: satellite imagery taken in 1994 (SPOT 1994) shows that approximately 800 ha (1980 ac) of the nesting habitat south of the Sanctuary had been converted to non-forest vegetation types, representing a 10% loss of total nearby nesting habitat in 18 years (Table 1). These changes are not depicted in Figure 5. However, if the nearby nesting habitat shown in Figure 5 was on the average the same quality as in the Sanctuary, the total area considered accessible to ‘alalā released at the Sanctuary (7531 ha; Table 2) could hold 18 breeding pairs.

Control of limiting factors

Prior to beginning a release program at this site, it would be necessary to integrate ‘alalā habitat management needs with the existing management plans for these lands (DLNR 1985) and the proposed management of the ahupua‘a (land section) of Pu‘u Wa‘awa‘a (TNCH 1998). These management plans call for use of pulse-grazing by cattle to help control alien grasses and vines, with the goal of encouraging regeneration of a native forest understory and reducing fire risk. Pulsed grazing of cattle within the Sanctuary could interfere with predator trapping, and affect revegetation rates and other activities. A new perimeter fence and access road around the Sanctuary are being constructed which will make feral ungulate removal and domestic cattle management feasible (DLNR 1996; T. Lum, DOFAW, pers. commun., 1999).

Five fenced exclosures for the protection and outplanting of rare plants, totalling less than 0.2 ha

(0.5 ac), presently exist within the forested part of the Sanctuary. The proposed multi-use plan (TNCH 1998) includes expansion of ungulate exclosures around remnant native vegetation within lower-elevation grazing areas of Pu‘u Wa‘awa‘a Ranch.

As a State Wildlife Sanctuary dedicated to native bird conservation, few structural impediments exist to management of threats to ‘alalā. Predator trapping has previously been conducted, and rehabilitation of native vegetation is a management priority (DLNR 1985). However, the relatively degraded state of the understory vegetation suggests that many years of active management may be needed to significantly improve the foraging habitat within the Sanctuary. Banana poka control is another complex issue. Control of this vine is a priority for management within the Sanctuary, creating a potential conflict between weed management and ‘alalā recovery needs if the Sanctuary were to be a release site.

The Sanctuary is bordered on the north and east by State lands used for ranching and for plant restoration, gathering and game management, respectively. A cooperative game management and hunting program exists on the State lease ranch lands. Educational materials for hunters using these game management areas, as well as residents of the Kaloko Mauka subdivision, would be needed to explain the release program and to help ensure that ‘alalā would not be confused with game birds.

Due to the limited size of the Sanctuary, the proximity of other forested lands, and the seasonality of food resources at this site, ‘alalā can be expected to wander outside of the Sanctuary as they did historically. Generally movements occurred within an altitude band of about 1070-1930 m (3500-6500 ft) elevation. However, dispersal from the Sanctuary could expose ‘alalā to mortality factors that cannot easily be controlled outside of State lands. These include predators, especially feral cats and domestic cats associated with residences, and shooting. If a release program were to be initiated and mortality rates outside the Sanctuary proved excessive, supplemental feeding could be used in an attempt to hold birds in the release area year-round. However, this would severely limit the size of a released population and might have negative effects on the birds’ social behavior and survival, due to potential risks of disease transmission and predator exposure.

Release and monitoring logistics

Access to the Sanctuary is over roads through Pu‘u Wa‘awa‘a Ranch that are open to government vehicles. No public access to the Sanctuary is currently authorized except during occasional, controlled hunts. Infrastructure associated with the 1996 reintroduction of ōma‘o includes two elevated hacking boxes, marked survey transects, and a primitive camp area. Perimeter and internal roads provide access to the proposed release site, campsite and all sides of the Sanctuary. Just inside the Sanctuary are a State cabin for management personnel and additional fenced exclosures for rare plant propagation. Both cellular phone and VHF radio reception are good (J. Giffin, pers. commun., 1998).

The Sanctuary is bordered on the east and north by State lands used for game management and ranching, respectively. Although project personnel would have unlimited access to these lands, only small areas of 'ālalā habitat occur there. To the west and south are private lands zoned for conservation and agriculture. The nearest residential area is the upper section of the Kaloko Mauka subdivision (Fig. 4), approximately 4 km (2.5 mi) from the proposed release site and 3 km (1.8 mi) from the boundary of the Sanctuary. This area appears as potential nesting habitat in Figure 5, and in fact several nests of 'ālalā were recorded within one km (0.6 mi) of upper Kaloko Drive in the mid-1970s (USFWS, unpubl. data). In addition to the many private parcels within the subdivision, large private landholdings adjacent to the Sanctuary contain forests that were used by 'ālalā in the recent past, and which might attract 'ālalā released at the Sanctuary. With the exception of Kaloko Drive and the roads of Pu'u Wa'awa'a Ranch, all access roads to potential nesting habitat within 5 km (3 mi) of the release site are over private lands. Agreements granting access by project personnel to private lands would make it much easier to monitor the health and activity of released 'ālalā and to recover quickly any ill or injured birds or carcasses.

Over time, 'ālalā released at the Sanctuary could establish nesting territories in suitable habitat elsewhere on Hualālai and in North Kona (Fig. 5). However, the amount of suitable habitat is declining. Between 1976 and 1994, satellite images show that approximately 800 ha (1980 ac, or 10%) of potential nesting habitat was converted to non-forest (Table 1, footnote 7). All of the affected lands were outside of the Conservation District. Of the total remaining nesting habitat considered accessible to 'ālalā released at the Sanctuary (7531 ha, Table 1), approximately 53% (3970 ha) consists of private lands or State lease lands outside the Conservation District. This underscores the importance of private landowners to the long-term success of a reintroduction program at the Sanctuary.

In the long term, strong feral ungulate control will be necessary within nesting habitat on Hualālai to prevent a continued decline in the capacity of the North Kona forests to support breeding pairs of 'ālalā. If management of upper-elevation private and State lands were to focus on maintaining or increasing habitat quality for forest birds, a small but significant population of 'ālalā might be maintained in North Kona.

Table 1. Nesting Habitat Available at Each Potential Release Site ¹						
Alt.	Potential Release Site	Contiguous nesting habitat (hectares) ²		Additional nearby ³ habitat (hectares)		Total
		Native ⁴	w/ Invaded ⁵	Native	w/ Invaded	
1	Pu'u Wa'awa'a	0	1652 ⁶	3150	5879 ⁷	7531
2	Honomalino	1695	3458 ⁸	303	839	4297
3	Kapāpala	2273	3043	5621	6509 ⁹	9552
4	Kūlani	2520	2520	5850	6266	8786
5	Hakalau	0	3003 ¹⁰	961	2285	5288
6	McCandless (no action)	1748	11596 ¹¹	3041	4450	16046

1) Vegetation data from Jacobi 1989, based on aerial photos taken 1976; both understory recovery in fenced areas (Hakalau, Kūlani, Pu'u Wa'awa'a) and further invasion in unfenced areas is likely.

2) Hectares x 2.471 = acres

3) Nearby habitat: No gap in native forest cover > 1 km, no highway crossing.

4) Native: native tree canopy and understory vegetation

5) Invaded: native tree canopy, understory partially to nearly all alien vegetation

6) Approximately 1/4 burned in 1995. Original area 2022 ha x 0.75 = 1652 ha

7) 6681 ha reduced by 802 ha shown by satellite imagery to be non-forest in 1994. 10% drop in total area.

8) 4061 ha reduced by 603 ha shown by satellite imagery to be non-forest in 1994. 12% drop in total area.

9) 8454 ha reduced by 1945 ha shown by satellite imagery to be non-forest in 1994. 17% drop in total area.

10) 4038 ha reduced by 1035 ha shown by satellite imagery to be non-forest in 1994. 16% drop in total area.

11) 12471 ha reduced by 875 ha shown by satellite imagery to be non-forest in 1994. 5% drop in total area.

2.3.2 Alternative 2: Release of 'alalā at Honomalino Section, South Kona Forest Reserve

Physical and biological characteristics of the area

The 1173 ha (2900 ac) Honomalino Section (Honomalino) is unencumbered State land being managed as part of the South Kona Forest Reserve and is located in the South Kona district. It extends up the slope of Mauna Loa from the Belt Highway at approximately 460 m to 1100 m (1500-3600 ft; Fig. 6). Two other State conservation areas are nearby: Kipāhoehoe Natural Area Reserve (NAR) is 3.2 km (2 mi) to the north, and Manukā NAR is 2.6 km (1.6 mi) to the south.

Annual rainfall is 1500-2000 mm (60-80 in, Fig. 7). Vegetation in the lower extension, below approximately 760 m (2500 ft) is dominated by non-native species. The proposed release area (Fig. 6) is characterized by moderately steep (13% slope), undulating topography beginning at about 820 m (2700 ft) with mainly wet 'ōhi'a forest extending into a small belt of mesic 'ōhi'a forest at the upper elevation of about 1100 m (3600 ft). The forest is fragmented into three areas by a sparsely vegetated recent lava flow. The forest understory is dominated by a limited

diversity of native trees and shrubs such as ōlapa, kōlea (*Myrsine* spp.), māmaki, and hō‘awa (*Pittosporum* spp.) from 1070-1100 m (3500-3600 ft), which appears to further decrease in diversity between about 820-1070 m (2700-3500 ft). From about 820-1100 m (2700-3600 ft) ‘ie‘ie (*Freycinetia arborea*) is a common forest component (USFWS, unpubl. data). Guava (*Psidium guajava*) occurs from about 820-1100 m (2700-3600 ft) in elevation and a *Passiflora* species appears periodically between 970 m and 1100 m (3200-3600 ft; USFWS, unpubl. data). Honomalino was only recently removed from grazing use, and the understory was impacted by cattle for decades, as well as by feral pigs (H. Horiuchi, DOFAW, pers. commun., 1999). Extensive logging of koa has occurred on the private lands surrounding Honomalino, and continues to some extent today, as does silvicultural planting of koa. Adjacent lands below 900 m (3000 ft) have been converted to agriculture.

The South Kona area around Honomalino held one of the last subpopulations of ‘alalā. The potential release site apparently contained a single nesting pair of ‘alalā in the late 1970s (Scott *et al.* 1986), and ‘alalā were heard there as recently as 1987 (USFWS 1998). A survey in 1995 did not detect ‘alalā in the area (USFWS, unpubl. data).

Native forest birds (‘amakihi, ‘apapane, i‘iwi, ‘elepaio) are present in moderate numbers within the proposed area (Scott *et al.* 1986). Although ‘ākepa are recorded from the site within the last 25 years, observers did not record this species or any other endangered birds while on transects in the proposed area in 1995 (USFWS, unpubl. data). No data on population trends of native birds at Honomalino are available.

Honomalino was examined for suitability as a potential release site in 1995 by some members of the ART. It was characterized as having a broken understory and mid-canopy, and a fair diversity of foraging plants of the proper age structure. Based on native vegetation qualities, native invertebrate populations were similarly assumed to be at moderate levels. Based on the abundance of non-native fruiting plants (e.g., guava, *Passiflora* sp), especially in the lower elevations, it is estimated that 10-25% of the food available to ‘alalā would be from these plants.

No estimates of alien predator (rats, cats, and mongoose) numbers have been made for Honomalino, but populations are likely to be high based on densities found by the USFWS crew releasing ‘alalā at the nearby McCandless Ranch (USFWS, unpubl. data). The adjacent macadamia nut orchard to the south has an ongoing rat control program that may reduce rat densities within the Reserve.

‘Io were seen between 820-1280 m (2700-4200 ft) by observers walking transects within the area during a 1995 survey for ‘alalā (USFWS, unpubl. data). A current research project to determine ‘io population, demography, and reproductive success throughout the island (J. Klavitter, unpubl. data) only sampled areas of South Kona well below this potential release site. However, the many edges of native forest in contact with open vegetation and agriculture appear to be ideal habitat for ‘io. Therefore the density of ‘io in Honomalino is assumed to be high.

Feral pigs are present in moderate numbers and are likely to be increasing (J. Giffin, pers. commun., 1999). Pigs are currently interfering with a rare plant restoration program, periodically rooting out or eating newly outplanted plants (H. Horiuchi, pers. commun., 1999). Feral cattle were observed during the 1995 survey. Densities of game birds are unknown. No avian disease surveys have been conducted, but the combination of lower elevation and feral pig presence suggests that mosquitoes are abundant. A high level of avian disease is therefore assumed to be present at Honomalino (C. Atkinson, BRD, pers. commun., 1998).

The proposed release site is in the upper half of the State parcel, and encompasses approximately 770 ha (1900 ac). About one-third of this area may represent native-dominated nesting habitat (Fig. 7). Although the proposed release area could potentially hold two pairs of 'alalā, it is unlikely that they could be kept entirely within the State boundary. Without a mesic koa and dry forest component it is likely that the 'alalā would search seasonally (moving upslope) in response to changing food resources.

Most of the nearby nesting habitat in the area is upslope of the State parcel, but has been variously impacted by grazing and koa logging. Satellite imagery taken in 1994 (SPOT 1994) shows that approximately 600 ha (1480 ac) of upper elevation forest delineated in 1976 had been partly or completely converted to non-forest vegetation types, representing a 12% loss of potential nesting habitat in 18 years. Forest clearing and feral ungulate activity continue to degrade nearby habitat, but because some large-scale conservation activities are occurring on the two nearby NARs (W. Stormont, DOFAW, pers. commun., 1999), trends in habitat quality in the area surrounding Honomalino are not uniformly downward.

The total area of nesting habitat accessible to 'alalā released at Honomalino is approximately 4300 ha (10,600 ac), which might support up to 10 pairs. However, the fact that much of the potential habitat is in isolated kīpuka (vegetated islands of older forest surrounded by younger lava flows) might lower its value to 'alalā, and thus the ultimate capacity of the area. It might eventually be possible for an expanding 'alalā population established from Honomalino to link with 'alalā from the forests of central Kona to the north.

Control of limiting factors

Access to Honomalino is through privately owned roads. Prior to establishment of a release site, a partnership with these landowners and others adjacent to Honomalino would need to be formed to ensure access to the site and the ability to track and recover released 'alalā. Because of the landlocked nature of Honomalino and the high probability that 'alalā would move onto private lands, the feasibility of this alternative would depend on obtaining access rights to private lands.

In addition, any release program would need to be integrated with potential competing public uses of the State parcel and with a proposed plan for sustainable koa logging and silviculture in the area surrounding Honomalino FR (K. Hum, The Nature Conservancy of Hawai'i (TNCH), pers. commun., 1999). This latter plan would involve lands directly upslope and adjacent to

Figure 6

Figure 7

the potential release site, underscoring the need to closely match any proposed management actions in the area.

No area fencing or habitat management infrastructure is in place, although a State cabin and small rare plant exclosures are on site. Prior to initiation of a release program, surveys of weeds, ungulates and predators would be necessary in order to plan control programs to enhance habitat value for 'ālalā. Fencing of the high-quality forest would probably be necessary to control feral pigs and improve understory vegetation. Public hunting is presently not permitted at Honomalino, primarily due to access issues (J. Giffin, pers. commun., 1999). However, game animal management plans propose that Honomalino be opened for public hunting (DLNR 1998b). Any potential conflicts with the needs of an 'ālalā release program would need to be resolved.

Because of the contiguous nature of the forest and the small size of the proposed release area, released 'ālalā can be expected to wander outside the State lands. Forest recovery actions by TNCH in the forest directly upslope from Honomalino could create an expanded area managed for native bird recovery. If a release program were to be initiated and mortality rates outside the State parcel proved excessive, supplemental feeding could be used to hold birds in the release area. However, this would severely limit the size of a released population and might have negative effects on the birds' social behavior and survival, due to potential risks of disease transmission and predator exposure.

In the long term, strong feral ungulate control and restoration of degraded forest will be necessary to prevent a continued decline in the capacity of the South Kona forests to support breeding pairs of 'ālalā. If restoration of understory vegetation is included in koa silviculture efforts, foraging and even nesting habitat for 'ālalā near Honomalino could increase in the coming decades.

Release and monitoring logistics

No publicly owned roads provide access to the proposed release site, surrounding lands, or the adjacent NARs. DOFAW has a legal easement over private lands for management purposes. Using this access route, potential hacking sites are accessible by truck. Because of the current lack of public access, human disturbance of the release site could be controlled.

A base camp area could be established on site. Cellular phone reception in the area is poor, so release personnel would need VHF radios to communicate.

In the area surrounding Honomalino, a relatively sparse road network on private lands provides access to forested lands (Fig. 6). A large forest block at the southeast corner of Honomalino is roadless. All access roads to potential nesting habitat within 5 km (3 mi) of the release site are over private lands. Agreements granting access by project personnel to private lands would make it much easier to monitor the health and activity of released 'ālalā and to recover quickly

any ill or injured birds or carcasses.

Because of its limited size, use of this release site for 'alalā reintroduction would likely be dependent on cooperative agreements with neighboring landowners. A mixed land use plan for the area has been proposed by TNCH, similar in some respects to that proposed at Pu'u Wa'awa'a, that includes sustainable koa forestry (K. Hum, pers. commun., 1999). Such a plan might allow expansion of an 'alalā population with minimal conflicts. Establishment of Safe Harbor Agreements (see Chapter 4) would likely be important elements in such a plan.

The total amount of potential nesting habitat in South Kona is declining. Between 1976 and 1994, satellite images show that approximately 600 ha (1490 ac, or 12%) of potential nesting habitat was converted to non-forest (Table 1, footnote 8). Almost all of the affected lands were outside of the Conservation District. Of the total nesting habitat considered accessible to 'alalā released at Honomalino (4297 ha, Table 1), approximately 78% (3342 ha) consists of private lands or State lease lands outside the Conservation District. A public-private partnership of agencies and landowners would be essential for the success of a reintroduction program at Honomalino.

The nearest residential area is directly downslope from the northern end of Honomalino, approximately 1 km (0.6 mi) from the State parcel boundary. Hawaiian Ocean View Estates, a large subdivision, is approximately 5.5 km (3.4 mi) to the south. Neither area contains significant nesting habitat.

2.3.3 Alternative 3: Release of 'alalā at Kapāpala

Physical and biological characteristics of the area

The area being considered as a release site ("Kapāpala") is approximately 1560 ha (3850 ac) in size and is located on the eastern slope of Mauna Loa in the district of Ka'ū (Fig. 8). It encompasses parts of the State owned Kapāpala FR, Ka'ū FR, and the Koa Management Area, from 1100 to 1800 m (3700 to 6000 ft) elevation. Private agricultural lands border the lower edge of the Ka'ū FR, and State and private lands used for grazing border its upper edge and the Koa Management Area and Kapāpala FR. The southern edge of Hawai'i Volcanoes National Park is approximately 8 km (5 mi) to the northeast.

Kapāpala is characterized by moderately steep to steep (13-22% slope), undulating topography beginning at 1070 m (3500 ft) with mesic koa/'ōhi'a forest extending southward into wet koa/'ōhi'a forest. As the Ka'ū FR extends southwest it is dominated by a wet 'ōhi'a forest. At the highest elevation at the proposed release site (about 1920 m or 6300 ft) a combination of dry 'ōhi'a and mesic 'ōhi'a forest forms a belt that borders mesic koa/'ōhi'a forest below. Average rainfall for the area ranges from 1250 mm/yr (49 in/yr) at the highest elevation to 2000 mm/yr (79 in/yr) at the lowest elevation (Fig. 9). At the north end of Kapāpala the understory is composed of scattered native trees and shrubs (ōlapa, pilo, kōlea, māmaki, *Clermontia* spp.,

‘ākala, *Rubus hawaiiensis*) with an understory dominated by native grasses. Further to the south (inside the Ka‘ū FR), the grass understory is replaced by a disturbed native shrub/tree fern understory.

The lands northeast of the Kapāpala site have been used for cattle grazing for decades. The State of Hawai‘i recently removed the Koa Management Area from grazing lease in order to experiment with sustainable koa forestry methods (P. Conry, pers. commun., 1998). Some selective logging of koa occurred along the boundary during road construction (J. Giffin, pers. commun., 1999).

No ‘alalā have been reported from this area since the early 1950s, although ‘alalā were seen in the late 1970s in the southern third of Ka‘ū FR (Scott *et al.* 1986, Banko and Banko 1980). No nests of ‘alalā have been reported from the area, possibly due to a lack of field work when the species was more abundant.

The Ka‘ū FR was surveyed by the USFWS for forest birds in 1978 and by DOFAW in 1995. Native forest birds (‘amakihi, ‘apapane, i‘iwi, ‘elepaio) are present in high numbers within the proposed release area (Scott *et al.* 1986). During an ‘alalā survey conducted in 1995 observers reported hearing and seeing ‘ākepa, Hawai‘i creeper, and ‘akiapōla‘au (*Hemignathus munroi*) at high elevations within the proposed release area (USFWS, unpubl. data). No data are available on trends in native forest bird abundance.

Kapāpala was examined for suitability as a potential release site in 1995 by members of the ART. It was characterized as having a broken understory and mid-canopy, and a fair diversity of foraging plants of the proper age structure. Based on native vegetation qualities, native invertebrate populations were similarly assumed to be at moderate abundance. Guava and banana poka were observed outside of the proposed release area, below about 970 m (3200 ft), during ‘alalā surveys in 1995 (USFWS, unpubl. data).

No estimates of alien predator (rats, cats, and mongoose) numbers have been made at Kapāpala, but populations are likely to be high based on densities found by the USFWS crew releasing ‘alalā in comparable forest at McCandless Ranch (USFWS, unpubl. data). Approximate densities of ‘io at Kapāpala are 0.008/ha (0.003/ac), suggesting that there are approximately 12 ‘io within the proposed release area (J. Klavitter, unpubl. data). These densities are similar to those at the current Kona Forest/McCandless Ranch release site.

Feral and escaped domestic cattle were removed from the Koa Management Area and the Kapāpala FR, and heavily culled in the northern end of the Ka‘ū FR, in the 1980s and early 1990s (J. Giffin, pers. commun., 1999). Feral pigs are present in high numbers in the Ka‘ū FR and to a lesser extent in the fenced Koa Management Area (H. Horiuchi, pers. commun., 1999). Kalij pheasants are the main game bird hunted within the area, but little is known about their population and distribution. No avian disease surveys have been conducted, but the similar elevation and feral pig abundance suggests that avian disease levels are similar to the high levels

found at McCandless Ranch (C. Atkinson, pers. commun., 1998).

The proposed release site includes the Koa Management Area and extends approximately 2.5 km (1.5 mi) into the Forest Reserves from the fenceline surrounding the Koa Management Area (Fig. 8). The boundaries of the proposed release site are approximate but encompass about 2100 ha (5200 ac). Although almost the entire area is covered in native-dominated 'ōhi'a or koa/'ōhi'a forest, much of this forest is classified into vegetation types not known to have supported 'alalā nesting or foraging. While those are therefore not classified as 'alalā habitat in Figure 9, it is the opinion of the ART that the vegetation is probably suitable for 'alalā, and that most of the mapped habitat "gaps" are largely due to the small numbers of 'alalā observations in the area.

As shown in Figure 9, only the eastern and western corners of the proposed release area appear to be suitable nesting habitat, and only a small portion of this is native-dominated. An additional one-third of the area appears to be suitable foraging habitat. The area is bordered by abandoned sugar cane plantations at the lower elevation and by dry native shrub/'ōhi'a forest at the highest elevation.

The proposed release area could hold 4-5 pairs of 'alalā, and the nesting habitat contiguous to the release site could hold perhaps 8 pair in total. Because the proposed release site is not distinct from the surrounding forest, released 'alalā would be expected to gradually diffuse into suitable habitat on public and possibly private lands remote from the release area.

Extensive areas of native-dominated nesting habitat exist within and above Ka'ū FR. The area of invaded nesting habitat south of Ka'ū FR (Fig. 9) no longer appears suitable for 'alalā, based on satellite imagery (SPOT 1994). This represents a loss of 17% of the potential nesting habitat in 18 years. The total area of nesting habitat accessible to 'alalā released at Kapāpala is approximately 9552 ha (23,600 ac), which might support up to 23 pairs. Because feral ungulate populations in the area are high, habitat quality for 'alalā is assumed to be declining.

Control of limiting factors

The reasons for the extirpation of 'alalā from Kapāpala are obscure; populations of other rare forest birds persist here, and no logging or commercial grazing has occurred in the Forest Reserves. Limiting factors contributing to the 'alalā's decline in this area may be similar to those found on McCandless Ranch: predation, disease, and perhaps food limitation (USFWS, unpubl. data). Possibly the conversion of low elevation forests to sugar cane and grazing land in the late 1800s restricted essential elevational migration of 'alalā. Limiting factors are likely still present, due to little forest recovery or active habitat management over the years.

Prior to beginning a release program at Kapāpala, management actions to control known limiting factors would need to be planned and integrated with existing and proposed activities at the site, which include hunting, gathering of native plants, and sustainable koa logging. Long-term forest recovery (i.e., an increase in food plant diversity, regeneration of understory and mid-canopy

Figure 8

Figure 9

forest cover, reduction of mosquito breeding habitat) will require that ungulate damage to vegetation be kept low over extensive areas and for a prolonged period. Invasive non-native plants are likely to continue to spread without ungulate reduction and without management personnel having access to areas currently in need of control.

The only conservation infrastructure near the potential release site is an ungulate-proof fence that surrounds the Koa Management Area, erected around 1992. It would require some maintenance to act as a complete barrier to feral pigs (H. Horiuchi, pers. commun., 1999). There is no active management for conservation at this time, except for localized predator trapping at a nēnē (*Branta sandvicensis*) conservation area on ranch lands to the east (J. Mello, DOFAW, pers. commun., 1999) and outplanting of rare plants (J. Giffin, pers. commun., 1999). Although there is road access up to the center of the proposed release site (i.e., the western corner of the Koa Management Area), no roads or mapped trails lead into the forests of either Forest Reserve, with the exception of the 'Ainapō road and trail.

Game mammals are legally hunted in both the Ka'ū and Kapāpala FR, but not in the Koa Management Area or on Kapāpala Ranch. Hunting of game birds occurs in all of these areas during the open season, November through January. A cooperative game management and bird hunting program exists on the State lease ranch lands. Educational materials for hunters using these areas would be needed to explain the release program and to help to ensure that 'alalā would not be confused with game birds. In addition to refurbishing the existing fence, new fencing of additional areas within the proposed release site would probably be necessary to control feral pigs and improve understory vegetation. Any perceived conflicts between public hunting and the needs of an 'alalā reintroduction program would need to be resolved.

The amount of high-quality habitat potentially accessible to 'alalā from a release site at Kapāpala is large, and if occupied would make a substantial contribution to 'alalā recovery. However, the limiting factors operating in this forest are unknown, and might require extensive control measures. The cooperation of neighboring landowners and the public would be essential for the success of reintroduction at Kapāpala.

Release and monitoring logistics

The upper end of the proposed release site is accessible by four-wheel drive vehicle over a combination of public and private roads, while access to the lower end is over private land. The Koa Management Area is bisected by an unused road, but no roads or mapped trails extend into the Ka'ū FR. No primitive campsite or hacking structures exist at Kapāpala. Access to the area is not currently controlled, but existing gates could be locked to control public access, if necessary. Both cellular phone and VHF radio reception is good (J. Giffin, pers. commun., 1998). The nearest residential area is Wood Valley, 8 km (5 mi) from the center of the proposed release site (Fig. 8). Pāhala, the nearest town, is approximately 17 km (10 mi) to the south.

Based on available food resources, initial groups of 'alalā may not need to move outside the

reintroduction site. Eventually, however, due either to population pressure or seasonal changes in food supply, 'ālalā may move southwest into the Ka'ū FR, onto adjacent ranch lands, or possibly into the higher elevation Kapāpala FR. Tracking and monitoring of any 'ālalā that move northeast onto State lands leased for ranching would require agreement of the lessee. The ranch lands that appear to be potential habitat are directly adjacent to the proposed release site (Fig. 9).

The public access road to the 'Ainapō trailhead would provide access to potential nesting habitat within the Kapāpala FR. Access to private roads above the Ka'ū FR would be especially important in monitoring movement of 'ālalā into higher elevation forests southward from the release area. However, the entry point for the road above the Ka'ū FR is 55 km (34 mi) by highway from the proposed release site, and from the highway to the end nearest Kapāpala is an additional 50 km (31 mi) over ranch roads. Therefore, even if the landowner were to grant access to reintroduction personnel, routine monitoring of 'ālalā via this route would be laborious. No established access routes, private or public, exist for the majority of the nearly 10,000 ha (24,000 ac) of potential nesting habitat accessible to 'ālalā released at Kapāpala (Fig. 9). This lack of access would limit both monitoring and retrieval of released 'ālalā and control of limiting factors.

The total amount of potential nesting habitat in Ka'ū is declining. Between 1976 and 1994, satellite images show that approximately 1945 ha (4800 ac, or 17%) of potential nesting habitat was converted to non-forest (Table 1, footnote 9). All of the affected lands were outside of the Conservation District. Of the remaining potential nesting habitat, approximately 7% (661 ha, 1630 ac) consists of private lands or State lease lands outside the Conservation District.

2.3.4 Alternative 4: Release of 'ālalā at Kūlani

Physical and biological characteristics of the area

The proposed release site in the Kūlani area is between 1650 and 1900 m (5400-6200 ft) elevation on the northeastern slope of Mauna Loa, in the district of South Hilo. The area being considered for the release program is approximately 1624 ha (4013 ac) in size (Fig. 10). The area is characterized by moderately steep (14% slope), undulating topography beginning at about 1590 m (5200 ft) with wet 'ōhi'a forest. The forest extends upward into mesic 'ōhi'a forest and finally into a combination of mesic koa/ 'ōhi'a and dry 'ōhi'a forest at the upper elevation (1890 m, 6200 ft). Annual rainfall is 2000-2500 mm (80-100 in), supporting a mesic to wet forest community (Fig. 11). In the mesic forest the understory is dominated by a diversity of native trees and shrubs ('ōlapa, pilo, kōlea, *Clermontia* spp., māmaki, hō'awa). The dry forest understory is dominated by pūkiawe (*Styphelia tameiameiae*), pilo (*Coprosma* spp.), and a'ali'i (*Dodonea viscosa*). Below 1590 m (5200 ft) the adjacent 'ōhi'a forest becomes wetter, with lower understory plant diversity. At elevations below 1530 m (5000 ft) the forest is dominated by a hapu'u fern understory. A good description of the area, including a checklist of native plants and animals, is available (OKMG 1998a).

The center of the proposed Kūlani release area is located about 17 km (11 mi) northwest of the visitors' center at Hawai'i Volcanoes National Park, 5 km (3 mi) from the Pu'u Maka'ala NAR and 8 km (5 mi) from the 'Ōla'a Tract of Hawai'i Volcanoes National Park. The Keauhou Bird Conservation Center, where 'alalā are raised for reintroduction, is 12 km (7.5 mi) from the center of the area.

The proposed area encompasses both State and private land. The State-owned land is reserved for the Kūlani Correctional Facility, and has been used for cattle grazing and logging in the past. Cattle grazing is now confined to a cleared area separating the two segments of the proposed release area. There is an enclosed piggery operation in another cleared area. Some logging of 'ōhi'a is conducted to supply fuelwood for the prison. The private land portion of the proposed release area includes portions of the Kīlauea Forest and Keauhou Ranch, both owned by Kamehameha Schools/B.P. Bishop Estate (KSBE). Kīlauea Forest has been managed for conservation, while parts of Keauhou Ranch have been commercially grazed and used for koa logging and silviculture. The area included in the proposed release area is no longer grazed.

The proposed release site is outside of the historic range of the 'alalā; the nearest 'alalā sightings have been 9-10 km (5-6 mi) to the south, near Kīlauea Crater. The most recent sightings at Volcano were in 1977. In 1910, 'alalā were found nesting about 16 km (10 mi) south of Kūlani in Kīpuka Puauulu/Bird Park. The Kūlani area has been repeatedly surveyed for forest birds since 1977 (Scott *et al.* 1986, USFWS, unpubl. data). Native and endangered forest birds ('amakihi, 'apapane, i'iwi, 'elepaio, 'ākepa, Hawai'i creeper, and 'akiapōla'au) are still present in high numbers within the proposed area (J. Jacobi, BRD, pers. commun., 1999).

Kūlani was assessed for suitability as a potential release site for 'alalā by biologists familiar with the area (J. Jacobi, R. Warshauer, T. Casey, pers. commun., 1998). It was characterized as having an intact understory and mid-canopy, and an excellent diversity of foraging plants of the proper age structure. Native invertebrates are known to be diverse and abundant (D. Foote, BRD, unpubl. data). A small infestation of banana poka occurs within the proposed release area, and yellow Himalayan raspberry (*Rubus ellipticus*) occurs in both mesic and wet forest as well as in pasture areas (R. Warshauer, BRD, pers. commun., 1998).

No estimates of alien predator (rats, cats, and mongoose) numbers have been made within the area, although populations numbers are assumed to be comparable with other areas of native forest, with the exception of areas of Keauhou Ranch which are nearly rat-free (see below). Hawaiian hawks occur in moderate numbers at Kūlani, according to a researcher conducting field surveys of 'io in the area (J. Klavitter, pers. commun., 1999).

Feral pigs and cattle have been removed from 25% of the public lands in the release area in the past five years. The remaining 75% of the area has been fenced and feral ungulates have been reduced to low numbers (T. Rubenstein, 'Ōla'a-Kīlauea Management Group, pers. commun., 1999). Game birds (kalij pheasant, turkey, ring-necked pheasant (*Phasianus colchicus*), Erkel's francolin) occur at Kūlani, but little is known about their numbers or distribution.

Due to the altitude and reduced level of ungulate activity, levels of avian disease are thought to be low at Kūlani. Mosquito populations occur mainly below about 1590 m (5200 ft) in elevation but small numbers of *Culex* mosquitoes have been trapped seasonally at the highest elevation (1890 m, 6200 ft) within the proposed release area (D. LaPointe, BRD, pers. commun., 1998). Mosquito populations and presumably avian disease levels are likely to stay low and may decrease with continued ungulate eradication efforts in the ‘Ōla‘a-Kīlauea management area.

The proposed release site is in the upper elevations of the Correctional Facility lands and adjacent private lands (Fig. 11) and includes intact koa-‘ōhi‘a forest. The boundaries of the proposed release site are approximate but encompass approximately 1624 ha (4013 ac). When aerial photos were taken in 1976 (Jacobi 1989), essentially all of the native forests in this area were native-dominated, and there has been little visible change up to 1994 (SPOT 1994).

As shown in Figure 11, extensive areas of forest surrounding Kūlani consist of vegetation types known to support ‘alalā breeding territories. However, ‘alalā are not known to have ever inhabited these forests, even when the species was relatively abundant. It is possible that the high rainfall downslope of the Volcano area, directly or indirectly, makes these forests unsuitable for ‘alalā (P. Banko, pers. commun., 1999). All known ‘alalā nests have been in forests receiving less than 2000 mm (80 in) of rain per year (USFWS, unpubl. data). Yet only about 7% (581 ha, 1430 ac) of the nesting habitat accessible to birds released at Kūlani receives less than 2000 mm/yr, and that habitat is represented by small, fragmented kīpuka (Fig. 11). Therefore, if high rainfall limits ‘alalā distribution, the nesting habitat shown in Figure 11 and Table 1 may greatly overestimate that which is actually suitable for released ‘alalā.

The potential nesting habitat contiguous to the release site (Table 1) could hold 6-7 pairs of ‘alalā. By including all nesting habitat accessible to ‘alalā released at Kūlani, extending from Kīlauea caldera to the Saddle Road, and assuming uniformly high habitat quality, approximately 21 pairs of ‘alalā could potentially inhabit the area. However, much of the habitat in the northern and southern parts of this area is in small kīpuka isolated by recent lava flows, younger forest types, or pasture (Fig. 11), and so may be too fragmented to support breeding territories of ‘alalā. Recent satellite imagery does not show an obvious deterioration of the nesting habitat shown in Figure 11 (SPOT 1994), but much of it is outside fenced areas. Because of the active management of ungulates and weeds in the ‘Ōla‘a-Kīlauea management area, habitat quality within the fenced areas is improving. However, assumption of similar high habitat quality in the surrounding area may be unwarranted.

Control of limiting factors

Kūlani, and adjacent Federal, State and private lands containing native forests of high value, are managed cooperatively as part of the ‘Ōla‘a-Kīlauea Management Group (OKMG). Prior to beginning a release program at this site, ‘alalā habitat management needs and release logistics would need to be integrated with the existing management plan for the ‘Ōla‘a-Kīlauea area (OKMG 1998a). Due to the security needs of the State prison facility and the private nature of

Figure 10

Figure 11

the KSBE lands, no conflicts between habitat management and public use are likely to arise.

Habitat management to date has concentrated on fencing blocks of forest and reducing or eliminating feral ungulate populations. Feral ungulate eradication and fencing are currently the top priority management effort being undertaken by the Ōla‘a-Kilauea partnership. An extensive network of roads and ungulate-proof fences exists (Fig. 10). Hunting is conducted by National Park Service (NPS) personnel and fences are maintained by prison crews supervised by NPS staff. Weed control, concentrating on yellow Himalayan raspberry, is also a high priority (T. Rubenstein, pers. commun., 1999). Establishment of predator-free zones at the proposed release site would be facilitated by the absence of feral ungulates that can disrupt traps. In addition, experimental broadcast applications of rodenticides have been conducted at Keauhou Ranch (T. Casey, unpubl. data), which, combined with bait stations, are keeping over 230 ha (570 ac) at very low rat densities (T. Casey, pers. commun., 1999).

The proposed release site adjoins the Mauna Loa FR and Upper Waiākea FR on the north and east, and Keauhou Ranch on the west and south. Some parts of these private lands have been used for grazing and koa logging (Warshauer and Jacobi 1982), with some areas now dedicated to koa silviculture. Public hunting is conducted in the FRs. Educational materials for hunters using these areas would be needed to explain the release program and to help ensure that ‘alalā would not be confused with game birds.

Due to the contiguous nature of the forest, ‘alalā could be expected to move outside the immediate release area. If rainfall or some correlated feature limits use of habitat downslope, movement might take place primarily to the north and south. The noise and traffic on Saddle Road may act as a barrier to movement (Reijnen *et al.* 1997), especially during and after the planned roadway improvement project takes place (USDOT 1997). Movement outside of the ‘Ōla‘a-Kilauea Management area could expose ‘alalā to mortality factors that cannot easily be controlled outside of managed lands. These include predators and shooting. If a release program were to be initiated and mortality rates outside the release area proved excessive, supplemental feeding could be used to hold birds in the release area year-round. However, this would severely limit the size of a released population and might have negative effects on the birds’ social behavior and survival, due to potential risks of disease transmission and predator exposure.

Release and monitoring logistics

Public access to Kūlani is strictly controlled. Reintroduction personnel would be subject to certain restrictions on movements and activities that are consistent with the public safety mission of the Kūlani Correctional Facility. For example, the ability to monitor released birds may occasionally be affected by prison “shut-downs” normally only lasting a few days (T. Rubenstein, pers. commun., 1998). No overnight camping would be allowed at Kūlani, and storage of gear would be off-site. At Keauhou Ranch, camping and storage could be on-site and movement within the ranch and Kilauea Forest would be subject to fewer restrictions.

Roads and fencelines provide good access to forested areas within the 'Ōla'a-Kīlauea Management area. Access via Keauhou Ranch would be important to effectively monitor 'alalā on the west side of Kūlani. Cellular phone use is not allowed in the area due to prison restrictions. However, VHF radio communication is good and the Hawai'i Volcanoes National Park repeater is easily accessed from the area (J. Jacobi, pers. commun., 1998).

It is possible that released birds may be attracted to or disturbed by sirens which are used by the prison periodically. Post-release monitoring and manipulation might involve capture and relocation of any 'alalā that frequent the prison area or that interact negatively with captive 'alalā at the Keauhou Bird Conservation Center.

The nearest residential area is Volcano Village, approximately 15 km (9.3 mi) from Kūlani. A small area of potential nesting habitat, immediately downslope from the village, is a detached remnant of forest once contiguous with that rimming Kīlauea Caldera, where 'alalā were sighted historically.

The dry 'ōhi'a forest and mesic koa /'ōhi'a belt within Kūlani is contiguous with the forest in Keauhou Ranch and would likely become a corridor for 'alalā movement. Movement downslope of the proposed release area is less likely as the forest becomes less diverse due to higher rainfall and density of hapu'u tree ferns (R. Warshauer, pers. commun., 1998). Potential nesting and foraging habitat to the north of Kūlani is accessible from Powerline Road and/or Tree Planting Road, although considerable hiking would be required. With the exception of Keauhou Ranch, all access roads to potential nesting habitat within 5 km (3 mi) of the release site are public. Agreements granting access by project personnel to private lands would make it much easier to monitor the health and activity of released 'alalā and to recover quickly any ill or injured birds or carcasses.

Of the total nesting habitat considered accessible to 'alalā released at Kūlani (8786 ha, 21,700 ac; Table 1), only about 5% (454 ha, 1122 ac) consists of private lands or State lease lands outside the Conservation District. These exceptions are the ranch lands south of Kūlani and a small parcel adjacent to Volcano Village. Thus most of the available habitat for 'alalā is protected from outright conversion from native forest to other uses. However, because active management of natural areas, even those zoned Conservation, is required to maintain the habitat value for 'alalā and other species, the participation of KSBE should greatly facilitate the long-term success of a reintroduction program at Kūlani.

2.3.5 Alternative 5: Release of 'alalā at Hakalau Forest National Wildlife Refuge

Physical and biological characteristics of the area

The proposed release site ("Hakalau") is within the Hakalau Forest National Wildlife Refuge (NWR) at an elevation of 1500-1700 m (5000-5500 ft) on the windward side of Mauna Kea, in the district of South Hilo (Fig. 12). The area being considered for the release program is

approximately 1000 ha (2500 ac) in size. Hakalau is located about 23 km (14 miles) northwest of Hilo. Two State conservation areas are nearby: Laupāhoehoe NAR is 9 km (5.6 mi) to the north, and Mauna Kea Ice Age NAR is 16 km (10 mi) to the west.

Annual rainfall is approximately 3000-3500 mm (120-140 in). The area is characterized by gradual (9% slope), undulating topography beginning at about 1530 m (5000 ft) with wet 'ōhi'a/koa forest. The forest extends upward into mesic koa/'ōhi'a forest where it is bordered at the upper reaches (about 1680 m, 5500 ft) by disturbed koa/'ōhi'a forest and finally pasture at about 1830 m (6000 ft). The understory within the proposed release site consists of a diversity of native trees and shrubs such as ōlapa (*Cheirodendron trigynum*), ōhelo (*Vaccinium* spp.), pilo, and kōlea, all approximately 8-10 years of age. Below 1530 m (5000 ft) the 'ōhi'a forest becomes wetter and hapu'u tree ferns dominate the understory (J. Jeffrey, USFWS, pers. commun., 1999). A large area of banana poka occurs approximately 8 km (5 mi) to the north of the proposed release area and blackberry (*Rubus argutus*) is common in disturbed mesic forest within and adjacent to the proposed release area. Other exotic plants of concern to NWR staff include English holly (*Ilex aquifolium*) and *Photenia davidiana*. Hakalau Forest NWR is well described in the EA (USFWS 1985) and the Feral Ungulate Management Plan (USFWS 1996), which also provides a checklist of species.

Prior to acquisition by the Federal government, the mesic upper portions of Hakalau Forest NWR were used for cattle grazing, and both feral cattle and feral pigs ranged throughout the forest (USFWS 1996). Forest recovery in the proposed release area began with the installation of ungulate-proof fencing and removal of feral ungulates. Neighboring lands to the north, south, and upslope to the west are still in grazing use.

Hakalau is well outside the historic range of the 'alalā. Although single 'alalā were observed near Hakalau in 1971 and 1975 (8 and 2.5 km (5 and 1 mi) from the release area, respectively), observations of 'alalā far outside of their normal range were not uncommon in the 1970s. These observations were presumably of birds from collapsing populations searching for conspecifics (Duckworth *et al.* 1992). No territorial 'alalā or nests have been reported from Mauna Kea.

Hakalau Forest NWR was established for the protection of habitat for native forest birds. Both common and endangered forest birds ('amakihi, 'apapane, i'iwi, 'elepaio, ākepa, Hawai'i creeper, and 'akiapōlā'au) are present in high numbers within the proposed area (J. Jeffrey, pers. commun., 1998). Nēnē utilize the grassy upper areas of the Refuge for grazing and nesting. The area was surveyed extensively in 1977 (Scott *et al.* 1986), and the ecosystems have been mapped by Refuge personnel (USFWS, unpubl. data). The proposed release site is characterized as having a broken understory and mid-canopy, and a fair diversity of foraging plants of the proper age structure. Based on native vegetation qualities, native invertebrate populations were similarly assumed to be at moderate levels. Due to the relative absence of non-native fruiting plants it is estimated that less than 10% of the food available to 'alalā would be from alien plants.

Beginning in 1994, BRD personnel began monitoring alien predator populations (rats, cats, and

mongoose) in a study area from 1500-1650 m (4900-5400 ft) elevation within Hakalau Forest NWR, approximately 4 km (2.5 mi) from the proposed release area and within comparable forest. Baseline information indicates that rats are “extremely abundant” in the area (B. Woodworth, BRD, pers. commun., 1998). Based on trapping results, mongoose outnumber feral cats in forested areas (G. Lindsey, unpubl. data). Rat control efforts in this study area were undertaken seasonally from 1996 through 1999 (B. Woodworth, unpubl. data). Hawaiian hawks are commonly observed and are believed to occur in high densities at Hakalau, according to a researcher conducting field surveys of ‘io in the area (J. Klavitter, pers. commun., 1999).

Feral cattle have been removed from almost all fenced units at Hakalau (Fig. 13), and feral pig populations have been reduced. Game birds (kalij pheasant, turkey, Erkel’s francolin, California quail (*Callipepla californica*)) occur on the Refuge. Kalij pheasants are the predominant game bird species found within the proposed release site although turkeys are found within more open forest above this area. California quail and Erkel’s francolin use pasture areas and higher elevations outside of the proposed release site (J. Jeffrey, pers. commun., 1998).

Avian disease is present at low levels within Hakalau Forest NWR (D. LaPointe, unpubl. data). Most mosquitoes appear to be associated with ranching activities north of the refuge.

The area being considered for the release program is approximately 1000 ha (2500 ac) in size (Fig. 13). The proposed release site is largely within a 622 ha (1540 ac) unit first fenced in 1992 that is nearly ungulate-free. About half of the proposed release area is invaded, but apparently suitable, nesting habitat (Fig. 13). Although the proposed release site could potentially hold two pairs of ‘alalā, it may not be suitable habitat year-round. Nesting habitat contiguous with the release site (3003 ha, 7420 ac) could contain seven to eight pairs. At the top of the koa/‘ōhi‘a belt, large pasture areas occur and are not likely to be traversed by the ‘alalā (D. Ball, pers. commun., 1999). Without the ability to move from wet habitat through mesic, and then into dry forest, it is unclear whether the area will provide the ‘alalā with seasonally abundant food resources.

Figure 13 depicts extensive areas of forest on Mauna Kea that consist of vegetation types known to support ‘alalā breeding territories. However, ‘alalā are not known to have inhabited these forests, even when the species was relatively abundant. It is possible that the high rainfall on the windward slope of Mauna Kea either directly or indirectly makes these forests unsuitable for ‘alalā (P. Banko, pers. commun., 1999). All known ‘alalā nests have been in forests receiving less than 2000 mm (80 in) of rain per year (USFWS, unpubl. data). Yet only about 2 % (130 ha, 320 ac) of the nesting habitat accessible to birds released at Hakalau receives less than 2000 mm/yr, and that habitat is represented by small, fragmented stands (Fig. 13). Therefore, the nesting habitat shown in Figure 13 and Table 1 may overestimate that which is actually suitable for released ‘alalā.

Figure 12

Figure 13

Most of the nearby nesting habitat in the area is within Hakalau Forest NWR (Fig. 12), but has been invaded to varying degrees by non-native grasses, a result of grazing by domestic and feral cattle. Satellite imagery taken in 1994 (SPOT 1994) shows that approximately 1000 ha (2500 ac) of the contiguous nesting habitat south of the NWR had been converted to non-forest vegetation types, representing a 16% loss of total nearby nesting habitat in 18 years (Table 1).

Hawaiian Home Lands to the south are used for cattle grazing above 1680 m (5500 ft). Mesic montane koa/‘ōhi‘a forest there extends upward to about 1950 m (6400 ft) (J. Jeffrey, pers. commun., 1998). This scattered canopy forest could be used as a corridor by ‘alalā to access a patch of high elevation dry forest, but its heavily grazed understory is not likely to provide ‘alalā with many food resources. The patches of native-dominated nesting habitat south of Hakalau near the Saddle Road appear intact in satellite images (SPOT 1994). The total area of nesting habitat accessible to ‘alalā released at Hakalau is approximately 5288 ha (13,100 ac), which might support up to 13 pairs. The active ungulate control at Hakalau suggests that much of the potential ‘alalā habitat on Mauna Kea is increasing in habitat quality. However, outside of the NWR, and even in its lower sections, the presence of high ungulate densities suggests that forest quality is in decline.

Control of limiting factors

Access to Hakalau is through public roads. Hakalau Forest NWR is closed to the public except for periodic birdwatching events, habitat restoration by volunteers, authorized ecotours, and supervised public ungulate management hunts. As the proposed release area occurs within a NWR, management of limiting factors should be unencumbered.

The NWR has an extensive fence network and feral ungulate populations have been reduced in most fenced units. Ungulate removal is continuing in the proposed release area (R. Wass, USFWS, pers. commun., 1999). Maintenance of fences is done by USFWS staff. Controlled public management hunts occur occasionally on the NWR as a method for reducing feral ungulate populations, but may be discontinued in the future (R. Wass, pers. commun., 1999). Establishment of a predator-free zone at the proposed release site would be facilitated by the absence of feral ungulates that can disrupt traps, and by the experience gained from ongoing predator control research.

Staff and volunteers have replanted almost 200,000 koa and other forest trees since 1987, and replanting of rare understory plants is underway. Attempts to control alien plant species are ongoing (J. Jeffrey, pers. commun., 1998).

Most of the potential nesting habitat accessible to ‘alalā released at Hakalau is within the NWR, but ‘alalā could be expected to wander onto neighboring Hawaiian Home Lands and possibly into the State owned Hilo FR. Any control of feral ungulates and small predators would be need to be carefully coordinated with ongoing cattle ranching activities on the lease lands. Fencing and predator control would be needed to enhance the nesting habitat patches near Saddle Road.

A potential problem at Hakalau is the high density of banana poka north of the proposed release area. It is likely that released ‘alalā will eventually find this food resource (as well as blackberry, *Photenia*, and English holly) and further contribute to its dispersal inside the NWR.

If a release program were to be initiated and mortality rates outside Hakalau proved excessive, or if ‘alalā come to depend on banana poka within the NWR as a primary food resource, supplemental feeding could be used to hold birds in the release area. However, this would severely limit the size of a released population and might have negative effects on the birds’ social behavior and survival, due to potential risks of disease transmission and predator exposure.

Release and monitoring logistics

A road requiring a 4-wheel drive vehicle provides access to the northern end of the proposed release site, and hiking the perimeter of the area is relatively easy along the fencelines. However, much of the nesting habitat within the NWR has no trail or road access. Various living quarters for project personnel, and storage sites for equipment, are available on-site. Both VHF radio and cellular phone reception in the area are good.

‘Alalā movements can be expected to the north of the proposed release area, expanding into the remaining forested portions of the Hakalau Forest NWR, and possibly to the south and upslope through Hawaiian Home Lands to about 1950 m (6400 ft). An agreement granting access by project personnel to this ranch area would make it much easier to monitor the health and activity of released ‘alalā and to recover quickly any ill or injured birds or carcasses. A public road provides access to nesting habitat near Saddle Road. The nearest residential area is Kaumana City, approximately 19 km (12 mi) from Hakalau. No suitable ‘alalā habitat occurs nearby.

The total amount of potential nesting habitat on Mauna Kea is declining. Between 1976 and 1994, satellite images show that approximately 1035 ha (2560 ac, or 16%) of potential nesting habitat was converted to non-forest (Table 1, footnote 10). All of the affected lands were outside of the Conservation District. Of the total remaining nesting habitat considered accessible to ‘alalā released at Hakalau (5288 ha, Table 1), approximately 24% (1259 ha) consists of private lands or State lease lands outside the Conservation District. A public-private partnership of agencies and landowners would facilitate the success of a reintroduction program at Hakalau.

2.3.6 Alternative 6: No Action (continue ‘alalā releases at Kona Forest/McCandless Ranch only)

In the absence of selection and implementation of any of the action alternatives, the ‘alalā release program would continue at its current central Kona site (“McCandless”), the location of the remaining wild population. Because of its excellent habitat characteristics, established infrastructure, potential for management of limiting factors, and presence of wild ‘alalā, this site will be utilized for ‘alalā releases with or without selection of other alternatives.

Physical and biological characteristics of the area

The current release area encompasses approximately 1150 ha (2250 ac) of Federal, State and private land in the South Kona district, on the western slope of Mauna Loa (Fig. 14). The McCandless Land and Cattle Company owns the private portion and holds a lease on the narrow State owned Waiea Tract, which separates the ranch lands from the Kona Forest Unit of the Hakalau Forest NWR. The State owned Kīpāhoehoe NAR is 12.6 km (7.8 mi) to the south.

The release area is characterized by moderately steep (16% slope), undulating topography extending from about 1250 m to 1770 m (4100-5800 ft) elevation. Annual rainfall is 900-1500 mm (35-60 in, Fig. 15). The lower portions of the release area (below approximately 1590 m or 5200 ft) consist of wet 'ōhi'a forest but the majority is mesic koa-'ōhi'a forest. The forest understory is dominated by a diversity of native trees and shrubs such as ōlapa, kōlea, pilo, and hō'awa, as well as hāpu'u tree ferns. Guava, strawberry guava (*Psidium cattleianum*) and Christmasberry (*Schinus terebinthifolius*) are found well below the release area, under 760 m (2500 ft) elevation. The entire release area has been in grazing use for decades, but the low stocking densities used have allowed much of the understory vegetation to persist.

The McCandless area holds the last remaining wild 'alalā (see section 1.2.3) and all the captive-bred birds released to date. Common native forest birds ('amakihi, 'apapane, i'iwi, 'elepaio) are present at high densities, and endangered forest birds (ākepa, Hawai'i creeper, and 'akiapōlā'au) are present in the area (USFWS, unpubl. data). The current release site has been characterized by the ART as having a broken understory and mid-canopy, and a high diversity of foraging plants of the proper age structure. Based on native vegetation qualities, native invertebrate populations are assumed to be at high levels. Due to the relative absence of non-native fruiting plants it is estimated that less than 10% of the food available to 'alalā is from alien plants.

Populations of feral cats and mongoose are low in the immediate vicinity of the release site, due to trapping pressure exerted by the USFWS field crew and TPF personnel. Rats are present at high densities, but may be controlled with bait stations in the near future if approval for diphacinone use in 'alalā habitat is obtained. Approximate densities of 'io at McCandless are 0.008/ha (0.003/ac), suggesting that there are approximately 53 'io within the 6300 ha (15,500 ac) survey area, and 9 within the current release area (J. Klavitter, unpubl. data).

Feral pigs are present in moderate numbers (D. Ball, pers. commun., 1999). Pigs are currently interfering with the predator trapping effort by disturbing the traps (K. Clarkson, pers. commun., 1999). Approximately 60-100 feral cattle are present on the Kona Forest Unit lands at any one time (D. Ledig, USFWS, unpubl. data), but fences keep most of them below the 1525 m (5000 ft) level. Densities of kalij pheasant, turkey and California quail are high. Both avian pox and avian malaria are present at high levels which appear to fluctuate seasonally (C. Atkinson, G. Massey, unpubl. data).

Essentially the entire current release area is nesting habitat, but only the lower one-third is

classified as having a native-dominated understory (Fig. 15). This area can potentially hold three to four pairs of 'ālalā (D. Ball, pers. commun., 1998), approximately the number that occupied it in the late 1980s (Duckworth *et al.* 1992). A large area (11,596 ha; 28,600 ac) of nesting habitat is contiguous with the release site, and could hold 29 pairs of 'ālalā if habitat quality were similar to the release site.

Nearby nesting habitat in central Kona extends both north and south of McCandless, but has been variously impacted by grazing and koa logging. Satellite imagery taken in 1994 (SPOT 1994) shows that approximately 875 ha (2200 ac) of forest delineated in 1976 had been converted to non-forest vegetation types, representing a 5% loss of potential nesting habitat in 18 years. Forest clearing and feral ungulate activity continue to degrade some forest lands, but because some large-scale conservation activities are planned at the Refuge (USFWS 1997a) and elsewhere near the release area, and smaller-scale habitat enhancement is already underway on McCandless Ranch, the overall habitat quality trend is mixed.

The total area of nesting habitat accessible to 'ālalā released at McCandless is approximately 16,046 ha (39,600 ac, Table 1), which might support up to 40 pairs. However, unless existing limiting factors are controlled through much of this area, it is questionable whether mortality rates could be reduced sufficiently for 'ālalā to reestablish and persist over this range. Present habitat quality is suspected to be similar or worse than that which existed during the contraction and disappearance of the historical 'ālalā population in Kona during the latter half of this century (Duckworth *et al.* 1992).

Control of limiting factors

Access to McCandless and the Refuge is over privately owned roads. A partnership involving USFWS, TPF, the landowners of McCandless Ranch and the bordering Kealia Ranch and Kuaola Refuge has been formed and acts to manage aspects of the release program and access issues. This partnership allows field personnel to freely track, observe, and recover released 'ālalā.

Various cattle-proof fences are in place at McCandless, and one unit on the ranch has been upgraded to allow control of feral pigs. Predator traps have been deployed in limited areas and on the road leading up to the release site. In the future, expanded fencing on ranch and NWR lands should allow removal of feral pigs and cattle, and also allow pulse-grazing of domestic cattle to reduce the potential for grass fires while allowing understory regeneration. No public hunting is currently allowed or planned.

In the long term, widespread control of feral ungulates and mammalian predators and restoration of degraded forest will be necessary to allow expansion of the 'ālalā population from the current release site into the large potential habitat represented by the forests of central Kona.

Figure 14

Figure 15

Release and monitoring logistics

No publicly owned roads provide access to the proposed release site or surrounding lands, and for this reason there is complete control of public access. Various roads and trails are in place at McCandless, in addition to a base camp, trailer, and two outdoor aviaries/hacking structures. Digital cellular phone reception in the area is good.

In the area surrounding the release area, a relatively sparse road network, all in private hands, provides access to forested lands (Fig. 15). All access roads to potential nesting habitat within 5 km (3 mi) of the release site are over private lands. Agreements granting access by project personnel to private lands outside the current partnership area would be useful to monitor the health and activity of dispersing ‘*alalā* and to recover quickly any ill or injured birds or carcasses. The nearest residential areas are scattered homes along the Belt Highway, approximately 6 km (4 mi) downslope from the release area, well outside of nesting or foraging habitat.

The potential nesting habitat in central Kona is the most extensive area still existing in the ‘*alalā*’s historic range. The total habitat area is declining, but not at the rate seen elsewhere in the ‘*alalā*’s historic range. Between 1976 and 1994, satellite images show that approximately 875 ha (2160 ac, or 5%) of potential nesting habitat was converted to non-forest (Table 1, footnote 11). All of this converted habitat was outside of the Conservation District. Of the total remaining nesting habitat considered accessible to ‘*alalā* released at McCandless (16,046 ha; 39,600 ac; Table 1), approximately 68% (10,857 ha; 26,800 ac) consists of private lands or State lease lands outside the Conservation District.

Because most of the ‘*alalā* habitat in Kona is privately owned, achieving the potential of the ‘*alalā* reintroduction program in this area will depend on public-private partnerships. The successful ‘*Alalā* Partnership Group now coordinating the release program at the Kona Forest/McCandless Ranch site could be expanded, or serve as a model in other areas, to accomplish the goals of ‘*alalā* recovery in Kona.

2.4 ALTERNATIVES NOT CONSIDERED IN DETAIL

Four other alternative release sites have been informally suggested for consideration over the last several years by various parties. Examination of their attributes in light of the selection criteria indicates that they are not viable candidates for ‘*alalā* release locations at this time.

Hōnaunau Forest: This potential release site in central Kona was considered because it is a large tract of native forest in the core of historic habitat, and supported a population of ‘*alalā* in the recent past. It was excluded from detailed consideration for several reasons. First, the area is entirely private land, and has no public access for project personnel. The habitat quality has not recently been assessed, and no fences or other conservation infrastructure are known to exist. For this area to be considered in the future, access and use provisions acceptable to the

landowner would need to be determined, vegetation and ungulate populations surveyed, and a predator control/habitat management plan prepared.

Southern Ka'ū Forest Reserve: This potential release area was considered because, like the Kapāpala site (Alternative 3), it would allow for expansion of an 'alalā population into a large area of contiguous native forest within historic habitat. It was excluded from detailed consideration for several reasons. The diversity and abundance of food resources are lower than at the northern end of the Forest Reserve (J. Giffin, pers. commun., 1998). Access to the release site is exclusively over private lands and roads, and no roads extend into the Forest Reserve, making release and monitoring difficult. No habitat management plans, fences, or other conservation infrastructure currently exist for this area. Future consideration of this area would require establishment of access, surveys of vegetation and populations of ungulates and predators, and formulation of a management plan.

Mauna Loa Strip, Hawai'i Volcanoes National Park: This potential release site encompasses the easternmost historic nest site for the 'alalā, and is on Federal land actively managed for native biodiversity. It was not considered in detail because the area with habitat characteristics most suitable for release and establishment of a population, Kīpuka Kī, is too small to support a release program. This kīpuka is about 94 ha (230 ac) in area, smaller than the typical home range of a single breeding pair of 'alalā. The surrounding forest is dominated by small koa trees less than 40 years old, with little fruit-producing understory. This site might eventually be colonized by 'alalā released at the Alternative 4 site, Kūlani.

Release on an island other than Hawai'i: Off-island releases have been proposed as a means of eliminating negative 'io-'alalā interactions; like 'alalā, 'io are endemic to the island of Hawai'i. Most of the remaining native forests on the smaller islands have higher rainfall than does the historic habitat of the 'alalā. Potential areas of mesic-to-wet koa-'ōhi'a forest do exist on Maui (Ha'ikū-Waikamoi), Kaua'i (various isolated mesic ridgetops), and Moloka'i (leeward summit of East Moloka'i). The potential food resources have not been assessed for 'alalā at any off-island site. Introduction of the 'alalā would potentially impact native ecosystems and species on other islands where it is not native. Serious consideration of off-island releases would only occur if 'io predation proves to be an intractable obstacle to 'alalā recovery on Hawai'i.

2.5 COMPARATIVE EVALUATION OF THE ALTERNATIVES

Table 2 summarizes the factors considered to be important in evaluating the advantages and disadvantages of each potential alternative reintroduction site. These factors are not listed in priority order. Factor ratings in parentheses () are estimated; see text for explanation.

The alternatives are not mutually exclusive, and in fact more than one alternative reintroduction site will be required to recover the 'alalā. This EA presents the relevant features of the various

alternatives to allow readers to evaluate their merits and constraints. A decision to implement one or more alternatives would be primarily based on the evaluation factors listed in Table 2, the relative effects of the actions (Table 5), and on potentially enabling opportunities that may occur in the future, such as cooperative agreements with key landowners.

At this time the agencies do not have a preferred alternative. The evaluation factors for the no action alternative, Alternative 6 (McCandless), are presented for comparative purposes. Releases of 'ālalā will continue at the current McCandless site regardless of selection of any of the action alternatives.

Table 2: Comparison of Alternatives Evaluation Factor	ALTERNATIVE					
	Pu'u Wa'awa'a	Honomalino	Kapāpala	Kūlani	Hakalau	McCandless
Abundance/diversity of food resources	moderate	moderate	moderate	high	moderate	high
Intactness of native vegetation	moderate	moderate	moderate	high	moderate	high
Within historic 'alalā range	yes	yes	yes	no	no	yes
Other 'alalā present	no	no	no	no	no	yes
Suitable climate and vegetation type	yes	yes	yes	unknown	unknown	yes
Native bird population levels	moderate	low	moderate	high	high	high
Proportion of food plants that are non-native	>75%	(10-25%)	<10%	<10%	<10%	<10%
Size of proposed release area, hectares (acres)*	200 (490)	770 (1900)	2100 (5200)	1624 (4013)	1000 (2500)	1150 (2250)
Total nesting habitat contiguous with release area	1652 ha	4061 ha	3043 ha	2520 ha	3003 ha	11596 ha
Potential number of breeding pairs, contiguous nesting habitat**	4	10	7-8	6-7	7-8	29
Total nesting habitat near release area	7531 ha	4297 ha	9552 ha	8786 ha	5288 ha	16046 ha
Potential number of breeding pairs in all nearby nesting habitat**	18	10	23	21	13	40
Density of mammalian predators	high	(high)	(high)	moderate	high	moderate
Density of 'Io	high	(high)	high	moderate	high	high
Feral ungulate populations	high	high	high	very low	very low	moderate
Mosquitoes/disease vectors	low	(high)	(moderate)	low	low	moderate
Existing conservation measures at site	some	none	some	many	many	some

Table 2: Comparison of Alternatives Evaluation Factor	ALTERNATIVE					
	Pu'u Wa'awa'a	Honomalino	Kapāpala	Kūlani	Hakalau	McCandless
Habitat quality trend on adjacent lands	declining	mixed	declining	improving	improving	mixed
Distance to residential areas	6 km***	2 km	8 km	8 km	>15 km	5 km
Number of private landowners/lessees with nearby nesting habitat	>10	5-6	2	1	1-2	4
Percent nearby nesting habitat under private control and outside conservation district	57%	78%	7%	5%	24%	68%
Ownership of access corridor	public	govt. easement	public	public	public	private
Access corridors within 1 km	roads	roads	roads	roads, trails	roads, trails	roads, trails
Percent lands accessible within 5 km	<25%	25-45%	<25%	45-75%	45-75%	>75%
Access corridors within 5 km	Roads, trails	roads	roads	roads, trails	roads, trails	roads, trails
Hiking distance to release site	none	none	<500 m	none	<500 m	none
Distance to sleeping/equipment storage	on site	on site	on site	<15 km	on site	on site
Communications (cellular phone, radio)	good	poor	good	fair	good	fair
Is human disturbance controllable	yes	yes	possibly	yes	yes	yes
Current level of public access to immediate area	restricted	some	some	none	restricted	none
Hunting/shooting levels in release area	high	low	moderate	none	none	none
Control, monitoring of shooting	easy	difficult	difficult	no shooting	no shooting	no shooting

* Hectares (ha) x 2.471 = Acres

** Assumes 400 ha/pair

*** Kilometers (km) x 0.6214 = Miles

CHAPTER 3. AFFECTED ENVIRONMENT

This chapter describes those aspects of the physical, cultural and biological environment that could be affected by the five action alternatives. Many aspects of each site have been described in the previous chapter in order to allow comparisons among the alternatives; therefore this chapter repeats some of the information presented in Chapter 2.

3.1 ALTERNATIVE 1: PU‘U WA‘AWA‘A

3.1.1 Physical environment

Volcanology, Topography, Soils, and Climate

The Sanctuary is on the north side of Hualālai, an active volcano in the post-shield eruptive stage. The summit caldera is buried in ash produced by numerous spatter and cinder cones that are aligned along two rift zones. The oldest exposed lavas on the mountain are at the Pu‘u Wa‘awa‘a (“furrowed hill”) pumice cone, and at the related Pu‘u Anahulu lava flow, both approximately 100,000 years old (UH Hilo 1998). Its latest eruption, in 1801, reached the sea. The entire mountain is classified as Volcanic Hazard Zone 4, on a hazard scale from 1 (most hazardous) to 9 (UH Hilo 1998). Soils are histosols with some volcanic ash content, generally less than 25 cm (10 in) deep on pāhoehoe lavas and less than 50 cm (20 in) deep on ‘a‘ā lavas (DLNR 1996).

The proposed release site is characterized by steep (30% grade), undulating topography. The eastern half of the Sanctuary contains numerous sinkholes, lava tubes and tree molds dating from 1,500 to 5,000 years before present.

Weather patterns generally are similar to those on the Kona coast, with sunny mornings. Convective heating during the day draws marine air upslope where it condenses into afternoon clouds and rain. Cool downslope winds at night disperse these clouds. The months of highest rainfall are November through February (DLNR 1996).

Hydrology and Water Resources

Annual rainfall is 750-1200 mm (29-47 in, DLNR 1996). Water percolates directly into the porous lava, and no perennial streams exist within the Sanctuary. Historically, Pu‘u Wa‘awa‘a Ranch has depended on rain catchment for its water needs.

3.1.2 Social and economic environment

Land ownership

The Sanctuary, the majority of Pu'u Wa'awa'a Ranch to the north, and the lands of Pu'u Anahulu to the east are owned by the State. To the west and south are private lands zoned for conservation and agriculture.

Land use

Portions of Pu'u Wa'awa'a have been used for cattle grazing for over 100 years. Management plans (DLNR 1985, 1996, TNCH 1998) call for use of pulse-grazing of the Sanctuary by cattle to help control alien grasses and vines, with the goal of encouraging regeneration of a native forest understory. The remainder of the State lease lands grazed by Pu'u Wa'awa'a Ranch are expected to remain in grazing use (TNCH 1998). Neighboring private lands are used for housing, ranching and agriculture.

Public use

At Pu'u Wa'awa'a, pig and game bird hunting occurs within the Sanctuary periodically, as scheduled by DOFAW. The neighboring Pu'u Anahulu Game Management Area (GMA) to the east is open for mammal and game bird hunting, as is the Pu'u Wa'awa'a Cooperative GMA on ranch lands downslope of the Sanctuary. Seasonal restrictions apply to most game species.

Archaeological and Historical Resources

Some scattered archeological resources have been observed in the lava tubes of the Sanctuary (J. Giffin, pers. commun., 1999). Paleontological remains of extinct native birds have been recovered from lava tubes in and around the Sanctuary (J. Giffin, pers. commun., 1999). Historical rock walls from ranching activity are also present in the Sanctuary. A brief overview of the historical and cultural heritage of the area is available in the Proposed Multi-Use Plan (TNCH 1998).

3.1.3 Biological environment

Native biodiversity

The proposed release site is characterized by a dry to mesic forest of 'ōhi'a and koa and is dominated by an understory of grass and native shrubs. The Sanctuary extends upward to approximately 1950 m (6400 ft) becoming a dry native shrub/'ōhi'a forest. The understory is dominated by alien grasses with small native shrubs and trees ('ōlapa, māmaki, pilo, *Clermontia* spp.) beginning to recover from cattle grazing (J. Giffin, pers. commun., 1998). Most of the recovering forest is less than 13 years old with young individual native trees and shrubs scattered

throughout patches of alien grass. A complete plant and bird species checklist is available (DLNR 1996).

The Sanctuary was surveyed by the USFWS for forest birds in 1978 (Scott *et al.* 1986) and by members of the ART for suitability as a release site in 1995. Several native forest birds (amakihī, ‘apapane, i‘iwi, ‘elepaio) are common within the Sanctuary. Low numbers of ‘ōma‘ō (less than 50 individuals) now occur within the Sanctuary as a result of reintroductions undertaken by researchers from TPF and BRD in 1996 (J. Nelson, pers. commun., 1999). Unique native invertebrates are present in the lava tubes within the Sanctuary (J. Giffin, unpubl. data), some of which remain undescribed (K. Williamson, Washington University, unpubl. data).

Rare, endangered and threatened species

Hualālai represents the northern limit of the historical range of the ‘alalā, and the Sanctuary area was the core of the population on the mountain in 1978 (Scott *et al.* 1986). ‘Alalā last nested in the Sanctuary in 1982. No ‘alalā have been reliably reported from Hualālai since 1991 (Duckworth *et al.* 1992).

Native forests that retain the plant community integrity needed by ‘alalā also tend to support numerous other rare Hawaiian animals. Table 3 shows the species of Federally protected animals that have been observed at Pu‘u Wa‘awa‘a and the other alternative sites since 1970 (not including ‘alalā; data extracted from HNHP 1998, USFWS 1998). Note that species shown under Alternative 6 refer only to observations made at the Kona Forest Unit of Hakalau Forest NWR. All species shown are listed as endangered, except Newell’s shearwater (*Puffinus newelli*), which is threatened.

Endangered forest birds (‘ākepa, Hawai‘i creeper) are found in low numbers within the Sanctuary area (Scott *et al.* 1986). Numbers of these endangered birds are apparently declining (DLNR 1996). ‘Ōpe‘ape‘a (*Lasiurus cinereus semotus*) are occasionally sighted in the Sanctuary (DLNR 1996). Approximately 25 ‘io are resident within a 7000 ha (17,000 ac) area which includes the Sanctuary (J. Klavitter, University of Washington, unpubl. data).

Table 3: Threatened and Endangered Animals at the Alternative Sites							
Species	Common Name	ALTERNATIVE*					
		1	2	3	4	5	6
<i>Anas wyvilliana</i>	koloa, Hawaiian duck					X	
<i>Branta sandvicensis</i>	nēnē, Hawaiian goose			X	X	X	
<i>Buteo solitarius</i>	‘io, Hawaiian hawk	X	X	X	X	X	X
<i>Hemignathus munroi</i>	‘akiapōlā‘au			X	X	X	X
<i>Lasiurus cinereus semotus</i>	‘ōpe‘ape‘a, Hawaiian hoary bat	X	X	X	X	X	X
<i>Loxops coccineus coccineus</i>	‘ākepa	X	X	X	X	X	X
<i>Oreomystis mana</i>	Hawai‘i creeper	X		X	X	X	X
<i>Psittirostra psittacea</i>	‘ō‘ū				X?		
<i>Puffinus newelli</i>	‘a‘o, Newell’s shearwater				X		

- * Alternative 1: Pu‘u Wa‘awa‘a
 Alternative 2: Honomalino
 Alternative 3: Kapāpala
 Alternative 4: Kūlani
 Alternative 5: Hakalau
 Alternative 6: No action: Kona Forest/McCandless (data from Kona Forest Unit only)

Table 4 shows selected species of rare plants known from Pu‘u Wa‘awa‘a and the other alternative sites. The species shown have been observed growing in ‘alalā foraging habitat within a 6 km (4 mi) radius of the center of each potential release site since 1970 (data extracted from HNHP 1998, USFWS 1998).

Table 4: Rare Plants at the Alternative Sites								
Species	Common Name	Fed. Status†	ALTERNATIVE*					
			1	2	3	4	5	6
<i>Asplenium fragile</i> var. <i>insulare</i>	(no common name)	E				X		
<i>Asplenium schizophyllum</i>	(no common name)	SOC				X	X	

Table 4: Rare Plants at the Alternative Sites

Table 4: Rare Plants at the Alternative Sites								
Species	Common Name	Fed. Status†	ALTERNATIVE*					
			1	2	3	4	5	6
<i>Bidens micrantha</i> ssp. <i>ctenophylla</i>	ko'oko'olau	C	X					
<i>Chamaecybe olowaluana</i>	'akoko	SOC	X					
<i>Clermontia lindseyana</i>	'ōhā wai	E			X	X	X	
<i>Clermontia peleana</i> ssp. <i>peleana</i>	'ōhā wai	E					X	
<i>Clermontia pyrularia</i>	'ōhā wai	E					X	
<i>Cyanea hamatiflora</i> ssp. <i>carlsonii</i>	hāhā	E	X					
<i>Cyanea marksii</i>	hāhā	SOC						X
<i>Cyanea shipmanii</i>	hāhā	E				X	X	
<i>Cyanea stictophylla</i>	hāhā	E	X		X	X		X
<i>Cyrtandra giffardii</i>	ha'iwale	E				X		
<i>Delissea undulata</i> ssp. <i>undulata</i>	(no common name)	E	X					
<i>Diellia erecta</i>	(no common name)	E		X				
<i>Dubautia arborea</i>	na'ena'e	SOC	X					
<i>Eurya sandwicensis</i>	anini	SOC				X	X	
<i>Hibiscadelphus hualalaiensis</i>	hau kuahiwi	E	X					
<i>Kokia drynarioides</i>	koki'o	E	X					
<i>Flueggea neowawraea</i>	mēhamehame	E		X				
<i>Lipochaeta venosa</i>	nehe	E	X					
<i>Melicope hawaiiensis</i>	alani	SOC	X			X		
<i>Nothocestrum breviflorum</i>	'aiea	E	X					X
<i>Phyllostegia racemosa</i>	kīponapona	E				X	X	
<i>Phyllostegia velutina</i>	(no common name)	E	X		X	X	X	X
<i>Phytolacca sandwicensis</i>	pōpolo kūmai	SOC				X		
<i>Plantago hawaiiensis</i>	laukahi kuahiwi	E	X			X		
<i>Pritchardia schattaueri</i>	loulu	E		X				
<i>Ranunculus hawaiiensis</i>	makou	SOC			X	X		

Table 4: Rare Plants at the Alternative Sites								
Species	Common Name	Fed. Status†	ALTERNATIVE*					
			1	2	3	4	5	6
<i>Rubus macraei</i>	‘ākala	SOC	X			X		X
<i>Sicyos macrophyllus</i>	‘ānunu	SOC	X					
<i>Stenogyne macrantha</i>	(no common name)	SOC	X	X		X		X
<i>Stenogyne scrophularioides</i>	(no common name)	SOC						X
<i>Trematolobelia grandifolia</i>	koli‘i	SOC				X	X	
<i>Vicia menziesii</i>	Hawaiian vetch	E	X			X		
<i>Zanthoxylum dipetalum</i> var. <i>tomentosum</i>	a‘e	E	X					
<i>Zanthoxylum hawaiiense</i>	a‘e	E	X					

* Alternative 1: Pu‘u Wa‘awa‘a

Alternative 2: Honomalino

Alternative 3: Kapāpala

Alternative 4: Kūlani

Alternative 5: Hakalau

Alternative 6: No action: Kona Forest/McCandless (data from Kona Forest Unit only)

† Federal Status: E=Endangered; C=Candidate for Endangered status; SOC=Species of concern

Twelve species of endangered plants, one candidate, and six species of concern occur in and near the proposed release area (Table 4). Several bear fruit types known to be fed upon by ‘alalā (e.g., hāhā, *Delissea undulata*, ‘ākala, ‘aiea), while others, such as *Phyllostegia* spp. and *Stenogyne* spp., have small hard fruits that may also be attractive to ‘alalā. Therefore, ‘alalā could assist reestablishment of these plants by dispersing their seeds.

Harmful, non-native species

Banana poka is found throughout the area and in some cases is smothering the ‘ōhi‘a canopy as well as the juvenile understory plants (J. Giffin, pers. commun., 1998). Due to the current lack of food plant diversity, banana poka is likely to become an important food resource for released ‘alalā. Some control actions for this vine, as well as for invasive silk oak, are ongoing within the Sanctuary.

Feral pigs are present in high numbers within the area, but feral cattle have been removed allowing forest regeneration to begin in the past 13 years. Feral sheep are common immediately outside the fenced Sanctuary boundary. Moderate densities of game birds (kalij pheasant, Erkel’s francolin, turkey) are found within the Sanctuary (J. Giffin, pers. commun., 1998).

“High numbers” of alien predators (rats and mongoose) were trapped within the Sanctuary during the ‘ōma‘o translocation effort done in 1996 (J. Nelson, pers. commun., 1998). Feral cats were not trapped or seen within the area during that time, although cats are associated with residences in the Kaloko Mauka subdivision to the south. State personnel report seeing feral cats often within the Sanctuary (J. Giffin, pers. commun., 1998).

Avian disease levels were monitored within the Sanctuary in January and November of 1994. Of 206 blood samples drawn from native forest birds only two (<1%) were found to be positive for malaria and three (1%) were found with active pox lesions. Based on these findings it is believed that avian disease levels are very low within the Sanctuary area (G. Massey, pers. commun., 1998). Although not directly observed, the organism that causes toxoplasmosis probably exists in the area due to the presence of feral cats.

3.2 ALTERNATIVE 2: HONOMALINO

3.2.1 Physical environment

Volcanology, Topography, Soils, and Climate

The proposed release area is on the southwest flank of Mauna Loa, and is subject to lava flows from the Southwest Rift Zone. The flows underlying the area vary in age from 1500-3000 years before present (USGS 1996). A flow from a 1926 eruption bisects the proposed release area. The area is classified as Volcanic Hazard Zone 2, on a hazard scale from 1 (most hazardous) to 9 (UH Hilo 1998). Soils are thin histosols characteristic of young wet forests on Mauna Loa (UH Hilo 1998). The area has an undulating topography and a moderate slope (13%).

Weather patterns generally are similar to those throughout the Kona coast, with sunny mornings. Convective heating during the day draws marine air upslope where it condenses into afternoon clouds and rain. Cool downslope winds at night disperse these clouds. The South Kona area is subject to accumulations of “vog,” volcanic emissions which accumulate in the lee of Mauna Loa, increasing the acidity of precipitation (Sutton and Elias 1993). Rainfall is relatively constant throughout the year, averaging 1500-2000 mm (60-80 in) annually (UH Hilo 1998).

Hydrology and Water Resources

The mid-elevation wet forest of South Kona is an important source of groundwater recharge (UH Hilo 1998). Water percolates directly into the porous lava, and no perennial streams exist within the Honomalino Section.

3.2.2 Social and economic environment

Land ownership

Honomalino is owned by the State and has been reserved for conservation use. Official inclusion as part of the South Kona FR awaits a metes and bounds survey which has not yet been completed (H. Horiuchi, pers. commun., 1999). Adjacent lands are all privately owned. Two other State conservation areas are nearby: Kīpāhoehoe NAR is 3.2 km (2 mi) to the north, and Manukā NAR is 2.6 km (1.6 mi) to the south.

Land use

Cattle were removed in the late 1950s after decades of grazing (H. Horiuchi, pers. commun., 1999), although feral cattle were observed in 1995 (USFWS, unpubl. data). Road access to the Section is through private land. No fencing or other habitat management infrastructure is in place, although a State cabin for land management workers is on-site. Some outplanted rare plants are protected from ungulates by small exclosures.

Land uses on neighboring private properties include macadamia nut agriculture, diversified agriculture, cattle grazing, residences, and koa forestry (logging and replanting). Some neighboring lands have recently been withdrawn from grazing use for conversion to koa plantations (K. Hum, pers. commun., 1999).

Public use

Because Honomalino is not yet officially part of the South Kona FR, and public access has not been secured, no public hunting or other uses have been authorized by DOFAW at this time (W. Stormont, pers. commun., 1999). It is proposed that the area be opened for public hunting once public access is developed.

Archaeological and Historical Resources

To our knowledge, no archeological surveys have been conducted at Honomalino. Historical resources have not been recorded (J. Giffin, pers. commun., 1999).

3.2.3 Biological environment

Native biodiversity

Honomalino is characterized by wet 'ōhi'a forest extending into a small belt of mesic 'ōhi'a forest at the upper elevation at about 1100 m (3600 ft). The understory is dominated by a limited diversity of native trees and shrubs (ōlapa, kōlea, māmaki, hō'awa) from 1070-1110 m (3500-3600 ft) which appears to decrease in diversity between about 820-1070 m (2700-3500 ft).

From about 820-1100 m (2700-3600 ft) 'ie'ie is a common forest component (USFWS, unpubl. data). Honomalino was only recently removed from grazing use, and therefore the understory has been impacted by cattle for decades, as well as by feral pigs (H. Horiuchi, pers. commun., 1999). State personnel are currently outplanting numerous species of native plants (koa, olopa (*Osmanthus sandwicensis*), māmane, ho'awa, pilo, loulou (*Pritchardia schattaueri*)) within exclosures. Native forest birds ('amakihi, 'apapane, i'iwi, 'elepaio) are present in moderate numbers within the proposed area (Scott *et al.* 1986).

Rare, endangered and threatened species

An 'alalā nest was observed at this potential release site in 1973, and a single nesting pair apparently persisted into the late 1970s (Scott *et al.* 1986). 'Alalā were heard there as recently as 1987. A survey in 1995 did not detect any 'alalā in the area (USFWS, unpubl. data).

Although 'ākepa are recorded from the site within the last 25 years, observers did not record this species while on transects in the proposed area in 1995 (USFWS, unpubl. data). 'Io were seen between 820-1280 m (2700-4200 ft) by observers walking transects within the proposed area during a 1995 survey for 'alalā (USFWS, unpubl. data). 'Ōpe'ape'a are commonly observed in the South Kona area (T. Menard, UH, unpubl. data).

Pritchardia schattaueri, an endangered, very tall loulou palm, is endemic to South Kona and has been reduced to less than 10 wild trees. The State has established an outplanted population of approximately 70 young trees in Honomalino (H. Horiuchi, pers. commun., 1999).

Other endangered plants found at Honomalino include *Diellia erecta*, a type of fern with less than 70 individuals, and mēhamehame (*Flueggea neowawraea*), a tree numbering less than 200 individuals (Table 4). *Stenogyne macrantha*, a species of concern, has fruits that may be attractive to 'alalā.

Harmful, non-native species

Guava occurs from about 820-1100 m (2700-3600 ft) in elevation and a *Passiflora* species appears periodically between 970 m and 1100 m (3200-3600 ft; USFWS, unpubl. data). Non-native grasses such as kikuyu grass (*Pennisetum clandestinum*) and meadow ricegrass (*Ehrharta stipoides*) are dominant in the understory.

Kalij pheasants occur in the area but nothing is known about their population levels and distribution. No censuses of alien predators (rats, cats, and mongoose) have been conducted but populations are likely to be consistent with those found in Central Kona by the USFWS crew releasing 'alalā at McCandless Ranch (USFWS, unpubl. data).

Avian disease levels have not been monitored within the proposed release site. The prevalence of hapu'u damage, which provides breeding habitat for mosquitoes, has not been assessed.

Although not directly observed, the organism that causes toxoplasmosis probably exists in the area due to the presence of feral cats.

Feral pigs are present in moderate numbers and are likely to be increasing (J. Giffin, pers. commun., 1999). They move into Honomalino seasonally and damage many of the rare plants outplanted by DOFAW; feral goats and sheep are abundant above the proposed release area and may pose similar problems to any revegetation activities there (H. Horiuchi, pers. commun., 1999). Feral cattle may also be present.

3.3 ALTERNATIVE 3: KAPĀPALA

3.3.1 Physical environment

Volcanology, Topography, Soils, and Climate

The proposed release area at Kapāpala is on the southeast flank of Mauna Loa from 1100 to 1800 m (3700 to 6000 ft) elevation. The flows underlying the area vary in age from 700-1500 years before present (USGS 1996). The rim of Moku'āweoweo Caldera currently shields the area from lava flows, leading to a classification as Volcanic Hazard Zone 6, on a hazard scale from 1 (most hazardous) to 9 (UH Hilo 1998). Soils are thin histosols characteristic of young wet forests on Mauna Loa (UH Hilo 1998). The area has an undulating topography and a moderate to steep slope (13-22% slope).

Hydrology and Water Resources

Annual rainfall for the area ranges from 1250 mm (49 in) at the highest elevation to 2000 mm (78 in) at the lowest elevation. The southeast flank of Mauna Loa is an important source of groundwater recharge (UH Hilo 1998). Rainwater percolates directly into the porous lava, and no perennial streams exist within the Kapāpala area. Approximately 1 km (0.6 mi) northeast of the proposed release area, within the Kapāpala FR, is Pakoa waterhole.

3.3.2 Social and economic environment

Land ownership

The potential release site at Kapāpala encompasses parts of the State-owned Kapāpala FR, Ka'ū FR, and Koa Management Area. Private agricultural lands border the lower edge of the Ka'ū FR, and State and private lands used for grazing border its upper edge and the Koa Management Area and Kapāpala FR.

Land use

The Koa Management Area, historically part of the State lands leased to Kapāpala Ranch, was withdrawn from grazing lease because of its large koa and potential for sustainable logging and gathering. Future management may include selective harvest of koa for canoe logs and minor forest products for cultural and subsistence uses.

Public use

Game mammals are hunted in both the Ka'ū and Kapāpala Forest Reserves, but not in the Koa Management Area or on Kapāpala Ranch. Hunting of game birds occurs in all of these areas during the open season, November through January. Some gathering of culturally important forest plants occurs near road access points (W. Stormont, pers. commun., 1999). Selective cutting and replanting of koa is planned for the Koa Management Area by DOFAW and permittees.

Recreational use of the historic 'Ainapō trail brings hikers within 1 km (0.6 mi) of the boundary of the proposed release area. Most hikers stay at the State cabin, near the 2300 m (7700 ft) level in the Kapāpala Forest Reserve.

Archaeological and Historical Resources

'Ainapō trail was the traditional and only route to the summit of Mauna Loa prior to the opening of the Red Hill route in the early 1900s, and portions of the current trail date to before European contact. It passes within 1 km (0.6 mi) of the proposed release area. No archeological or historical resources are known from the Kapāpala site itself (H. Horiuchi, pers. commun., 1999).

3.3.3 Biological environment

Native biodiversity

The Kapāpala site is characterized by mesic koa/'ōhi'a forest beginning at 1070 m (3500 ft) extending southward into wet koa/'ōhi'a forest. At the highest elevation (1800 m, 6000 ft) a combination of dry 'ōhi'a and mesic 'ōhi'a forest forms a belt that borders mesic koa/'ōhi'a forest below. At the north end of the proposed release area the understory is composed of scattered native trees and shrubs (ōlapa, pilo, kōlea, māmaki, *Clermontia*, 'ākala) with an understory dominated by native grasses. Further to the south, inside the Ka'ū Forest Reserve, the grass understory is replaced by a disturbed native shrub/tree fern understory. Native forest birds ('amakihi, 'apapane, i'iwi, 'elepaio) are present at high densities within the proposed release area (Scott *et al.* 1986).

Rare, endangered and threatened species

No ‘*alalā* have been reported from the proposed release area since the early 1950s. During an ‘*alalā* survey conducted in 1995, observers reported hearing and seeing ‘*ākepa*, Hawai‘i creeper, and ‘*akiapōla‘au* at high elevations within the proposed release area (USFWS, unpubl. data). Approximate densities of ‘*io* at Kapāpala are 0.008/ha (0.003/ac), suggesting that there are approximately 12 ‘*io* within the proposed release area (J. Klavitter, unpubl. data). A flock of nēnē occurs in the pasture lands adjacent to the proposed release site and may range into the Koa Management Area (J. Mello, pers. commun., 1999)

Three species of endangered plants, and one species of concern, occur within the proposed release area (Table 4). Two, ‘*ōhā wai* and *hāhā*, bear types of fruit that ‘*alalā* are known to eat, while *Phyllostegia velutina* has small hard fruits that may also be attractive to ‘*alalā*. Therefore, ‘*alalā* could assist reestablishment of these plants by dispersing their seeds.

Harmful, non-native species

Feral pigs are present in the release area (J. Giffin, pers. commun., 1998). Feral cattle were removed from the Koa Management Area by DOFAW in the early 1990s, and stock-proof fences now prevent further escapes of domestic stock into the forest. However, feral cattle from more distant parts of Ka‘ū FR are likely to recolonize the unfenced portions proposed release area.

Kalij pheasants are the main game bird hunted within the reserve area (J. Mello, pers. commun., 1999), but little is known about their population and distribution within the area. No censuses of alien predators (rats, cats, and mongoose) have been conducted within the area, but their densities are likely to be similar to other forest areas on the island. Traps for cats and mongoose are maintained by volunteers in the nēnē habitat downslope of the proposed release area, and ranch personnel actively control wild dogs that venture onto the ranch (J. Mello, pers. commun., 1999). Avian disease levels have not been assessed at Kapāpala. Although not directly observed, the organism that causes toxoplasmosis probably exists in the area due to the presence of feral cats.

3.4 ALTERNATIVE 4: KŪLANI

3.4.1 Physical environment

Volcanology, Topography, Soils, and Climate

The proposed release site at Kūlani is between 1650 and 1900 m (5400-6200 ft) elevation on the northeast slope of Mauna Loa, an active volcano in the shield-building stage. The area is subject to lava flows originating from the northeast rift zone, and is classified as Volcanic Hazard Zone 2, on a hazard scale from 1 (most hazardous) to 9 (UH Hilo 1998). The northern end of the proposed release site is bounded by an ‘*a‘ā* flow from 1942. The soils of the area are thin

histosols formed over a complex mosaic of Mauna Loa flows and spatter/cinder deposits from 400-10,000 years old (USGS 1996). The proposed release site is characterized by moderately steep (14% slope) and undulating topography. The areas covered by pāhoehoe lava contain numerous lava tubes, skylights and tree molds.

Weather patterns are dominated by clear mornings, changing to tradewind-induced showers during the day and evening, with frequent fog and mist. Cool, downslope winds predominate at night. Annual rainfall is 2000-2500 mm (80-100 in).

Hydrology and Water Resources

Despite the high rainfall, water percolates directly into the porous lava, and no perennial streams exist within the proposed release area. Kūlani Correctional Facility depends on rain catchment for its water needs.

3.4.2 Social and economic environment

Land ownership

The proposed area is on State owned land reserved for the Kūlani Correctional Facility, and on private lands owned by KSBE. The proposed release site adjoins the Mauna Loa FR and Upper Waiākea FR on the north and east, and parts of the KSBE owned Kilauea Forest and Keauhou Ranch on the west and south.

Land use

The State portion of the proposed area is reserved for the Kūlani Correctional Facility, and has been subject to some cattle grazing and logging in the past. Grazing is now confined to a cleared area separating the two segments of the proposed release area. Some logging of 'ōhi'a is conducted to supply fuelwood for the prison.

This site, and adjacent Federal, State and private lands containing native forests of high value, are managed cooperatively for biodiversity values as part of the 'Ōla'a-Kilauea Management Group (OKMG). Habitat management to date has concentrated on fencing blocks of forest and reducing or eliminating feral ungulate populations. Feral ungulate eradication and fencing are currently the number one priority management effort being undertaken by the Ōla'a -Kilauea partnership. Weed management is also currently ongoing (T. Rubenstein, pers. commun., 1999).

The KSBE portion of the proposed release site is being used for a forest recovery project involving ungulate and rat control. Over 230 ha (570 ac) are being maintained at very low rat densities by means of toxicant baits (T. Casey, pers. commun., 1999).

Public use

There is no current or projected public use of the Kūlani release site due to the security needs of the prison. Hunting occurs in the Upper Waiākea FR and the Mauna Loa FR bordering the proposed release site. No public hunting is allowed within the proposed release area.

Archaeological and Historical Resources

The area has not been surveyed for archaeological features, and none are known at the present time (OKMG 1998b).

3.4.3 Biological environment

Native biodiversity

The forest at Kūlani extends upward into mesic ‘ōhi‘a forest and finally into a combination of mesic koa/‘ōhi‘a and dry ‘ōhi‘a forest at the upper elevation (1890 m, 6200 ft). In the mesic forest the understory is dominated by a diversity of native trees and shrubs (‘ōlapa, pilo, kōlea, *Clermontia* spp., māmaki, hō‘awa). The dry forest understory is dominated by pūkiawe (*Styphelia tameiameia*), pilo, and a‘ali‘i (*Dodonea viscosa*). Below 1590 m (5200 ft) the adjacent ‘ōhi‘a forest becomes wetter, with lower understory plant diversity. At elevations below 1530 m (5000 ft) the forest is dominated by a hapu‘u fern understory. A good description of the area, including a checklist of native plants and animals, is available (OKMG 1998a).

‘Amakihi, ‘apapane, i‘iwi, ‘ōma‘o, and ‘elepaio are native forest birds present at high densities within the proposed release area. Native forest invertebrates are known to be diverse and abundant (D. Foote, BRD, unpubl. data). The lava tube caves in the area have yielded a large array of specialized cave arthropods, some unique to the area (F. Howarth, Bishop Museum, unpubl. data).

Rare, endangered and threatened species

Species of endangered forest birds known from Kūlani are ‘akiapōlā‘au, ‘ākepa, Hawai‘i creeper, and ‘ō‘ū (Table 3). The ‘ō‘ū has not been seen since the 1980s despite intensive surveys and is probably extinct. Other listed birds present in the area are nēnē, found in grassy areas surrounding the prison, and ‘io, present in “moderate” numbers at Kūlani (J. Klavitter, pers. commun., 1998). The ‘a‘o or Newell’s shearwater (*Puffinus newelli*) may nest in burrows in the area. The ‘ōpe‘ape‘a is seen seasonally at Kūlani (T. Menard, pers. commun., 1998).

Nine species of endangered plants and eight species of concern occur in and near the proposed release area (Table 4). Several bear fruit types known to be fed upon by ‘alalā (e.g., hāhā, ‘ōhā wai, ‘ākala, anini), while others, such as alani, ha‘iwale, kīponapona, pōpolo kūmai, and *Stenogyne macrantha*, have fruits that may also be attractive to ‘alalā. Therefore, ‘alalā could

assist reestablishment of these plants by dispersing their seeds.

Harmful, non-native species

A small infestation of banana poka occurs within the proposed release area, and yellow Himalayan raspberry occurs in both mesic and wet forest as well as in nearby pasture areas (R. Warshauer, pers. commun., 1999). The invasive tree *Myrica faya*, or faya tree, which has invaded large areas of Hawai'i Volcanoes National Park, is established near the Keauhou Bird Conservation Center (KBCC) and may be spreading into upland areas near the release site.

Feral pigs and cattle have been removed from 25% of the proposed release area in the past 5 years. The remaining 75% of the area has been fenced and feral ungulates have been reduced to low numbers (T. Rubenstein, pers. commun., 1999). No estimates of alien predator (rats, cats, and mongoose) numbers have been made within the area, although populations are assumed to be comparable with other areas of native forest. However, the KSBE portion of the proposed release site has been treated for over five years with diphacinone baits, and has been nearly rat-free for that period.

Due to the altitude and reduced level of ungulate activity, levels of avian disease are thought to be low at Kūlani. Mosquito populations occur mainly below about 1590 m (5200 ft) in elevation but small numbers of *Culex* mosquitoes have been trapped seasonally at the highest elevation (1890 m, 6200 ft) within the proposed release area (D. LaPointe, pers. commun., 1998). Although not directly observed, the organism that causes toxoplasmosis probably exists in the area due to the presence of feral cats.

3.5 ALTERNATIVE 5: HAKALAU

3.5.1 Physical environment

Volcanology, Topography, Soils, and Climate

The proposed Hakalau release site is at an elevation of 1500 to 1700 m (5000-5500 ft) on the windward east slope of Mauna Kea, a dormant volcano. The underlying lava flows are over 10,000 years old (USGS 1996). The area is classified as Volcanic Hazard Zone 8, on a hazard scale from 1 (most hazardous) to 9 (UH Hilo 1998). The soils are andisols, derived from volcanic ash (UH Hilo 1998). The topography of the area is gradual (9% slope) and undulating.

Hydrology and Water Resources

Annual rainfall for the area ranges from 3000 mm (120 in) at the highest elevation to 3500 mm (140 in) at the lowest elevation. The western slope of Mauna Kea is an important source of groundwater recharge (UH Hilo 1998). The upper reaches of four perennial streams pass through

the proposed release area (Fig. 12). From north to south, they are Kolekole Stream, Kapu'e Stream, Honoli'i Stream, and Auehi Stream.

3.5.2 Social and economic environment

Land ownership

The proposed Hakalau release site is contained within the Federally owned Hakalau Forest NWR, which is dedicated to conservation of native biodiversity, especially native forest birds. The Refuge is bordered on the north and south by sections of the State owned Hilo FR, on the west by Hawaiian Home Lands used for grazing, and on the east by various private landholdings.

Land use

Prior to acquisition by the Federal government, the mesic upper portions of Hakalau Forest NWR were used for cattle grazing, and both feral cattle and feral pigs ranged throughout the forest (USFWS 1996). Neighboring lands to the north, south, and upslope to the west are still in grazing use.

Public use

Public use of Hakalau Forest NWR is limited to permitted ecotours which focus on birdwatching, yearly public information "open houses," and regulated and supervised management hunts for feral ungulates.

Archaeological and Historical Resources

One cultural resource site, a rock cairn or ahu, is located within the proposed release area (Tomonari-Tuggle 1996).

3.5.3 Biological environment

Native biodiversity

The Hakalau site is characterized by wet 'ōhi'a/koa forest at about 1530 m (5000 ft) elevation. The forest extends upward into mesic koa/'ōhi'a forest where it is bordered at the upper reaches (about 1680 m, 5500 ft) by disturbed koa/'ōhi'a forest and finally pasture at about 1830 m (6000 ft). The understory within the proposed release site consists of a diversity of native trees and shrubs such as ōlapa, ōhelo, pilo, and kōlea, all approximately 8-10 years of age. Below 1530 m (5000 ft) the 'ōhi'a forest becomes wetter and hapu'u tree ferns dominate the understory. Common native forest birds ('amakihi, 'apapane, i'iwi, 'elepaio) are present in high numbers within the proposed area.

Rare, endangered and threatened species

Endangered forest birds (ākepa, Hawai'i creeper, and 'akiapōlā'au) attain their highest population densities at Hakalau Forest NWR, and are relatively common in the proposed release area (Table 3). In addition, koloa (*Anas wyvilliana*) are sometimes found in the streams and catchment ponds of the area, nēnē graze in grassy areas and reproduce in the upper elevations, and 'io occur in high densities at Hakalau (J. Klavitter, pers. commun., 1998). 'Ōpe'ape'a are also seen seasonally at the Refuge (J. Jeffrey, pers. commun., 1999).

Six species of endangered plants and three species of concern occur in and near the proposed release area (Table 4). Several bear fruit types known to be fed upon by 'alalā (e.g., hāhā, 'ōhā wai, anini), while others, such as *Phyllostegia* spp., have small hard fruits that may also be attractive to 'alalā. Therefore, 'alalā could assist reestablishment of these plants by dispersing their seeds.

Harmful, non-native species

A large area of banana poka occurs approximately 8 km (5 mi) to the north of the proposed release area, and blackberry is common in disturbed mesic forest within and adjacent to the proposed release area. Another alien plant, English holly (*Ilex aquifolium*), occurs at the southern margin of the proposed release area. All of these invasive alien plants are spread by birds which eat the fruit.

Rats are extremely abundant in the area (G. Lindsey, pers. commun., 1999). Mongoose outnumber feral cats in forested areas, but both occur in the proposed release site. Feral pigs have been removed from almost all fenced units at Hakalau, as have feral cattle. Avian disease is present at low levels within Hakalau Forest NWR (C. Atkinson, unpubl. data). Although not directly observed, the organism that causes toxoplasmosis probably exists in the area due to the presence of feral cats.

3.6 ALTERNATIVE 6: NO ACTION

3.6.1 Physical environment

Volcanology, Topography, Soils, and Climate

The current South Kona release area is at an elevation of 1250 to 1700 m (4000-5500 ft) on the leeward west slope of Mauna Loa, an active volcano in the shield-building stage. The area is subject to lava flows originating from Mauna Loa's southwest rift zone, and is classified as Volcanic Hazard Zone 2, on a hazard scale from 1 (most hazardous) to 9 (UH Hilo 1998). The southern end of the current release site is bounded by an 'a'a flow from 1950. The soils of the area are thin histosols formed over a complex mosaic of Mauna Loa flows from 400-6,000 years

old (USGS 1996). The area is characterized by moderately steep (16% slope) and undulating topography.

Weather patterns are dominated by clear mornings, changing to convection-induced clouds and showers during the day and evening, with frequent fog and mist. Cool, downslope winds predominate at night. Annual rainfall is 900-1500 mm (35-60 in), but is augmented by an unquantified amount of fog drip. Volcanic haze (“vog”) produced by the eruption of Kīlauea volcano has been a common feature of the area since 1983.

Hydrology and Water Resources

Rainfall and fog drip percolates directly into the porous lava, and therefore no perennial streams exist within the proposed release area. McCandless Ranch depends on rain catchment for its water needs.

3.6.2 Social and economic environment

Land ownership

The current release site encompasses parts of the private lands of the McCandless Land and Cattle Company, the State owned Waiea tract leased to McCandless, and portions of the Federally owned Kona Forest Unit of the Hakalau Forest NWR. The Kona Forest Unit was purchased from Kai Malino Ranch in late 1997. These properties are bordered on the north by Kealia Ranch, on the south by portions of Yee Hop Ranch, and on the east by Kahuku Ranch and Kuaola Refuge (the private portion of the former Kai Malino Ranch).

Land use

The current release area is zoned for agriculture. Past uses of portions of the release area include cattle grazing and selective logging of ‘ōhi‘a and koa. No logging has occurred for several years. Cattle grazing at very low stocking densities continues in the area. Guided ecotours are conducted on private and leased State lands.

Conservation infrastructure in place includes fences for cattle and pig control, a grid of cat and mongoose traps, two ‘alalā field aviaries, isolation boxes for birds undergoing observation or veterinary treatment, and a field camp for ‘alalā project personnel.

Public use

There is currently no public access to or use of the properties in the release area.

Archaeological and Historical Resources

No archeological surveys of the current release site have been conducted. No permanent pre-contact settlements are thought to have existed in this upland forest (USFWS 1997b). Scattered structures and features from historic ranching activities exist within the release area, but have not been assessed for their historical value.

3.6.3 Biological environment

Native biodiversity

The current release site at McCandless is characterized by mesic koa-‘ōhi‘a forest grading into wet ‘ōhi‘a forest below 1590 m (5200 ft). The forest extends upward into dry ‘ōhi‘a forest and shrubland above approximately 1830 m (6000 ft). The forest understory is dominated by a diversity of native trees and shrubs such as ōlapa, kōlea, pilo, and hō‘awa, as well as hāpu‘u tree ferns. Common native forest birds (‘amakihi, ‘apapane, i‘iwi, ‘elepaio) are present in high numbers within the release area.

Rare, endangered and threatened species

Endangered forest birds (ākepa, Hawai‘i creeper, and ‘akiapōlā‘au) occur at low densities in and around the current release area (Table 3). Adult and juvenile ‘io are often observed in the area. ‘Ōpe‘ape‘a are occasionally observed in open areas of the release site.

Three species of endangered plants, and four species of concern, occur within the Refuge portion of the current release area (Table 4). Several bear fruit types known to be fed upon by ‘alalā (e.g., hāhā, ‘ākala, ‘aiea), while others, such as *Phyllostegia* spp. and *Stenogyne* spp., have small hard fruits that may also be attractive to ‘alalā.

Harmful, non-native species

Guava, strawberry guava, and Christmasberry are common near the release area, below 760 m (2500 ft) elevation. Banana poka is present within 2 km (1.2 mi) to the south. All of these invasive alien plants are spread by birds which eat the fruit.

Populations of feral cats and mongoose are moderate near the aviaries and release structures, due to trapping pressure exerted by the USFWS field crew and TPF personnel. Rats are not presently controlled, and their densities are high. Both avian pox and avian malaria are present at moderate levels which appear to fluctuate seasonally (C. Atkinson, unpubl. data). The organism that causes toxoplasmosis is known to exist in the area, and its persistence is due to the presence of feral cats. Feral pigs are present in moderate numbers. Approximately 60-100 feral cattle are present on the Kona Forest Unit lands at any one time (USFWS, unpubl. data). Feral sheep occasionally range downward into the release area from higher elevations.

CHAPTER 4. ENVIRONMENTAL CONSEQUENCES

This chapter discusses the potential effects of implementing each of the alternatives and the likely consequences of those effects. The issues and concerns treated in this chapter were identified through the scoping process described in Chapter 1.

Implementation of any of the alternatives, including the No Action alternative, will likely result in released ‘*alalā* or their wild-born progeny venturing onto privately owned or leased land. These ‘*alalā* could occupy areas as transients while foraging, or could establish and maintain breeding territories in suitable habitat.

Although the ‘*alalā*, themselves, are not expected to have an effect on the land, their legal status as an endangered species could result in new land use restrictions. This is because some of the land use activities could result in “take” of ‘*alalā* as defined by the ESA. Take is defined (ESA, section 3(18)), as “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct.” Section 9 of the ESA prohibits take without a permit. For this reason, private landowners may be reluctant to allow reintroduced ‘*alalā* onto their property.

Recognizing that the ESA may have inadvertently created a disincentive for landowners to manage their land in a way that benefits listed species, the USFWS developed the Safe Harbor policy (USFWS 1999), which is implemented through Safe Harbor Agreements (SHAs) and the issuance of Safe Harbor permits. These Agreements are voluntary and are used to ensure that landowners who manage their land in a way that benefits listed species will not have new restrictions placed on their land as a result of their voluntary actions. In 1997, the State changed its law (HRS 195D) to allow for SHAs, and the USFWS and DOFAW have created a process which allows the landowner to enter into one Agreement with both agencies. It is hoped that landowners who may be reluctant to support ‘*alalā* recovery efforts for fear of future land use restrictions will, through the Safe Harbor process, gain the regulatory assurances they need to fully support and possibly participate in recovery actions for the ‘*alalā*.

4.1 ALTERNATIVE 1: PU‘U WA‘AWA‘A

4.1.1 Effects on the physical environment

Volcanology, Topography, Soils, and Climate

The proposed action would not affect the volcanology, topography, or climate of the Sanctuary. Removal of feral ungulates, a feature of existing and proposed management plans (DLNR 1985, TNCH 1998) that would also be consistent with an ‘*alalā* release program, would reduce soil disturbance and increase ground cover by plants. This would reduce compaction and erosion of soil. Vehicle use would be confined to existing roads, minimizing soil erosion.

Hydrology and Water Resources

The hydrology and water resources of the Sanctuary would not be affected by the proposed project. Human waste generated by field personnel would be contained and periodically removed from the site and would not enter ground water.

4.1.2 Effects on the social and economic environment

Population, employment and local economy

Except for transient occupation of the field camp during 'ālalā releases and monitoring activities, no change in the human population of the area is expected to result from the action.

Biological technicians involved in site preparation, maintenance and monitoring of released 'ālalā could be employees of USFWS, DOFAW, or a private contractor, and could potentially be local residents. Other activities in the Sanctuary would be done by DOFAW personnel. The establishment and expansion of an 'ālalā population at Pu'u Wa'awa'a could provide an opportunity for birdwatching tours on neighboring private lands, employing local residents.

Land Use

Because the Pu'u Wa'awa'a Forest Bird Sanctuary was established to support forest bird recovery, a release program for 'ālalā would be completely compatible with the existing land use. Adjacent State lands presently used for hunting and grazing would remain in those uses. Grazing patterns described in the proposed management plan for the State lands (TNCH 1998) are compatible with a release program.

Ongoing land uses on private lands adjacent to the Sanctuary would not be affected by a release program. For example, pre-existing cattle ranching activities continue to take place at and around the current release site in central Kona.

Permission would be sought to allow access to private lands by reintroduction personnel for purposes of monitoring any released 'ālalā that moved onto private lands. However, the success of a reintroduction program at the Sanctuary would not depend on obtaining access rights to private lands.

Development

Reintroduction of 'ālalā to the Sanctuary would not directly affect potential development of surrounding private lands. However, development activities that resulted in significant degradation of native forest could reduce the seasonal foraging habitat or nesting habitat of a reestablished population of 'ālalā.

‘Alalā dispersing from the release site or migrating in search of seasonal foods will likely visit the same areas on Hualālai frequented by the population before its demise in the late 1970s: Upper Hualālai Ranch, the Kaloko Mauka subdivision, Palani Ranch, and Honua‘ula Forest Reserve. As noted in Table 2, approximately 57% of the total nesting habitat accessible to ‘alalā released at the Sanctuary consists of private lands or State lease lands outside the Conservation District. Owners or lessees of these lands might want to obtain the regulatory assurances provided by SHAs prior to potential establishment of ‘alalā on their land.

Public Use

Game bird and mammal hunting are the primary public uses that could be affected by an ‘alalā release program at the Sanctuary. ‘Alalā are known to be attracted to gunfire, and may perch near humans and alarm-call repeatedly. In the past, hunters have been known to shoot such ‘alalā to keep the birds from alerting their quarry (D. Woodside, USFWS, pers. commun., 1998). There is also a potential for bird hunters to confuse the ‘alalā with kalij pheasant. For these reasons, an ‘alalā-specific education program and materials would be necessary for hunters that use areas in and near the Sanctuary where ‘alalā might be encountered.

Although periodic hunts are carried out within the Sanctuary, current management plans call for removal of feral pigs from the Sanctuary soon after completion of the perimeter fence (DLNR 1996). This will likely entail control hunts for three to five years.

Nesting ‘alalā are very sensitive to human presence, and nests apparently have been abandoned simply due to the presence of people near the nest (P. Banko, pers. commun., 1999). Therefore, if ‘alalā nested where their territories could be affected by hunting, local closures might be established during nesting season, approximately March through July, on public hunting lands. This may also be the case for Honua‘ula FR on the south slope of Hualālai.

Cultural resources

Because there would be no construction or ground disturbance associated with a release program, archeological or other existing cultural resources of the Sanctuary would not be affected by the action. However, the ‘alalā is a native Hawaiian bird with a prominent cultural image. It has been considered an ‘aumakua or family guardian deity and its feathers were used to decorate kahili (Malo 1951). Reestablishment and maintenance of a population of these impressive birds may be considered an important enhancement of the cultural resources of the area.

The proposed Multi-Use Plan for the Pu‘u Wa‘awa‘a area (TNCH 1998) calls for continued ranching combined with cultural and habitat recovery activities. Presence of the ‘alalā as a focus of recovery actions in the area could increase interest and support for the Multi-Use Plan.

4.1.3 Effects on the biological environment

Native biodiversity

Reintroduction of 'ālalā to the forests of North Kona would restore a formerly abundant, but now missing, component of the bird fauna, and therefore increase native biodiversity in the area. The measures to control threats to 'ālalā that would be instituted as part of a release program would have broad positive effects on native biodiversity. Feral ungulate removal would allow regeneration of native understory plants and would reduce disturbance and compaction of soil. Trapping of small mammalian predators should reduce mortalities of all bird species in the area. This is especially true of rats, since research has shown that rat control can significantly increase the reproductive success of Hawaiian forest birds (Woodworth *et al.*, in prep.). In addition, rats are known to severely reduce reproduction of many Hawaiian plants through seed predation and herbivory (Cuddihy and Stone 1990).

'Alalā eat fruits of, and spread the seeds of, many native plants. Passage through an 'ālalā has been shown to increase the germination rate of native *Clermontia* seeds (F. Duvall, unpubl. data), and this may be true for other species of plants as well. The impact of such dispersal on plant diversity and abundance would be highest within 'ālalā territories, and would be cumulative.

'Alalā are known predators on small forest birds, especially nestlings and eggs. This predation is greatest during the breeding season, when nestlings and eggs make up a significant part of the diet fed to 'ālalā chicks and nesting females (D. Ball, unpubl. data). Released 'ālalā therefore could have a negative effect on the reproduction of other forest birds in the area. However, predator control instituted to protect 'ālalā nests and fledglings should reduce predator densities in the area, possibly compensating for the increased mortality due to 'ālalā. The abundance of fledgling forest birds in areas within and outside of 'ālalā breeding territories could be measured to determine if 'ālalā predation was a significant problem. There is a potential for 'ālalā to compete with 'ōma'ō for fruit, but the impact on populations of 'ōma'ō would be difficult to measure.

Endangered, threatened or candidate species

Reintroduction of 'ālalā to the Sanctuary would produce several benefits for the 'ālalā and the recovery effort. Release of other juvenile corvids in areas without conspecifics has reduced the time to first breeding (J. Marzluff, U. Washington, pers. commun., 1998), but this effect has not been tested in 'ālalā. Other important research questions include determination of factors limiting 'ālalā populations in areas besides the current release area, and observing social development and dispersal behavior in the absence of adult, wild 'ālalā. Such research would help refine reintroduction strategies and improve the recovery program.

In addition, establishment of a breeding population, even two or three pairs within the Sanctuary, would provide a valuable source of young 'ālalā for reintroduction elsewhere or for augmenting

the captive breeding flock. Such a population would also reduce the chance that a catastrophic event could eliminate the wild flock. However, even a population of 18 breeding pairs, utilizing all suitable habitat in North Kona (Table 2), would probably be too small to be self-sustaining in isolation (Duckworth *et al.* 1992), and would require monitoring and occasional supplementation with outside individuals in order to avoid decline and extirpation.

Predation by 'alalā on nestlings of 'ākepa and Hawai'i creeper could negatively affect these endangered birds, whose populations on Hualālai are small and isolated. As with non-endangered forest birds, control of mammalian predators might increase fledging success enough to compensate for any increased mortality due to 'alalā.

As stated in section 2.2.1, a program of behavioral modification might be instituted for resident, territorial 'io. This could involve capture and aversive conditioning to 'alalā or a surrogate prey item. Lethal control or relocation of resident 'io is not contemplated, although temporary capture and holding of resident 'io might be considered in order to protect an 'alalā nest during the breeding season. These activities should not affect the local population numbers or distribution of 'io.

Numerous outplantings of *Cyanea stictophylla* exist in the Sanctuary. Because this plant produces fruit that should be attractive to 'alalā, as are those of the related *Clermontia* spp., reintroduction of this bird could facilitate reestablishment of *C. stictophylla* throughout the forest.

Harmful non-native species

Predator control associated with a release program would reduce densities of feral cats, mongoose and (with approval for toxicants) rats within the release area. Although cats and mongoose prey on introduced rodents, it is unclear whether these predators control rodent populations in Hawaiian forest (G. Lindsey, pers. commun., 1999). Therefore it is unknown whether rat and mouse populations would increase as a result of control of some of their predators. Complete control of feral cats would have to be achieved and maintained for toxoplasmosis to be eliminated from the release area.

Control of banana poka, using cattle or herbicides, without provision of alternative food sources would decrease the value of the Sanctuary as habitat for 'alalā. Conversely, long-term reliance of 'alalā on banana poka for food might tend to continue or increase the infestation of this vine through seed dispersal. However, even assuming the absence of feral pigs as dispersers of banana poka seeds, the dispersal effect of an 'alalā population of less than 10 birds would probably be insignificant compared to ongoing dispersal by much larger numbers of kalij pheasant (J. Giffin, pers. commun., 1999). Banana poka control efforts would have to be managed, both in area and timing, in order not to adversely affect 'alalā establishment and survival.

4.1.4 Other Effects

Irreversible and Irretrievable Commitments of Resources

This alternative would not result in an irreversible or irretrievable commitment of resources by the agencies.

Cumulative Effects

If habitat management actions such as predator and feral ungulate control could take place on neighboring private lands, possibly through the development of SHAs, further benefits to native biodiversity would ensue.

4.1.5 Mitigation Measures

Sites for trails and campsites would be selected so as not to affect rare plants. Hacking structures would be dismantled after completion of the project. Toxicants, if used for predator control, would be used in accordance with registered labels and adequate signage would be posted. Biologists would monitor the area for signs of non-target poisoning if toxicants are used. Vehicles and equipment would be cleaned to avoid introducing additional weeds into the area, and the release area would be inspected periodically for incipient weed infestations.

4.2 ALTERNATIVE 2: HONOMALINO

4.2.1 Effects on the physical environment

Volcanology, Topography, Soils, and Climate

The proposed action would not affect the volcanology, topography, or climate of Honomalino. Control of feral ungulates would reduce soil disturbance and increase ground cover by plants. This would reduce compaction and erosion of soil. Vehicle use would be confined to existing roads, minimizing soil erosion.

Hydrology and Water Resources

The hydrology and water resources of Honomalino would not be affected by the proposed project. Human waste generated by field personnel would be contained and periodically removed from the site and would not enter ground water.

4.2.2 Effects on the social and economic environment

Population, employment and local economy

Except for transient occupation of the field camp during 'alalā releases and monitoring activities, no change in the human population of the area is expected to result from the action. Biological technicians involved in site preparation, maintenance and monitoring of released 'alalā could be employees of USFWS, DOFAW, or a private contractor, and could potentially be local residents. Other activities in the Forest Reserve, such as fence building, would be done by DOFAW personnel.

Fencing materials would be purchased on-island, producing income for local business. The establishment and expansion of an 'alalā population at Honomalino could provide an opportunity for birdwatching tours, employing local residents.

Land Use

Native bird reintroduction and recovery is a land use fully consistent with the conservation mission of the Forest Reserve system, of which Honomalino is a part. Implementation of this alternative would not change the land use of the proposed release area.

Ongoing land uses on private lands adjacent to Honomalino would not be affected by a release program. For example, pre-existing cattle ranching activities continue to take place at and around the current release site in central Kona.

Permission would be sought for access to neighboring private lands by reintroduction personnel for purposes of monitoring any released 'alalā that moved onto private lands. Because of the landlocked nature of Honomalino and the high probability that 'alalā would move onto private lands, the feasibility of this alternative would depend on obtaining access rights to private lands.

Development

Reintroduction of 'alalā to Honomalino would not directly affect potential development of surrounding private lands. However, development activities that resulted in significant degradation of native forest could reduce the foraging habitat or nesting habitat of a reestablished population of 'alalā.

'Alalā are unlikely to frequent or occupy private lands downslope of the release site because they contain little or no native vegetation. At elevations at or above the release site, 'alalā could easily wander onto and forage on private lands. As noted in Table 2, approximately 78% of the total nesting habitat accessible to 'alalā released at Honomalino consists of private lands outside the Conservation District. Owners or lessees of these lands might want to obtain the regulatory assurances provided by SHAs prior to potential establishment of 'alalā on their land.

Public Use

No current public use of Honomalino would be impacted by ‘alalā reintroduction or habitat management activities. Feral ungulate control, conducted as part of a release program, would remove part of Honomalino from its proposed use as a public game mammal hunting area. However, public participation would be solicited in eliminating feral mammals from any fenced units. Prior to the construction of an ungulate enclosure within a Honomalino, DOFAW would be required to publish an environmental assessment of the action, allowing public review and comment. Game bird and mammal hunting could proceed outside core managed areas, and bird hunting may be allowed in fenced areas during times other than the ‘alalā breeding season.

Cultural resources

Placement of hacking towers and the location of any base camp area would avoid disturbance of any archeological features discovered during the release program.

The ‘alalā is a native Hawaiian bird with a prominent cultural image. It has traditionally been considered an ‘aumakua or family guardian deity, it was kept as a pet, and its feathers were used to decorate kahili (Malo 1951). Reestablishment and maintenance of a population of these impressive birds may be considered an important enhancement of the cultural resources of the area.

4.2.3 Effects on the biological environment

Native biodiversity

Reintroduction of ‘alalā to the forests of South Kona would restore a formerly abundant, but now missing, component of the bird fauna, and therefore increase native biodiversity in the area.

There are currently no plans, besides outplanting of rare native plants, to proactively manage Honomalino for biodiversity values. The measures to control threats to ‘alalā that would be instituted as part of a release program would have broad positive effects on native biodiversity in an area of historic habitat for ‘alalā. Feral ungulate control would allow regeneration of native understory plants and would reduce mortality of outplanted rare species. Trapping of small mammalian predators should reduce mortalities of all bird species in the area. Control of rats, in addition, would probably increase the reproduction of many forest plants.

‘Alalā eat fruits of, and spread the seeds of, many native plants. The impact of such dispersal on plant diversity and abundance would be highest within ‘alalā territories, and would be cumulative.

‘Alalā are known predators on small forest birds, especially nestlings and eggs. This predation in

greatest during the breeding season, when nestlings and eggs make up a significant part of the diet fed to 'alalā chicks and nesting females (D. Ball, unpubl. data). Released 'alalā therefore could have a negative effect on the reproduction of other forest birds in the area. However, predator control instituted to protect 'alalā nests and fledglings should reduce predator densities in the area, possibly compensating for the increased mortality due to 'alalā. The abundance of fledgling forest birds in areas within and outside of 'alalā breeding territories could be measured to determine if 'alalā predation was a significant problem.

Endangered, threatened or candidate species

Reintroduction of 'alalā to Honomalino would produce several benefits for the 'alalā and the recovery effort. Release of other juvenile corvids in areas without conspecifics has reduced the time to first breeding (J. Marzluff, pers. commun., 1999), but this effect has not been tested in 'alalā. Other important research questions include determination of factors limiting 'alalā populations in areas besides the current release area, and observing social development and dispersal behavior in the absence of adult, wild 'alalā. Such research would help refine reintroduction strategies and improve the recovery program.

In addition, establishment of a breeding population, even two or three pairs within Honomalino, would provide a valuable source of young 'alalā for reintroduction elsewhere or for augmenting the captive breeding flock. Such a population would also reduce the chance that a catastrophic event could eliminate the wild flock.

Expansion of a reintroduced 'alalā population to more than a few pairs is uncertain at this time due to the current rate of habitat change on neighboring forested lands. However, a population of 10 breeding pairs, utilizing all nearby nesting habitat in South Kona (Table 2), still would be too small to be self-sustaining in isolation (Duckworth *et al.* 1992), and would require monitoring and occasional supplementation with outside individuals in order to avoid decline and extirpation. Should 'alalā populations in Kona become robust, exchange of individuals between central and South Kona subpopulations could occur via natural dispersal of juveniles. This could produce a "rescue effect" (Brown and Kodrick-Brown 1977), injecting new individuals into the small South Kona population and preventing its extirpation.

Placement of hacking towers and other release support facilities would occur above the range of the endangered plants at Honomalino, and would avoid impacting DOFAW outplantings.

A program of behavioral modification might be instituted for resident, territorial 'io. This could involve capture and aversive conditioning to 'alalā or a surrogate prey item. Lethal control or relocation of resident 'io is not contemplated, although temporary capture and holding of resident 'io might be considered in order to protect an 'alalā nest during the breeding season. These activities should not affect the local population numbers or distribution of 'io.

Harmful non-native species

Predator control associated with a release program would reduce densities of feral cats, mongoose and (with approval for toxicants) rats within the release area. Although cats and mongoose prey on introduced rodents, it is unclear whether these predators control rodent populations in Hawaiian forest (G. Lindsey, pers. commun., 1998). Therefore it is unknown whether rat and mouse populations would increase as a result of control of some of their predators.

There is no present control program for feral ungulates or invasive weeds at Honomalino. Therefore, habitat management associated with this alternative would produce a net benefit by instituting such programs over at least part of the State lands.

Discovery and exploitation of existing *Passiflora* or guava by released 'ālalā might tend to continue or increase the infestation of these plants through seed dispersal. However, even assuming the absence of feral pigs as dispersers of these seeds, the dispersal effect of an 'ālalā population of less than 10 birds would probably be insignificant compared to ongoing dispersal by much larger numbers of kalij pheasant (J. Giffin, pers. commun., 1999). Control of these invasive plants would concentrate on the home ranges of released 'ālalā in order to minimize the potential effect of 'ālalā-assisted seed dispersal.

4.2.4 Other Effects

Irreversible and Irretrievable Commitments of Resources

This alternative would not result in an irreversible or irretrievable commitment of resources by the agencies.

Cumulative Effects

If habitat management actions, such as predator and feral ungulate control could take place on neighboring private lands, possibly through the development of SHAs, further benefits to native biodiversity would ensue.

4.2.5 Mitigation Measures

Sites for trails, hack towers, and campsites would be selected so as not to affect rare plants. Hacking structures would be dismantled after completion of the project. Toxicants, if used for predator control, would be used in accordance with registered labels and adequate signage would be posted. Biologists would monitor the area for signs of non-target poisoning if toxicants are used. Vehicles and equipment would be cleaned to avoid introducing additional weeds into the area, and the release area would be inspected periodically for incipient weed infestations.

4.3 ALTERNATIVE 3: KAPĀPALA

4.3.1 Effects on the physical environment

Volcanology, Topography, Soils, and Climate

The proposed action would not affect the volcanology, topography, or climate of Kapāpala. Control of feral ungulates would reduce soil disturbance and increase ground cover by plants. This would reduce compaction and erosion of soil. Vehicle use would be confined to existing roads, minimizing soil erosion.

Hydrology and Water Resources

The hydrology and water resources of Kapāpala would not be affected by the proposed project. Human waste generated by field personnel would be contained and periodically removed from the site and would not enter ground water.

4.3.2 Effects on the social and economic environment

Population, employment and local economy

Except for transient occupation of the field camp during ‘alalā releases and monitoring activities, no change in the human population of the area is expected to result from the action. Biological technicians involved in site preparation, maintenance and monitoring of released ‘alalā could be employees of USFWS, DOFAW, or a private contractor, and could potentially be local residents. Other activities on State lands, such as fencebuilding and repair, would be done by DOFAW personnel.

Fencing materials would be purchased on-island, producing income for local business. The establishment and expansion of an ‘alalā population at Kapāpala could provide an opportunity for birdwatching tours, employing local residents.

Land Use

Native bird reintroduction and recovery is fully consistent with the conservation mission of the Forest Reserve system. The existing plans to use the Koa Management Area as a demonstration and experimentation area for sustainable forestry would not be impaired by implementation of this alternative, and would in fact be enhanced. ‘Alalā are easy to monitor and their ability to maintain home ranges in the face of various forestry practices would provide an objective measure of sustainability.

Ongoing land uses on private lands adjacent to Kapāpala would not be affected by a release

program. For example, pre-existing cattle ranching activities continue to take place at and around the current release site in central Kona.

Permission would be sought to allow access to the proposed release area over private roads. Permission would also be sought for access to private lands by reintroduction personnel for purposes of monitoring any released 'ālalā that wandered outside public lands. However, the success of a reintroduction program at Kapāpala would not depend on obtaining access rights to private lands.

Development

Reintroduction of 'ālalā to Kapāpala would not directly affect potential development of surrounding private lands, because most of these lands are within the Conservation District. However, activities that resulted in significant degradation of native forest could reduce the foraging or nesting habitat of a reestablished population of 'ālalā.

As noted in Table 2, only about 7% of the total nesting habitat accessible to 'ālalā released at Kapāpala consists of private lands or State lease lands outside the Conservation District. Owners or lessees of these lands might want to obtain the regulatory assurances provided by SHAs prior to potential establishment of 'ālalā on their land.

Public Use

Because the Koa Management Area is currently closed to game mammal hunting, ungulate control in that part of the proposed release area would have no effect on public hunting. Figure 9 suggests that the other potential nesting habitat within the proposed release area is in the more remote upper elevations of Ka'ū FR and just inside the boundary of the Kapāpala FR. Ungulate control measures would be prioritized to protect primarily nesting habitat, and so at least initially, the lower sections of the Ka'ū FR would remain available for public hunting. Prior to the construction of an ungulate enclosure within a Forest Reserve, DOFAW would be required to publish an environmental assessment of the action, allowing public review and comment.

'Alalā are known to be attracted to gunfire, and may perch near humans and alarm-call repeatedly. In the past, hunters have been known to shoot such 'ālalā to keep the birds from alerting their quarry (D. Woodside, pers. commun., 1998). There is also a potential for bird hunters to confuse the 'ālalā with kalij pheasant. For these reasons, an 'ālalā-specific education program and materials would be necessary for hunters that use areas near Kapāpala where 'ālalā might be encountered. Local game bird hunters are used to hunting in the presence of nēnē, another listed species, and have hunted the area for many years without significant conflicts.

Nesting 'ālalā are very sensitive to human presence. Therefore, if 'ālalā nested where their territories could be affected by hunting, local closures might be established during nesting season, approximately March through July. This should not affect game bird hunting, which

occurs November through January.

Gathering of native plants for cultural purposes within the Forest Reserves would not be affected by implementation of this alternative, unless it became necessary for DOFAW to enforce access restrictions to the fenceline road surrounding the Koa Management Area. Exclusion of the public from nest areas during breeding season may be more than offset by the increased diversity and abundance of native plants that would follow habitat management. As traditional gathering rights are protected, any perceived conflicts between gathering and an 'alalā reintroduction program would need to be resolved.

Recreational hiking along the 'Ainapō trail would not be impacted by the release program, although publicized presence of 'alalā could increase use of access roads, the trail and the State cabin. If nesting occurred near the trail or cabin, a user education effort would be needed to minimize the potential for conflict during the breeding season, and to prevent possible scavenging by 'alalā at the cabin.

Cultural resources

Placement of hacking towers and the location of any primitive camping area would avoid disturbance of any archeological features discovered during the release program.

The 'alalā is a native Hawaiian bird with a prominent cultural image. It has traditionally been considered an 'aumakua or family guardian deity, it was kept as a pet, and its feathers were used to decorate kahili (Malo 1951). Reestablishment and maintenance of a population of these impressive birds may be considered an important enhancement of the cultural resources of the area.

4.3.3 Effects on the biological environment

Native biodiversity

Reintroduction of 'alalā to the forests of Ka'ū would restore a formerly abundant, but now missing, component of the bird fauna, and therefore increase native biodiversity in the area. There are currently no plans to proactively manage Kapāpala for biodiversity values. The measures to control threats to 'alalā that would be instituted as part of a release program would have broad positive effects on an area that is an important repository for native biodiversity. Feral ungulate control would allow regeneration of native understory plants. Trapping of small mammalian predators should reduce mortalities of all bird species in the area. Control of rats would probably increase the reproduction of many forest plants.

'Alalā eat fruits of, and spread the seeds of, many native plants. The impact of such dispersal on plant diversity and abundance would be highest within 'alalā territories, and would be cumulative.

‘Alalā are known predators on small forest birds, especially nestlings and eggs. This predation is greatest during the breeding season, when nestlings and eggs make up a significant part of the diet fed to ‘alalā chicks and nesting females (D. Ball, unpubl. data). Released ‘alalā therefore could have a negative effect on the reproduction of other forest birds in the area. However, predator control instituted to protect ‘alalā nests and fledglings should reduce predator densities in the area, possibly compensating for the increased mortality due to ‘alalā. The abundance of fledgling forest birds in areas within and outside of ‘alalā breeding territories could be measured to determine if ‘alalā predation was a significant problem. There is a potential for ‘alalā to compete with ‘ōma‘o for fruit, but the impact on populations of ‘ōma‘o would be difficult to measure.

Endangered, threatened or candidate species

Reintroduction of ‘alalā to Kapāpala would produce several benefits for the ‘alalā and the recovery effort. Release of other juvenile corvids in areas without conspecifics has reduced the time to first breeding (J. Marzluff, pers. commun., 1998), but this effect has not been tested in ‘alalā. Other important research questions include determination of factors limiting ‘alalā populations in areas besides the current release area, and observing social development and dispersal behavior in the absence of adult, wild ‘alalā. Such research would help refine reintroduction strategies and improve the recovery program.

Establishment of a breeding population would provide a valuable source of young ‘alalā for reintroduction elsewhere or for augmenting the captive breeding flock. Such a population would also reduce the chance that a catastrophic event could eliminate the wild flock.

Expansion of a reintroduced ‘alalā population to a large size is possible at Kapāpala due to the large area of potential nesting habitat nearby (Table 2). However, unless access and other problems are solved that restrict the agencies’ ability to control limiting factors, it is questionable whether mortality rates could be reduced sufficiently for ‘alalā to reestablish and persist over much of this range. Present habitat quality is suspected to be similar or worse than that which existed during the demise of the historical ‘alalā population in Ka‘ū.

Placement of hacking towers and other release support facilities would avoid impacting any endangered plants at Kapāpala. *Clermontia lindseyana* and *Cyanea stictophylla* could benefit from reintroduction of ‘alalā because their fruit is attractive to crows and the seeds would be spread throughout the forest. The impact of such dispersal would be highest within ‘alalā territories, and would be cumulative.

A program of behavioral modification might be instituted for resident, territorial ‘io. This could involve capture and aversive conditioning to ‘alalā or a surrogate prey item. Lethal control or relocation of resident ‘io is not contemplated, although temporary capture and holding of resident ‘io might be considered in order to protect an ‘alalā nest during the breeding season. These activities should not affect the local population numbers or distribution of ‘io.

Harmful non-native species

Predator control associated with a release program would reduce densities of feral cats, mongoose and (with approval for toxicants) rats within the release area. Although cats and mongoose prey on introduced rodents, it is unclear whether these predators control rodent populations in Hawaiian forest (G. Lindsey, pers. commun., 1998). Therefore it is unknown whether rat and mouse populations would increase as a result of control of some of their predators.

There is no projected removal program for feral ungulates or invasive weeds for Ka'ū FR or Kapāpala FR. Therefore, habitat management associated with an 'alalā release program would produce a net benefit to native ecosystems by instituting such programs over part of the Forest Reserves.

Discovery and exploitation of banana poka or guava at low elevations by released 'alalā might tend to spread these plants into the release area through seed dispersal. However the dispersal effect of a small initial 'alalā population of approximately 10 birds (Table 2) would probably be insignificant compared to ongoing dispersal by much larger numbers of kalij pheasant (J. Giffin, pers. commun., 1999). Control of these invasive plants would concentrate on the home ranges of released 'alalā in order to minimize the potential effect of 'alalā-assisted seed dispersal.

4.3.4 Other Effects

Irreversible and Irretrievable Commitments of Resources

This alternative would not result in an irreversible or irretrievable commitment of resources by the agencies.

Cumulative Effects

If habitat management actions, such as predator and feral ungulate control could take place on neighboring private lands, possibly through the development of SHAs, further benefits to native biodiversity would ensue.

4.3.5 Mitigation Measures

Sites for trails, fences, hack towers, and campsites would be selected so as not to affect rare plants. Hacking structures would be dismantled after completion of the project. Toxicants, if used for predator control, would be used in accordance with registered labels and adequate signage would be posted. Biologists would monitor the area for signs of non-target poisoning if toxicants are used. Vehicles and equipment would be cleaned to avoid introducing additional weeds into the area, and the release area would be inspected periodically for incipient weed infestations.

4.4 ALTERNATIVE 4: KŪLANI

4.4.1 Effects on the physical environment

Volcanology, Topography, Soils, and Climate

The proposed action would not affect the volcanology, topography, or climate of Kūlani. Vehicle use would be confined to existing roads, minimizing soil erosion.

Hydrology and Water Resources

The hydrology and water resources of Kūlani would not be affected by the proposed project.

4.4.2 Effects on the social and economic environment

Population, employment and local economy

No change in the human population of the area is expected to result from the action. Biological technicians involved in site preparation, maintenance and monitoring of released ‘alalā could be employees of USFWS, DOFAW, or a private contractor, and could potentially be local residents. Other activities on State lands would be done by existing Federal and State personnel or prison inmates. Potential ecotourism activities on Keauhou Ranch might be positively affected by the presence of one of the world’s rarest birds.

Land Use

Implementation of this alternative would take place within the framework of the proposed management plan for the area (OKMG 1998a). No effects of the release program on prison operations at Kūlani are predicted because the security needs of the prison would take precedence over the access and monitoring needs of project personnel. Potential conflicts with other operational aspects of the prison would be resolved prior to project initiation within the ‘Ōla‘a-Kīlauea Partnership process.

Operations of Keauhou Ranch would be unaffected by ‘alalā reintroduction, although the forested northwestern corner of the ranch adjacent to the proposed release site, as well as some of the more lightly grazed kīpuka, might be visited by released birds. A planned SHA will reduce the actual or perceived legal risks associated with ‘alalā presence on these private lands. The SHA would allow for access to private lands by reintroduction personnel for purposes of monitoring released ‘alalā.

Although KBCC is over 7 km (4 mi) from the proposed release area, and is not in an area of nesting or foraging habitat, it is possible that released ‘alalā could find the facility and interact

with the captive flock. Negative interactions might force a recapture of released birds for relocation, but would not significantly affect operations at KBCC.

Development

Reintroduction of ‘alalā to Kūlani would not directly affect potential development of surrounding private lands. However, activities that resulted in significant degradation of native forest could reduce the foraging or nesting habitat of a reestablished population of ‘alalā.

As noted in Table 2, only about 5% of the total nesting habitat accessible to ‘alalā released at Kūlani consists of private or State lease lands outside the Conservation District. Owners or lessees of these lands might want to obtain the regulatory assurances provided by SHAs prior to potential establishment of ‘alalā on their land.

Public Use

Game bird and mammal hunting are the primary public uses that could be affected by an ‘alalā release program at Kūlani. ‘Alalā are known to be attracted to gunfire, and may perch near humans and alarm-call repeatedly. In the past, hunters have been known to shoot such ‘alalā to keep the birds from alerting their quarry (D. Woodside, pers. commun., 1998). There is also a potential for bird hunters to confuse the ‘alalā with kalij pheasant. For these reasons, an education program and materials specific to ‘alalā would be necessary for hunters that use areas near Kūlani where ‘alalā might be encountered. These areas include the adjoining Upper Waiākea FR, Pu‘u Maka‘ala NAR, and the ‘Ōla‘a Tract (Fig. 10). However, members of the ART do not expect ‘alalā to nest or forage extensively in areas much below 1525 m (5000 ft) due to the very high rainfall (Fig. 11) and low food plant density.

Cultural resources

The ‘alalā is a native Hawaiian bird with a prominent cultural image. It was considered an ‘aumakua or family guardian deity in traditional times, and its feathers were used to decorate kahili (Malo 1951). Establishment and maintenance of a population of these impressive birds may be considered an important enhancement of the cultural resources of the area. Placement of hacking towers would carefully avoid impacting any archaeological or historical resources discovered during construction.

4.4.3 Effects on the biological environment

Native biodiversity

The ‘alalā had no known historical presence at Kūlani. However, because the plant and animal communities found at Kūlani are very similar to those found a few kilometers away, where ‘alalā are known to have nested, there is little reason to suspect that the ecological effects of an ‘alalā

introduction would differ substantially from a reintroduction to formerly occupied habitat.

The measures to control threats to ‘alalā that would be instituted as part of a release program would have broad positive effects on an area that is an important repository for native biodiversity. Trapping of small mammalian predators should reduce mortalities of all bird species in the area. Control of rats would probably increase the reproduction of many forest plants. However, expenditure of resources at Kūlani would preclude those same resources being spent in portions of the ‘alalā’s historic range where little or no biodiversity protection is occurring.

‘Alalā eat fruits of, and spread the seeds of, many native plants. The impact of such dispersal on plant diversity and abundance would be highest within ‘alalā territories, and would be cumulative. There is a potential for ‘alalā to compete with ‘ōma‘o for fruit, but the impact on populations of ‘ōma‘o would be difficult to measure. With ongoing forest recovery, fruit should become more abundant with time.

‘Alalā are known predators on small forest birds, especially nestlings and eggs. This predation is greatest during the breeding season, when nestlings and eggs make up a significant part of the diet fed to ‘alalā chicks and nesting females (D. Ball, unpubl. data). However, predator control instituted to protect ‘alalā nests and fledglings should reduce predator densities in the area, possibly compensating for the increased mortality due to ‘alalā. The abundance of fledgling forest birds in areas within and outside of ‘alalā breeding territories could be measured to determine if ‘alalā predation is a significant problem.

Endangered, threatened or candidate species

Introduction of ‘alalā to Kūlani would produce several benefits for the ‘alalā and the recovery effort. Release of other juvenile corvids in areas without conspecifics has reduced the time to first breeding (J. Marzluff, pers. commun., 1998), but this effect has not been tested in ‘alalā. Other important research questions include determination of factors limiting ‘alalā populations in areas besides the current release area, description of factors that control(led) the limits of historic range, and observation of social development and dispersal behavior in the absence of adult, wild ‘alalā. Such research would help refine reintroduction strategies and improve the recovery program.

In addition, establishment of a breeding population, even two or three pairs within the release area, would provide a valuable source of young ‘alalā for reintroduction elsewhere or for augmenting the captive breeding flock. Such a population would also reduce the chance that a catastrophic event could eliminate the wild flock.

If the high quality of the habitat surrounding Kūlani resulted in tightly packed breeding territories, a substantial population of ‘alalā could occupy nearby habitat (Table 2). The number of potential breeding pairs (estimated at 21, Table 2) might suffice for a self-sustaining

population in the long term. On the other hand, if climatic or other environmental factors originally limited 'alalā to its historic range, introductions to Kūlani could fail to lead to a breeding population.

Predation by 'alalā on nestlings of 'ākepa, 'akiapōla'au, and Hawai'i creeper could negatively affect these endangered birds. As with non-endangered forest birds, control of mammalian predators might increase fledging success enough to compensate for any increased mortality due to 'alalā. Because it is unlikely that 'alalā would prey upon adult birds, nest predation would most likely cause shifts in breeding territories of these birds rather than their elimination from the Kūlani area. Monitoring the distribution of these species with reference to 'alalā distribution would help determine the extent of negative interaction.

A program of behavioral modification might be instituted for resident, territorial 'io. This could involve capture and aversive conditioning to 'alalā or a surrogate prey item. Lethal control or relocation of resident 'io is not contemplated, although temporary capture and holding of resident 'io might be considered in order to protect an 'alalā nest during the breeding season. These activities should not affect the local population numbers or distribution of 'io.

Placement of hacking towers and other release support facilities would avoid impacting any endangered plants at Kūlani. 'Ōhā wai, hāhā, anini, and other rare and endangered plants with attractive fruit could benefit from reintroduction of 'alalā because their seeds would be spread throughout the forest. The impact of such dispersal would be highest within 'alalā territories, and would increase over time.

Harmful non-native species

Predator control associated with a release program would reduce densities of feral cats, mongoose and (with approval for toxicants) rats within the release area. Although cats and mongoose prey on introduced rodents, it is unclear whether these predators control rodent populations in Hawaiian forest (G. Lindsey, pers. commun., 1998). Therefore it is unknown whether rat and mouse populations would increase as a result of control of some of their predators.

Discovery and exploitation of banana poka, yellow Himalayan raspberry, or faya tree by released 'alalā might continue or increase the infestation of these plants through seed dispersal. Control of these invasive plants could concentrate on the home ranges of released 'alalā in order to minimize the potential effect of 'alalā-assisted seed dispersal.

Because of the ongoing and planned feral ungulate and weed control at Kūlani, the net benefit of this alternative is lower than Alternatives 2 and 3, where no conservation measures are in place.

4.4.4 Other Effects

Irreversible and Irrecoverable Commitments of Resources

This alternative would not result in an irreversible or irretrievable commitment of resources by the agencies.

Cumulative Effects

In conjunction with the ongoing and planned conservation measures within the OKMG area of action, the predator control measures undertaken as part of an 'alaī introduction would make the Kūlani area one of the most highly managed natural areas in Hawai'i. This would help to ensure the perpetuation of the native species and ecosystems contained in the area. If habitat management actions could take place on neighboring private lands, possibly through the development of SHAs, further benefits to native biodiversity would ensue.

4.4.5 Mitigation Measures

Sites for trails, hack towers, and campsites would be selected so as not to affect rare plants. Hacking structures would be dismantled after completion of the project. Toxicants, if used for predator control, would be used in accordance with registered labels and adequate signage would be posted. Biologists would monitor the area for signs of non-target poisoning if toxicants are used. Vehicles and equipment would be cleaned to avoid introducing additional weeds into the area, and the release area would be inspected periodically for incipient weed infestations.

4.5 ALTERNATIVE 5: HAKALAU

4.5.1 Effects on the physical environment

Volcanology, Topography, Soils, and Climate

The proposed action would not affect the volcanology, topography, or climate of Hakalau. Vehicle use would be confined to existing roads, minimizing soil erosion.

Hydrology and Water Resources

The hydrology and water resources of Hakalau would not be affected by the proposed project. Human waste generated by field personnel would be contained and periodically removed from the site and would not enter streams or ground water.

4.5.2 Effects on the social and economic environment

Population, employment and local economy

Except for periodic occupations of field camps and cabins by release personnel, no change in the human population of the area is expected to result from the action. Biological technicians involved in site preparation, maintenance and monitoring of released 'alalā could be employees of USFWS, DOFAW, or a private contractor, and could potentially be local residents. Other activities on Federal lands would be done by existing Federal personnel.

Land Use

Implementation of this alternative would take place within the framework of existing management plans for the Refuge, therefore no effects of the release program on the operation of Hakalau Forest NWR are expected.

Extensive utilization of ranch lands adjoining the Refuge is unlikely because few food plants exist within pasture areas. However, a SHA should eliminate actual and perceived legal risks associated with 'alalā presence on these private and leasehold lands.

Permission would be sought for access to private lands by reintroduction personnel for purposes of monitoring any released 'alalā that wandered outside public lands. However, the success of a reintroduction program at Hakalau would not depend on obtaining access rights to private lands.

Development

Introduction of 'alalā to Hakalau would not directly affect potential development of surrounding private lands and leasehold lands. However, development activities that resulted in significant degradation of native forest could reduce the foraging habitat or nesting habitat of a reestablished population of 'alalā.

As noted in Table 2, approximately 24% of the total nesting habitat accessible to 'alalā released at Hakalau consists of private or leasehold lands outside the Conservation District. Owners or lessees of these lands might want to obtain the regulatory assurances provided by SHAs prior to potential establishment of 'alalā on their land.

Public Use

Game bird and mammal hunting are the primary public uses that could be affected by an 'alalā release program at Hakalau. 'Alalā are known to be attracted to gunfire, and may perch near humans and alarm-call repeatedly. In the past, hunters have been known to shoot such 'alalā to keep the birds from alerting their quarry (D. Woodside, pers. commun., 1998). There is also a potential for bird hunters to confuse the 'alalā with kalij pheasant. For these reasons, an 'alalā-

specific education program and materials would be necessary for hunters that use areas within and near Hakalau where 'alalā might be encountered. These areas include parts of the Refuge itself, the intervening Piha Tract of the Hilo FR, the Laupāhoehoe FR, and areas of the Hilo FR near Saddle Road (Fig. 12). However, members of the ART doubt that 'alalā would nest or forage extensively in areas much below 1525 m (5000 ft) due to the very high rainfall (Fig. 13).

Ecotourism and other public opportunities to observe rare Hawaiian birds would possibly increase with initiation of an 'alalā release program, because Hakalau is already popular with birders due to its high concentration of endangered forest birds.

Cultural resources

The 'alalā is a native Hawaiian bird with a prominent cultural image. It was considered an 'aumakua or family guardian deity in traditional times, and its feathers were used to decorate kahili (Malo 1951). Establishment and maintenance of a population of these impressive birds may be considered an enhancement of the cultural resources of the area. Placement of hacking towers would carefully avoid impacting any archaeological or historical resources.

4.5.3 Effects on the biological environment

Native biodiversity

The 'alalā had no known historical presence at Hakalau. However, because the plant and animal communities found at Hakalau are similar to those found elsewhere on the island where 'alalā are known to have occurred, there is little reason to suspect that the ecological effects of an 'alalā introduction would differ substantially from a reintroduction to formerly occupied habitat.

The measures to control threats to 'alalā that would be instituted as part of a release program would have broad positive effects on an area that is an important repository for native biodiversity. Trapping of small mammalian predators should reduce mortalities of all bird species in the area. Control of rats would probably increase the reproduction of many forest plants. However, expenditure of resources at Hakalau would preclude those same resources being spent in portions of the 'alalā's historic range where little or no biodiversity protection is occurring.

'Alalā eat fruits of, and spread the seeds of, many native plants. The impact of such dispersal on plant diversity and abundance would be highest within 'alalā territories, and would be cumulative. There is a potential for 'alalā to compete with 'ōma'ō for fruit, but the impact on populations of 'ōma'ō would be difficult to measure. With ongoing forest recovery, fruit should become more abundant with time.

'Alalā are known predators on small forest birds, especially nestlings and eggs. This predation is greatest during the breeding season, when nestlings and eggs make up a significant part of the

diet fed to 'alalā chicks and nesting females (D. Ball, unpubl. data). Released 'alalā, therefore, could have a negative effect on the reproduction of other forest birds in the area. However, predator control instituted to protect 'alalā nests and fledglings should reduce predator densities in the area, possibly compensating for the increased mortality due to 'alalā. The abundance of fledgling forest birds in areas within and outside of 'alalā breeding territories could be measured to determine if 'alalā predation is a significant problem.

Endangered, threatened or candidate species

Introduction of 'alalā to Hakalau would produce several benefits for the 'alalā and the recovery effort. Release of other juvenile corvids in areas without conspecifics has reduced the time to first breeding (J. Marzluff, pers. commun., 1998), but this effect has not been tested in 'alalā. Other important research questions include determination of factors limiting 'alalā populations in areas besides the current release area, description of factors that control(led) the limits of historic range, and observation of social development and dispersal behavior in the absence of adult, wild 'alalā. Such research would help refine reintroduction strategies and improve the recovery program.

In addition, establishment of a breeding population, even one or two pairs within the release area, would provide a valuable source of young 'alalā for reintroduction elsewhere or for augmenting the captive breeding flock. Such a population would also reduce the chance that a catastrophic event could eliminate the wild flock. However, even a population of 13 breeding pairs, utilizing all suitable habitat on windward Mauna Kea (Table 2), would probably be too small to be self-sustaining in isolation (Duckworth *et al.* 1992), and would require monitoring and occasional supplementation with outside individuals in order to avoid decline and extirpation. On the other hand, if climatic or other environmental factors originally limited 'alalā to its historic range, introductions to Hakalau could fail to lead to a breeding population.

Predation by 'alalā on nestlings of 'ākepa, 'akiapōlā'au, and Hawai'i creeper could negatively affect these endangered birds, which Hakalau Forest NWR was established to protect. As with non-endangered forest birds, control of mammalian predators might increase fledging success enough to compensate for any increased mortality due to 'alalā. Because it is unlikely that 'alalā would prey upon adult birds, nest predation would most likely cause shifts in breeding territories of these birds rather than their elimination from the area. Monitoring the distribution of these species with reference to 'alalā distribution would help determine the extent of negative interaction.

A program of behavioral modification might be instituted for resident, territorial 'io. This could involve capture and aversive conditioning to 'alalā or a surrogate prey item. Lethal control or relocation of resident 'io is not contemplated, although temporary capture and holding of resident 'io might be considered in order to protect an 'alalā nest during the breeding season. These activities should not affect the local population numbers or distribution of 'io.

Placement of hacking towers and other release support facilities would avoid impacting any endangered plants at Hakalau. *Clermontia lindseyana*, *Clermontia pyrularia* and *Cyanea shipmanii* could benefit from reintroduction of ‘alalā because their fruit is attractive to crows and the seeds would be spread throughout the forest. The impact of such dispersal would be highest within ‘alalā territories, and would be cumulative.

Harmful non-native species

Predator control associated with a release program would reduce densities of feral cats, mongoose and (with approval for toxicants) rats within the release area. Although cats and mongoose prey on introduced rodents, it is unclear whether these predators control rodent populations in Hawaiian forest (G. Lindsey, pers. commun., 1998). Therefore it is unknown whether rat and mouse populations would increase as a result of control of some of their predators.

Discovery and exploitation of banana poka, blackberry, holly, or other fruiting invasive plants by released ‘alalā would likely introduce or increase an infestation of these plants through seed dispersal. Control of these invasive plants could concentrate on the home ranges of released ‘alalā in order to minimize the potential effect of ‘alalā-assisted seed dispersal.

Because of the ongoing and planned feral ungulate and weed control at Hakalau, the net benefit of this alternative is lower than Alternatives 2 and 3, where no conservation measures are in place.

4.5.4 Other Effects

Irreversible and Irrecoverable Commitments of Resources

This alternative would not result in an irreversible or irretrievable commitment of resources by the Service.

Cumulative Effects

In conjunction with the ongoing and planned conservation measures within Hakalau Forest NWR, the predator control measures undertaken as part of an ‘alalā introduction would make Hakalau one of the most highly managed natural areas in Hawai‘i. This would help to ensure the perpetuation of the native species and ecosystems contained in the area. If habitat management actions could take place on neighboring private lands, possibly through the development of SHAs, further benefits to native biodiversity would ensue.

4.5.5 Mitigation Measures

Sites for hack towers would be selected so as not to affect rare plants. Hacking structures would

be dismantled after completion of the project. Toxicants, if used for predator control, would be used in accordance with registered labels and adequate signage would be posted. Biologists would monitor the area for signs of non-target poisoning if toxicants are used. Vehicles and equipment would be cleaned to avoid introducing additional weeds into the area, and the release area would be inspected periodically for incipient weed infestations.

4.6 ALTERNATIVE 6: NO ACTION

Selection of the No Action alternative would continue the present release program at the Kona Forest Unit and McCandless Ranch, with no other reintroduction sites becoming available in the near future. Management actions currently anticipated for the Refuge lands (USFWS 1997a) would continue as proposed.

4.6.1 Effects on the physical environment

Volcanology, Topography, Soils, and Climate

The release program has no effect on the volcanology, topography, soils, or climate of the current release site. Because no effects are anticipated at any alternate site, selection of this alternative will have no effect on these resources.

Hydrology and Water Resources

The release program has no effect on the hydrology and water resources of the current release site. Because no effects are anticipated at any alternate site, selection of this alternative will have no effect on these resources.

4.6.2 Effects on the social and economic environment

Population, employment and local economy

Selection of this alternative would allow for little expansion of ecotourism based on 'ālalā viewing beyond that presently occurring, due to the low levels of public use compatible with a release program at any one site. Current staffing levels at the Kona Forest Unit may be maintained or may slightly increase with time, with little or no effect on local employment.

Land Use

Selection of this alternative would restrict 'ālalā releases to the Kona Forest/McCandless area, and would therefore increase the number of 'ālalā released there in a given amount of time. This would tend to increase the rate at which 'ālalā disperse from this source area. Neighboring landowners may have 'ālalā dispersing onto their properties sooner than would be the case if

multiple release sites were available.

Without releases of 'ālalā at other sites, landowners adjacent to the proposed alternative release sites would not be subject to the perceived legal risks associated with having 'ālalā on their properties. No monitoring personnel would seek permission to track or recover 'ālalā on lands adjacent to any other proposed release site.

Development

Restricting 'ālalā releases to the McCandless area, and therefore increasing the number of 'ālalā released there in a given amount of time, would tend to increase the rate at which 'ālalā disperse from this source area. Neighboring landowners may have 'ālalā on their properties sooner than would be the case if any of the action alternatives were selected.

Without releases of 'ālalā at other sites, landowners adjacent to those proposed release sites would not be subject to the perceived legal risks associated with having 'ālalā on their properties. This may increase the amount of time available, perhaps indefinitely, to develop private lands without the potential regulatory complications inherent in developing habitat occupied by an endangered species in the absence of SHAs.

Public Use

This alternative does not affect hunting, gathering or other use of public lands. No restrictions, beyond those currently in place, would be created for areas now open to the public adjacent to the proposed alternative sites.

Cultural resources

Selection of the no action alternative would restrict 'ālalā to a small part of their former range for the foreseeable future. The culturally significant presence of the 'ālalā in upland forests elsewhere on the island would be absent. Educational materials would not be prepared or distributed to hunters, so fewer people would become aware of the 'ālalā and conservation issues than would be the case with Alternatives 1, 2, 3 or 4.

4.6.3 Effects on the biological environment

Native biodiversity

Under the no action alternative, the 'ālalā will not be reintroduced to other areas within its historic range. The ecological functions of this species will not be carried out, with unknown effects on the native ecosystems where the 'ālalā had been present for thousands of years.

Selection of this alternative will restrict habitat management activities aimed at limiting factors

of 'ālalā to the current release site. Financial resources and staffing that could have partly or fully controlled major causes of ecosystem decline would not go to presently unmanaged sites.

Selection of the no action alternative would also prevent the introduction or reintroduction of a predator on native forest birds to areas outside central Kona. This would protect the local populations of forest birds from crow predation. However, these same populations of forest birds would not benefit from predator control programs aimed at controlling 'ālalā mortality. It is unknown whether this alternative would represent a net gain or loss for forest bird populations.

Endangered, threatened or candidate species

Selection of this alternative would prevent the agencies from implementing a set of actions that a large number of experts have regarded as essential for the recovery of the critically endangered 'ālalā (USFWS 1982, Giffin *et al.* 1987, Duckworth *et al.* 1992, USFWS 1993). Such actions include management of limiting factors in suitable habitat, establishment of multiple subpopulations, and reproduction and subsequent growth of the 'ālalā population in the wild.

The current understanding of the factors limiting 'ālalā populations has been impaired by the lack of comparative sites, where different factors or different levels of the same factors would help show their relative importance. Management of limiting factors will continue to be hampered until it is determined which factors are most important to control under which circumstances. Selection of the no action alternative would allow managers to focus on factors limiting the McCandless population, but would provide no guidance on management priorities outside that limited area.

The expansion of the 'ālalā population in the wild, if all birds are released in a single area, will be limited by rate at which these birds disperse and spread into neighboring areas. Conversely, selection of one or more action alternatives increases the potential population expansion rate because there is more neighboring habitat around multiple sites than around a single site. The rate at which 'ālalā move into adjacent areas appears to be slow, based on observations to date (USFWS, unpubl. data). In addition, the no action alternative would limit the eventual 'ālalā population to the size that could be supported by forests in Kona accessible to birds released at McCandless. Large areas of forest capable of supporting 'ālalā would not be recolonized. Because expansion of the total 'ālalā population is important to preserving the genetic diversity of the species, restricting the release to McCandless would have a negative effect on the 'ālalā.

Restriction of releases to the McCandless area does not provide additional populations of 'ālalā outside of captivity. Therefore, a catastrophic event (e.g., fire, lava flow, hurricane) at the current release site could eliminate all 'ālalā in the wild.

The lack of alternative reintroduction sites will force the agencies to release yearly cohorts of juveniles within a fairly small area where they are virtually certain to interact with previous cohorts and the remaining wild adult 'ālalā. Large numbers of interacting juveniles may delay

social development of the birds, such as pair formation and breeding (J. Marzluff, pers. commun., 1999). Selection of this alternative would therefore reduce the total number of young ‘alalā that could be released in a year. Because of this limitation, the rate of production of ‘alalā from the captive breeding facilities would probably be kept lower than would be the case with selection of any of the other alternatives, slowing population growth.

By restricting ‘alalā to the McCandless site for the indefinite future, endangered plants known or suspected to benefit from dispersal via ‘alalā (e.g., hāhā, ‘aiea, *Delissea undulata*) which occur at the alternative release sites will not be dispersed by these birds. Some of these plant species consist of only a few individuals, and are thought to be rare, at least in part, because of a lack of effective dispersers (Cuddihy and Stone 1990). Therefore selection of the no action alternative might contribute to the extirpation or extinction of endangered plants.

Selection of the no action alternative would prevent the introduction or reintroduction of a predator on native forest birds to areas outside central Kona. This would prevent the local populations of at least three, and possibly four (if the ‘ō‘ū is extant), endangered forest birds from being negatively affected by crow predation. However, these same populations of forest birds would not benefit from habitat restoration and predator control programs aimed at controlling ‘alalā mortality. It is unknown whether this would represent a net gain or loss for these forest bird populations.

Harmful non-native species

Selection of this alternative will restrict habitat management activities aimed at factors that limit ‘alalā to the current release site. Resources that could have partly or fully controlled alien species such as predatory mammals, ungulates, and disease vectors in multiple areas will instead be concentrated at a single site. Therefore, fewer total destructive animals will be controlled under this alternative.

With ‘alalā releases confined to McCandless, the opportunity will not exist for ‘alalā to spread the seeds of invasive fruiting plants into or around other natural areas. Whether the contribution of ‘alalā to the spread of these weeds would actually be significant in any case is unknown.

4.6.4 Other Effects

Irreversible and Irretrievable Commitments of Resources

Selection of this alternative will not entail any irreversible or irretrievable commitments of resources by the agencies.

Cumulative Effects

Selection of the no action alternative would limit future agency actions to those associated with the existing program and release site. No additional sites would be managed for ‘alalā or associated habitat values, as would be the case with Alternatives 2 or 3, and none of the cumulative effects identified for the other alternatives would take place.

4.6.5 Mitigation Measures

No mitigation over that already occurring is proposed for the current release program. Mitigation of any deleterious effects of this alternative that are due to a lack of expansion of the ‘alalā recovery program would require selection of an alternative release site. If none of the present action alternatives are chosen, additional sites will be examined for possible inclusion in the recovery program.

4.7 SUMMARY OF CONSEQUENCES OF THE ALTERNATIVES

Table 5 presents a summary of the estimated net effects of implementing the various alternatives on specific resources or issues identified during scoping (Section 1.10). In this table, a “0” indicates that the net effect would be no change, a “-” indicates that the alternative would lead to a decrease in the resource or activity, a “+” or “++” indicates that the alternative would induce an increase or a large increase in the resource or activity, respectively; a “+/-” indicates that the alternative would result in both clear increases and decreases in different aspects of the resource, and a “?” shows that there is insufficient information to predict the net effect. These estimated net effects are based on the agencies’ best information and prediction at this time, and are subject to modification if new information is obtained during the public review and comment period.

None of the alternatives would affect the physical environment or change existing land use. Reestablishment of an ‘alalā population at Pu‘u Wa‘awa‘a, Honomalino or Kapāpala could increase the opportunities for ecotourism on neighboring private lands if ‘alalā, one of the world’s rarest birds, could be viewed on those properties. The other potential alternative release sites have no nearby private lands that would benefit from such economic opportunities.

Fencing to control feral ungulates would need to be purchased and installed if either Honomalino or Kapāpala were selected as alternatives. The other sites already have ungulate-proof fencing planned or in place. Development of private lands, taken here to include such activities as clearing of native forest for home sites, could conceivably be negatively affected by reestablishment of ‘alalā populations at either Pu‘u Wa‘awa‘a or Honomalino. However, these negative effects might only occur if such activities would result in taking of ‘alalā without a permit. Such permits, as part of SHAs, would be available to private landowners (see Chapter 4).

Current public uses of forest lands would not be affected by a release program at any alternative

site, with the possible exception of Kapāpala, where small areas of public hunting lands might be fenced for ungulate control. For all potential alternative sites, establishment of a population of ‘alalā would restore a majestic component of the natural cultural heritage of Hawai‘i to the area.

The habitat management actions associated with an ‘alalā release program at the five proposed alternative sites would increase populations of native plants and invertebrates due to reduction in ground disturbance, weed dispersal, and herbivory by introduced mammals. This effect would be stronger in areas currently without intensive habitat management (Honomalino and Kapāpala) than in areas currently under management. Selection of the no-action alternative would deprive some areas of beneficial habitat management, and therefore would have a negative effect on biodiversity.

Selection of any of the three proposed alternative sites that lie within the historic range of the ‘alalā would allow the population to expand significantly and would therefore produce a positive benefit to the ‘alalā. However, because the size and quality of potential habitat surrounding these alternative release sites vary, the potential net benefit to the ‘alalā is not equal for each alternative.

Although substantial areas of apparently suitable habitat exist at Kūlani and Hakalau, these sites are outside of the historic range. ‘Alalā may be unable to persist in these areas due to climatic or other unknown factors, rendering the potential population benefits of these alternatives less clear. Selection of the no action alternative would limit the ‘alalā to a single population on the island, slowing potential growth of the population and keeping the free-ranging birds vulnerable to a localized, catastrophic environmental event.

At all of the potential alternative release sites, an ‘alalā release program would have both positive and negative effects on other native forest birds. While these birds are known to benefit from management actions that would improve the habitat for ‘alalā, a population of ‘alalā may increase the mortality rate of other forest birds due to nest predation. Because even rare birds persist in the present habitat of the ‘alalā, the overall effect of nest predation may not be very large. Selection of the no action alternative would provide no support for habitat management actions at any of the proposed alternative sites.

Conservation actions on private lands would be supported by selection of Pu‘u Wa‘awa‘a, Honomalino, or Kūlani, because landowners adjacent to or within the proposed release sites could become parties to SHAs that provide conservation benefits to ‘alalā. In addition, financial support for management activities on private lands may be available to private partners through various government programs. Selection of the other potential alternative sites might or might not involve private partners as participants in SHAs, depending on the dispersal and expansion of ‘alalā populations. Selection of the no action alternative would provide fewer opportunities for private lands conservation than would selection of any other alternative.

Table 5. Summary of Effects Resource or Issue	ALTERNATIVE					
	Pu'u Wa'awa'a	Honomalino	Kapāpala	Kūlani	Hakalau	No Action
Physical Environment	0	0	0	0	0	0
Social and Economic Environment						
Ecotourism	+	+	+	+	0	0
Fence construction/maintenance	0	+	+	0	0	0
Land Use	0	0	0	0	0	0
Development	?	?	0	0	0	0
Public use	0	0	-	0	0	0
Cultural resources	+	+	+	+	+	0
Biological Environment						
Native biodiversity (plants, invertebrates)	+	++	++	+	+	-
'Alalā population	++	+	++	++?	+?	-
Populations of native forest birds	+/-	+/-	+/-	+/-	+/-	-
Control of harmful nonnative species	+	++	++	+	+	-
Other Concerns						
Private lands conservation actions	+	+	?	+	?	-

CHAPTER 5. SIGNIFICANCE CRITERIA

The proposed project is not expected to cause significant impacts to the environment, pursuant to the significance criteria established by the State of Hawai'i Environmental Council (Hawai'i Administrative Rules, Section 11-200-12) and discussed below; therefore, the preliminary expectation is a Finding of No Significant Impact.

The proposed actions do not involve an irrevocable commitment to loss or destruction of any natural or cultural resource. All actions proposed in this Draft Environmental Assessment (DEA) are anticipated to enhance the recovery of the 'alalā (*Corvus hawaiiensis*).

The proposed actions will not curtail the range of beneficial uses of the environment. All affected areas are within the Conservation District, and the activities proposed are intended to enhance the sites for endangered forest birds, native plants, and other wildlife.

The proposed actions will not conflict with the State's long-term environmental policies. The proposed actions will not conflict with the environmental policies set forth in the State Plan and Chapter 344, HRS, in that the proposed management actions will not damage sensitive natural resources nor emit excessive noise or contaminants.

The proposed actions will not substantially adversely affect the economic and social welfare of the community. The proposed activities utilize the most cost-effective conservation strategies for the recovery of a critically endangered species.

The proposed actions will not substantially adversely affect the public health of the community. The proposed actions will not emit excessive noise or contaminants and will not have substantial adverse affects on public health.

The proposed actions will not involve substantial secondary impacts, such as population changes or effects on public facilities. The proposed actions will not affect any existing public recreational facilities and will not induce population growth in the area.

The proposed actions will not involve a substantial degradation of environmental quality. Utilizing the best management practices will minimize impacts to the environment during implementation of these proposed actions.

The proposed actions will not have cumulative impacts or involve a commitment for larger actions. The proposed actions will not have negative cumulative impacts or involve significant commitment for larger actions than those described.

The proposed actions will not adversely affect a rare, threatened, or endangered species, or its habitat. Actions described will be implemented in a manner to avoid harm to any endangered

plants or other rare, threatened, or endangered species, and many of the activities may benefit endangered species and their habitat.

The proposed actions will not substantially affect air or water quality or ambient noise levels. Because of the scale of the project, it will not substantially affect air or water quality or ambient noise levels. The habitat management actions proposed will, in fact, improve the quality of the watershed.

The proposed project is not located in an environmentally sensitive area (e.g., flood plain, tsunami zone, and coastal zone). All sites are in upland forested areas. Although the sites are located in various subzones of the Conservation District, the proposed actions are in accordance with requirements of the preservation subzone.

The proposed actions will not substantially affect scenic vistas and view planes identified in county or State plans or studies. The project will not affect any of the listed sites or vistas for Hawai'i.

The proposed project will not require substantial energy consumption. The affected area is not on a local power grid, and, with sources being battery or generator power, energy consumption will be minimal.

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CHAPTER 7: LIST OF AGENCIES, ORGANIZATIONS, AND PERSONS CONSULTED

This draft EA will be distributed to the following agencies, organizations, and interested individuals:

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Office of Hawaiian Affairs (Linda Colburn, Administrator)

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Public Library System

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Environmental Center

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Secretariat for Conservation Biology (Nancy Glover)

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7.3 COUNTY AGENCIES

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Sierra Club, Hawai'i Chapter

The Wildlife Society - Hawai'i Chapter

National and International Organizations

American Bird Conservancy

American Ornithologists Union

American Museum of Natural History

BirdLife (formerly known as the International Council for Bird Preservation)

International Union for the Conservation of Nature

National Audubon Society

RARE Center for Tropical Conservation

Smithsonian Institution

Society for Conservation Biology

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APPENDIX A: ‘Alalā Release Site Evaluation

Working Criteria List

- Priority 1 Criteria: Features which are assumed at this time to be critical to releasing and establishing alala in the wild. A significant lack or uncorrectable problem in any of these criteria would result in the site being rejected from consideration.
- Priority 2 Criteria: Features that are necessary to consider but are not assumed to be critical to release objectives. Excessive problems in this category could result in the site being rejected from consideration.
- Priority 3 Criteria: Features which would add to or detract from the suitability of a site, but are not critical to site selection.

I. Priority 1 Criteria

A. Site Suitability

1. Presence of safe release site
2. Limitations of public access to immediate release site
3. Presence of forage plant and invertebrate populations
4. Presence of suitable roost and nest site overstory
5. Ability to manage limiting factors (e.g., predators)

B. Logistics

1. Access to release site by reintroduction personnel
2. Access to general release area by monitoring personnel
3. Access to adjacent lands by monitoring personnel

II. Priority 2 Criteria

A. Site Suitability

1. Within historic breeding and foraging habitat
2. Presence or lack of conspecifics
3. Cooperative land use management

B. Logistics

1. Visibility of the birds to reintroduction and monitoring personnel
2. Proximity of support facilities (e.g., housing, equipment storage)
3. Availability of communications system (e.g., cellular phone)

C. Man-made Threats/Hazards

1. Hunting and shooting levels in the area
2. Habitat modification activities (e.g., Koa harvesting, land clearing)
3. Presence of adjacent housing developments

D. Suitability of Adjacent Lands (for population expansion)

1. Current land use on adjacent areas
2. Expected long-term land use on adjacent areas
3. Cooperation of adjacent land use managers

III. Priority 3 Criteria

A. Site Suitability

1. Historic use of the release site by wild alala
2. Prevailing weather patterns (dry vs wet forest)
3. Presence or lack of feral ungulates
4. Presence or lack of disease vectors (e.g., mosquitoes, biting flies)
5. Presence or lack of non-native plant species
6. Presence or lack of non-native bird species

APPENDIX B: ‘Alalā Recovery Team Members

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