13. Hawai`i Creeper, *Oreomystis mana*

DESCRIPTION AND TAXONOMY

Adult Hawai`i creeper foraging on `ōhi`a trunk. Photo © Jack Jeffrey.

The Hawai`i creeper is a small Hawaiian honeycreeper (family Fringillidae, subfamily Drepanidinae) 10.8 to 13.0 centimeters (4.3 to 5.1 inches) in length and 13.7 grams (0.48 ounces) average weight (Lepson and Woodworth 2001). It is predominantly olive green on the back and dull greenish-buff below, with a white chin and throat. The brownish-white bill is almost straight, the iris is dark hazel, and the legs and feet are dark brown. Immatures are paler below, with less contrast between the throat and breast, and they usually have a prominent yellowish-white superciliary line. Field identification is complicated by its similarities in appearance and behavior with the Hawai`i `amakihi (*Hemignathus virens*), Hawai`i `ākepa (*Loxops coccineus coccineus*), and Japanese white-eye (*Zosterops japonicus*) (Scott *et al.* 1979).

At the time of European discovery, each of the six main Hawaiian Islands harbored a small, straight-billed, simple-tongued, insectivorous bird. The Hawai`i creeper was first described as *Himatione mana* by Wilson (1891a). Subsequent nomenclature has been problematic (reviewed in Pratt 1992b, 2001), and the species has variously been considered a full species (Perkins 1903), a subspecies of *Paroreomyza bairdi* (Bryan and Greenway 1944) and a subspecies of *Loxops maculata* (Amadon 1950). It is currently classified as *Oreomystis mana* (American Ornithologists' Union 1998) following Pratt (1979, 1992b), but recent evidence (Olson and James 1995, Fleischer *et al.* 2001) supports its inclusion as a full species in the genus *Loxops.*

LIFE HISTORY

Hawai`i creepers defend a small, 10 to 20 meter (33 to 66 feet) radius area immediately surrounding the nest, and forage over a 4 to 7 hectare (9.9 to 17.3 acre) home range during the breeding season (Ralph and Fancy 1994a, VanderWerf 1998b). Females do all or most of the nest building and incubate, brood, and feed the chicks; males assist by feeding the female both on and off the nest and by feeding the young (Sakai and Johanos 1983; VanderWerf 1998b; J. Nelson, U. S. Geological Survey, unpubl. data). During the nonbreeding season, pairs range over a wider area of about 11 hectares (27.2 acres) and join other forest birds in mixed-species flocks (VanderWerf 1998b).

The Hawai`i creeper generally feeds on insects, spiders, and invertebrates that are gleaned from the trunks and branches of mature trees (Scott *et al.* 1986). During the breeding season in Hakalau Forest National Wildlife Refuge, Hawai`i creepers foraged at a mean height of 13 meters (43 feet). Most foraging maneuvers were gleans (59 percent) or hangs (24 percent); they also probed, pecked, flaked, pried, and pulled substrates to obtain prey (n = 579 maneuvers, 35 individuals; U.S. Geological Survey, unpubl. data). Foraging took place primarily on the branches (63.7 percent of maneuvers), trunks (13.3 percent) and foliage (12.4 percent) of live `ōhi`a (*Metrosideros polymorpha*) and koa (*Acacia koa*) trees; the remainder of maneuvers were in subcanopy trees (specifically, `ōlapa [*Cheirodendron trigynum*]), dead trees, or epiphytes (n = 579 maneuvers; U.S. Geological Survey, unpubl. data). Beetle larvae make up a large part of its diet (Amadon 1950, Conant 1981a), but no detailed information on prey taken is available.

Nests of Hawai`i creepers have been found from January to August (Sakai and Ralph 1980, Scott *et al.* 1980, Sakai and Johanos 1983, VanderWerf 1998b, Woodworth *et al.* 2001), but peak breeding occurs from February to May, and molt occurs from May to August (Ralph and Fancy 1994a, Woodworth *et al.* 2001). A small proportion (less than 5 percent) of individuals may overlap breeding and molting activities (Ralph and Fancy 1994a, Woodworth *et al.* 2001).

A total of 78 nests of this species have been documented (Sakai and Ralph 1980, Scott *et al.* 1980, Sakai and Johanos 1983, VanderWerf 1998b, Woodworth *et al.* 2001). Based on 61 nests found at Hakalau Forest National Wildlife Refuge from 1994 to 1999, Hawai`i creepers generally build cup nests at mid-canopy at about 13 meters (43 feet) in height (range 2.8 to 24 meters [9 to 79 feet]) and about 1.5 meters (5 feet) from the main bole of the tree (range 0 to 4.8 meters [0 to 16 feet]). Most (86 percent) are open cup nests but a few (14 percent) are cavity or pseudo-cavity nests. Clutch size is usually two eggs, nest building requires 11 to 19 days, incubation 13 to 17 days, and the nestling period is 18 days (Sakai and Johanos 1983, VanderWerf 1998b, Woodworth *et al.* 2001). Approximately one-third of recorded nesting attempts have been abandoned before egg-laying commenced (33 percent, n = 6, VanderWerf 1998b; 27.9 percent, n = 61, Woodworth *et al.* 2001). At Hakalau Forest National Wildlife Refuge from 1994 to 1999, daily survival rates of active creeper nests were 0.950 ± 0.011 (standard error), and an average of 1.7 chicks fledged from successful nests (Woodworth *et al.* 2001). Only a fraction of known-fate nesting attempts are successful (11 percent, n = 9, Sakai and Johanos 1983; 50 percent, n = 6, VanderWerf 1998b; 20.4 percent, n = 49, Woodworth *et al.* 2001). The relatively high rate of nest failure across studies is alarming, especially given the relatively inaccessible locations where these birds nest. Further study is needed to elucidate the causes of these failures.

Data from marked pairs suggest that Hawai`i creepers readily re-nest after failure, and two pairs have been recorded re-nesting after fledging young earlier in the season (U.S. Geological Survey, unpubl. data). Parent Hawai`i creepers feed fledglings for at least 3 weeks post-fledging, but within 1 month of leaving the nest young are foraging independently for food (although still following parents; VanderWerf 1998b, Woodworth *et al.* 2001).

Hawai`i creepers have relatively high annual adult survival of about 73 to 88 percent (Ralph and Fancy 1994a, Woodworth *et al.* 2001), and juvenile survival of about 33 percent (Woodworth *et al.* 2001). The high survival rate of Hawai`i creepers in Hakalau in part may reflect the rarity of disease in this high-elevation refugium, above the level of mosquito populations.

In general, the reproductive potential of the Hawai`i creeper appears to be low due to its small clutch size, relatively long developmental period, and limited breeding season. This low reproductive potential is exacerbated by the high rate of nesting failures, possibly due to the introduction of mammalian nest predators. High adult and juvenile survival rates may compensate to some extent for low annual productivity, but if disease were to reach the upper elevation rain forests, it could have devastating effects. More detailed demographic data are needed to assess the implications for population persistence of the Hawai`i creeper.

Hawai`i creepers are non-migratory, but during the nonbreeding season they range more widely; the average nonbreeding home range size of 10 Hawai`i creepers was 11.9 ± 7.7 hectares (29.4 ± 19.0 acres) (range 4.3 to 27.1 hectares [10.6 to 66.9 acres]), and individual banded birds have been observed in different locations 1 to 4 kilometers (0.62 to 2.48 miles) apart (VanderWerf 1998b). Snetsinger (1995) observed a Hawai`i creeper in māmane (*Sophora chrysophylla*) forest 7 kilometers (4.35 miles) from the nearest known population.

HABITAT DESCRIPTION

Hawai`i creepers are most common in mesic and wet forests above 1,500 meters (5,000 feet) elevation (Scott *et al.* 1986). The species prefers relatively undisturbed koa/`ōhi`a forests (Sakai and Johanos 1983), and the highest densities occur in areas least modified by logging and grazing (Scott *et al.* 1986). The largest population (see Range and Status below) exists on the windward slope of Mauna Kea in the vicinity of Hakalau Forest National Wildlife Refuge. Annual rainfall at Hakalau averages 2,500 millimeters (98 inches), and the forest canopy is dominated by `ōhi`a and koa. The subcanopy is composed of `ōlapa, pūkiawe (*Styphelia tameiameiae*), `ōhelo (*Vaccinium calycinum*), `ākala (*Rubus hawaiiensis*), kolea (*Myrsine sandwicensis*), kāwa`u (*Ilex anomala*), and *Cibotium* tree ferns (U.S. Geological Survey, unpubl. data). Hawai`i creepers also have been observed occasionally in māmane forest at higher elevations, and may have been more widespread in this habitat historically (Figure 16; Snetsinger 1995).

Hawai`i creeper, along with `akiapōlā`au (*Hemignathus munroi*) and Hawai`i `ākepa, show a decreasing population density gradient from south to north across three sites in Hakalau Forest National Wildlife Refuge (2.18 ± 0.50 birds per hectare in the south at Pua `Ākala, compared with 0.57 ± 0.23 birds per hectare in the north at Maulua). The causes for the density gradient are not completely understood, but cavity availability was lower in the Pedro area than at Pua `Ākala (Hart 2001), food availability was one-third lower at Maulua than at Pua `Ākala (Fretz 2002), and prevalence of pox virus was higher at Maulua than at Pua `Ākala (VanderWerf 2001a), all of which may partially explain the lower population density to the north. Feral pig sign was negatively correlated with Hawai`i creeper density across the three sites. The frequency of disease epizootics in different sections of the refuge should be investigated.

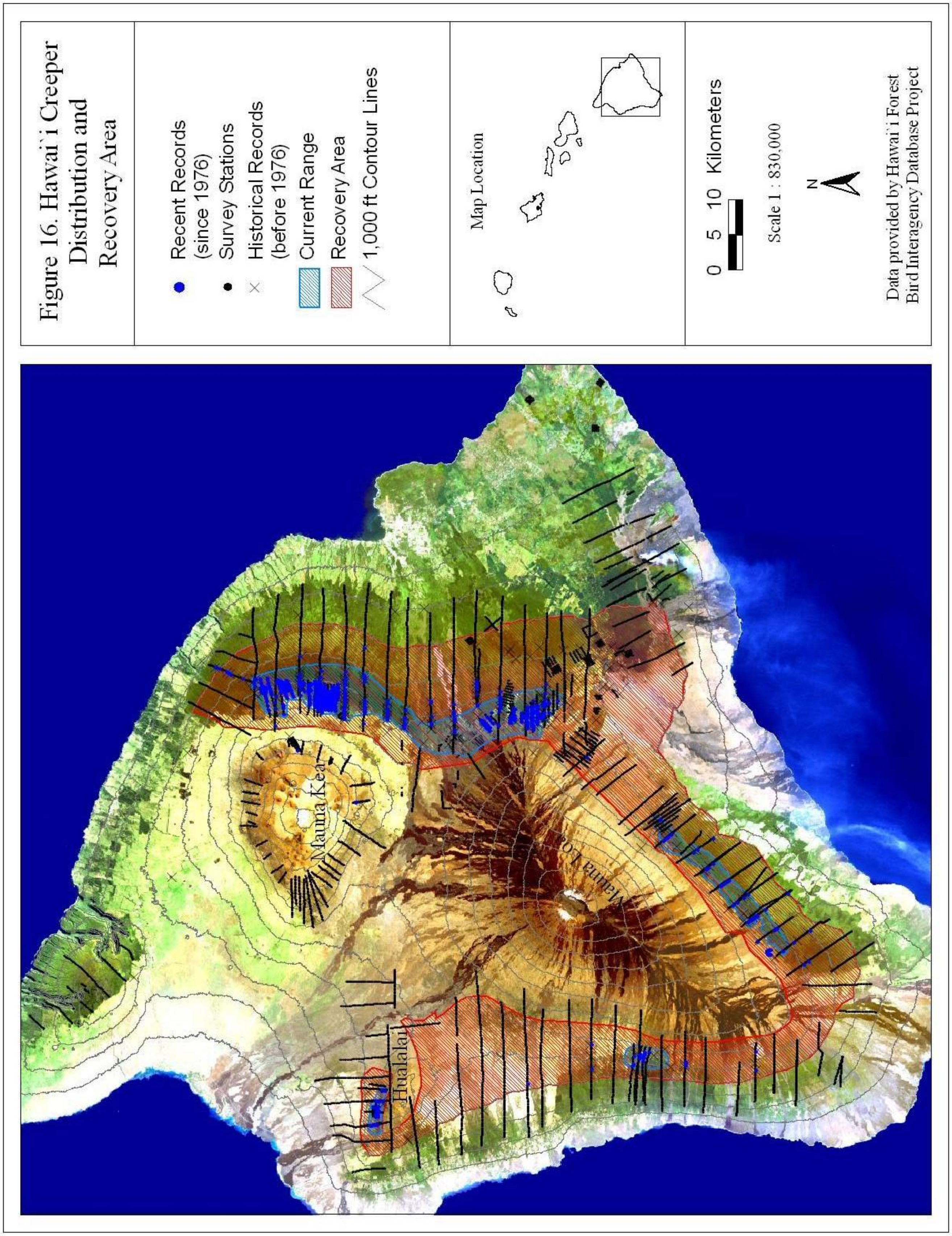


Figure 16. Hawai`i Creeper Distribution and Recovery Area

HISTORICAL AND CURRENT RANGE AND STATUS

In the 1890s, Hawai`i creepers were found in `ōhi`a and `ōhi`a/koa forests throughout the island of Hawai`i, usually above 1,070 meters (3,600 feet) elevation (Perkins 1903). Creepers were recorded in the Kona and Ka`ū districts as well as the forests above Hilo (Figure 16). Perkins noted that they were very abundant and generally distributed but had some puzzling gaps in their distribution, especially at lower elevations. In general, the creeper's decline was not well documented, perhaps in part due to difficulties of field identification (Scott *et al.* 1979). However, a drastic decline in numbers in Hawai`i Volcanoes National Park during the 1930s and 1940s was noted, and the species had virtually disappeared from the park by about 1960 (Conant 1975, Banko and Banko 1980).

As of 1979, the Hawai`i creeper was confined to four disjunct populations in wet and mesic forests, primarily above 1,500 meters (5,000 feet) (Figure 16; Scott *et al.* 1986). Two populations near Kona totaled only about 300 birds, and a third, near Ka`ū, consisted of about 2,100 birds. The Hāmākua coast on the windward side of Mauna Kea, where 10,000 ± 1,200 birds reside, supports the largest remaining population of Hawai`i creepers (Scott *et al.* 1986). A population recorded on Kohala Mountain in 1972 by Van Riper (1982) could not be relocated during the Hawai`i Forest Bird Survey in the early 1980s (Scott *et al.* 1986).

REASONS FOR DECLINE AND CURRENT THREATS

Modification and loss of habitat, avian disease, predation by introduced mammals, and competition with introduced birds all probably played a part in the decline of the Hawai`i creeper. Many areas of `ōhi`a/koa forest have been logged or grazed, severely degrading the quality of remaining habitat. Hawai`i creepers are rarely found below about 1,500 meters (5,000 feet), probably because of the distribution of mosquitoes that transmit avian malaria and avian pox (Warner 1968, van Riper *et al.* 1986). Nest success rates for Hawai`i creepers are alarmingly low (11 to 50 percent), which may reflect the invasion of alien nest predators, particularly black rats (*Rattus rattus*), into their habitat. Hawai`i creeper nests may be especially vulnerable to rat predation because of their proximity to the main trunk of nest trees (Woodworth *et al.* 2001), where rats may be more likely to encounter them. It has also been suggested that the Hawai`i creeper may be negatively impacted by competition from the insectivorous Japanese white-eye (Dunmire 1961, Mountainspring and Scott 1985). The Japanese White-eye is the most common introduced species on the island of Hawai`i. Based on mist-netting studies, 17 percent of the avian biomass at Hakalau Forest National Wildlife Refuge is made up of exotic species (primarily Japanese white-eyes and red-billed leiothrix [*Leiothrix lutea*]; U.S. Geological Survey, unpubl. data).

CONSERVATION EFFORTS

The Hawai`i creeper was federally listed as endangered on September 25, 1975 (U.S. Fish and Wildlife Service 1975), became protected under the State of Hawai`i endangered species law on March 22, 1982, and was included in the Hawai`i Forest Bird Recovery Plan (U.S. Fish and Wildlife Service 1983a). Surveys to document the status and trends of Hawaiian forest birds are undertaken by the State of Hawai`i approximately every 5 years, and annual surveys are conducted at Hakalau.

Conservation efforts for the Hawai`i creeper have focused predominantly on the protection and management of high-elevation native forests. The Hakalau Forest National Wildlife Refuge was established in 1985 primarily to protect and manage habitat for native birds, including the Hawai`i creeper. Much of the refuge has been fenced and efforts are underway to remove feral pigs from the refuge. Planting of koa and other native plants began in early 1989, and over 350,000 koa seedlings and 30,000 other native species have been planted thus far. The `Ōla`a/Kīlauea Partnership and Kona Unit of Hakalau Forest National Wildlife Refuge also provide protection and management of forest for habitat. Two other relevant conservation actions were the removal of cattle and fencing of the Kapāpala Forest Reserve and the Pu`u Wa`awa`a Forest Bird Sanctuary. Plans to remove ungulates from the State Kīpāhoehoe Natural Area Reserve and from lands at Honomalino, owned by The Nature Conservancy of Hawai`i, would protect recovery areas that could serve as sites for reintroducing Hawai`i creeper.

Research on factors that limit populations of endangered Hawaiian forest birds has been ongoing since the late 1980s. The productivity, recruitment, and survival of the Hawai`i creeper was investigated as part of a larger study by the U.S. Geological Survey from 1994 to 1999 (Woodworth *et al.* 2001). In case captive propagation becomes necessary for the Hawai`i creeper (see Recovery Strategy), technology has been developed for the collection of wild eggs, artificial incubation of eggs, hand-rearing of chicks, maintenance of adult Hawai`i creepers in captivity, and captive-breeding of the species.

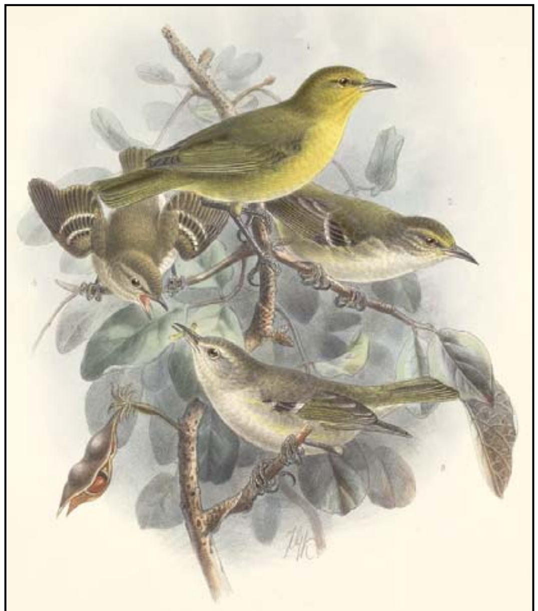
RECOVERY STRATEGY

The primary strategy for the recovery of the Hawai`i creeper is the protection and management of remaining `ōhi`a/koa forests above 1,500 meters (5,000 feet) elevation, and the restoration of degraded forests (Figure 16). To maintain connectivity and allow dispersal among fragmented patches of habitat, cattle should be removed from several key parcels and habitat restoration pursued, such as at the Kapāpala Forest Reserve and adjoining lands leased by the State for ranching. Management for avian disease should focus on reduction of breeding habitat for mosquitoes through drainage of stock ponds; public education and container removal in residential areas; and reduction in feral pig populations. Rodent control can be pursued through snap-trapping and diphacinone bait in bait stations in key parcels, but these methods are infeasible over large areas (Nelson *et al.* 2002). Therefore, registration for aerial broadcast of rodenticides should be aggressively pursued, and studies should be undertaken to determine its efficacy and public health implications (e.g., non-target effects, including accumulation in ungulate tissue and residue in water supplies). Reintroduction of captively propagated Hawai`i creepers into former habitat (e.g., the Mauna Loa Strip Road in Hawai`i Volcanoes National Park) could be undertaken after appropriate habitat management steps have been taken, and could be expected to speed the process of recolonization and recovery.

Because the population is relatively large and the threat of extinction is not imminent, recovery may be achieved more cost effectively through habitat management, therefore captive propagation currently is of lower priority for this species. Progeny from captive-propagation efforts would provide birds for reintroduction in order to establish and enhance populations of Hawai`i creeper in managed recovery areas.

14. O`ahu `Alauahio (O`ahu Creeper), *Paroreomyza maculata*

DESCRIPTION AND TAXONOMY



O`ahu creeper. © from Rothschild (1893-1900). Courtesy of Smithsonian Institution Libraries.

Description. The O`ahu creeper, or O`ahu `alauahio, is a small, sexually dichromatic Hawaiian honeycreeper (family Fringillidae, subfamily Drepanidinae) approximately 11 centimeters (4.3 inches) in total body length. Males are olive-green above and bright yellow below, with a yellow forehead and superciliary line, and a dark eye line. Females and immatures are grayish-green above and yellowish-white below, with two prominent white wingbars. The bill is straight, relatively short, dark above, and pale below (Shallenberger and Pratt 1978).

Identification. The O`ahu creeper is very similar in appearance to the O`ahu `amakihi (*Hemignathus flavus*), and separating these two species in the field can be difficult (Shallenberger and Pratt 1978). O`ahu creepers have a shorter, straight bill, a more distinct pale superciliary, and a pale forehead. Female and immature creepers generally have larger and more prominent white wingbars than female and immature `amakihi, but this character is variable in both species (Shallenberger and Pratt 1978).

Taxonomy. The O`ahu creeper is a Hawaiian honeycreeper (family Fringillidae; subfamily Drepanidinae) endemic to the island of O`ahu. It is currently placed in the genus *Paroreomyza* (Olson and James 1982b, Pratt 1992b, American Ornithologists' Union 1998), but its generic designation has changed repeatedly and it has at various times been placed in the genera *Oreomyza* (Perkins 1903), *Oreomystis* (Stejneger 1903), and *Loxops* (Amadon 1950, Shallenberger and Pratt 1978). The closest relatives and only congeners of the O`ahu creeper are the Maui (*P. montana*) and Moloka`i (*P. flammea*) creepers, and all three taxa have been considered conspecific by some authors (e.g., Munro 1960).

LIFE HISTORY

Little is known about the life history of the O`ahu creeper, but it is thought to be similar in most respects to its close relative, the Maui creeper. Almost nothing is known of its breeding biology or nesting season. Only two nests and one set of eggs have ever been found, both in January 1901 (Bryan 1905). O`ahu creepers apparently formed foraging flocks during parts of the year. Perkins (1903) reported that as many as a dozen creepers often were seen together, and Swedberg (in Shallenberger and Pratt 1978) reported a flock of 30 to 50 birds at Poamoho Trail in September 1968, some of which were collected and proved to be O`ahu creepers.

The O`ahu creeper is insectivorous and forages by creeping methodically up and down the trunks and branches of large trees, probing the bark for insects. It rarely forages in foliage and does not visit flowers like the `amakihi (Perkins 1903, Shallenberger and Pratt 1978). Perkins (1903) reported that it fed largely on caterpillars and spiders, and that the stomach contents of specimens included large numbers of Carabid beetles.

The short, sharp call has been described as “chip,” “chick,” and “chirk.” (Perkins 1903, Shallenberger and Pratt 1978, Pratt *et al.* 1987). The song has never been described, but might be similar to that of the Maui creeper. Despite hundreds of observations of O`ahu creeper, Perkins (1903) never reported hearing its song, and it may sing very infrequently.

HABITAT DESCRIPTION

The preferred habitat of the O`ahu creeper may be mid-elevation koa/`ōhi`a (*Acacia koa*/*Metrosideros polymorpha*) forests in valleys or on side-ridges. Perkins reported that the species was partial to large koa trees, but that they also occurred in areas without koa. All three observations reported by Shallenberger and Pratt (1978) were in mixed koa/`ōhi`a forest at elevations from 300 to 600 meters (1,000 to 2,000 feet), not on summits.

HISTORICAL AND CURRENT RANGE AND STATUS

The historical range and abundance of the O`ahu creeper are poorly known, partly because it may already have been uncommon and in decline when it was first observed by early naturalists (Figure 17). Perkins (1903) "found all species of *Oreomyza* (now *Paroreomyza* on O`ahu and Maui and *Oreomystis* on Kaua`i and Hawai`i) to be abundant" on their respective islands, but called the O`ahu form "less numerous than any." Perkins (1903) also described the O`ahu creeper as "a common enough species" and "found on both mountain ranges," but said, "it seems to have entirely disappeared from the mountains in the immediate neighborhood of Honolulu, where it formerly occurred." Similarly, Munro (1960) stated that O`ahu creepers were "fairly common in the 1890s," but that he had "tramped many miles of newly made C.C.C. [Civilian Conservation Corps] trails on O`ahu in 1935 and did not see a single individual." Palmer (in Rothschild 1893 to 1900) reported that he found O`ahu creepers "only in the upland region of Wailua" above 350 meters (1,500 feet) elevation.

The O`ahu creeper has undoubtedly declined very seriously since it was first observed, and at present no individuals have been seen in over 20 years. The current range, the rate and extent of decline, and even whether the species still exists are difficult to determine, however, due to the difficulty in distinguishing this species from the O`ahu `amakihi. Many reports may have been based on misidentifications, and the true historical and current status of this species is clouded. Shallenberger and Pratt (1978) compiled 41 supposed observations of O`ahu creeper reported in the journal `Elepaio, and judged that the identification was certain in only 3 cases, probable in 6, possible in 26, and unlikely in 6. In over 200 person-days of field work in the central Ko`olau Mountains, Shallenberger and Vaughn (1978) observed this species only three times, in north Hālawa Valley, Moanalua Valley, and in a valley south of Mānana Trail. The last well-documented observation was of two birds on December 12, 1985, on Poamoho Trail during the Waipi`o Christmas Bird Count (Bremer 1986). There have been several reports from different areas since, but details of the observations have been inconclusive and the birds were never relocated.

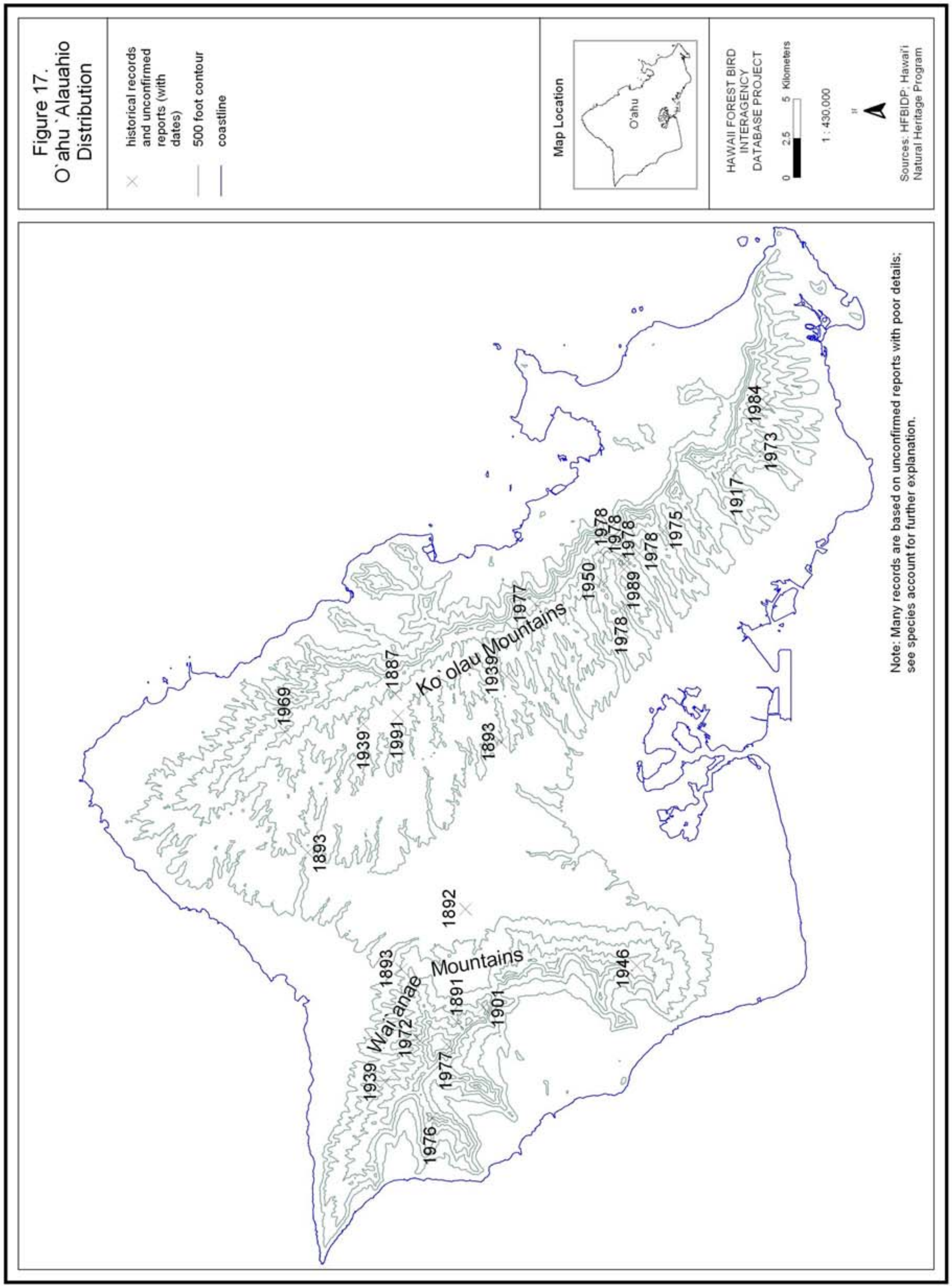


Figure 17.
O`ahu `Alauahio
Distribution
historical records and unconfirmed reports (with dates)
500 foot contour
coastline
Map Location
O'ahu
HAWAII FOREST BIRD
INTERAGENCY
DATABASE PROJECT
0 2.5 5 Kilometers
1 : 430,000
Sources: HFBIDP; Hawai'i Natural Heritage Program
Ko`olau Mountains
Wai`anae Mountains
1969
1939
1991
1887
1893
1939
1977
1950
1978
1978
1978
1978
1989
1978
1975
1917
1973
1984
1893
1892
1893
1891
1901
1946
1972
1939
1977
1976
Note: Many records are based on unconfirmed reports with poor details;
see species account for further explanation.

Small populations of \`i\`iwi have been rediscovered recently on O\`ahu in both the Wai\`anae and Ko\`olau Mountains (VanderWerf and Rohrer 1996), and it is possible that isolated populations of the O\`ahu creeper also still exist in remote areas of the island. O\`ahu was not included in the Hawai\`i Forest Bird Survey (Scott *et al.* 1986) or the Hawai\`i Rare Bird Search (Reynolds and Snetsinger 2001), and relatively few qualified observers spend much time in the mid-elevation koa/\`ōhi\`a forests where O\`ahu creepers are most likely to occur (Shallenberger and Pratt 1978). Given the lack of systematic surveys for the species, the status of the O\`ahu creeper is presently unknown.

REASONS FOR DECLINE AND CURRENT THREATS

Much of the decline in distribution of forest birds on O\`ahu can be attributed to habitat loss, especially at low elevations.  O\`ahu has the largest human population and is among the most disturbed of the Hawaiian Islands. Fifty-nine percent of the island has been developed for urban or agricultural use (Hawai\`i Heritage Program 1991).  Other than habitat loss, the specific reasons for the decline of the O\`ahu creeper are poorly known, but it likely faces the same threats as many Hawaiian forest birds. Diseases carried by the introduced southern house mosquito (*Culex quinquefasciatus*), particularly avian malaria (*Plasmodium relictum*) and avian pox (*Poxvirus avium*), are known to be serious threats to many native Hawaiian forest birds (van Riper *et al.* 1986, Atkinson *et al.* 1995), and they likely have been a major factor in the disappearance of the O\`ahu creeper.  The threat of disease may be especially serious on O\`ahu, because no parts of the island are high enough to provide refuge from the primary disease vector, mosquitoes, which cannot tolerate the cold temperatures at high elevations (Warner 1968). Predation by introduced mammals, particularly the black rat (*Rattus rattus*), has been a major factor in the decline of the O\`ahu \`elepaio (*Chasiempis sandwichensis ibidis*) (VanderWerf and Smith 2002), and also may have affected the O\`ahu creeper.

CONSERVATION EFFORTS

The O\`ahu creeper was federally listed as endangered on October 13, 1970 (U.S. Fish and Wildlife Service 1970), and thus receives protection under the Endangered Species Act.  Species listed under the Federal Endangered Species Act were automatically added to the State of Hawai\`i list of endangered species on March 22, 1982, and are thus also protected by State law. The recently created

O`ahu Forest National Wildlife Refuge protects a large area of native forest in the north-central Ko`olau Mountains near several of the most recent O`ahu creeper observations (U.S. Fish and Wildlife Service 2000a), but whether the species still occurs in the area is unknown.

RECOVERY STRATEGY

See the Rare Bird Discovery Protocol in Section III-D.

15. Kākāwahie (Moloka`i Creeper), *Paroreomyza flammea*

DESCRIPTION AND TAXONOMY

Moloka`i creeper. © from Rothschild (1893-1900). Courtesy of Smithsonian Institution Libraries.

The kākāwahie, or Moloka`i creeper, was known only from Moloka`i, but is now thought by some to be extinct (Baker and Baker 2000). The last sighting of this sexually dimorphic honeycreeper occurred in April 1963 (Pekelo 1963). A detailed description of the species was made only by the early specimen collectors and observers; Munro (1944) described the adult males as mostly scarlet in various shades, adult females as brown with scarlet washes and markings, and juvenile males ranging from female-like brown to the adult males' scarlet with many gradations. The bill is short and straight. Its calls were described as chip or chirping notes similar to other creeper calls (Munro 1944, Pekelo 1963). Its closest relatives are the Maui creeper (*P. montana*) and the O`ahu creeper (*P. maculata*). The kākāwahie is in the Hawaiian honeycreeper family (family Fringillidae, subfamily Drepanidinae).

LIFE HISTORY

Only fragmentary information is available about the life history of the kākāwahie from the writings of early naturalists and the few notes reported in the 1960s (Perkins 1903, Munro 1944, Pekelo 1963). This species is an insectivore that gleans vegetation and bark in wet `ōhi`a (*Metrosideros polymorpha*) forests. Only minimal information exists about the nest and young (Munro 1944).

HABITAT DESCRIPTION

This species was known only from high elevation, boggy areas of Moloka`i (Munro 1944, Pekelo 1963). There is no detailed description of its habitat. The last detections, in the 1960s, were on the west rim of Pelekunu

Valley on the `Ōhi`alele Plateau in moss-shrouded `ōhi`a and `ōlapa (*Cheirodendron trigynum*) trees.

HISTORICAL AND CURRENT RANGE AND STATUS

Historically, the species was recorded only from Moloka`i (see Figure 8 on page 2-29). There have been no sightings since 1963. The 1980 Hawaiian Forest Bird Survey failed to detect the species on Moloka`i, and reported similar failures of earlier searches (Scott *et al.* 1986). All surveys and special searches since 1988 have failed to detect this species (Reynolds and Snetsinger 2001; Hawai`i Department of Land and Natural Resources, unpubl. data). This species may possibly be extinct, but there was a significant gap in the area covered by the Hawai`i Rare Bird Search in the 1990s due to restrictions on access, and one of the largest areas of remaining pristine native forest, the Oloku`i Plateau, was not surveyed for kākāwahie. Additional surveys are needed to confirm the status of this species.

REASONS FOR DECLINE AND CURRENT THREATS

Reasons for the decline and loss of the species are unknown, but presumably are the same as for other endangered forest birds on Moloka`i and Maui.

CONSERVATION EFFORTS

The Moloka`i creeper was federally listed as an endangered species on October 13, 1970 (U.S. Fish and Wildlife Service 1970), became protected under the State of Hawai`i endangered species law on March 22, 1982, and was included in the Maui-Moloka`i Forest Birds Recovery Plan (U.S. Fish and Wildlife Service 1984a). No other specific conservation efforts for this species have been initiated.

RECOVERY STRATEGY

See the Rare Bird Discovery Protocol in Section III-D.

16. Hawai`i `Ākepa, *Loxops coccineus coccineus*

DESCRIPTION AND TAXONOMY

Adult male Hawai`i `ākepa foraging in `ōhi`a foliage. Photo © Jack Jeffrey.

The Hawai`i `ākepa is a small sexually dichromatic Hawaiian honeycreeper (family Fringillidae, subfamily Drepanidinae) endemic to the island of Hawai`i. Its total length is approximately 10 centimeters (3.9 inches) and its weight varies from 10 to 12 grams (0.34 to 0.41 ounces). Adult males are bright orange, while females are grayish green with a yellow breast-band. The male adult plumage is not obtained until the molt preceding the fourth year. Males have a female-like subadult plumage (without breast-band) during their second year and a male-like subadult plumage during their third year (Lepson and Freed 1995). The male-like subadult plumage varies from bright orange on the head and breast to dull brownish orange over the entire body. Females are entirely gray during their second year. Thereafter they acquire a variable amount of yellow and orange on the breast, throat, and head (Freed and Lepson, unpubl. data). Plumage brightness is loosely related to age, but most females never acquire extensive orange-yellow on the head. Juvenal plumage, similar in both sexes, is grayish green above, pale gray below, often with a whitish superciliary line (Lepson and Freed 1997).

The Hawai`i `ākepa has a long notched tail. The bill is conical and generally pale yellow in color. The laterally-skewed tips of the asymmetrical bill are caused by the tip of the lower mandible curving to the right or left (Richards and Bock 1973). There also is an asymmetry in the legs, with a slightly longer tarsus on the side opposite to which the mandible crosses (Knox 1983). These are considered "handedness" adaptations for opening up leaf and flower buds for arthropod prey. The tongue shows adaptations for nectarivory with the brushy tip and the sides rolled up to form a tube (Gadow 1891).

Close-up showing asymmetrical bill of `ākepa. Photo © Eric VanderWerf.

The bird was originally described as *Fringilla coccinea* from specimens collected by the James Cook expedition of 1779 (Medway 1981). It was occasionally placed in the genus *Hypoloxias* (Wilson and Evans 1890 to 1899). Its current nomenclature is based on Rothschild (1893 to 1900). The Hawai`i `ākepa shares subspecific status with the Maui `ākepa (*Loxops c. ochraceus*) and the O`ahu `ākepa (*Loxops c. rufus*). The O`ahu subspecies is extinct and the Maui subspecies is probably extinct, meaning the Hawai`i `ākepa now likely comprises the entire species.

LIFE HISTORY

The Hawai`i `ākepa is an obligate cavity nester, with most nests found in large old-growth `ōhi`a (*Metrosideros polymorpha*) and koa (*Acacia koa*) trees (Lepson and Freed 1997, Freed 2001). It has a clearly defined breeding season, with nest-building from early March to late May, egg-laying from mid-March to late May, hatching in late March to early June, and fledging from April 2 to June 30 (Lepson and Freed 1997). Fledglings stay with their parents until September or October, and both adults and juveniles frequently join interspecific foraging flocks with other Hawaiian honeycreepers, particularly Hawai`i creepers (*Oreomystis mana*), and also `akiapōlā`au (*Hemignathus munroi*), Hawai`i `amakihi (*Hemignathus virens*), `i`iwi (*Vestiaria coccinea*), and `apapane (*Himatione sanguinea*). Only one brood can be raised per year. Studies of prey abundance indicate that breeding is initiated during a time of declining prey availability and that termination of parental care in September occurs during the annual peak in prey availability (Fretz 2000).

Females do all or most of the nest building and incubate, brood, and feed the chicks; males assist by feeding the female both on and off the nest and by feeding the young (Lepson and Freed 1997). Clutch size ranges from one to three eggs, with two as the modal number (Lepson and Freed 1997). Based on recent observations of accessible Hawai`i `ākepa nests, some eggs failed to hatch in four of six nests (L. Freed, University of Hawai`i, pers. comm.). No nestling mortality was detected. Nestlings 6 days old weighed as much as their parents, and those 12 days old weighed up to 1.5 times that of their parents. The productivity of nests, usually one fledgling, appears to be limited more by hatching success than by provisioning of nestlings. Despite the potential vulnerability of cavity nesting species to predators such as rats (Lack 1968, Nilsson 1986), nesting success is high at the Pua `Ākala tract of Hakalau Forest National Wildlife Refuge, in that 79 percent of nests of known fate over a 7-year period fledged young (Lepson and Freed 1995). However, based on captures of females without brood patches during June, not all females attempt to nest in a given year. In addition, predation on fledglings by `io (*Buteo solitarius*) has been documented (Lepson and Freed 1997). Adults have high annual survivorship ranging from 0.70 for Kīlauea/Keauhou (Ralph and Fancy 1994a) to 0.82 at Hakalau Forest National Wildlife Refuge (Lepson and Freed 1995).

The molting season is clearly defined. Molting in adults begins primarily in June (Lepson and Freed 1995). Molt is a post-nesting phenomenon that coincides with the fledgling period, and extends until October. The only exception is that second year males that do not attempt to breed begin their molt in March.

Intense competition occurs among males from October to March (Lepson and Freed 1995). The Hawai`i `ākepa is non-territorial, so dominance is the major form of aggression. Physical fights, chases, and group displays are part of the competition. Group displays may include up to six males perched in the same tree who take turns flying out, singing, and returning, all in the presence of a female. Aerial displays of up to eight males sometimes result in spectacular "dogfights" with birds rising as high as 100 meters (330 feet) in the air before breaking up.

It appears that variation in female plumage and fitness drives this competition. More colorful females have both higher survival and higher nesting success than duller females of the same age (Freed and Lepson, unpubl. data). Extensively orange-yellow females comprise only 11 percent of the population, and orange-yellow females comprise 25 percent. Thus, despite an even sex ratio (Lepson and Freed 1995), males are competing for only a fraction of females with above-average fitness.

The Hawai`i `ākepa feeds primarily on small insects, spiders, and caterpillars throughout the year. It rarely feeds on nectar. Foraging occurs mainly on the terminal leaf clusters of `ōhi`a, and to a lesser extent among koa leaves and seedpods (Perkins 1903, Conant 1981a, Fretz 2000). Food availability for `ākepa is closely associated with the structure and density of the terminal portions of the `ōhi`a canopy (Fretz 2002). During the dry summer of 1999, several birds were captured with `ākala (*Rubus hawaiiensis*) berry pulp dried on their bills. They may have been using the berries as a source of water. Birds also have been seen foraging occasionally in the leaves of naio (*Myoporum sandwicense*), `a`ali`i (*Dodonaea viscosa*), pūkiawe (*Styphelia tameiameiae*), pilo (*Coprosma* spp.), `ōhelo (*Vaccinium calycinum*), and `ākala (Perkins 1903).

Adults and juveniles are strongly philopatric to the breeding area (Lepson and Freed 1995). Maximum distance traveled was 5 kilometers (3.1 miles) for an adult female and the same distance for a juvenile (Lepson and Freed 1997). Both males and females, banded as juveniles, tend to breed within 250 meters (820 feet) of their natal nest. Hart (2000) reported home range sizes of 5.9 and 4.8 hectares (14.6 and 11.9 acres) for males and females, respectively, during the non-breeding season, and substantially smaller ranges during the breeding season. Ralph and Fancy (1994a) reported that the average home range of the Hawai`i `ākepa was 3.9 hectares (9.6 acres).

HABITAT DESCRIPTION

Hawai`i `ākepa are birds of old-growth `ōhi`a or `ōhi`a/koa forest (Freed 2001). Their density depends in part on the density of large trees because only large trees provide the cavities required for nesting (Hart 2000, 2001; Freed 2001). The average size of trees used for nesting is 1 meter (3.3 feet) in diameter at breast height (Freed 2001). `Ōhi`a appear to be more important to `ākepa than koa, because the highest density of Hawai`i `ākepa on Mauna Loa, in the Ka`ū Forest Reserve, is in an area without koa (Jacobi 1978, Scott *et al.* 1986). Large `ōhi`a trees provide both cavities for nest-sites and the preferred foraging substrate, whereas large koa trees provide mainly cavities (Freed 2001). The highest `ākepa density at Hakalau Forest National Wildlife Refuge on Mauna Kea exists in an area with large trees but heavily disturbed understory. Breeding densities of this population appear to be limited by the availability of nest sites (Hart 2000), and the population may be at or near carrying capacity with respect to food availability (Fretz 2000).

HISTORICAL AND CURRENT RANGE AND STATUS

The historical range of the Hawai`i `ākepa once included much of the island of Hawai`i, presumably wherever there were large trees that provided nest cavities (shown in Freed 1999). The major change in distribution has been the complete loss of birds from lower elevations, below 1,300 meters (4,300 feet). However, the range has also contracted somewhat at upper elevations as well (Freed 1999, Scott *et al.* 1986).

Hawai`i `ākepa are currently found in 5 disjunct populations in `ōhi`a/koa forests in Hāmākua, Kūlani/Keauhou, Ka`ū, southern Kona, and Hualālai, totaling approximately 14,000 ± 2,500 birds in 1980 (Figure 18; Scott *et al.* 1986). The highest densities occurred in the southwestern portion of the Ka`ū Forest Reserve and in the Pua `Ākala Tract of Hakalau Forest National Wildlife Refuge (Scott *et al.* 1986), and these supported by far the largest populations, comprising 5,300 ± 1,500 birds and 7,900 ± 1,800 birds, respectively. The populations in southern Kona and Hualālai were much smaller; approximately 660 ± 250 birds combined (Scott *et al.* 1986), and apparently have declined since those surveys. Hawai`i `ākepa occur in a gradient of population density, with a small core area of highest density in the Pua `Ākala area and rapid decreases in density away from the core (Scott *et al.* 1986, Hart 2001). This pattern is more pronounced for `ākepa than for other endangered forest birds (Scott *et al.* 1986).

REASONS FOR DECLINE AND CURRENT THREATS

Modification and loss of habitat and avian disease are the main factors that have contributed to the decline of Hawai`i `ākepa. Predation by introduced mammals also may have played a role. Clearing of forest by logging and ranching has been extensive, greatly reducing the amount of suitable habitat for Hawai`i `ākepa and other forest birds, and resulting in fragmentation of the remaining forest habitat. Hawai`i `ākepa are especially sensitive to the loss of old growth forest due to their dependence on large trees with cavities for nesting (Freed 2001). Much old-growth forest has been cleared for pasture at upper elevations (Tomonari-Tuggle 1996).

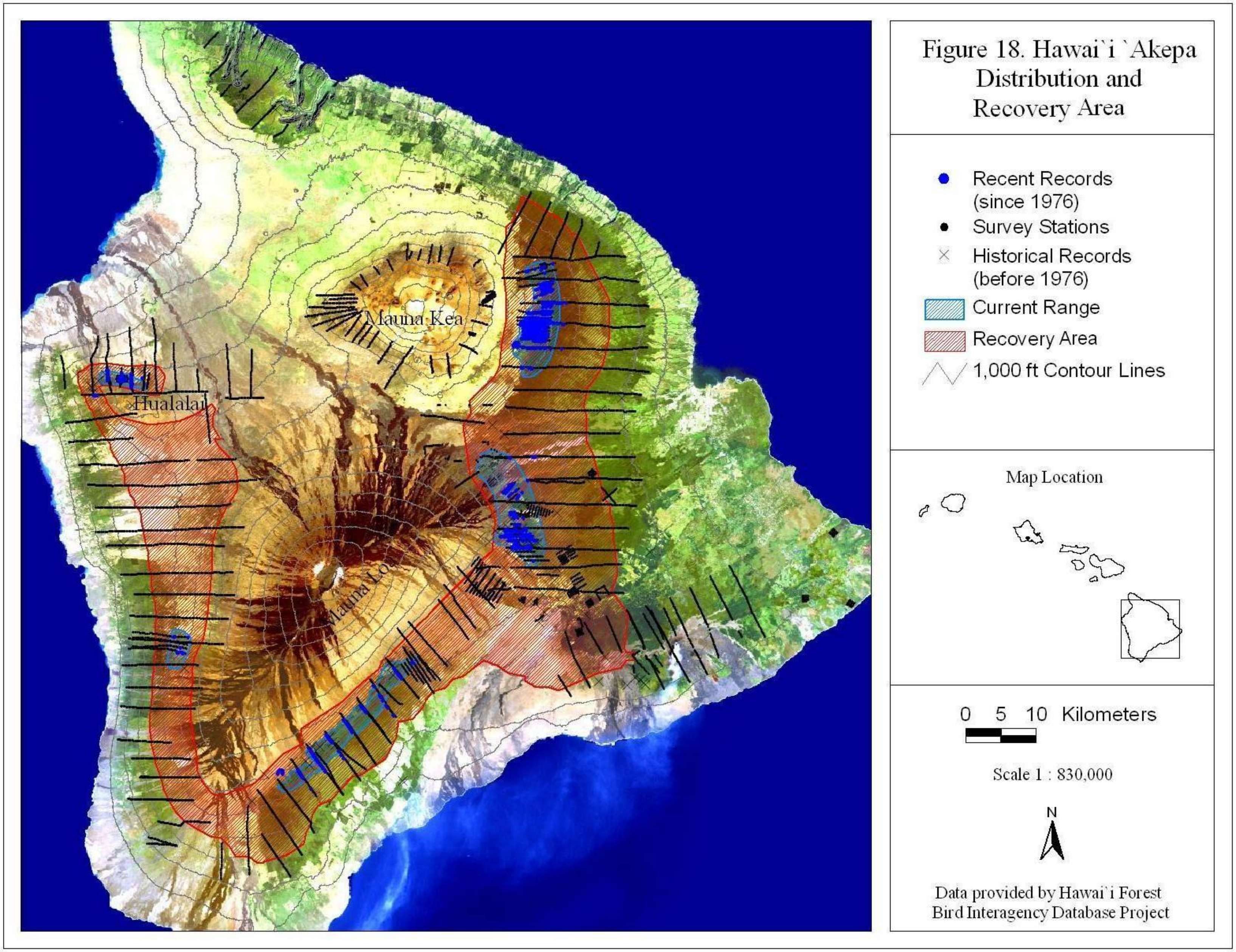


Figure 18. Hawai`i `Akepa Distribution and Recovery Area

The slow growth rate of `ōhi`a trees suggest that large trees are extremely old, and when a large tree with a cavity falls, it may require a long time before it is replaced (Freed 2001). This problem is magnified because large trees in disturbed areas are more susceptible to windfall than smaller trees. The areas of highest `ākepa density are in disturbed areas and trees large enough to provide nest sites are falling at a rate of 5 trees per square kilometer (13 per square mile) per year at Hakalau Forest National Wildlife Refuge. Reduction of nest sites in high-density areas is a major threat that is already decreasing the number of breeding pairs in the upper Pua `Ākala tract. In addition, the increased light under which `ōhi`a seedlings are germinating is producing trees with an almost exclusively sympodial (multi-trunked) growth form, which typically do not produce cavities suitable for `ākepa nests. The `ōhi`a trees used as nest sites by the birds are almost exclusively monopodial (straight and single-trunked) in form (Freed 2001).

`Ākepa are not found below 1,300 meters (4,300 feet), presumably because of the distribution of the introduced mosquito (*Culex quinquefasciatus*) that transmits avian malaria (*Plasmodium relictum*) and avian pox (*Poxvirus avium*) (van Riper *et al.* 1986, 2002). Both the mosquito and malarial parasite are limited in elevation by temperature (LaPointe 2000). Greater exposure of remaining `ākepa populations to vectors and pathogens is likely to occur with global climate change (Benning *et al.* 2002). The birds at upper elevations have not been under natural selection by disease and must be considered naive with respect to disease. While individual birds at the lower end of the range might have evolved tolerance or resistance to malaria or pox virus, the strong philopatry (low dispersal) makes it unlikely that the genotypes of tolerant individuals would extend into the range of naive birds. There is significant risk that there will not be enough time for relevant genotypes to evolve that could respond to natural selection from increased exposure to disease.

CONSERVATION EFFORTS

The Hawai`i `ākepa was federally listed as endangered on October 13, 1970 (U.S. Fish and Wildlife Service 1970), became protected under the State of Hawai`i endangered species law on March 22, 1982, and was included in the Hawai`i Forest Bird Recovery Plan (U.S. Fish and Wildlife Service 1983a).

Conservation efforts for the species have focused primarily on protection and management of high-elevation native forests. The Hakalau Forest National Wildlife Refuge was established in 1985, primarily to provide protection and management of habitat for native birds, including the Hawai`i `ākepa. Much of the refuge has been fenced and efforts are underway to remove feral pigs from the refuge. Planting of koa and other native plants began in early 1989, and over 350,000 koa seedlings and 30,000 other native species have been planted thus far. The `Ōla`a/Kīlauea Partnership and Kona Unit of Hakalau Forest National Wildlife Refuge also protect and manage forest habitat. Two other relevant conservation actions were the removal of cattle and fencing of the Kapāpala Forest Reserve and the Pu`u Wa`awa`a Forest Bird Sanctuary. Plans to remove ungulates from the State Kīpāhoehoe Natural Area Reserve and from lands at Honomalino, owned by The Nature Conservancy of Hawai`i, would protect recovery areas that could serve as sites for reintroducing Hawai`i `ākepa. The recent purchase of the former Kahuku Ranch by the National Park Service will help protect and restore forest habitat adjacent to the area of highest `ākepa density in Ka`u.

Research using comparison of forest structure and `ākepa demography in areas of low and high population density has highlighted the significance of large trees with cavities to this bird (Hart 2000, 2001). Additional research with artificial cavities has shown that the birds will use artificial cavities attached to the outside of trees and successfully nest in them (Freed 2001). Artificial cavities are a promising conservation tool that can be used to increase nest site availability until a time when growth and recruitment of large `ōhi`a trees provide sufficient natural nest sites.

Hawai`i `ākepa are one of the few species of Hawaiian forest birds for which the significance of food availability has been quantitatively investigated. This work confirmed the strong reliance of `ākepa on terminal `ōhi`a foliage for food (Fretz 2000), showed that reproductive success is associated with food availability among years in the Pua `Ākala tract of the Hakalau Forest National Wildlife Refuge (Fretz *et al.,* in prep.), and suggests `ākepa populations may be at or near carrying capacity with respect to food even where nest sites are apparently limited (Fretz *et al.,* in prep.). Food availability is also closely associated with habitat structure, including subtle aspects of canopy foliage density. This type of variation in canopy structure may be common at regional scales and therefore has the potential to influence `ākepa densities (Fretz 2002). In addition, food availability is seasonal and the well-defined timing of breeding seen in `ākepa may be an adaptation to exploit this seasonality so that food is maximally available at the time of independence of the young (Fretz 2000; Fretz *et al.,* in prep.).

RECOVERY STRATEGY

Habitat Protection and Nest Site Management. The most important component of the recovery strategy for the Hawai`i `ākepa is habitat protection and nest site management. Protection of old-growth forest ecosystems is essential to the long-term recovery of this species, but is not sufficient to conserve populations in the short-term due to the rapid loss of large trees containing cavities suitable for nesting. Large trees cannot be protected against windfall or hillier terrain, which cannot support large trees (Hart 2000, Freed 2001). The use of artificial cavities as a management tool is needed to enable existing populations to hold their own despite loss of nest-site trees. Artificial cavities also have potential to increase the density of nesting pairs within an area or to establish new populations in forests that have suitable foraging substrate but lack large trees with cavities. To complement these efforts, research needs to address factors that affect the growth form of regenerating `ōhi`a. Management of growth form, including removal of ungulates that destroy the apical meristem (growing tip) of seedlings, and possibly providing wind shields or shading, may be essential for long-term regeneration of monopodial `ōhi`a trees that are most likely to develop natural cavities and provide suitable nest sites for `ākepa (Freed 2001).

Disease. Eradication of mosquitoes is not practical with methods currently available, and the birds themselves may be the best way of addressing the threat from disease. Some of the more common native birds have evolved tolerance or resistance to disease (Cann and Douglas 1999, Woodworth *et al*. 2005) and this is associated with larger clutch size and multiple broods per year, which provides greater opportunity to respond to natural selection (Freed 1999). It is crucial to know what is happening at the lower limits of elevation of Hawai`i `ākepa. If individuals are discovered that tolerate disease, then genetic techniques can determine if those genotypes are present outside the range of disease. If those genotypes are not present outside the range, then an appropriate management strategy would be to move birds with pertinent genotypes into populations of birds that are not tolerant.

Predator control. Control of alien predators, especially rats, has been shown to be an effective method of increasing reproduction and survival in other Hawaiian forest birds (VanderWerf and Smith 2002). However, the degree of threat from alien rodents may vary among species and locations, and rodent control programs initially should be conducted in an experimental way to document their effect on `ākepa populations. Ground-based methods of rodent control using snap traps and diphacinone bait stations have been effective on a small scale, but are labor intensive. Effective large-scale rodent control likely will require aerial broadcast methods. Registration of aerial broadcast of diphacinone for rodent control with the U.S. Environmental Protection Agency should be actively pursued and supported.

Captive Propagation. Recovery of the Hawai`i `ākepa may be achieved most effectively through *in situ* management techniques such as habitat management because the current population is relatively large, and captive propagation is not considered essential for recovery at this time. However, captive propagation technology is being developed for the Hawai`i `ākepa in case it is needed to help reestablish wild populations (Zoological Society of San Diego 2004). Techniques developed for Hawai`i `ākepa include protocols for collection of wild eggs, artificial incubation of eggs, hand-rearing of chicks, and maintenance of adults in captivity. Similar techniques developed for other species of honeycreepers have resulted in successful captive breeding, and it is anticipated that the Hawai`i `ākepa will breed in captivity when they reach reproductive age. Progeny from such captive propagation efforts would provide birds for reintroduction in order to establish and enhance wild populations.

17. Maui `Ākepa, *Loxops coccineus ochraceus*

DESCRIPTION AND TAXONOMY


Maui `akepa. © from Rothschild (1893-1900). Courtesy of Smithsonian Institution Libraries.

The Maui `ākepa closely resembles the better known Hawai`i `ākepa (*L. c. coccineus*) in coloration and biometrics (Lepson and Freed 1997; also see Hawai`i `ākepa account). The Maui subspecies differs as follows: (1) adult males vary from dull brownish orange to ochraceus rather than bright orange and (2) females are duller and less yellowish (Amadon 1950). However, no quantitative comparison of the subspecies has been attempted, and females may fall within the range of variability in the Hawai`i subspecies. Plumage sequence and differences between females and young males have not been determined from study skins for Maui `ākepa. Plumage sequence and sexual differences may be the same as for the Hawai`i race. Seasonality and pattern of molt has yet to be described from study skins, and again may be the same as for the Hawai`i race. The Maui `ākepa was described by Finsch (1880), but has been regarded as a subspecies of `ākepa in all modern accounts. The phylogenetic relationship between the Maui and Hawai`i `ākepa has not been investigated by molecular genetics, which in the future may influence their taxonomic placement. The Maui `ākepa is a member of the Hawaiian honeycreeper family (family Fringillidae, subfamily Drepanidinae).

LIFE HISTORY

Almost nothing about the life history of the Maui `ākepa appears in the historical record (Perkins 1903, Rothschild 1893 to 1900, Henshaw 1902, Banko 1984a). Henshaw (1902) found Maui `ākepa in small groups with young in June when the birds were molting. Rothschild (1893 to 1990) claimed they fed on small beetles and other insects, whereas Henshaw (1902) and Perkins (1903) agreed that they fed chiefly on caterpillars and small spiders. Perkins also noted that they drank `ōhi`a (*Metrosideros polymorpha*) nectar.

Perkins (1903) reported watching a pair of Maui `ākepa building a nest in the terminal foliage of a tall `ōhi`a tree. This nest site differs strikingly from the sites in tree cavities chosen by Hawai`i `ākepa. The frequency with which Maui `ākepa nest in tree foliage versus hollows in branches would be important to discover. Refer to the account of Hawai`i `ākepa for comparable information about that subspecies.

HABITAT DESCRIPTION

All specimens of Maui `ākepa were collected in `ōhi`a/koa (*Acacia koa*) rainforest at 1,200 to 1,800 meters (4,000 to 6,000 feet) elevation on the northwest rift of Haleakalā. Rothschild (1893 to 1990) found Maui `ākepa foraging in `ōhi`a. Perkins (1903) noted that the birds were "often seen in koa trees but more often in `ōhi`a." Henshaw (1902) commented that they much preferred koa to `ōhi`a for foraging. Palmer also found `ākepa in mid-elevation `ōhi`a forest, and all likely sightings this century have been in `ōhi`a forest at 1,700 to 2,100 meters (5,500 to 7,000 feet; as described in Rothschild 1893 to 1900). The past distribution of the Hawai`i `ākepa once encompassed a wide range of habitats from 600 meters (2,000 feet) to timberline, and the Maui subspecies may also have once occupied all forests within its range. The current habitat of the Maui `ākepa is mixed shrub montane wet forest (Jacobi 1985) above 1,500 meters (5,000 feet), the same as for other endangered birds on Maui.

HISTORICAL AND CURRENT RANGE AND STATUS

In the absence of early historical surveys, the extent of the geographical range of the Maui `ākepa cannot be reconstructed. This bird occupied at least Maui Island, and one might expect that it also inhabited Moloka`i and Lāna`i Islands like other forest birds in the Maui Nui group, but there are no fossil records of `ākepa from any of these islands (James and Olson 1991). All historical records of the Maui `ākepa were from high elevation forests most accessible to naturalists, near Olinda and Ukulele Camp on the northwest rift of Haleakalā, and from mid-elevation forests in Kīpahulu Valley (see Figure 14 on page 2-94). This range suggests that the birds were missing from forests at lower elevations, perhaps due to the introduction of disease-transmitting mosquitoes to Lahaina in 1826 (Hardy 1960). However, it may be that the Maui `ākepa originally occupied all forests on Maui. Complete destruction of habitat was not extensive during the 20th century, but ecological changes in the forests probably have caused the species to decline to its restricted geographic range. Reports by naturalists at the turn of the century varied in their estimates of abundance of the Maui `ākepa, ranging from rare to locally abundant (Banko 1984a).

From 1970 to 1995, there have been few credible sightings of Maui `ākepa (Banko 1984a, Engilis 1990). Scott *et al.* (1986) estimated a total population of 230 ± 290 birds, in 2 populations on northwestern and eastern Haleakalā. However, this estimate was based on potentially confusing auditory detections, not on visual observations. Songs of the Maui `ākepa were reportedly heard in 1994 and 1995 during the Hawai`i Rare Bird Search, but visual confirmation of the species was not obtained, and it is possible there was some confusion with similar songs or mimicry of the Maui parrotbill (*Pseudonestor xanthophrys*) (Reynolds and Snetsinger 2001). The current population, if any, therefore remains undetected and most likely survives in the vicinity of the northeastern rift of Haleakalā, the location of the last reports. Thorough surveys from 1995 through 1999 turned up no `ākepa in this area (Reynolds and Snetsinger 2001; Hawai`i Department of Land and Natural Resources, unpubl. data), but the conclusion of the Hawai`i Rare Bird Search was that based on the available evidence, it is not possible to either confirm or disprove that the Maui `ākepa is extant (Reynolds and Snetsinger 2001).

REASONS FOR DECLINE AND CURRENT THREATS

Reasons for decline and current threats presumably are the same as for other endangered forest birds on Maui. In addition, we can speculate that rats may have played an especially important role as nest predators of `ākepa. While the only nest of Maui `ākepa ever reported was built in tree foliage, the birds may also have selected tree cavities like the very similar Hawai`i `ākepa. In Maui forests, nest trees are of shorter stature than where `ākepa survive on Hawai`i Island. Suitable cavity sites on Maui are low in the vegetation, some near or at ground level, and thus more accessible to rats. High densities of both black and Polynesian rats (*Rattus rattus* and *R. exulans*) infest `ākepa habitat on Maui (Sugihara 1997).

CONSERVATION EFFORTS

The Maui `ākepa was federally listed as an endangered species on October 13, 1970 (U.S. Fish and Wildlife Service 1970), became protected under the State of Hawai`i endangered species law on March 22, 1982, and was included in the Maui-Moloka`i Forest Birds Recovery Plan (U.S. Fish and Wildlife Service 1984a). No effort has been initiated in the field specifically for Maui `ākepa. However, this species has, or could have, benefited in the long-term from habitat restoration to assist other endangered birds on Maui (see Maui parrotbill and po`ouli accounts).

RECOVERY STRATEGY

See the Rare Bird Discovery Protocol in Section III-D.

18. \`Ākohekohe (Crested Honeycreeper), *Palmeria dolei*

DESCRIPTION AND TAXONOMY

Adult \`ākohekohe. Photo © Eric VanderWerf.

The \`ākohekohe, or crested honeycreeper, is the largest (24 to 29 gram [0.8 to 1.0 ounce]) honeycreeper remaining on Maui Nui (Maui, Moloka\`i, Lāna\`i, and Kaho\`olawe). Primarily a black-plumaged bird, the \`ākohekohe's lanceolate body feathers are strikingly tipped with orange-red, its throat and breast feathers are tipped with gray, silver, or white, and its wing and tail feathers are distinctly white-tipped. A distinctive brush of white feathers curling forward over the bill comprises the crest, giving the species its English name. Brilliant orange feathers surround the eyes and extend to and cover the nape, feathers on the thighs can be orange or yellowish-white, and the feathers of the epaulettes are white with orange tips. The somewhat curved bill, the feet, and the legs are black. Sexes are identical in plumage pattern and coloration, but males are larger and heavier and can be determined with accuracy by measurements (Simon *et al.* 1998). Juvenile plumage is drab and cryptic yellow-brown or brown-gray, the body plumage lacks all orange-scarlet or orange and silver colors on the feathers or tips, and both the gray tail and wing feathers lack white tips. The crest of the juveniles is short and not as pronounced; its color is yellowish-white. The feet, legs, and bill of juveniles are gray to black.

\`Ākohekohe show no geographic variation in plumage, and have no subspecies, although they once were found on the two islands of Maui and Moloka\`i. Fleischer *et al.* (2001) showed that, based on DNA analyses, \`ākohekohe are most closely related to \`apapane (*Himatione sanguinea*) and \`i\`iwi (*Vestiaria coccinea*). The \`ākohekohe is a member of the Hawaiian honeycreeper family (family Fringillidae, subfamily Drepanidinae).

LIFE HISTORY

The \`ākohekohe is primarily nectarivorous, but also feeds on caterpillars, spiders, and dipterans (flies) (Perkins 1903, Carothers 1986, VanGelder and

Smith 2001). Nectar is primarily sought from flowers of `ōhi`a (*Metrosideros polymorpha*), but also from several subcanopy tree and shrub species (Berlin *et al.* 2000, VanGelder and Smith 2001). Insects are taken mostly by gleaning `ōhi`a foliage, buds, and flower clusters (VanGelder 1996). VanGelder (1996) observed the species to spend almost 70 percent of the day in foraging activities.

`Ākohekohe defend relatively discrete feeding and nesting territories throughout the year by chasing and calling (Pratt *et al.* 2001b, VanGelder and Smith 2001). The species appears to be monogamous for more than one breeding season, with pair formation starting in October, nesting occurring mainly between November and May, and some pairs raising two to three successful broods in a season (VanGelder and Smith 2001). `Ākohekohe nests were an average of 14 meters (46 feet) above ground in the terminal ends of branches below the canopy foliage of `ōhi`a trees (Berlin and VanGelder 1999, VanGelder and Smith 2001). The open cup nest is built by the female, who lays one to two eggs. Incubation by the female lasts 17 days, and the chicks fledge after 3 to 4 weeks. Chicks can forage independently after 10 to 14 days, or longer when the chicks are from the last brood of the season (Berlin and VanGelder 1999). Independent juveniles flock in small groups and disperse to the edge of the species' range (Scott *et al.* 1986).

Vocalizations of the `ākohekohe include various guttural clucking gurgles, raspy croaks, buzzing sounds, and clear upslurred whistles; no distinctly ordered sound repertoire or song strophe is produced (Perkins 1903, Berlin and VanGelder 1999, VanGelder and Smith 2001).

HABITAT DESCRIPTION

At present `ākohekohe survive in montane wet and mesic forests dominated by `ōhi`a. The habitat is generally as described for the Maui parrotbill (*Pseudonestor xanthophrys*), except that the lower limit of the `ākohekohe's elevational range is higher, at roughly 1,700 meters (5,576 feet) although some nonbreeding birds may wander further down slope. Fossil bones found in caves at low elevation on the southwestern slopes of Haleakalā suggest that the species once inhabited very different dry forest habitat (James and Olson 1991).

HISTORICAL AND CURRENT RANGE AND STATUS

`Ākohekohe currently are found only in 58 square kilometers (22 square miles) of wet and mesic montane forest dominated by `ōhi`a on the northeastern slope of Haleakalā Volcano in east Maui. Their elevational range has been reported to be from 1,100 to 2,300 meters (3,600 to 7,550 feet), but nearly all birds occur from 1,500 to 2,100 meters (5,000 to 6,600 feet), with some nonbreeding birds found further down slope (Conant 1981b; Scott *et al.* 1986; Hawai`i Division of Forestry and Wildlife, unpubl. data). `Ākohekohe occur from just west of the Waikamoi Drainage in the Ko`olau Forest Reserve east through the Ko`olau and Hāna Forest Reserves and around to Haleakalā National Park lands in Kīpahulu Valley and southeast of Kuiki to Manawainui Valley. The current geographic range is much restricted compared to the known historical range that included native wet forests of the island of Moloka`i (Figure 19; Perkins 1903, Banko 1987). On Moloka`i, the bird was found at 1,200 meters (4,000 feet) on the high forested plateau between Wailau and Pelekunu valleys where the species was not known to have survived later than 1907 (Bryan 1908). On Maui, the species was first collected in the 1890s on the western slopes of Kula in mesic koa (*Acacia koa*)/`ōhi`a forest, but by 1920 it was already absent due to deforestation caused by logging and cattle-ranching (Berger 1981). `Ākohekohe now inhabit only 5 percent of the estimated historical range of 1,015 square kilometers (385 square miles) on Maui and none of the 262 square kilometers (100 square miles) on Moloka`i Island (Scott *et al.* 1986).

James and Olson (1991) have reported subfossil evidence of the species from low, dry forest areas of southeastern and southwestern Maui, indicating the current and historical range of the species is much altered from its original pre-human distribution. No fossils are known from Moloka`i.

The total number of `ākohekohe was estimated to be 3,800 ± 700 (95 percent confidence interval) birds in 1980 by the Hawai`i Forest Bird Survey (Scott *et al.* 1986). Surveys of the same transects in 1992 (Hawai`i Department of Land and Natural Resources, unpubl. data), and limited surveys from 1995 to 1997 by U.S. Geological Survey biologists, indicated approximately the same densities of birds within the same range.

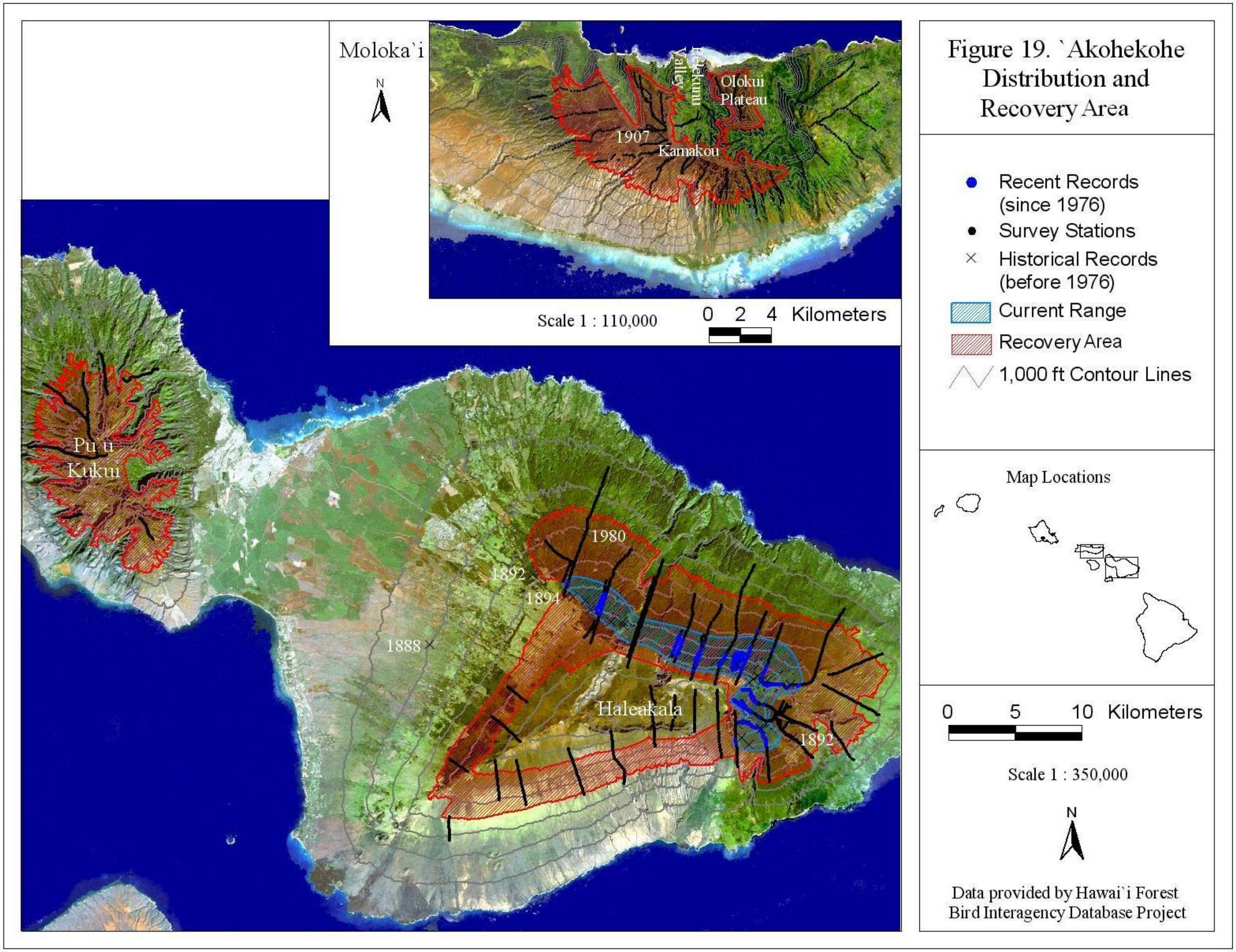


Figure 19. `Akohekohe Distribution and Recovery Area

REASONS FOR DECLINE AND CURRENT THREATS

`Ākohekohe are restricted to higher elevation forests due to the presence of mosquito-borne diseases at lower elevations, and are restricted at upper elevations in some areas by destruction of forest habitat. `Ākohekohe may be particularly vulnerable to mosquito-borne diseases because they migrate altitudinally in response to varying `ōhi`a flowering phenology (Conant 1981a), potentially increasing their exposure to mosquitoes at lower elevations. Avian malaria was recently isolated from an `ākohekohe in Hanawī Natural Area Reserve (Feldman *et al.* 1995). Laboratory challenge experiments have shown that the `i`iwi, which is closely related to the `ākohekohe but more common and has a wider distribution, is extremely vulnerable to avian malaria, with 90 percent of experimental birds dying after being bitten by infected mosquitoes (Atkinson *et al.* 1995). Black and Polynesian rats (*Rattus rattus* and *R. exulans*) are serious predators on adults and nests of Hawaiian forest birds and are abundant in `ākohekohe habitat (Sugihara 1997, Malcolm *et al.* 2002), and Simon *et al.* (2001) found rat predation on an `ākohekohe adult and egg, as evidenced by rat droppings and bird remains in the nest. The remains of an `ākohekohe were found in a barn owl pellet from Hanawī, and feral cat scats also contained remains of other native forest birds (Kowalsky *et al.* 2002). Damage by feral pigs to understory vegetation may deplete nectar resources needed during times of year when `ōhi`a is less available.

CONSERVATION EFFORTS

The `ākohekohe was federally listed as endangered on March 11, 1967 (U.S. Fish and Wildlife Service 1967), protected under State of Hawai`i endangered species law on March 22, 1982, and was included in the Maui-Moloka`i Forest Bird Recovery Plan (U.S. Fish and Wildlife Service 1984a).

Conservation efforts for the `ākohekohe have included creation of the 3,035 hectare (7,500 acre) Hanawī Natural Area Reserve to provide additional habitat protection. The upper 800 hectares (2,000 acres) of Hanawī was fenced by 1996, and all ungulates were removed by 1997 (B. Evanson, Maui Department of Fish and Wildlife, pers. comm.). Adjacent forest lands have been protected through acquisition by the National Park Service and formation of the East Maui Watershed Partnership. Ecological and life history research has been conducted since 1992 (Simon *et al.* 1998, 2001; Berlin *et al.* 2001; Pratt *et al.* 2001b; VanGelder and Smith 2001). Research on captive breeding for the `ākohekohe was initiated in 1997, when eggs were removed to the Maui Forest Bird Conservation Center and the Keauhou Bird Conservation Center following the recommendations of Ellis *et al.* (1992). Six individuals hatched in captivity from late-stage wild eggs. Three individuals died before 1 year of age; three are currently surviving. No success at captive production of `ākohekohe has been attained to date due to the aggressive nature of this species and incompatibility of the paired birds.

RECOVERY STRATEGY

The long-term recovery strategy for the `ākohekohe is generally similar to that for the Maui parrotbill because they currently inhabit roughly similar geographic areas and face common threats. Habitat management, such as fencing and control of feral pigs that damage flowering plants, may allow `ākohekohe populations to increase in density. Forest restoration through fencing and removal of feral ungulates in currently degraded areas, particularly on the leeward slopes of Haleakalā, would increase the amount of available habitat and allow range expansion. Control of mosquitoes or their breeding sites may be needed to render existing forest on West Maui and Moloka`i suitable for endangered birds like `ākohekohe. Research to better understand threats and optimize management methods, particularly rat predation and disease, is also important.

The establishment of a second `ākohekohe population in historically occupied habitat on leeward East Maui, West Maui, or Moloka`i is an important component of the recovery strategy in order to reduce the threat from catastrophes such as hurricanes and epizootics of disease that could eliminate a single population. In contrast to the Maui parrotbill, translocation of wild-caught adult birds may be the preferred method of establishing a second `ākohekohe population, because the aggressive nature of this species (Carothers 1986) makes it difficult and expensive to propagate in captivity. However, establishment and maintenance of an effective captive-breeding program for future releases into disease-free recovery areas should remain an option if translocations of wild birds do not succeed in establishing a second population. The suitability of West Maui and Moloka`i as release sites for translocated birds is currently questionable due to the presumed presence of avian diseases in these lower elevation areas.

19. Po`ouli, *Melamprosops phaeosoma*

DESCRIPTION AND TAXONOMY


Adult po`ouli. Photo by Paul Baker.

The po`ouli is a medium-sized, 26 gram (0.9 ounce), stocky Hawaiian honeycreeper (family Fringillidae, subfamily Drepanidinae) easily recognized by its brown plumage and characteristic black mask framed by a gray crown and white cheek patch. Robust birds, they have short wings and tail, stout legs and feet, and a conical finch-like bill. Plumages of the po`ouli are not well known (Engilis *et al.* 1996, Baker 1998), but observations at two nests revealed that adults of both sexes and young differ subtly in coloration. Males have whitish underparts, whereas females (and perhaps young males) have a grayish throat and breast. Fledglings have whitish underparts, a mask smaller than that of the adults, and a pale tip to the mandible. The original species description (Casey and Jacobi 1974) was based on two specimens now believed to be in immature (first basic) plumage, because they look like females but retain a pale tip to the mandible. There is no information on molt.

The po`ouli comprises a monotypic genus and species that, remarkably, was not discovered until 1973 (Casey and Jacobi 1974). Morphological and genetic studies agree that the po`ouli forms a unique lineage within the Hawaiian honeycreepers (Casey and Jacobi 1974, James and Olson 1991, Fleischer *et al.* 2001). Pratt (1992a) suggested that the po`ouli may not be a Hawaiian honeycreeper, but also noted the similarity in tongue morphology with another honeycreeper, the Maui creeper or `alauahio (*Paroreomyza montana*).

LIFE HISTORY

Po`ouli have been observed singly, in pairs, and in family groups with a single young (Pratt *et al.* 1997b). It is unknown whether po`ouli pairs defend territories, but during studies of a nesting pair, territorial behavior, such as singing in vicinity of the nest after eggs were laid or consistent chasing of birds of other species that approached the nest, were not observed (Kepler *et al.* 1996). However, no other po`ouli occurred in the vicinity of the nest.

Our knowledge of po`ouli breeding biology is based on two sequential nestings by the same pair in 1986 (Kepler *et al.* 1996). Egg-laying took place on about March 10 and April 26 and 27 for the first and second nests, respectively. Clutch size was probably two eggs. The second, successful nest fledged only one of the two young, which spent 21 days in the nest. The female alone incubated the eggs and brooded the chicks, but both parents fed the chicks. The male fed the female at or away from the nest throughout the nesting cycle. This provisioning became important in poor weather -- either wind or rain -- when the female spent more time on the nest. Both po`ouli nests were typical of the nests of other honeycreepers: an open cup composed of twigs and mosses and lined with thin fern rootlets (Engilis *et al.* 1996). The nests were 8 meters (26 feet) high in tall `ōhi`a (*Metrosideros polymorpha*) trees and were hidden among leaf-bearing twigs (Kepler *et al.* 1996). Both nests are stored at the Bishop Museum in Honolulu.

Po`ouli forage primarily on tree branches, making extensive use of the subcanopy and understory. They seem to prefer the native hydrangea, kanawao (*Broussaisia arguta*), the native holly, kāwa`u (*Ilex anomala*), and `ōhi`a (Mountainspring *et al.* 1990, Pratt *et al.* 1997b). Po`ouli glean, probe, and excavate moss mats, lichen, and bark for small invertebrate prey. Detailed examination of stomach contents from the two type specimens revealed a diet of tiny native snails, beetles, and proportionately few other arthropods (Baldwin and Casey 1983). Based on foraging observations, Mountainspring *et al.* (1990) believed that po`ouli took proportionately more *Lepidoptera* and *Coleoptera* larvae. The most common food items seen delivered to po`ouli chicks were these larvae and Succineid snails (Hawaiian land snails in the family Succineidae) (Kepler *et al.* 1996).

Po`ouli often associate with mixed species foraging flocks of other insectivorous honeycreepers, especially Maui `alauahio and Maui parrotbill (*Pseudonestor xanthophrys*), gleaning insects from branches and foliage. Observers searching such flocks increase their chances of locating po`ouli.

Po`ouli are unusually quiet, and surveys or variable circular plot counts that depend on vocal detections are not appropriate for this species. Males rarely sing and do so mostly as part of courtship prior to egg-laying. The song is a series of chip notes alternating in pitch. The infrequent chip notes are similar to those of Maui `alauahio, but often characteristically paired or given in rapid succession. Interestingly, most of the recently observed po`ouli calls have been very similar to those of the Maui parrotbill, with which po`ouli often associate, including an up-slurred "chu-wee" and a soft "whit" contact call (J. Bruch, Hawai`i Department of Land and Natural Resources, pers. comm.).

HABITAT DESCRIPTION

Po`ouli occur in montane wet forests from timberline at 2,100 meters (7,000 feet) elevation down to a lower limit of 1,440 meters (4,750 feet). The terrain is steep and dissected by numerous stream gulches. This area is characterized by high rainfall, delivered mostly by the trade wind weather system, exceeding 5 meters (200 inches) annually in some areas. The vegetation is mixed montane wet forest (Jacobi 1985) with an average canopy height of 13 meters (43 feet) and 60 percent crown cover, dominated by `ōhi`a. Areas of similar habitat remain unoccupied to the southeast and west. The range of the po`ouli coincides with high population densities of other honeycreeper species, a distribution believed to be delimited by disease-bearing mosquitoes prevalent at elevations below 1,500 meters (5,000 feet) (Scott *et al.* 1986). Po`ouli are associated with low levels of disturbance to soil and vegetation by feral pigs (Mountainspring *et al.* 1990). Po`ouli are believed to require an intact subcanopy and understory for foraging and cover and therefore are intolerant of habitat alteration by feral pigs.

HISTORICAL AND CURRENT RANGE AND STATUS

The po`ouli apparently was unknown to the Hawaiians, and it eluded western naturalists during the discovery period of Hawaiian ornithology at the end of the 19th century. It was discovered in 1973 by a team of university students (Casey and Jacobi 1974). Since then, po`ouli have been confined to a 1,300-hectare (3,200-acre) section of forest on the northern and eastern slopes of Haleakalā Volcano, Maui (Figure 20; Mountainspring *et al.* 1990). The type locality was between the eastern and western forks of Hanawī Stream. Fossil evidence shows that the po`ouli once inhabited drier forests at lower elevation on the leeward slope of Haleakalā, indicating it once had a much broader geographic and habitat range (James and Olson 1991).

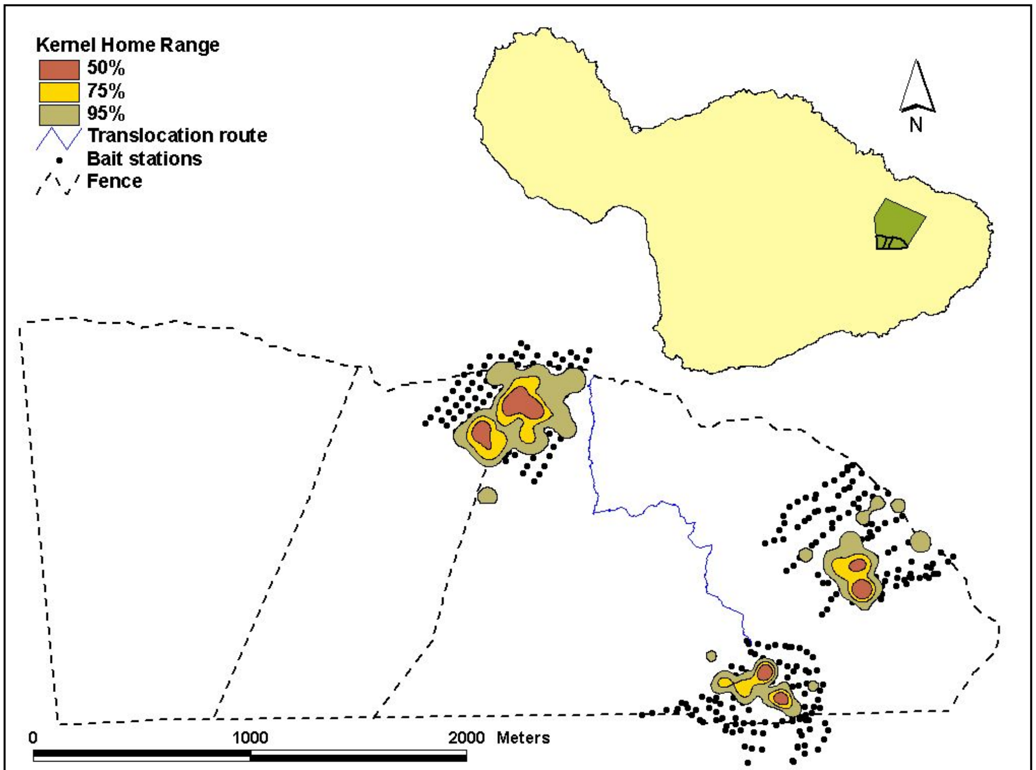


Figure 20. Location of po`ouli home ranges in Hanawī Natural Area Reserve. Map by Bill Sparklin, Maui Forest Bird Recovery Project.

The po`ouli population was estimated at 140 ± 280 birds in the early 1980s (Scott *et al*. 1986), but estimates of population size and density are not accurate and are considered imprecise due to the species' low density and cryptic behavior. Po`ouli numbers and range have since declined to a tiny population over at most a few hundred hectares. Attempts to estimate population size and density have met with frustration because of the bird's poor detectability. Mountainspring *et al.* (1990) reported densities at the type locality of 76 ± 8 (standard error) birds per square kilometer in 1976, 15 ± 7 birds per square kilometer in 1981, and 8 ± 4 birds per square kilometer in 1985 (30.8 ± 3.2 birds per 100 acres in 1976, 6.1 ± 2.8 birds per 100 acres 1981, and 3.2 ± 1.6 birds per 100 acres in 1985). No birds were found in the type locality from 1993 to 1995 (J. Simon, U.S. Geological Survey, unpubl. data). Surveys in 1994 to 1995 found perhaps as many as six po`ouli at four locations, from the west rim of Kūhiwa Valley at 1,880 meters (6,200 feet) east to the upper reaches of Helele`ike`ōhā Stream at 1,570 meters (5,200 feet) (Baker 2001, Reynolds and Snetsinger 2001). Thorough surveys of the historical range in 1997 to 2000 located only three birds, all in Hanawī Natural Area Reserve, and no others have been located since these birds were color-banded in 1996 and 1997 (Hawai`i Department of Land and Natural Resources, unpubl. data). The last three known birds occurred in non-overlapping home ranges separated by 0.75 to 1.7 kilometers (0.5 to 1 mile) (Groombridge *et al*. 2004b). They had never been observed together since they were banded, so there were no known breeding pairs, and the last documented reproduction occurred in 1995 (Reynolds and Snetsinger 2001). Genetic sexing of the three birds produced conflicting results, but the best available information indicated they consisted of one male and two females. Following an attempted translocation in 2002 to form a breeding pair and efforts to capture the remaining po`ouli for captive breeding (details provided in the Recovery Strategy section), one of the three known remaining birds died of natural causes in captivity in 2004, and the other two have not been seen since 2003 and 2004. Currently it is not known whether any po`ouli remain in the wild.

REASONS FOR DECLINE AND CURRENT THREATS

Habitat damage by feral pigs is thought to be an important cause of the decline in po`ouli numbers (Mountainspring *et al.* 1990). Other threats have not been directly linked to the po`ouli, but the species can be assumed vulnerable to the same threats that impact other honeycreepers, particularly mosquito-borne diseases and nest predation by alien rats. Po`ouli and other endangered honeycreepers likely are restricted to cold, high elevation areas by the prevalence of mosquito-borne diseases in the lowlands. Both black and Polynesian rats (*Rattus rattus* and *R. exulans*) are abundant in po`ouli habitat (Sugihara 1997, Malcolm *et al.* 2002). These animals feed largely on invertebrates (Sugihara 1997) and have been blamed for the decline of native land snails, which are an important food for the po`ouli (Hadfield *et al.* 1993). Another predator of the native land snails in po`ouli habitat is the abundant, nonnative garlic snail (*Oxychilus alliarius*).

CONSERVATION EFFORTS

The po`ouli was federally listed as an endangered species on September 25, 1975 (U.S. Fish and Wildlife Service 1975), and was included in the Maui-Moloka`i Forest Bird Recovery Plan (U.S. Fish and Wildlife Service 1984a). Decline of the po`ouli prompted conservation agencies to protect its entire historical range, as it was known at the time, by creation of the 3,035-hectare

(7,500-acre) State Hanawī Natural Area Reserve. The upper 800 hectares (2,000 acres) of Hanawī was fenced by 1996, and all ungulates were removed by 1997 (B. Evanson, Maui Division of Forestry and Wildlife, pers. comm.). These actions have stabilized soil erosion and stimulated vegetation recovery. The National Park Service has fenced and removed feral ungulates from areas adjacent to Hanawī. Formation of the East Maui Watershed Partnership, a consortium of government agencies, nongovernmental agencies, and private landowners, has helped to further protect the forests of east Maui, and this group has fenced large areas of rainforest downhill from Hanawī Natural Area Reserve. Ecological and life-history research was carried out under the direction of the USGS Biological Resources Discipline during 1994 to 1996 (Baker 2001). Ground-based predator control was conducted in the home ranges of the last three known birds (Malcolm *et al*. 2002). The Hawai`i Department of Land and Natural Resources and the U.S. Fish and Wildlife Service jointly fund the Maui Forest Bird Recovery Project. Activities of this project include control of small mammals in an attempt to reduce the threat of predation on adults and nests and competition for invertebrate prey, research on optimizing rodent control methods, and mist-netting, banding, and collecting blood samples to monitor demography and disease prevalence in native bird populations, particularly the po`ouli. The same program attempted to translocate one po`ouli into the home range of another to encourage breeding, and brought one bird into captivity in an attempt to form of a breeding pair (see below).

RECOVERY STRATEGY

Fundamental to the long-term strategy for recovery of the po`ouli is the protection and management of high elevation rainforests on East Maui. While the canopy of this forest remains relatively intact, the understory has been severely degraded by feral pigs in places, and subcanopy trees have died as a result of soil loss and disturbance to roots. The recovery of vegetation should proceed rapidly at first as ferns and native shrubs move into disturbed areas. The regeneration of subcanopy trees will be slower, but within a few decades should return the forest to a restored condition.

Alternative strategies for recovery of the po`ouli were outlined in The Environmental Assessment for Proposed Management Actions to Save the Po`ouli (U.S. Fish and Wildlife Service and Hawai`i Department of Land and

Natural Resources 1999). This document included solicitation for public input on recovery strategies, including continued habitat management only, field translocation with "hard" release to create a breeding pair, field translocation with "soft" release by temporarily holding birds in a field aviary, and bringing all three remaining birds into captivity for propagation. Based on the Environmental Assessment and subsequent public comments, it was decided that the best strategy for recovering the po`ouli was continued habitat management, including predator control, in conjunction with translocation of a female po`ouli into the home range of the last male, in hopes that they would form a breeding pair and nest (U.S. Fish and Wildlife Service and Hawai`i Department of Land and Natural Resources 1999).

Translocation methods were developed by the Maui Forest Bird Recovery Project, using the non-endangered Maui `alauahio or Maui creeper as a surrogate species. Sixteen Maui creepers were translocated between the po`ouli home ranges using different methods of confinement during transport and over varying distances. All trials resulted in zero mortality, and white blood cell counts indicated that stress levels were lower in birds transported with a minimum of restriction on their movement within the transport container (Groombridge *et al*. 2004a). These trials demonstrated that Hawaiian honeycreepers could be safely transported on foot over the steep and rugged terrain separating the po`ouli home ranges, and helped to identify the best methods and protocols for translocating the po`ouli.

Following the surrogate translocation work, a holding-cage was designed to allow brief observation of a captive po`ouli immediately after its translocation and prior to its release. The 30 × 30× 60 centimeter (12 × 12 × 24 inch) holding cage was constructed from soft white cloth walls stretched within a lightweight rigid frame, and was designed to house two birds separately side-by-side. If it became necessary to hold a single po`ouli in field captivity for several days, either as a result of injury or due to weather conditions that precluded helicopter transport, then the holding-cage could separately house a ‘tutor’ individual of an ecologically-compatible species (e.g., Maui parrotbill) to encourage acclimation and feeding behavior. An externally mounted video camera provided continual remote monitoring of the bird’s behavior via a television monitor 20 meters (66 feet) away. Both natural food, such as native Succineid snails (Baldwin and Casey 1983), and supplemental foods routinely used for captive propagation of other insectivores, including waxworms and mealworms, were provided inside the holding cage.

Veterinary facilities were set up in Hanawī to deal with possible injuries to a po`ouli. Requirements focused on delivering a veterinary capacity that could handle critical medical requirements for a period of up to 3 consecutive days, a time frame considered to be a likely delay to any helicopter evacuation of an injured po`ouli due to bad weather. Veterinary equipment consisted of an avian intensive care unit with a controlled environmental temperature and oxygen enriching capacity, general anesthesia and surgical capabilities, equipment and supplies to treat traumatic injuries, antimicrobial drugs, and diagnostic equipment required to perform complete blood counts, cytology, and harvest plasma for chemical analysis. In the event of a death of a po`ouli, various tissues would be collected for cell culture and immediately sent to both the Zoological Society of San Diego's Conservation and Research for Endangered Species center and the Audubon Nature Institute Center for Research of Endangered Species.

A detailed protocol to carry out a po`ouli translocation was cooperatively designed and approved by the U.S. Fish and Wildlife Service, the Hawai`i Department of Land and Natural Resources, and the Zoological Society of San Diego in December 2001. After nearly 2 years of preparation, efforts to capture and translocate po`ouli began in January 2002. On April 4, 2002, a presumed female po`ouli was captured and translocated 2.5 kilometers (1.6 miles) on foot into the home range of the male (Groombridge *et al*. 2004b; see Figure 20). Transit time for the bird was 1 hour and 15 minutes. Upon arrival, the female was examined by an avian veterinarian and determined to be in good health. Following examination, a radio transmitter was attached to the bird, and it was observed for approximately 2 hours in the holding cage. While in captivity, the bird consumed several food items, including nonnative waxworms and native Succineid snails. The female po`ouli was released within the male's home range at dusk that evening. The following morning, radio telemetry signals confirmed that she had roosted within the male's home range overnight and was still present. However, signals throughout the morning indicated that she was steadily moving back toward her own home range, and by that evening she had traveled back to her capture site. The female po`ouli was radio-tracked for 9 days within her home range following her return. It is not known whether the two birds encountered one another, but there was no indication that they did (Groombridge *et al.* 2004b).

Although the translocation was unsuccessful in establishing a wild breeding pair, several important lessons were learned from the effort (Groombridge *et al*. 2004b). First, field biologists demonstrated that individuals of the species could be safely manipulated. Subsequent sightings of the translocated bird indicated that it was not adversely affected by its handling, transport, and temporary captivity. Second, the bird showed signs of potential positive acclimation to captivity, reacting passively to its holding cage and readily consuming foreign food. Third, information gained from observations and radio-telemetry was used to refine estimates of the birds' home ranges.

On June 25, 2002, representatives of the U.S. Fish and Wildlife Service, Hawai`i Department of Land and Natural Resources, Maui Forest Bird Recovery Project, Zoological Society of San Diego, and the Hawaiian Forest Bird Recovery Team convened on Maui to discuss the next step in attempting to recover the po`ouli. Several alternatives from the 1999 Environmental Assessment were discussed, including another translocation attempt, placing the birds in a field aviary in Hanawī, removing the birds from the wild and placing them in captivity, or taking no further action. In addition, a new alternative was introduced which called for the birds to be placed in a field aviary at a more accessible location. It was clear that there were risks associated with all the options and that the chances of success were low no matter what alternative was chosen. Each option appeared to have advantages and disadvantages, and the decision was extremely difficult. No alternative was universally supported. A structured decision-making process was used to help evaluate and compare the alternatives based on the best available information and expertise (VanderWerf *et al*. 2006). Although most participants agreed that the first translocation attempt was worthwhile, a second translocation attempt was rejected because available evidence indicated that adult Hawaiian forest birds have high site fidelity and usually return to their own home range following translocation (Fancy *et al*. 1997, 2001; Groombridge *et al*. 2004a), and there was no reason to suspect a second female po`ouli to behave differently. The two options that were judged to have the highest probability of success were removal to captivity and a field aviary in a more accessible location. Based on the results of the decision process, consensus eventually was reached within the U.S. Fish and Wildlife Service and Hawai`i Department of Land and Natural Resources, the two agencies mandated to recover the species, to capture the three known birds and remove them from the wild for captive breeding. The factors that ultimately were judged to favor removal to captivity over a field aviary were that removal to captivity could be implemented more quickly, which was considered important given the advanced age of the three birds, and that it would be more difficult to provide adequate veterinary care in a field aviary and ensure the safety of the birds from predators, severe weather, and vandals. The Zoological Society of San Diego expressed with reservations that they would undertake the difficult task of attempting to manage and breed the po`ouli in captivity at the Maui Bird Conservation Center. Captive breeding programs for Hawaiian forest birds operated by the Zoological Society of San Diego at the Keauhou Bird Conservation Center and the Maui Bird Conservation Center have been very successful (Kuehler *et al*. 2000, 2001; ZSSD 2004), but establishing a successful program with just a single breeding pair would be the ultimate avicultural challenge.

A detailed protocol for capturing the remaining wild po`ouli and transferring them to captivity was cooperatively designed and approved by the U.S. Fish and Wildlife Service, the Hawai`i Department of Land and Natural Resources, and the Zoological Society of San Diego in January 2003, for the purpose of establishing a captive propagation and reintroduction program. The agencies involved in this effort recognized that there were risks involved in such an attempt to capture wild birds and transport them into captivity. In light of the extreme rarity of the po`ouli, strict operational guidelines were followed throughout the capture effort to ensure that these risks were addressed and mitigated to the fullest extent possible.

Adverse weather and practical constraints hampered capture efforts, but on September 9, 2004 the first of the three po`ouli was captured and removed to captivity at the Maui Bird Conservation Center. Genetic sexing using a blood sample taken from the bird in captivity indicated it was a male. This result conflicted with that of earlier tests and cast some doubt on the sex of the two remaining birds, leading to the possibility that only one sex of po`ouli had remained for the past several years. Even more remarkable, upon capture the bird was found to have only one functioning eye, probably as a result of a previous traumatic injury (K. Swinnerton, Maui Forest Bird Recovery Project, pers. obs.), and it was found to have been infected with avian malaria before it was captured (C. Atkinson, unpubl. data).

Sadly, after being successfully maintained in captivity for 78 days, the captive po`ouli died on 26 November 2004, before a potential mate could be obtained. The death of the captive bird was obviously a severe setback to the recovery of the species. Necropsy results revealed several chronic health problems, indicating the likely cause of death was old age (B. Rideout, Zoological Society of San Diego, pers. comm.). Although the bird had avian malaria, the infection was sub-clinical and was not the primary cause of death. Tissue samples were collected from the bird immediately following its death, and fibroblast cells were successfully grown and cryogenically preserved at the Zoological Society of San Diego's center for Conservation and Research for Endangered Species.

The remaining two birds have not been seen since December 2003 and January 2004 (Maui Forest Bird Recovery Project, unpubl. data.). If they are located, or if new birds are discovered, efforts to facilitate formation of a breeding pair will resume if at all possible. Although much of the suitable habitat on east Maui has been surveyed for po`ouli (Reynolds and Snetsinger 2001; Maui Forest Bird Recovery Project, unpubl. data), there are some areas that have not been thoroughly searched, and due to the rugged terrain and cryptic nature of the species it is not possible to say with certainty that no additional po`ouli exist.

See the Rare Bird Discovery Protocol in Section III-D.

20. \`Akikiki (Kaua\`i Creeper), *Oreomystis bairdi*

DESCRIPTION AND TAXONOMY

Adult \`akikiki foraging on \`ōhi\`a trunk. Photo © Jack Jeffrey.

The Kaua\`i creeper, or \`akikiki, is a small honeycreeper, 10.9 to 12.2 centimeters (4.3 to 4.8 inches) in length and 11.5 to 17.0 grams (0.39 to 0.58 ounces) in weight, endemic to the Island of Kaua\`i. Its head, back, sides, and flanks are dull gray to olive, the throat, breast, belly, and undertail coverts are white to off-white. The bill is short and slightly downcurved, the tail is short and square-tipped, and the legs, feet, nails, and bill are dull pink. Male and female plumages are identical. Juveniles are similar to adults but are distinguishable by white "spectacles" around the eyes. The song is a short, descending trill. Males and females give a soft "whit" contact call.

At the time of European discovery, each of the six main Hawaiian Islands harbored a small, straight-billed, simple-tongued, insectivorous bird. The Kaua\`i creeper was first described as *Oreomyza bairdi* by Stejneger in 1887 (the genus was later changed to *Oreomystis* because *Oreomyza* had been used previously, Stejneger 1903). Subsequent nomenclature has been problematic (reviewed in Pratt 1992b, Foster *et al.* 2000), and the species has been variously considered a full species *Oreomystis bairdi* (Perkins 1903), a subspecies of *Paroreomyza bairdi* (Bryan and Greenway 1944), and a subspecies of *Loxops maculata* (Amadon 1950). It is currently classified as *Oreomystis bairdi* (American Ornithologists' Union 1998) following Pratt (1979, 1992b), but its inclusion with the Hawai\`i creeper in the genus is a matter of ongoing debate (Johnson *et al.* 1989, Fleischer *et al.* 1998, Pratt 2001). Additional evidence, particularly molecular, may confirm that the Maui \`alauahio (*P. montana newtoni*) is the closest living relative of the \`akikiki (Foster *et al.* 2000). The \`akikiki is in the Hawaiian honeycreeper family (family Fringillidae, subfamily Drepanidinae).

LIFE HISTORY

The life history of the Kaua`i creeper or `akikiki is poorly known. Data below have been summarized from Eddinger (1972) and Foster *et al.* (2000), except where otherwise noted. `Akikiki are usually found in pairs, family groups, and small flocks of 5 to 6 (rarely up to 12) individuals (J. Denny, Hawai`i Department of Land and Natural Resources, pers. comm.; T. Snetsinger, U.S. Geological Survey, pers. comm.). `Akikiki also form mixed-species flocks with `akeke`e (*Loxops caeruleirostris*), `anianiau (*Hemignathus parvus*), Kaua`i `amakihi (*Hemignathus kauaiensis*), and Kaua`i `elepaio (*Chasiempis sandwichensis sclateri*), and historically with `akialoa (*Hemignathus procerus*), and Kaua`i nukupu`u (*Hemignathus lucidus hanapepe*) (Perkins 1903, Munro 1944).

Nest construction has been observed from March to May, and first nests are probably active by mid- to late-March or April. The earliest fledgling was sighted in late April (T. Casey, Kamehameha Schools, pers. comm.), and the breeding season is believed to last into June or July. Only eight nests of the Kaua`i creeper have been found (J. Foster, U.S. Geological Survey, pers. comm.) and only three of these have been reported in the literature (Eddinger 1972, Foster *et al.* 2000). Females and males both participate in nest-building, although the extent of male help is unclear. Three open-cup nests found in the Alaka`i were all 8 to 9 meters (26 to 29 feet) high in the crowns of `ōhi`a (*Metrosideros polymorpha*) trees and were composed primarily of moss, with `ōhi`a bark, plant rootlets, and other fine plant fibers; two others were at 4 and 6 meters (13 and 20 feet) and at least one included `ōlapa (*Cheirodendron trigynum*) bark (J. Denny, pers. comm.). A nest found on 24 May 2006 in the Halepā`ākai area of the Alaka`i contained a single large nestling and was approximately 12 meters (40 feet) high in the crown of a 14 meter (46 foot) tall `ōhi`a tree (E. VanderWerf, unpubl. data). One nest required 14 days from nest completion to first egg (Eddinger 1972). Clutch size is probably two eggs, incubation probably lasts 16 to 18 days, and the nestling period probably lasts 17 to 19 days, based on traits of the closely related Hawai`i creeper (VanderWerf 1998b, Woodworth *et al.* 2001). Family groups of parent(s) and one or two juveniles can be found throughout the year.

No data exist on the survival rate of nests, overall proportion of nests surviving to fledge, or causes of nest failure. One of the two nests found by Eddinger (1972) was abandoned in the egg stage, and one contained two nestlings (fate unknown). The fates of the other five nests that have been found are unknown because nests were not revisited. Pairs can fledge two young, based on observations of a family group with two very young fledglings (J. Foster, pers. comm.). A long parental-dependency period makes double-brooding unlikely, although no data are available.

The Kaua`i creeper generally forages on trunks, branches, and twigs of live and dead `ōhi`a and koa (*Acacia koa*) and occasionally forages in subcanopy shrubs. Creepers feed primarily on insects, insect larvae, and spiders that they glean and probe from the bark, lichens, and moss. In May 2006 an adult Kaua`i creeper was observed excavating the dead twig of a hoawa (*Pittosporum*) tree (E. VanderWerf, unpubl. data), though this may be a rare foraging behavior. Nectarivory and frugivory also have been rarely observed.

No data are available on the annual survival rate of the Kaua`i creeper. The congeneric Hawai`i creeper has a relatively high annual adult survival of about 73 to 88 percent and juvenile survival of about 33 percent (Ralph and Fancy 1994a, Woodworth *et al.* 2001). However, these high survival rates may reflect in part the rarity of avian disease at high elevations (more than 1,500 meters [5,000 feet]) where these data were collected (see below).

HABITAT DESCRIPTION

The habitat description that follows is primarily from Foster *et al.* (2000). Kaua`i creepers occur primarily in mesic and wet forests. In the eastern edge of the species' range, annual rainfall exceeds 13,000 millimeters (512 inches) a year, declining to 1,100 millimeters (43 inches) at the western edge at Kōke`e State Park. This rainfall gradient and varied topography cause great variability in habitat within Kaua`i creeper range. The montane wet forest is dominated by `ōhi`a with a subcanopy of `ōlapa, lapalapa (*Cheirodendron* spp.), and `ōhi`a ha (*Syzygium sandwicensis*). The forest understory is occupied by many species of native shrubs and small trees, typically including `ōhelo (*Vaccinium calycinum*), kanawao (*Broussaisia arguta*), haha`aiakamanu (*Clermontia fauriei)*, kāwa`u (*Ilex anomala*), kōlea (*Myrsine lessertiana*), na`ena`e (*Dubautia* spp.),and pūkiawe (*Styphelia tameiameiae*). The ground cover consists of ferns, mosses, herbs, and lichens. Lowland habitats have been drastically altered by introduced weeds and feral ungulates.

HISTORICAL AND CURRENT RANGE AND STATUS

The Kaua`i creeper is endemic to the island of Kaua`i. It was considered common from high to low elevation in native forests in the late 1800s (Perkins 1903), and was locally abundant on and near the Alaka`i Plateau in the early 1960s (Richardson and Bowles 1964). From 1968 to 1973, John Sincock surveyed 50 points (a total of 866 half-hour counts) throughout the Island of Kaua`i and estimated the population to number 6,832 ± 966 birds in a range encompassing areas from 600 to 1,600 meters (1,968 to 5,248 feet) elevation (Sincock 1982; Figure 21). In 1981, the Hawaii Forest Bird Survey estimated there were approximately 1,650 ± 450 Kaua`i creepers in a 25 square kilometer (9.7 square mile) area of the southeastern Alaka`i, in the vicinity of what is now known as Sincock's Bog (Scott *et al.* 1986). Sincock *et al.* (U.S. Fish and Wildlife Service 1983b) had estimated the population in this same area to be 2,300 ± 700 birds. More recently, surveys in March and April 2000 by Foster *et al.* (2004) showed that in the last 30 years the range has decreased from 88 to 36 square kilometers (from 34 to 14 square miles), the species has disappeared from much of the periphery of its range, and the estimated population has declined from 6,832 ± 966 to 1,472 ± 680 birds (Figure 21).

REASONS FOR DECLINE AND CURRENT THREATS

Modification and loss of habitat, avian disease, predation by introduced mammals, and competition from introduced birds have likely played a part in the decline of the Kaua`i creeper.

Habitat loss and degradation/Invasive species. The habitat of the Kaua`i creeper has been and continues to be negatively affected by invasive alien plant species that displace native plant species used by the creeper for foraging and nesting, and by the action of feral ungulates, particularly feral pigs and goats.

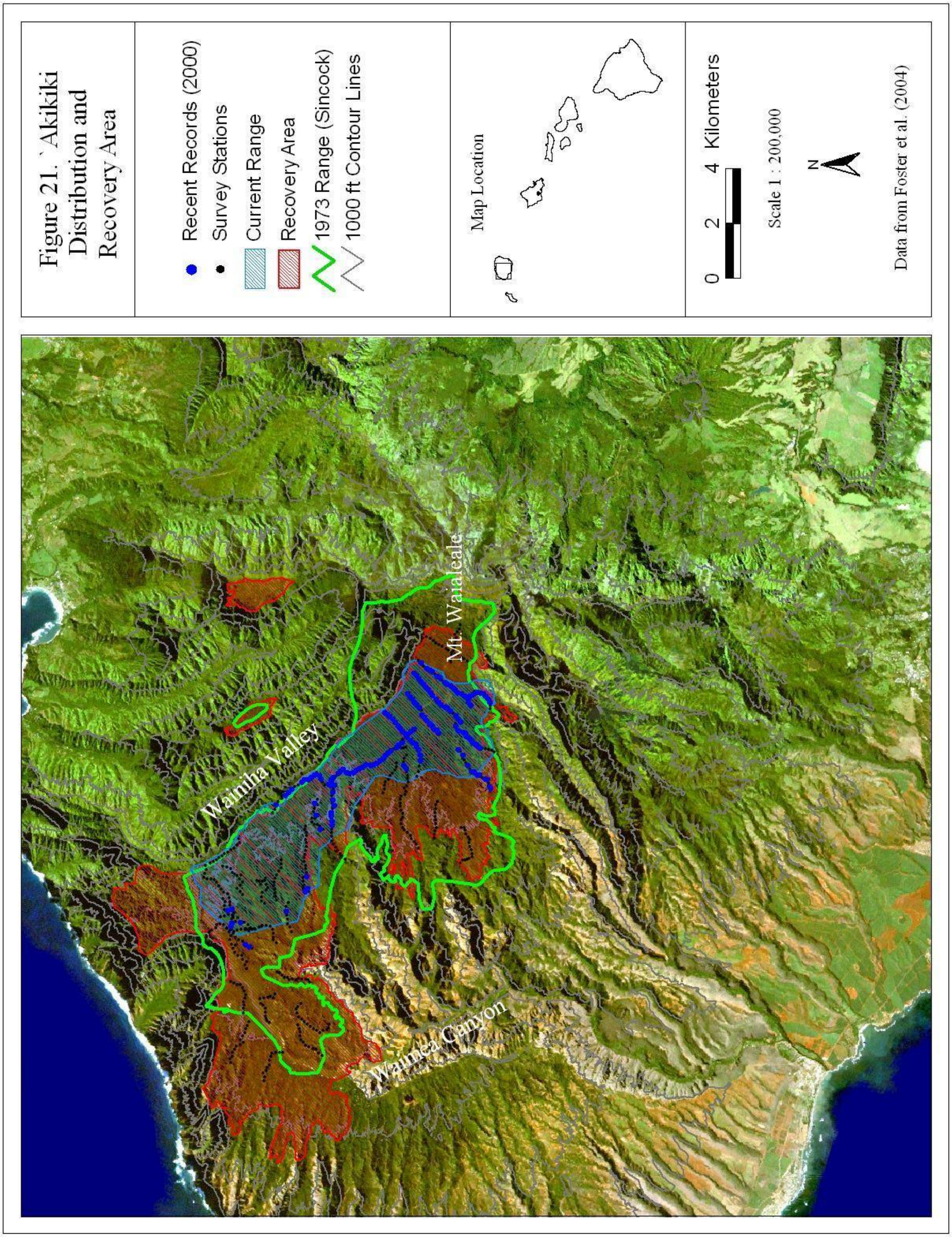


Figure 21. `Akikiki Distribution and Recovery Area

Feral pigs and goats have had a long-term damaging effect upon native pristine forests in the Alaka`i region, opening space for weeds, and transporting weed seeds into the forest. The negative impacts of feral ungulates on forested ecosystems in Hawai`i include direct browsing of native plants, soil erosion, disruption of plant regeneration, spreading of invasive alien weeds, opening of space for invasive alien plants, and creation of mosquito breeding habitat (Cabin *et al.* 2000). Habitat degradation resulting from the invasion of many nonnative weeds has drastically changed the forest structure and integrity. Furthermore, two hurricanes in 1982 and 1992 have severely disrupted portions of native forest and made space for germination and expansion of alien plants.

It has been suggested that the Kaua`i creeper may be negatively impacted by competition from the insectivorous Japanese white-eye (*Zosterops japonicus*; Mountainspring and Scott 1985). Japanese white-eyes are extremely common, numbering over 255,000 during Sincock's surveys from 1968 to 1973 (Sincock 1982). New avian species that have recently become established on Kaua`i, such as the Japanese bush-warbler (*Cettia diphone*), could eventually become competitors for food and space. Perhaps less obvious, but potentially detrimental to the Kaua`i creeper, are additions of new exotic invertebrates to the forest ecosystem. The role of alien invertebrates is unclear; new insects may compete with or prey upon the native insect prey of the creeper, or they could be used as prey by the creeper.

Disease. Avian diseases transmitted by the introduced southern house mosquito (*Culex quinquefasciatus*), including pox (*Poxvirus avium*) and malaria (*Plasmodium relictum*), are thought to play a major role in limiting the distribution of Kaua`i creepers. The Kaua`i creeper is restricted to higher elevation areas where mosquitoes and the diseases they carry are less prevalent (Scott *et al.* 1986), but mosquitoes have been captured as high as Sincock's Bog at 1,330 meters (4,400 feet) elevation and are likely to occur to the highest elevations on Kaua`i (D. LaPointe, U.S. Geological Survey, pers. comm.). Mist-netting of forest birds from 1994 to 1997 in three locations, Pihea-Alaka`i Swamp Trail, Koia`e Camp, and Sincock's Bog, documented 2 to 5 percent of all birds with active malaria infections in these areas, and up to 12 percent with malarial antibodies (C. Atkinson, U.S. Geological Survey, unpubl. data, cited in LaPointe 2000). Malarial infection rates were highest in the west, at Pihea, and lowest in Sincock's Bog. None of the 10 Kaua`i creepers tested for malaria had active infections or evidence of past infection (C. Atkinson, U.S. Geological Survey, unpubl. data, cited in LaPointe 2000), but more data is needed to determine if this low infection rate is caused by a low transmission rate or high mortality of infected birds.

Predation from introduced and native species. The biology of the Kaua`i creeper has been little studied and predation on adults and nests has not been documented, but several introduced mammals known to be serious predators on Hawaiian forest birds are present in the Alaka`i swamp on Kaua`i where `akikiki occur (Tweed *et al.* 2000), including black rats (*Rattus rattus*), Polynesian rats (*R. exulans*), Norway rats (*R. norvegicus*), and feral cats (*Felis catus*). Two species of owls, the native pueo or Hawaiian short-eared owl (*Asio flammeus sandwichensis*) and introduced barn owl (*Tyto alba*), are known to prey on forest passerines (Snetsinger *et al.* 1994).

Other Factors. Hurricanes struck Kaua`i in 1982 and 1992 and significantly reduced habitat by destroying forests and promoting the spread of alien weeds. Surveys by Foster *et al*. (2000) showed that the Kaua`i creeper declined significantly from 1989 to 1994.

Climate change poses a threat to the Kaua`i creeper and other Hawaiian forest birds by causing an increase in the elevation at which regular transmission of avian malaria occurs (Benning *et al*. 2002). Experimental evidence has shown that the malarial parasite does not develop in birds below 13 degrees Celsius (55 degrees Fahrenheit), and field studies have found that maximum malaria transmission occurs where mean ambient summer temperature is 17 degrees Celsius (63 degrees Fahrenheit; LaPointe 2000). Between 13 and 17 degrees Celsius, malaria transmission is limited and usually associated with warmer periods, such as El Nino events (Feldman *et al*. 1995). There are no forested areas on Kaua`i where mean ambient temperature is below 13 degrees Celsius, meaning all areas are subject to malaria at least periodically. Benning *et al*. (2002) used GIS (Geographic Information System) simulation to show that an increase in temperature of 2 degrees Celsius (3.6 degrees Fahrenheit), which is predicted by some climatic models (Pounds *et al*. 1999, Still *et al*. 1999, IPCC 2001), would raise the 17 degree isotherm by 300 meters (985 feet), resulting in an 85 percent decrease in the land area where malaria transmission currently is only periodic.

SPECIES-SPECIFIC CONSERVATION EFFORTS

Legal protection. The Kaua`i creeper is a candidate for listing under the Endangered Species Act (U.S. Fish and Wildlife Service 2005). If the creeper is listed federally, it will be added automatically to the State of Hawai`i's list of endangered species.

Ecological Studies. In June 1985, the Hawai`i Division of Forestry and Wildlife and the U.S. Fish and Wildlife Service conducted the first systematic survey of forest bird populations throughout the Alaka`i region since John Sincock's 1968 to 1973 surveys. A total of 34 transects were surveyed using standard variable circular plot methodology, including over 77 linear kilometers (48 miles) and 550 point count stations covering approximately 100 square kilometers (38 square miles) of the Alaka`i region (Figure 21). The surveys included the majority of native forest on Kaua`i above about 1,200 meters (4,000 feet). Surveys by Foster *et* al. (2000) have provided more recent estimates of the range and abundance. In combination these surveys have demonstrated serious declines in the abundance and distribution of the species.

Captive propagation and reintroduction. The Zoological Society of San Diego currently is developing techniques for rearing *Oreomystis* creepers from eggs and breeding them in captivity, using the related Hawai`i creeper as a surrogate. To date, nine Hawai`i creepers have been reared from eggs collected from the wild, and two Hawai`i creeper pairs have produced eggs in captivity. In June 2000, the first Hawai`i creeper egg laid in captivity successfully hatched at the Keauhou Bird Conservation Center in Volcano, Hawai`i (The Peregrine Fund 1997, 1998, 1999; The Peregrine Fund and Zoological Society of San Diego 2000).

HABITAT-WIDE CONSERVATION EFFORTS

The habitat that is home to the `akikiki also harbors (or harbored) populations of six other endangered forest birds: the `ō`ū (*Psittirostra psittacea*), Kaua`i `ō`ō (*Moho braccatus*), kāma`o (*Myadestes myadestinus*), Kaua`i nukupu`u (*Hemignathus lucidus hanapepe*), Kaua`i `akialoa (*Hemignathus procerus*), and puaiohi (*Myadestes palmeri*). The area is also important as a watershed, and is popular for recreational hiking, bird watching, and hunting. Thus, there have been ongoing efforts aimed at protecting the Alaka`i region, including legal protection, periodic surveys, control of feral ungulates, education and outreach, and ecological studies.

Legal Protection. The Forest Reserve Act of 1903 was an important action that protected watersheds in Hawai`i. The Act has been strengthened and re-titled "Hawai`i Department of Land and Natural Resources Title 13, Chapter 104 Rules Regulating Activities Within Forest Reserves," and provides protection to native forest habitats from certain degrading factors caused by human activities. The Hawai`i Department of Land and Natural Resources established the 4,022 hectare (9,938 acre) Alaka`i Wilderness Preserve in 1964 (Administrative Rule No. 1, Chapter 3), recognizing the pristine forest values of that area, and the need to control potential degrading factors.

Periodic Surveys and Inventories. Regular surveys and inventories of Kaua`i forest bird populations and habitat conditions within the Alaka`i Wilderness Preserve have been conducted on established transects since the late 1960s. John L. Sincock, research biologist with the U.S. Fish and Wildlife Service, Kaua`i Field Station, conducted intensive status and distribution surveys of Kaua`i forest birds between 1968 and 1973 (Sincock 1982). Large-scale multi-agency surveys were conducted on established transects in 1981, 1985, 1989, 1993, 1994, and 2000 (Hawai`i Department of Land and Natural Resources, unpubl. data; U.S. Geological Survey, unpubl. data; Foster *et al*. 2004). The Hawai`i Rare Bird Search and Survey Team made an intensive systematic effort to locate any surviving endangered Kaua`i forest bird populations still in existence on Kaua`i (Reynolds and Snetsinger 2001).

Control of Feral Ungulates. The Hawai`i Department of Land and Natural Resources has maintained liberal public hunting seasons to minimize forest damage caused by feral pigs and goats within the Alaka`i Wilderness Preserve for several decades. Unfortunately, public hunting is effective only in the more accessible areas of the preserve, and ungulate populations in more remote areas remain high. Limited aerial reconnaissance and aerial shooting of feral goats and pigs has been attempted in the most remote regions, but has not proven to be economically effective. Long-term protection of the Alaka`i from feral ungulates will require creativity, commitment, political practical understanding, an extensive public relations campaign, and significant financial support.

Information and Education. Materials featuring Kaua`i's endangered forest birds, as well as those found on other islands, have been published and distributed to schools to assist efforts to inform the public and gain support for funding to preserve endangered species. Privately-funded filmmakers including the British Broadcasting Company and the National Geographic Society have assisted by filming and publicizing the plight of endangered forest birds. Several articles have appeared in popular nature magazines and local newspapers to tell the story of the endangered Hawaiian forest birds, including those on Kaua`i. Most recently, Audubon magazine featured the puaiohi recovery effort in an article in its February 1999 issue.

Ecological Studies. Dr. Carter Atkinson of the Biological Resources Discipline, U.S. Geological Survey, initiated forest bird disease studies on several of the main Hawaiian islands, including Kaua`i, focusing primarily on blood-borne diseases within the range of endangered Hawaiian forest birds. This research is aimed at understanding the significance of disease and confirming the long-held theory that diseases brought to Hawai`i by introduced exotic birds and the establishment of alien vectors of disease such as mosquitoes has had a major role in the decline and extinction of native birds in Hawai`i.

CONSERVATION STRATEGY

The primary strategy for the conservation of the Kaua`i creeper and to preclude the need for listing this species under the Endangered Species Act is protection and management of remaining forest above 1,200 meters (4,000 feet) in the Alaka`i Wilderness Preserve and surrounding State and private lands (Figure 21).

Habitat Protection. Prospects for conservation lie in maintaining and restoring forest habitat by developing, testing, and applying broad-scale habitat restoration measures, including:

- Minimizing populations of feral ungulates through a combination of hunting, fencing, snaring, and possibly development of lethal non-toxicant devices for use in areas inaccessible to hunters, or in areas closed to hunters;

- Controlling the encroachment of noxious weed plants and insects through tested bio-control, and where feasible, mechanical and chemical measures; and
- Continuing enforcement of State and Federal laws that protect against destructive human activities and developments.

Predator Control. Long-term protection of many Hawaiian forest birds, including the Kaua`i creeper, likely will require large-scale control of alien predators, particularly black rats and feral cats. Development of safe and effective toxicants and application methods for control of feral cats and introduced rodents in remote forested habitat is severely needed. Preventing the introduction of additional alien predators, especially the small Indian mongoose (*Herpestes auropunctatus*), which currently is found on other Hawaiian islands, is also important.

Captive Propagation and Reintroduction Programs. Development of captive breeding and release techniques for *Oreomystis* creepers, including the Kaua`i creeper, may be needed and should be pursued if funds are available.

Population Surveys and Monitoring. A primary need is an intensive demographic study of Kaua`i creeper to document key aspects of its life history, especially survival rate, causes of mortality, susceptibility to disease, recruitment rates, and causes of nest failure, in concert with management actions designed to mitigate key limiting factors. Continued monitoring of the status of forest bird populations and their habitats is needed to measure the effectiveness of management actions.

21. Bishop's `Ō`ō, *Moho bishopi*

DESCRIPTION and TAXONOMY

Bishop's `ō`ō. © from Rothschild (1893-1900). Courtesy Smithsonian Institution Libraries.

Bishop's `ō`ō, considered a "species of concern," was a large, 12-inch (31-centimeter) long, vociferous, long-tailed black forest bird with a yellow ear patch, undertail coverts, and axillary (under the wing) tufts. Bishop's `ō`ō was known with certainty only from Moloka`i, and was a member of the honeyeater family (*Meliphagidae*), originating in Australia and the South Pacific and not related to the Hawaiian honeycreepers. The genus *Moho* was endemic to the Hawaiian Islands. The Bishop's `ō`ō was last seen in 1904 (Munro 1944), though there were unconfirmed reports into the 1980s (Sabo 1982). Detailed descriptions of this species and its calls were provided by Perkins (1903) and Munro (1944).

LIFE HISTORY

Information on the life history of the Bishop's `ō`ō is very fragmentary and known only from the writings of early naturalists (Perkins 1903, Munro 1944). Apparently this species was primarily nectarivorous, preferring lobelia (*Lobelia* spp.) flowers, but it also fed on insects. Nothing is known of its nesting biology.

HABITAT DESCRIPTION

Munro (1944) reported Bishop's `ō`ō from forested areas with `ōhi`a (*Metrosideros polymorpha*) and lobeliads in the upper elevations of Moloka`i. Possible detections of `ō`ō on Maui were from montane rainforest of northeastern East Maui (Sabo 1982).

HISTORICAL AND CURRENT RANGE AND STATUS

Historically, this species was recorded only from Moloka`i (see Figure 8 on page 2-29). Subfossil remains of *Moho* from Maui may be this species (James and Olson 1991). Black birds reported to be `ō`ō, and perhaps most likely this species, have been reported historically from `ōhi`a forests on Maui according to Banko (1980 to 1984) and most recently Sabo (1982), but these reports were never confirmed. The 1980 Hawaiian Forest Bird Survey failed to detect this species on Moloka`i or Maui (Scott *et al.* 1986), nor have subsequent searches and other field work turned up any (Reynolds and Snetsinger 2001). This species should most likely be considered extinct.

REASONS FOR DECLINE AND CURRENT THREATS

Reasons for the early decline and loss of Bishop's `ō`ō are unknown, but presumably are the same as for other endangered forest birds on Moloka`i and Maui. Additionally, this species was hunted by early Hawaiians for its yellow plumes, and it is possible that unregulated feather collecting in the 1800s, when guns became available, contributed to the bird's demise.

CONSERVATION EFFORTS

No specific efforts to conserve this species have been initiated because no individuals are known to exist and the species is almost certainly extinct.

CONSERVATION STRATEGY

It is very unlikely that this species survives on either Moloka`i or Maui. However, the Rare Bird Discovery Protocol in Section III-D is provided in the event that the species should possibly persist.

III. RECOVERY

A. Recovery Goal and Objectives

The ultimate goal of this plan is to achieve the successful conservation and recovery of the 19 Hawaiian forest birds listed as endangered. Once recovery is achieved, the protections of the Endangered Species Act (Act) are no longer necessary and these species may be removed from the Federal List of Endangered and Threatened Wildlife and Plants (delisted). For the candidate species and species of concern, the goal is to address the threats to the species and arrest or reverse the declines in their populations such that the protections of the Act are not required and the need to list the species is precluded.

In order to reach these recovery goals, the primary objective of this plan is to specify how to restore and maintain each species to self-sustaining populations, while at the same time promoting natural demographic and evolutionary processes. Small populations are especially susceptible to extinction by chance demographic events, and species with a limited distribution are more susceptible to extinction due to catastrophes (e.g., hurricanes, fires, disease) and environmental stochasticity (e.g., periodic absence of an important food item).

For each taxon, the recovery objectives are to:

(1) Restore populations to levels that allow the taxon to persist despite demographic and environmental stochasticity and that are large enough to allow natural demographic and evolutionary processes to occur;
(2) Protect enough habitat to support these populations; and
(3) Identify and remove the threats responsible for its decline.

In addition, stabilization of the current population(s) is considered an interim recovery objective. Once stabilization has been accomplished, the focus should shift to the recovery of viable, self-sustaining populations. For species that are extremely rare (no individuals can be located), an implicit interim objective is to locate any remaining individuals and implement the Rare Bird Discovery Protocol (Section III-D).

B. Recovery Criteria

Recovery criteria common to all taxa covered by this recovery plan are listed below. More specific criteria have been developed for well-studied taxa based on their life histories, and for taxa with specific recovery needs. These recovery criteria are based on the threats that have caused the decline of Hawaiian forest birds, as discussed in the Introduction, and they include population stability and growth rates, habitat protection, and threat management. For those taxa for which sufficient information was available (O`ahu `elepaio, puaiohi, palila, Maui parrotbill, `akiapōlā`au, Hawai`i creeper, Hawai`i `ākepa, `ākohekohe, po`ouli, and `akikiki), we have developed species-specific recovery criteria, listed in Table 6. For species that have not been detected in 10 or more years, the general recovery criteria provided still pertain in the long-term; however, the immediate recovery need is to continue searching for them, following the Rare Bird Discovery Protocol (Section III-D), and to find nesting pairs if possible. These species include the kāma`o, `oloma`o, Kaua`i `ō`ō, `ō`ū , Kaua`i `akialoa, Kaua`i nukupu`u, Maui nukupu`u, O`ahu `alauahio, kākāwahie, and Maui `ākepa. Bishop's `ō`ō also falls into this category, although as the species is not yet listed, the recovery criteria do not technically apply. More specific recovery criteria will be developed for these taxa should the species be relocated and sufficient information becomes available to do so.

Forest bird surveys are conducted on only one of the main Hawaiian islands each year, because there are limited numbers of personnel trained to survey Hawaiian forest birds, and the time frame in which surveys can be conducted is limited to only a few months each year during the forest bird breeding season. The surveys rotate among Hawai`i, Maui, Moloka`i, O`ahu, and Kaua`i, but Hawai`i is divided in halves because of its larger size and thus takes 2 years to survey. Systematic surveys have been conducted only once on O`ahu, in 1991, though targeted surveys for the O`ahu `elepaio are conducted each year in portions of the island (VanderWerf *et al*. 2001). After 15 years, this survey schedule will thus produce four data points on each island, which is the minimum required to conduct a meaningful population trend analysis. We feel this amount of information will be adequate to determine if a species can be downlisted under recovery criterion 2, in conjunction with other downlisting criteria identified below. However, a greater number of data points are needed (seven data points, or censuses every 5 years over a 30-year period) to be able to determine population trends with the improved confidence necessary for delisting, in conjunction with other delisting criteria. Because populations may fluctuate in response to good or poor breeding years and environmental factors, we feel it is important to survey over a long enough time so that results are representative of long-term trends.

A taxon may be downlisted from endangered to threatened when all four of the following criteria are met, as well as any species-specific downlisting criteria listed in Table 6:

1. The species occurs in two or more viable populations or a viable metapopulation* (as described in Table 6; viable as defined in criterion 2) that represent the ecological, morphological, behavioral, and genetic diversity of the species.

2. Viability of the populations is demonstrated through either a) quantitative surveys that show that the number of individuals in each isolated population or in the metapopulation has been stable or increasing for 15 consecutive years, or b) demographic monitoring that shows each population or the metapopulation has an average growth rate (lambda, λ) not less than 1.0 over a period of at least 15 consecutive years; and total population size is not expected to decline by more than 20 percent within the next 15 consecutive years for any reason.

3. Sufficient habitat in recovery areas (described in Section III-C) is protected and managed to achieve Criteria 1 and 2 above.

4. The threats that were responsible for the decline of the species have been identified and controlled.

The 21 taxa of Hawaiian forest birds covered in this plan all face the same set of threats, including habitat loss and degradation, disease, predation, and natural stochastic events. However, the severity of these threats varies among species depending on their life history and current distribution. Moreover, these

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* A metapopulation, as used here, is defined as a group of partially isolated populations belonging to the same species among which at least occasional exchange of individuals occurs.

factors interact in complex and dynamic ways that are only partly understood, and the degree to which each threat must be managed in order to recover each species is difficult to ascertain. For example, transmission and prevalence of avian diseases and abundance of alien predators vary from year to year and from site to site, causing fluctuations in the amount of management that would be needed to ameliorate these threats. If bird populations are stable in the long-term, despite periodic episodes of increased disease, predation, and other threats, then the species can be considered safe from extinction. Setting a recovery criterion of demographic persistence highlights the need for effective monitoring, and helps ensure that all threats have been adequately managed and any population increases are not transient.

A taxon may be delisted due to recovery when the downlisting criteria described above, as well as any species-specific criteria listed in Table 6 for species downlisting and delisting, have been satisfied for at least 30 consecutive years. To delist because of extinction will require additional information gathering, including sufficient survey effort in areas where the species was detected most recently and in other areas of the species' historical range, as described in individual species accounts. An analysis of historical information, search effort, and survey results will be conducted to determine the probability of the species' extinction, and based on this analysis the species could be considered for delisting because of extinction (see Section D, Rare Bird Search Protocol below for discussion on designation of species as "potentially extinct").

We set recovery criteria to serve as objective, measurable guidelines to assist us in determining when a listed species has recovered to the point that the protections of the Act are no longer necessary. However, the actual change in status (downlisting or delisting) requires a separate rulemaking process based upon an analysis of the same five factors considered in the listing of a species (see page 5-2). The recovery criteria presented in this recovery plan thus represent our best assessment of the conditions that would most likely result in a determination that downlisting or delisting of a taxon is warranted as the outcome of a formal five factor analysis in a subsequent regulatory rulemaking. Achieving the prescribed criteria is an indication that the taxon no longer meets the definition of threatened or endangered under the Act, but this must be confirmed by a thorough analysis of the five factors.

Table 6. Additional species-specific recovery criteria for some of the Hawaiian forest birds, as discussed in Section III-B, Recovery Criteria. See individual species accounts for discussion of the recovery strategy and justification of recovery criteria.

Table 6. Additional Species-specific Recovery Criteria		
Listed Species	Downlisting Criteria	Delisting Criteria
O`ahu `elepaio	Existing core populations in Waikāne/Kahana, southern Ko`olau, central Ko`olau, southern Wai`anae, Schofield Barracks West Range, and Mākaha/Wai`anae Kai are viable, or function as viable metapopulations on both the windward and leeward sides of the Ko`olau and Wai`anae Mountains, and criteria 2 and 3 apply over a 15-year period.	Same as downlisting, and criteria 2 and 3 apply over a 30-year period.
Puaiohi	Total population of 1,000 adults in at least 5 subpopulations (Mōhihi, Kawaikōī, Koai`e, Halehaha/Halepā`ākai, and Halekua drainages) that constitute a single metapopulation, and criteria 2 and 3 apply over a 15-year period.	Same as downlisting, but with total population of 2,000 adults, and criteria 2 and 3 apply over a 30-year period.
Palila	Viable populations exist on the southwestern slope of Mauna Kea, either the northern, eastern or the southern slope of Mauna Kea, and at least one other location on Hualālai or Mauna Loa, and criteria 2 and 3 apply over a 15-year period.	Same as downlisting, and criteria 2 and 3 apply over a 30-year period.
Maui parrotbill	Viable populations exist on Haleakalā and either West Maui or Moloka`i, and criteria 2 and 3 apply over a 15-year period.	Same for downlisting, and criteria 2 and 3 apply over a 30-year period.
`Akiapōlā`au	Viable populations or metapopulations exist in Hāmākua, Kūlani/Kīlauea/Keauhou, Ka`ū, south Kona, and māmane forest on Mauna Kea, and criteria 2 and 3 above apply over a 15-year period.	Same as downlisting, and criteria 2 and 3 apply over a 30-year period.

Table 6. Additional Species-specific Recovery Criteria		
Listed Species	Downlisting Criteria	Delisting Criteria
Hawai`i creeper	Viable populations or metapopulations exist in Hāmākua, Kūlani/Kīlauea/Keauhou, Ka`ū, south Kona, and Pu`u Wa`awa`a/Hualālai, and criteria 2 and 3 above apply over a 15-year period.	Same as downlisting, and criteria 2 and 3 apply over a 30-year period.
Hawai`i `ākepa	Viable populations or metapopulations exist in Hāmākua, Kūlani/Kīlauea/Keauhou, Ka`ū, south Kona, and Pu`u Wa`awa`a/Hualālai, and criteria 2 and 3 above apply over a 15-year period.	Same as downlisting, and criteria 2 and 3 apply over a 30-year period.
`Ākohekohe	Viable populations exist on Haleakalā and either West Maui or Moloka`i, and criteria 2 and 3 apply over a 15-year period.	Same as downlisting, and criteria 2 and 3 apply over a 30-year period.
Po`ouli	Viable populations exist on Haleakalā and West Maui, and criteria 2 and 3 apply over a 15-year period.	Same as downlisting, and criteria 2 and 3 apply over a 30-year period.
Candidate Species	Guidelines to preclude listing; short-term goal	Long-term goal
`Akikiki	Total population of 6,000 birds throughout 75 percent of the area occupied from 1968 to 1973 (Sincock surveys, Sincock 1982), and criteria 2 and 3 apply over a 15-year period.	Total population of 10,000 birds throughout the entire area occupied from 1968 to 1973 (Sincock surveys, Sincock 1982), and criteria 2 and 3 apply over a 30-year period.

C. Recovery Areas

1. Guidelines for Establishing Recovery Area Boundaries

To better address the recovery needs of endangered Hawaiian forest birds, we established "recovery area" boundaries to emphasize where recovery efforts should be focused. We define "recovery area" as those areas of habitat that will allow for the long-term survival and recovery of endangered Hawaiian forest birds. The identification of recovery areas is based on a biological evaluation of habitat potentially important for the recovery of Hawaiian forest birds only, and conveys no legal obligation on the part of private landowners to manage their lands for forest bird recovery. The delineation of recovery areas should not be confused with "critical habitat," a formal designation that requires analysis of both biological and economic factors. Listing of most of the species in this plan, except the O`ahu `elepaio (listed in 2000) and Hawai`i creeper and po`ouli (listed in 1975), preceded the legal requirements of the Endangered Species Act of 1973 to consider the designation of critical habitat at time of listing, therefore critical habitat was not a consideration for these species. Of the birds in this plan, critical habitat has been designated for the O`ahu `elepaio (U.S. Fish and Wildlife Service 2001) and palila (U.S. Fish and Wildlife Service 1977). Implementation of the recovery actions identified in the Recovery Actions Narrative (Section IV) within the recovery areas identified on each island will address the threats to each species and allow for its stabilization, recovery, and ultimately, delisting.

The biological determination of recovery area boundaries was based on each species' ecology, conservation needs, current and former distribution, and the recovery criteria of protecting and establishing viable populations and metapopulations. Historical and subfossil records indicate that the distribution of many species was originally much larger than the area identified as recovery area for each species in this plan. The overall purpose of recovery areas is to guide efforts to stabilize and recover listed species. Recovery areas include lands that currently provide habitat for existing populations, lands that are currently unoccupied but contain suitable habitat to provide for expansion of existing populations and establishment of new populations, and, in cases where sufficient suitable habitat currently is not available for recovery, lands where habitat could be restored. In addition, recovery areas also include intervening areas that will facilitate dispersal of birds and gene flow among high elevation populations that are currently isolated, thereby increasing the effective population size and possibly creating a metapopulation. Lands within recovery area currently differ in suitability for forest bird recovery; some areas already contain high quality habitat and support core populations of endangered forest birds, whereas others may need intensive management and restoration before they can be considered suitable.

The foremost concern in determining recovery areas for the great majority of endangered Hawaiian forest birds is to provide areas that are free of introduced mosquitoes and disease. This habitat occurs primarily at upper elevations because the cooler temperatures at these elevations are less suitable for both the introduced mosquito vector and the malarial parasite (van Riper *et al.* 1986, LaPointe 2000). In addition, there is generally less habitat degradation and urbanization at these higher elevations. Recovery areas therefore focus on existing habitat and restorable habitat at high elevations, up to treeline on the higher islands (Maui and Hawai`i) and to the mountain summits on lower islands (Kaua`i, O`ahu, and Moloka`i). The lower elevational boundaries in most cases were chosen to include areas that provide a buffer from transmission of avian disease by mosquitoes, which can travel up to 3 kilometers (1.9 miles) and possibly farther depending on environmental conditions (D. LaPointe, U.S. Geological Survey, unpubl. data).

For species on some islands (Maui, Moloka`i, O`ahu), recovery areas occur in blocks that are separated by large gaps of unsuitable developed land, while on other islands (Hawai`i, Kaua`i) there is one contiguous block that contains a mosaic of different habitat types that vary in degree of suitability. Within this mosaic some areas may support permanent breeding populations, while others may be used only temporarily as dispersal corridors. On all main islands except Kaua`i, which has only a single mountain, it should be possible, in principle, to establish two or more disjunct viable populations. The establishment of more than one population will help incorporate existing variation, provide the opportunity for local adaptation to evolve, and spread the risk associated with catastrophes such as hurricanes and fires. In the event that the amount of recovery area possible on an isolated mountain does not support a viable population, translocation of individuals from a viable population, or other management techniques, can be used to create a managed metapopulation among different isolated mountains or blocks of habitat.

Within the identified recovery areas, every attempt should be made to manage for continuous habitat that matches the historical distribution and environmental conditions in which the life history characteristics of each species evolved, such as dispersal. High philopatry of juveniles is characteristic of all the endangered Hawaiian forest birds studied thus far, and these birds are not expected to cross wide habitat gaps. The maintenance or development of continuous habitat within recovery areas will facilitate dispersal and connectivity. Contiguous recovery area is also important for providing heterogeneity in forest structure that can shape local adaptation and genetic variability, and for permitting movements in response to seasonal variation in food resource availability. The density of birds is not expected to be uniform throughout the recovery area; source-sink dynamics, metapopulation dynamics, and seasonal movements in response to geographic variation in resources should be included where they naturally would exist.

The immediate recovery action needed for species that have not been detected in 10 or more years is to continue searching for them, following the Rare Bird Discovery Protocol (Section III-D), and to find nesting pairs if possible. These species include the kāma`o, `oloma`o, Kaua`i `ō`ō, `ō`ū , Kaua`i `akialoa, Kaua`i nukupu`u, Maui nukupu`u, O`ahu `alauahio, kākāwahie, Maui `ākepa, and Bishop's `ō`ō. With the exception of the `ō`ū on the island of Hawai`i, we have not identified separate recovery areas for species that have not been seen recently because areas that should be searched are included in the recovery area for other species. We have identified recovery area for the `ō`ū because it is most likely to occur in different parts of Hawai`i than other species on the Island. Maps of recovery areas and historical and current ranges for all 21 species covered by this plan are presented with the species accounts (Figures 6 – 11 and 13 – 21).

2. Hawai`i Recovery Areas

<u>`Akiapōlā`au</u>

- Recovery areas encompass all portions of the current and historical ranges that lie above the mosquito zone and within elevations that can be expected to support suitable forest habitat, including areas that currently contain forest and areas where forest could be restored (Figure 15, page 2-101). `Akiapōlā`au inhabit both koa/`ōhi`a (*Acacia koa*/*Metrosideros polymorpha*) forest and māmane (*Sophora chrysophylla*) forest. More than half of the recovery area is currently in a heavily degraded state and will need restoration. Recent observations of \`akiapōlā\`au using relatively young koa plantations on Kamehameha Schools land at Keauhou Ranch and at Hakalau Forest National Wildlife Refuge indicate that both old growth and second growth forest are suitable.

- Avian diseases transmitted by mosquitoes limit \`akiapōlā\`au distribution at low elevations in all forest areas. Because of differences in topography, wind patterns, and temperature, mosquitoes have differing elevational limits on different mountain slopes. Therefore, the lower limit of suitable habitat occurs at 910 meters (3,000 feet) on the eastern slope of Mauna Kea, 910 meters (3,000 feet) on the eastern and southeastern slopes of Mauna Loa, 1,210 meters (4,000 feet) on the western slopes of Mauna Loa, and 1,150 meters (3,800 feet) on the northern slope of Hualālai.

- The upper limit of recovery area is delineated by the highest elevation edge of the historical koa and māmane vegetation zones on all volcanoes.

<u>Hawai\`i Creeper and Hawai\`i \`Ākepa</u>

- Recovery areas encompass all portions of the current and historical ranges of these species that lie above the mosquito zone and within elevations that can be expected to support suitable forest habitat, including areas that currently contain forest and areas where forest could be restored (Figure 16, page 2-112 and Figure 18, page 2-129). Both species are found in koa-\`ōhi\`a forest, but unlike the \`akiapōlā\`au they do not regularly inhabit māmane forest, such as that found at higher elevations on Mauna Kea. Hawai\`i \`ākepa are currently restricted to only a portion of their recovery area due to the limited availability of large diameter trees for nesting as well as other limiting factors.

- The lower limit of recovery area is determined by the distribution of mosquitoes, the same as for the \`akiapōlā\`au.

- The upper limit of recovery area is delineated by the highest elevation edge of koa and \`ōhi\`a vegetation zones on all volcanoes.

Palila

- The palila is an extreme food specialist, preferring unhardened māmane (*Sophora chrysophylla*) seeds in green pods or in pods that are just beginning to turn brown. Palila are dependent on māmane and māmane/naio (*Myoporum sandwicense*) forest for all their needs.

- The elevational range of māmane forest is the most important variable of response of palila to available habitat. A wide belt of māmane forest results in more consistent availability of seeds within the range of daily movements typically made by palila, especially during the breeding season. Remaining large areas of māmane and māmane-naio forest that meet the biological requirements of palila or that are restorable occur at elevations above 1,360 meters (4,500 feet) on Mauna Kea and the western slope of Mauna Loa.

- The current population of palila is concentrated on the southwestern slope of Mauna Kea. Additional habitat is needed to reestablish populations or a metapopulation in portions of the historical range on the northern, eastern, or southern slope of Mauna Kea, and on Mauna Loa, as described in the recovery criteria. Management and restoration of māmane forest may be necessary at some sites before they are suitable for palila establishment.

- The upper limit of recovery area is delineated by the highest elevation edge of the historical māmane and māmane-naio forest on Mauna Kea and the upper limit of historical māmane and māmane-naio forest on the western slope of Mauna Loa.

3. Maui Nui Recovery Areas

Maui Parrotbill and \`Ākohekohe

- Currently there is only one population each of Maui parrotbill and \`ākohekohe, both on the windward side of Haleakalā volcano on east Maui (Figure 13, page 2-80 and Figure 19, page 2-141). Suitable habitat is needed in other areas to achieve at least two populations or a metapopulation of each species on Maui Nui (Maui, Moloka\`i, Lāna\`i, and Kaho\`olawe). Parrotbills and \`ākohekohe are known to have occurred on Moloka\`i, but not on Lāna\`i or

Kaho`olawe.  West Maui and Moloka`i currently contain intact native forest that appears suitable for both species, except for the presence of mosquitoes and avian diseases. Forest habitat on Lāna`i and Kaho`olawe is much more degraded, occurs at lower elevations, and would require a great deal more restoration than forest on West Maui or Moloka`i.  It is possible that Lāna`i and Kaho`olawe may again provide suitable habitat for forest birds, possibly including parrotbills and `ākohekohe, but no recovery areas for these species have been identified on those islands because other areas currently provide more cost effective recovery potential.

- Haleakalā population: Haleakalā currently supports a population of approximately 3,800 `ākohekohe that occupy about 58 square kilometers (22 square miles) from 1,100 to 2,300 meters (3,600 to 7,550 feet) elevation, and a population of approximately 500 Maui parrotbills that occupy about 50 square kilometers (19 square miles) from 1,200 to 2,350 meters (4,000 to 7,700 feet) elevation. For each species these areas represent less than 5 percent of the estimated historical ranges on Maui (Scott *et al*. 1986). Both species appear to occupy almost all habitat that is currently suitable, given disease constraints at lower elevations and boundaries of native vegetation. Population increases could be achieved by increasing the amount of suitable habitat or possibly by enhancing habitat quality and increasing carrying capacity. The potential for increasing carrying capacity is poorly known, however, and to ensure the potential for population increase, additional suitable habitat must be restored from 1,210 to 2,120 meters (4,000 to 7,000 feet) on the leeward slopes and from 1,515 to 2,120 meters (5,000 to 7,000 feet) on the western slopes. A lower elevational limit of 750 meters (2,500 feet) on windward Haleakalā encompasses nonbreeding habitat for some birds following seasonal flowering downslope.

- West Maui population: The recovery area indicated in Figure 13, from 750 meters (2,500 feet) to the summit of Pu`u Kukui at 1,765 meters (5,788 feet), encompasses all remaining forest habitat on West Maui currently suitable for forest bird habitation.  Most of this area is already managed for conservation, and vegetation condition in some areas is virtually pristine.  Populations of parrotbill and `ākohekohe situated here would provide second geographically disjunct populations for each of these species. Only a small area is high enough to provide disease- and vector-free habitat, but management actions such as strategic fencing to exclude feral pigs might reduce mosquito breeding habitat and disease transmission.

- Moloka`i population: The recovery area indicated in Figure 19, from 750 meters (2,500 feet) to the summits of Oluku`i at 1,403 meters (4,602 feet) and Kamakou at 1,515 meters (4,970 feet), encompasses all remaining forest habitat on Moloka`i currently suitable for forest bird habitation. The upper elevations are managed for conservation, and habitat conditions and disease implications are similar to West Maui.

Po`ouli

- No po`ouli are currently known to exist in the wild. As the habitat requirements for the po`ouli are poorly understood, it must be assumed that habitat needs of this species are similar to those of the Maui parrotbill, with which it is sympatric and often associates, and that recovery needs of the po`ouli will be met by the recovery area identified for Maui parrotbill (Figure 13, page 2-80). Fossil evidence suggests the original range of the po`ouli probably encompassed the full range of forest habitats on the windward, leeward, and western slopes of East Maui. To allow for recovery of a population on Haleakalā, additional habitat must be restored on the leeward slopes from 1,210 to 2,120 meters (4,000 to 7,000 feet) and from 1,515 to 2,120 meters (5,000 to 7,000 feet) on the western slopes.

- To accomplish the goal of a second population it will be necessary to establish po`ouli in some part of Maui Nui other than Haleakalā. West Maui is the most appropriate area because po`ouli are not known to have inhabited Moloka`i or Lāna`i (Olson and James 1991). If it is not possible to establish a population on West Maui, then Moloka`i could be considered as an alternative, but at this time West Maui is given higher priority because it is within the known range of the species. The indicated area on West Maui in Figure 13, from 750 meters (2,500 feet) to the summit of Pu`u Kukui at 1,765 meters (5,788 feet), encompasses all remaining forest habitat sufficient for forest bird habitation on West Maui. This area is already managed for conservation, and vegetation condition in some areas is virtually pristine. Only a small area is high enough to provide disease- and vector-free habitat, but management actions such as strategic fencing to exclude feral pigs might reduce mosquito breeding habitat and disease transmission.

4. Lāna`i and Kaho`olawe

Currently there is no forest bird recovery area identified on Lāna`i or Kaho`olawe. These islands once supported a variety of forest birds, including a now-extinct endemic species in the case of Lāna`i, the Lāna`i hookbill (*Dysmorodrepanis munroi*; James *et al.* 1989), but they are now highly disturbed, contain little (Lāna`i) or no (Kaho`olawe) forest, and are too low in elevation to provide disease free habitat. Efforts are underway to restore native ecosystems on both islands (Kaho`olawe Island Reserve Commission 2004), and it is possible that they may be suitable for reintroduction of forest birds at some point in the future. Their status should be reassessed in future revisions of this plan.

5. O`ahu Recovery Areas

O`ahu `Elepaio

- Recovery areas include all areas that are currently occupied by the O`ahu `elepaio, excluding one very small, isolated area near Hau`ula that contains only a single male (Figure 6, page 2-7).

- Currently unoccupied lands were added to provide for range expansion, dispersal corridors, and recovery of viable populations or metapopulations. Lands were considered to have greater recovery value and were included first if they: (a) provided forest types more preferred by `elepaio, (b) were more recently occupied, or (c) were contiguous, formed large blocks of suitable habitat, and helped link existing populations.

- Boundaries of recovery areas were determined by the extent of suitable forest, which in many areas coincided with the boundaries of State Forest Reserves, Natural Area Reserves, and other conservation lands. Urban and agricultural lands generally were not included because they did not contain suitable forest, but lower Wailupe Valley, which is zoned for urban use but has not been developed yet, was included because it contains suitable forest and is currently occupied by O`ahu `elepaio.

- Although disease is a serious threat to the O`ahu `elepaio, it was not considered in delineating recovery areas because no parts of the island are high enough to provide refuge from mosquitoes and all areas are subject to disease (VanderWerf *et al*. 2006).

6. Kaua`i Recovery Areas

<u>Puaiohi</u>

- Puaiohi currently have a more restricted distribution than the `akikiki because they are found only in areas with deeply eroded, rocky stream beds that provide nest sites on cliff ledges that are relatively safe from alien predators. Puaiohi currently exist at a density of about 16 birds per square kilometer (42 birds per square mile) in the core of their range that contains the best remaining habitat (Snetsinger *et al.* in prep.). However, it may be possible to increase the distribution and abundance of puaiohi by improving habitat quality through the use of predator-resistant artificial nesting structures. Surrounding lowland areas are too degraded to consider as possible habitat and would require development of methods for dealing with avian disease. The small amount of forest habitat at high elevations outside the Alaka`i/Koke`e region may make it difficult to establish a second population that is functionally isolated. Recovery area for the puaiohi (Figure 9, page 2-36) includes:

    - o All the high elevation montane wet forest remaining in the Alaka`i/Kōke`e region above 900 to 1,060 meters (3,000 to 3,500 feet), that contains suitable stream beds with suitable nest sites;

    - o Montane wet and mesic forest and scrub on Lā`au Ridge and Nāmolokama Peak, based on historical distribution of the species in these areas documented by John Sincock (Sincock 1982). However, Lā`au and Nāmolokama are isolated habitat areas that may be too small to sustain viable populations separate from the main population in the Alaka`i; and

- All of the Alaka`i Wilderness Preserve, portions of Kōke`e State Park, and private lands to the south deemed recoverable.

`Akikiki

- `Akikiki recovery will require protecting and managing as much of the remaining forest habitat on Kaua`i as possible, as well as restoring forest habitat in additional areas to allow range expansion. It may also be possible to increase population density in some areas by improving habitat quality, though there is limited information available about habitat needs in this species. As with the puaiohi, the small amount of forest habitat at high elevations outside the Alaka`i/Koke`e region may make it difficult to establish a second population that is functionally isolated. Recovery areas for the `akikiki (Figure 21, page 2-159) include:

    - All the high elevation montane wet forest remaining in the Alaka`i/Kōke`e region above 900 to 1,060 meters (3,000 to 3,500 feet), except steep unforested cliffs;

    - Montane wet and mesic forest and scrub on Lā`au Ridge and Nāmolokama Peak, based on historical distribution of the species in these areas documented by John Sincock (Sincock 1982). However, Lā`au and Nāmolokama are isolated habitat areas that may be too small to sustain viable populations separate from the main population in the Alaka`i; and

    - All of the Alaka`i Wilderness Preserve, portions of Kōke`e State Park, and private lands to the south and northeast deemed to be recoverable.

Other Endangered Kaua`i Forest Birds

There have been no confirmed sightings of the Kaua`i `akialoa, Kaua`i nukupu`u, Kaua`i `ō`ō, kāma`o, and `ō`ū for several years, but it is possible that some of these species still exist. All recent observations of these species occurred within the boundaries of the recovery area identified for the puaiohi, so for the purposes of this recovery plan, their recovery areas are included within that of the puaiohi. However, historical data suggest that some of these species (e.g., nukupu`u) were originally more widespread than puaiohi, existing in lower-elevation koa (*Acacia koa*) forests. Presumably the Alaka`i was a last refuge from disease for these species, but it may not necessarily provide the preferred or optimal habitat.

D. Rare Bird Discovery Protocol

1. Background and Justification

While numerous surveys of forest birds have taken place since 1976, the majority of these surveys have focused on determining the relative abundance of species and have not targeted individual species or populations. With the status and life history characteristics of many critically endangered species unknown, there is an urgent need to collect information before management strategies can be developed and implemented. Moreover, given the magnitude of the threats to Hawaiian forest birds, immediate management measures should be undertaken whenever possible. In October 1993, personnel of the U.S. Fish and Wildlife Service formed a field team (the Hawai`i Rare Bird Search Team), to determine the status of rare forest birds in the Hawaiian Islands. The objectives of this project (excerpted from Draft Memorandum, U.S. Fish and Wildlife Service, October 17, 1993) were to: (1) systematically search areas of forest habitat on all of the main Hawaiian Islands in an attempt to locate critically endangered forest bird species; (2) assist with field surveys and more detailed ecological surveys in areas where any of the extremely rare birds might be found; (3) coordinate, via the project leader, annual systematic Statewide surveys of Hawaiian forest bird populations; and (4) investigate sightings of rare bird species by other observers, and conduct follow-up surveys if deemed necessary.

These objectives helped to guide the activities of the Hawaiian Rare Bird Search Team through 1996. The purpose in developing the following protocol is to add additional objectives and establish guidelines in the event of a future rediscovery of a species that is extremely rare or possibly extinct. These additional objectives are to: (5) maximize data collection efforts; (6) facilitate communication and decisions between collaborating individuals, agencies, and species working groups; and (7) provide the information necessary to formulate the most effective and successful conservation management strategies for the target species.

2. Target Species

The species for which these protocols may pertain, generally those numbering fewer than 50 individuals and/or that have not been seen for 10 years or longer, include:

kāma`o (large Kaua`i thrush)	*Myadestes myadestinus*
oloma`o (Moloka`i thrush)	*Myadestes lanaiensis rutha*
Kaua`i `ō`ō	*Moho braccatus*
Bishop's `ō`ō	*Moho bishopi*
`ō`ū	*Psittirostra psittacea*
Kaua`i `akialoa	*Hemignathus procerus*
Kaua`i nukupu`u	*Hemignathus lucidus hanapepe*
Maui nukupu`u	*Hemignathus lucidus affinis*
O`ahu `alauahio (O`ahu creeper)	*Paroreomyza maculata*
kākāwahie (Moloka`i creeper)	*Paroreomyza flammea*
Maui `ākepa	*Loxops coccineus ochraceus*
po`ouli	*Melamprosops phaeosoma*

3. Protocol

The following outline shows the steps, the order to be followed, and the agencies, teams, working groups, and cooperators responsible for each step.

i. Identify and prioritize target species (Hawaiian Forest Bird Recovery Team, Captive Propagation Working Group).

Determination of species priority and status, including categorization as "possibly extinct" or "extinct," should be made only after thorough analysis of the number of years since the species was last observed, the rate and causes of decline, condition of preferred habitat, accessibility of habitat, natural history characteristics, frequency and thoroughness of previous searches, and the joint recommendations of the participating biologists of the U.S. Fish and Wildlife Service, Hawai`i Division of Forestry and

Wildlife, U.S. Geological Survey, National Park Service, and Hawaiian Forest Bird Recovery Team.

ii. Search, find, and study target species (U.S. Fish and Wildlife Service, Hawai`i Division of Forestry and Wildlife, U.S. Geological Survey, private birdwatchers*).

Once a target species is located, an intensive search of the surrounding vicinity should be made to study the target species and determine:

a) Number of individuals, and, if possible, sex and age of each.

b) Immediate threat(s) to the population (e.g., predators, disease, human disturbance, habitat loss, hurricane and other weather-related risks, avian competitors, pesticides, etc.).

c) Reproductive status (e.g., observations/descriptions of nests, photos of nests when possible, copulation, courtship, carrying of nesting material or insects, vocalizations, etc.).

d) Foraging activities (e.g., identification and quantification of food, and collection of samples for nutrient analyses).

e) Inter- and intra-specific behavioral interactions.

iii. Evaluate all possible management strategies (Hawaiian Forest Bird Recovery Team, Captive Propagation Working Group, U.S. Fish and Wildlife Service, Hawai`i Division of Forestry and Wildlife, U.S. Geological Survey, and National Park Service).

After the target species has been initially observed and its situation documented, the U.S. Fish and Wildlife Service and/or Hawai`i

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* Private citizens who sight any of these rare birds are requested to report their observations immediately to either the Pacific Islands Fish and Wildlife Office of the U.S. Fish and Wildlife Service, or to the Hawai`i Division of Forestry and Wildlife.

Division of Forestry and Wildlife, in consultation with the Hawaiian Forest Bird Recovery Team and Captive Propagation Working Group, will consider some or all of the following procedures and management actions:

a) Mist-netting and banding of individuals with U.S. Fish and Wildlife Service metal bands and unique combination of color bands to facilitate monitoring.

b) Collecting feather and/or blood samples for genetics, sexing, and veterinary evaluation.

c) Attachment of transmitters on some or all individuals to allow tracking of movements.

d) Implementation of control measures for potential threats (e.g., fencing, trapping, poisoning, shooting, public education, etc.).

e) Implementation of measures that may enhance reproductive success in the wild (e.g., providing supplementary food stations, artificial nests and nesting material, and field aviaries).

f) Translocation, in situations where birds of the opposite sex exist but are not paired.

g) Removal from the wild of individuals and nestlings and/or eggs for transfer to one of the captive propagation facilities for propagation and/or hand-rearing for release. These actions will be coordinated with the managers of the captive propagation facilities. Timely and practical issues such as cage space, available labor, and transfer logistics, will require discussion before each proposed action. Avicultural options including egg/nest manipulation, and captive propagation will be evaluated based on current levels of expertise. Subsequent release options will be dependent on available habitat, levels of habitat management (i.e., continuous funding and implementation), and current levels of expertise.

h) Cryopreservation. If removal from the wild of individuals is attempted, and mortality occurs during capture, transport, or later when the animal is in captivity, appropriate techniques should be used to cryopreserve gonads and ovaries for possible transplantation in hosts and to cryopreserve other body tissues for cloning and post-mortem methods to propagate the species.

iv. Initiate intervention if necessary (U.S. Fish and Wildlife Service, Hawai`i Division of Forestry and Wildlife, Captive Propagation Working Group, U.S. Geological Survey, National Park Service).

Each management strategy selected will require participation by various combinations of agencies, personnel and/or facilities managers. Each step will require population specific protocols, which should be developed by all entities involved prior to the time of need.

If invasive procedures are undertaken, their effectiveness will be evaluated and a summary report will be written and circulated by the responsible participants. This report will critically evaluate each procedure and its relative impact on the species in question. At that time a preliminary long-range plan with specific goals and objectives should be developed for species restoration.

If it is determined that a technique is not effective, or is potentially too hazardous to the survival of the individual or population in relation to the recovery of the species in question, it will be suspended. If an approach is determined to be beneficial or cannot yet be evaluated, it may be continued after consultation.

IV. RECOVERY ACTIONS

The recovery program for the Hawaiian forest birds is organized into six broad categories of recovery actions:

1) **Protect Ecosystems for Recovery of Endangered Forest Birds**, which includes recommendations for new partnerships, private and Federal conservation agreements on private lands, and land use and management goals;

2) **Manage Forest Ecosystems for the Benefit and Recovery of Endangered Forest Birds**, which includes recommendations for reforestation of recovery areas, reducing or eliminating the detrimental effects of alien plants, feral ungulates, and introduced predators, and ways to decrease the threat of avian disease;

3) **Develop Captive Propagation and Related Recovery Strategies**, which describes techniques and priorities for the captive propagation and release of Hawaiian forest birds into the wild;

4) **Conduct Research as Needed**, which describes general categories of research needed to better evaluate threats to Hawaiian forest birds and to develop and evaluate management strategies to address those threats;

5) **Monitor Changes in the Distribution and Abundance of Forest Birds**, which describes systematic surveys to monitor changes in the distribution and abundance of forest birds, to help evaluate the effects of management actions, and to provide necessary information for developing measures of population stability for future listing actions; and

6) **Public Awareness and Information**, which describes important outreach and information activities.

The general recovery action categories above are not assigned priority numbers for implementation, but each specific recovery action was assigned an implementation priority number (see below; also Table 19, Implementation Schedule). Tables in the recovery action narrative are organized by island and land parcel, and show priority numbers to help landowners identify management needs for their lands and the relative importance of each action for recovery of forest birds. The detailed Recovery Action Narrative below is preceded by a Step-down Outline, showing only the most general recovery action categories.

Definition of Recovery Action Priorities:

Priority 1 — An action that must be taken to prevent extinction or to prevent a species from declining irreversibly in the foreseeable future.

Priority 2 — An action that must be taken to prevent a significant decline in the species' population, habitat quality, or some other significant negative impact short of extinction.

Priority 3 — All other actions necessary to meet the recovery objectives.

A. Step-down Outline of Recovery Actions

1. Protect Ecosystems for Recovery of Endangered Forest Birds.

    1.1 Describe and delineate recovery areas.

    1.2 Continue existing partnerships and develop new partnerships.

    1.3 Secure recovery areas through conservation easements, partnership agreements, safe harbor agreements, changes in land use designation, leases, or purchase from willing sellers.

    1.4 Provide private landowners with financial and regulatory incentives to restore and manage suitable habitat for native forest birds.

2. Manage Forest Ecosystems for the Benefit and Recovery of Endangered Forest Birds.

2.1 Reforest recovery areas that no longer contain the necessary constituent elements for species recovery.

2.2 Reduce or eliminate the detrimental effects of ungulates on vegetation within forest ecosystems.

2.3 Reduce or eliminate the detrimental effects of alien plants within forest ecosystems, through mechanical, chemical, or biological means, as appropriate.

2.4 Reduce or eliminate the detrimental effects of alien mammalian predators (rats, mice, feral cats, mongooses) on forest birds.

2.5 Decrease the threat of avian disease.

2.5.1 Prevent introduction of new diseases and disease vectors into Hawai`i.

2.5.2 Prevent movement of diseases and disease vectors between islands.

2.5.3 Control the mosquito vector (*Culex quinquefasciatus*) of avian pox and malaria.

2.5.4 Foster ability of native birds to tolerate or develop resistance to avian pox and malaria.

2.5.5 Monitor long-term changes in the prevalence and transmission of avian diseases in recovery forest bird habitats.

2.6 Reduce or eliminate effects of other alien species.

2.6.1 Prevent introductions of new detrimental species.

2.6.2 Eradicate all incipient populations of new nonnative vertebrate species.

2.6.3 Reduce or eliminate the detrimental effects of *vespulid* wasps (yellow jackets) on forest birds within forest ecosystems.

3. Develop Captive Propagation and Related Recovery Strategies.

3.1 Periodically evaluate and identify the target species that will require captive propagation for recovery and the appropriate strategy to be used.

3.2 Develop captive propagation programs for target species, including both endangered and surrogate species.

3.3 Develop methods of evaluating, selecting, and preparing sites for releases and/or translocation of endangered birds to ensure long-term persistence of reintroduced populations.

3.4 Acquire funding to build additional facilities to maintain, propagate, incubate, and rear endangered species and, if necessary, surrogate species.

3.5 Identify wild populations and/or individuals with potential natural disease resistance on a species-by-species basis.

3.6 Develop and refine techniques for the release of captive-reared birds into managed habitat.

3.7 For each of the species identified as candidates for captive propagation, establish demographic goals for captive propagation programs, e.g., how many birds to produce using which demographic strategy over what period of time and released into how many sites.

3.8 Develop species-specific reintroduction guidelines based on risk assessments that consider the behavioral, disease, demographic and genetic needs of the species, with the ultimate goal being the re-establishment of wild populations.

3.9 Provide biological samples from captive-held birds to an approved holding location or locations determined on a species-by-species basis for use in genetic and/or veterinary examination.

3.10 If egg collections fail, develop methods of bringing nestling birds, juveniles, and/or adults into captivity with concomitant quarantine procedures.

3.11 Establish a cryogenic cell culture of germplasm of the endangered Hawaiian avifauna at two partner institutions willing to hold the cell line in perpetuity.

3.12 Evaluate the outplacement of endangered species currently at the Keauhou Bird Conservation Center and Maui Conservation Center to the Honolulu Zoo or other qualified institutions.

4. Conduct Research as Needed.

4.1 Identify the threats that cause geographical variation in density and that maintain populations at or below carrying capacity within particular locations.

4.2 Study the magnitude of threats and, if appropriate, develop and evaluate effective methods for control.

4.3 Evaluate the effectiveness of threat management actions.

4.4 Determine safety of threat management to non-target species.

4.5 Investigate role of natural selection in dealing with threats.

4.6 Conduct research that may lead to new tools for managing forest birds or their habitat, or to identification of emerging or unrecognized threats.

4.7 Special research considerations for translocations and reintroduction programs.

4.7.1 Evaluate effectiveness of translocations of both disease survivors and disease resistant forest birds for restoration of populations in areas with active disease transmission.

4.7.2 Determine optimal parameters for translocation and reintroduction efforts.

4.7.3 Evaluate the relative costs of habitat suitability analysis versus experimental translocation or reintroduction.

4.8 Special research considerations for disease and parasitism.

4.8.1 Determine the effects of land use changes on disease transmission.

4.8.2 Determine the effects of long-term climate change on disease transmission.

4.8.3 Conduct research on the feasibility of vaccines for avian pox and malaria, methods for their delivery, and possible effects on host-parasite coevolutionary adaptations.

4.8.4 Conduct research on genetic variability, virulence, and interactions between avian pox virus and malarial parasites and how these variants interact with susceptible and resistant host genotypes.

4.8.5 Determine dispersal distances of adult mosquitoes from point sources outside of recovery area.

4.8.6 Determine the feasibility of decreasing malarial transmission through genetic manipulation of vector populations.

4.8.7 Determine the role that ectoparasites such as ticks and lice play in transmission of avian pox, particularly during the nesting cycle when adults may pass infections to offspring.

4.8.8 Determine the role that endoparasites such as *Coccidea* play in demography of birds.

4.8.9 Monitor long-term changes in the prevalence and transmission of avian diseases in forest bird recovery areas.

4.9 Special research considerations for monitoring.

4.10 Research needs and priorities by species.

5. Monitor Changes in the Distribution and Abundance of Forest Birds.

5.1 Systematically survey all forest bird habitat on Kaua`i, O`ahu, Moloka`i, Lāna`i, Maui, and Hawai`i at least once every 5 years to determine changes in distribution and population size of all native and nonnative forest birds.

5.2 Conduct systematic annual surveys of selected forest areas to more carefully monitor changes in distribution and population size and efficacy of management actions.

5.3 Establish and support an interagency Forest Bird Monitoring Coordinator position to coordinate monitoring and provide regular reports on the status and trend of forest bird populations.

6. Public Awareness and Information.

6.1 Build alliances with the public through outdoor experience with native forest birds and their forest habitats.

6.1.1 Promote and support public native species awareness and environmental education through increased visitor access on trails with interpretive and educational displays.

6.1.2 Promote increased access and interpretation programs on Federal, State, County, and private refuges, parks, preserves, and other lands where native species are found.

6.1.3 Expand visitor awareness with development of visitor centers, displays, facilities, and public interpretive programs.

6.1.4 Promote the opening of State Forest Reserve trails to the general public for nature walks and birding on all islands.

6.1.5 Support the Nā Ala Hele Trail System.

6.2 Fund, support, and promote programs that inform teachers and educate children, lawmakers, the local public, and visitors.

6.2.1 Fund and support teacher education programs that promote native species issues.

6.2.2 Support and fund programs that educate children about Hawai`i's natural environments and that inform the public through non-traditional partnerships.

6.2.3 Create a clearinghouse, such as a website or "hotline," for information and educational materials about Hawai`i's native species.

6.2.4 Provide information and promote awareness of the harmful effects of some alien species to public health, native species, and native ecosystems.

6.3 Use a professional marketing agency and business marketing techniques (television, radio, internet, newspapers, advertising, and magazines) to promote awareness of the uniqueness of Hawai`i's native species and gain local support for endangered species and related conservation issues.

6.3.1 Conduct market research on the public's knowledge of native species and attitudes towards conservation in order to provide information on the most direct ways to inform the public and gain support for native species.

6.3.2 Promote and fund the development of public service announcements for television and radio about native species and their habitat.

6.3.3 Promote private business use of native species likenesses, images, and names on old and new products and use them in advertising and logos.

6.3.4 Promote fundraisers and solicit corporate funding and promotion to expand the economic base for public awareness and information campaigns.

6.4 Promote the creation of and support "Friends" groups, partnerships, environmental outreach programs, and other groups to provide support for parks, refuges, reserves, and natural areas to cultivate understanding and conservation of Hawai`i's natural and cultural resources.

6.4.1. Recruit, train, and support volunteer community leaders to organize native species outreach and awareness programs at the community level.

6.4.2. Develop and support partnership and outreach programs with other conservation agencies, native Hawaiian groups, hunter groups, and private landowners.

B. Recovery Actions Narrative

1. Protect Ecosystems for Recovery of Endangered Forest Birds.

1.1 Describe and delineate recovery areas. (Priority 1)
Recovery area maps have been created for each island and for species with known current distributions (Figures 6, 9, 11, 13, 15, 16, 18, 19, and 21; see also Section III-C, Recovery Areas).

1.2 Continue existing partnerships and develop new partnerships. (Priority 2)
Partnerships among local community groups, private individuals, non-governmental organizations, and State and Federal agencies contribute substantially to conservation efforts and community education. Existing partnerships should be continued, and expanded if appropriate, and new partnerships should be developed on islands where they currently do not exist. The goals and mission of each partnership are described below:

1.2.1 \`Ōla\`a/Kīlauea Partnership. The \`Ōla\`a/Kīlauea Partnership is a cooperative land management effort for approximately 24,240 hectares (60,000 acres) on the island of Hawai\`i. This joint management program offers an exceptional opportunity to preserve a large, functioning native ecosystem and the endangered species that depend on it for survival. It can also serve as a model for future biological resource conservation efforts.

1.2.2 Kahikinui Forest Partnership Working Group, Maui. The Working Group's mission/purpose is to revive Hawaiian Home Lands beneficiary involvement in management of the 3,030 hectare (7,500 acre) Kahikinui Forest Reserve, to protect the Kahikinui Forest Reserve from further deterioration, to begin the process of restoration of its native flora and fauna, and to integrate forest management with the Department of Hawaiian Home

Lands and the beneficiary community initiative to resettle the ahupua`a* of Kahikinui.

1.2.3 **The East Maui Watershed Partnership** is a voluntary effort between six public and private landowners and the County of Maui to jointly protect the 40,400-hectare (100,000-acre) core of critical watershed against ungulates, destructive weeds, insect pests, and other threats. The long-range goal is to stop ungulate damage in native forests and other upland areas and to limit ungulate damage in lowland forests to levels that prevent loss of forest cover, utilizing increased public hunting, and fencing in the strategy.

1.2.4 **The Leeward Haleakalā Watershed Restoration Partnership** began in June 2003 as a voluntary effort among 11 private and public landowners and managers to restore healthy and sustainable koa (*Acacia koa*) forests on the leeward side of Haleakalā from `Ulupalakua to Kaupō above 1,067 meters (3,500 feet) elevation, encompassing 17,473 hectares (43,175 acres). This area once supported some of the tallest and most extensive koa forests in the islands, but today only about 5 percent remain. Restoration of these forests will greatly enhance the watershed potential, provide for the long-term survival of many native plants and animals, and present possibilities for the renewable use of koa for canoes and woodworking.

1.2.5 **The West Maui Mountains Watershed Partnership** is a voluntary cooperative effort between eight public and private landowners of Kahalawai with a shared commitment to the long-term protection and preservation of the West Maui Mountains Watershed. The partners recognize that cooperation is the key to a timely and successful watershed management program to protect this

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* A section of land that extends from the mountain top to the ocean.

region from alien pest animals, weeds, inappropriate human activities, and other threats.

1.2.6 **The East Moloka`i Watershed Partnership** is a coalition of conservation interests, landowners, and County, State, and Federal government agencies bringing together economic and conservation interests to save, protect, and enhance water resources and native forest species and ecosystems. The East Moloka`i Watershed Partnership is based on community-wide planning and economic revitalization efforts under the U.S. Department of Agriculture Empowerment Zone Initiative, with a focus on watershed protection, sustainability, and Moloka`i's culture and traditions.

1.2.7 **Ko`olau Mountains Watershed Partnership, O`ahu.** The memorandum of understanding made among landowners in this partnership provides for accretive, cooperative management "to maintain a healthy forested watershed." The partners also agreed to jointly develop a management plan, but it is still in draft form. The overall goals of the partnership are generally consistent with and favorable toward the recovery of forest birds, but the degree of current management varies substantially among landowners. Certain parcels of land that support important core populations of O`ahu `elepaio have been identified for additional, more specific measures to protect and manage forest habitat.

1.3 **Secure recovery areas through conservation easements, partnership agreements, safe harbor agreements, changes in land use designation, leases, or purchase from willing sellers.** Table 7 lists, by island, recovery areas requiring protection. Habitat management plans should be written for all protected areas, and protection could be implemented through conservation easements, partnerships, changes in land use designation, or, if necessary, land exchanges or purchase from willing sellers. Public

(Federal, State, and County) lands should be managed or restored to provide suitable habitat for native forest birds. Private lands should be managed through easements, partnerships, and safe harbor agreements whenever possible. Further incentives such as tax breaks and partnership financial rewards could be used to secure recovery areas and for reforestation programs (see Recovery Action 1.4) and reducing or eliminating the detrimental effects of ungulates on vegetation within forest ecosystems (see Recovery Action 2.2), in addition to planting assistance programs. Several watershed partnerships are in effect across the State, and the overall goals of these partnerships are generally consistent with and favorable to the recovery of forest birds, but the degree of current management varies substantially among landowners. Most land parcels contained in these partnerships are not included in Table 7, but a few parcels have been identified as possibly requiring additional protection because they support particularly important populations of forest birds or because there are concerns about the extent of current management. In Table 7, under Landowner/Comments, the most appropriate approach(es) to achieving land protection are listed. While private lands in many cases are best managed through partnerships or easements, parcels may be considered for purchase by private and public conservation organizations when owners are interested in selling and an organization is prepared to take on ownership and management. Because the course of such acquisitions varies greatly with each situation, this recovery plan can only prioritize parcels for their potential contribution to recovery area and state that, when the opportunity arises, purchase in each case should be weighed as an option for forest bird conservation.

Table 7. Parcels in recovery areas in need of protection or that should remain protected for forest bird recovery. The "Landowner/Comments" column includes suggested means of protection. Island codes: H = Hawai`i; K = Kaua`i; MA = Maui; MO = Moloka`i; O = O`ahu. Species Codes: AKEP = Hawai`i `ākepa; AKIP = `akiapōlā`au; AKOH = `ākohekohe; HCRE = Hawai`i creeper; KAAK = Kaua`i `akialoa; KACR = Kaua`i creeper; KAMO = kāma`o; KANU = Kaua`i nukupu`u; MAPA = Maui parrotbill; OAEL = O`ahu `elepaio; OO = Kaua`i `ō`ō; OU = `ō`ū; PALI = palila; POOU = po`ouli; PUAI = puaiohi. Refer to the Implementation Schedule, Key to Acronyms on page 5-7 for landowner and partnership abbreviations.

Table 7. Parcels in recovery areas in need of protection					
Recovery Action #	**Island**	**Land Parcel, Tax Map Key (TMK)**	**Species Targeted**	**Landowner/Comments**	**Priority**
1.3.1	H	Northeastern Slopes of Mauna Kea, Portions of 344014002 344014003 343010002 343010008	AKIP PALI	Hawai`i DLNR. Currently leased for cattle grazing. By lease, conservation easement, change of jurisdiction, or change in land use designation to protective subzone of conservation.	2
1.3.2	H	Kanakaleonui Corridor, 338001009	AKIP HCRE AKEP PALI	Hawai`i DHHL. Provides vital link between mesic koa forest and dry māmane forest. By conservation easement, lease, or partnership. Remove grazing and enhance natural communities.	1
1.3.3	H	Hilo Forest Reserve, Laupāhoehoe Section, 337001004	AKIP HCRE AKEP OU	Hawai`i DOFAW. Currently the Laupāhoehoe Section of Hilo Forest Reserve Area. By change in land use designation to conservation protective subzone. Mid-elevation forest with native tree canopy vulnerable to destruction by continued sustained yield pig hunting.	2

Table 7. Parcels in recovery areas in need of protection					
Recovery Action #	**Island**	**Land Parcel, Tax Map Key (TMK)**	**Species Targeted**	**Landowner/Comments**	**Priority**
1.3.4	H	Hilo Forest Reserve, Pīhā Section, 333001004	AKIP HCRE AKEP OU	Hawai`i DOFAW. Important wet and mesic forest remnants. Currently the Pīhā Section of Hilo Forest Reserve, bounded on both sides by Hakalau Forest National Wildlife Refuge. By conservation easement or change in land use designation to protective subzone of conservation. Mid-elevation forest with intact native tree canopy vulnerable to destruction by sustained yield pig hunting.	2
1.3.5	H	Kīpuka `Āinahou Nēnē Sanctuary, 338001008	AKIP HCRE AKEP	Hawai`i DHHL, leased by DOFAW and currently under annual lease. A long-term lease should be negotiated.	2
1.3.6	H	Humu`ula, 338001002	AKIP HCRE AKEP PALI	Hawai`i DHHL. Restorable. A vital link between wet and dry forest communities. Former lease for cattle grazing recently terminated. By lease, conservation easement, cooperative agreement, or partnership.	1
1.3.7	H	Humu`ula, Portions of 338001007	AKEP AKIP HCRE PALI	Hawai`i DHHL. Leased to Parker Ranch for grazing. Restorable. A vital link between wet and dry forest communities. By lease, conservation easement, cooperative agreement, or partnership.	2
1.3.8	H	Luma`ia Section, 326018002	AKIP HCRE AKEP	Hawai`i DHHL, adjacent to Hakalau Forest National Wildlife Refuge. Highest mesic forest remnant on the eastern slope of Mauna Kea. By lease, conservation easement, cooperative agreement, or partnership.	1

Table 7. Parcels in recovery areas in need of protection					
Recovery Action #	**Island**	**Land Parcel, Tax Map Key (TMK)**	**Species Targeted**	**Landowner/Comments**	**Priority**
1.3.9	H	TMK 326018001	AKIP HCRE AKEP	Hawai`i DLNR, Land Division. Leased for cattle grazing. Important mesic and wet koa/`ōhi`a forest remnants, link between wet and dry forest communities. By lease, conservation easement, change of jurisdiction, or change in land use designation to conservation.	1
1.3.10	H	Ka`ohe Lease, 344015002	AKIP PALI	Hawai`i DLNR, Land Division, currently leased for cattle grazing. A link could be restored between wet and dry forest communities. By lease, conservation easement, change of jurisdiction, or change in land use designation to conservation.	1
1.3.11	H	Keauhou Ranch, 399001004	AKIP HCRE AKEP	Kamehameha Schools. Remnant mesic koa and `ōhi`a forest. By lease or conservation easement. Currently a member of the Ōla`a-Kīlauea Partnership.	2
1.3.12	H	Kapāpala Ranch, Portions of 398001010	AKIP HCRE AKEP	Hawai`i DLNR, Land Division, Kapāpala Ranch. Currently leased for cattle grazing. Restorable. A link between forest to the east and west. By lease, conservation easement, or change in land use designation to conservation.	2
1.3.13	H	Ka`ū Forest Reserve, 397001007	AKIP HCRE AKEP	The Nature Conservancy of Hawaii. Protect wet forest habitat from development.	2
1.3.14	H	Ka`ū Forest Reserve, Portions of 397001006 397001005	AKIP HCRE AKEP	Kamehameha Schools. Protect wet forest habitat from development. By lease, conservation easement, partnership agreement, or purchase from willing seller.	2
1.3.15	H	Kahuku Ranch, Portions of 392001002	AKIP HCRE AKEP	Recently purchased by Hawai`i Volcanoes National Park. Valuable wet and mesic forest habitat that links Ka`ū Forest and South Kona Forest. Restorable.	1

Table 7. Parcels in recovery areas in need of protection					
Recovery Action #	**Island**	**Land Parcel, Tax Map Key (TMK)**	**Species Targeted**	**Landowner/Comments**	**Priority**
1.3.16	H	Honomalino, 389006004 389006029	AKIP HCRE AKEP	Scott C. Rolles Trust. Links Ka`ū Forest and South Kona Forest. By lease, conservation easement, partnership, change in land use designation, or purchase from willing seller.	2
1.3.17	H	Pāpā, 388001001	AKIP HCRE AKEP	The Nature Conservancy, Kona Hema Preserve. Recently sold by Koa Aina Ventures. A link between Ka`ū Forest and South Kona Forest.	2
1.3.18	H	Yee Hop Ranch, Portions of 388001003 388001004 387012001 392001005 387012003 387012004 387001007 387001006 387001011 387001004	AKIP HCRE AKEP	Yee Hop Ranch Ltd. Provides links between state owned land parcels and protects contiguous forest habitat in South Kona from development. By lease, conservation easement, partnership agreement, change in land use designation, or purchase from willing seller.	2
1.3.19	H	`Alae Ranch, Portions of 387001014	AKIP HCRE AKEP	Hawai`i DLNR, Land Division. Currently leased for cattle grazing. By conservation easement, lease, change of jurisdiction, or change in land use designation to conservation protective subzone.	3
1.3.20	H	McCandless Ranch, Portions of 392001003 386001001	AKIP HCRE AKEP	McCandless Ranch. Protect contiguous forest habitat in South Kona from development. By lease, conservation easement, partnership agreement, change in land use designation, or purchase from willing seller.	2

Table 7. Parcels in recovery areas in need of protection					
Recovery Action #	**Island**	**Land Parcel, Tax Map Key (TMK)**	**Species Targeted**	**Landowner/Comments**	**Priority**
1.3.21	H	Waiea Tract, 386001003	AKIP HCRE AKEP	Hawai`i DLNR. Land Division. Protect contiguous forest habitat in South Kona from continued degradation. Currently leased for cattle grazing. By conservation easement, lease, change of jurisdiction, or change in land use designation to conservation protective subzone.	2
1.3.22	H	Keālia Ranch, 385001001	AKIP HCRE AKEP	Kamehameha Schools. By lease, conservation easement, partnership agreement, change in land use designation, or purchase from willing seller.	2
1.3.23	H	Hōnaunau Forest, 384001001 384001002 383001001 383001002	AKIP HCRE AKEP PALI	Kamehameha Schools. By lease, conservation easement, partnership agreement, change in land use designation, or purchase from willing seller.	2
1.3.24	H	Keālia Ranch, Portions of 385001002	AKIP HCRE AKEP	Elizabeth Stack *et al.* Protect contiguous forest habitat in South Kona from development. By lease, conservation easement, partnership agreement, change in land use designation, or purchase from willing seller.	2
1.3.25	H	Kealakekua Development Corp., Portions of 382001001	AKIP PALI	Protect contiguous forest habitat in South Kona from development, and provide habitat for a second palila population. Restorable. By lease, conservation easement, partnership agreement, change in land use designation, or purchase from willing seller.	3

Table 7. Parcels in recovery areas in need of protection					
Recovery Action #	**Island**	**Land Parcel, Tax Map Key (TMK)**	**Species Targeted**	**Landowner/Comments**	**Priority**
1.3.26	H	Pu`u Lehua, Portions of 378001003 378001007 372002001 378001001	AKIP PALI HCRE	Kamehameha Schools. Provides habitat for a second palila population. Restorable. By lease, conservation easement, partnership agreement, change in land use designation to conservation, or purchase from willing seller.	2
1.3.27	MA	Ko`olau Forest Reserve, 224016003 224016004 228008001 228008007	AKOH MAPA POOU	Alexander and Baldwin, East Maui Irrigation. Additional measures may be needed to ensure forest bird recovery. By partnership, safe harbor agreement, easement, change of land use designation to protective subzone of conservation, or purchase from willing seller.	1
1.3.28	MA	Kīpahulu Forest Reserve, Kukui`ula, 216001007	AKOH, MAPA, POOU	J. Haili. Small parcel at lower edge of recovery area. By partnership with LHWRP.	3
1.3.29	MA	Kīpahulu Forest Reserve, Kukui`ula, 216001006	AKOH MAPA POOU	Cleveland Kalalau. Small parcel at lower edge of recovery area. By partnership with LHWRP.	3
1.3.30	MA	Kīpahulu Forest Reserve, 216001005 217001033 217002035 217004006 218001007	AKOH MAPA POOU	Hawai`i DOFAW. Isolated; secure access for management needed. By continuing partnership with LHWRP.	1
1.3.31	MA	Kīpahulu Forest Reserve, 217001032	AKOH MAPA POOU	A. Kaapana *et al.* Small parcel at lower edge of recovery area. By partnership with LHWRP.	3
1.3.32	MA	Kīpahulu Forest Reserve, 217001024	AKOH MAPA POOU	Kaupō Ranch Ltd. Small parcel at lower edge of recovery area. By partnership with LHWRP.	2

Table 7. Parcels in recovery areas in need of protection					
Recovery Action #	**Island**	**Land Parcel, Tax Map Key (TMK)**	**Species Targeted**	**Landowner/Comments**	**Priority**
1.3.33	MA	Nu`u, 218001001	AKOH MAPA POOU	Kaupō Ranch Ltd. Degraded former forest land in need of active management. By continuing partnership with LHWRP, safe harbor agreement, conservation easement, change of land use designation, or purchase from willing seller. Acquisition being negotiated by NPS.	3
1.3.34	MA	Nu`u, 218001002	AKOH MAPA POOU	James Campbell Est. Degraded former forest land in need of active management. By continuing partnership with LHWRP, safe harbor agreement, conservation easement, change of land use designation, or purchase from willing seller. Acquisition being negotiated by NPS.	3
1.3.35	MA	Kahikinui Forest Reserve, 218001006 218001005 218001009	AKOH MAPA POOU	Hawai`i DOFAW. Isolated; secure better access for management. Degraded former forest land in need of active management. By continuing partnership with LHWRP.	1
1.3.36	MA	Kahikinui Homelands, 219001003 219001007 219001008 219001011	AKOH MAPA POOU	Hawai`i DHHL. Degraded former forest land in active forest stewardship program with FWS. By continuing partnership with LHWRP.	1
1.3.37	MA	Upper Auwahi, 219001006 221009001 222001001 222001034	AKOH MAPA POOU	`Ulupalakua Ranch Inc. Pasture with ongoing restoration at selected sites in partnership with DOI and NHPS. By continuing partnership with LHWRP, conservation easement, safe harbor agreement, change in land use designation, or purchase from willing seller.	2

Table 7. Parcels in recovery areas in need of protection					
Recovery Action #	**Island**	**Land Parcel, Tax Map Key (TMK)**	**Species Targeted**	**Landowner/Comments**	**Priority**
1.3.38	MA	Kula Forest Reserve, 222007001	AKOH MAPA POOU	Hawai`i DOFAW. By continuing partnership with LHWRP. Degraded forest dominated by alien species. Resolve conflicting management as game management area.	2
1.3.39	MA	Kēōkea, 222004033	AKOH MAPA POOU	James Campbell Est. Degraded former forest in need of active management. By partnership with LHWRP, conservation easement, safe harbor agreement, change in land use designation, or purchase from willing seller.	2
1.3.40	MA	Waiohuli, 222005052	AKOH MAPA POOU	James Campbell Est. Degraded former forest in need of active management. By continuing partnership with LHWRP, conservation easement, safe harbor agreement, change in land use designation, or purchase from willing seller.	2
1.3.41	MA	Ka`ono`ulu, 222007002 222006009 222006032 222007010	AKOH MAPA POOU	Ka`ono`ulu Ranch Co. Ltd. Degraded former forest in need of active management. By continuing partnership with LHWRP, conservation easement, safe harbor agreement, or purchase from willing seller.	2
1.3.42	MA	Waiakoa, 222008001	AKOH MAPA POOU	Lucky Shoji USA Inc. *et al.* Degraded former forest in need of active management. By partnership with LHWRP, conservation easement, safe harbor agreement, change of land use designation, or purchase from willing seller.	2

Table 7. Parcels in recovery areas in need of protection					
Recovery Action #	**Island**	**Land Parcel, Tax Map Key (TMK)**	**Species Targeted**	**Landowner/Comments**	**Priority**
1.3.43	MA	Kamehame Nui/Kealahou, 223005002	AKOH MAPA POOU	John Zwaanstra. Degraded former forest in need of active management. By continuing partnership with LHWRP, conservation easement, safe harbor agreement, change of land use designation, or purchase from willing seller.	2
1.3.44	MA	Haleakalā Ranch (Pūlehu Nui/ Kalialinui), 223005003	AKOH MAPA POOU	Haleakalā Ranch Co. Degraded former forest in need of active management. By continuing partnership with LHWRP, conservation easement, safe harbor agreement, change of land use designation, or purchase from willing seller.	1
1.3.45	MA	Waikamoi Preserve, 223005004	AKOH MAPA POOU	Haleakalā Ranch Co. Under active management by The Nature Conservancy of Hawai`i through conservation easement. In EMWP and NAPS. Support continued management by TNCH, or by purchase from willing seller.	1
1.3.46	MA	West Maui Forest Reserve, Wailuku, 233003003 235003001 236003001	AKOH MAPA POOU	Wailuku Agriculture. In West Maui Watershed Partnership (WMWP). By conservation easement or purchase from willing seller.	2
1.3.47	MA	West Maui Forest Reserve, Launiupoko, 247001002	AKOH MAPA POOU	American Factors (Amfac)/JMB Hawai`i Co. In WMWP. By conservation easement, safe harbor agreement, or purchase from willing seller.	2
1.3.48	MA	West Maui Forest Reserve, Kaua`ula, 246025001	AKOH MAPA POOU	American Factors (Amfac)/JMB Hawai`i Co. In WMWP. By conservation easement, safe harbor agreement, or purchase from willing seller.	2

Table 7. Parcels in recovery areas in need of protection					
Recovery Action #	**Island**	**Land Parcel, Tax Map Key (TMK)**	**Species Targeted**	**Landowner/Comments**	**Priority**
1.3.49	MA	West Maui Forest Reserve, Kahoma, 245022001	AKOH MAPA POOU	Kamehameha Schools. In WMWP. By conservation easement, safe harbor agreement, or purchase from willing seller.	2
1.3.50	MA	West Maui Forest Reserve, Pu`u Kī/Haakea, 245022002 245022004	AKOH MAPA POOU	American Factors (Amfac)/JMB Hawai`i Co. In WMWP. By conservation easement, safe harbor agreement, or purchase from willing seller.	2
1.3.51	MA	Kapunakea Preserve, 244007001	AKOH MAPA POOU	American Factors (Amfac)/JMB Hawai`i Co. Currently managed by TNCH through conservation easement. In WMWP and NAPS. By purchase from willing seller.	2
1.3.52	MA	West Maui Forest Reserve, Kapāloa, 244007007	AKOH MAPA POOU	Unknown. In WMWP. By conservation easement, safe harbor agreement, or purchase from willing seller.	2
1.3.53	MA	Pu`u Kukui Watershed Management Area, 242001001 241001017	AKOH MAPA POOU	Maui Land and Pineapple. In WMWP and NAPS. Support continued conservation management by Maui Land and Pine, or by purchase from willing seller.	2
1.3.54	MO	Moloka`i Forest Reserve, Kahanui, 252014001	AKOH MAPA POOU	R. W. Myer Ltd., *et al.* By easement, safe harbor agreement, or purchase from willing seller.	2
1.3.55	MO	Moloka`i Forest Reserve, Pelekunu Valley, 259006011	AKOH MAPA POOU	The Nature Conservancy of Hawai`i. Support continued Management by TNCH.	2
1.3.56	MO	Moloka`i Forest Reserve, Pelekunu Valley, Wawaeolepe, 259008017	AKOH MAPA POOU	Wm. Hitchcock *et al.* By easement, safe harbor agreement, or purchase from willing seller.	2
1.3.57	MO	Moloka`i Forest Reserve, Pelekunu Valley, 254003032	AKOH MAPA POOU	The Nature Conservancy of Hawai`i. Support continued Management by TNCH.	2
1.3.58	MO	Moloka`i Forest Reserve, Wailau Valley and Oloku`i, 259006004	AKOH MAPA POOU	G. Brown III *et al.* By easement, safe harbor agreement, or purchase from willing seller.	2

Table 7. Parcels in recovery areas in need of protection					
Recovery Action #	**Island**	**Land Parcel, Tax Map Key (TMK)**	**Species Targeted**	**Landowner/Comments**	**Priority**
1.3.59	MO	Moloka`i Forest Reserve, Laeokapuna, 257005027	AKOH MAPA POOU	P. Hodgins. By easement, safe harbor agreement, or purchase from willing seller.	2
1.3.60	MO	Moloka`i Forest Reserve, Keanakoholua, 257005001	AKOH MAPA POOU	M. Hustice Trust. By easement, safe harbor agreement, or purchase from willing seller.	2
1.3.61	MO	Moloka`i Forest Reserve, Manawai, 256006013	AKOH MAPA POOU	P. Petro Trust. By easement, safe harbor agreement, or purchase from willing seller.	2
1.3.62	MO	Moloka`i Forest Reserve, West `Ōhi`a Gulch, 256006010	AKOH MAPA POOU	E. Wond Trust. By easement, safe harbor agreement, or purchase from willing seller.	2
1.3.63	MO	Moloka`i Forest Reserve, Keawa Nui, 256006007	AKOH MAPA POOU	Kamehameha Schools. In EMOWP. By easement, safe harbor agreement, or purchase from willing seller.	2
1.3.64	MO	Moloka`i Forest Reserve, Pua`ahala, 256006002	AKOH MAPA POOU	K&H Horizons Hawai`i. In EMOWP. By easement, safe harbor agreement, or purchase from willing seller.	2
1.3.65	MO	Moloka`i Forest Reserve, Kumu`eli, 256006001	AKOH MAPA POOU	D. Fairbanks III Trust. In EMOWP. By easement, safe harbor agreement, or purchase from willing seller.	2
1.3.66	MO	Moloka`i Forest Reserve, Kamalō, 255001016 255001006 255001017	AKOH, MAPA, POOU	Kamehameha Schools. In EMOWP. By easement, safe harbor agreement, or purchase from willing seller.	2
1.3.67	MO	Moloka`i Forest Reserve, Mākolelau, 255001015	AKOH MAPA POOU	Ashton Pitts Jr. Trust. By easement, safe harbor agreement, or purchase from willing seller.	2
1.3.68	MO	Kamakou Preserve, Kawela, 2540003026	AKOH MAPA POOU	Moloka`i Ranch Ltd., The Nature Conservancy of Hawai`i. In EMOWP. By easement, safe harbor agreement, or purchase from willing seller.	2

Table 7. Parcels in recovery areas in need of protection					
Recovery Action #	**Island**	**Land Parcel, Tax Map Key (TMK)**	**Species Targeted**	**Landowner/Comments**	**Priority**
1.3.69	MO	Moloka`i Forest Reserve, Kawela, 254003001 254003028	AKOH MAPA POOU	Kawela Plantation Homes Association. By easement or purchase from willing seller. In EMOWP.	2
1.3.70	MO	Moloka`i Forest Reserve, Kaunakakai, 253003005	AKOH MAPA POOU	Moloka`i Ranch Ltd. By easement, safe harbor agreement, or purchase from willing seller.	2
1.3.71	O	Pia Valley, 37003073 37003033	OAEL	Benjamin Cassiday, James Pflueger. Upper valley in KMWP, but additional measures may be needed to ensure protection of large `elepaio population. Lower valley zoned conservation, but no other protection. By enrollment in KMWP, easement, or purchase from willing seller.	1
1.3.72	O	Lower Wailupe Valley, 36004001	OAEL	City and County of Honolulu. Contains lower edge of large `elepaio population. Currently zoned urban. By enrollment in KMWP, easement, change in land use designation, or purchase from willing seller.	1
1.3.73	O	Kūpaua Valley, 37004001 37004002	OAEL	Hawai`i Humane Society. Upper valley in KMWP, but additional measures needed to ensure protection of large `elepaio population. By easement, safe harbor agreement, enrollment in KMWP, or purchase from willing seller.	1
1.3.74	O	Kuli`ou`ou Valley, 38013001	OAEL	Joseph Paiko Trust. Contains western half of small `elepaio population. By easement, safe harbor agreement, enrollment in KMWP, or purchase from willing seller.	1
1.3.75	O	Ka`alākei Valley, 39009001	OAEL	Hawai`i Kai Development Co. Contains small `elepaio population. By easement, safe harbor agreement, enrollment in KMWP, or purchase from willing seller.	2

Table 7. Parcels in recovery areas in need of protection					
Recovery Action #	**Island**	**Land Parcel, Tax Map Key (TMK)**	**Species Targeted**	**Landowner/Comments**	**Priority**
1.3.76	O	Kapālama, 14015009	OAEL	Julius Chung Trust. Small parcel. By partnership in KMWP.	3
1.3.77	O	Moanalua Valley, 11013001	OAEL	Damon Estate. In KMWP, but additional measures may be needed to ensure protection of large `elepaio population. By easement, safe harbor agreement or purchase from willing seller.	1
1.3.78	O	South Hālawa Valley, Tripler Ridge, 99011001	OAEL	Queen's Medical Center. In KMWP, but additional measures may be needed to ensure protection of large `elepaio population. By easement, safe harbor agreement, or purchase from willing seller.	1
1.3.79	O	Waikāne Valley, 48014005	OAEL	SMF Enterprises. In KMWP, but additional measures may be needed to ensure protection of large `elepaio population. By easement, safe harbor agreement, or purchase from willing seller.	1
1.3.80	O	Waianu Valley, 48014003 48013014	OAEL	Waiāhole Irrigation Co. Ltd. In KMWP, but additional measures may be needed to ensure protection of large `elepaio population. By easement, safe harbor agreement, or purchase from willing seller.	2
1.3.81	K	Southern Alaka`i Plateau, Portions of 417001001	PUAI KACR KAMO KAAK OO OU KANU	Robinson Family Partners. Develop cooperative management agreement or purchase from willing seller.	1

Table 7. Parcels in recovery areas in need of protection					
Recovery Action #	**Island**	**Land Parcel, Tax Map Key (TMK)**	**Species Targeted**	**Landowner/Comments**	**Priority**
1.3.82	K	Upper Wainiha Pali, Portions of 458001001	PUAI KACR KAMO KAAK OO OU KANU	Alexander and Baldwin Hawai`i Inc. Currently under surrender agreement to DLNR. Area under management of DLNR. Land is remote, no public access. Adequately protected at present and for foreseeable future. Any change in this status should be reassessed.	2

1.4 Provide private landowners with financial and regulatory incentives to restore and manage suitable habitat for native forest birds. Approximately one-half of lands in the State conservation district are privately owned. Many private landowners are interested in taking conservation measures but may be concerned they will face additional regulation as a result of their voluntary stewardship. Other landowners are willing to implement conservation actions but lack the resources to do so.

1.4.1 Continue and expand private landowner incentive programs that support restoration and management of private lands, including the U.S. Department of Interior's Landowner Incentive Program (LIP) and Private Stewardship Grants Program (PSGP), the State of Hawai`i's Natural Areas Partnership Program (NAPP) and Forest Stewardship Program (FSP), and the U.S. Department of Agriculture's Healthy Forest Reserve Program, Wildlife Habitat Incentives Program (WHIP), and other "farm bill" programs (those authorized through the Food Security Act of 1985).

1.4.2 Continue to provide regulatory incentives and assurances to private landowners, such as safe harbor agreements, and encourage making these a permanent provision of Hawai`i State law.

1.4.3 **Provide dedicated State and Federal staffing** to administer and provide technical support for private landowner programs.

1.4.4 **Develop local, State, and Federal tax incentives** for landowners who convert lands to native forest, provide greater conservation management of forested lands, or agree to protect native forest through term or permanent easements.

2. Manage Forest Ecosystems for the Benefit and Recovery of Native Forest Birds.

2.1 **Reforest recovery areas that no longer contain the necessary constituent elements for species recovery.** (Priority 1-3) Recovery of most forest bird species included in this plan will require reforestation of degraded habitats. Parcels in need of restoration efforts and bird species expected to benefit from these efforts are listed in Table 8.

Table 8. Parcels in recovery areas needing reforestation. Island codes: H = Hawai`i; K = Kaua`i; MA = Maui; MO = Moloka`i; O = O`ahu. Species Codes: AKEP = Hawai`i `ākepa; AKIP = `akiapōlā`au; AKOH = `ākohekohe; HCRE = Hawai`i creeper; KAAK = Kaua`i `akialoa; KACR = Kaua`i creeper; KAMO = kāma`o; KANU = Kaua`i nukupu`u; MAPA = Maui parrotbill; OAEL = O`ahu `elepaio; OO = Kaua`i `ō`ō; OU = `ō`ū; PALI = palila; POOU = po`ouli; PUAI = puaiohi. Refer to the Implementation Schedule, Key to Acronyms (page 5-7) for landowner and partnership abbreviations.

Table 8. Parcels in recovery area needing reforestation

Recovery Action #	Island	Land Parcel, Tax Map Keys	Species Targeted	Landowner/Comments	Priority
2.1.1	H	Northeastern Slope of Mauna Kea, Portions of 344014002 344014003 343010002 343010008	AKIP PALI	Hawai`i DLNR, Land Division. Reforest and restore pasturelands to dry māmane and mesic koa forest.	2
2.1.2	H	Kanakaleonui Corridor, 338001009	AKIP HCRE AKEP PALI	Hawai`i DHHL. Provides a vital link between mesic koa forest and dry māmane forest. Restore upper pasturelands.	1
2.1.3	H	Hilo Forest Reserve, Laupāhoehoe Section, 337001004	AKIP HCRE AKEP OU	Hawai`i DOFAW. Remove alien trees, restore transition forest from wet `ōhi`a to mesic koa.	3
2.1.4	H	Hilo Forest Reserve, Pīhā Section, 333001004	AKIP HCRE AKEP OU	Hawai`i DOFAW. Remove alien trees. Restore transition forest from wet `ōhi`a to mesic koa. Facilitate understory regeneration.	3
2.1.5	H	Hakalau Forest NWR, 337001010 329005005 333001007 329005003	AKIP HCRE AKEP	USFWS. Remove alien trees and continue successful forest restoration program.	1
2.1.6	H	Kīpuka `Āinahou Nēnē Sanctuary, 338001008	AKIP HCRE AKEP	Hawai`i DHHL, leased by DOFAW. Facilitate canopy tree and understory regeneration.	3

Table 8. Parcels in recovery area needing reforestation					
Recovery Action #	Island	Land Parcel, Tax Map Keys	Species Targeted	Landowner/Comments	Priority
2.1.7	H	Humu`ula, 338001002	AKIP HCRE AKEP PALI	Hawai`i DHHL. Restorable. A vital link between wet and dry forest. Reforest pasturelands to transition forest from mesic koa to dry māmane.	2
2.1.8	H	Humu`ula, Portions of 338001007	AKEP AKIP HCRE PALI	Hawai`i DHHL, leased to Parker Ranch. Reforest pasturelands to native montane dryland habitat.	2
2.1.9	H	Luma`ia Section, 326018002	AKIP HCRE AKEP	Hawai`i DHHL, adjacent to Hakalau Forest National Wildlife Refuge. Vital link between montane mesic forest and montane dry forest. Protect existing forest and reforest pasturelands.	2
2.1.10	H	Pu`u `Ō`ō Ranch, 326018001	AKIP HCRE AKEP	Hawai`i DLNR, Land Division, leased to Pu`u `Ō`ō Ranch. Important mesic and wet koa/`ōhi`a forest remnants, and vital link between wet and dry forest communities. Protect and reforest.	2
2.1.11	H	Ka`ohe, 344015002	AKIP PALI	Hawai`i DLNR, Land Division. Protect and reforest.	2
2.1.12	H	Mauna Kea Forest Reserve, 344015001	AKIP PALI	Hawai`i DLNR. Restore montane dry māmane/naio forest.	1
2.1.13	H	Keauhou Ranch, 399001004	AKIP HCRE AKEP	Kamehameha Schools. Reforest transition wet `ōhi`a, mesic koa and dry māmane/sandalwood.	3
2.1.14	H	Hawai`i Volcanoes National Park, 399001002	AKIP HCRE AKEP	Hawai`i Volcanoes National Park. Continue dryland forest restoration.	3
2.1.15	H	Kapāpala Ranch, 398001004	AKIP HCRE AKEP	Hawai`i DLNR, Land Division, Kapāpala Ranch. A link between forest communities to the east and west. Remove alien trees, restore montane dry koa, `ōhi`a and māmane forest.	2
2.1.16	H	Ka`ū Forest Reserve, 397001007	AKIP HCRE AKEP	Mauna Kea Agribusiness. Protect and facilitate natural regeneration.	3

Table 8. Parcels in recovery area needing reforestation					
Recovery Action #	Island	Land Parcel, Tax Map Keys	Species Targeted	Landowner/Comments	Priority
2.1.17	H	Ka`ū Forest Reserve, Portions of 397001006 397001005	AKIP HCRE AKEP	Kamehameha Schools. Protect and facilitate natural regeneration.	2
2.1.18	H	Kahuku Ranch, Portions of 392001002	AKIP HCRE AKEP	Samuel M. Damon Trust. Valuable wet and mesic forest habitat needs restoring. A link between Ka`ū Forest and the South Kona Forest.	2
2.1.19	H	Honomalino, 389006004 389006029	AKIP HCRE AKEP	Scott C. Rolles Trust. A link between Ka`ū Forest and South Kona Forest. Protect and restore montane mesic koa forest.	3
2.1.20	H	Pāpā, 388001001	AKIP HCRE AKEP	The Nature Conservancy, Kona Hema Preserve. Recently sold by Koa Aina Ventures. A link between Ka`ū Forest and South Kona Forest. Restore montane mesic koa forest.	3
2.1.21	H	TNCH, Honomalino, 389001001	AKIP HCRE AKEP	The Nature Conservancy of Hawai`i. Continue forest restoration program.	3
2.1.22	H	Honomalino Forest Reserve, 389001002	AKIP HCRE AKEP	Hawai`i DOFAW. Restore montane mesic koa and `ōhi`a forest.	2
2.1.23	H	Yee Hop Ranch, Portions of 388001003 388001004 387012001 392001005 387012003 387012004 387001007 387001006 387001011 387001004	AKIP HCRE AKEP	Yee Hop Ranch Ltd. Provides links between State land parcels and protects contiguous forest habitat in South Kona from development. Protect and restore wet `ōhi`a, mesic koa and dry māmane/naio forest.	2
2.1.24	H	Kona Forest NWR, 386001001	AKIP HCRE AKEP	USFWS. Restore montane mesic koa and `ōhi`a forest.	1

Table 8. Parcels in recovery area needing reforestation					
Recovery Action #	Island	Land Parcel, Tax Map Keys	Species Targeted	Landowner/Comments	Priority
2.1.25	H	`Alae Ranch, Portions of 387001014	AKIP HCRE AKEP	Hawai`i DLNR, Land Division, leased to `Alae Ranch. Protect and restore wet `ōhi`a forest.	3
2.1.26	H	McCandless Ranch and E. Stack *et al.*, Portions of 392001003 386001001 385001002	AKIP HCRE AKEP	Protects contiguous forest habitat in South Kona from development. Restore pasture to mesic koa and dry māmane/naio forest.	2
2.1.27	H	Waiea Tract, 386001003	AKIP HCRE AKEP	Hawai`i DLNR, Land Division. Protects contiguous mesic koa forest habitat in South Kona.	2
2.1.28	H	Keālia Ranch 385001001 and Portions of 384001001 383001001	AKIP HCRE AKEP	Kamehameha Schools. Restore mesic koa forest and dry māmane/naio forest.	2
2.1.29	H	Kealakekua Development Corp., Portions of 382012001	AKIP PALI	Kealakekua Development Corp. Protect contiguous forest habitat in South Kona, provide habitat for a second palila population. Restore wet `ōhi`a, mesic koa and dry montane māmane forest.	3
2.1.30	H	Pu`u Lehua, Portions of 378001003 378001007 378001002 378001001	AKIP PALI	Kamehameha Schools. Protects contiguous forest habitat in South Kona from development, and provide habitat for a second palila population. Restore mesic koa and dry montane māmane forest.	2
2.1.31	H	Pu`u Wa`awa`a, 371001001 371001006	HCRE AKEP	Hawai`i DOFAW, Pu`u Wa`awa`a Forest Bird Sanctuary. Restore montane mesic koa and māmane/naio forest habitat.	2
2.1.32	H	Haulālai Ranch, 372002001	HCRE AKEP	Kamehameha Schools. Restore mesic and dry montane forest.	2
2.1.33	MA	Haleakalā National Park, 218001007	AKOH MAPA POOU	NPS. Restore montane mesic forest in Kaupō Gap.	1

Table 8. Parcels in recovery area needing reforestation					
Recovery Action #	Island	Land Parcel, Tax Map Keys	Species Targeted	Landowner/Comments	Priority
2.1.34	MA	Kīpahulu Forest Reserve, 217004006	AKOH MAPA POOU	Hawai`i DOFAW. Restore montane mesic forest along cliffs and head of Manawainui Valley.	2
2.1.35	MA	Nu`u, 218001001	AKOH MAPA POOU	Kaupō Ranch Ltd. Restore montane mesic forest and shrubland.	3
2.1.36	MA	Nu`u, 218001002	AKOH MAPA POOU	James Campbell Est. Restore montane mesic forest and shrubland.	3
2.1.37	MA	Kahikinui Forest Reserve, 218001006 218001005 218001009	AKOH MAPA POOU	Hawai`i DOFAW. Restore montane mesic forest and shrubland.	1
2.1.38	MA	Kahikinui Homelands, 219001003 219001007 219001008 219001011	AKOH MAPA POOU	Hawai`i DHHL. Support ongoing restoration of montane mesic forest and shrubland.	1
2.1.39	MA	Upper Auwahi, 219001006 221009001 222001001 222001034	AKOH MAPA POOU	`Ulupalakua Ranch Inc. Support ongoing restoration of montane mesic forest and shrubland.	2
2.1.40	MA	Kula Forest Reserve, 222007001	AKOH MAPA POOU	Hawai`i DOFAW. Restore montane mesic forest and shrubland. Replace nonnative trees.	2
2.1.41	MA	Kēōkea, 222004033	AKOH MAPA POOU	James Campbell Est. Restore montane mesic forest and shrubland. Replace nonnative trees.	2
2.1.42	MA	Waiohuli, 222005052	AKOH MAPA POOU	James Campbell Est. Restore montane mesic forest and shrubland. Replace nonnative trees.	2
2.1.43	MA	Ka`ono`ulu, 222007002 222006009 222007010 222006032	AKOH MAPA POOU	Ka`ono`ulu Ranch Co. Ltd. Restore montane mesic forest and shrubland. Replace nonnative trees.	3

Table 8. Parcels in recovery area needing reforestation					
Recovery Action #	Island	Land Parcel, Tax Map Keys	Species Targeted	Landowner/Comments	Priority
2.1.44	MA	Waiakoa, 222008001	AKOH MAPA POOU	Lucky Shoji USA Inc. *et al.* Restore montane mesic forest and shrubland. Replace nonnative trees.	3
2.1.45	MA	Kamehame Nui/Kealahou, 223005002	AKOH MAPA POOU	John Zwaanstra. Restore montane mesic forest and shrubland.	3
2.1.46	MA	Haleakalā Ranch (Pūlehu Nui/Kalialinui), 223005003	AKOH MAPA POOU	Haleakalā Ranch Co. Restore montane mesic forest and shrubland.	1
2.1.47	MA	Waikamoi Preserve, 223005004	AKOH MAPA POOU	Haleakalā Ranch Co., The Nature Conservancy of Hawai`i. Restore montane mesic forest and shrubland at high elevation. Replace nonnative trees.	1
2.1.48	MA	Makawao Forest Reserve, 224016001 224016002	AKOH MAPA POOU	Hawai`i DOFAW. Restore montane mesic forest and shrubland. Replace nonnative trees.	2
2.1.49	MA	West Maui NAR, Kahakuloa, 231006001	AKOH MAPA POOU	Hawai`i DOFAW. Restore montane wet forest and shrubland.	2
2.1.50	MA	West Maui Forest Reserve, Kaheawa, 248001001	AKOH MAPA POOU	Hawai`i DOFAW. Restore montane wet forest and shrubland. Replace nonnative trees.	2
2.1.51	MA	West Maui Forest Reserve, Ukumehame/Olowalu, West Maui NAR, Līhau, 248001002	AKOH MAPA POOU	Hawai`i DOFAW. Restore montane wet forest and shrubland.	2
2.1.52	MA	Pu`u Kukui Watershed Management Area, 241001017	AKOH MAPA POOU	Maui Land and Pineapple. Restore montane wet forest and shrubland. Replace nonnative trees.	2
2.1.53	MO	Moloka`i Forest Reserve, Kalamāula, 252014003	AKOH MAPA POOU	Hawai`i DOFAW. Restore montane wet forest and shrubland. Replace nonnative trees.	2
2.1.54	MO	Moloka`i Forest Reserve, Kahanui, 252014001	AKOH MAPA POOU	R. W. Myer Ltd., *et al.* Restore montane wet forest and shrubland. Replace nonnative trees.	2

Table 8. Parcels in recovery area needing reforestation					
Recovery Action #	Island	Land Parcel, Tax Map Keys	Species Targeted	Landowner/Comments	Priority
2.1.55	MO	Moloka`i Forest Reserve, Kahanui, 261001004	AKOH MAPA POOU	Hawai`i DOFAW. Restore montane wet forest and shrubland. Replace nonnative trees.	2
2.1.56	MO	Moloka`i Forest Reserve, Kamalō, 255001016 255001006 255001017	AKOH MAPA POOU	Kamehameha Schools. Restore montane mesic forest and shrubland.	2
2.1.57	MO	Moloka`i Forest Reserve, Mākolelau, 255001015	AKOH MAPA POOU	Ashton Pitts Jr. Trust. Restore montane mesic forest and shrubland.	3
2.1.58	MO	Kamakou Preserve, Kawela, 2540003026	AKOH MAPA POOU	Moloka`i Ranch Ltd, The Nature Conservancy of Hawai`i. Restore montane mesic forest and shrubland. Replace nonnative trees.	2
2.1.59	MO	Moloka`i Forest Reserve, Kawela, 254003001	AKOH MAPA POOU	Kawela Plantation Homes Association. Restore montane mesic forest and shrubland.	3
2.1.60	MO	Moloka`i Forest Reserve, Kamiloloa/ Makakupaīa, 254003025	AKOH MAPA POOU	Hawai`i DOFAW. Restore montane mesic forest and shrubland. Replace nonnative trees.	2
2.1.61	MO	Moloka`i Forest Reserve, Kaunakakai, 253003005	AKOH MAPA POOU	Moloka`i Ranch Ltd. Restore montane mesic forest and shrubland. Replace nonnative trees.	3
2.1.62	O	Mākua Military Reservation	OAEL	U.S. Army. Portions of upper valley recently burned, need reforestation.	3
2.1.63	K	Kōke`e State Park, 414001013 459001016 414001020 414001014 414001002 and numerous small parcels	KACR	Hawai`i DLNR, Division of State Parks. Additional protection may be needed to secure remaining forested habitat.	3

2.2 Reduce or eliminate the detrimental effects of ungulates on vegetation within forest ecosystems.

The detrimental effects of introduced feral ungulates including pigs, cattle, goats, sheep, mouflon, axis deer, and other species on forest ecosystems is well documented (Loope and Scowcroft 1985, Stone 1985, Stone *et al.* 1992, Loh and Tunison 1999). These alien species damage forest bird habitat and negatively affect forest bird populations by removing native understory vegetation, suppressing regeneration of native canopy species, and dispersing seeds of invasive alien plant species in their fur, hooves, and droppings. Effective control or elimination of introduced ungulates requires fencing in most cases. The most cost-effective approach in the long term to restore habitat damaged by feral ungulates is to fence areas and remove all ungulates using drives, hunting, snaring, and other measures as appropriate. Parcels where fencing and/or ungulate control are needed for recovery of species included in this plan are listed in Table 9.

Table 9. Parcels in recovery areas needing fencing and ungulate control. Island codes: H = Hawai\`i; K = Kaua\`i; MA = Maui; MO = Moloka\`i; O = O\`ahu. Species Codes: AKEP = Hawai\`i \`ākepa; AKIP = \`akiapōlā\`au; AKOH = \`ākohekohe; HCRE = Hawai\`i creeper; KAAK = Kaua\`i \`akialoa; KACR = Kaua\`i creeper; KAMO = kāma\`o; KANU = Kaua\`i nukupu\`u; MAPA = Maui parrotbill; OAEL = O\`ahu \`elepaio; OO = Kaua\`i \`ō\`ō; OU = \`ō\`ū; PALI = palila; POOU = po\`ouli; PUAI = puaiohi. Refer to the Implementation Schedule, Key to Acronyms (page 5-7) for landowner and partnership abbreviations.

Table 9. Parcels in recovery areas needing fencing and ungulate control

Recovery Action #	Island	Land Parcel, TMKs	Species Targeted	Current Landowner/Comments	Priority
2.2.1	H	Northeastern slopes of Mauna Kea, portions of 344014002 344014003 343010002 343010008	AKIP PALI	Hawai\`i DLNR, Land Division.	2

Table 9. Parcels in recovery areas needing fencing and ungulate control					
Recovery Action #	Island	Land Parcel, TMKs	Species Targeted	Current Landowner/Comments	Priority
2.2.2	H	Kanakaleonui Corridor, 338001009	AKIP HCRE AKEP PALI	Hawai`i DHHL. Provides vital link between mesic koa forest and dry māmane forest. Currently under lease for cattle grazing.	1
2.2.3	H	Hilo Forest Reserve, Laupāhoehoe and Pīhā Sections, 337001004 333001004	AKIP HCRE AKEP	Hawai`i DOFAW. Currently managed for game hunting.	2
2.2.4	H	Hakalau Forest NWR, 337001010 333001007 329005005 329005003	AKIP HCRE AKEP	USFWS. Ungulate control under way. Construct additional fences and control ungulates in unmanaged areas.	1
2.2.5	H	Luma`ia Section 326018002	AKIP HCRE AKEP	Hawai`i DHHL, adjacent to Hakalau Forest National Wildlife Refuge. Encourage fencing and ungulate removal.	2
2.2.6	H	Pu`u `Ō`ō Ranch, 326018001	AKIP HCRE AKEP	Hawai`i DLNR, Land Division, Pu`u `Ō`ō Ranch lease. Encourage fencing and ungulate removal.	2
2.2.7	H	Kīpuka `Āinahou Nēnē Sanctuary, 338001008	AKIP HCRE AKEP	Hawai`i DHHL. Encourage fencing and ungulate removal.	2
2.2.8	H	Ka`ohe, 344015002	AKIP PALI	Hawai`i DLNR, Land Division. Suspend lease. Fence and remove ungulates.	2
2.2.9	H	Mauna Kea Forest Reserve, 344015001 344016003 338001004	AKIP PALI	Hawai`i DLNR. Palila critical habitat. Continue to remove ungulates.	1
2.2.10	H	Waiākea Forest Reserve, Upper Portion, 324008001	AKIP AKEP HCRE	Hawai`i DOFAW. Fence and remove ungulates.	1

Table 9. Parcels in recovery areas needing fencing and ungulate control					
Recovery Action #	Island	Land Parcel, TMKs	Species Targeted	Current Landowner/Comments	Priority
2.2.11	H	Waiākea Forest Reserve, Lower Portion, 324008001	OU	Hawai`i DOFAW. Fence and remove ungulates.	1
2.2.12	H	`Ōla`a/Kīlauea Partnership, 324008009 399001007 399001004 324008025 319001001 319001007	AKIP HCRE AKEP	Kamehameha Schools, Keauhou Ranch. Kūlani Correctional Facility, Pu`u Maka`ala NAR, HVNP.	1
2.2.13	H	Kapāpala Forest Reserve, Portions of 398001004	AKIP HCRE AKEP	Hawai`i DLNR, Land Division, Kapāpala Forest Reserve. Fence and remove ungulates.	2
2.2.14	H	Ka`ū Forest Reserve, 397001001	AKIP HCRE AKEP OU	Hawai`i, DOFAW, Ka`ū Forest Reserve. Fence and remove ungulates.	1
2.2.15	H	Kahuku Ranch, Portions of 392001002	AKIP HCRE AKEP	Recently purchased by NPS. Fence and remove ungulates, particularly mouflon sheep.	1
2.2.16	H	Manukā NAR, Upper portions of 391001002	AKIP HCRE AKEP	Hawai`i, DOFAW. Fence and remove ungulates.	2
2.2.17	H	TNCH, Honomalino, 389001001	AKIP HCRE AKEP	The Nature Conservancy of Hawai`i. Fence and remove ungulates.	3
2.2.18	H	Yee Hop Ranch, 392001005	AKIP HCRE AKEP	Yee Hop Ranch Ltd. Fence and remove ungulates.	3
2.2.19	H	Kona Forest NWR, 386001001	AKIP HCRE AKEP	USFWS. Fence and remove ungulates.	2

Table 9. Parcels in recovery areas needing fencing and ungulate control					
Recovery Action #	Island	Land Parcel, TMKs	Species Targeted	Current Landowner/Comments	Priority
2.2.20	H	McCandless Ranch and E. Stack *et al.*, 392001003 386001001 385001002	AKIP HCRE AKEP	McCandless Ranch and E. Stack *et al.* Fence and remove ungulates.	2
2.2.21	H	Waiea Tract, 386001003	AKIP HCRE AKEP	Hawai`i DLNR, Land Division. Fence and remove ungulates.	2
2.2.22	H	Hōnaunau Forest, 384001001 384001002 383001001 383001002	AKIP HCRE AKEP	Kamehameha Schools. Fence and remove ungulates.	2
2.2.23	H	Pu`u Lehua, Portion of 378001003	PALI	Kamehameha Schools. Fence and remove ungulates.	2
2.2.24	MA	Ko`olau Forest Reserve, 224016003 224016004 228008001 228008007	AKOH MAPA POOU	Alexander and Baldwin, East Maui Irrigation. EMWP fence protects lower boundary in east; TNCH protects upper boundary. Remove ungulates from protected areas. Additional ungulate removal needed from unprotected areas.	1
2.2.25	MA	Ko`olau Forest Reserve, 211002002 212004005 229014001 211001050 211001044	AKOH MAPA POOU	Hawai`i DOFAW. EMWP fencing underway to protect forest above about 3,600 ft. Remove ungulates above fence. Additional ungulate control needed from unprotected areas below fence. Proposed additions to Hanawī NAR would support forest bird recovery.	1
2.2.26	MA	Hanawī NAR and Ko`olau Forest Reserve, 212004007	AKOH MAPA POOU	Hawai`i DLNR. NAR fencing protects 1,734 acres, ungulate-free, above 5,400 ft. Fence and remove ungulates from remain portions of NAR (above 2,500 ft. for bird management).	1

Table 9. Parcels in recovery areas needing fencing and ungulate control					
Recovery Action #	Island	Land Parcel, TMKs	Species Targeted	Current Landowner/Comments	Priority
2.2.27	MA	Hāna Forest Reserve, 210001001 214001001 215001001	AKOH MAPA POOU	Hawai`i DLNR. Fencing and ungulate control urgently needed. Proposed additions to Hanawī NAR would support forest bird recovery.	1
2.2.28	MA	Haleakalā National Park, 213001003 216001002 216001001 216001003 217004016 216010001	AKOH MAPA POOU	NPS. Mostly protected by fencing, ungulate removal needs to be completed in some areas. Fence and remove ungulates from remaining areas, e.g., Ka`āpahu.	1
2.2.29	MA	Kīpahulu Forest Reserve, Kukui`ula, 216001007	AKOH MAPA POOU	J. Haili. Encourage ungulate control and fencing.	3
2.2.30	MA	Kīpahulu Forest Reserve, Kukui`ula, 216001006	AKOH MAPA POOU	C. Kalalau. Encourage ungulate control and fencing.	3
2.2.31	MA	Kīpahulu Forest Reserve, 216001005 217001033 217002035 217004006	AKOH MAPA POOU	Hawai`i DLNR. Fence and remove ungulates.	1
2.2.32	MA	Kīpahulu Forest Reserve, 217001032	AKOH MAPA POOU	A. Ka`apana *et al.* Encourage ungulate control and fencing.	3
2.2.33	MA	Kīpahulu Forest Reserve, 217001024	AKOH MAPA POOU	Kaupō Ranch Ltd. Encourage ungulate control and fencing.	2
2.2.34	MA	Nu`u, 218001001	AKOH MAPA POOU	Kaupō Ranch Ltd. Encourage ungulate control and fencing.	3
2.2.35	MA	Nu`u, 218001002	AKOH MAPA POOU	James Campbell Est. Encourage ungulate control and fencing.	3

Table 9. Parcels in recovery areas needing fencing and ungulate control					
Recovery Action #	Island	Land Parcel, TMKs	Species Targeted	Current Landowner/Comments	Priority
2.2.36	MA	Kahikinui Forest Reserve, 218001006 218001005 218001009	AKOH MAPA POOU	Hawai`i DOFAW. Fencing of portion underway. Complete fencing and ungulate removal from Forest Reserve above 4,000 ft.	1
2.2.37	MA	Kahikinui Homelands, 219001003 219001007 219001008 219001011	AKOH MAPA POOU	Hawai`i DHHL. Fencing of portions underway. Continue fencing through partnership programs. Ungulate removal above 4,000 ft.	1
2.2.38	MA	Upper Auwahi, 219001006 221009001 222001001 222001034	AKOH MAPA POOU	`Ulupalakua Ranch Inc. Some exclosures for plant protection in place or underway. Encourage fencing and ungulate removal above 4,000 ft.	1
2.2.39	MA	Kula Forest Reserve, 222007001	AKOH MAPA POOU	Hawai`i DOFAW. Currently a sustained yield game management area. For portions within forest bird recovery area, fence and remove ungulates to allow regeneration of native forest.	2
2.2.40	MA	Kēōkea, 222004033	AKOH MAPA POOU	James Campbell Est. Fence and remove ungulates within forest bird recovery area, manage with Kula Forest Reserve.	2
2.2.41	MA	Waiohuli, 222005052	AKOH MAPA POOU	James Campbell Est. Fence and remove ungulates within forest bird recovery area, manage with Kula Forest Reserve.	2
2.2.42	MA	Ka`ono`ulu, 222007002 222006009 222007010 222006032	AKOH MAPA POOU	Ka`ono`ulu Ranch Co. Ltd. Fence and remove ungulates within forest bird recovery area, manage with Kula Forest Reserve.	2

Table 9. Parcels in recovery areas needing fencing and ungulate control					
Recovery Action #	Island	Land Parcel, TMKs	Species Targeted	Current Landowner/Comments	Priority
2.2.43	MA	Waiakoa, 222008001	AKOH MAPA POOU	Lucky Shoji USA Inc. *et al.* Fence and remove ungulates within forest bird recovery area, manage with Kula Forest Reserve.	2
2.2.44	MA	Kamehame Nui/Kealahou, 223005002	AKOH MAPA POOU	John Zwaanstra. Fence and remove ungulates within forest bird recovery area.	2
2.2.45	MA	Haleakalā Ranch (Pūlehu Nui/ Kalialinui), 223005003	AKOH MAPA POOU	Haleakalā Ranch Co. The ranch is formulating a conservation reforestation plan. Fence and remove ungulates within forest bird recovery area.	2
2.2.46	MA	Waikamoi Preserve, 223005004	AKOH MAPA POOU	Haleakalā Ranch Co., The Nature Conservancy of Hawai`i. Strategic fencing and ungulate control protects the Preserve. Additional protection, especially from deer, may be warranted.	1
2.2.47	MA	Makawao Forest Reserve, 224016001 224016002	AKOH MAPA POOU	Hawai`i DOFAW. Public hunting currently permitted. Fence and remove ungulates within forest bird recovery area.	1
2.2.48	MA	West Maui NAR, Kahakuloa, 231006001	AKOH MAPA POOU	Hawai`i DLNR. Protect with strategic fencing and remove ungulates within forest bird recovery area.	2
2.2.49	MA	West Maui Forest Reserve, Waihe`e, 232014001	AKOH MAPA POOU	Maui Board of Water Supply. Strategic fencing and ungulate removal within forest bird recovery area.	2
2.2.50	MA	West Maui Forest Reserve, Kou, 232014002	AKOH MAPA POOU	Hawai`i DOFAW. Strategic fencing and ungulate removal within forest bird recovery area.	2
2.2.51	MA	West Maui Forest Reserve, Wailuku, 233003003 235003001 236003001	AKOH MAPA POOU	Wailuku Agriculture. Strategic fencing and ungulate removal within forest bird recovery area.	2

Table 9. Parcels in recovery areas needing fencing and ungulate control					
Recovery Action #	Island	Land Parcel, TMKs	Species Targeted	Current Landowner/Comments	Priority
2.2.52	MA	West Maui Forest Reserve, `Īao, 233003004,	AKOH MAPA POOU	Hawai`i DOFAW. Strategic fencing and ungulate removal within forest bird recovery area.	2
2.2.53	MA	West Maui Forest Reserve, Kealaloloa, 236001014	AKOH MAPA POOU	Hawai`i DOFAW. Strategic fencing and ungulate removal within forest bird recovery area.	2
2.2.54	MA	West Maui Forest Reserve, Manawainui Plant Reserve, 236001052 248001010	AKOH MAPA POOU	Hawai`i DOFAW. Strategic fencing and ungulate removal within forest bird recovery area.	2
2.2.55	MA	West Maui Forest Reserve, Kaheawa, 248001001	AKOH MAPA POOU	Hawai`i DOFAW. Strategic fencing and ungulate removal within forest bird recovery area.	2
2.2.56	MA	West Maui Forest Reserve, Ukumehame/ Olowalu, West Maui NAR, Līhau, 248001002	AKOH MAPA POOU	Hawai`i DOFAW. Strategic fencing and ungulate removal within forest bird recovery area.	2
2.2.57	MA	West Maui Forest Reserve, Launiupoko, 247001002	AKOH MAPA POOU	American Factors (Amfac)/JMB Hawai`i Co. Strategic fencing and ungulate removal within forest bird recovery area.	2
2.2.58	MA	West Maui Forest Reserve, Pūehuehu, 247001004	AKOH MAPA POOU	Hawai`i DOFAW. Strategic fencing and ungulate removal within forest bird recovery area.	2
2.2.59	MA	West Maui Forest Reserve, Kaua`ula, 246025001	AKOH MAPA POOU	American Factors (Amfac)/JMB Hawai`i Co. Strategic fencing and ungulate removal within forest bird recovery area.	2
2.2.60	MA	West Maui Forest Reserve, Pana`ewa, 246025002	AKOH MAPA POOU	Hawai`i DOFAW. Strategic fencing and ungulate removal within forest bird recovery area.	2

Table 9. Parcels in recovery areas needing fencing and ungulate control					
Recovery Action #	Island	Land Parcel, TMKs	Species Targeted	Current Landowner/Comments	Priority
2.2.61	MA	West Maui Forest Reserve, Kahoma, 245022001	AKOH MAPA POOU	Kamehameha Schools. Strategic fencing and ungulate removal within forest bird recovery area.	2
2.2.62	MA	West Maui Forest Reserve, Kahoma, 245022005	AKOH MAPA POOU	Hawai`i DOFAW. Strategic fencing and ungulate removal within forest bird recovery area.	2
2.2.63	MA	West Maui Forest Reserve, Pu`u Kī/Haakea, 245022002 245022004	AKOH MAPA POOU	American Factors (Amfac)/JMB Hawai`i Co. Strategic fencing and ungulate removal within forest bird recovery area.	2
2.2.64	MA	West Maui Forest Reserve, Wahikuli, 245022003	AKOH MAPA POOU	Hawai`i DOFAW. Strategic fencing and ungulate removal within forest bird recovery area.	2
2.2.65	MA	Kapunakea Preserve, Amfac/JMB, TNCH, 244007001	AKOH MAPA POOU	American Factors (Amfac)/JMB Hawai`i Co., TNCH. Strategic fencing and ungulate removal within forest bird recovery area.	2
2.2.66	MA	West Maui Forest Reserve, Kapāloa, 244007007	AKOH MAPA, POOU	Unknown. Strategic fencing and ungulate removal within forest bird recovery area.	2
2.2.67	MA	West Maui NAR, Honokōwai, 244007004	AKOH MAPA POOU	Hawai`i DLNR. Strategic fencing and ungulate removal within forest bird recovery area.	2
2.2.68	MA	Pu`u Kukui Watershed Management Area, 242001001, 241001017	AKOH MAPA POOU	Maui Land and Pineapple. Strategic fencing and ungulate removal within forest bird recovery area.	2
2.2.69	MO	Moloka`i Forest Reserve, Kalama`ula, 252014003	AKOH MAPA POOU	Hawai`i DOFAW. Strategic fencing and ungulate removal within forest bird recovery area.	2
2.2.70	MO	Moloka`i Forest Reserve, Kahanui, 252014001	AKOH MAPA POOU	R. W. Myer Ltd., *et al.* Strategic fencing and ungulate removal within forest bird recovery area.	2
2.2.71	MO	Moloka`i Forest Reserve, Kahanui, 261001004	AKOH MAPA POOU	Hawai`i DOFAW. Strategic fencing and ungulate removal within forest bird recovery area.	2

Table 9. Parcels in recovery areas needing fencing and ungulate control					
Recovery Action #	Island	Land Parcel, TMKs	Species Targeted	Current Landowner/Comments	Priority
2.2.72	MO	Moloka`i Forest Reserve, Waikolu, 261001002	AKOH MAPA POOU	Hawai`i DOFAW. Ungulate control currently ongoing at Pu`u Ali`i NAR. Strategic fencing and ungulate removal within forest bird recovery area.	2
2.2.73	MO	Moloka`i Forest Reserve, Pelekunu Valley, 259006011	AKOH MAPA POOU	The Nature Conservancy of Hawai`i. Ungulate control currently ongoing. Strategic fencing and ungulate removal within forest bird recovery area.	2
2.2.74	MO	Moloka`i Forest Reserve, Pelekunu Valley, Wawaeolepe, 259008017	AKOH MAPA POOU	Wm. Hitchcock, *et al*. Strategic fencing and ungulate removal within forest bird recovery area.	2
2.2.75	MO	Moloka`i Forest Reserve, Pelekunu Valley, 254003032	AKOH MAPA POOU	The Nature Conservancy of Hawai`i. Ungulate control currently ongoing. Strategic fencing and ungulate removal within forest bird recovery area.	2
2.2.76	MO	Oloku`i NAR, Moloka`i Forest Reserve, Wailau Valley, 259006002	AKOH MAPA POOU	Hawai`i DOFAW. Naturally isolated but vulnerable to incursion. Ungulate control ongoing. Strategic fencing and ungulate removal within forest bird recovery area.	2
2.2.77	MO	Moloka`i Forest Reserve, Wailau Valley and Oloku`i, 259006004	AKOH MAPA POOU	G. Brown III, *et al*. Strategic fencing and ungulate removal within forest bird recovery area.	2
2.2.78	MO	Moloka`i Forest Reserve, Laeokapuna, 257005027	AKOH MAPA POOU	P. Hodgins. Strategic fencing and ungulate removal within forest bird recovery area.	2
2.2.79	MO	Moloka`i Forest Reserve, Keanakoholua, 257005001	AKOH MAPA POOU	M. Hustice Trust. Strategic fencing and ungulate removal within forest bird recovery area.	2

Table 9. Parcels in recovery areas needing fencing and ungulate control					
Recovery Action #	Island	Land Parcel, TMKs	Species Targeted	Current Landowner/Comments	Priority
2.2.80	MO	Moloka`i Forest Reserve, `Uala`pue, 256006026	AKOH MAPA POOU	Hawai`i DOFAW. Strategic fencing and ungulate removal within forest bird recovery area.	2
2.2.81	MO	Moloka`i Forest Reserve, Kahananui, 256006014	AKOH MAPA POOU	Hawai`i DOFAW. Strategic fencing and ungulate removal within forest bird recovery area.	2
2.2.82	MO	Moloka`i Forest Reserve, Manawai, 256006013	AKOH MAPA POOU	P. Petro Trust. Strategic fencing and ungulate removal within forest bird recovery area.	2
2.2.83	MO	Moloka`i Forest Reserve, eastern `Ōhi`a Gulch, 256006011	AKOH MAPA POOU	Hawai`i DOFAW. Strategic fencing and ungulate removal within forest bird recovery area.	2
2.2.84	MO	Moloka`i Forest Reserve, West `Ōhi`a Gulch, 256006010	AKOH MAPA POOU	E. Wond Trust. Strategic fencing and ungulate removal within forest bird recovery area.	2
2.2.85	MO	Moloka`i Forest Reserve, Keawa Nui, 256006007	AKOH MAPA POOU	Kamehameha Schools. Strategic fencing and ungulate removal within forest bird recovery area.	2
2.2.86	MO	Moloka`i Forest Reserve, Pua`ahala, 256006002	AKOH MAPA POOU	K&H Horizons Hawai`i. Strategic fencing and ungulate removal within forest bird recovery area.	2
2.2.87	MO	Moloka`i Forest Reserve, Kumu`eli, 256006001	AKOH MAPA POOU	D. Fairbanks III Trust, (Austin Estate?). In EMOWP; currently fencing portions and removing ungulates. Continue strategic fencing and remove ungulates within forest bird recovery area.	2
2.2.88	MO	Moloka`i Forest Reserve, Kamalō, 255001016 255001006 255001017	AKOH MAPA POOU	Kamehameha Schools. In EMOWP; currently fencing portions and removing ungulates. Strategic fencing and ungulate removal within forest bird recovery area.	2

Table 9. Parcels in recovery areas needing fencing and ungulate control					
Recovery Action #	Island	Land Parcel, TMKs	Species Targeted	Current Landowner/Comments	Priority
2.2.89	MO	Moloka`i Forest Reserve, Mākolelau, 255001015	AKOH MAPA POOU	Ashton Pitts Jr. Trust. Strategic fencing and ungulate removal within forest bird recovery area.	2
2.2.90	MO	Kamakou Preserve, Kawela, 2540003026	AKOH MAPA POOU	Moloka`i Ranch Ltd., The Nature Conservancy of Hawai`i. In EMOWP. Ungulate control currently ongoing. Strategic fencing and ungulate removal within forest bird recovery area.	2
2.2.91	MO	Moloka`i Forest Reserve, Kawela, 254003001	AKOH MAPA POOU	Kawela Plantation Homes Association. Strategic fencing and ungulate removal within forest bird recovery area.	2
2.2.92	MO	Moloka`i Forest Reserve, Kamiloloa/ Makakupa`ia, 254003025	AKOH MAPA POOU	Hawai`i DOFAW. Strategic fencing and ungulate removal within forest bird recovery area.	2
2.2.93	MO	Moloka`i Forest Reserve, Kaunakakai, 253003005	AKOH MAPA POOU	Moloka`i Ranch Ltd. Strategic fencing and ungulate removal within forest bird recovery area.	2
2.2.94	O	Honouliuli Preserve, 92005013	OAEL	James Campbell Estate, managed by The Nature Conservancy of Hawai`i. One 40-acre exclosure completed, a second is planned. More, larger fences needed to exclude ungulates from as much of the preserve as possible.	1
2.2.95	O	Lualualei Naval Magazine, 88001001	OAEL	U.S. Navy. Fencing and eradication of ungulates and/or time/area closure to hunting may be needed in preparation for aerial broadcast of rodenticides. Not open to public hunting.	2

Table 9. Parcels in recovery areas needing fencing and ungulate control					
Recovery Action #	Island	Land Parcel, TMKs	Species Targeted	Current Landowner/Comments	Priority
2.2.96	O	Schofield Barracks West Range, 77001001	OAEL	U.S. Army. Ungulate control to protect forest and reduce mosquito breeding habitat. Fencing and eradication of ungulates and/or time/area closure to hunting may be needed in preparation for aerial broadcast of rodenticides. Not open to public hunting.	1
2.2.97	O	Pahole NAR, 68001002	OAEL	Hawai`i State. Fencing and ungulate eradication to protect forest, reduce mosquito breeding habitat. Fencing and eradication of ungulates and/or time/area closure to hunting may be needed in preparation for aerial broadcast of rodenticides. Currently few `elepaio, but high potential for augmentation.	2
2.2.98	O	Kahanahāiki Valley, 81001012	OAEL	U.S. Army. Fencing and eradication of ungulates and/or time/area closure to hunting may be needed in preparation for aerial broadcast of rodenticides.	2
2.2.99	O	O`ahu Forest NWR, 95004001 76001001	OAEL	U.S. Fish and Wildlife Service. Fencing and eradication of ungulates and/or time/area closure to hunting may be needed in preparation for aerial broadcast of rodenticides. Currently no `elepaio, but high potential for reintroduction.	3
2.2.100	O	Lower Ka`ala NAR, 67003025	OAEL	Hawai`i State. Currently few `elepaio, but high potential for augmentation/ reintroduction. Fencing and eradication of ungulates and/or time/area closure to hunting may be needed in preparation for aerial broadcast of rodenticides.	3

Table 9. Parcels in recovery areas needing fencing and ungulate control					
Recovery Action #	Island	Land Parcel, TMKs	Species Targeted	Current Landowner/Comments	Priority
2.2.101	K	Halehaha, Halepā`ākai and Koai`e drainages, Alaka`i Wilderness Preserve, Portions of 414001003	PUAI KACR KAMO KAAK OO OU KANU	Hawai`i DOFAW. Fencing of at least a 4 km square area in the Halepā`ākai and Koai`e Stream drainage and eradication of pigs is needed to protect key habitat. Fencing and ungulate control and/or time/area closure to hunting may be needed in preparation for aerial broadcast of rodenticides.	1
2.2.102	K	Upper Mōhihi and Waiakoali drainages, Alaka`i Wilderness Preserve, Portions of 414001003	PUAI KACR KAMO KAAK OO OU KANU	Hawai`i DOFAW. Fencing as much of the core puaiohi population as possible. Fencing and ungulate control and/or time/area closure to hunting in preparation for aerial broadcast of rodenticide.	2
2.2.103	K	Alaka`i Wilderness Preserve 4414001003	PUAI KACR KAMO KAAK OO OU KANU	Hawai`i DOFAW. Strategic fencing to exclude ungulates from as much of the preserve as practical.	2
2.2.104	K	Southern Alaka`i Plateau, Portions of 417001001	PUAI AKIK	Gay and Robinson Partnership with DLNR/ DOFAW. Fencing and ungulate control may be needed in preparation for aerial broadcast of rodenticides.	2

2.3 Reduce or eliminate the detrimental effects of alien plants within forest ecosystems, through mechanical, chemical, or biological means, as appropriate. (Priority 1-3)

Habitat degradation resulting from the invasion of nonnative weeds is a long-term, pervasive threat in many recovery areas. Alien plants can drastically alter forest structure and function and impact forest birds by choking out native vegetation, altering food availability and phenology, and altering roost- and nest-site availability. Priority control efforts should be aimed at eradicating incipient populations of known forest invasives, and controlling established populations of species that highly impact forest structure or function. For species that have become established and are beyond the means of mechanical or chemical control, research into biological control agents is imperative. Table 10 lists species, genera, and families of plants that pose serious threats to habitat needed for forest bird recovery on all islands.

Table 10. Alien plant taxa known or suspected to pose a significant threat to forest bird recovery areas on the main Hawaiian Islands. At the species level, 39 taxa of alien grasses, shrubs, vines, or trees pose a significant threat to forest bird recovery areas. At higher taxonomic levels, all known naturalized taxa from five genera and four families pose significant threats to forest bird recovery areas. Urgency of the need for management of each taxon is represented by a code: 1 = high; 2 = moderate; 3 = low.

Table 10. Threatening alien plant taxa.

Scientific Name	Common Name	Hawai`i	Maui Nui	O`ahu	Kaua`i
Acacia mearnsii	black wattle	3	1		3
Acacia melanoxylon	Australian blackwood		1		3
Cinchona pubescens	quinine		1	3	
Cinnamomum burmannii	padang cassia		2		
Cinnamomum camphora	camphor tree		1		
Cortaderia jubata	Andean pampas grass	2	2		
Cortaderia selloana		2	2		
Delairea odorata	German ivy	2			
Ehrharta stipoides	meadow ricegrass	2			
Erigeron karvinskianus	daisy fleabane		3		1

Table 10. Threatening alien plant taxa.					
Scientific Name	**Common Name**	**Hawai`i**	**Maui Nui**	**O`ahu**	**Kaua`i**
Heliocarpus popayanensis	white moho	3	3	1	
Holcus lanatus	velvetgrass, Yorkshire fog	3	3		
Ilex aquifolium	English or European holly	1	2		
Juncus effuses	Japanese mat rush	1	3		2
Juncus planifolius	rush	3	3		
Lantana camara	lantana, lakana	3	3	1	
Leptospermum scoparium	New Zealand tea tree			2	
Lonicera japonica	Japanese honeysuckle	3	3		2
Melinis minutiflora	molasses grass	3	3		3
Myrica faya	firetree	1	2		1
Oplismenus hirtellus	basketgrass, honohono			3	
Panicum maximum	Guinea grass	3	2		
Paspalum conjugatum	Hilo grass, mau`u-hilo	3	3		3
Paspalum urvillei	Vasey grass	3	3		2
Pennisetum clandestinum	kikuyu grass	1			
Pennisetum setaceum	fountain grass	1			
Pyracantha angustifolia	firethorn, pyracantha	3	3		3
Rubus argutus	blackberry	1	1	1	1
Rubus discolor		3	2		
Rubus ellipticus var. *obcordatus*	yellow Himalayan raspberry	1	2		
Rubus niveus	hill or mysore raspberry	3	2		
Rubus rosifolius	thimbleberry	3	3	2	2
Schinus terebinthifolius	Christmas berry	2	2	1	
Schizachyrium condensatum	beardgrass	3	3		2
Setaria palmifolia	palmgrass	2	2	2	
Sphaeropteris cooperi	Australian tree fern	2	2	2	2
Toona ciliata	Australian red cedar		3	1	
Ulex europaeus	gorse	2	2		

Genera					
Eucalyptus spp. (90+ spp)	gum trees	2	1	1	3
Ficus (microcarpa, nota, platyphyllum, rubigenosa)	figs	2	2	1	
Fraxinus (uhdei, griffithi)	ashes	1	1	3	
Hedychium (coronarium, flavescens, gardnerianum)	gingers	1	1	3	1
Psidium (cattleianum, guajava)	guavas	1	1	1	1
Families					
Melastomataceae	Melastome family	1	1	1	3
Passifloraceae	Passion fruit family	1	2	2	2
Pinaceae	Pine family	2	2		
Proteaceae	Protea family	2	3	2	

2.4 Reduce or eliminate the detrimental effects of alien mammalian predators (rats, mice, feral cats, mongooses) on forest birds.

Hawaiian birds evolved in the absence of mammalian predators and are extremely vulnerable to the novel selection pressure exerted by these introduced species, particularly rats (*Rattus* spp.) and feral cats (*Felis catus*). The black rat (*R. rattus*) is thought to have been a major cause of the declines in native bird populations in the early 1900s (Atkinson 1977), and it continues to limit recovery of listed forest birds through predation on eggs, nestlings, and adults (Amarasekare 1993, VanderWerf 2001, VanderWerf and Smith 2002). Feral cats have a widespread distribution throughout forest bird habitat on all of the main Hawaiian Islands, and have been described as “the most dangerous predator ever introduced by man” because of their devastating effect on island bird populations (Ebenhard 1988). The small Indian mongoose (*Herpestes auropunctatus*) has had a major negative effect on the nēnē, seabirds, and waterbirds (U.S. Fish and Wildlife Service 1999, Hodges and Nagata 2001, Hu *et al.* 2001), but its limited climbing ability suggests it is a lesser threat to forest birds than rats and feral cats. Nonetheless, field observations and necropsies by

National Park Service personnel indicate the impact of mongooses should not be underestimated (D. Reeser, National Park Service, pers. comm.). Recovery of most Hawaiian forest bird species will require active predator control efforts, as well as increased research into the development of effective means for controlling predators over large areas of forest. Attempts at reintroducing birds by translocation or captive releases to areas where they have been extirpated should be accompanied by predator control.

2.4.1 Control alien mammalian predators in core forest bird habitat by trapping, poisoning, and other means (see Table 11).

Table 11. Parcels in recovery areas where predator control is needed. Island codes: H = Hawai`i; K = Kaua`i; MA = Maui; MO = Moloka`i; O = O`ahu. Species Codes: AKEP = Hawai`i `ākepa; AKIP = `akiapōlā`au; AKOH = `ākohekohe; HCRE = Hawai`i creeper; KAAK = Kaua`i `akialoa; KACR = Kaua`i creeper; KAMO = kāma`o; KANU = Kaua`i nukupu`u; MAPA = Maui parrotbill; OAEL = O`ahu `elepaio; OO = Kaua`i `ō`ō; OU = `ō`ū; PALI = palila; POOU = po`ouli; PUAI = puaiohi. Refer to the Implementation Schedule, Key to Acronyms (page 5-7) for landowner and partnership abbreviations.

Table 11. Parcels in recovery areas where predator control is needed					
Recovery Action #	Island	Land Parcel, TMKs	Species Targeted	Current Landowner/Comments	Priority
2.4.1.1	H	Northeastern slopes of Mauna Kea, portions of 344014002 344014003 343010002 343010008	AKIP PALI	Hawai`i DLNR, State Land Division.	2
2.4.1.2	H	Kanakaleonui Corridor, 338001009	AKIP HCRE AKEP PALI	Hawai`i DHHL. Predator control needed in conjunction with reforestation to allow range expansion by forest birds.	2
2.4.1.3	H	Hilo Forest Reserve, Laupāhoehoe and Pīhā Sections, 337001002 333001004	AKIP HCRE AKEP	Hawai`i, DOFAW. Currently managed for game hunting.	2
2.4.1.4	H	Hakalau Forest NWR, 337001010 333001007 329005005 329005003	AKIP HCRE AKEP	USFWS. Currently managed forest bird habitat. Predator control needed to protect core populations of three listed species.	1
2.4.1.5	H	326018002	AKIP HCRE AKEP	Hawai`i DHHL. Adjacent to Hakalau Forest National Wildlife Refuge.	2
2.4.1.6	H	Pu`u `Ō`ō Ranch, 326018001	AKIP HCRE AKEP	Hawai`i DLNR, State Land Division, Pu`u `Ō`ō Ranch lease.	2

Table 11. Parcels in recovery areas where predator control is needed					
Recovery Action #	Island	Land Parcel, TMKs	Species Targeted	Current Landowner/Comments	Priority
2.4.1.7	H	Kīpuka \`Āinahou Nēnē Sanctuary, 338001008	AKIP HCRE AKEP	Hawai\`i DHHL.	2
2.4.1.8	H	Ka\`ohe, 344015002	AKIP PALI	Hawai\`i DLNR, State Land Division. Suspend lease.	2
2.4.1.9	H	Mauna Kea Forest Reserve, 344015001 344016003 338001004	AKIP PALI	Hawai\`i DOFAW. Palila critical habitat. Feral cats known to be predators in this area.	1
2.4.1.10	H	Waiākea Forest Reserve, Upper portion, 324008001	AKIP AKEP HCRE	Hawai\`i, DOFAW.	2
2.4.1.11	H	Waiākea Forest Reserve, lower portion, 324008001	OU	Hawai\`i, DOFAW.	2
2.4.1.12	H	\`Ōla\`a/Kīlauea Partnership, 324008009 399001007 399001004 324008025 319001001 319001007	AKIP HCRE AKEP	Kamehameha Schools, Keauhou Ranch. Kūlani Correctional Facility, Pu\`u Maka\`ala NAR, HVNP.	1
2.4.1.13	H	Kapāpala Forest Reserve, Portions of 398001004	AKIP HCRE AKEP	Hawai\`i DLNR, Land Division, Kapāpala Forest Reserve. Needs predator control.	2
2.4.1.14	H	Ka\`ū Forest Reserve, 397001001	AKIP HCRE AKEP OU	Hawai\`i DOFAW. Predator control needed to protect large populations of three listed species.	1
2.4.1.15	H	Kahuku Ranch, Portions of 392001002	AKIP HCRE AKEP	Samuel M. Damon Trust. Purchase by NPS.	2
2.4.1.16	H	Manukā NAR, Upper portions of 391001002	AKIP HCRE AKEP	Hawai\`i, DOFAW.	2

Table 11. Parcels in recovery areas where predator control is needed					
Recovery Action #	Island	Land Parcel, TMKs	Species Targeted	Current Landowner/Comments	Priority
2.4.1.17	H	TNCH, Honomalino, 389001001	AKIP HCRE AKEP	The Nature Conservancy of Hawai`i.	2
2.4.1.18	H	Yee Hop Ranch, 392001005	AKIP HCRE AKEP	Yee Hop Ranch Ltd.	2
2.4.1.19	H	Kona Forest NWR, 386001001	AKIP HCRE AKEP	USFWS. Predator control needed to protect last wild `alalā and other listed species.	1
2.4.1.20	H	McCandless Ranch and E. Stack *et al.*, 392001003 386001001 385001002	AKIP HCRE AKEP	Elizabeth Stack *et al.*, McCandless Ranch.	2
2.4.1.21	H	Waiea Tract, 386001003	AKIP HCRE AKEP	Hawai`i State, DLNR, State Land Division.	2
2.4.1.22	H	Hōnaunau Forest, 384001001 384001002 383001001 383001002	AKIP HCRE AKEP	Kamehameha Schools.	2
2.4.1.23	H	Pu`u Lehua, Portion of 378001003	PALI	Kamehameha Schools.	2
2.4.1.24	H	Pu`u Wa`awa`a Forest Bird Sanctuary, 371001001 371001006	AKIP HCRE AKEP	Hawai`i State, DLNR, DOFAW.	2
2.4.1.25	MA	Ko`olau Forest Reserve, 224016003 224016004 228008001 228008007	AKOH MAPA POOU	Alexander and Baldwin, East Maui Irrigation. Portions providing habitat for endangered species; remaining portions are priority 2.	1

Table 11. Parcels in recovery areas where predator control is needed					
Recovery Action #	Island	Land Parcel, TMKs	Species Targeted	Current Landowner/Comments	Priority
2.4.1.26	MA	Ko`olau Forest Reserve, 211002002 212004005 229014001 211001050 211001044	AKOH MAPA POOU	Hawai`i State. Portions providing habitat for endangered species; remaining portions are priority 2.	1
2.4.1.27	MA	Hanawī NAR and Ko`olau Forest Reserve, 212004007	AKOH MAPA POOU	Hawai`i State. Portions providing habitat for endangered species; remaining portions are priority 2.	1
2.4.1.28	MA	Hāna Forest Reserve, 210001001 214001001 215001001	AKOH MAPA POOU	Hawai`i State. Portions providing habitat for endangered species; remaining portions are priority 2.	1
2.4.1.29	MA	Haleakalā National Park, 213001003 216001002 216001001 216001003 217004016 216010001 218001007	AKOH MAPA POOU	National Park Service. Portions providing habitat for endangered species; remaining portions are priority 2.	1
2.4.1.30	MA	Kīpahulu Forest Reserve, 216001005 217001033 217002035 217004006	AKOH MAPA POOU	Hawai`i State. Adjacent to known populations of AKOH and MAPA. Potential for range expansion.	2
2.4.1.31	MA	Kahikinui Forest Reserve, 218001006 218001005 218001009	AKOH MAPA POOU	Hawai`i State. Potential long-term site for reintroduction.	2
2.4.1.32	MA	Kahikinui Homelands, 219001003 219001007 219001008 219001011	AKOH MAPA POOU	Hawai`i State, DHHL. Potential long-term site for reintroduction.	2

Table 11. Parcels in recovery areas where predator control is needed					
Recovery Action #	Island	Land Parcel, TMKs	Species Targeted	Current Landowner/Comments	Priority
2.4.1.33	MA	Kula Forest Reserve, 222007001	AKOH MAPA POOU	Hawai`i State. Potential long-term site for reintroduction.	3
2.4.1.34	MA	Haleakalā Ranch (Pūlehu Nui/ Kalialinui), 223005003	AKOH, MAPA, POOU	Haleakalā Ranch Co. Adjacent to current populations. Likely site of near-term range expansion for AKOH and MAPA.	3
2.4.1.35	MA	Waikamoi Preserve, 223005004	AKOH MAPA POOU	Haleakalā Ranch Co., The Nature Conservancy of Hawai`i. Portions providing habitat for endangered species, priority #1; remaining portions, priority #2.	1
2.4.1.36	MA	Makawao Forest Reserve, 224016001 224016002	AKOH MAPA POOU	Hawai`i State. Likely site of near-term range expansion for AKOH and MAPA.	2
2.4.1.37	MA	West Maui NAR, Kahakuloa, 231006001	AKOH MAPA POOU	Hawai`i State. Primary site for reintroduction.	2
2.4.1.38	MA	West Maui NAR, Līhau, 248001002	AKOH MAPA POOU	Hawai`i State. Potential long-term site for reintroduction.	3
2.4.1.39	MA	West Maui Forest Reserve, Pana`ewa, 246025002	AKOH MAPA POOU	Hawai`i State. Potential long-term site for reintroduction.	3
2.4.1.40	MA	Kapunakea Preserve Amfac/JMB, TNCH, 244007001	AKOH MAPA POOU	American Factors (Amfac)/JMB Hawai`i Co., TNCH. Primary site for reintroduction.	2
2.4.1.41	MA	West Maui NAR, Honokōwai, 244007004	AKOH MAPA POOU	Hawai`i State. Primary site for reintroduction.	2
2.4.1.42	MA	Pu`u Kukui Watershed Management Area, 242001001 241001017	AKOH MAPA POOU	Maui Land and Pineapple. Primary site for reintroduction.	2
2.4.1.43	MO	Moloka`i Forest Reserve, Pu`u Ali`i NAR and Waikolu, 261001002	AKOH MAPA POOU	Hawai`i State. Primary site for reintroduction.	2

Table 11. Parcels in recovery areas where predator control is needed					
Recovery Action #	Island	Land Parcel, TMKs	Species Targeted	Current Landowner/Comments	Priority
2.4.1.44	MO	Moloka`i Forest Reserve and Oloku`i NAR, Wailau Valley, 259006002	AKOH MAPA POOU	Hawai`i State. Primary site for reintroduction.	2
2.4.1.45	MO	Kamakou Preserve, Kawela, 2540003026	AKOH MAPA POOU	Moloka`i Ranch Ltd., The Nature Conservancy of Hawai`i. Primary site for reintroduction.	2
2.4.1.46	O	Honouliuli Preserve, 92005013	OAEL	James Campbell Est. The Nature Conservancy of Hawai`i has controlled rodents since 2000 with snap traps and bait stations. Control should be continued and expanded, using aerial broadcast if possible.	1
2.4.1.47	O	Lualualei Naval Magazine, 88001001	OAEL	U.S. Navy. Rodent control initiated in 2002 using diphacinone bait stations and snap traps, should be continued and expanded, using aerial broadcast if possible.	2
2.4.1.48	O	Schofield Barracks West Range, 77001001	OAEL	U.S. Army. Environmental Division has controlled rodents on a small-scale using snap traps and bait stations, but insufficient access to be effective. Aerial broadcast of rodenticide would increase scale, less access needed.	1
2.4.1.49	O	Honolulu Watershed Forest Reserve (Wailupe), 36004004	OAEL	Hawai`i DOFAW. Rodent control begun in 1997 using snap traps and bait stations, should be continued and expanded, using aerial broadcast if possible.	1
2.4.1.50	O	North Hālawa Valley, 99011002	OAEL	Kamehameha Schools. Rodent control needed to protect core `elepaio population.	1
2.4.1.51	O	Moanalua Valley, 11013001 11013002	OAEL	Damon Estate. Rodent control needed to protect core `elepaio population.	1

Table 11. Parcels in recovery areas where predator control is needed					
Recovery Action #	Island	Land Parcel, TMKs	Species Targeted	Current Landowner/Comments	Priority
2.4.1.52	O	Waikāne Valley, 48014005	OAEL	SMF Enterprises. Rodent control needed to protect core `elepaio population.	1
2.4.1.53	O	Kahana Valley State Park, 52001001 52002001	OAEL	Hawai`i DLNR, State Parks. Rodent control needed to protect core `elepaio population.	1
2.4.1.54	O	Mākaha Valley, 84002014 84002001	OAEL	City and County of Honolulu. Rodent control needed to protect core `elepaio population.	1
2.4.1.55	O	Pahole NAR, 68001002	OAEL	Hawai`i DLNR, NARS. Rodent control conducted in 1999 using bait stations. Currently few `elepaio, but aerial broadcast would help prepare site for reintroduction.	2
2.4.1.56	O	Kahanahāiki Valley, 81001012	OAEL	U.S. Army. Rodent and mongoose control begun in 1998 using snap traps, bait stations, and live traps. Currently few `elepaio, aerial broadcast would help prepare site for reintroduction.	2
2.4.1.57	O	O`ahu Forest NWR, 95004001 76001001	OAEL	USFWS. Currently no `elepaio, rodent control would help prepare site for reintroduction.	2
2.4.1.58	O	Lower Ka`ala NAR, 67003025	OAEL	Hawai`i DLNR, NARS. Currently few `elepaio, predator control would help prepare site for reintroduction.	3
2.4.1.59	K	Halehaha, Halepā`ākai, and Koai`e drainages, Alaka`i Wilderness Preserve, 414001003	PUAI KACR KAMO KAAK OO OU KANU	Hawai`i DOFAW. Recommend aerial broadcast of rodenticide in Halehaha and Halepā`ākai drainages, and a tributary of Koai`e Stream.	1

Table 11. Parcels in recovery areas where predator control is needed					
Recovery Action #	Island	Land Parcel, TMKs	Species Targeted	Current Landowner/Comments	Priority
2.4.1.60	K	Upper Mōhihi and upper Waiakoali drainages, Alaka`i Wilderness Preserve, 414001003	PUAI KACR KAMO KAAK OO OU KANU	Hawai`i DOFAW. Pending study of threat posed by rats to core puaiohi population, aerial broadcast of rodenticides in upper Mōhihi and Waiakoali drainages. Ground-based protection of active nests.	2
2.4.1.61	K	Upper Kawaikōī, Alaka`i Wilderness Preserve, 459001001	PUAI KACR KAMO KAAK OO OU KANU	Hawai`i DOFAW. Ground-based bait station rodent control in association with puaiohi release, and ground-based feral cat control.	2
2.4.1.62	K	Southern Alaka`i Plateau, 417001001 (in part)	PUAI AKIK KAMO KAAK OO OU NUKU	Robinson Family Partners, aerial broadcast of rodenticide in conjunction with release program for puaiohi.	2

2.4.2 Continue the public information campaign explaining the need and low relative risks of using aerial broadcast of diphacinone for conservation purposes. (Priority 1)

2.4.3 Examine feasibility/appropriateness of time/area closure of public use areas when using broadcast application of diphacinone. (Priority 1)

2.5 Decrease the threat of avian disease.

Introduced avian disease and disease vectors have had a devastating effect on Hawai`i's endemic forest birds. The introduction of the southern house mosquito (*Culex quinquefasciatus*) to the islands in 1826, introduction of avian pox virus (*Poxvirus avium*) in the 1800s, and the introduction of avian malaria (*Plasmodium relictum*) in the early 1900s each played significant roles in the wave of extinctions of lowland native birds that occurred in the late 19th and early 20th centuries (Warner 1968, van Riper *et al*. 1986). Both diseases continue to limit the geographic range, recruitment, and survivorship of native forest bird populations, with the most significant impacts on Hawaiian honeycreepers (subfamily Drepanidinae) at elevations below 1,200 meters (4,000 feet) (Atkinson *et al*. 1995, 2000; VanderWerf 2001). Differences between the current and historical ranges of most species can, in large part, be explained by high susceptibility to introduced diseases. With the exception of the O`ahu `elepaio, all populations of endangered Hawaiian forest birds occur at elevations higher than 1,200 meters (4,000 feet), where thermal constraints limit development of the malarial parasite in the mosquito vector (LaPointe 2000) and where abundance of mosquito vectors is low (van Riper *et al*. 1986, LaPointe 2000). Given the high susceptibility of isolated island populations to disease introductions and the significant impacts of established diseases, high priority should be given to efforts to prevent introductions of new vectors and pathogens and efforts to control or mitigate the effects of those that are already established in the Hawaiian Islands.

2.5.1 Prevent introduction of new diseases and disease vectors into Hawai`i.

Hawai`i has become a textbook example of what can happen to a highly susceptible wildlife population after introduction of a novel pathogen. Preventing the introduction of new diseases and disease vectors to Hawai`i must receive high priority because of potential impacts on wildlife populations, domestic animals, and human health. An Avian Disease Working Group involving representatives of the U.S. Fish and Wildlife Service, National Park Service, Department of Defense, U.S. Geological Survey, State Division of Forestry and Wildlife, State Department of Agriculture, State Department of Health, the Animal and Plant Health Inspection Service, the U.S. Postal Service, and key private landowners should be convened to identify loopholes and propose legislation for regulating movement of live animals and potentially infectious biological material both into the State and between islands.

2.5.1.1 Enforce existing quarantine laws for importation of pet birds. (Priority 1)

The pet bird trade rather than domestic poultry or the poultry industry poses the greatest threat to endemic forest birds because of the large number of species involved, their ability to establish breeding populations in remote native forest habitats, and lack of regulation and enforcement. Efforts should be made to encourage local production of pet birds in disease-free facilities to minimize numbers of new hosts entering the State. A public outreach program is needed to educate pet bird owners about the threats pet birds pose to the endemic avifauna. Existing quarantine and importation laws should be enforced and made more restrictive. The Avian Disease Working Group should meet to determine whether a centralized quarantine facility similar to the facility for rabies quarantine for dogs and cats should be established for imported birds.

2.5.1.2 Work with the Postal Service and the State Department of Agriculture to ban shipments of poultry and game birds to Hawai`i via first class mail. (Priority 1)
Importation of day-old poultry and game birds from flocks that are not tested or certified to be free of avian pathogens can be an important unregulated route for entry of new pathogens into the State. The Avian Disease Working Group should meet to propose legislation that will close loopholes in laws regulating movement of domestic and wild birds to Hawai`i. An outreach program is needed to educate the public about the potential dangers of unregulated shipments of live birds to public health, domestic poultry, pet birds, and wildlife.

2.5.1.3 Establish a monitoring program for new diseases and diagnose causes of avian disease outbreaks. Rapid response to new introductions of both diseases and disease vectors is essential for containing their spread. The Avian Disease Working Group should meet to discuss strategies for monitoring for disease outbreaks and to discuss creation of a rapid response plan for containing and eradicating new outbreaks that threaten endemic wildlife. This plan should identify responsible parties, lines of authority, and funding sources for actual control operations.

2.5.1.3.1 Develop a list of priority diseases to be screened in all imported cage birds and poultry. (Priority 1)

Some pathogens, such as West Nile virus (Bernard *et al*. 2000), pose an inherently greater risk to wildlife than others, particularly those with a broad host range and those that affect species with close phylogenetic relationships to Hawaiian avifauna. The Avian Disease Working Group should identify a list of "hot" pathogens that may pose a high risk for the endemic avifauna. Mandatory testing for these pathogens should be required for imported birds that may serve as potential carriers.

2.5.1.3.2 Respond to and determine causes of avian disease outbreaks in forest bird recovery areas and in other areas. (Priority 1)

Because of their close proximity to human habitation, areas outside forest bird recovery areas may be where a new pathogen or vector is detected. Long-term funding and expansion of diagnostic and research capabilities at the Honolulu Field Station of the U.S. Geological Survey - National Wildlife Health Center and veterinary expertise at the Hawai`i Division of Forestry and Wildlife should be supported. All State and Federal wildlife biologists and technical support personnel should receive training in how to collect wildlife carcasses and recognize potential wildlife disease outbreaks so that Federal and State wildlife disease experts can be notified immediately about potential outbreaks. Agencies responsible for this training should be identified by the Avian Disease Working Group. The Avian Disease Working Group should prepare detailed protocols, lines of responsibility and designate funding sources to eradicate new disease introductions into the state and to control the spread of existing pathogens into new areas.

2.5.1.4 Work to stop global climate change. (Priority 1) Global warming and local climate change are a serious threat to listed species in Hawai`i primarily because of the potential for movement of disease carrying mosquitoes into higher elevation avian refugia currently free of mosquito breeding sites. This work will require cooperation by appropriate agencies and entities to develop agreements and technologies needed to slow greenhouse gas emissions, a significant factor contributing to global climate change.

2.5.2 Prevent movement of diseases and disease vectors between islands.

Detailed knowledge about potential routes of introduction and spread of diseases and disease vectors between islands is essential for preventing spread of introduced pathogens and vectors. Research that identifies these routes and assesses their relative importance should be supported. Once obtained, this information should be used to assess the magnitude of the problem, institute new procedures for preventing transport of vectors on vessels and aircraft, and introduce new legislation to make inter-island movement of live birds subject to stricter regulation and enforcement.

2.5.2.1 Initiate inspection programs for all inter-island vessels, including ships, airplanes, and barges and their cargos to intercept and kill mosquito larvae and adults. (Priority 1)

Commercial shipping is the most likely route by which mosquitoes first reached the Hawaiian Islands. It is not known whether ocean traffic still plays a role in the spread of mosquitoes from island to island or whether aircraft are now the primary vehicles. Research should assess these risks, attempt to measure the magnitude of the problem, and identify measures that can be taken to decontaminate these vessels. High risk cargos, e.g., bromeliads for the commercial nursery industry, old tires, and containers that may hold water, should be targeted for inspection to insure that mosquito larvae are not transported between islands.

2.5.2.2 Enforce and toughen existing laws that require health certificates for inter-island movement of pet birds and poultry. (Priority 1)

Existing regulations require a health certificate for inter-island movement of domestic poultry and pet birds, but this does not require that birds undergo quarantine or be tested for specific pathogens. Research that assesses the magnitude of inter-island movement of live birds and the effectiveness of existing regulations in preventing spread of pathogens should be conducted in order to justify legislation that will toughen existing laws.

2.5.2.3 Establish disease monitoring protocols for captive native birds to assess presence of avian disease in captive held populations and risk of

transfer of disease strains between avian captive holding facilities. (Priority 2)
The inter-island transport and release of birds that are reared in captive propagation facilities can be a route for movement of disease organisms between isolated populations and facilities if these birds are not reared under mosquito netting or in isolation from wild and domestic birds. Adequate quarantine and isolation protocols must be maintained at all times and periodic disease screening should be conducted to assess efficacy of those protocols.

2.5.2.3.1 Develop a list of diseases of concern for which captive birds should be routinely tested before they can be transferred between avian captive holding facilities. (Priority 2)

2.5.3 Control the mosquito vector (*Culex quinquefasciatus*) of avian pox and malaria.
Source reduction by eliminating larval habitats for mosquito vectors is still the most effective way to manage mosquito populations, although emerging technologies that use cytoplasmic incompatibility to control adult populations or genetic manipulation of vectors to reduce their capacity to transmit infections may be feasible in the future.

2.5.3.1 Determine primary source areas of mosquitoes through surveys of potential larval habitats.
Culex quinquefasciatus is a mosquito that has become established in native and nonnative habitats in the Hawaiian Islands at elevations below 1,800 meters (5,900 feet), although a few records exist from sites as high as 2,100 meters (6,900 feet) (Goff and van Riper 1980). The

preferred larval habitat is standing water with a high organic content, although larvae of this mosquito can develop in clear, clean aquatic habitats if other sites are not available. Primary sources for *Culex* mosquitoes in Hawai`i are man-made bodies of water (cattle troughs, buckets, cans, and small ponds) in residential and agricultural areas that are contaminated with animal or human waste and feral animal-damaged tree ferns that catch and hold rain water in forest habitats. Other sites that contribute to mosquito productivity are temporary ground pools, pig wallows, tree holes, and stream margins, but their relative role in contributing to epidemic outbreaks or pox and malaria are not known (D. LaPointe and C. Atkinson, U.S. Geological Survey, unpubl. data). Effective control depends on identifying and either eliminating or treating these sites over areas large enough to exceed the flight range of adult mosquitoes. The ability of adult *Culex* to travel up to 3 kilometers (1.9 miles) through closed-canopy forest (D. LaPointe, U.S. Geological Survey, unpubl. data) and potentially much farther along natural and man-made corridors such as fence lines, roads, and lava flows makes it important to create a suitable buffer around recovery areas where management actions can be taken to reduce numbers of mosquitoes.

2.5.3.1.1 Survey recovery areas for mosquito breeding sites and adjacent lands for mosquito breeding sites that may serve as sources of wind-dispersed adult mosquitoes (see Table 12).

Table 12. Areas where mosquito surveys are needed. Island codes: H = Hawai`i; K = Kaua`i; MA = Maui; MO = Moloka`i; O = O`ahu. For key to landowner and partnership acronyms, refer to the Implementation Schedule (page 5-7).

Table 12. Areas where mosquito surveys are needed				
Recovery Action #	Island	Land Parcel, Tax Map Keys	Current Landowner/Comments	Priority
2.5.3.1.1.1	H	Portions of parcels between the 2,000 and 5,000 foot contour lines on Mauna Loa and Kīlauea Volcanoes that include recovery area	Results of surveys for larval mosquitoes conducted by U.S. Geological Survey-BRD in the Upper Waiākea Forest Reserve, Hawai`i Volcanoes National Park, and Kona Unit of Hakalau Forest National Wildlife Refuge indicate that primary larval habitats are feral pig damaged tree ferns, cattle troughs and stock ponds, and infrastructure associated with human dwellings. Extensive work already conducted in these areas lowers priority ranking.	3
2.5.3.1.1.2	H	Portions of parcels between the 3,400 and 5,000 foot contour lines on Mauna Kea Volcano that include recovery area	Preliminary surveys by U.S. Geological Survey-BRD conducted at Hakalau Forest National Wildlife Refuge found abundant larval habitat in feral pig damaged tree ferns, but few mosquitoes. Larvae were rarely found in stagnant pools along stream margins. Additional work is needed in these areas to document seasonal trends and distribution of mosquito vectors.	1
2.5.3.1.1.3	H	Portions of parcels 371001001,372002001, 374002008,374001003, 374002007, 374001002 between the 3,400 and 5,000 foot contour lines on Hualālai Volcano that include recovery area	Surveys for adult and larval mosquitoes have not been conducted in these areas and have high priority. Preliminary disease surveys by State of Hawai`i, Hawai`i Department of Land and Natural Resources have shown that pox and malaria are present, but nothing is known about the dynamics of their transmission.	1

Table 12. Areas where mosquito surveys are needed				
Recovery Action #	Island	Land Parcel, Tax Map Keys	Current Landowner/Comments	Priority
2.5.3.1.1.4	H	Portions of windward Hāmākua parcels between the 3,400 and 2,000 foot contour lines on Mauna Kea Volcano that are adjacent to or within 3 kilometers (1.9 miles) of recovery area	Surveys for adult and larval mosquitoes have not been conducted in these areas. Their windward location makes them possible sources for wind-dispersed mosquitoes that could threaten higher elevation habitats, but their distance from recovery area makes them lower priority.	2
2.5.3.1.1.5	H	Portions of parcels on Kīlauea Volcano that are adjacent to or within 3 kilometers (1.9 miles) of recovery area	Results of surveys for larval mosquitoes conducted by U.S. Geological Survey-BRD in Hawai`i Volcanoes National Park and Keauhou Ranch indicate that primary larval habitats are feral pig damaged tree ferns, cattle troughs and stock ponds, and infrastructure associated with human dwellings. Mosquito survey work on parcels on Kīlauea Volcano near recovery area should determine relative contributions of human-associated dwellings and infrastructure and forest habitat to mosquito populations. High priority areas include Volcano Village and surrounding subdivisions and agricultural lands.	2
2.5.3.1.1.6	H	Portions of parcels on Hualālai Volcano that are adjacent to or within 3 kilometers (1.9 miles) of recovery area	Surveys for adult and larval mosquitoes have not been conducted in these areas. Their close proximity to recovery area on Hualālai and role as potential sources of dispersing adult mosquitoes give them high priority for surveys.	2

Table 12. Areas where mosquito surveys are needed				
Recovery Action #	Island	Land Parcel, Tax Map Keys	Current Landowner/Comments	Priority
2.5.3.1.1.7	M	Multiple land parcels in recovery area between 2,500 and 5,000 foot contour lines	Limited surveys by U.S. Geological Survey-BRD from 4,000-6,000 feet on parcels 224016002 and 223005004 suggest that tree ferns damaged by feral pigs may be a primary larval habitat for mosquitoes and a major contribution to mosquito populations. The importance of temporary and permanent pools in stream drainages is less clear. Additional surveys throughout recovery area in this elevation zone are needed to prioritize mosquito control efforts.	1
2.5.3.1.1.8	M	Multiple land parcels on the northern slope of Haleakalā between the 2,500 foot contour line and Hāna Highway	Mosquito surveys in these parcels have not been conducted and their relative contribution to mosquito populations on East Maui is not known. These parcels could be a significant source of wind-dispersed mosquitoes that could threaten higher elevation habitats, but are classified as lower priority because of their distance from recovery area.	2
2.5.3.1.1.9	M	217004006	Manawainui Valley incursion into recovery area, from 2,500 to 1,600 feet. Deep valleys may serve as natural corridors for dispersal of wind-blown mosquitoes. Because of their potential role as natural funnels, priority ranking for mosquito surveys is higher.	1
2.5.3.1.1.10	M	215001001	Waiho`i Valley incursion into recovery area, from 2,500 to 2,000 feet.	1
2.5.3.1.1.11	M	216001002	Kīpahulu Valley incursion into recovery area, from 2,500 to 1,600 feet.	1
2.5.3.1.1.12	M	211002002	Ke`anae Valley incursion into recovery area, from 1,800 to 2,500 feet.	1

Table 12. Areas where mosquito surveys are needed				
Recovery Action #	Island	Land Parcel, Tax Map Keys	Current Landowner/Comments	Priority
2.5.3.1.1.13	M	Multiple parcels below and within 3 kilometers (1.9 miles) of the 4,000 foot contour line on the southern and western slopes of Haleakalā	Surveys for adult and larval mosquitoes have not been conducted in these areas, but high density of rural development, particularly on the western slopes of Haleakalā, could be a significant source of mosquitoes. Priority for this area is low until suitable recovery area has been restored.	3
2.5.3.1.1.14	M	Multiple land parcels in recovery area between 2,500 and 5,000 foot contour lines	Surveys for adult and larval mosquitoes have not been conducted in these areas. Detailed knowledge about the dynamics of disease transmission in the West Maui mountains is needed.	1
2.5.3.1.1.15	M	233003003, 235003001, 233003004, and multiple smaller parcels within `Īao Valley	`Īao Valley incursion into recovery area, from 2,500 to 600 feet. Low elevation parcels located in deep valleys in the West Maui mountains could be a significant source of wind-dispersed mosquitoes that could threaten higher elevation habitats.	2
2.5.3.1.1.16	M	232014001, 233003003	Waiehu Valley incursion into recovery area, from 2,500 to 600 feet.	2
2.5.3.1.1.17	M	232014001	Waihe`e Valley incursion into recovery area, from 2,500 to 600 feet.	2
2.5.3.1.1.18	M	231006001	Kahahuloa Valley incursion into recovery area, from 2,500 to 600 feet.	2
2.5.3.1.1.19	M	241001017	Honokōhau Valley incursion into recovery area, from 2,500 to 600 feet.	2
2.5.3.1.1.20	M	236003001, 235003001	Waikapū Valley incursion into recovery area, from 2,500 to 600 feet.	2
2.5.3.1.1.21	M	241001017	Honolua Valley incursion into recovery area, from 2,500 to 600 feet.	2
2.5.3.1.1.22	M	242001001	Honokahua Valley incursion into recovery area, from 2,500 to 600 feet.	2
2.5.3.1.1.23	M	242001001	Kahana Valley incursion into recovery area, from 2,500 to 600 feet.	2

Table 12. Areas where mosquito surveys are needed				
Recovery Action #	Island	Land Parcel, Tax Map Keys	Current Landowner/Comments	Priority
2.5.3.1.1.24	M	244007004, 244007011, 244007001, 244007005	Honokōwai Valley incursion into recovery area, from 2,500 to 600 feet.	2
2.5.3.1.1.25	M	245022001	Kahoma Valley incursion into recovery area, from 2,500 to 600 feet.	2
2.5.3.1.1.26	M	246025002	Kanahā Valley incursion into recovery area, from 2,500 to 600 feet.	2
2.5.3.1.1.27	M	246025001, 247001002	Mākila Valley incursion into recovery area, from 2,500 to 600 feet.	2
2.5.3.1.1.28	M	248001002	Olowalu Valley incursion into recovery area, from 2,500 to 600 feet.	2
2.5.3.1.1.29	M	248001002	Ukumehame Valley incursion into recovery area, from 2,500 to 600 feet.	2
2.5.3.1.1.30	M	236003001	Pōhākea Valley incursion into recovery area, from 2,500 to 600 feet.	2
2.5.3.1.1.31	M	245022003	Waihikuli Valley incursion into recovery area, from 2,500 to 600 feet.	2
2.5.3.1.1.32	M	245022004	Hanakea Valley incursion into recovery area, from 2,500 to 600 feet.	2
2.5.3.1.1.33	M	Multiple parcels below and up to 3 kilometers (1.9 miles) from the 2,500 contour line around the West Maui mountains	Surveys for adult and larval mosquitoes have not been conducted in these areas, but they could be important sources for wind-dispersed mosquitoes, particularly rural and urban areas in and near Kahului and Lahaina. Priority for surveying these areas is lower because of their distance from recovery area.	3
2.5.3.1.1.34	MO	Multiple land parcels in recovery area	Surveys for adult and larval mosquitoes have not been conducted in these areas and virtually nothing is known about disease threats to forest birds. Vector surveys and disease studies should be done prior to attempts to reintroduce endangered birds.	1

Table 12. Areas where mosquito surveys are needed

Recovery Action #	Island	Land Parcel, Tax Map Keys	Current Landowner/Comments	Priority
2.5.3.1.1.35	MO	261001002, 259006011, 259006002 and smaller windward parcels in Waihānau, Wai`ale`ia, Waikolu, Pelekunu, and Wailau Valleys that are adjacent to or within 3 kilometers (1.9 miles) of recovery area	Surveys for adult and larval mosquitoes have not been conducted in these areas. Their windward location increases the possibility they funnel mosquitoes into higher elevation habitats.	2
2.5.3.1.1.36	MO	Parcels in Kaunakakai Gulch	Kaunakakai Gulch may act as a natural corridor for dispersal of mosquitoes from urban/suburban Moloka`i directly into recovery area.	2
2.5.3.1.1.37	MO	Portions of parcels 252014003, 253003005, 254003025, 254003001, 255001006 and others that are adjacent to or within 3 kilometers (1.9 miles) of the southern and eastern boundaries of recovery area on leeward Moloka`i	Surveys for adult and larval mosquitoes have not been conducted in these areas. Since the region is deeply dissected by numerous stream valleys that could funnel mosquitoes into recovery area, vector surveys should ideally extend from the lower boundary of recovery area to the coastline, particularly in locations with rural agricultural development.	2
2.5.3.1.1.38	O	Portions of parcels that include recovery area	Surveys for adult and larval mosquitoes have not been done and nothing is known about the dynamics of disease transmission in these areas.	1
2.5.3.1.1.39	O	Portions of parcels that are adjacent to or within 3 kilometers (1.9 miles) of recovery area	Detailed surveys for adult and larval mosquitoes have not been done in these areas. It is likely that urban and suburban development and agriculture are primary contributors to mosquito populations that may disperse into recovery area, but this needs to be documented.	2

Table 12. Areas where mosquito surveys are needed				
Recovery Action #	Island	Land Parcel, Tax Map Keys	Current Landowner/Comments	Priority
2.5.3.1.1.40	K	Portions of parcels 414001020, 414001014, 414001013, 459001016, 459001001, 414001003, 417001001, 458001001 and others that include recovery area	Preliminary surveys of parcels 414001013 and 414001003 by U.S. Geological Survey-BRD have failed to find larval mosquitoes in extensive bogs on the lower Alaka`i Plateau. Mosquito larvae were rarely found in stagnant areas of stream margins. Additional detailed surveys needed to determine whether stream margins are the primary sources for adult mosquitoes in remote areas of the plateau. Detailed vector surveys are needed in developed areas of Kōke`e to determine relative role that human housing and infrastructure plays on generation of mosquitoes.	1
2.5.3.1.1.41	K	Portions of parcels 459001001, 458001001, 458002002, 459001003, 459001002 that are adjacent to or within 3 kilometers (1.9 miles) of recovery area	Surveys for adult and larval mosquitoes have not been conducted in windward valleys of the Alaka`i Plateau and it is not clear whether wind dispersal through these natural corridors could be a source of mosquito vectors at higher elevations.	2
2.5.3.1.1.42	K	Portions of parcels 414001014, 414001020, 414002040, 414001003, 417001001 that are adjacent to or within 3 kilometers (1.9 miles) of recovery area	Surveys for adult and larval mosquitoes have not been conducted in leeward valleys and slopes of the Alaka`i Plateau; it is not clear whether wind dispersal up steep canyons that abut the southern plateau rim could be a source of mosquito vectors at higher elevations. Surveys should extend into stream drainages in Waimea Canyon to determine extent of mosquito habitat at lower elevations and its potential threat to higher elevation forests.	2

2.5.3.1.2 Eliminate or treat larval habitats in recovery areas and adjacent areas with BTI (*Bacillus thuringensis israeliensis* toxin), Dunk®, or other environmentally compatible pesticides that are safe for non-target organisms. (Priority 1) Known mosquito sources within recovery areas or within 3 kilometers (1.9 miles) of the lower, windward boundaries of recovery areas have the highest priority for control. Adjacent leeward parcels and stream valleys are lower in priority because of lower rainfall and location in the wind shadow of major topographic features. Windward areas more than 3 kilometers (1.9 miles) from the lower boundaries of recovery areas have the lowest priority. BTI currently is the most specific, environmentally compatible pesticide available for use against *Culex* mosquitoes. It has not been evaluated on all related Nematoceran diptera (other members of the order Diptera, suborder Nematocera, to which mosquitoes belong) and the potential non-target effects of this pesticide should be evaluated against endemic diptera prior to broad scale use over large areas. Use is recommended in situations where application is limited to stock ponds and other man-made bodies of water where non-target effects are not at issue. In remote areas where primary larval habitats are associated with feral pig damaged tree ferns, fencing and elimination of feral ungulates, coupled with manual drainage of all damaged ferns, can eliminate larval habitats and reduce mosquito populations if coverage is adequate and treatment areas are large enough to buffer emigration of adult mosquitoes from adjacent non-recovery area.

2.5.3.1.3 Eliminate or treat larval habitats associated with human development (e.g., residential areas, agricultural sites, game bird waterers) that are located within or adjacent to recovery areas; coordinate efforts with the State Department of Health. (Priority 1)

In locations where human development is close to recovery area (e.g., subdivisions and ranches adjacent to Hawai`i Volcanoes National Park, Kōke`e State Park, and the Alaka`i Wilderness Preserve), larval habitats associated with residential and agricultural development may be primary sources for mosquitoes responsible for seasonal epizootics of pox and malaria. Outreach efforts should be made to inform the public about eliminating refuse, cleaning gutters, covering catchment tanks, and treating stock ponds and cattle troughs and increasing public awareness about threats to human (e.g., Japanese B encephalitis, West Nile Fever), animal (dog heartworm), and wildlife (avian malaria and pox) health from mosquitoes. These efforts should be coordinated with the State Department of Health.

2.5.3.1.3.1 Eliminate or treat cattle troughs and stock ponds. (Priority 1)

2.5.3.1.3.2 Eliminate or treat game bird waterers in areas where they might impact native forest birds. (Priority 1)

2.5.3.1.3.3 Repair rain gutters, cover catchment tanks, and eliminate containers that catch and hold rainwater in agricultural and residential locations near recovery areas. (Priority 1)

2.5.3.1.3.4 Initiate public outreach efforts to inform the public about potential human and animal diseases transmitted by mosquitoes and how source reduction can reduce those threats. (Priority 1)

2.5.3.1.4 Eliminate larval habitats associated with feral animals in recovery area and adjacent lands. (Priority 1) Primary sources of mosquitoes in these areas are fallen tree ferns (*Cibotium* spp.) that have been hollowed enough by feral pigs and rodents to catch and hold rain water. Reduction of numbers of feral pigs through fencing and hunting followed by manual drainage of these bodies of water can significantly reduce available larval habitat, but more than 75 percent of these tree ferns must be eliminated and the treatment area must exceed the minimal dispersal range of adult *Culex* mosquitoes to be effective (C. Atkinson and D. LaPointe, U.S. Geological Survey, unpubl. data). Rodents may contribute to less than 10 percent of these sites (D. LaPointe, U.S. Geological Survey, unpubl. data), but additional research is needed.

2.5.3.1.4.1 Identify and fence priority recovery areas below 1,520 meters (5,000 feet) and control feral ungulates to prevent creation of new larval habitats. (Priority 1)

2.5.3.1.4.2 Manually drain feral pig-damaged tree ferns that hold water and fill or drain pig wallows in

appropriate areas to reduce mosquito breeding sites. (Priority 2)

2.5.3.1.5 Identify natural sites (e.g., stream margins, tree holes) that serve as larval habitat and determine feasibility of treatment or elimination. (Priority 2)
Streams, stream margins, tree holes, bogs, and natural ponds are potential larval habitat for *Culex* mosquitoes. The importance of these larval habitats should be documented through additional research.

2.5.4 Foster ability of native birds to tolerate or develop resistance to avian pox and malaria. In the absence of continual introductions of new strains or genetic variants of avian pox and malaria to Hawai`i, the disease system (vector, parasite, and avian hosts) will begin to evolve new relationships through processes of natural selection. Current evolutionary theory predicts that the virulence of the disease agents will decrease and the resistance of highly susceptible forest birds to these introduced diseases will increase (van Riper *et al*. 1986, Atkinson *et al*. 1995, Cann and Douglas 1999, Jarvi *et al*. 2001, Shehata *et al*. 2001). Direct evidence for this process is still limited and based primarily on observations of breeding populations of more common native species (e.g., O`ahu `amakihi, O`ahu `elepaio, `apapane) at elevations where transmission of pox and malaria is believed to be stable and endemic.

2.5.4.1 Ensure that existing low elevation native bird populations and habitats within current zones of disease transmission are protected to preserve disease tolerant genotypes. (Priority 1)

2.5.4.2 Use birds that occur in areas with disease transmission as founders for translocations to establish new populations. (Priority 2)

2.5.5 Monitor long-term changes in the prevalence and transmission of avian diseases in forest bird recovery areas. (Priority 2)

Monitoring that documents the long-term patterns of change in the epidemiology and pathogenicity of introduced avian diseases will be important for measuring the effectiveness of management actions and for determining how complex interactions between abiotic and biotic environmental factors, anthropogenic factors, native and nonnative hosts, vectors and diseases are evolving.

2.6 Reduce or eliminate effects of alien species.

Introductions of nonnative species to the Hawaiian Islands have caused changes to native ecosystems and harm to native forest birds through habitat modification, disease, and competition. Efforts to reduce the numbers of new introductions of detrimental species and to control nonnative species that are already introduced are necessary to conserve and recover Hawaiian forest birds.

2.6.1 Prevent introductions of new detrimental species.

Prevention of the introduction of new detrimental species to the Hawaiian Islands is the most efficient way to protect native ecosystems. Once an invasive species has become established, technologies may not exist for its removal or control, and control programs can be very expensive. The most efficient way to prevent further damage to native ecosystems due to effects of new detrimental species is to prevent their introduction.

2.6.1.1 Encourage Hawai`i Department of Agriculture to modify import lists to exclude reptiles and amphibians from commercial sale. (Priority 2) Reptiles and amphibians that escape into the wild may impact listed forest birds by preying on insects or other foods upon which these species feed, predating eggs, nestlings and adults, and as food for forest bird predators, increasing predator populations.

2.6.1.2 Encourage the Hawai`i Department of Agriculture to modify import lists to decrease the numbers of vertebrate species allowed into the State. (Priority 2)

2.6.1.3 Assist the Hawai`i Department of Agriculture with obtaining an enforcement branch to pursue smuggling and release violations. (Priority 2)

2.6.1.4 Encourage the adoption of State injurious species lists as part of Federal injurious wildlife listed under the Lacey Act. (Priority 2)

2.6.1.5 Encourage the Hawai`i Department of Agriculture, Hawai`i Department of Land and Natural Resources, U.S. Fish and Wildlife Service, and County police departments to develop a task force to pursue smuggling and release violations.
(Priority 2)

2.6.1.6 **Provide single point-of-exit at airports** to help facilitate inspection of cargo and interdiction of alien species. (Priority 2)

2.6.1.7 **Increase the numbers of Hawai`i Department of Agriculture and U.S. Department of Agriculture inspectors** to better cover nursery cargo and passenger baggage/hand-carry. (Priority 2)

2.6.1.8 **Secure Congressional approval of U.S. Department of Agriculture quarantine of goods imported from the U.S. mainland.** (Priority 2)

2.6.1.9 **Prevent inter-island expansion of established vertebrates with currently restricted ranges**. (Priority 1)

2.6.2 **Eradicate all incipient populations of new nonnative vertebrate species.** (Priority 1)

2.6.2.1 **Prevent spread of *Eleutherodactylus* frogs to new areas.** (Priority 1) The coqui frog, *Eleutherodactylus coqui*, was accidentally introduced into Hawai`i from Puerto Rico in about 1988. It is established on Hawai`i and Maui, and there are incipient populations in other areas. Coqui frogs can reach extremely high densities, up to 10,000 animals per hectare, and are known to consume large numbers of insects. Insectivorous birds in particular may be threatened by competition for food with the coqui, and all forest birds, regardless of their usual diet, may be affected during the breeding season when they rely on insects to feed their young.

2.6.2.2 Eradicate/control populations of *Eleutherodactylus* where possible. (Priority 1)

2.6.3 Reduce or eliminate the detrimental effects of *vespulid* wasps (yellow jackets) on forest birds within forest ecosystems. (Priority 2)

Vespulid wasps are known to consume large biomass of insect foods. Insectivorous birds in particular are likely to be affected by the consequent reduction in available prey, and all forest birds may be affected during the breeding season, when they rely more on insects to feed their young.

3. Develop Captive Propagation and Related Recovery Strategies. Establish or augment populations of endangered species in suitable, managed habitat using captive propagation and reintroduction techniques. (Priority 1)

Captive propagation programs are developed in accordance with the guidelines established by the U.S. Fish and Wildlife Service's Policy on Controlled Propagation (U.S. Fish and Wildlife Service 2000c) the International Union for the Conservation of Nature, World Conservation Union's Conservation Breeding Specialist Group's policy on captive propagation (International Union for the Conservation of Nature 1987, 2000), the World Conservation Union's Reintroduction Specialist Group's Guidelines for Reintroduction (International Union for the Conservation of Nature 1998), the American Association of Zoological Parks and Aquariums Reintroduction Advisory Group's guidelines (Beck 1992), Conservation Breeding Specialist Group's Conservation Assessment Management Plan recommendations (Ellis *et al*. 1992), and Small Population Management Advisory Group Guidelines (AZA, Small Population Management Group 2000).

3.1 Periodically evaluate and identify the target species that will require captive propagation for recovery and the appropriate strategy to be used. (Priority 1)

Evaluation of the importance of captive propagation in recovery of each species requires consideration of criteria such as taxonomic uniqueness, urgency (degree of threat), and cause of decline in the wild. Also of consideration are the available knowledge of species' natural history, status of current research, habitat management efforts in the field, and the potential for collaboration, practical considerations (funding and expertise/labor), population size, probability that the species will breed in captivity in sufficient numbers to reestablish a wild population, release history, availability of suitable release sites, political environment (existence of habitat conservation plans, safe harbor agreements, etc.), the species' value as a basic component of the ecosystem (e.g., significance as a seed disperser or pollinator), cultural value, educational value, and value as a model for the recovery of other endangered species. The relative cost versus benefit for maintaining a self-sustaining or genetically viable reproducing flock of birds in captivity versus the cost for maintaining a field team to locate nests, collect eggs, incubate, rear, and release need to be weighed. The most effective recovery programs are those that can accomplish their goals for the least amount of investment. The appropriate captive propagation strategy should be selected based on the recovery imperative, the status of the wild population, the accessibility of eggs and the difficulty in locating nests, and the relative effectiveness of alternative recovery strategies. Table 13 provides an overview of recovery strategies and priorities for the use of captive propagation facilities for Hawaiian forest bird species. Refer to Appendix B for a more detailed discussion of prioritization considerations.

3.2 Develop captive propagation programs for target species, including both endangered and surrogate species. (Priority 1) Such programs will require review of known avicultural and release technology in order to address an array of ecologically diverse species, from obligate nectarivores to generalists and insectivores. All aspects of captive management must be considered, including the demographics of small populations, adult diets, incubation, neonatal hand-feeding regimes, enclosure requirements (dimensions, enrichment, and construction materials), veterinary requirements, mate selection, and proper socialization of captive-reared birds. Aviculture and release technology is

Table 13. Captive propagation program strategies and priorities for facilities use. Captive propagation strategies are as follows: 1) No Captive Program Necessary (other recovery strategies more appropriate), 2) Translocation, 3) Rear and Release, 4) Captive-breeding/Immediate Release, 5) Captive-breeding/Self-sustaining Population, 6) Captive-breeding/Production for Restoration, 7) Emergency Search and Rescue, and 8) Technology Development (see Appendix B for more detailed definitions of these strategies). Captive breeding priorities are defined as follows: 1) Species in critical need of recovery efforts involving captive propagation techniques; 2) Species in great need of recovery efforts involving captive propagation techniques, but with somewhat larger population numbers; 3) Species in need of recovery efforts, but for which techniques involving captive propagation are less effective than translocation, habitat management, or habitat restoration; and 4) Non-endangered surrogate species for which captive breeding techniques could be developed to aid the recovery of endangered species. Further details are provided in Appendix B.

Table 13. Captive propagation program strategies and priorities for facilities use.

Species	Captive Propagation Strategies	Captive Breeding Priority
\`alalā	5, 6	1
kāma\`o, oloma\`o, Kaua\`i oo, Bishop's \`o\`o, \`o\`u, \`akialoa, Kaua\`i nukupu\`u, Maui nukupu\`u, O\`ahu \`alauahio, kākāwahie, Maui \`ākepa, po\`ouli	5, 6, 7	1
palila	8, 4	2
nēnē	4	2
Maui parrotbill	8, 4	2
puaiohi	4	2
Kaua\`i creeper	8, 4	3
\`akiapōlā\`au	8, 4	3
O\`ahu \`elepaio	1, 2, 3	3
Hawai\`i \`ākepa	8, 4	3
Hawai\`i creeper	8, 4	3
\`ākohekohe	8, 2, 3	3
Hawai\`i \`elepaio	8	4
\`i\`iwi	8	4
\`ōma\`o	8	4

recognized to be a process of continuous development, refinement, and enhancement. The development of this technology comes only with the experience gained from working with each Hawaiian species and incorporating that experience across the entire spectrum of Hawaiian forest birds. Between 1994 and 2000, the technology to incubate, rear, and maintain 12 species of Hawaiian forest birds was developed, including the endangered Hawai`i creeper, Hawai`i `ākepa, palila, `alalā, Maui parrotbill, and puaiohi. In the future, similar programs may be initiated for `ō`ū, `akiapōlā`au, Maui nukupu`u, Maui `ākepa, oloma`o, po`ouli, O`ahu creeper, kāma`o, Kaua`i nukupu`u, Kaua`i `akialoa, and Kaua`i `ō`ō if nests can be located and eggs collected. Captive management of the Hawai`i `elepaio as a surrogate species will provide propagation and release techniques required for future work with the endangered O`ahu `elepaio. The development of translocation methods for the `ākohekohe should continue, and captive breeding technology should be developed if translocation efforts fail. The appropriate captive propagation strategy for each species should be evaluated and implemented through the development of annual Work Plans and Five-Year Work Plans established between the operators of the captive propagation facilities, Division of Forestry and Wildlife, and the Service, and will include input from the public and Recovery Team(s) and Working Groups. The plans should incorporate the most current information on dynamics of the wild population, available funding, research developments, disease information, available release sites, the relative benefit of captive release strategies compared to other recovery strategies, and the progress made in the captive maintenance and propagation of these species.

3.2.1 `Ō`ū, Maui nukupu`u, Maui `ākepa, oloma`o, O`ahu creeper, kāma`o, Kaua`i nukupu`u, Kaua`i `akialoa, and Kaua`i `ō`ō. (Priority 1)

For these species, which are considered nearly or possibly extinct, efforts should be made to search for adults, and to collect eggs for incubation and captive rearing to establish captive breeding flocks whose progeny will be used for reintroduction into managed habitats in the future. Should no breeding pairs exist in the wild, efforts should be made to create pairs by translocation, bringing birds into captivity, or other appropriate means.

3.2.2 Po`ouli. (Priority 1)

There has been no known reproduction of the po`ouli in the wild since 1995, and a translocation attempt in 2002 failed to produce a wild pairing (see species account). Efforts are currently underway to bring the two po`ouli that may remain in the wild into captivity for propagation. Habitat management to prepare for reintroduction to the wild also must continue.

3.2.3 Puaiohi. (Priority 2)

Maintain a captive breeding flock to produce offspring for reintroductions into managed habitat. Current efforts to maintain a captive flock for reintroduction of progeny have been very successful, with high survival of released birds and subsequent breeding in the wild.

3.2.4 `Akiapōlā`au. (Priority 2)

Collect eggs for incubation and captive rearing to establish a captive breeding flock whose progeny will be used for reintroduction into managed habitat. Because `akiapōlā`au nests are difficult to locate and access, a strategy to maintain a captive breeding flock for release of progeny is recommended.

3.2.5 Maui Parrotbill.

Because Maui parrotbill nests are difficult to locate and access, a strategy to maintain a captive breeding flock for release of progeny is recommended.

3.2.5.1 Collect eggs of Maui parrotbills and maintain a captive breeding flock whose progeny will be used for reintroduction into managed habitat in the future. (Priority 2)

3.2.5.2 **Develop methods for releasing captive birds into managed habitat** on Haleakalā, or on West Maui or Moloka`i if disease is known to no longer be a threat in these areas. (Priority 2)

3.2.6 `Ākohekohe.

3.2.6.1 **Translocate wild birds to West Maui or Moloka`i to establish a second population**, if disease is known to no longer be a threat in these areas. (Priority 2)

3.2.6.2 **Collect eggs for incubation and captive rearing**. (Priority 2) If translocations fail, use "rear and release" of progeny from wild-collected eggs, or establish a captive breeding flock whose progeny will be used for reintroduction into managed habitat in the future.

3.2.7 Palila.

3.2.7.1 **Collect eggs for incubation and captive rearing.** (Priority 2)

3.2.7.2 **If the genetic diversity of palila in the captive flock drops below acceptable levels (defined as less than 90 percent), collect wild eggs.** (Priority 2)

3.2.7.3 **Maintain a captive breeding flock whose progeny will be used for reintroduction into managed habitat.** (Priority 2) Initial attempts at translocation of wild palila have not been successful. Releases of captive reared birds may be a more effective strategy to establish a new and disjunct population of palila on Mauna Loa or Mauna Kea.

3.2.8 Hawai`i `Ākepa and Hawai`i Creeper.
Because nests of these species are difficult to locate and access, a strategy to maintain a captive breeding flock for release of progeny is recommended.

3.2.8.1 Collect eggs for incubation and captive rearing. (Priority 3)

3.2.8.2 Maintain captive flocks of Hawai`i `ākepa and Hawai`i creeper whose progeny will be used for reintroduction into native, managed habitat in the future, or rear and release in managed habitat. (Priority 3)

3.2.9 O`ahu `Elepaio. (Priority 3)
Collect the eggs of Hawai`i `elepaio to serve as a surrogate to develop techniques to breed, incubate, rear, and release the endangered O`ahu subspecies. At this time recovery strategies other than captive propagation and release, such as predator control, are likely to be most effective for recovering the O`ahu `elepaio. If these strategies are not successful, rear and release methods may be needed.

3.3 Develop methods of evaluating, selecting, and preparing sites for releases and/or translocation of endangered birds to ensure long-term persistence of reintroduced populations, including potentially suitable habitat outside the species' known historic range. The goal is to select and restore habitat that fulfills the year-round requirements for the species to ensure that birds remain in the managed habitat (e.g., sufficient seasonal food resources, nesting and roosting sites). Site selection and subsequent management should include the evaluation of the species' natural history requirements, vegetative analysis, physical qualities (area), elevation, elevational gradient, topography, soil characteristics, prevailing weather patterns, corridor potential, proximity to other congeneric populations, biological limiting factors (e.g., diseases, mosquitoes, predators, food availability, feral ungulates, alien competitors), anthropogenic threats, historical habitat modification and cultural practices of pre-contact Hawaiians, and current level of management and landowner cooperation and integration (habitat conservation plans, safe harbor agreements, etc.). Methods also should consider prevalence of threats identified, and the species' likely response to novel habitat and threats. If areas available for releases may not provide all requirements during some periods of the year but logistical or other concerns necessitate release in these areas, then technologies must be available to support released birds during periods when essential niche characteristics are temporarily absent. Species and areas currently in need of habitat evaluation and selection for releases of endangered birds include:

3.3.1 Leeward Haleakalā, West Maui, and Moloka`i for Maui forest birds. (Priority 2)

3.3.2 Upland dry forest areas on Mauna Kea and Mauna Loa for palila. (Priority 2)

3.3.3 Additional sites for ongoing releases of puaiohi. (Priority 2)

3.3.4 South Kona, Kapāpala/Ka`ū, and upland forests of Mauna Kea for `akiapōlā`au. (Priority 2).

3.4 Acquire funding to build additional facilities to maintain, propagate, incubate, and rear endangered species and, if necessary, surrogate species. (Priority 1)

The U.S. Fish and Wildlife Service and the State of Hawai`i will attempt to provide funding to operate the existing captive breeding facilities and to construct additional facilities, supplemented by private sector funding. Funding needs and availability will be considered in Annual Workplans and Five-Year Work Plans that prioritize the captive propagation activities for the year as well as for the long-term.

3.5 Identify wild populations and/or individuals with potential natural disease resistance on a species-by-species basis.
(Priority 1)
It is possible that populations or individual birds exist that have some natural resistance to introduced pathogens. If so, these birds could serve as the founder stock for reestablishing populations within a species' historical range. Whenever possible, those populations or individuals with demonstrated resistance through multiple generations should be exploited as a recovery resource, either through translocation or through captive propagation. Currently there is anecdotal evidence of disease resistance or tolerance in some individuals within populations of the O`ahu `elepaio (VanderWerf 2006) and the non-endangered O`ahu `amakihi (*Hemignathus flavus*) (Shehata *et al*. 2001) and Hawai`i `amakihi (*Hemignathus virens virens*) (Jarvi *et al*. 2001), but this needs to be more fully examined and confirmed. Similar resistance or tolerance should be sought in other endangered species. However, if captive-breeding of founders from potentially disease-resistant populations is undertaken in the future, management of captive flocks also should continue to focus on the preservation of genetic diversity in order to avoid any potentially adverse effects associated with artificial selection in a captive environment (American Zoological and Aquarium Association, Small Population Management Group 2000).

3.6 Develop and refine techniques for the release of captive-reared birds into managed habitat.
Options include both hard- and soft-release, with the difference being the amount of support the released birds receive during their transition to independence. Initially, releases should be conservative and provide as much support as logistically possible (soft release); for example, providing supplemental food, protection from weather if necessary, and veterinary attention if required. When more is known regarding a species' tolerance to the rigors of release, harder releases can be considered.

3.6.1 Monitor dispersal, survival, and mortality of released birds to refine propagation and release techniques. (Priority 1)

The value of this aspect is often overlooked or underestimated as a component of captive propagation for recovery. It is important to monitor released birds to determine their long-term survivorship, potential to utilize managed habitat, and capacity reproduce and expand their population.

3.6.2 Develop and refine release (hacking) procedures. (Priority 2)

Various release methods should be considered for each species, subject to constraints of the release site. To be considered are microhabitat, size, dimension, and exact location of the hacking aviary; location and positioning of supplemental food stations; locations of field observations; and logistical considerations for the construction and dismantling of each release aviary. Continue to develop and refine species specific (or program specific) reintroduction guidelines based on risk assessments that consider the behavioral, disease, demographic, and genetic needs of the species, with the ultimate goal being the reestablishment and recovery of wild populations.

3.7 For each of the species identified as candidates for captive propagation, establish demographic goals for the captive propagation program, e.g., how many birds to produce using which demographic strategy over what period of time and released into how many sites. (Priority 2)

The augmentation of wild populations using captive propagation requires the development of cost-effective management programs that are designed to maintain population genetic diversity and demographic security considering the resources available.

3.8 Develop species specific reintroduction guidelines based on risk assessments that consider the behavioral, disease, demographic, and genetic needs of the species, with the ultimate goal being the re-establishment of wild populations. (Priority 2)

3.9 Provide biological samples from captive held birds to an approved holding location or locations determined on a species-by-species basis for use in genetic and veterinary examination. (Priority 2)

Biological samples, such as blood, taken from captive birds can be used for a variety of purposes, including testing genetic relatedness of founder populations or their progeny, development of genetic libraries, and veterinary health studies. These studies may be crucial to understanding the threats endangered Hawaiian forest birds face in their native habitat and developing effective recovery and captive management strategies.

3.10 If egg collections fail, develop methods of bringing nestling birds, juveniles, and/or adults into captivity with concomitant quarantine procedures. (Priority 2)

3.11 Establish a cryogenic cell culture of germplasm of the endangered Hawaiian avifauna at two partner institutions willing to hold the cell line in perpetuity. Although the advancement of several technologies (e.g., cloning and embryo transfers) may still be several years in the future, it will be increasingly important to anticipate the future potential of such options and to preserve the cell lines while there is still the chance to do so. Collaborating institutions with laboratory resources, institutional stability, and long-term interest need to be identified. The goals of such efforts should be established in advance.

3.11.1 Obtain and hold cryogenic germplasm of the rarest species in the event of death, or if a population is below 300 individuals. (Priority 1)

3.11.2 Obtain and hold cryogenic germplasm for all other endangered forest birds. (Priority 2)

3.12 Evaluate the outplacement of endangered species currently at the Keauhou Bird Conservation Center and Maui Conservation Center to the Honolulu Zoo or other qualified institutions.

3.12.1 Evaluate the Honolulu Zoo or other qualified institutions as repositories for those endangered species and/or individuals that are not contributing to the captive propagation program. (Priority 2)
These would include non-reproductive, non-releasable individuals, individuals of species that are in the captive program but for which it is not a high priority to continue to enlarge the captive inventory through breeding, and species which do not have a release component at the present time. Benefits would include public education as well as freeing up aviary space for higher priority species.

4. Conduct Research as Needed.
The complexity of threats to endangered forest birds and the large number of actions proposed to deal with these threats require that research and management go hand-in-hand. The relative importance of different threats may vary in space and time among species of birds, so it is important to identify the threats to particular populations through research. Adaptive threat management requires the development of methods to control identified threats and evaluation of the effectiveness of those control methods. In addition, populations may be subject to intrinsic natural properties, such as vulnerability to demographic and environmental stochasticity, low reproductive rates and dispersal, source/sink relations, and social habitat selection. Thus we need to determine the role of food, nest-sites, forest structure, diseases, predators, and competitors as the basis for different densities of birds. Opportunities for applied research are available using both experimental approaches as well as observational studies that take advantage of correlational patterns in the distribution of the bird species and their threats. The knowledge gained from research is the basis for identifying threats,

prioritizing management actions for ecosystems as well as individual species, determining the effectiveness of implemented actions, and developing new or improving existing management approaches.

4.1 Identify the threats that cause geographical variation in density and that maintain populations at or below carrying capacity within particular locations.

4.1.1 Identify species-specific niche requirements and the role of habitat degradation and competition in reducing carrying capacity. (Priority 2)

The availability of resources such as prey types, foraging substrates, nest-sites, and roost sites can dictate the carrying capacity of the environment. Knowledge of species niche requirements and the availability of required resources, in relation to the expected and actual number of individuals, is an effective method of identifying the magnitude of a threat. Habitat degradation and competition are threats that can reduce carrying capacity, and therefore population density and size.

4.2 Study the magnitude of threats and, if appropriate, develop and evaluate effective methods for control.

The numerous species that threaten forest birds have their own life histories, including feeding habits, breeding biology, and dispersal characteristics. Effective control of plants and animals that threaten forest birds can be greatly enhanced by knowledge of their biology. Experimental approaches to control will be needed to assess the effectiveness of the methods developed in reducing populations of these species.

4.2.1 Develop improved methods for controlling alien mammalian predators over large areas.

4.2.1.1 Continue efforts to register hand and aerial broadcast methods for dispersing diphacinone toxicants for controlling predators. (Priority 1) Experimental studies on Hawai`i and O`ahu have demonstrated that diphacinone can be effective in reducing numbers of introduced rodents (VanderWerf and Smith 2002) and mongooses (Keith *et al.* 1989, Stone *et al*. 1994, Smith *et al*. 2000). The current registration allows only application using bait stations, which is very labor-intensive and limits effective use of this tool to small areas. For control of predators over a spatial scale that is meaningful for recovery of endangered forest birds, additional efforts leading to registration labels that allow hand- or aerial-broadcasting of diphacinone are needed. A public education campaign that explains the need for use of diphacinone and its relative safety is also necessary.

4.2.1.2 Evaluate the efficacy of toxicants other than diphacinone for controlling mammalian predators and take the steps needed for their registration. (Priority 2)

4.2.1.3 Develop and evaluate improved methods for controlling predators, such as more efficient traps, contraceptives, and predator-proof fences for important areas. (Priority 1)

4.2.2 Rat control study. (Priority 1)
Study rat ecology in forest bird habitats to determine food habits, breeding success, and selection of foraging, roosting, and breeding habitat at appropriate spatial scales in order to determine which aspects of their ecology might be the weakest link in their ability to survive control programs.

4.2.3 Feral cat control study. (Priority 1)
Study feral cat ecology in forest bird habitats to determine habitat selection, food habits, range, and density so control methods can be designed more efficiently.

4.2.4 Mongoose control study. (Priority 1)
Study mongoose ecology in forest bird habitats to determine habitat selection, food habits, range, and density so control methods can be designed more efficiently.

4.2.5 Mosquito control study. (Priority 1)

4.2.6 Ungulate exclusion and control study. (Priority 2)
Experimental tests are needed of alternative methods for controlling and/or excluding feral pigs, goats, sheep, mouflon, and axis deer.

4.2.7 Weed control study. (Priority 2)

4.2.8 Yellow jacket wasp control study. (Priority 2)
Determine the factors that limit yellow jacket populations seasonally in some areas in order to develop effective methods of control. In addition, dietary work is needed to increase understanding of the potential impacts of yellow jackets on insectivorous forest birds that specialize on different components of the forest arthropod community.

4.2.9 Barn owl (*Tyto alba*) and pueo (*Asio flammeus sandwichensis*) study. (Priority 2)
Study barn owls and pueo in forest bird habitats to determine densities and impacts on native forest birds.

4.2.10 Avian competitor control study.
Study nonnative passerines in forest habitats to determine food habits, breeding success, range, density, nesting habitat, and direct and indirect competitive interactions

with native forest birds in order to determine the extent of niche overlap and competition with native forest birds and, if necessary, how their populations might be best controlled.

4.2.10.1 **Investigate red-billed leiothrix (*Leiothrix lutea*) as a competitor and reservoir for disease on Maui and Hawai`i.** (Priority 2)

4.2.10.2 **Investigate competition for food and space and disease relations between O`ahu `elepaio and introduced birds** such as red-vented bulbul (*Pycnonotus cafer*), white-rumped shama (*Copsychus malabaricus*), and Japanese white-eye (*Zosterops japonicus*). (Priority 2)

4.2.10.3 **Investigate role of Japanese white-eye and Japanese bush-warbler (*Cettia diphone*) as competitors and reservoirs of disease for on all islands.** (Priority 2)

4.2.11 **Determine best methods for conducting reforestation efforts.** (Priority 2)
Habitat degradation poses threats to species by reducing the carrying capacity of the habitat. Development of effective methods for restoration is needed to mitigate this threat.

4.2.12 **Investigate nonnative invertebrates in forest habitats** to determine distribution, direct and indirect interactions with native invertebrates, role as a prey base for nonnative birds and mammals, and effects on flora. (Priority 2)

4.3 **Evaluate the effectiveness of threat management actions.**
Partial or total removal of a threat should result in an increase in population size through changes in demographic parameters. This means that knowledge of the natural history of the Hawaiian forest birds should include refined estimates of demographic rates,

including nesting success, seasonal fecundity of females, proportion of females and males attempting to breed, annual survival of adults and juveniles, and sex ratio. Knowledge of causes of nest failure and mortality can provide a link between demographic parameters and a particular threat. Measuring the increase in a demographic parameter or in the number of individuals following an experimental management action is the best way of assessing the magnitude of a threat and the effectiveness of the management action.

4.3.1 Examine response of bird populations to habitat restoration, including the provisioning of food, foraging substrates, nest-sites, and roost sites, as well as the effects of habitat restoration on threats such as mosquitoes, predators, and competitors. (Priority 2)
Responses include stage of restoration at which species first appear (if not present at time restoration work commences), the resources used for feeding and nesting, the stage at which species become permanently resident, and population growth in relation to change in habitat.

4.4 Determine safety of threat management to non-target species and address public health and other concerns regarding threats management.

4.4.1 Address public health concerns regarding aerial broadcast of rodenticide and its effects on both game and non-game non-target species, and its persistence in watershed and sediments. (Priority 1)

4.5 Investigate the role of natural selection in dealing with threats.
Threats represent natural selection pressures on endangered birds, and because natural selection can lead to adaptation, it is appropriate to view natural selection as a means of threat management. Evolutionary responses to selection are expected when there is time for appropriate genetic variation to arise and the

surviving individuals are capable of maintaining a viable population.

4.5.1 Identify geographical variation in behavior and reproduction of forest birds that may make them less susceptible to threats.

4.5.1.1 Determine if roost site selection and specific mosquito avoidance behaviors (e.g., nocturnal roosting posture) reduce exposure to mosquitoes and predators. (Priority 2)

4.5.1.2 Determine if nest structure and location may provide protection from high winds, rain and cold, and predators. (Priority 2)

4.5.2 Identify individuals and genotypes that are tolerant or resistant to disease.

In the absence of continual introductions of new strains or genetic variants of avian pox and malaria to Hawai`i, the disease system (vector, parasite, and avian hosts) will begin to evolve new relationships through processes of natural selection. Current evolutionary theory predicts that the virulence of the disease agents will decrease and resistance of highly susceptible forest birds to these introduced diseases will increase (van Riper *et al.* 1986, Atkinson *et al*. 1995, Cann and Douglas 1999, Jarvi *et al.* 2001, Shehata *et al*. 2001). Direct evidence for this process is still limited and based primarily on observations of breeding populations of O`ahu `amakihi, O`ahu `elepaio, `apapane, and Hawai`i `amakihi at elevations where transmission of pox and malaria is stable and endemic. The genetic and physiological characteristics that allow some individuals to survive malaria and pox infection while others die are still poorly understood. Whether an individual survives infection is related to sex, age, and overall pre-infection body condition (Atkinson *et al.* 1995, 2000; Yorinks and Atkinson 2000). Other genetic factors probably are involved (Cann and Douglas 1999, Jarvi *et al.* 2001, Shehata *et al*. 2001) and may explain why some honeycreeper species (e.g., `i`iwi) are more susceptible to disease than others (e.g., Hawai`i `amakihi and `apapane).

4.5.2.1 Develop molecular methods for identifying individuals that are more likely to resist or survive pox and malaria infections. (Priority 1) Research that identifies specific genetic markers for disease resistance should be supported so that informed decisions about maintaining genetic diversity in isolated populations can be made. For example, failure to identify specific haplotypes associated with disease resistance might eventually lead to their loss from a small population if other, more easily identified markers are used as the measure of genetic variability. This is especially important for native species that are extremely susceptible to disease.

4.5.2.2 Refine diagnostic methods for identifying individuals that have survived diseases and have acquired immunity to reinfection. (Priority 1) Recently developed polymerase chain reaction (PCR) (Feldman *et al*. 1995) and serological (Atkinson *et al.* 2001b) tests for avian malaria should be refined to adapt them for use under field conditions. In particular, quantitative competitive PCR tests should be refined to detect low level chronic infections of malaria and fluctuations in parasitemia that may occur over time. New diagnostic tests for avian pox are urgently needed both to easily identify active pox infections and to identify survivors of past infections.

4.6 Conduct research that may lead to new tools for managing forest birds or their habitat, or to identification of emerging or unrecognized threats.

4.6.1 Investigate ways to enhance resource availability for particular species within existing habitat. (Priority 2)

4.6.1.1 Determine if additional nesting sites, including artificial devices, can be provided and used.

4.6.1.1.1 Determine if experimental artificial cavities increase the density of breeding pairs of Hawai`i `ākepa or expand the range of the birds through colonization of habitat without natural cavities. (Priority 2)

4.6.1.1.2 Test the design and efficacy of rat-proof artificial nest structures for puaiohi on Kaua`i. (Priority 2)

4.6.1.2 Determine if application of fertilizer to host plants increases growth, flowering, and abundance of arthropods as a means of increasing the prey base for insectivorous birds. (Priority 2)

4.6.1.3 Develop effective techniques for restoration of degraded and deforested lands. (Priority 2) See Recovery Action 4.2.11.

4.6.2 Document population structure.

A population is not a static entity either in space or time. Individuals may move within a year to track food resources, or engage in natal or breeding dispersal. In addition, source/sink dynamics are expected between populations at carrying capacity and those below carrying capacity. Isolated small populations may suffer from inbreeding depression. Research on population structure extends the results of research on a single population or a limited number of populations. In addition, knowledge of population structure is essential for translocation and reintroduction programs that seek to establish new populations or to augment small populations.

4.6.2.1 Develop a comprehensive library of informative microsatellite loci for all species. (Priority 2) Such loci, when neutral, are useful identifying geographic patterns, alternative patterns of gene flow (dispersal), and state-based dispersal. They can also be used for estimating effective population size and levels of inbreeding, as well as population assignment of individuals for identifying immigrants. Eventually, microsatellites under natural selection can be used for quantitative trait mapping, a procedure involving linkage analysis with functional loci that may be useful in identifying individuals tolerant or resistant to disease.

4.6.2.2 Document genetic population structure of species with single populations. (Priority 2)

4.6.2.3 Document source/sink metapopulation structure along gradients in density, particularly elevational gradients. (Priority 2) If disease is truly a major threat, then populations at upper elevations may be sources and populations at lower elevations may be sinks. There is an expectation that dispersal rates will be biased: more birds will disperse from upper elevations to lower elevations. One consequence of this is that tolerant or resistant genotypes of birds from lower elevations will not be present at upper elevations. Management for disease, especially in light of climate change, requires knowledge of metapopulation structure.

4.6.2.4 **Document genetic relationships among individuals in isolated populations** such as may be found on different volcanoes or in different areas of a fragmented population. Such populations may exhibit a different type of metapopulation structure than found along a gradient. (Priority 2)

4.6.2.5 **Determine patterns of dispersal by age and sex.** (Priority 2)

4.6.2.6 **Determine seasonal patterns of movement by age and sex.** (Priority 2)

4.6.3 **Conduct population and metapopulation viability analyses.** (Priority 2)
Recovery criteria specify the calculation of the population growth rate, or lambda (λ), as an indicator of stable or increasing populations. The Nature Conservancy's Population Viability Handbook specifies additional analyses that can be used to assess population viability within a single population or a metapopulation (Morris *et al.* 1999).

4.6.3.1 **Conduct trend analysis using count data.** (Priority 2)

4.6.3.2 **Use demographic data for estimating lambda.** (Priority 2)

4.6.4 **Investigate natural and alien species-induced native plant species die-back phenomena affecting forest bird habitats.** (Priority 2)

Recent die-back of over 60 percent of the koa (*Acacia koa*) tree canopy in Kīpahulu Valley, Maui, possibly caused by the native moth *Scotorythra paludicola* and the wilt-causing fungus *Fusarium oxysporum f.sp koae*, for example, raises concerns regarding the effects of local die-back of key plant species in forest bird habitats and the impacts of plant species die-back phenomena on listed species distributions and population numbers.

4.7 Special research considerations for translocations and reintroduction programs.

Translocations and reintroductions of captive-bred birds are recognized as important managerial tools for expanding the range of a species, for supplementing a small population, or for genetic management.

4.7.1 Evaluate the effectiveness of translocations of both disease survivors and disease resistant forest birds for restoration of populations in areas with active disease transmission. (Priority 1)

In the absence of specific genetic markers for disease resistance, applied research should be supported to determine whether translocation of survivors of past pox and malaria infections can be used to establish self-sustaining populations in native forests where disease transmission is now endemic, and whether such individuals can be incorporated into a captive breeding population for reintroduction programs.

4.7.2 Determine optimal parameters for translocation and reintroduction efforts. (Priority 2)

Translocation efforts require estimates of carrying capacity in alternative translocation sites, determination of the number of individuals and timing to achieve establishment of the new population, and assessment of the translocation on population structure.

4.7.3 Evaluate the relative costs of habitat suitability analysis versus experimental translocation or reintroduction. (Priority 3)

Translocation or reintroduction of individuals requires an assessment of the likelihood of success. This may take the form of assessments of habitat suitability prior to the releases, or alternatively, of experimental releases followed by careful monitoring of the released birds. The relative cost-effectiveness of these alternatives will vary among species and sites. Thus, evaluation of the relative costs of the alternatives will provide guidance for the effective use of funds.

4.8 Special research considerations for disease and parasitism.

Disease is the most complex threat to Hawaiian forest birds because characteristics of the hosts, vector, and pathogens are all involved. In addition, this is the one threat for which the birds can evolve tolerance or resistance. The numerous topics in this section reflect these issues and possibilities.

4.8.1 Determine the effects of land use changes on disease transmission. (Priority 2)

Changing patterns of land use and their effects on mosquito populations and movement may be one of the most important factors affecting stability of disease transmission, particularly in regions where residential and agricultural use occurs near recovery areas. Land use changes that affect mosquito productivity and movements should be identified so that mosquito free reserves and conservation easements can be located around forest bird recovery areas. These factors may be particularly important for the design of safe, disease-free corridors to link recovery areas at different elevations or geographic locations of the same island.

4.8.2 Determine effects of long-term climate change on disease transmission. (Priority 2)

The key role that environmental temperature plays in limiting the development of malarial parasites in the mosquito vector and increasing the duration of the gonotrophic cycle* of *Culex* makes it likely that climate chang could shift patterns of disease transmission from mid-elevation habitats into the last high elevation refugia on Hawai`i, Maui and Kaua`i. Research that predicts the magnitude of possible warming, its effects at fine spatial scales on precipitation patterns, and its effects on mean daily temperatures should be supported. This information should be used to develop disease risk maps for recovery areas under different scenarios of climatic change.

4.8.3 Conduct research on the feasibility of vaccines for avian pox and malaria, methods for their delivery, and possible effects on host-parasite coevolutionary adaptations. (Priority 2)

Research on experimental vaccines for control of pox and malaria transmission, methods for their delivery to wild free-ranging birds, and their effects on host-parasite coevolutionary adaptations should be supported. The use of vaccines for control of both malaria and viral infections is an active field of investigation concerning human and domestic animal health that may have direct application to Hawai`i. Developments in this field should be followed closely, even though practical application of these technologies to disease control may be years away. Modeling methods should also be used to examine the potential effects of vaccine use on the stability of disease transmission and overall effects on selection for parasite virulence and host resistance.

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* the cycle of egg maturation and oviposition (egg laying) following a blood meal in female mosquitoes; the length of the cycle depends on external temperature

4.8.4 Conduct research on genetic variability, virulence, and interactions between avian pox virus and malarial parasites and how these variants interact with susceptible and resistant host genotypes. (Priority 2)
It is possible that concurrent pox and malaria infections interact in susceptible and resistant hosts in ways that are not immediately predictable, with effects on disease transmissibility and selection for parasite and viral variants that are either more or less virulent than predicted. The role that these interactions play in how the disease system is evolving and how interventions in the disease cycle, e.g., use of a pox vaccine or reduction in mosquito densities, may affect stability of the system are unknown.

4.8.4.1 Use molecular methods to identify specific markers that correlate with phenotypic differences in virulence. (Priority 2)
Research that identifies specific molecular markers that correlate with parasite phenotypic traits should be supported. These can be used to identify specific strains of the disease organisms for incorporation into plans to prevent further spread of pox and malaria variants between and within islands. This information will be particularly useful in translocation studies involving individuals that have survived acute malarial infections and that now carry the parasite at chronic levels. These individuals should not be introduced into areas where their parasite variants do not occur to prevent further spread of the disease organisms.

4.8.4.2 Determine whether concomitant infections with pox and malaria affect virulence and transmissibility. (Priority 2)
Experimental studies that document the interactions of concurrent pox and malarial

infections on host survivorship are needed. This information is important for understanding the epidemiology of the diseases and for being able to identify and possibly manage conditions that might affect the severity of future disease outbreaks.

4.8.5 Determine dispersal distances of adult mosquitoes from point sources outside of recovery areas. (Priority 1)
Dispersal of adult *Culex* mosquitoes along natural and man-made corridors from low elevation source areas may be the primary factor supporting transmission of avian pox and malaria in some habitats. A good example of this is the Alaka`i Plateau, where adult mosquitoes and disease transmission have been documented (D. LaPointe and C. Atkinson U.S. Geological Survey, unpubl. data), but where larval *Culex* have rarely been found. In these situations, the identification of source areas and primary routes of dispersal will be essential for determining feasibility and methods for vector control.

4.8.6 Determine the feasibility of decreasing malarial transmission through genetic manipulation of vector populations. (Priority 2)
Research on the control of malarial transmission through genetic manipulation of vector populations is an active field of investigation concerning human and domestic animal health that may have direct application to Hawai`i. Practical application of these technologies to disease control may be years away, but this research should be supported since Hawai`i's isolation and absence of an endemic mosquito fauna make the islands an exceptional location for testing new technologies.

4.8.7 Determine the role that ectoparasites such as ticks and lice play in transmission of avian pox, particularly during the nesting cycle when adults may pass infections to offspring. (Priority 2)

Studies that document the affects of ectoparasites on transmission of avian pox are needed to help in the design of disease control strategies at the nest for critically endangered species where intensive management may be desirable. Treatment of nests, nestlings, and adult birds with insecticides may be practical in some situations and might prevent the transfer of virus to offspring in situations where one or both parents carry active infections.

4.8.8 Determine the role that endoparasites such as *Coccidea* play in demography of birds. (Priority 2)

4.8.9 Monitor long-term changes in the prevalence and transmission of avian diseases in forest bird recovery areas. (Priority 2)

Research and monitoring that documents the long-term patterns of change in the epidemiology and pathogenicity of introduced avian diseases will be important for measuring the effectiveness of management actions and for determining how complex interactions between abiotic and biotic environmental factors, anthropogenic factors, native and nonnative hosts, vectors and diseases are evolving.

4.9 Special research considerations for monitoring. (Priority 2)

Develop and test improved survey and monitoring techniques for extremely rare species and species that are difficult to monitor using standard methods.

4.10 Research needs and priorities by species.

Species differ in their threats and research needs. Table 14 identifies priority research needs for each species, with special reference to populations and locations that provide opportunities conducive to research or in which research needs are especially pressing. In a few instances priorities for individual species may differ from the priorities assigned to the general research categories of the research needs section of the recovery action narrative.

Table 14. Research needs and priorities by species. Island codes: H = Hawai`i; K = Kaua`i; MA = Maui; MO = Moloka`i; O = O`ahu. Species Codes: AKEP = Hawai`i `ākepa; AKIP = `akiapōlā`au; AKOH = `ākohekohe; HCRE = Hawai`i creeper; KAAK = Kaua`i `akialoa; KACR = Kaua`i creeper; KAMO = kāma`o; KANU = Kaua`i nukupu`u; MAPA = Maui parrotbill; OAEL = O`ahu `elepaio; OO = Kaua`i `ō`ō; OU = `ō`ū; PALI = palila; POOU = po`ouli; PUAI = puaiohi.

Table 14. Research needs and priorities by species

	Category of Research (Recovery Action Narrative general action number)	Species	Island	Area	Research Description	Priority
4.10.1	Identify the threats that cause geographical variation in density (4.1)	AKEP HCRE AKIP	H	Hawai`i	Determine the basis for variation in density of birds and termination of range.	2
4.10.2	Identify the threats that cause geographical variation in density (4.1)	HCRE	H	Hakalau Forest NWR, Honohina Tract	Determine the basis for low nesting success documented at Honohina Tract (wet habitat) using cameras on nests while documenting rainfall.	2
4.10.3	Identify the threats that cause geographical variation in density (4.1)	AKEP HCRE AKIP	H	Hawai`i	Determine the role of food in timing of breeding, attempts to breed, and breeding success.	2

Table 14. Research needs and priorities by species						
	Category of Research (Recovery Action Narrative general action number)	Species	Island	Area	Research Description	Priority
4.10.4	Identify the threats that cause geographical variation in density (4.1)	AKOH MAPA	MA	Maui	Determine why these birds are limited to high elevations.	2
4.10.5	Identify the threats that cause geographical variation in density (4.1)	KACR PUAI	K	Alaka`i Wilderness Area	Examine factors that determine abundance and distribution, including elevational range.	2
4.10.6	Identify the threats that cause geographical variation in density (4.1)	KACR	K	Alaka`i Wilderness Area	Determine the role of food as the basis for different densities of the bird in continuous habitat.	2
4.10.7	Evaluate the effectiveness of threat management actions; determine response of bird population to removal or reduction of a threat (4.3)	PALI	H	Mauna Kea and Mauna Loa	Determine population response to predator control efforts.	2
4.10.8	Evaluate the effectiveness of threat management actions; determine response of bird population to removal or reduction of a threat (4.3)	MAPA AKOH POOU	MA	Maui	Determine population response to predator control efforts.	1

Table 14. Research needs and priorities by species						
	Category of Research (Recovery Action Narrative general action number)	Species	Island	Area	Research Description	Priority
4.10.9	Evaluate the effectiveness of threat management actions; determine response of bird population to removal or reduction of a threat (4.3)	OAEL	O	O`ahu	Determine the effect of predator control on survival of female O`ahu `elepaio.	2
4.10.10	Evaluate the effectiveness of threat management actions: determine response of bird population to removal or reduction of a threat (4.3)	KACR PUAI	K	Alaka`i Wilderness Area	Measure effect of experimental test of broad-scale predator control on nest success, adult and post-fledging survival, and population trends.	1
4.10.11	Evaluate the effectiveness of threat management actions; examine response of populations to habitat restoration (4.3)	PALI	H	Mauna Kea and Mauna Loa	Determine population response to forest regeneration and restoration efforts.	2
4.10.12	Evaluate the effectiveness of threat management actions; examine response of populations to habitat restoration (4.3)	AKEP HCRE AKIP	H	Hawai`i	Determine use of regenerating/restored canopy trees as substrates for feeding.	2
4.10.13	Evaluate the effectiveness of threat management actions; examine response of populations to habitat restoration (4.3)	MAPA AKOH	MA	Maui	Determine population response to forest regeneration and restoration efforts.	2

Table 14. Research needs and priorities by species						
	Category of Research (Recovery Action Narrative general action number)	Species	Island	Area	Research Description	Priority
4.10.14	Evaluate the effectiveness of threat management actions; examine response of populations to habitat restoration (4.3)	KACR PUAI	K	Kaua`i	Determine population response to experimental control of weeds (e.g., ginger).	2
4.10.15	Evaluate the effectiveness of threat management actions; develop molecular methods for identifying individuals that are more likely to survive pox and malaria infections or to resist them (4.5.2.1)	AKEP HCRE AKIP	H	Hawai`i	Determine if tolerance or resistance to malaria and pox virus is evolving at the lower portion of the elevational range of these birds.	1
4.10.16	Investigate role of natural selection in dealing with threats; develop molecular methods for identifying individuals that are more likely to survive pox and malaria infections or to resist them (4.5.2.1)	OAEL	O	O`ahu	Determine if tolerance or resistance to malaria and pox virus is evolving in any of the fragmented populations.	2
4.10.17	Document population structure; document genetic population structure of species with single populations (4.6.2.2)	POOU MAPA AKOH	MA	Maui	Document genetic population structure.	2

Table 14. Research needs and priorities by species						
	Category of Research (Recovery Action Narrative general action number)	Species	Island	Area	Research Description	Priority
4.10.18	Document population structure; document source/sink metapopulation structure along gradients in density, particularly elevational gradients (4.6.2.3)	AKEP HCRE AKIP	H	Hawai`i	Document dispersal characteristics in populations along lateral and elevational gradients of density.	2
4.10.19	Document population structure; document source/sink metapopulation structure along gradients in density, particularly elevational gradients (4.6.2.3)	AKIP	H	Hawai`i	Determine the basis of variation in size of home range in areas of different density of the bird and in areas with different forest structure.	2
4.10.20	Document population structure; determine genetic as well as morphological, behavioral, ecological, and vocal variation among core populations (4.6.2.4)	AKEP HCRE AKIP	H	Mauna Kea, Mauna Loa, and Hualālai	Determine genetic as well as morphological, behavioral, ecological, and vocal variation among core populations.	2
4.10.21	Document population structure; determine genetic, morphological, behavioral, ecological, and vocal variation among core populations (4.6.2.4)	OAEL	O	O`ahu	Determine morphological, genetic, behavioral, ecological, and vocal variation among core populations.	2

Table 14. Research needs and priorities by species						
	Category of Research (Recovery Action Narrative general action number)	Species	Island	Area	Research Description	Priority
4.10.22	Document population structure; determine patterns of dispersal by age and sex (4.6.2.5)	OAEL	O	O`ahu	Determine patterns of dispersal by age and sex.	2
4.10.23	Conduct population and metapopulation viability analyses (4.6.3)	OAEL	O	O`ahu	Determine survival of juveniles, calculate lambda in different populations, and conduct sensitivity analysis to help prioritize recovery actions.	2
4.10.24	Conduct population and metapopulation viability analyses (4.6.3)	AKEP HCRE AKIP	H	Hawai`i	Calculate lambda in populations in different portions of the recovery area.	2
4.10.25	Special research considerations for monitoring (4.9)	KACR PUAI	K	Alaka`i Wilderness Area	Conduct development and testing of improved survey and monitoring techniques.	2

5. Monitor Changes in the Distribution and Abundance of Forest Birds.

5.1 Conduct systematic surveys of all forest bird habitat on Kaua`i, O`ahu, Moloka`i, Lāna`i, Maui, and Hawai`i at least once every 5 years to determine changes in distribution and population size of all native and nonnative forest birds. At a minimum, surveys should include all transects surveyed during the Hawai`i Forest Bird Surveys in 1976 to 1981, and additional transects should be established on O`ahu to adequately survey all recovery area on that island. (Priority 1) Recovery of any of the species included in this plan requires documentation of stable or increasing populations by either periodic surveys or calculation of the population growth rate (lambda, λ) in cases where more detailed population parameters have been estimated. Populations of all forest birds must be monitored at regular intervals using standardized methods to determine trends in population size, changes in distribution, and whether management practices are sustaining bird populations. Since the late 1970s, various agencies have cooperated in an attempt to resurvey at 5-year intervals each of the transects first surveyed during the Hawai`i Forest Bird Surveys. Surveys of all forest bird habitat on the major islands at 5-year intervals through an interagency effort should continue. The Island of O`ahu was not surveyed by the Hawai`i Forest Bird Surveys, and it will be necessary to establish transects on that island that adequately survey all recovery area.

5.2 Conduct systematic annual surveys of selected forest areas to more carefully monitor changes in distribution and population size and efficacy of management actions.

Areas supporting core populations of endangered species and areas where management actions are being carried out should be surveyed at more frequent intervals to more carefully monitor variation in populations and provide for adaptive modification of management actions, as described in Table 15.

5.3 Establish and support an interagency Forest Bird Monitoring Coordinator position to coordinate monitoring and provide regular reports on the status and trend of forest bird populations. (Priority 1)

A permanent interagency coordinator is needed to serve as the "resident expert" on forest bird monitoring in Hawai`i. This person would coordinate all aspects of forest bird monitoring in Hawai`i, including scheduling and organizing field surveys, conducting training sessions, ensuring that data collected during each survey are entered into a standardized database that is available to all agencies, analyzing data from each survey and producing status and trend reports at regular intervals, and producing updated GIS maps of current distributions of each species.

Table 15. Recovery areas requiring avian monitoring more frequently than every 5 years. Island codes: H = Hawai`i; K = Kaua`i; MA = Maui; MO = Moloka`i; O = O`ahu.

Table 15. Recovery areas requiring avian monitoring more frequently than every 5 years				
Recovery Action #	Island	Study Area	Survey Need/ Comments	Priority
5.2.1	H	Mauna Kea, māmane forest	Annual survey	2
5.2.2	H	Hakalau Forest NWR	Annual survey	2
5.2.3	H	Kona Unit, Hakalau Forest NWR	Annual survey	2
5.2.4	H	Ka`ū Forest	Every 2 years	2
5.2.5	H	Pu`u Wa`awa`a Forest Bird Sanctuary	Every 2 years	2
5.2.6	H	Kūlani	Annual survey	2
5.2.7	H	Keauhou Ranch/Kīlauea Forest	Annual survey	2
5.2.8	H	Mauna Loa Strip	Biannual survey	2
5.2.9	MA	Hanawī NAR	Annual survey	2
5.2.10	MA	Waikamoi Preserve	Annual survey	2
5.2.11	MA	Kīpahulu Valley	Annual survey	2
5.2.12	O	Wailupe Valley, to monitor efficacy of predator control	Annual survey	2
5.2.13	O	Pia Valley, to monitor efficacy of predator control	Annual survey	2
5.2.14	O	Honouliuli Preserve, to monitor efficacy of predator control	Annual survey	2
5.2.15	O	Schofield Barracks West Range, to monitor efficacy of predator control	Annual survey	2
5.2.16	O	Any other areas where active management is undertaken	Annual survey	2
5.2.17	K	Alaka`i Wilderness Preserve puaiohi "core" habitat	Annual survey	2

6. Public Awareness and Information.

Inform and educate the general public and lawmakers about Hawai`i's native and endemic species, and their habitats, to create a Statewide conservation ethic and to build alliances for conservation within the State of Hawai`i. Public information plays an important role in all recovery programs. Without public and lawmaker support, recovery actions may be impossible to attain. An informed public will support recovery actions, reduce time and budget costs, reduce controversy, and even persuade lawmakers to support changes necessary to preserve and protect endangered species and their habitat.

6.1 Build alliances with the public through outdoor experience with native forest birds and their forest habitats.
People are more likely to support programs for native species that they have observed first hand, rather than those with which they have had no experience. Hawaii's native forest birds are generally only found on private lands or in remote places where the public is unlikely to visit. Providing roadside stops, trails, and better visitor access within native forest habitat will increase public experience with native bird species and their habits. This will expand community knowledge and create alliances between the public and conservation agencies, leading to more public support for protection of natural places and species.

6.1.1 Promote and support public native species awareness and environmental education through increased visitor access on trails with interpretive and educational displays. The first line of action in promoting public environmental education is bringing the public in direct contact with native species and habitats. The development of new trails and enhancement of existing trails with interpretive displays will increase public access and exposure to native species, bringing about awareness and support for these species and their native habitats (see Table 16).

6.1.2 Promote increased access and interpretation programs on Federal, State, County, and private refuges, parks, preserves, and other lands where native species are found (see Table 17).

Table 16. Sites where interpretive information is needed (scenic overlooks and trails where interpretive information should be developed or where existing trails need enhancement). Island codes: H = Hawai`i; K = Kaua`i; MA = Maui; MO = Moloka`i; O = O`ahu. NWR = National Wildlife Refuge, NAR = Natural Area Reserve.

Table 16. Sites where interpretive information is needed				
Recovery Action #	Island	Area	Development Needed	Priority
6.1.1.1	H	Saddle Road 21 mile marker overlook and trail	Develop a scenic overlook with parking, a nature trail, and interpretive signage that discusses native forest birds and their habitat.	3
6.1.1.2	H	Saddle Road, Pu`u `ō`ō Trail	Trailhead access and parking area need improvement, interpretive displays should be installed to bring attention to native forest birds.	3
6.1.1.3	H	Hawai`i Volcanoes National Park, Mauna Loa Strip Road.	Develop short loop trails, pullouts, and interpretive displays along the Mauna Loa Strip Road.	3
6.1.1.4	H	Hakalau Forest NWR	Expand visitor use with a loop trail and interpretive displays.	2
6.1.1.5	H	Mauna Kea Pu`u Lā`au	Establish a loop trail within palila habitat and provide interpretive signs about the bird and its habitat. This would concentrate visitor usage and minimize disturbance, spread of weeds, and potential for fires.	2
6.1.1.6	H	`Ainapō Trail	Work with Nā Ala Hele to add a bird component to their brochure and interpretive signs at parking areas.	3
6.1.1.7	H	Pu`u Wa`awa`a Forest Bird Sanctuary	Develop a system of trails with interpretive signs.	3

Table 16. Sites where interpretive information is needed				
Recovery Action #	Island	Area	Development Needed	Priority
6.1.1.8	H	Pu`u Maka`ala, Laupāhoehoe, Kīpāhoehoe, Manukā, and Pu`u O`umi NAR	Develop a system of trails with interpretive signs.	3
6.1.1.9	MA	Haleakalā National Park, Hosmer Grove	Develop interpretive signs for the nature trail.	3
6.1.1.10	MA	Polipoli State Park	Develop an interpretive kiosk for the parking area and signs and brochures for the Waiakoa Loop Trail that include bird information.	3
6.1.1.11	MA	Pu`u Kukui, Maui Land and Pineapple	Develop access, trails, and interpretive signs for the Pu`u Kukui Trail.	3
6.1.1.12	MA	Waihe`e Ridge Trail	Develop an interpretive display at the top of the trail.	3
6.1.1.13	MA	Kahakuloa NAR	Po`elua Road, develop trail and interpretation on birds and other native biota.	3
6.1.1.14	MO	Hanalilolilo Trail	Develop an interpretive trail to rim of Pēpē`ōpae Bog.	3
6.1.1.15	MO	Moloka`i Forest Reserve Pu`u Ali`i NAR	Develop an interpretive kiosk at the Waikolu Lookout describing native forest birds and their habitat.	3
6.1.1.16	O	Kuli`ou`ou Trail, `Aiea Loop Trail	Develop interpretive signs and brochures for trails focusing on common native forest birds and the endangered O`ahu `elepaio.	2
6.1.1.17	K	Kōke`e State Park	Develop interpretive signs at Kalalau and Pu`u O Kila lookouts and educational brochures for all Kōke`e State Park trails that include native forest birds.	2

Table 17. Sites where increased access and interpretation are needed. Island codes: H = Hawai`i; K = Kaua`i; MA = Maui; MO = Moloka`i; O = O`ahu. NAR = Natural Area Reserve.

Table 17. Sites where increased access and interpretation are needed				
Recovery Action #	Island	Area	Development Needed	Priority
6.1.2.1	H	Hakalau Forest NWR, Hakalau and Kona Forest Units	Conduct open houses on a basis regular basis and develop open public access opportunities.	3
6.1.2.2	H	Pu`u Wa`a Wa`a Wildlife Sanctuary	Improve public access and interpretation.	3
6.1.2.3	MA	Waikamoi Preserve The Nature Conservancy	Expand public access opportunities into areas with native forest birds.	3
6.1.2.4	MA	Makawao Forest Reserve	Develop public access and interpretation of the Idyllwild entrance to the reservoir on the 4,300 foot contour road.	3
6.1.2.5	MA	Hanawī NAR	Increase limited public access for bird study and permitted public access.	3
6.1.2.6	MA	Haleakalā National Park	Increase public access opportunities for bird viewing in consultation with park staff.	3
6.1.2.7	MO	Kamakou Preserve, The Nature Conservancy	Improve public access by connecting the preserve with Hanalilolilo trail.	3
6.1.2.8	O	Barber's Point	Develop interpretive displays and sponsor regular trips to sinkholes at Barber's Point to see fossil bird bones.	3
6.1.2.9	O	Honouliuli Preserve, The Nature Conservancy	Support public education through the Project Stewardship program run by The Nature Conservancy of Hawai`i.	2

6.1.3 Expand visitor awareness with development of visitor centers, displays, facilities, and public interpretive programs (see Table 18).

Table 18. Sites where visitor centers, displays, and interpretive programs are needed. Island codes: H = Hawai`i; K = Kaua`i; MA = Maui; MO = Moloka`i; O = O`ahu.

Table 18. Sites where visitor centers, displays, and interpretive programs are needed				
Recovery Action #	Island	Area	Development Needed	Priority
6.1.3.1	H	Hakalau Forest National Wildlife Refuge	Develop a visitor center with interpretive displays and docents promoting refuge programs to protect Hawaii's endangered flora, fauna, and ecosystems.	2
6.1.3.2	MA	Haleakalā National Park	Construct an interpretive display in the campground at Palikū providing information on programs by the NP and State for Maui parrotbill, `ākohekohe and other native forest birds, and create a bird identification brochure for visitors park-wide.	2
6.1.3.3	O	Honolulu Zoo	Provide support for developing a Hawai`i forest bird display at Honolulu Zoo.	2

6.1.4 Promote the opening of State Forest Reserve trails to the general public for nature walks and birding on all islands. (Priority 2)

6.1.5 Support the Nā Ala Hele Trail System. (Priority 3)

6.2 Fund, support, and promote programs that inform teachers and educate children, lawmakers, local public, and visitors about Hawaii's native and endangered flora and fauna.

Most people in Hawai`i are unfamiliar with Hawaii's native species and the problems associated with their decline. Raising the level of awareness on endangered species issues at the community level is the key to the success of the recovery of these species. Informed teachers will aid in educating the community and lawmakers, and with public backing, will support habitat protection and endangered species recovery.

6.2.1 Fund and support teacher education programs that promote native species issues.

Teachers provide the basis for educating a large segment of the population, therefore educating teachers about endangered species issues should be paramount. Providing teachers with interesting, appropriate, and up to date teaching materials for classroom use is an important part of this educational program.

6.2.1.1 Institute core curriculum programs at the university level emphasizing Hawaii's native species for elementary and high school teacher education programs. (Priority 2)

6.2.1.2 Develop an interpretation internship program for university students specializing in the field of forest bird information and education. (Priority 2)

6.2.1.3 Provide permanent funding for programs such as Imi Pono No Ka Aina, an Environmental Educator program at Hawai`i Volcanoes National Park that educates teachers through accredited workshops in environmental and native species issues.
(Priority 2)

6.2.1.4 Fund the development and distribution of educational materials that provides teachers with "student friendly" information about native and endangered species.

6.2.1.4.1 **Develop forest bird posters for schools, emphasizing each of the native forest birds and keyed to each island's endemic species.** (Priority 3)

6.2.1.4.2 **Keauhou Ranch/Kīlauea Forest Reserve. Assist Kamehameha Schools with ongoing development of environmental learning opportunities.** (Priority 3)

6.2.2 **Support and fund programs that educate children about Hawai`i's natural environments and that inform the public through non-traditional partnerships.** Classroom learning is only one facet of the learning process. Outdoor programs at organized learning centers give students the opportunity to relate to the natural environment that they might not ordinarily experience. Intimate knowledge of native environments and species through the outdoor experience likely will produce future supporters for these environments. The use of non-traditional partnerships also can help children attain experience from members of the community in environmental education programs.

6.2.2.1 **Fund and support programs at nature centers on all islands that provide school children with a "hands on" approach to learning about Hawai`i's native species**: Keokeolani Outdoor Education Program on the Big Island; Maui Outdoor Education Center on Maui; Hawai`i Nature Center on O`ahu; The Discovery Outdoor Education Center on Kaua`i; and funding for the establishment of a Moloka`i Outdoor Education Center. (Priority 2)

6.2.2.2 Fund and support organizations such as \`Ōhi\`a Productions and Keauhou Bird Conservation Center that provide environmental educational programs to Hawaii's school children. (Priority 2)

6.2.2.2.1 Provide funding for \`Ōhi\`a Productions to perform on other islands and to produce videos of previous performances for distribution to schools throughout Hawai\`i. (Priority 2)

6.2.2.3 Develop and support programs such as Mālama Hawai\`i that encourage widespread awareness of conservation goals through a diverse coalition of traditional and non-traditional partnerships. (Priority 2)

6.2.3 Create a clearinghouse, such as a website or "hotline," for information and educational materials about Hawai\`i's native species.

Teachers, students, lawmakers, businesses, conservation groups, and the general public should have the most current information available to them. Scientists from Federal and State agencies have the current information.

6.2.3.1 Fund, create, and support continuous maintenance of an informational website focused on native species and their habitats, as well as alien species and their effects on native species, and provide up to date information that can be utilized and copied onto other web sites to spread the information. (Priority 2)

6.2.3.1.1 Obtain funding to develop technology for remote digital broadcast from an

O`ahu `elepaio "nest cam" to local schools through a web site. (Priority 3)

6.2.4 **Provide information and promote awareness of the harmful effects of some alien species to public health, native species, and native ecosystems.**
Alien species are the leading cause endangerment and extinction of native species in Hawai`i. Harmful effects include habitat degradation caused by alien ungulates and weeds; native bird extinctions caused by exotic mosquito-borne diseases; predation from introduced rats, cats, and mongooses; and possible impacts to Hawaii's ecosystems and economy.

6.2.4.1 **Initiate and support public outreach efforts about the effect of rats and cats as vectors for human disease, agricultural pests, and predation on native species**, such as the Cats Indoors program of the American Bird Conservancy. Provide film and video footage of the harmful effects rats and cats have on native species and humans. (Priority 1)

6.2.4.2 **Initiate public outreach efforts to inform the public about potential human and animal diseases transmitted by mosquitoes and how source reduction can reduce those threats.** Provide film and video footage of the harmful effects alien mosquitoes and disease have on native species and humans. (Priority 1)

6.2.4.3 **Inform the public on the value of feral ungulate control and weed control in native forests by providing film and video footage of the harmful effects alien weeds and ungulates have on native species and agriculture.** (Priority 2)

6.3 **Use a professional marketing agency and business marketing techniques (television, radio, internet, newspapers, advertising, and magazines) to promote awareness of the uniqueness of Hawai`i's native species and gain local support for endangered species and related conservation issues.** Radio, television, contests, and promotions featuring local entertainers, celebrities, and heroes to promote public information and awareness of environmental issues and other mass marketing techniques are effective and should be used to increase the public's awareness of native and endangered species and their associated problems.

6.3.1 **Conduct market research on the public's knowledge of native species and attitudes towards conservation in order to provide information on the most direct ways to inform the public and gain support for native species.** (Priority 2)

6.3.2 **Promote and fund the development of Public Service Announcements for television and radio about native species and their habitat.**

6.3.2.1 **Assist in the development of public service announcements about native species** by providing local television stations with footage of native species with natural sounds and suggest their use as background visuals or sounds during credits for local or other programming. (Priority 2)

6.3.2.2 **Use local heroes, entertainers, sports figures, or other role models to promote local pride in native common and endangered species.** (Priority 2)

6.3.2.3 **Promote the use of sponsored prize-winning contests on local radio, television stations, and newspapers to promote native species awareness.** (Priority 3)

6.3.2.3.1 **Sponsor and support contests**, such as a forest bird website contest among high school students, a forest bird essay contest in schools with prizes for different grade levels, a forest bird photo contest, or a song writing contest with the song to be used for as a theme for a locally produced nature program. (Priority 3)

6.3.2.4 Fund daily, weekly, or monthly programs in newspapers, radio, and television stations that provide a short informative environmental education story. (Priority 3)

6.3.2.4.1 Develop a weekly column provided to all newspapers in Hawai`i with information on native species and ecosystem issues, and the writing shared by conservation organizations throughout the State. (Priority 3)

6.3.2.4.2 Develop a weekly program for radio stations on all islands providing information on native species and ecosystem issues, with the writing shared by conservation organizations throughout the State. (Priority 3)

6.3.2.4.3 Develop a half-hour weekly or monthly television program about Hawaii's native species and their habitat. (Priority 3)

6.3.3 Promote private business use of native species likenesses, images, and names on old and new products and use them in advertising and logos.

6.3.3.1 Promote the use of the \`i\`iwi or a caricature of \`i\`iwi as the "poster child" for native species in advertising and in education. (Priority 3)

6.3.3.2 Provide native species images and promote the use of these images in advertising by marketing agencies, local and national fast food corporations, and advertising on tray-liners, milk cartons, and other heavily-used advertising media. (Priority 3)

6.3.4 Promote fund raisers and solicit corporate funding and promotion to expand the economic base for public awareness and information campaigns.

6.3.4.1 Promote the hosting of special events in cooperation with major local hotels and corporations as funding partners to champion native species and ecosystem awareness. (Priority 3)

6.4 Promote the creation of and support "Friends" groups, partnerships, environmental outreach programs, and other groups to provide support for parks, refuges, reserves, and natural areas to cultivate understanding and conservation of Hawaii's natural and cultural resources. Funding and labor support for environmental education is often in short supply. The establishment of Friends groups and partnerships helps fill the need by supplying volunteers and funds to maintain these important programs. Many refuges and parks rely greatly on these resources to champion new programs and maintain old ones at little or no cost.

6.4.1 Recruit, train, and support volunteer community leaders to organize native species outreach and awareness programs at the community level.

6.4.1.1 Support conservation outreach organizations to promote conservation at a "grass roots" level. (Priority 2)

6.4.1.2 Develop a "mentor" program in which natural science professionals provide field opportunities for young people to learn about Hawaii's native species. (Priority 3)

6.4.1.3 Support the use of volunteers in projects on State, Federal, and private lands that will contribute to the enhancement of native habitat and increase the level of awareness and pride in native species within the local populace. (Priority 2)

6.4.1.4 Support the development of a volunteer "clearinghouse" to provide volunteers for resource management, education, and outreach. (Priority 3)

6.4.2 Develop and support partnership and outreach programs with other conservation agencies, native Hawaiian groups, hunter groups, and private landowners. (Priority 2)

6.4.2.1 Develop and maintain partnerships with Kamehameha Schools, The Nature Conservancy of Hawai`i, Hawai`i Audubon Society, Pig Hunters of Hawai`i, Hawai`i Conservation Alliance, and other non-governmental organizations to promote environmental awareness. (Priority 2)

V. IMPLEMENTATION SCHEDULE

Recovery actions in the Implementation Schedule are prioritized in a two-part ranking system. First, each action is assigned a “priority number” from 1 (highest priority) to 3 (lowest priority) (see Definition of Action Priorities, below). Second, within each priority number, actions are broken down into “priority tiers” from 1 (highest priority) to 3 (lowest priority). For example, an action with a priority number of 1 and a priority tier of 1 has higher priority than an action with a priority number of 1 and a priority tier of 2. The recovery tier rankings are based on several criteria, including whether the land in question is currently occupied by the species, the current suitability of the habitat for the species, the number of existing populations, and the probability of species extinction. Higher tier rankings are assigned to actions for species with only one population, actions for species that could go extinct more rapidly, and actions for habitat that is currently occupied. Numbers in the Action Number column correspond to descriptions of recovery actions in the recovery action narrative (Section IV) of this recovery plan. This implementation schedule is provided to assist in selecting the most important (highest priority) recovery actions for implementation. Appendix A provides a list of land parcels and recovery actions as an aid to landowners and land managers who may wish to see a complete list by parcel of habitat-based recovery actions for their lands. Recovery actions in Appendix A are from Tables 7, 8, 9, and 11 of the Recovery Actions Narrative. Many recovery actions benefit multiple species, including habitat-based actions.

During the writing of this plan, the Hawaiian Forest Bird Recovery Team suggested developing “Five-year Recovery Work Plans” to make the larger recovery plan more accessible to landowners and resource managers. These Work Plans include key near-term recovery actions for each species. The Pacific Islands Fish and Wildlife Office of the U.S. Fish and Wildlife Service completed these Work Plans in 2003. Each Work Plan provides a brief species summary, a description of the primary threats to the species, and lists 10 to 15 key recovery actions to be completed in the next 5 years. Species Five-year Recovery Work Plans are available from the Pacific Islands Fish and Wildlife Office, Honolulu, Hawai`i, and are also provided here as Appendices F through L to this plan.

1. Definition of Action Priorities.

Priority 1 – An action that must be taken to prevent extinction or to prevent a species from declining irreversibly in the foreseeable future.

Priority 2 – An action that must be taken to prevent a significant decline in species population or habitat quality or some other significant negative impact short of extinction.

Priority 3 – All other actions necessary to meet recovery objectives.

2. Threat Categories.

We consider five major categories of threats to species in order to list, delist, or reclassify a species:

A – The present or threatened destruction, modification or curtailment of its habitat or range;

B – Overutilization for commercial, recreational, scientific, or educational purposes;

C – Disease or predation;

D – The inadequacy of existing regulatory mechanisms; and

E – Other natural or manmade factors affecting its continued existence.

The Listing Factor column in the Implementation Schedule indicates which of the five threat categories each recovery action is meant to address in order to meet the recovery criteria of creating viable populations or metapopulations and management of recovery areas (see Recovery Criteria, page 3-2). The majority of recovery actions in this plan address threats to habitat (factor A) and disease or predation (factor C). The overutilization of Hawaiian forest birds for commercial, recreational, scientific, or educational purposes (factor B) and inadequacies of existing regulatory mechanisms (factor D) are not considered to be significant current threats. Population monitoring does not fit under the above threat categories, but in order to determine whether recovery criteria have been met, it is essential to evaluate population trends, the effects of threats on populations, and measure population responses to management.

3. Definitions of Action Durations.

Continual – An action that will be implemented on a routine basis once begun and will continue until recovery has been achieved (estimated at 30 years).

Ongoing – An action that has already been initiated and will continue until the action is no longer necessary. If no discrete time frame is provided, it is assumed that the action will continue until recovery has been achieved (estimated at 30 years).

Unknown – Action duration is not known at this time or action is not being implemented currently.

Complete – Action has been completed.

4. Responsible Parties for Action Implementation.

We, the U.S. Fish and Wildlife Service, have the statutory responsibility for implementing this recovery plan. Only Federal agencies are mandated to take part in the effort. The recovery actions identified here are intended as a guide for meeting the recovery goals in this plan, and imply no legal obligations of State and local government agencies or private landowners to implement them. However, in most cases the recovery of the listed species included in this plan will require the involvement and cooperation of Federal, State, local, and private interests. For each recovery action described in the Implementation Schedule, the column titled “Responsible Parties” lists the primary Federal and State agencies with the authority or responsibility for implementing or funding recovery actions and conservation groups, partnerships, and private landowners that may also wish to be involved in recovery implementation. An asterisk (*) identifies the logical lead partner(s) for implementing recovery actions. The listing of a party in the Implementation Schedule does not require the identified party to implement the action(s) or to secure funding for implementing the action(s). Access to private lands and implementation of recovery actions on land parcels that are privately owned will be by mutual agreement with the landowner in cooperation with the Service and any other appropriate parties.

5. Cost Estimates for Recovery Actions.

In addition to providing a prioritized list of recovery actions, the Implementation Schedule provides estimated costs of implementing recovery actions. The method used to estimate costs of different types of recovery actions are described below. Estimates for these actions are based on average costs of similar actions implemented to date. Differences in local conditions likely will result in variation from estimates for some of these actions in some areas. Slight differences between total costs and annual costs for some continual and ongoing actions are due to rounding of annual costs. In these instances, total cost is the most accurate approximation of funding needed to complete a recovery action. In some cases, as described below, although we were able to estimate the total cost of an action, it was not possible to accurately break that cost down into annual estimates, because those costs varied widely between years depending on the stage of work or because the point at which funding would become available to carry out the action was highly uncertain.

Secure Recovery Areas: Costs to secure recovery areas cannot be determined at this time because numerous methods are available (conservation easement, partnership agreement, safe harbor agreement, change in land use designation, change of jurisdiction, lease, or purchase from willing seller) that vary widely in their potential cost, and it is not possible to speculate which method might be most appropriate or effective in the future. Many land parcels in question are owned by State or local governments or private interests, and the most appropriate method of securing habitat will depend on the disposition and willingness of the landowner.

Reforestation and Restoration: Cost for each action number equals total acreage in the recovery area parcel(s) to be reforested or restored multiplied by cost per acre for reforestation or restoration. The current cost per acre for reforestation is estimated at $600/acre for high intensity effort, $400/acre for moderate intensity effort, and $200/acre for low intensity effort; $200/acre is used for areas that only require management to assist natural forest regeneration. Costs for forest restoration at Kōke`e State Park on Kaua`i are by expert opinion.

Fencing and Feral Ungulate Removal: Cost for each action number equals total acreage in the recovery area parcel(s) requiring fencing multiplied by cost per acre for fencing added to the total acreage in the recovery area parcel(s) requiring ungulate removal multiplied by cost/acre for ungulate removal. Cost/acre for fencing = $312.50 for Hawai`i, $570.50 for Maui and Kaua`i, and $891 for deer fencing. Because populations of Axis deer on Maui and Moloka`i are expanding their range and growing rapidly, it is anticipated that deer-proof fencing will be required for these two islands. Costs are based on the cost of fencing to enclose 1 square mile of area (4 linear miles of fence) or 640 acres. Detailed plans for fencing were not available for most areas. For larger units fencing costs may be somewhat less than estimated, and it may be possible to reduce costs in some cases by strategic placement of fencing segments.

Hunting to reduce feral ungulates in unfenced areas is beneficial to forest bird habitat and will contribute to forest bird recovery. However, fencing and complete removal of feral ungulates will provide the most benefit to forest bird habitats and is most cost effective over the long-term. Hunting alone in fenced areas may reduce feral ungulate numbers, but is unlikely to result in complete removal. Cost per acre for ungulate removal ($22.00/acre/3-year period) therefore is based on snaring within fenced areas to reduce ungulates to zero. One-way gates and other means of reducing numbers of ungulates in fenced areas are included in the cost for fencing designs.

There will be costs to maintain fences and to monitor for and remove ungulates from ungulate free fenced areas should a breach in exclosures occur. It is difficult to predict these costs because it is not possible to know when damage to fencing might occur or how extensive this might be, whether or if ungulates entered into the fenced area and when, and because fence maintenance requirements will likely differ depending upon climate, terrain, vegetation over-story and other factors. We have estimated these costs to be on average $6.25/acre/year to monitor and repair fencing and $3.57/acre/year to monitor for ungulate presence inside fenced areas. We have added fence maintenance and ungulate monitoring costs on a per acre basis multiplied by 30 (the number of years estimated to recovery) to the cost for fence construction and ungulate removal.

Funding is not currently available for most reforestation, restoration, fencing, and feral ungulate removal, and opportunities to implement these actions are often determined by availability of funds and personnel, access to lands, and cooperation of parties involved. Therefore, cost estimates for these recovery actions are presented only under total costs and are not broken down by year. Highest priority projects should be implemented first as funding becomes available.

Predator Control: The cost for each action number equals total acreage in the recovery area parcel where predators (primarily cats, mongoose, and rats) are to be controlled, multiplied by cost/acre/year for control. The cost per year for ground-based rodent baiting and cat/mongoose removal combined = $40/acre/trip, or $160/acre/year for four trips. Recovery of most species included in this plan will require large-scale predator control, and many of the land parcels involved are too large and the terrain is too rugged for ground-based methods to be effective. Adequate predator control in many areas will require aerial broadcast application of toxicants, and approval of this method is still pending from the Environmental Protection Agency. Costs for predator control for many parcels at this time may change and could be substantially lower depending on the methodology approved by the Environmental Protection Agency for aerial broadcast application of diphacinone rodenticide for conservation purposes in Hawai`i.

Captive Propagation: Currently, captive propagation and reintroduction programs for Hawaiian forest birds receive approximately $1 million each year. As more species and larger numbers of captive-reared birds are released into the wild, costs are expected to increase because of greater demands for space in propagation facilities, increased facilities maintenance costs, larger releases, and more post-release monitoring. Total costs for captive propagation and reintroduction programs can reasonably be expected to increase to approximately $1.5 to $2 million per year. Because program priorities will of necessity shift over time, specific costs for captive propagation and related recovery strategies have not been assigned by year. We have estimated total costs of $60 million for all activities under the general heading of captive propagation and related recovery strategies, or $2 million per year for a 30-year period.

Total Costs: Cost totals for each recovery action in the Total Costs column of the Implementation Table are the total costs for the completion of a recovery action over the time it will take until a species has been recovered. Some species with larger current populations and wider distribution may be recovered in less than 30 years, whereas recovery of other species will require substantial habitat restoration, which could take more than 30 years. For the purposes of this recovery plan, we have estimated that we can expect all the species in this plan with current populations of greater than 300 individuals to be recovered in 30 years. For actions that are continual or ongoing, the total cost is based on the annual costs summed over 30 years, unless otherwise noted.

6. Key to Acronyms and Responsible Parties (not all are mentioned in the Implementation Schedule)**:**

ADWG – Avian Disease Working Group
APHIS-WS-NWRC – (USDA) Animal Plant Health Inspection Service, Wildlife Services, National Wildlife Research Center
AZA – American Association of Zoological Parks and Aquariums
BIGHA – Big Island Gamebird Hunters Association
BIISC – Big Island Invasive Species Committee
CPWG – Captive Propagation Working Group
DHHL – Department of Hawaiian Home Lands
DOI – U.S. Department of Interior
DLNR – Hawai`i Department of Land and Natural Resources
DOD – Department of Defense
DOFAW – Hawai`i Division of Forestry and Wildlife
EMOWP – East Moloka`i Watershed Partnership
EMWP – East Maui Watershed Partnership
FAA – Federal Aviation Administration
FHWA – Federal Highway Administration
HDOA – Hawai`i Department of Agriculture
HDOE – Hawai`i Department of Education
HDPH – Hawai`i Department of Public Health
HFBRT – Hawai`i Forest Bird Recovery Team
HVNP – Hawai`i Volcanoes National Park
HZ – Honolulu Zoo
KMWP – Ko`olau Mountains Watershed Partnership

KS – Kamehameha Schools
LHWRP – Leeward Haleakala Watershed Restoration Partnership
MFBRP – Maui Forest Bird Recovery Program
MWP – Maui Watershed Partnership
NAPS – Natural Areas Partnership
NAR – Natural Area Reserve
NGO – Nongovernmental Organization
NHPS – Native Hawaiian Plant Society
NPS – National Park Service
NWR – National Wildlife Refuge
OKP –` Ōla`a/Kīlauea Partnership
TBD – To Be Determined
TMK – Tax Map Key
TNCH – The Nature Conservancy of Hawai`i
TPF – The Peregrine Fund
UH – University of Hawai`i
UNK – Unknown
USDA – U.S. Department of Agriculture
USFS – U.S. Forest Service
USFWS – U.S. Fish and Wildlife Service
USGS – U.S. Geological Survey
VC – Veterinary Consortium
WDTF – Wildlife Disease Task Force
WMWP – West Maui Mountains Watershed Partnership
ZSSD – Zoological Society of San Diego

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds												
Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
1	1	1.1	A	Describe and delineate recovery areas	Complete	*USFWS, *HFBRT						
2	1	1.2.1	A	Continue existing and develop new partnerships: \`Ōla\`a/Kīlauea Partnership, Hawai\`i	Ongoing	*All Landowners, Land Managers, and Other Parties	TBD[1]					
2	1	1.2.2	A	Continue existing and develop new partnerships: Kahikinui Forest Partnership Working Group, Maui	Ongoing	*All Landowners, Land Managers, and Other Parties	TBD[1]					
2	1	1.2.3	A	Continue existing and develop new partnerships: East Maui Watershed Partnership	Ongoing	*All Landowners, Land Managers, and Other Parties	TBD[1]					
2	1	1.2.4	A	Continue existing and develop new partnerships: Leeward Haleakalā Watershed Restoration Partnership, Maui	Ongoing	*All Landowners, Land Managers, and Other Parties	TBD[1]					
2	1	1.2.5	A	Continue existing and develop new partnerships: West Maui Mountains Watershed Partnership	Ongoing	*All Landowners, Land Managers, and Other Parties	TBD[1]					

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds												
Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	1	1.2.6	A	Continue existing and develop new partnerships: East Moloka`i Watershed Partnership	Ongoing	*All Landowners, Land Managers, and Other Parties	TBD[1]					
2	1	1.2.7	A	Continue existing and develop new partnerships: Ko`olau Mountains Watershed Partnership, O`ahu	Ongoing	*All Landowners, Land Managers, and Other Parties	TBD[1]					
2	1	1.3.1	A	Secure recovery area: Portions of TMKs 344014002 344014003 343010002 343010008	Unknown	*DLNR, State Land Division	TBD[1]					Hawai`i DLNR. Currently leased for cattle grazing. By lease, conservation easement, change of jurisdiction, or change in land use designation to protective subzone of conservation.
1	2	1.3.2	A	Secure recovery area: Kanakaleonui Corridor, TMK 338001009	Ongoing	*DHHL	TBD[1]					Hawai`i DHHL. Provides vital link between mesic koa forest and dry māmane forest. By conservation easement, lease, or partnership. Remove grazing and enhance natural communities.

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds

Priority #	Priority Tier	Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units) Total	FY 07	FY 08	FY 09	FY 10	Comments/Notes
2	2	1.3.3	A	Secure recovery area: Hilo Forest Reserve, Laupāhoehoe Section, TMK 337001004	Unknown	*DLNR, *DOFAW	TBD[1]					Hawai`i DOFAW. Currently the Laupāhoehoe Section of Hilo Forest reserve Area. By change in land use designation to conservation protective subzone. Mid-elevation forest with native tree canopy vulnerable to destruction by continued sustained yield pig hunting.
2	1	1.3.4	A	Secure recovery area: Hilo Forest Reserve, Pīhā Section, TMK 333001004	Unknown	*DLNR, *DOFAW	TBD[1]					Hawai`i DOFAW. Important wet and mesic forest remnants. Currently the Pīhā Section of Hilo Forest Reserve, bounded on both sides by Hakalau Forest National Wildlife Refuge. By conservation easement or change in land use designation to protective subzone of conservation. Mid-elevation forest with intact native tree canopy vulnerable to destruction by sustained yield pig hunting.

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds

Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	2	1.3.5	A	Secure recovery area: Kīpuka `Āinahou Nēnē Sanctuary, TMK 338001008	Unknown	*DHHL, *DOFAW	TBD[1]					Hawai`i DHHL, leased by DOFAW and currently under annual lease. A long-term lease should be negotiated.
1	3	1.3.6	A	Secure recovery area: Humu`ula, TMK 338001002	Unknown	*DHHL	TBD[1]					Hawai`i DHHL. Restorable. A vital link between wet and dry forest communities. Former lease for cattle grazing recently terminated. By lease, conservation easement, cooperative agreement, or partnership.
2	2	1.3.7	A	Secure recovery area: Humu`ula, Portions of TMK 338001007	Unknown	*DHHL	TBD[1]					Hawai`i DHHL. Leased to Parker Ranch for grazing. Restorable. A vital link between wet and dry forest communities. By lease, conservation easement, cooperative agreement, or partnership.
1	3	1.3.8	A	Secure recovery area: TMK 326018002	Unknown	*DHHL	TBD[1]					Hawai`i DHHL, adjacent to Hakalau Forest National Wildlife Refuge. Highest mesic forest remnant on the eastern slope of Mauna Kea. By lease, conservation easement, cooperative agreement, or partnership.

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds												
Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
1	3	1.3.9	A	Secure recovery area: TMK 326018001	Unknown	*DLNR, State Land Division	TBD[1]					Hawai`i DLNR, Land Division. Leased for cattle grazing. Important mesic and wet koa/`ōhi`a forest remnants, link between wet and dry forest communities. By lease, conservation easement, change of jurisdiction, or change in land use designation to conservation.
1	2	1.3.10	A	Secure recovery area: TMK 344015002	Unknown	*DLNR, State Land Division	TBD[1]					Hawai`i DLNR, Land Division, currently leased for cattle grazing. Restore link between wet and dry forest communities. By lease, conservation easement, change of jurisdiction, or change in land use designation to conservation.
2	2	1.3.11	A	Secure recovery area: Keauhou Ranch, TMK 399001004	Unknown	*KS	TBD[1]					Kamehameha Schools. Remnant mesic koa and `ōhi`a forest. By lease or conservation easement. Currently a member of the Ōla`a-Kīlauea Partnership.

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds												
Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	2	1.3.12	A	Secure recovery area: Kapāpala Ranch, Portions of TMK 398001010	Unknown	*DLNR, State Land Division, Kapāpala Ranch	TBD[1]					Hawai`i DLNR, Land Division, Kapāpala Ranch. Currently leased for cattle grazing. Restorable. A link between forest to the east and west. By lease, conservation easement, or change in land use designation to conservation.
2	2	1.3.13	A	Secure recovery area: Ka`ū Forest Reserve, TMK 397001007	Unknown	*Mauna Kea Agribusiness	TBD[1]					The Nature Conservancy of Hawai`i. Protect wet forest habitat from development.
2	2	1.3.14	A	Secure recovery area: Ka`ū Forest Reserve, Portions of TMKs 397001006 and 397001005	Unknown	*KS	TBD[1]					Kamehameha Schools. Protect wet forest habitat from development. By lease, conservation easement, partnership agreement, or purchase from willing seller.
1	1	1.3.15	A	Secure recovery area: Kahuku Ranch, Portions of TMK 392001002	Unknown	*Samuel M. Damon Trust, Kahuku Ranch	TBD[1]					Recently purchased by Hawai`i Volcanoes National Park. Valuable wet and mesic forest habitat that links Ka`ū Forest and South Kona Forest. Restorable.

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds												
Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	1	1.3.16	A	Secure recovery area: Honomalino, TMKs 389006004 and 389006029	Unknown	*Scott C. Rolles Trust	TBD[1]					Scott C. Rolles Trust. Links Ka`ū Forest and South Kona Forest. By lease, conservation easement, partnership, change in land use designation, or purchase from willing seller.
2	3	1.3.17	A	Secure recovery area: Pāpā, TMK 388001001	Complete	*The Nature Conservancy	UNK					The Nature Conservancy, Kona Hema Preserve. Recently sold by Koa Aina Ventures. A link between Ka`ū Forest and South Kona Forest.
2	2	1.3.18	A	Secure recovery area: Portions of TMKs 388001003 388001004 387012001 392001005 387012003 387012004 387001007 387001006 387001011 387001004	Unknown	*Yee Hop Ranch Ltd.	TBD[1]					Yee Hop Ranch Ltd. Provides links between state owned land parcels and protects contiguous forest habitat in South Kona from development. By lease, conservation easement, partnership agreement, change in land use designation, or purchase from willing seller.

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds

Priority #	Priority Tier	Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units) Total	FY 07	FY 08	FY 09	FY 10	Comments/Notes
3	3	1.3.19	A	Secure recovery area: `Alae Ranch, Portions of TMK 387001014	Unknown	*DLNR, State Land Division	TBD[1]					Hawai`i DLNR, Land Division. Currently leased for cattle grazing. By conservation easement, lease, change of jurisdiction, or change in land use designation to conservation protective subzone.
2	1	1.3.20	A	Secure recovery area: McCandless Ranch, Portions of TMKs 392001003 and 386001001	Unknown	*McCandless Ranch	TBD[1]					McCandless Ranch. Protect contiguous forest habitat in South Kona from development. By lease, conservation easement, partnership agreement, change in land use designation, or purchase from willing seller.
2	1	1.3.21	A	Secure recovery area: Waiea Tract, TMK 386001003	Unknown	*DLNR, State Land Division	TBD[1]					Hawai`i DLNR. Land Division. Protect contiguous forest habitat in South Kona from continued degradation. Currently leased for cattle grazing. By conservation easement, lease, change of jurisdiction, or change in land use designation to conservation protective subzone.

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds

Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	1	1.3.22	A	Secure recovery area: Keālia Ranch, TMK 385001001	Unknown	*KS	TBD[1]					Kamehameha Schools. By lease, conservation easement, partnership agreement, change in land use designation, or purchase from willing seller.
2	1	1.3.23	A	Secure recovery area: Hōnaunau Forest, TMKs 384001001 384001002 383001001 383001002	Unknown	*KS	TBD[1]					Kamehameha Schools. By lease, conservation easement, partnership agreement, change in land use designation, or purchase from willing seller.
2	1	1.3.24	A	Secure recovery area: Keālia Ranch, Portions of TMK 385001002	Unknown	*Elizabeth Stack *et al.*	TBD[1]					Elizabeth Stack *et al.* Protect contiguous forest habitat in South Kona from development. By lease, conservation easement, partnership agreement, change in land use designation, or purchase from willing seller.

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds												
Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
3	1	1.3.25	A	Secure recovery area: Portions of TMK 382001001	Unknown	*Kealakekua Development Corp.	TBD[1]					Protect contiguous forest habitat in South Kona from development, and provide habitat for a second palila population. Restorable. By lease, conservation easement, partnership agreement, change in land use designation, or purchase from willing seller.
2	1	1.3.26	A	Secure recovery area: Pu`u Lehua, Portions of TMKs 378001003 378001007 372002001 378001001	Unknown	*KS	TBD[1]					Kamehameha Schools. Provides habitat for a second palila population. Restorable. By lease, conservation easement, partnership agreement, change in land use designation to conservation, or purchase from willing seller.

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds												
Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
1	2	1.3.27	A	Secure recovery area: Ko`olau Forest Reserve, TMKs 224016003 224016004 228008001 228008007	Unknown	*Alexander and Baldwin, *East Maui Irrigation, *EMWP	TBD[1]					Alexander and Baldwin, East Maui Irrigation. Additional measures may be needed to ensure forest bird recovery. By partnership, safe harbor agreement, easement, change of land use designation to protective subzone of conservation, or purchase from willing seller.
3	3	1.3.28	A	Secure recovery area: Kīpahulu Forest Reserve, Kukui`ula, TMK 216001007	Unknown	*J. Haili, *EMWP	TBD[1]					J. Haili. Small parcel at lower edge of recovery area. By partnership with LHWRP.
3	3	1.3.29	A	Secure recovery area: Kīpahulu Forest Reserve, Kukui`ula, TMK 216001006	Unknown	*Kalalau, Cleveland, *EMWP	TBD[1]					Cleveland Kalalau. Small parcel at lower edge of recovery area. By partnership with LHWRP.
1	3	1.3.30	A	Secure recovery area: Kīpahulu Forest Reserve, TMKs 216001005 217001033 217002035 217004006 218001007	Unknown	*DLNR, *EMWP, *NPS	TBD[1]					Hawai`i DOFAW. Isolated; secure access for management needed. By continuing partnership with LHWRP.

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds												
Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
3	3	1.3.31	A	Secure recovery area: Kīpahulu Forest Reserve, TMK 217001032	Unknown	*A. Kaapana *et al.*, *EMWP	TBD[1]					A. Kaapana *et al.* Small parcel at lower edge of recovery area. By partnership with LHWRP.
2	2	1.3.32	A	Secure recovery area: Kīpahulu Forest Reserve, TMK 217001024	Unknown	*Kaupō Ranch Ltd., *EMWP	TBD[1]					Kaupō Ranch Ltd. Small parcel at lower edge of recovery area. By partnership with LHWRP.
3	1	1.3.33	A	Secure recovery area: Nu`u, TMK 218001001	Unknown	*Kaupō Ranch Ltd., *EMWP, *NPS	TBD[1]					Kaupō Ranch Ltd. Degraded former forest land in need of active management. By continuing partnership with LHWRP, safe harbor agreement, conservation easement, change of land use designation, or purchase from willing seller. Acquisition being negotiated by NPS.

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds												
Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
3	2	1.3.34	A	Secure recovery area: Nu`u, TMK 218001002	Unknown	*James Campbell Est., *EMWP	TBD[1]					James Campbell Est. Degraded former forest land in need of active management. By continuing partnership with LHWRP, safe harbor agreement, conservation easement, change of land use designation, or purchase from willing seller. Acquisition being negotiated by NPS.
1	2	1.3.35	A	Secure recovery area: Kahikinui Forest Reserve, TMKs 218001006 218001005 218001009	Unknown	*DLNR, *EMWP	TBD[1]					Hawai`i DOFAW. Isolated; secure better access for management. Degraded former forest land in need of active management. By continuing partnership with LHWRP.
1	2	1.3.36	A	Secure recovery area: Kahikinui Homelands, TMKs 219001003 219001007 219001008 219001011	Unknown	*DHHL, USFWS, *EMWP	TBD[1]					Hawai`i DHHL. Degraded former forest land in active forest stewardship program with FWS. By continuing partnership with LHWRP.

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds

Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	1	1.3.37	A	Secure recovery area: Upper Auwahi, TMKs 219001006 221009001 222001001 222001034	Unknown	*`Ulupalakua Ranch Inc., DOI, NHPS, *EMWP	TBD[1]					`Ulupalakua Ranch Inc. Pasture with ongoing restoration at selected sites in partnership with DOI and NHPS. By continuing partnership with LHWRP, conservation easement, safe harbor agreement, change in land use designation, or purchase from willing seller.
2	2	1.3.38	A	Secure recovery area: Kula Forest Reserve, TMK 222007001	Unknown	*DLNR, *EMWP	TBD[1]					Hawai`i DOFAW. By continuing partnership with LHWRP. Degraded forest dominated by alien species. Resolve conflicting management as game management area.
2	3	1.3.39	A	Secure recovery area: Kēōkea, TMK 222004033	Unknown	*James Campbell Est., *EMWP	TBD[1]					James Campbell Est. Degraded former forest in need of active management. By partnership with LHWRP, conservation easement, safe harbor agreement, change in land use designation, or purchase from willing seller.

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds												
Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	3	1.3.40	A	Secure recovery area: Waiohuli, TMK 222005052	Unknown	*James Campbell Est., *EMWP	TBD[1]					James Campbell Est. Degraded former forest in need of active management. By continuing partnership with LHWRP, conservation easement, safe harbor agreement, change in land use designation, or purchase from willing seller.
2	3	1.3.41	A	Secure recovery area: Ka`ono`ulu, TMKs 222007002 222006009 222006032 222007010	Unknown	*Ka`ono`ulu Ranch Co. Ltd., *EMWP	TBD[1]					Ka`ono`ulu Ranch Co. Ltd. Degraded former forest in need of active management. By continuing partnership with LHWRP, conservation easement, safe harbor agreement, or purchase from willing seller.
2	3	1.3.42	A	Secure recovery area: Waiakoa, TMK 222008001	Unknown	*Lucky Shoji USA Inc., *EMWP	TBD[1]					Lucky Shoji USA Inc. *et al.* Degraded former forest in need of active management. By partnership with LHWRP, conservation easement, safe harbor agreement, change of land use designation, or purchase from willing seller.

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds

Priority #	Priority Tier	Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units) Total	FY 07	FY 08	FY 09	FY 10	Comments/Notes
2	3	1.3.43	A	Secure recovery area: Kamehame Nui/Kealahou, TMK 223005002	Unknown	*John Zwaanstra, *EMWP	TBD[1]					John Zwaanstra. Degraded former forest in need of active management. By continuing partnership with LHWRP, conservation easement, safe harbor agreement, change of land use designation, or purchase from willing seller.
1	2	1.3.44	A	Secure recovery area: Haleakalā Ranch (Pūlehu Nui /Kalialinui), TMK 223005003	Unknown	*Haleakalā Ranch Co., *EMWP	TBD[1]					Haleakalā Ranch Co. Degraded former forest in need of active management. By continuing partnership with LHWRP, conservation easement, safe harbor agreement, change of land use designation, or purchase from willing seller.
1	1	1.3.45	A	Secure recovery area: Waikamoi Preserve, TMK 223005004	Unknown	*Haleakalā Ranch Co., *TNCH, *EMWP	TBD[1]					Haleakalā Ranch Co. Under active management by The Nature Conservancy of Hawai`i through conservation easement. In EMWP and NAPS. Support continued management by TNCH, or by purchase from willing seller.

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds												
Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	1	1.3.46	A	Secure recovery area: West Maui Forest Reserve, Wailuku, TMKs 233003003 235003001 236003001	Unknown	*Wailuku Agriculture, *WMWP	TBD[1]					Wailuku Agriculture. In West Maui Watershed Partnership (WMWP). By conservation easement or purchase from willing seller.
2	3	1.3.47	A	Secure recovery area: West Maui Forest Reserve, Launiupoko, TMK 247001002	Unknown	*Amfac/JMB Hawai`i Co., *WMWP	TBD[1]					American Factors (Amfac)/JMB Hawai`i Co. In WMWP. By conservation easement, safe harbor agreement, or purchase from willing seller.
2	3	1.3.48	A	Secure recovery area: West Maui Forest Reserve, Kaua`ula, TMK 246025001	Unknown	*Amfac/JMB Hawai`i Co., *WMWP	TBD[1]					American Factors (Amfac)/JMB Hawai`i Co. In WMWP. By conservation easement, safe harbor agreement, or purchase from willing seller.
2	3	1.3.49	A	Secure recovery area: West Maui Forest Reserve, Kahoma, TMK 245022001	Unknown	*KS, *WMWP	TBD[1]					Kamehameha Schools. In WMWP. By conservation easement, safe harbor agreement, or purchase from willing seller.

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Priority #	Priority Tier	Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units) Total	FY 07	FY 08	FY 09	FY 10	Comments/Notes
2	3	1.3.50	A	Secure recovery area: West Maui Forest Reserve, Pu` u Kī/Haakea, TMKs 245022002 245022004	Unknown	*Amfac/JMB Hawai`i Co., *WMWP	TBD[1]					American Factors (Amfac)/JMB Hawai`i Co. In WMWP. By conservation easement, safe harbor agreement, or purchase from willing seller.
2	3	1.3.51	A	Secure recovery area: Kapunakea Preserve, Amfac/ JMB Hawai`i Co., TNCH, TMK 244007001	Unknown	*Amfac/JMB Hawai`i Co., *TNCH, *WMWP, NAPS	TBD[1]					American Factors (Amfac)/JMB Hawai`i Co. Currently managed by TNCH through conservation easement. In WMWP and NAPS. By purchase from willing seller.
2	3	1.3.52	A	Secure recovery area: West Maui Forest Reserve, Kapāloa, TMK 244007007	Unknown	*WMWP	TBD[1]					Unknown. In WMWP. By conservation easement, safe harbor agreement, or purchase from willing seller.
2	1	1.3.53	A	Secure recovery area: Pu`u Kukui Watershed Management Area, TMKs 242001001 241001017	Unknown	*Maui Land and Pineapple, *WMWP, NAPS	TBD[1]					Maui Land and Pineapple. In WMWP and NAPS. Support continued conservation management by Maui Land and Pine, or by purchase from willing seller.
2	2	1.3.54	A	Secure recovery area: Moloka`i Forest Reserve, Kahanui, TMK 252014001	Unknown	*R. W. Myer Ltd., *et al.*	TBD[1]					R. W. Myer Ltd., *et al.* By easement, safe harbor agreement, or purchase from willing seller.

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	2	1.3.55	A	Secure recovery area: Moloka`i Forest Reserve, Pelekunu Valley, TMK 259006011	Unknown	*TNCH	TBD[1]					The Nature Conservancy of Hawai`i. Support continued Management by TNCH.
2	3	1.3.56	A	Secure recovery area: Moloka`i Forest Reserve, Pelekunu Valley, Wawaeolepe, TMK 259008017	Unknown	*William Hitchcock, *et al.*	TBD[1]					Wm. Hitchcock *et al.* By easement, safe harbor agreement, or purchase from willing seller.
2	2	1.3.57	A	Secure recovery area: Moloka`i Forest Reserve, Pelekunu Valley, TMK 254003032	Unknown	*TNCH	TBD[1]					The Nature Conservancy of Hawai`i. Support continued Management by TNCH.
2	1	1.3.58	A	Secure recovery area: Moloka`i Forest Reserve, Wailau Valley and Oloku`i, TMK 259006004	Unknown	*G. Brown III, *et al.*	TBD[1]					G. Brown III *et al.* By easement, safe harbor agreement, or purchase from willing seller.
2	3	1.3.59	A	Secure recovery area: Moloka`i Forest Reserve, Laeokapuna, TMK 257005027	Unknown	*P. Hodgins	TBD[1]					P. Hodgins. By easement, safe harbor agreement, or purchase from willing seller.
2	3	1.3.60	A	Secure recovery area: Moloka`i Forest Reserve, Keanakoholua, TMK 257005001	Unknown	*M. Hustice Trust	TBD[1]					M. Hustice Trust. By easement, safe harbor agreement, or purchase from willing seller.

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Priority #	Priority Tier	Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units) Total	FY 07	FY 08	FY 09	FY 10	Comments/Notes
2	3	1.3.61	A	Secure recovery area: Moloka`i Forest Reserve, Manawai, TMK 256006013	Unknown	*P. Petro Trust	TBD[1]					P. Petro Trust. By easement, safe harbor agreement, or purchase from willing seller.
2	3	1.3.62	A	Secure recovery area: Moloka`i Forest Reserve, West `Ōhi`a Gulch, TMK 256006010	Unknown	*E. Wond Trust	TBD[1]					E. Wond Trust. By easement, safe harbor agreement, or purchase from willing seller.
2	3	1.3.63	A	Secure recovery area: Moloka`i Forest Reserve, Keawa Nui, TMK 256006007	Unknown	*KS	TBD[1]					Kamehameha Schools. In EMOWP. By easement, safe harbor agreement, or purchase from willing seller.
2	3	1.3.64	A	Secure recovery area: Moloka`i Forest Reserve, Pua`ahala, TMK 256006002	Unknown	*K&H Horizons Hawai`i	TBD[1]					K&H Horizons Hawai`i. In EMOWP. By easement, safe harbor agreement, or purchase from willing seller.
2	3	1.3.65	A	Secure recovery area: Moloka`i Forest Reserve, Kumu`eli, TMK 256006001	Unknown	*D. Fairbanks III Trust	TBD[1]					D. Fairbanks III Trust. In EMOWP. By easement, safe harbor agreement, or purchase from willing seller.
2	3	1.3.66	A	Secure recovery area: Moloka`i Forest Reserve, Kamalō, TMKs 255001016 255001006 255001017	Unknown	*KS	TBD[1]					Kamehameha Schools. In EMOWP. By easement, safe harbor agreement, or purchase from willing seller.

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	3	1.3.67	A	Secure recovery area: Moloka`i Forest Reserve, Mākolelau, TMK 255001015	Unknown	*Ashton Pitts Jr. Trust	TBD[1]					Ashton Pitts Jr. Trust. By easement, safe harbor agreement, or purchase from willing seller.
2	2	1.3.68	A	Secure recovery area: Kamakou Preserve, Kawela, TMK 2540003026	Unknown	*Moloka`i Ranch Ltd., TNCH	TBD[1]					Moloka`i Ranch Ltd., The Nature Conservancy of Hawai`i. In EMOWP. By easement, safe harbor agreement, or purchase from willing seller.
2	3	1.3.69	A	Secure recovery area: Moloka`i Forest Reserve, Kawela, TMKs 254003001 254003028	Unknown	*Kawela Plantation Homes Association	TBD[1]					Kawela Plantation Homes Association. By easement or purchase from willing seller. In EMOWP.
2	3	1.3.70	A	Secure recovery area: Moloka`i Forest Reserve, Kaunakakai, TMK 253003005	Unknown	*Moloka`i Ranch Ltd.	TBD[1]					Moloka`i Ranch Ltd. By easement, safe harbor agreement, or purchase from willing seller.

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
1	1	1.3.71	A	Secure recovery area: Pia Valley, TMKs 37003073 37003033	Unknown	*Benjamin Cassiday, *James Pflueger, *KMWP	TBD[1]					Benjamin Cassiday, James Pflueger. Upper valley in KMWP, but additional measures may be needed to ensure protection of large `elepaio population. Lower valley zoned conservation, but no other protection. By enrollment in KMWP, easement, or purchase from willing seller.
1	3	1.3.72	A	Secure recovery area: Lower Wailupe Valley, TMK 36004001	Unknown	*City and County of Honolulu	TBD[1]					City and County of Honolulu. Contains lower edge of large `elepaio population. Currently zoned urban. By enrollment in KMWP, easement, change in land use designation, or purchase from willing seller.
1	2	1.3.73	A	Secure recovery area: Kūpaua Valley, TMKs 37004001 and 37004002	Unknown	*Hawai`i Humane Society, *KMWP	TBD[1]					Hawai`i Humane Society. Upper valley in KMWP, but additional measures needed to ensure protection of large `elepaio population. By easement, SHA, enrollment in KMWP, or purchase from willing seller.

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
1	2	1.3.74	A	Secure recovery area: Kuli`ou`ou Valley, TMK 38013001	Unknown	*Joseph Paiko Trust, *KMWP	TBD[1]					Joseph Paiko Trust. Contains western half of small `elepaio population. By easement, SHA, enrollment in KMWP, or purchase from willing seller.
2	3	1.3.75	A	Secure recovery area: Ka`alākei Valley, TMK 39009001	Unknown	*Hawai`i Kai Development Co., *KMWP	TBD[1]					Hawai`i Kai Development Co. Contains small `elepaio population. By easement, SHA, enrollment in KMWP, or purchase from willing seller.
3	3	1.3.76	A	Secure recovery area: Kapālama, TMK 14015009	Unknown	*Julius Chung Trust, *KMWP	TBD[1]					Julius Chung Trust. Small parcel. By partnership in KMWP.
1	1	1.3.77	A	Secure recovery area: Moanalua Valley, TMK 11013001	Unknown	*Amon Estate, *KMWP	TBD[1]					Damon Estate. In KMWP, but additional measures may be needed to ensure protection of large `elepaio population. By easement, SHA or purchase from willing seller.
1	1	1.3.78	A	Secure recovery area: South Hālawa Valley, Tripler Ridge, TMK 99011001	Unknown	*Queen's Medical Center, *KMWP	TBD[1]					Queen's Medical Center. In KMWP, but additional measures may be needed to ensure protection of large `elepaio population. By easement, SHA, or purchase from willing seller.

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Priority #	Priority Tier	Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units) Total	FY 07	FY 08	FY 09	FY 10	Comments/Notes
1	1	1.3.79	A	Secure recovery area: Waikāne Valley, TMK 48014005	Unknown	*SMF Enterprises, *KMWP	TBD[1]					SMF Enterprises. In KMWP, but additional measures may be needed to ensure protection of large `elepaio population. By easement, SHA, or purchase from willing seller.
2	3	1.3.80	A	Secure recovery area: Waianu Valley, TMKs 48014003 and 48013014	Unknown	*Waiāhole Irrigation Co. Ltd., *KMWP	TBD[1]					Waiāhole Irrigation Co. Ltd. In KMWP, but additional measures may be needed to ensure protection of large `elepaio population. By easement, SHA, or purchase from willing seller.
1	2	1.3.81	A	Secure recovery area: Southern Alaka`i Plateau, Portion of TMK 417001001	Unknown	*Robinson Family Partners	TBD[1]					Robinson Family Partners. Develop cooperative management agreement or purchase from willing seller.
2	1	1.3.82	A	Secure recovery area: Upper Wainiha Pali, Portion of TMK 458001001	Unknown	*Alexander and Baldwin, Hawai`i Inc., *DLNR	TBD[1]					Alexander and Baldwin Hawai`i Inc. Currently under surrender agreement to DLNR. Area under management of DLNR. Land is remote, no public access. Adequately protected at present and for foreseeable future. Any change in this status should be reassessed.

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	2	2.1.1	A	Reforest areas on the Northeast slope of Mauna Kea, Portions of TMKs 344014002 344014003 343010002 343010008	Unknown	*DLNR, State Land Division	31.5					Hawai`i DLNR, Land Division. Reforest and restore pasturelands to dry māmane and mesic koa forest.
1	3	2.1.2	A	Reforest areas of the Kanakaleonui Corridor, TMK 338001009	Unknown	*DHHL	15.1					Hawai`i DHHL. Provides a vital link between mesic koa forest and dry māmane forest. Restore upper pasturelands.
3	1	2.1.3	A	Reforest areas of the Hilo Forest Reserve, Laupāhoehoe Section, TMK 337001004	Unknown	*DLNR, *DOFAW	0.9					Hawai`i DOFAW. Remove alien trees, restore transition forest from wet `ōhi`a to mesic koa.
3	2	2.1.4	A	Reforest areas of the Hilo Forest Reserve, Pīhā Section, TMK 333001004	Unknown	*DLNR, *DOFAW	1.4					Hawai`i DOFAW. Remove alien trees. Restore transition forest from wet `ōhi`a to mesic koa. Facilitate understory regeneration.

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Priority #	Priority Tier	Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units) Total	FY 07	FY 08	FY 09	FY 10	Comments/Notes
1	1	2.1.5	A	Reforest areas of Hakalau Forest NWR, TMKs 337001010 329005005 333001007 329005003	Ongoing	*USFWS	33.7					USFWS. Remove alien trees and continue successful forest restoration program.
3	2	2.1.6	A	Reforest areas of Kīpuka `Āinahou Nēnē Sanctuary, TMK 338001008	Unknown	*DHHL, *DOFAW	17.8					Hawai`i DHHL, leased by DOFAW. Facilitate canopy tree and understory regeneration.
2	3	2.1.7	A	Reforest areas of Humu`ula, TMK 338001002	Unknown	*DHHL	29.8					Hawai`i DHHL. Restorable. A vital link between wet and dry forest. Reforest pasturelands to transition forest from mesic koa to dry māmane.
2	2	2.1.8	A	Reforest areas of Humu`ula, Portions of TMK 338001007	Unknown	*DHHL, Parker Ranch	71.6					Hawai`i DHHL, leased to Parker Ranch. Reforest pasturelands to native montane dryland habitat.
2	2	2.1.9	A	Reforest areas of Lama`ia Section, TMK 326018002	Unknown	*DHHL	14.3					Hawai`i DHHL, adjacent to Hakalau Forest National Wildlife Refuge. Vital link between montane mesic forest and montane dry forest. Protect existing forest and reforest pasturelands.

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	2	2.1.10	A	Reforest areas of Pu`u `Ō`ō Ranch, TMK 326018001	Unknown	*DLNR, State Land Division, Pu`u `Ō`ō Ranch	17.8					Hawai`i DLNR, Land Division, leased to Pu`u `Ō`ō Ranch. Important mesic and wet koa/`ōhi`a forest remnants, and vital link between wet and dry forest communities. Protect and reforest.
2	2	2.1.11	A	Reforest areas of Ka`ohe, TMK 344015002	Unknown	*DLNR, State Land Division	0.9					Hawai`i DLNR, Land Division. Protect and reforest.
1	3	2.1.12	A	Reforest areas of Mauna Kea Forest Reserve, TMK 344015002	Unknown	*DLNR	3.9					Hawai`i DLNR. Restore montane dry māmane/naio forest.
3	1	2.1.13	A	Reforest areas of Keauhou Ranch, TMK 399001004	Unknown	*KS, Keauhou Ranch	108.7					Kamehameha Schools. Reforest transition wet `ōhi`a, mesic koa and dry māmane/sandalwood.
3	1	2.1.14	A	Reforest areas of HVNP, TMK 399001002	Unknown	*HVNP	13.1					Hawai`i Volcanoes National Park. Continue dryland forest restoration.
2	2	2.1.15	A	Reforest areas of Kapāpala Ranch, Portions of TMK 398001004	Unknown	*DLNR, State Land Division, Kapāpala Ranch	11.9					Hawai`i DLNR, Land Division, Kapāpala Ranch. A link between forest communities to the east and west. Remove alien trees, restore montane dry koa, `ōhi`a and māmane forest.

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Priority #	Priority Tier	Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units) Total	FY 07	FY 08	FY 09	FY 10	Comments/Notes
3	1	2.1.16	A	Reforest areas of Ka`ū Forest Reserve, TMK 397001007	Unknown	*Mauna Kea Agribusiness	1.1					Mauna Kea Agribusiness. Protect and facilitate natural regeneration.
2	1	2.1.17	A	Reforest areas of Ka`ū Forest Reserve, Portions of TMKs 397001006 and 397001005	Unknown	*KS	5.3					Kamehameha Schools. Protect and facilitate natural regeneration.
2	1	2.1.18	A	Reforest portions of TMK 392001002	Unknown	*Samuel M. Damon Trust	11.2					Samuel M. Damon Trust. Valuable wet and mesic forest habitat needs restoring. A link between Ka`ū Forest and the South Kona Forest.
3	1	2.1.19	A	Reforest areas of Honomalino, TMKs 389006004 389006029	Unknown	*Scott C. Rolles Trust	0.5					Scott C. Rolles Trust. A link between Ka`ū Forest and South Kona Forest. Protect and restore montane mesic koa forest.
3	1	2.1.20	A	Reforest areas of Papa, TMK 388001001	Unknown	*Koa Aina Ventures	8.2					The Nature Conservancy, Kona Hema Preserve. Recently sold by Koa Aina Ventures. A link between Ka`ū Forest and South Kona Forest. Restore montane mesic koa forest.
3	1	2.1.21	A	Reforest areas of Honomalino, TMK 389001001	Unknown	*TNCH	12.0					The Nature Conservancy of Hawai`i. Continue forest restoration program.

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#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	1	2.1.22	A	Reforest areas of Honomalino Forest Reserve, TMK 389001002	Unknown	*DLNR	1.3					Hawai`i DOFAW. Restore montane mesic koa and `ōhi`a forest.
2	3	2.1.23	A	Reforest areas of Yee Hop Ranch, Portions of TMKs 388001003 388001004 387012001 392001005 387012003 387012004 387001007 387001006 387001011 387001004	Unknown	*Yee Hop Ranch Ltd.	27.9					Yee Hop Ranch Ltd. Provides links between State land parcels and protects contiguous forest habitat in South Kona from development. Protect and restore wet `ōhi`a, mesic koa and dry māmane/naio forest.
1	3	2.1.24	A	Reforest areas of Kona Forest NWR, TMK 386001001	Unknown	*USFWS	2.0					USFWS. Restore montane mesic koa and `ōhi`a forest.
3	2	2.1.25	A	Reforest areas of `Alae Ranch, Portions of TMK 387001014	Unknown	*DLNR, State Land Division	0.9					Hawai`i DLNR, Land Division, leased to `Alae Ranch. Protect and restore wet `ōhi`a forest.

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#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	3	2.1.26	A	Reforest areas of McCandless Ranch and E. Stack *et al.*, Portions of TMKs 392001003 386001001 385001002	Unknown	*McCandless Ranch	12.9					Protects contiguous forest habitat in South Kona from development. Restore pasture to mesic koa and dry māmane/naio forest.
2	1	2.1.27	A	Reforest areas of Waiea Tract, TMK 386001003	Unknown	*DLNR, State Land Division	1.9					Hawai`i DLNR, Land Division. Protects contiguous mesic koa forest habitat in South Kona.
2	1	2.1.28	A	Reforest areas of Keālia Ranch, TMK 385001001 and Portions of TMKs 384001001 and 383001001	Unknown	*KS	4.2					Kamehameha Schools. Restore mesic koa forest and dry māmane/naio forest.
3	2	2.1.29	A	Reforest areas of TMK 382012001	Unknown	*Kealakekua Development Corp.	31.9					Kealakekua Development Corp. Protect contiguous forest habitat in South Kona, provide habitat for a second palila population. Restore wet `ōhi`a, mesic koa and dry montane māmane forest.

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Priority #	Priority Tier	Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units) Total	FY 07	FY 08	FY 09	FY 10	Comments/Notes
2	1	2.1.30	A	Reforest areas of Pu`u Lehua, Portions of TMKs 378001003 378001007 378001002 378001001	Unknown	*KS	145.8					Kamehameha Schools. Protects contiguous forest habitat in South Kona from development, and provide habitat for a second palila population. Restore mesic koa and dry montane māmane forest.
2	1	2.1.31	A	Reforest areas of Pu`u Wa`awa`a Forest Bird Sanctuary, TMKs 371001001 371001006	Unknown	*DOFAW	34.3					Hawai`i DOFAW, Pu`u Wa`awa`a Forest Bird Sanctuary. Restore montane mesic koa and māmane/naio forest habitat.
2	3	2.1.32	A	Reforest areas of Hualālai Ranch, TMK 372002001	Unknown	*KS	11.8					Kamehameha Schools. Restore mesic and dry montane forest.
1	3	2.1.33	A	Reforest areas of Haleakalā National Park, TMK 218001007	Unknown	*NPS	8.8					National Park Service. Restore montane mesic forest in Kaupō Gap.
2	2	2.1.34	A	Reforest areas of Kīpahulu Forest Reserve, TMK 217004006	Unknown	*DLNR, *DOFAW	0.2					Hawai`i DOFAW. Restore montane mesic forest along cliffs and head of Manawainui Valley.
3	2	2.1.35	A	Reforest areas of Nu`u, TMK 218001001	Unknown	*Kaupō Ranch Ltd.	2.7					Kaupō Ranch Ltd. Restore montane mesic forest and shrubland.
3	1	2.1.36	A	Reforest areas of Nu`u, TMK 218001002	Unknown	*James Campbell Est.	4.3					James Campbell Est. Restore montane mesic forest and shrubland.

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds												
Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
1	3	2.1.37	A	Reforest areas of Kahikinui Forest Reserve, TMKs 218001006 218001005 218001009	Unknown	*DLNR, *DOFAW	2.8					Hawai`i DOFAW. Restore montane mesic forest and shrubland.
1	3	2.1.38	A	Reforest areas of Kahikinui Homelands, TMKs 219001003 219001007 219001008 219001011	Unknown	*DHHL	21.1					Hawai`i DHHL. Support ongoing restoration of montane mesic forest and shrubland.
2	2	2.1.39	A	Reforest areas of Upper Auwahi, TMKs 219001006 221009001 222001001 222001034	Unknown	*`Ulupalakua Ranch Inc.	8.1					`Ulupalakua Ranch Inc. Support ongoing restoration of montane mesic forest and shrubland.
2	3	2.1.40	A	Reforest areas of Kula Forest Reserve, TMK 222007001	Unknown	*DLNR	11.7					Hawai`i DOFAW. Restore montane mesic forest and shrubland. Replace nonnative trees.
2	3	2.1.41	A	Reforest areas of Kēōkea, TMK 222004033	Unknown	*James Campbell Est.	0.5					James Campbell Est. Restore montane mesic forest and shrubland. Replace nonnative trees.

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds												
Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	2	2.1.42	A	Reforest areas of Waiohuli, TMK 222005052	Unknown	*James Campbell Est.	1.7					James Campbell Est. Restore montane mesic forest and shrubland. Replace nonnative trees.
3	3	2.1.43	A	Reforest areas of Ka`ono`ulu, TMKs 222007002 222006009 222007010 222006032	Unknown	*Ka`ono`ulu Ranch Co. Ltd.	3.5					Ka`ono`ulu Ranch Co. Ltd. Restore montane mesic forest and shrubland. Replace nonnative trees.
3	1	2.1.44	A	Reforest areas of Waiakoa, TMK 222008001	Unknown	*Lucky Shoji USA Inc.	0.7					Lucky Shoji USA Inc. *et al.* Restore montane mesic forest and shrubland. Replace nonnative trees.
3	2	2.1.45	A	Reforest areas of Kamehame Nui/Kealahou, TMK 223005002	Unknown	*John Zwaanstra	3.3					John Zwaanstra. Restore montane mesic forest and shrubland.
1	3	2.1.46	A	Reforest areas of Haleakalā Ranch (Pūlehu Nui/Kalialinui), TMK 223005003	Unknown	*Haleakalā Ranch Co.	4.1					Haleakalā Ranch Co. Restore montane mesic forest and shrubland.
1	3	2.1.47	A	Reforest areas of Waikamoi Preserve, TMK 223005004	Unknown	*Haleakalā Ranch Co., *TNCH	29.8					Haleakalā Ranch Co., The Nature Conservancy of Hawai`i. Restore montane mesic forest and shrubland at high elevation. Replace nonnative trees.

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds												
Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	2	2.1.48	A	Reforest areas of Makawao Forest Reserve, TMK 224016001 224016002	Unknown	*DLNR	6.9					Hawai`i DOFAW. Restore montane mesic forest and shrubland. Replace nonnative trees.
2	3	2.1.49	A	Reforest areas of West Maui NAR, Kahakuloa, TMK 231006001	Unknown	*DLNR	5.8					Hawai`i DOFAW. Restore montane wet forest and shrubland.
2	3	2.1.50	A	Reforest areas of West Maui Forest Reserve, Kaheawa, TMK 248001001	Unknown	*DLNR	0.6					Hawai`i DOFAW. Restore montane wet forest and shrubland. Replace nonnative trees.
2	2	2.1.51	A	Reforest areas of West Maui Forest Reserve, Ukumehame/ Olowalu, West Maui NAR, Līhau, TMK 248001002	Unknown	*DLNR	18.4					Hawai`i DOFAW. Restore montane wet forest and shrubland.
2	1	2.1.52	A	Reforest areas of Pu`u Kukui Watershed Management Area, TMK 241001017	Unknown	*Maui Land and Pineapple	11.6					Maui Land and Pineapple. Restore montane wet forest and shrubland. Replace nonnative trees.
2	2	2.1.53	A	Reforest areas of Moloka`i Forest Reserve, Kalamāula, TMK 252014003	Unknown	*DLNR	1.6					Hawai`i DOFAW. Restore montane wet forest and shrubland. Replace nonnative trees.
2	3	2.1.54	A	Reforest areas of Moloka`i Forest Reserve, Kahanui, TMK 252014001	Unknown	*R. W. Myer Ltd., *et al.*	3.4					R. W. Myer Ltd., *et al.* Restore montane wet forest and shrubland. Replace nonnative trees.

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds

Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	3	2.1.55	A	Reforest areas of Moloka`i Forest Reserve, Kahanui, TMK 261001004	Unknown	*DLNR	0.05					Hawai`i DOFAW. Restore montane wet forest and shrubland. Replace nonnative trees.
2	3	2.1.56	A	Reforest areas of Moloka`i Forest Reserve, Kamalō, TMKs 255001016 255001006 255001017	Unknown	*KS	6.0					Kamehameha Schools. Restore montane mesic forest and shrubland.
3	3	2.1.57	A	Reforest areas of Moloka`i Forest Reserve, Mākolelau, TMK 255001015	Unknown	*Ashton Pitts Jr. Trust	1.0					Ashton Pitts Jr. Trust. Restore montane mesic forest and shrubland.
2	2	2.1.58	A	Reforest areas of Kamakou Preserve, Kawela, TMK 2540003026	Unknown	*Moloka`i Ranch Ltd., *TNCH	11.1					Moloka`i Ranch Ltd, The Nature Conservancy of Hawai`i. Restore montane mesic forest and shrubland. Replace nonnative trees.
3	2	2.1.59	A	Reforest areas of Moloka`i Forest Reserve, Kawela, TMK 254003001	Unknown	*Kawela Plantation Homes Association	3.7					Kawela Plantation Homes Association. Restore montane mesic forest and shrubland.
2	2	2.1.60	A	Reforest areas of Moloka`i Forest Reserve, Kamiloloa/Makakupaīa, TMK 254003025	Unknown	*DLNR	5.3					Hawai`i DOFAW. Restore montane mesic forest and shrubland. Replace nonnative trees.

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Priority #	Priority Tier	Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units) Total	FY 07	FY 08	FY 09	FY 10	Comments/Notes
3	3	2.1.61	A	Reforest areas of Moloka`i Forest Reserve, Kaunakakai, TMK 253003005	Unknown	*Moloka`i Ranch Ltd.	2.5					Moloka`i Ranch Ltd. Restore montane mesic forest and shrubland. Replace nonnative trees.
3	3	2.1.62	A	Reforest areas of Mākua Military Reservation	Unknown	*U.S. Army	6.0					U.S. Army. Portions of upper valley recently burned, need reforestation.
3	2	2.1.63	A	Reforest areas of Kōke`e State Park, TMKs 414001013 459001016 414001020 414001014 414001002 and numerous small parcels within	Unknown	*DLNR, Division of State Parks	20.0					Hawai`i DLNR, Division of State Parks. Additional protection may be needed to secure remaining forested habitat.
2	1	2.2.1	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation on the northeast slopes of Mauna Kea, Portions of TMKs 344014002 344014003 343010002 343010008	Continual	*DLNR, State Land Division	48.7					Hawai`i DLNR, Land Division.

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
1	2	2.2.2	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Kanakaleonui Corridor, TMK 338001009	Continual	*DHHL	33.4					Hawai`i DHHL. Provides vital link between mesic koa forest and dry māmane forest. Currently under lease for cattle grazing.
2	2	2.2.3	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Hilo Forest Reserve, Laupāhoehoe and Pīhā Sections, TMKs 337001004 333001004	Continual	*DLNR, *DOFAW	63.1					Hawai`i DOFAW. Currently managed for game hunting.
1	1	2.2.4	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Hakalau Forest NWR, TMKs 337001010 329005005 333001007 329005005 329005003	Continual	*USFWS	114.4					USFWS. Ungulate control under way. Construct additional fences and control ungulates in unmanaged areas.
2	1	2.2.5	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Lama`ia Section, TMK 326018002	Continual	*DHHL	44.3					Hawai`i DHHL, adjacent to Hakalau Forest National Wildlife Refuge. Encourage fencing and ungulate removal.

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	2	2.2.6	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Pu`u `Ō`ō Ranch, TMK 326018001	Continual	*DLNR, State Land Division, Pu`u `Ō`ō Ranch	36.7					Hawai`i DLNR, Land Division, Pu`u `Ō`ō Ranch lease. Encourage fencing and ungulate removal.
2	1	2.2.7	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Kīpuka `Āinahou Nēnē Sanctuary, TMK 338001008	Continual	*DHHL	55.0					Hawai`i DHHL. Encourage fencing and ungulate removal.
2	2	2.2.8	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Ka`ohe, TMK 344015002	Continual	*DLNR, State Land Division	2.8					Hawai`i DLNR, Land Division. Suspend lease. Fence and remove ungulates.
1	1	2.2.9	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Mauna Kea Forest Reserve, TMKs 344015001 344016003 338001004	Continual	*DLNR, *DOFAW	127.7					Hawai`i DLNR. Palila critical habitat. Continue to remove ungulates.

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
1	3	2.2.10 and 2.2.11	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Waiākea Forest Reserve, TMK 324008001	Continual	*DLNR, *DOFAW	229.8					Hawai`i DOFAW. Fence and remove ungulates.
1	2	2.2.12	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within `Ōla`a/Kīlauea Partnership, TMKs 324008009 399001007 399001004 324008025 319001001 319001007	Continual	*KS, Keauhou Ranch, Kūlani Correctional Facility, *Maka`ala NAR, *HVNP	218.7					Kamehameha Schools, Keauhou Ranch. Kūlani Correctional Facility, Pu`u Maka`ala NAR, HVNP.
2	1	2.2.13	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Kapāpala Forest Reserve, Portions of TMK 398001004	Continual	*DLNR, State Land Division	92.0					Hawai`i DLNR, Land Division, Kapāpala Forest Reserve. Fence and remove ungulates.
1	1	2.2.14	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Ka`ū Forest Reserve, TMK 397001001	Continual	*DLNR, *DOFAW	306.7					Hawai`i DOFAW, Ka`ū Forest Reserve. Fence and remove ungulates.

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
1	2	2.2.15	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Kahuku Ranch, Portions of TMK 392001002	Continual	*NPS	231.6					Recently purchased by NPS. Fence and remove ungulates, particularly mouflon sheep.
2	2	2.2.16	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Manukā NAR, Upper Portions of TMK 391001002	Continual	DLNR, DOFAW	21.3					Hawai`i DOFAW. Fence and remove ungulates.
3	1	2.2.17	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Honomalino, TMK 389001001	Continual	*TNCH	0.9					The Nature Conservancy of Hawai`i. Fence and remove ungulates.
3	1	2.2.18	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Yee Hop Ranch, TMK 392001005	Continual	*Yee Hop Ranch Ltd.	38.0					Yee Hop Ranch Ltd. Fence and remove ungulates.
2	1	2.2.19	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Kona Forest NWR, TMK 386001001	Continual	*USFWS	24.6					USFWS. Fence and remove ungulates.

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	1	2.2.20	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within McCandless Ranch, Portions of TMKs 392001003 386001001 385001002	Continual	*McCandless Ranch and E. Stack *et al.*	92.2					McCandless Ranch and E. Stack *et al.* Fence and remove ungulates.
2	2	2.2.21	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Waiea Tract, TMK 386001003	Continual	*DLNR, State Land Division	5.8					Hawai`i DLNR, Land Division. Fence and remove ungulates.
2	2	2.2.22	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Hōnaunau Forest, TMKs 384001001 384001002 383001001 383001002	Continual	*KS	50[2]					Kamehameha Schools. Fence and remove ungulates

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	1	2.2.23	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Pu`u Lehua, Portions of TMKs 378001003 378001007 372002001 378001001	Continual	*KS	135.2					. Kamehameha Schools. Fence and remove ungulates.
1	1	2.2.24	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Ko`olau Forest Reserve, TMKs 224016003 224016004 228008001 228008007	Continual	*Alexander and Baldwin, *East Maui Irrigation, EMWP, TNCH	50[2]					Alexander and Baldwin, East Maui Irrigation. EMWP fence protects lower boundary in east; TNCH protects upper boundary. Remove ungulates from protected areas. Additional ungulate removal needed from unprotected areas.
1	1	2.2.25	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Ko`olau Forest Reserve, TMKs 211002002 212004005 229014001 211001050 211001044	Continual	*DLNR, *EMWP	50[2]					Hawai`i DOFAW. EMWP fencing underway to protect forest above about 3,600 ft. Remove ungulates above fence. Additional ungulate control needed from unprotected areas below fence. Proposed additions to Hanawī NAR would support forest bird recovery.

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
1	1	2.2.26	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Hanawī NAR and Ko`olau Forest Reserve, TMK 212004007	Continual	*DLNR	100[2]					Hawai`i DLNR. NAR fencing protects 1,734 acres, ungulate-free, above 5,400 ft. Fence and remove ungulates from remain portions of NAR (above 2,500 ft. for bird management).
1	3	2.2.27	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Hāna Forest Reserve, TMK 210001001 214001001 215001001	Continual	*DLNR	106.9					Hawai`i DLNR. Fencing and ungulate control urgently needed. Proposed additions to Hanawī NAR would support forest bird recovery.
1	1	2.2.28	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Haleakalā National Park, TMK 213001003 216001002 216001001 216001003 217004016 216010001	Continual	*NPS	50[2]					NPS. Mostly protected by fencing, ungulate removal needs to be completed in some areas. Fence and remove ungulates from remaining areas, e.g., Ka`āpahu.

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Priority #	Priority Tier	Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units) Total	FY 07	FY 08	FY 09	FY 10	Comments/Notes
3	3	2.2.29	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Kīpahulu Forest Reserve, Kukui`ula, TMK 216001007	Continual	*J. Haili	0.2					J. Haili. Encourage ungulate control and fencing.
3	2	2.2.30	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Kīpahulu Forest Reserve, Kukui`ula, TMK 216001006	Continual	*Kalalau, Cleveland	0.6					C. Kalalau. Encourage ungulate control and fencing.
1	3	2.2.31	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Kīpahulu Forest Reserve, TMKs 216001005 217001033 217002035 217004006	Continual	*DLNR	20.3					Hawai`i DLNR. Fence and remove ungulates.
3	2	2.2.32	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Kīpahulu Forest Reserve, TMK 217001032	Continual	*A. Ka`apana *et al.*	0.1					A. Ka`apana *et al.* Encourage ungulate control and fencing.

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	2	2.2.33	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Kīpahulu Forest Reserve, TMK 217001024	Continual	*Kaupō Ranch Ltd.	0.2					Kaupō Ranch Ltd. Encourage ungulate control and fencing.
3	3	2.2.34	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Nu`u, TMK 218001001	Continual	*Kaupō Ranch Ltd.	8.1					Kaupō Ranch Ltd. Encourage ungulate control and fencing.
3	3	2.2.35	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Nu`u, TMK 218001002	Continual	*James Campbell Estate	13.0					James Campbell Est. Encourage ungulate control and fencing.
1	2	2.2.36	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Kahikinui Forest Reserve, TMKs 218001006 218001005 218001009	Continual	*DLNR	50[2]					Hawai`i DOFAW. Fencing of portion underway. Complete fencing and ungulate removal from Forest Reserve above 4,000 ft.

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds

Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
1	2	2.2.37	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Kahikinui Homelands, TMKs 219001003 219001007 219001008 219001011	Continual	*DHHL	50[2]					Hawai`i DHHL. Fencing of portions underway. Continue fencing through partnership programs. Ungulate removal above 4,000 ft.
1	2	2.2.38	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Upper Auwahi, TMKs 219001006 221009001 222001001 222001034	Continual	*`Ulupalakua Ranch Inc.	50[2]					`Ulupalakua Ranch Inc. Some exclosures for plant protection in place or underway. Encourage fencing and ungulate removal above 4,000 ft.
2	1	2.2.39	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Kula Forest Reserve, TMK 222007001	Continual	*DLNR	35.1					Hawai`i DOFAW. Currently a sustained yield game management area. For portions within forest bird recovery area, fence and remove ungulates to allow regeneration of native forest.

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	2	2.2.40	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Kēōkea, TMK 222004033	Continual	*James Campbell Est.	1.6					James Campbell Est. Fence and remove ungulates within forest bird recovery area, manage with Kula Forest Reserve.
2	2	2.2.41	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Waiohuli, TMK 222005052	Continual	*James Campbell Est.	5.2					James Campbell Est. Fence and remove ungulates within forest bird recovery area, manage with Kula Forest Reserve.
2	2	2.2.42	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Ka\`ono\`ulu, TMKs 222007002 222006009 222007010 222006032	Continual	*Ka\`ono\`ulu Ranch Co. Ltd.	10.6					Ka\`ono\`ulu Ranch Co. Ltd. Fence and remove ungulates within forest bird recovery area, manage with Kula Forest Reserve.
2	3	2.2.43	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Waiakoa, TMK 222008001	Continual	*Lucky Shoji USA Inc. *et al.*	2.2					Lucky Shoji USA Inc. *et al.* Fence and remove ungulates within forest bird recovery area, manage with Kula Forest Reserve.
2	2	2.2.44	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Kamehame Nui/Kealahou, TMK 223005002	Continual	* John Zwaanstra	10.0					John Zwaanstra. Fence and remove ungulates within forest bird recovery area.

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	2	2.2.45	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Haleakalā Ranch (Pūlehu Nui/Kalialinui), TMK 223005003	Continual	*Haleakalā Ranch Co.	12.2					Haleakalā Ranch Co. The ranch is formulating a conservation reforestation plan. Fence and remove ungulates within forest bird recovery area.
1	1	2.2.46	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Waikamoi Preserve, TMK 223005004	Complete	*Haleakalā Ranch Co.	20[2]					Haleakalā Ranch Co., The Nature Conservancy of Hawai`i. Strategic fencing and ungulate control protects the Preserve. Additional protection, especially from deer, may be warranted.
1	3	2.2.47	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Makawao Forest Reserve, TMKs 224016001 224016002	Continual	*DLNR	20.5					Hawai`i DOFAW. Public hunting currently permitted. Fence and remove ungulates within forest bird recovery area.
2	2	2.2.48	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within West Maui NAR, Kahakuloa, TMK 231006001	Continual	*DLNR	17.5					Hawai`i DLNR. Protect with strategic fencing and remove ungulates within forest bird recovery area.

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	2	2.2.49	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within West Maui Forest Reserve, Waihe`e, TMK 232014001	Continual	*Maui Board of Water Supply	31.8					Maui Board of Water Supply. Strategic fencing and ungulate removal within forest bird recovery area.
2	2	2.2.50	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within West Maui Forest Reserve, Kou, TMK 232014002	Continual	*DLNR	0.8					Hawai`i DOFAW. Strategic fencing and ungulate removal within forest bird recovery area.
2	2	2.2.51	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within West Maui Forest Reserve, Wailuku, TMKs 233003003 235003001 236003001	Continual	*Wailuku Agriculture	59.7					Wailuku Agriculture. Strategic fencing and ungulate removal within forest bird recovery area.
2	3	2.2.52	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within West Maui Forest Reserve, `Īao, TMK 233003004	Continual	*DLNR	0.8					Hawai`i DOFAW. Strategic fencing and ungulate removal within forest bird recovery area.

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds													
Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	3	2.2.53	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within West Maui Forest Reserve, Kealaloloa, TMK 236001014	Continual	*DLNR	4.1					Hawai`i DOFAW. Strategic fencing and ungulate removal within forest bird recovery area.
2	2	2.2.54	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within West Maui Forest Reserve, Manawainui Plant Reserve, TMKs 236001052 248001010	Continual	*DLNR	0.7					Hawai`i DOFAW. Strategic fencing and ungulate removal within forest bird recovery area.
2	3	2.2.55	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within West Maui Forest Reserve, Kaheawa, TMK 248001001	Continual	*DLNR	1.7					Hawai`i DOFAW. Strategic fencing and ungulate removal within forest bird recovery area.
2	3	2.2.56	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within West Maui Forest Reserve, Ukumehame/Olowalu, West Maui NAR, Līhau, TMK 248001002	Continual	*DLNR	55.1					Hawai`i DOFAW. Strategic fencing and ungulate removal within forest bird recovery area.

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds													
Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)						Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10		
2	2	2.2.57	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within West Maui Forest Reserve, Launiupoko, TMK 247001002	Continual	*Amfac/JMB Hawai`i Co.	14.1						American Factors (Amfac)/JMB Hawai`i Co. Strategic fencing and ungulate removal within forest bird recovery area.
2	3	2.2.58	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within West Maui Forest Reserve, Pūehuehu, TMK 247001004	Continual	*DLNR	2.6						Hawai`i DOFAW. Strategic fencing and ungulate removal within forest bird recovery area.
2	3	2.2.59	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within West Maui Forest Reserve, Kaua`ula, TMK 246025001	3 years	*Amfac/JMB Hawai`i Co.	2.7						American Factors (Amfac)/JMB Hawai`i Co. Strategic fencing and ungulate removal within forest bird recovery area.
2	3	2.2.60	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within West Maui Forest Reserve, Pana`ewa, TMK 246025002	Continual	*DLNR	12.0						Hawai`i DOFAW. Strategic fencing and ungulate removal within forest bird recovery area.

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds												
Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	3	2.2.61	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within West Maui Forest Reserve, Kahoma, TMK 245022001	Continual	*KS	10.5					Kamehameha Schools. Strategic fencing and ungulate removal within forest bird recovery area.
2	3	2.2.62	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within West Maui Forest Reserve, Kahoma, TMK 245022005	Continual	*DLNR	0.3					Hawai`i DOFAW. Strategic fencing and ungulate removal within forest bird recovery area.
2	2	2.2.63	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within West Maui Forest Reserve, Kaua`ula/Haakea, TMKs 245022002 245022004	Continual	*Amfac/JMB Hawai`i Co.	2.5					American Factors (Amfac)/JMB Hawai`i Co. Strategic fencing and ungulate removal within forest bird recovery area.
2	3	2.2.64	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within West Maui Forest Reserve, Wahikuli, TMK 245022003	Continual	*DLNR	2.9					Hawai`i DOFAW. Strategic fencing and ungulate removal within forest bird recovery area.

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds												
Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	2	2.2.65	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Kapunakea Preserve, Amfac/JMB, TNCH, TMK 244007001	Continual	*Amfac/JMB Hawai`i Co., *TNCH	9.1					American Factors (Amfac)/JMB Hawai`i Co., TNCH. Strategic fencing and ungulate removal within forest bird recovery area.
2	3	2.2.66	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within West Maui Forest Reserve, Kapāloa, TMK 244007007	Continual	UNK	2.1					Unknown. Strategic fencing and ungulate removal within forest bird recovery area.
2	3	2.2.67	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within West Maui NAR, Honokōwai, TMK 244007004	Continual	*DLNR	11.0					Hawai`i DLNR. Strategic fencing and ungulate removal within forest bird recovery area.
2	3	2.2.68	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Pu`u Kukui Watershed Management Area, TMKs 242001001 241001017	Continual	*Maui Land and Pineapple	48.8					Maui Land and Pineapple. Strategic fencing and ungulate removal within forest bird recovery area.

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds												
Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	3	2.2.69	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Moloka`i Forest Reserve, Kalamāula, TMK 252014003	Continual	*DLNR	4.8					Hawai`i DOFAW. Strategic fencing and ungulate removal within forest bird recovery area.
2	2	2.2.70	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Moloka`i Forest Reserve, Kahanui, TMK 252014001	Continual	*R. W. Myer, *et al.*	10.3					R. W. Myer Ltd., *et al.* Strategic fencing and ungulate removal within forest bird recovery area.
2	3	2.2.71	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Moloka`i Forest Reserve, Kahanui, TMK 261001004	Continual	*DLNR	0.2					Hawai`i DOFAW. Strategic fencing and ungulate removal within forest bird recovery area.
2	2	2.2.72	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Moloka`i Forest Reserve, Waikolu and Pu`u Ali`i NAR, TMK 261001002	Continual	*DLNR	21.6					Hawai`i DOFAW. Ungulate control currently ongoing at Pu`u Ali`i NAR. Strategic fencing and ungulate removal within forest bird recovery area.

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds													
Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	2	2.2.73	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Moloka`i Forest Reserve, Pelekunu Valley, TMK 259006011	Continual	*TNCH	15.7					The Nature Conservancy of Hawai`i. Ungulate control currently ongoing. Strategic fencing and ungulate removal within forest bird recovery area.
2	3	2.2.74	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Moloka`i Forest Reserve, Pelekunu Valley, Wawaeolepe, TMK 259008017	Continual	*William Hitchcock, *et al.*	0.2					Wm. Hitchcock, *et al.* Strategic fencing and ungulate removal within forest bird recovery area.
2	2	2.2.75	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Moloka`i Forest Reserve, Pelekunu Valley, TMK 254003032	Continual	*TNCH	1.4					The Nature Conservancy of Hawai`i. Ungulate control currently ongoing. Strategic fencing and ungulate removal within forest bird recovery area.
2	3	2.2.76	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Moloka`i Forest Reserve, Wailau Valley, TMK 259006002	Continual	*DLNR	25.6					Hawai`i DOFAW. Naturally isolated but vulnerable to incursion. Ungulate control ongoing. Strategic fencing and ungulate removal within forest bird recovery area.

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds												
Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	3	2.2.77	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Moloka`i Forest Reserve, Wailau Valley and Oloku`i, TMK 259006004	Continual	*G. Brown III, *et al.*	0.5					G. Brown III, *et al*. Strategic fencing and ungulate removal within forest bird recovery area.
2	3	2.2.78	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Moloka`i Forest Reserve, Laeokapuna, TMK 257005027	Continual	*P. Hodgins	1.4					P. Hodgins. Strategic fencing and ungulate removal within forest bird recovery area.
2	3	2.2.79	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Moloka`i Forest Reserve, Keanakoholua, TMK 257005001	Continual	*M. Hustice Trust	4.3					M. Hustice Trust. Strategic fencing and ungulate removal within forest bird recovery area.
2	3	2.2.80	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Moloka`i Forest Reserve, `Uala`pue, TMK 256006026	Continual	*DLNR	1.2					Hawai`i DOFAW. Strategic fencing and ungulate removal within forest bird recovery area.

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds												
Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	3	2.2.81	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Moloka`i Forest Reserve, Kahananui, TMK 256006014	Continual	*DLNR	1.1					Hawai`i DOFAW. Strategic fencing and ungulate removal within forest bird recovery area.
2	3	2.2.82	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Moloka`i Forest Reserve, Manawai, TMK 256006013	Continual	*P. Petro Trust	1.5					P. Petro Trust. Strategic fencing and ungulate removal within forest bird recovery area.
2	3	2.2.83	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Moloka`i Forest Reserve, east `Ōhi`a Gulch, TMK 256006011	Continual	*DLNR	2.0					Hawai`i DOFAW. Strategic fencing and ungulate removal within forest bird recovery area.
2	3	2.2.84	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Moloka`i Forest Reserve, West `Ōhi`a Gulch, TMK 256006010	Continual	*E. Wond Trust	1.0					E. Wond Trust. Strategic fencing and ungulate removal within forest bird recovery area.

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	3	2.2.85	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Moloka`i Forest Reserve, Keawa Nui, TMK 256006007	Continual	*KS	1.1					Kamehameha Schools. Strategic fencing and ungulate removal within forest bird recovery area.
2	3	2.2.86	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Moloka`i Forest Reserve, Pua`ahala, TMK 256006002	Continual	*K&H Horizons Hawai`i	0.8					K&H Horizons Hawai`i. Strategic fencing and ungulate removal within forest bird recovery area.
2	3	2.2.87	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Moloka`i Forest Reserve, Kumu`eli, TMK 256006001	Continual	*D. Fairbanks III Trust, EMOWP	50[2]					D. Fairbanks III Trust, (Austin Estate?). In EMOWP; currently fencing portions and removing ungulates. Continue strategic fencing and remove ungulates within forest bird recovery area.
2	2	2.2.88	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Moloka`i Forest Reserve, Kamalō, TMKs 255001016 255001006 255001017	Continual	*KS, *EMOWP	50[2]					Kamehameha Schools. In EMOWP; currently fencing portions and removing ungulates. Strategic fencing and ungulate removal within forest bird recovery area.

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds												
Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	3	2.2.89	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Moloka`i Forest Reserve, Mākolelau, TMK 255001015	Continual	*Ashton Pitts Jr. Trust	3.1					Ashton Pitts Jr. Trust. Strategic fencing and ungulate removal within forest bird recovery area.
2	2	2.2.90	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Kamakou Preserve, Kawela, TMK 2540003026	Continual	*Moloka`i Ranch Ltd., *TNCH, EMOWP	33.2					Moloka`i Ranch Ltd., The Nature Conservancy of Hawai`i. In EMOWP. Ungulate control currently ongoing. Strategic fencing and ungulate removal within forest bird recovery area.
2	3	2.2.91	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Moloka`i Forest Reserve, Kawela, TMKs 254003001	Continual	*Kawela Plantation Homes Association	11.2					Kawela Plantation Homes Association. Strategic fencing and ungulate removal within forest bird recovery area.
2	3	2.2.92	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Moloka`i Forest Reserve, Kamiloloa/ Makakupaīa, TMK 254003025	Continual	*DLNR	15.7					Hawai`i DOFAW. Strategic fencing and ungulate removal within forest bird recovery area.

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds													
Priority #	Priority Tier	Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units) Total	FY 07	FY 08	FY 09	FY 10	Comments/Notes
2	3	2.2.93	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Moloka`i Forest Reserve, Kaunakakai, TMK 253003005	Continual	*Moloka`i Ranch Ltd.	0.7					Moloka`i Ranch Ltd. Strategic fencing and ungulate removal within forest bird recovery area.
1	2	2.2.94	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Honouliuli Preserve, TMK 92005013	Continual	*James Campbell Est., *TNCH	31.7					James Campbell Estate, managed by The Nature Conservancy of Hawai`i. One 40-acre exclosure completed, a second is planned. More, larger fences needed to exclude ungulates from as much of the preserve as possible.
2	2	2.2.95	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Lualualei Naval Magazine, TMK 88001001	Continual	*U.S. Navy	13.7					U.S. Navy. Fencing and eradication of ungulates and/or time/area closure to hunting may be needed in preparation for aerial broadcast of rodenticides. Not open to public hunting.

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds												
Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
1	3	2.2.96	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Schofield Barracks West Range, TMK 77001001	Continual	*U.S. Army	16.2					U.S. Army. Ungulate control to protect forest and reduce mosquito breeding habitat. Fencing and eradication of ungulates and/or time/area closure to hunting may be needed in preparation for aerial broadcast of rodenticides. Not open to public hunting.
2	2	2.2.97	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Pahole NAR, TMK 68001002	Continual	*DLNR	5.8					Hawai`i State. Fencing and ungulate eradication to protect forest, reduce mosquito breeding habitat. Fencing and eradication of ungulates and/or time/area closure to hunting may be needed in preparation for aerial broadcast of rodenticides. Currently few `elepaio, but high potential for augmentation.
2	3	2.2.98	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Kahanahāiki Valley, TMK 81001012	Continual	*U.S. Army	2.2					U.S. Army. Fencing and eradication of ungulates and/or time/area closure to hunting may be needed in preparation for aerial broadcast of rodenticides.

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds													
Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
3	2	2.2.99	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within O`ahu Forest NWR, TMKs 95004001 and 76001001	Continual	*USFWS	57.6					U.S. Fish and Wildlife Service. Fencing and eradication of ungulates and/or time/area closure to hunting may be needed in preparation for aerial broadcast of rodenticides. Currently no `elepaio, but high potential for reintroduction.
3	2	2.2.100	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Lower Ka`ala NAR, TMK 67003025	Continual	*DLNR	9.5					Hawai`i State. Currently few `elepaio, but high potential for augmentation/ reintroduction. Fencing and eradication of ungulates and/or time/area closure to hunting may be needed in preparation for aerial broadcast of rodenticides.

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds												
Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
1	1	2.2.101	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Halehaha, Halepā`ākai, and Koai`e drainages, Alaka`i Wilderness Preserve, Portions of TMK 414001003	Continual	*DLNR, *DOFAW	8.7					Hawai`i DOFAW. Fencing of at least a 4 km square area in the Halepā`ākai and Koai`e Stream drainage and eradication of pigs is needed to protect key habitat. Fencing and ungulate control and/or time/area closure to hunting may be needed in preparation for aerial broadcast of rodenticides.
2	1	2.2.102	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Upper Mōhihi and upper Waiakoali drainages, Alaka`i Wilderness Preserve, Portions of TMK 414001003	Continual	*DLNR, *DOFAW	11.4					Hawai`i DOFAW. Fencing as much of the core puaiohi population as possible. Fencing and ungulate control and/or time/area closure to hunting in preparation for aerial broadcast of rodenticide.
2	1	2.2.103	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Alaka`i Wilderness Preserve, TMK 414001003	Continual	*DLNR, *DOFAW	100[2]					Hawai`i DOFAW. Strategic fencing to exclude ungulates from as much of the preserve as practical.

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds												
Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	1	2.2.104	A, C	Reduce or eliminate the detrimental effects of ungulates on vegetation within Southern Alaka`i Plateau, Portions of TMK 417001001	Continual	*Robinson Family Partners	20[2]					Gay and Robinson Partnership with DLNR/ DOFAW. Fencing and ungulate control may be needed in preparation for aerial broadcast of rodenticides.
1-3	1-3	2.3	A	Reduce or eliminate the detrimental effects of exotic plants through mechanical, chemical, or biological means, as appropriate	Ongoing	All Land Managers	TBD[3]					
2	2	2.4.1.1	C	Control alien mammalian predators by trapping, poisoning and other means on northeastern slopes of Mauna Kea, Portions of TMKs 344014002 344014003 343010002 343010008	Continual	*DLNR, State Land Division	378.3	12.6	12.6	12.6	12.6	Hawai`i State, DLNR, State Land Division.
2	1	2.4.1.2	C	Control alien mammalian predators by trapping, poisoning and other means in Kanakaleonui Corridor, TMK 338001009	Continual	*DHHL	181.3	6.0	6.0	6.0	6.0	Hawai`i State, DHHL. Provides a vital link between mesic koa forest and dry māmane forest habitats.

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	2	2.4.1.3	C	Control alien mammalian predators by trapping, poisoning and other means in Hilo Forest Reserve, Laupāhoehoe and Pīhā Sections, TMKs 337001002 and 333001004	Continual	*DLNR, *DOFAW	32.5	1.1	1.1	1.1	1.1	Hawai`i State, DLNR, DOFAW. Currently managed for game hunting.
1	1	2.4.1.4	C	Control alien mammalian predators by trapping, poisoning and other means in Hakalau Forest NWR, TMKs 337001010 333001007 329005005 329005003	Ongoing	*USFWS	404.4	13.5	13.5	13.5	13.5	Currently managed forest bird habitat.
2	1	2.4.1.5	C	Control alien mammalian predators by trapping, poisoning and other means in TMK 326018002	Continual	*DHHL	171.0	5.7	5.7	5.7	5.7	Hawai`i State DHHL, adjacent to Hakalau Forest National Wildlife Refuge.
2	2	2.4.1.6	C	Control alien mammalian predators by trapping, poisoning and other means in Pu`u Ō`ō Ranch, TMK 326018001	Continual	*DLNR, State Land Division, Pu`u `Ō`ō Ranch	213.7	7.1	7.1	7.1	7.1	Hawai`i State, DLNR, State Land Division, Pu`u Ō`ō Ranch lease.

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	1	2.4.1.7	C	Control alien mammalian predators by trapping, poisoning and other means in Kīpuka `Āinahou Nēnē Sanctuary, TMK 338001008	Continual	*DHHL	213.6	7.1	7.1	7.1	7.1	Hawai`i State, DHHL.
2	1	2.4.1.8	C	Control alien mammalian predators by trapping, poisoning and other means in Ka`ohe 344015002	Continual	*DLNR, State Land Division	10.8	0.36	0.36	0.36	0.36	Hawai`i State DLNR, State Land Division.
1	1	2.4.1.9	C	Control alien mammalian predators by trapping, poisoning and other means in Mauna Kea Forest Reserve, TMKs 344015001 344016003 338001004	Continual	*DLNR	244.1	8.1	8.1	8.1	8.1	Hawai`i State DLNR. Palila critical habitat.
2	1	2.4.1.10 and 2.4.1.11	C	Control alien mammalian predators by trapping, poisoning and other means in Waiākea Forest Reserve, TMK 324008001	Continual	*DLNR, *DOFAW	1783.7	59.5	59.5	59.5	59.5	Hawai`i State DLNR, DOFAW.

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
1	1	2.4.1.12	C	Control alien mammalian predators by trapping, poisoning and other means in `Ōla`a/Kīlauea Partnership, TMKs 324008009 399001007 399001004 324008025 319001001 319001007	Continual	*KS, Keauhou Ranch, *DOFAW, *HVNP	1373.2	45.8	45.8	45.8	45.8	Kamehameha Schools, Keauhou Ranch, Kūlani Correctional Facility, Pu`u Maka`ala NAR, HVNP.
2	1	2.4.1.13	C	Control alien mammalian predators by trapping, poisoning and other means in Kapāpala Forest Reserve, Portions of TMK 398001004	Continual	*DLNR, State Land Division	142.8	4.8	4.8	4.8	4.8	Hawai`i State DLNR, State Land Division, Kapāpala Forest Reserve.
1	1	2.4.1.14	C	Control alien mammalian predators by trapping, poisoning and other means in Ka`ū Forest Reserve, TMK 397001001	Continual	*DLNR, *DOFAW	2380.6	79.4	79.4	79.4	79.4	Hawai`i State DLNR, DOFAW, Ka`ū Forest Reserve.
2	1	2.4.1.15	C	Control alien mammalian predators by trapping, poisoning and other means in Kahuku Ranch, portions of TMK 392001002	Continual	*Samuel M. Damon Trust	1348.4	44.9	44.9	44.9	44.9	Samuel M. Damon Trust. Purchase by NPS.

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds

Priority #	Priority Tier	Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units) Total	FY 07	FY 08	FY 09	FY 10	Comments/Notes
2	2	2.4.1.16	C	Control alien mammalian predators by trapping, poisoning and other means in Manukā NAR, Upper portions of TMK 391001002	Continual	*DLNR, *DOFAW	42.8	1.4	1.4	1.4	1.4	
2	1	2.4.1.17	C	Control alien mammalian predators by trapping, poisoning and other means in TNCH, Honomalino, TMK 389001001	Continual	*TNCH	144.4	4.8	4.8	4.8	4.8	
2	2	2.4.1.18	C	Control alien mammalian predators by trapping, poisoning and other means in Yee Hop Ranch, TMK 392001005	Continual	*Yee Hop Ranch Ltd.	147.5	4.9	4.9	4.9	4.9	
1	1	2.4.1.19	C	Control alien mammalian predators by trapping, poisoning and other means in Kona Forest NWR, TMK 386001001	Continual	*USFWS	85.5	2.9	2.9	2.9	2.9	

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds												
Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	2	2.4.1.20	C	Control alien mammalian predators by trapping, poisoning and other means in McCandless Ranch, TMKs 392001003 386001001 385001002	Continual	*McCandless Ranch	154.5	5.1	5.1	5.1	5.1	
2	1	2.4.1.21	C	Control alien mammalian predators by trapping, poisoning and other means in Waiea Tract, TMK 386001003	Continual	*DLNR, State Land Division	45.3	1.5	1.5	1.5	1.5	
2	1	2.4.1.22	C	Control alien mammalian predators by trapping, poisoning and other means in Hōnaunau Forest, TMKs 384001001 384001002 383001001 383001002	Continual	*KS	574.3	19.1	19.1	19.1	19.1	
2	1	2.4.1.23	C	Control alien mammalian predators by trapping, poisoning and other means in Pu`u Lehua, Portion of TMK 378001003	Continual	*KS	839.7	28.0	28.0	28.0	28.0	

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds												
Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	1	2.4.1.24	C	Control alien mammalian predators by trapping, poisoning and other means in Pu`u Wa`awa`a Bird Sanctuary, TMKs 371001001 and 371001006	Continual	*DLNR, *DOFAW	411.8	13.7	13.7	13.7	13.7	
1	1	2.4.1.25	C	Control alien mammalian predators by trapping, poisoning and other means in Ko`olau Forest Reserve, TMKs 224016003 224016004 228008001 228008007	Continual	*Alexander and Baldwin, *East Maui Irrigation	438.2	14.6	14.6	14.6	14.6	Alexander and Baldwin, East Maui Irrigation. Portions supporting breeding habitat for endangered species, priority #1; remaining portions, priority #2 and tier #2.
1	1	2.4.1.26	C	Control alien mammalian predators by trapping, poisoning and other means in Ko`olau Forest Reserve, TMKs 211002002 212004005 229014001 211001050 211001044	Continual	*DLNR, *DOFAW	491.4	16.4	16.4	16.4	16.4	Hawai`i State, DLNR, DOFAW. Portions supporting breeding habitat for endangered species, priority #1; remaining portions, priority #2 and tier #2.

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds												
Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
1	1	2.4.1.27	C	Control alien mammalian predators by trapping, poisoning and other means in Hanawī NAR and Ko`olau Forest Reserve, TMK 212004007	Continual	*DLNR, *DOFAW	353.2	11.8	11.8	11.8	11.8	Hawai`i State, DLNR, DOFAW. Portions supporting breeding habitat for endangered species, priority #1; remaining portions, priority #2 and tier #2.
1	1	2.4.1.28	C	Control alien mammalian predators by trapping, poisoning and other means in Hāna Forest Reserve, TMKs 210001001 214001001 215001001	Continual	*DLNR, *DOFAW	428.7	14.3	14.3	14.3	14.3	Hawai`i State, DLNR, DOFAW. Portions supporting breeding habitat for endangered species, priority #1; remaining portions, priority #2 and tier #2.
1	1	2.4.1.29	C	Control alien mammalian predators by trapping, poisoning and other means in Haleakalā National Park, TMKs 213001003 216001002 216001001 216001003 217004016 216010001 218001007	Continual	*NPS	498.0	16.6	16.6	16.6	16.6	NPS. Portions supporting breeding habitat for endangered species, priority #1; remaining portions, priority #2 and tier #2.

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Priority #	Priority Tier	Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units) Total	FY 07	FY 08	FY 09	FY 10	Comments/Notes
2	2	2.4.1.30	C	Control alien mammalian predators by trapping, poisoning and other means in Kīpahulu Forest Reserve, TMKs 216001005 217001033 217002035 217004006	Continual	*DLNR, *DOFAW	81.3	2.7	2.7	2.7	2.7	Hawai`i State, DLNR, DOFAW. Adjacent to known populations of AKOH and MAPA. Potential for range expansion.
2	3	2.4.1.31	C	Control alien mammalian predators by trapping, poisoning and other means in Kahikinui Forest Reserve, TMKs 218001006 218001005 218001009	Continual	*DLNR, *DOFAW	106.2	3.5	3.5	3.5	3.5	Hawai`i State, DLNR, DOFAW. Potential long-term site for reintroduction.
2	3	2.4.1.32	C	Control alien mammalian predators by trapping, poisoning and other means in Kahikinui Homelands, TMKs 219001003 219001007 219001008 219001011	Continual	*DHHL	253.3	8.4	8.4	8.4	8.4	Hawai`i State, DHHL. Potential long-term site for reintroduction.

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Priority #	Priority Tier	Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units) Total	FY 07	FY 08	FY 09	FY 10	Comments/Notes
3	3	2.4.1.33	C	Control alien mammalian predators by trapping, poisoning and other means in Kula Forest Reserve, TMK 222007001	Continual	*DLNR, *DOFAW	140.8	4.7	4.7	4.7	4.7	Hawai`i State, DLNR, DOFAW. Potential long-term site for reintroduction.
3	2	2.4.1.34	C	Control alien mammalian predators by trapping, poisoning and other means in Haleakalā Ranch (Pūlehu Nui/Kalialinui), TMK 223005003	Continual	*Haleakalā Ranch Co.	48.8	1.6	1.6	1.6	1.6	Haleakalā Ranch Co. Adjacent to current range. Likely site of near-term range expansion for AKOH and MAPA.
1	1	2.4.1.35	C	Control alien mammalian predators by trapping, poisoning and other means in Waikamoi Preserve, TMK 223005004	Continual	*Haleakalā Ranch Co., *TNCH	357.3	11.9	11.9	11.9	11.9	Haleakalā Ranch Co., The Nature Conservancy of Hawai`i. Portions supporting breeding habitat for endangered species, priority #1; remaining portions, priority #2 and tier #2.
2	3	2.4.1.36	C	Control alien mammalian predators by trapping, poisoning and other means in Makawao Forest Reserve, TMKs 224016001 224016002	Continual	*DLNR, *DOFAW	82.3	2.7	2.7	2.7	2.7	Hawai`i State, DLNR, DOFAW. Likely site of near-term range expansion for AKOH and MAPA.

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	3	2.4.1.37	C	Control alien mammalian predators by trapping, poisoning and other means in West Maui NAR, Kahakuloa, TMK 231006001	Continual	*DLNR, *DOFAW	70.0	2.3	2.3	2.3	2.3	Hawai`i State, DLNR, DOFAW. Primary site for reintroduction.
3	3	2.4.1.38	C	Control alien mammalian predators by trapping, poisoning and other means in West Maui NAR, Līhau, TMK 248001002	Continual	*DLNR, *DOFAW	221.0	7.4	7.4	7.4	7.4	Hawai`i State, DLNR, DOFAW. Potential long-term site for reintroduction.
3	3	2.4.1.39	C	Control alien mammalian predators by trapping, poisoning and other means in West Maui Forest Reserve, Pana`ewa, TMK 246025002	Continual	*DLNR, *DOFAW	48.3	1.6	1.6	1.6	1.6	Hawai`i State, DLNR, DOFAW. Potential long-term site for reintroduction.
2	3	2.4.1.40	C	Control alien mammalian predators by trapping, poisoning and other means in Kapunakea Preserve, Amfac/JMB Hawai`i Co., TNCH, TMK 244007001	Continual	*TNCH, *American Factors	36.5	1.2	1.2	1.2	1.2	American Factors (Amfac)/JMB Hawai`i Co., TNCH. Primary site for reintroduction.

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Priority #	Priority Tier	Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units) Total	FY 07	FY 08	FY 09	FY 10	Comments/Notes
2	3	2.4.1.41	C	Control alien mammalian predators by trapping, poisoning and other means in West Maui NAR, Honokōwai, TMK 244007004	Continual	*DLNR, *DOFAW	43.9	1.5	1.5	1.5	1.5	Hawai`i State, DLNR, DOFAW. Primary site for reintroduction.
2	2	2.4.1.42	C	Control alien mammalian predators by trapping, poisoning and other means in Pu`u Kukui Watershed Management Area, TMKs 242001001 241001017	Continual	*Maui Land and Pineapple	195.6	6.5	6.5	6.5	6.5	Maui Land and Pineapple. Primary site for reintroduction.
2	2	2.4.1.43	C	Control alien mammalian predators by trapping, poisoning and other means in Moloka`i Forest Reserve and Pu`u Ali`i NAR, Waikolu, TMK 261001002	Continual	*DLNR, *DOFAW	86.6	2.9	2.9	2.9	2.9	Hawai`i State, DLNR, DOFAW. Primary site for reintroduction.
2	2	2.4.1.44	C	Control alien mammalian predators by trapping, poisoning and other means in Moloka`i Forest Reserve and Oloku`i NAR, Wailau Valley, TMK 259006002	Continual	*DLNR, *DOFAW	102.5	3.4	3.4	3.4	3.4	Hawai`i State, DLNR, DOFAW. Primary site for reintroduction.

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	2	2.4.1.45	C	Control alien mammalian predators by trapping, poisoning and other means in Kamakou Preserve, Kawela, TMK 2540003026	Continual	*Moloka`i Ranch Ltd., *TNCH	133.2	4.4	4.4	4.4	4.4	Moloka`i Ranch Ltd, TNCH. Primary site for reintroduction.
1	1	2.4.1.46	C	Control alien mammalian predators by trapping, poisoning and other means in Honouliuli Preserve, TMK 92005013	Ongoing	*James Campbell Estate, *TNCH	173.7	5.8	5.8	5.8	5.8	James Campbell Estate. The Nature Conservancy of Hawai`i has controlled rodents in a 40 acre exclosure using snap traps and bait stations. Control should be continued and expanded, using aerial broadcast if possible.
2	2	2.4.1.47	C	Control alien mammalian predators by trapping, poisoning and other means in Lualualei Naval Magazine, TMK 88001001	Ongoing	*U.S. Navy	75.1	2.5	2.5	2.5	2.5	U.S. Navy. Control rodents using diphacinone bait stations, or by aerial broadcast if possible.

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Priority #	Priority Tier	Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units) Total	FY 07	FY 08	FY 09	FY 10	Comments/Notes
1	1	2.4.1.48	C	Control alien mammalian predators by trapping, poisoning and other means in Schofield Barracks West Range, TMK 77001001	Ongoing	*U.S. Army	88.9	3.0	3.0	3.0	3.0	U.S. Army. Environmental Division has attempted small-scale rat control using snap traps and bait stations, but insufficient access to be effective. Aerial broadcast of rodenticide would increase scale, less access needed.
1	1	2.4.1.49	C	Control alien mammalian predators by trapping, poisoning and other means in Honolulu Watershed Forest Reserve (Wailupe), TMK 36004004	Ongoing	*DLNR, *DOFAW	47.8	1.6	1.6	1.6	1.6	Hawai`i State, DLNR, DOFAW. Rodent control conducted from 1999-2000 using snap traps and bait stations. Aerial broadcast would increase scale.
1	2	2.4.1.50	C	Control alien mammalian predators by trapping, poisoning and other means in North Hālawa Valley, TMK 99011002	Continual	*KS	6.0	0.2	0.2	0.2	0.2	Kamehameha Schools. Rodent control needed to protect core `elepaio population.

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
1	1	2.4.1.51	C	Control alien mammalian predators by trapping, poisoning and other means in Control alien mammalian predators by trapping, poisoning and other means in Moanalua Valley, TMKs 11013001 and 11013002	Continual	*Damon Estate	13.1	0.4	0.4	0.4	0.4	Damon Estate. Rodent control needed to protect core `elepaio population.
1	2	2.4.1.52	C	Control alien mammalian predators by trapping, poisoning and other means in Waikāne Valley, TMK 48014005	Unknown	*SMF Enterprises	17.8	0.6	0.6	0.6	0.6	SMF Enterprises. Rodent control needed to protect core `elepaio population.
1	2	2.4.1.53	C	Control alien mammalian predators by trapping, poisoning and other means in Kahana Valley State Park, TMKs 52001001 and 52002001	Continual	*DLNR, *DOFAW	17.8	0.6	0.6	0.6	0.6	Hawai`i State. Rodent control needed to protect core `elepaio population.
1	2	2.4.1.54	C	Control alien mammalian predators by trapping, poisoning and other means in Mākaha Valley, TMKs 84002014 and 84002001	Continual	*City and County of Honolulu	6.0	0.2	0.2	0.2	0.2	City and County of Honolulu. Rodent control needed to protect core `elepaio population.

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	2	2.4.1.55	C	Control alien mammalian predators by trapping, poisoning and other means in Pahole NAR, TMK 68001002	Ongoing	*DLNR, *DOFAW	31.5	1.0	1.0	1.0	1.0	Hawai`i State, DLNR, DOFAW. Rodent control conducted in 1999 using bait stations. Currently few `elepaio, but aerial broadcast would help prepare site for reintroduction/augmentation.
2	1	2.4.1.56	C	Control alien mammalian predators by trapping, poisoning and other means in Kahanahāiki Valley, TMK 81001012	Ongoing	*U.S. Army	11.9	0.4	0.4	0.4	0.4	U.S. Army. Rodent and mongoose control conducted from 1998-2000 using snap traps, bait stations, and live traps. Currently few `elepaio, but aerial broadcast would help prepare site for reintroduction/augmentation.
2	2	2.4.1.57	C	Control alien mammalian predators by trapping, poisoning and other means in O`ahu Forest NWR, TMKs 95004001 and 76001001	Continual	*USFWS	315.4	10.0	10.0	10.0	10.0	U.S. Fish and Wildlife. Currently few `elepaio, but rodent control would help prepare site for augmentation or reintroduction.
3	2	2.4.1.58	C	Control alien mammalian predators by trapping, poisoning and other means in Lower Ka`ala NAR, TMK 67003025	Continual	*DLNR, *DOFAW	52.2	1.7	1.7	1.7	1.7	Hawai`i State, DLNR, DOFAW. Currently few `elepaio, but aerial broadcast of rodenticide would help prepare site for reintroduction or augmentation.

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Priority #	Priority Tier	Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units) Total	FY 07	FY 08	FY 09	FY 10	Comments/Notes
1	1	2.4.1.59	C	Control alien mammalian predators by trapping, poisoning and other means in Halehaha, Halepā`ākai, and Koai`e drainages, Alaka`i Wilderness Preserve, TMK 414001003	Continual	*DLNR, *DOFAW	47.4	1.6	1.6	1.6	1.6	Hawai`i State, DLNR, DOFAW. Recommend aerial broadcast of rodenticide in Halehaha and Halepā`ākai drainages, and a tributary to Koai`e Stream.
2	1	2.4.1.60	C	Control alien mammalian predators by trapping, poisoning and other means in Upper Mōhihi and upper Waiakoali drainages, Alaka`i Wilderness Preserve, TMK 414001003	Ongoing	*DLNR, *DOFAW	62.3	2.0	2.0	2.0	2.0	Hawai`i State, DLNR, DOFAW. Depending on outcome of study whether rats pose threat to core puaiohi population, recommend aerial broadcast of rodenticides in upper Mōhihi and Waiakoali drainages. Ground-based protection of active nest-sites.
2	1	2.4.1.61	C	Control alien mammalian predators by trapping, poisoning and other means in Upper Kawaikōī, Alaka`i Wilderness Preserve, TMK 459001001	Ongoing	*DLNR, *DOFAW	11.9	0.4	0.4	0.4	0.4	Hawai`i State, DLNR, DOFAW. Ground-based bait station rodent control in association with puaiohi release, and ground-based feral cat control.

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	1	2.4.1.62	C	Control alien mammalian predators by trapping, poisoning and other means in Southern Alaka`i Plateau, portions of TMK 417001001	Continual	*Robinson Family Partners	12.0	0.4	0.4	0.4	0.4	Robinson Family Partners, in conjunction with release program for puaiohi. Total cost based continuous implementation for 30 years (estimated time to delisting).
1	1	2.4.2	C	Continue the public information campaign explaining the need for aerial broadcast of diphacinone for conservation purposes.	3 years	*State and Federal Agencies	4.0	2.0	1.0	1.0		
1	1	2.4.3	C	Examine feasibility/ appropriateness of time/area closure of public use areas when using broadcast application of diphacinone	2 years	*State and Federal Agencies	2.0	1.0	1.0			
1	1	2.5.1.1	C	Enforce existing quarantine laws for importation of pet birds	Ongoing	*State and Federal Departments of Agriculture, ADWG	30.0	1.0	1.0	1.0	1.0	Total cost based on equivalent of one additional enforcement officer per year for 30 years.

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Priority #	Priority Tier	Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units) Total	FY 07	FY 08	FY 09	FY 10	Comments/Notes
1	1	2.5.1.2	C	Work with Postal Service and the State Department of Agriculture to ban shipments of day-old poultry and game birds to Hawai`i via first class mail	4 years	*U.S. Postal Service, *State Dept. of Agriculture, ADWG	4.0	1.0	1.0	1.0	1.0	
1	1	2.5.1.3.1	C	Develop a list of priority diseases that should be screened for in all imported cage birds and poultry, and establish monitoring program for new diseases	Ongoing	*ADWG	60.0	2.0	2.0	2.0	2.0	
1	1	2.5.1.3.2	C	Respond to and determine causes of avian disease outbreaks	Continual	*ADWG	60.0	2.0	2.0	2.0	2.0	
1	1	2.5.1.4	A, C, E	Work to stop global climate change	Continual	*Research Institutions, *USFWS, DOFAW, HFBRT	15.0	0.5	0.5	0.5	0.5	

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#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
1	1	2.5.2.1	C	Initiate inspection programs for all interisland vessels, including ships, airplanes, and barges and their cargos, to intercept and kill mosquito larvae and adults	Continual	*State and Federal Departments of Agriculture, ADWG	30.0	1.0	1.0	1.0	1.0	
1	1	2.5.2.2	C	Enforce and toughen existing laws that require health certificates for interisland movement of pet birds and poultry	Ongoing	Research Institutions, *State and Federal Agencies	30.0	1.0	1.0	1.0	1.0	
2	3	2.5.2.3	C	Establish disease monitoring protocols for captive native birds to assess presence of avian disease in captive held populations and risk of transfer of disease strains between avian captive holding facilities	Ongoing	*ZSSD, USFWS, *USGS, DOFAW, ADWG	15.0	0.5	0.5	0.5	0.5	
2	3	2.5.2.3.1	C	Develop a list of diseases of concern for which captive birds should be routinely tested before they can be transferred between avian captive holding facilities	2 years	*ZSSD, USFWS, *USGS, DOFAW, *ADWG	5.0	2.5	2.5			

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Priority #	Priority Tier	Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units) Total	FY 07	FY 08	FY 09	FY 10	Comments/Notes
3	1	2.5.3.1.1.1	C	Mosquito surveys on Hawai`i between 2,000 and 5,000 ft. on Mauna Loa and Kīlauea that include recovery area	2 years	*USGS, USFWS, DOFAW	5.0	2.5	2.5			
1	3	2.5.3.1.1.2	C	Mosquito surveys on Hawai`i between 3,400 and 5,000 ft. on Mauna Kea that include recovery area	4 years	*USGS, USFWS, DOFAW	10.0	2.5	2.5	2.5	2.5	
1	3	2.5.3.1.1.3	C	Mosquito surveys between 3,400 and 5,000 ft. on Hualālai that include recovery area, portions of TMKs 371001001, 372002001, 374002008, 374001003, 374002007, 374001002	1 year	*USGS, USFWS, DOFAW	2.5	2.5				
2	2	2.5.3.1.1.4	C	Mosquito surveys of windward Hāmākua between 3,400 and 2,000 ft. on Mauna Kea adjacent to or within 3 km of recovery area	4 years	*USGS, USFWS, DOFAW	10.0	2.5	2.5	2.5	2.5	
2	2	2.5.3.1.1.5	C	Mosquito surveys on Kīlauea adjacent to or within 3 kilometers of recovery area	2 years	*USGS, USFWS, DOFAW	5.0	2.5	2.5			

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#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	2	2.5.3.1.1.6	C	Mosquito surveys on Hualālai adjacent to or within 3 km of recovery area	1 year	*USGS, USFWS, DOFAW	2.5	2.5				
1	3	2.5.3.1.1.7	C	Mosquito surveys between 2,500 and 5,000 ft. on Haleakalā that include recovery area	4 years	*USGS, NPS USFWS, DOFAW	10.0	2.5	2.5	2.5	2.5	East Maui Recovery area below the 5,000 ft. contour line.
2	2	2.5.3.1.1.8	C	Mosquito surveys, TMK 217004006	1 year	*USGS, USFWS, DOFAW	2.5	2.5				East Maui Manawainui Valley incursion into recovery area, below 2,500 ft. contour line.
1	3	2.5.3.1.1.9	C	Mosquito surveys, TMK 217004006	1 year	*USGS, USFWS, DOFAW	2.5	2.5				East Maui Manawainui Valley incursion into recovery area from 2,500 to 1,600 feet.
1	3	2.5.3.1.1.10	C	Mosquito surveys, TMK 215001001	1 year	*USGS, NPS, USFWS, DOFAW	2.5	2.5				East Maui Waiho`i Valley incursion into recovery area, below 2,500 to 2,000 feet.
1	3	2.5.3.1.1.11	C	Mosquito surveys, TMK 216001002	1 year	*USGS, USFWS, DOFAW	2.5	2.5				East Maui Kīpahulu Valley incursion into recovery area, from 2,500 to 1,600 feet.
1	3	2.5.3.1.1.12	C	Mosquito surveys, TMK 211002002	4 years	*USGS, USFWS, DOFAW	10.0	2.5	2.5	2.5	2.5	East Maui Ke`anae Valley incursion into recovery area from 2,500 to 1,800 feet.

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
3	2	2.5.3.1.1.13	C	Mosquito surveys below and within 3 km of the 4,000 ft. contour line on the southern and western slopes of Haleakalā	2 years	*USGS, USFWS, DOFAW	5.0	2.5	2.5			East Maui land parcels adjacent to recovery area and also in need of extensive restoration.
1	3	2.5.3.1.1.14	C	Mosquito surveys of West Maui in recovery area between 2,500 and 5,000 ft. contour lines	2 years	*USGS, USFWS, DOFAW	5.0	2.5	2.5			Multiple land parcels in West Maui Mountains.
2	2	2.5.3.1.1.15	C	Mosquito surveys within `Īao Valley, West Maui, TMKs 233003003, 235003001, 233003004, and multiple smaller parcels	1 year	*USGS, USFWS, DOFAW	1.0	1.0				`Īao Valley incursion into recovery area, between 2,500 ft. and 600 ft.
2	2	2.5.3.1.1.16	C	Mosquito surveys of West Maui, TMKs 232014001 and 233003003	1 year	*USGS, USFWS, DOFAW	1.0	1.0				Waiehu Valley incursion into recovery area, between 2,500 ft. and 600 ft.
2	2	2.5.3.1.1.17	C	Mosquito surveys of West Maui, TMK 232014001	1 year	*USGS, USFWS, DOFAW	1.0	1.0				Waihe`e Valley incursion into recovery area, between 2,500 ft. and 600 ft.
2	2	2.5.3.1.1.18	C	Mosquito surveys of West Maui, TMK 231006001	1 year	*USGS, USFWS, DOFAW	1.0	1.0				Kahakuloa Valley incursion into recovery area, between 2,500 ft. and 600 ft.
2	2	2.5.3.1.1.19	C	Mosquito surveys of West Maui, TMK 241001017	1 year	*USGS, USFWS, DOFAW	1.0	1.0				Honokōhau Valley incursion into recovery area, between 2,500 ft. and 600 ft.

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Priority #	Priority Tier	Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units) Total	FY 07	FY 08	FY 09	FY 10	Comments/Notes
2	2	2.5.3.1.1.20	C	Mosquito surveys of West Maui, TMKs 236003001 and 235003001	1 year	*USGS, USFWS, DOFAW	1.0	1.0				Waikapū Valley incursion into recovery area, between 2,500 ft. and 600 ft.
2	2	2.5.3.1.1.21	C	Mosquito surveys of West Maui, TMK 241001017	1 year	*USGS, USFWS, DOFAW	1.0	1.0				Honolua Valley incursion into recovery area, between 2,500 ft. and 600 ft.
2	2	2.5.3.1.1.22	C	Mosquito surveys, of West Maui, TMK 242001001	1 year	*USGS, USFWS, DOFAW	1.0	1.0				Honokahua Valley incursion into recovery area, between 2,500 ft. and 600 ft.
2	2	2.5.3.1.1.23	C	Mosquito surveys of West Maui, TMK 242001001	1 year	*USGS, USFWS, DOFAW	1.0	1.0				Kahana Valley incursion into recovery area, between 2,500 ft. and 600 ft.
2	2	2.5.3.1.1.24	C	Mosquito surveys of West Maui, TMKs 244007004, 244007011, 244007001, and 244007005	1 year	*USGS, USFWS, DOFAW	1.0	1.0				Honokōwai Valley incursion into recovery area, between 2,500 ft. and 600 ft.
2	2	2.5.3.1.1.25	C	Mosquito surveys of West Maui, TMK 245022001	1 year	*USGS, USFWS, DOFAW	1.0	1.0				Kahoma Valley incursion into recovery area, between 2,500 ft. and 600 ft.
2	2	2.5.3.1.1.26	C	Mosquito surveys of West Maui, TMK 246025002	1 year	*USGS, USFWS, DOFAW	1.0	1.0				Kanahā Valley incursion into recovery area, between 2,500 ft. and 600 ft.
2	2	2.5.3.1.1.27	C	Mosquito surveys of West Maui, TMKs 246025001 and 247001002	1 year	*USGS, USFWS, DOFAW	1.0	1.0				Mākila Valley incursion into recovery area, between 2,500 ft. and 600 ft.

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	2	2.5.3.1.1.28	C	Mosquito surveys of West Maui, TMK 248001002	1 year	*USGS, USFWS, DOFAW	1.0	1.0				Olowalu Valley incursion into recovery area, between 2,500 ft. and 600 ft.
2	2	2.5.3.1.1.29	C	Mosquito surveys of West Maui, TMK 248001002	1 year	*USGS, USFWS, DOFAW	1.0	1.0				Ukumehame Valley incursion into recovery area, between 2,500 ft. and 600 ft.
2	2	2.5.3.1.1.30	C	Mosquito surveys of West Maui, TMK 236003001	1 year	*USGS, USFWS, DOFAW	1.0	1.0				Pōhākea Valley incursion into recovery area, between 2,500 ft. and 600 ft.
2	2	2.5.3.1.1.31	C	Mosquito surveys of West Maui, TMK 245022003	1 year	*USGS, USFWS, DOFAW	1.0	1.0				Waihikuli Valley incursion into recovery area, between 2,500 ft. and 600 ft.
2	2	2.5.3.1.1.32	C	Mosquito surveys of West Maui, TMK 245022004	1 year	*USGS, USFWS, DOFAW	1.0	1.0				Hanakea Valley incursion into recovery area, between 2,500 ft. and 600 ft.
3	2	2.5.3.1.1.33	C	Mosquito surveys of multiple parcels in West Maui below and up to 3 km from the 2,500 contour line that do not include major stream valleys listed above	3 years	*USGS, USFWS, DOFAW	7.5	2.5	2.5	2.5		Land parcels around West Maui Mountains that are adjacent to recovery area.
1	3	2.5.3.1.1.34	C	Mosquito surveys in multiple parcels that include recovery area on Moloka`i	2 years	*USGS, USFWS, DOFAW	5.0	2.5	2.5			

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Priority #	Priority Tier	Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units) Total	FY 07	FY 08	FY 09	FY 10	Comments/Notes
2	2	2.5.3.1.1.35	C	Mosquito surveys in Waihānau, Wai`ale`ia, Waikolu, Pelekunu, and Wailau Valleys on Moloka`i that are adjacent to or within 3 km of recovery area, TMK's 261001002, 259006011, 259006002 and smaller windward parcels	1 year	*USGS, USFWS, DOFAW	2.5	2.5				
2	2	2.5.3.1.1.36	C	Mosquito surveys in Kaunakakai Gulch on Moloka`i	1 year	*USGS, USFWS, DOFAW	1.0	1.0				Emphasis should extend to determining role of urban/suburban development in and around Kaunakakai on generation of mosquitoes.
2	2	2.5.3.1.1.37	C	Mosquito surveys adjacent to or within 3 km of the southern and eastern boundaries of recovery area on leeward Moloka`i, portions of TMKS 252014003, 253003005, 254003025, 254003001, 255001006 and others	2 years	*USGS, USFWS, DOFAW	5.0	2.5	2.5			Vector surveys should ideally extend from the lower boundary of recovery area to the coastline, particularly in areas with rural agricultural development.

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#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
1	3	2.5.3.1.1.38	C	Mosquito surveys of parcels on O`ahu that include recovery area	4 years	*USGS, USFWS, DOFAW, DOD	10.0	2.5	2.5	2.5	2.5	
2	2	2.5.3.1.1.39	C	Mosquito surveys of parcels on O`ahu that are adjacent to or within 3 km of recovery area	4 years	*USGS, USFWS, DOFAW DOD	10.0	2.5	2.5	2.5	2.5	
1	3	2.5.3.1.1.40	C	Mosquito surveys on Kaua`i that include recovery area, TMKs 414001020, 414001014, 414001013, 459001016, 459001001, 414001003, 417001001, 458001001 and others	3 years	*USGS, USFWS, DOFAW	7.5	2.5	2.5	2.5		Surveys should focus on relative roles of human development in Kōke`e and natural oviposition sites in the central Alaka`i in generating mosquitoes.
2	2	2.5.3.1.1.41	C	Mosquito surveys on Kaua`i that are adjacent to or within 3 km of recovery area, portions of TMKs 459001001, 458001001, 458002002, 459001003, 459001002	1 year	*USGS, USFWS, DOFAW	2.5	2.5				Windward parcels that are adjacent to recovery area on the Alaka`i Plateau, including Wainiha Valley.

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Priority #	Priority Tier	Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units) Total	FY 07	FY 08	FY 09	FY 10	Comments/Notes
2	2	2.5.3.1.1.42	C	Mosquito surveys on Kaua`i that are adjacent to or within 3 km of recovery area, portions of TMKs 414001014, 414001020, 414002040, 414001003, 417001001	1 year	*USGS, USFWS, DOFAW	2.5	2.5				Leeward parcels that are adjacent to recovery area on the Alaka`i Plateau, including Waimea Canyon.
1	1	2.5.3.1.2	C	Eliminate or treat mosquito breeding sites in recovery area and adjacent areas at elevations below 5,000 ft. with BTI (Dunk®) or other environmentally compatible pesticides that are safe for non-target organisms	Ongoing	*Land Managers, *State and Federal Agencies	100.0					Cost approximate; will depend on findings of vector surveys to identify and prioritize areas for treatment and results of experimental treatments of efficiency and effects on non-target species.
1	2	2.5.3.1.3	C	Eliminate or treat mosquito breeding habitat associated with human development (e.g., residential areas, agricultural sites); coordinate efforts with the State Department of Health	Ongoing	*Land Managers, *State and Federal Agencies, *State Departments of Health and Education	100.0					Cost approximate; will depend on findings of vector surveys to identify and prioritize areas for treatment and results of experimental treatments of efficiency and effects on non-target species.

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#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
1	1	2.5.3.1.3.1	C	Eliminate or treat cattle troughs and stock ponds	Ongoing	*Land Managers, State Departments of Health and Education	15.0	0.5	0.5	0.5	0.5	Use findings from vector surveys to identify and prioritize areas for treatment.
1	1	2.5.3.1.3.2	C	Eliminate or treat game bird waterers in areas where they might impact native forest birds	Ongoing	*Land Managers, *State and Federal Agencies	3.0	0.1	0.1	0.1	0.1	Use findings from vector surveys to identify and prioritize areas for treatment.
1	1	2.5.3.1.3.3	C	Repair rain gutters, cover catchment tanks, and eliminate containers that catch and hold rainwater around residential and agricultural sites near recovery area	Ongoing	*Land Managers, *State Departments of Health and Education	20.0					Use findings from vector surveys to identify and prioritize areas for treatment.
1	2	2.5.3.1.3.4	C	Initiate public outreach efforts to inform the public about potential human and animal diseases transmitted by mosquitoes and how source reduction can reduce those threats	3 years	Land Managers, *State Departments of Health and Education	4.0	2.0	1.0	1.0		

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#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
1	1	2.5.3.1.4.1	C	Identify and fence priority recovery areas at elevations below 5,000 ft. and control feral ungulates to prevent creation of new larval habitats	Ongoing	*Land Managers, *State and Federal Agencies	100.0					Use findings from vector surveys to identify and prioritize areas for treatment.
2	1	2.5.3.1.4.2	C	Manually drain feral pig-damaged tree ferns that hold water and fill or drain pig wallows in appropriate areas to reduce mosquito breeding sites	Ongoing	*Land Managers, USGS, USFWS, DOFAW	20.0					Use findings from vector surveys to identify and prioritize areas for treatment.
2	1	2.5.3.1.5	C	Identify natural sites (e.g., stream margins, tree holes) that serve as larval habitat and determine feasibility of treatment or elimination	Ongoing	Land Managers, *USGS, USFWS, DOFAW	10.0					Use findings from vector surveys to identify and prioritize areas for treatment.
1	1	2.5.4.1	C	Insure that existing low elevation native bird populations and habitats within current zones of disease transmission are protected to preserve disease tolerant genotypes	Ongoing	Research Institutions, UH, *USFWS, USGS, *DOFAW, ADWG	100.0					Identify low elevation native bird populations through statewide surveys, monitor status and trends of those populations, and work to insure that habitat is protected.

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	1	2.5.4.2	C	Use birds that occur in areas with disease transmission as founders for translocations to establish new populations	Ongoing	Research Institutions, UH, *USFWS, USGS, *DOFAW, ADWG	90.0	3.0	3.0	3.0	3.0	
2	2	2.5.5	C	Monitor long-term changes in the prevalence and transmission of avian diseases in recovery forest bird habitats	Ongoing	*Research Institutions, *UH, *USFWS, *USGS, DOFAW, ADWG	75.0	2.5	2.5	2.5	2.5	Identify priority areas for long-term monitoring in areas that will be intensively managed.
2	2	2.6.1.1	A	Encourage HDOA to modify import lists to exclude reptiles and amphibians from commercial sale	1 year	*HDOA, *APHIS, USFWS, DLNR	0.1	0.1				
2	1	2.6.1.2	A	Encourage HDOA to modify import lists to decrease the numbers of vertebrate species allowed into the state	1 year	*HDOA, *APHIS, USFWS, DLNR	0.1	0.1				
2	1	2.6.1.3	A	Assist HDOA obtain an enforcement branch to pursue smuggling and release violations	4 years	*HDOA, *APHIS, USFWS, DLNR	20.0	5.0	5.0	5.0	5.0	

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#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	1	2.6.1.4	A	Encourage USFWS to adopt state injurious species lists as part of federal injurious wildlife list under the Lacey Act	1 year	*USFWS, DLNR	0.1	0.1				
2	2	2.6.1.5	A	Encourage HDOA, DLNR, USFWS, and county police departments to develop a task force to pursue smuggling and release violations	1 year	*HDOA, APHIS, *USFWS, *DLNR, *County Police Departments	5.0	5.0				
2	2	2.6.1.6	A	Provide single point-of-exit at airports	Unknown	*FAA, *County Airports, HDOA, APHIS, USFWS, DLNR	100.0					
2	2	2.6.1.7	A	Increase the numbers of HDOA and USDA inspectors to better cover nursery cargo and passenger baggage/hand-carry	Unknown	County Airports, *HDOA, *USDA	20.0					
2	1	2.6.1.8	A	Secure congressional approval of USDA quarantine of mainland	Unknown	*USDA, APHIS, USFWS, DLNR	10.0					

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Priority #	Priority Tier	Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units) Total	FY 07	FY 08	FY 09	FY 10	Comments/Notes
1	1	2.6.1.9	A	Prevent inter-island expansion of established vertebrates of restricted range, including brown treesnake	Ongoing	*HDOA, *APHIS, USFWS, DLNR	600.0	20.0	20.0	20.0	20.0	
1	2	2.6.2	A	Eradicate all incipient populations of new nonnative vertebrates	4 years	*APHIS, USFWS, DLNR	80.0	20.0	20.0	20.0	20.0	
1	2	2.6.2.1	A	Prevent spread of *Eleutherodactylus* frogs to new areas	4 years	*APHIS, USFWS, DLNR	80.0	20.0	20.0	20.0	20.0	
1	3	2.6.2.2	A	Eradicate/control populations of *Eleutherodactylus* where possible	4 years	*APHIS, USFWS, DLNR	80.0	20.0	20.0	20.0	20.0	
2	1	2.6.3	A	Reduce or eliminate the detrimental effects of *vespulid* wasps (yellow jackets) on forest birds within forest ecosystems	Ongoing	*USFWS, DLNR, NPS	75.0	2.5	2.5	2.5	2.5	
1	1-3	3	E	Develop captive propagation, translocation and related recovery strategies	Ongoing	*ZSSD, *USFWS, USGS, *DOFAW, HFBRT	600.0	20.0	20.0	20.0	20.0	Annual and total costs for captive propagation program, which would implement all related recovery strategies.

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#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
1	2	3.1	E	Periodically evaluate and identify the target species that will require captive propagation for recovery and the appropriate strategy to be used	Ongoing	*ZSSD, *USFWS, USGS, *DOFAW, HFBRT	TBD[4]					
1	2	3.2	E	Develop captive propagation programs for target species, including both endangered and surrogate species	Ongoing	*ZSSD, *USFWS, USGS, *DOFAW, HFBRT	TBD[4]					
1	1	3.2.1	E	For species considered nearly extinct, efforts should be made to collect eggs for incubation and captive rearing to establish captive breeding flocks whose progeny will be used for reintroduction into native, managed habitat in the future	Ongoing	*ZSSD, *USFWS, USGS, *NPS, *DOFAW, HFBRT	TBD[4]					\`Ō\`ū, Maui nukupu\`u, Maui \`ākepa, oloma\`o, O\`ahu creeper, kāma\`o, Kaua\`i nukupu\`u, \`akialoa, and Kaua\`i \`Ō\`ō.

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#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
1	1	3.2.2	E	Continue habitat management, attempt to promote pairing and reproduction, in captivity if necessary, and collect eggs for captive propagation and reintroduction into managed habitat	Ongoing	*ZSSD, *USFWS, USGS, *NPS, *DOFAW, HFBRT	TBD[4]					Po`ouli.
2	1	3.2.3	E	Maintain a captive breeding flock of whose progeny will be used for reintroduction into managed habitat	Ongoing	*ZSSD, USFWS, USGS, DOFAW, HFBRT	TBD[4]					Puaiohi.
2	2	3.2.4	E	Collect eggs for incubation and captive rearing to establish a captive breeding flock whose progeny will be used for reintroduction into managed habitat	Ongoing	*ZSSD, *USFWS, *USGS, *NPS, DOFAW, HFBRT	TBD[4]					`Akiapōlā`au.
2	1	3.2.5.1	E	Collect the eggs of Maui parrotbill and maintain a captive breeding flock whose progeny will be used for reintroduction into managed habitat in the future	Ongoing	*ZSSD, USFWS, USGS, *NPS, *DOFAW, HFBRT	TBD[4]					Maui parrotbill.

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2	2	3.2.5.2	E	Develop rear and release methods for managed native habitat on leeward Haleakalā (Kahikinui), West Maui or Moloka`i, when disease is no longer known to be a threat	Ongoing	*ZSSD, USFWS, USGS, DOFAW, HFBRT	TBD[4]					Maui parrotbill.
2	3	3.2.6.1	E	Continue program to use translocation to West Maui or Moloka`i as recovery strategy	Ongoing	ZSSD, USFWS, USGS, NPS, *DOFAW, HFBRT	TBD[4]					`Ākohekohe.
3	1	3.2.6.2	E	Collect eggs for incubation and captive rearing. If translocations fail, use "rear and release" technology for birds reared from wild eggs or establish captive breeding flock whose progeny will be used for reintroduction into managed habitat	Ongoing	*ZSSD, USFWS, USGS, *DOFAW, HFBRT	TBD[4]					`Ākohekohe.
2	2	3.2.7.1	E	Collect eggs for incubation and captive rearing	Ongoing	*ZSSD, USFWS, USGS, NPS, *DOFAW, HFBRT	TBD[4]					Palila.

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#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	2	3.2.7.2	E	If the genetic diversity of palila in the captive flock drops below acceptable levels (defined as <90%); collect wild eggs	Ongoing	*ZSSD, USFWS, *USGS, DOFAW, HFBRT	TBD[4]					Palila.
2	1	3.2.7.3	E	Maintain a captive breeding flock whose progeny will be used for reintroduction into managed habitat	Ongoing	*ZSSD, USFWS, USGS, DOFAW, HFBRT	TBD[4]					Palila.
3	3	3.2.8.1	E	Collect eggs for incubation and captive rearing	Ongoing	*ZSSD, *USFWS, *USGS, DOFAW, HFBRT	TBD[4]					Hawai`i `ākepa and Hawai`i creeper.
3	2	3.2.8.2	E	Maintain captive flocks of Hawai`i `ākepa and Hawai`i creeper whose progeny will be used for reintroduction into managed habitat in the future, or rear and release in managed habitat	Ongoing	*ZSSD, USFWS, USGS, DOFAW, HFBRT	TBD[4]					Hawai`i `ākepa and Hawai`i creeper.

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3	1	3.2.9	E	Collect the eggs of Hawai`i `elepaio to serve as a surrogate to develop the techniques to breed, incubate, rear and release the endangered O`ahu subspecies.	Ongoing	*ZSSD, USFWS, USGS, DOFAW, HFBRT	TBD[4]					O`ahu `elepaio.
2	1	3.3.1	E	Develop methods of evaluating, selecting, and preparing sites for release of endangered birds to ensure long-term persistence of birds reintroduced to West Maui and Moloka`i	Ongoing	*ZSSD, *USFWS, USGS, *NPS, *DOFAW, *HFBRT	TBD[4]					Maui forest birds.
2	1	3.3.2	E	Develop methods of evaluating, selecting, and preparing sites for release of endangered birds to ensure long-term persistence of palila reintroduced to upland dry forest on Mauna Kea and Mauna Loa	Ongoing	*ZSSD, *USFWS, *USGS, *NPS, *DOFAW, HFBRT	TBD[4]					Palila.

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2	1	3.3.3	E	Develop methods of evaluating, selecting, and preparing sites for release of endangered birds to ensure long-term persistence of reintroduced puaiohi populations	Ongoing	*ZSSD, *USFWS, USGS, *NPS, *DOFAW, HFBRT	TBD[4]					Puaiohi.
2	1	3.3.4	E	Develop methods of evaluating, selecting, and preparing sites for release of endangered birds to ensure long-term persistence of \`akiapōlā\`au reintroduced to South Kona, Kapāpala/Ka\`ū, and upland forests of Mauna Kea	Ongoing	*ZSSD, *USFWS, *USGS, *NPS, *DOFAW, HFBRT	TBD[4]					\`Akiapōlā\`au.
1	1	3.4	E	Acquire funding to build additional facilities to maintain, propagate, incubate and rear endangered species and if necessary, surrogate species	Ongoing	*Private sector funding, ZSSD, USFWS, DOFAW, HFBRT	TBD[4]					

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1	1	3.5	E	Identify wild populations and/or individuals with potential natural disease resistance on a species by species basis	Ongoing	USFWS, *USGS, DOFAW	TBD[4]					
1	2	3.6.1	E	Develop and refine techniques for the release of captive-reared birds into managed habitat: Monitor dispersal, survival, and mortality of released birds to refine propagation and release techniques	Ongoing	*ZSSD, *USFWS, *USGS, *DOFAW	TBD[4]					
2	1	3.6.2	E	Develop and refine techniques for the release of captive-reared birds into managed habitat: Develop and refine release (hacking) procedures	Ongoing	*ZSSD, USFWS, USGS, DOFAW	TBD[4]					

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds												
Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	2	3.7	E	For each of the species identified as candidates for captive propagation, it is important to establish demographic goals for captive propagation program, i.e. how many birds to produce using which demographic strategy over what period of time and released into how many sites	Ongoing	*ZSSD, *USFWS, *USGS, *NPS, *DOFAW	TBD[4]					
2	3	3.8	E	Develop species specific reintroduction guidelines based on risk assessments that consider the behavioral, disease, demographic and genetic needs of the species	Ongoing	*ZSSD, *USFWS, *USGS, *NPS, *DOFAW	TBD[4]					
2	3	3.9	E	Provide biological material from captive held birds to an agreed holding location or locations determined on a species by species basis	Unknown	*ZSSD, USFWS, USGS, DOFAW	TBD[4]					

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	2	3.10	E	If egg collections fail, develop methods by which to bring nestling birds, juveniles, and/or adults into captivity with concomitant quarantine procedures	Unknown	*ZSSD, *USFWS, USGS, *DOFAW	TBD[4]					
1	3	3.11.1	E	Establish a cryogenic cell culture of germplasm of the endangered Hawaiian avifauna at two partner institutions willing to hold the cell line in perpetuity: In the case of the rarest species in the event of death, or if population is below 300 individuals	Unknown	*ZSSD, ADWG, VC, *USFWS, USGS, DOFAW	5.0					
2	2	3.11.2	E	Establish a cryogenic cell culture of germplasm of the endangered Hawaiian avifauna at two partner institutions willing to hold the cell line in perpetuity: Obtain and hold cryogenic germplasm for all other endangered forest birds	Unknown	*ZSSD, ADWG, VC, *USFWS, USGS, DOFAW	5.0					

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	3	3.12.1	E	Evaluate the Honolulu Zoo or other qualified institutions as repositories for those endangered species and/or individuals that are not contributing to the captive propagation program	1 year	*ZSSD, *HZ, *USFWS, DOFAW, VC	0.1	0.1				
2	1	4.1.1	E	Identify species-specific niche requirements and the role of habitat degradation and competition in reducing carrying capacity	4 years	*Research Institutions, *UH, USFWS, *USGS, *NPS, DOFAW	21.0	6.0	6.0	6.0	3.0	
1	1	4.2.1.1	C	Continue efforts to register hand and aerial broadcast methods for dispersing diphacinone toxicants for controlling predators	4 years (ongoing)	Research Institutions, UH, *USFWS, USGS, NPS, *DOFAW	6.0	1.5	1.5	1.5	1.5	
2	1	4.2.1.2	C	Evaluate the efficacy of other toxicants than diphacinone for controlling mammalian predators and take the steps needed for their registration	4 years	*Research Institutions, *UH, *USFWS, USGS, NPS, *DOFAW	10.0	2.5	2.5	2.5	2.5	

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
1	1	4.2.1.3	C	Develop and evaluate improved methods for controlling predators such as more efficient traps, contraceptives, and predator-proof fences for critical areas	4 years (ongoing)	*Research Institutions, *UH, *USFWS, USGS, NPS, *DOFAW	10.0	2.5	2.5	2.5	2.5	
1	1	4.2.2	C	Rat study	4 years (ongoing)	*Research Institutions, *UH, USFWS, *USGS, *NPS, *DOFAW	10.0	2.5	2.5	2.5	2.5	
1	2	4.2.3	C	Feral cat study	4 years (ongoing)	*Research Institutions, *UH, USFWS, *USGS, *NPS, *DOFAW	6.0	1.5	1.5	1.5	1.5	
1	3	4.2.4	C	Mongoose study	4 years (ongoing)	*Research Institutions, *UH, USFWS, *USGS, *NPS, DOFAW	6.0	1.5	1.5	1.5	1.5	
1	2	4.2.5	C	Mosquito study	4 years (ongoing)	*Research Institutions, *UH, USFWS, *USGS, *NPS, DOFAW	10.0	2.5	2.5	2.5	2.5	

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Priority #	Priority Tier	Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units) Total	FY 07	FY 08	FY 09	FY 10	Comments/Notes
2	2	4.2.6	A	Ungulate exclusion and control study	4 years (ongoing)	*Research Institutions, *UH, USFWS, *USGS, *NPS, *DOFAW	12.0	3.0	3.0	3.0	3.0	Experimental tests are needed of alternative methods for controlling and/or excluding feral pigs, goats, sheep, mouflon, and axis deer.
2	1	4.2.7	E	Weed study/control	Ongoing	*Research Institutions, *UH, USFWS, USGS, NPS, *DOFAW	TBD[3]					
2	1	4.2.8	E	Yellow jacket wasp study	4 years (ongoing)	*Research Institutions, *UH, USFWS, USGS, NPS, *DOFAW	4.0	1.0	1.0	1.0	1.0	
2	3	4.2.9	C	Barn owl and pueo study	3 years (ongoing)	*Research Institutions, *UH, USFWS, *USGS, NPS, DOFAW	1.5	0.5	0.5	0.5		
2	3	4.2.10	E	Avian competitor study	4 years (ongoing)	*Research Institutions, *UH, USFWS, *USGS, NPS, DOFAW	8.0	2.0	2.0	2.0	2.0	

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Priority #	Priority Tier	Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units) Total	FY 07	FY 08	FY 09	FY 10	Comments/Notes
2	1	4.2.10.1	E	Investigate red-billed leiothrix as competitor and reservoir for disease for po`ouli and Maui parrotbill	3 years (ongoing)	*Research Institutions, *UH, USFWS, *USGS, NPS, DOFAW	3.0	1.0	1.0	1.0		
2	1	4.2.10.2	E	Investigate competition for food and space, and disease relations, between O`ahu `elepaio and introduced birds	3 years (ongoing)	*Research Institutions, *UH, USFWS, *USGS, NPS, DOFAW	3.0	1.0	1.0	1.0		
2	1	4.2.10.3	E	Investigate role of Japanese White-eye and newly appeared Japanese Bush-warbler as competitors and reservoirs of disease for Hawai`i `ākepa, Hawai`i creeper, and `akiapōlā`au	3 years (ongoing)	*Research Institutions, *UH, USFWS, USGS, NPS, *DOFAW	3.0	1.0	1.0	1.0		
2	1	4.2.11	A	Determine best ways of conducting reforestation efforts	4 years (ongoing)	*Research Institutions, *UH, USFWS, *USGS, NPS, *DOFAW	4.0	1.0	1.0	1.0	1.0	

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Priority #	Priority Tier	Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units) Total	FY 07	FY 08	FY 09	FY 10	Comments/Notes
2	1	4.2.12	A, C, E	Investigate nonnative invertebrates in forest habitats to determine distribution, direct and indirect interactions with native invertebrates, role as a prey base for nonnative birds and mammals, and effects on flora.	10 years (ongoing)	*Research Institutions, *UH, USFWS, *USGS, *NPS, DOFAW	10.0	1.0	1.0	1.0	1.0	
2	1	4.3.1	A, C	Examine response of populations to habitat restoration, including the provisioning of food, foraging substrates, nest-sites, and roost sites, as well as the effects of habitat restoration on threats such as mosquitoes, predators, and competitors	Ongoing	*Research Institutions, *UH, USFWS, *USGS, NPS, *DOFAW	40.0					
1	1	4.4.1	C	Address public health concerns regarding aerial broadcast of rodenticide and its effects on both game and non-game non-target species, and its persistence in watershed and sediments	3 years	Research Institutions, UH, *USFWS, USGS, NPS, *DOFAW	6.0	2.0	2.0	2.0		

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#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	3	4.5.1.1	C	Determine if sleeping habits may reduce exposure to mosquitoes and predators	1 year	*Research Institutions, *UH, USFWS, *USGS, NPS, DOFAW	0.5	0.5				
2	3	4.5.1.2	C, E	Determine if nest structure and location may provide protection from high winds, rain and cold, and predators	3 years	*Research Institutions, *UH, USFWS, *USGS, NPS, DOFAW	3.0	1.0	1.0	1.0		
1	1	4.5.2.1	C	Develop molecular methods for identifying individuals who are more likely to survive pox and malaria infections or to resist them	4 years	*Research Institutions, *UH, USFWS, *USGS, DOFAW	8.0	2.0	2.0	2.0	2.0	
1	2	4.5.2.2	C	Refine diagnostic methods for identifying individuals who have survived acute disease and who have acquired immunity to reinfection	3 years (ongoing)	*Research Institutions, *UH, USFWS, *USGS, DOFAW	6.0	2.0	2.0	2.0		
2	3	4.6.1	E	Investigate ways to enhance resource availability for particular species within existing habitat.	Ongoing	*Research Institutions, *UH, USFWS, *USGS, NPS, DOFAW	10.0					

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Priority #	Priority Tier	Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units) Total	FY 07	FY 08	FY 09	FY 10	Comments/Notes
2	2	4.6.1.1.1	E	Determine if experimental artificial cavities increase the density of breeding pairs of Hawai`i `ākepa or expand the range of the birds through colonization of habitat without natural cavities	4 years (ongoing)	Research Institutions, *UH, USFWS, USGS, DOFAW	2.0	0.5	0.5	0.5	0.5	
2	1	4.6.1.1.2	C	Test the design and efficacy of rat-proof artificial nest structures for puaiohi on Kaua`i	Ongoing (ongoing)	Research Institutions, UH, USFWS, USGS, *DOFAW	1.5	0.5	0.5	0.5		
2	3	4.6.1.2	A	Determine if application of fertilizer to host plants increases growth, and productivity of flowers and arthropods	Complete	*Research Institutions, *UH, USFWS, USGS, *NPS, DOFAW	10.0					
2	1	4.6.1.3	A	Develop effective techniques for restoration of degraded and deforested lands	4 years	*Research Institutions, *UH, *USFWS, *USGS, *NPS, *DOFAW	8.0	2.0	2.0	2.0	2.0	

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Priority #	Priority Tier	Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units) Total	FY 07	FY 08	FY 09	FY 10	Comments/Notes
2	3	4.6.2.1	E	Develop a comprehensive library of microsatellite loci	3 years	*Research Institutions, ZSSD, *UH, USFWS, *USGS, DOFAW	6.0	2.0	2.0	2.0		
2	3	4.6.2.2	E	Document genetic population structure of species with single populations	3 years (ongoing)	*Research Institutions, *UH, USFWS, *USGS, DOFAW	6.0	2.0	2.0	2.0		
2	2	4.6.2.3	E	Document source/sink metapopulation structure along gradients in density, particularly elevational gradients	3 years (ongoing)	*Research Institutions, *UH, USFWS, *USGS, *NPS, DOFAW	6.0	2.0	2.0	2.0		
2	3	4.6.2.4	E	Document genetic relationships among individuals in isolated populations such as may be found on different volcanoes or in different areas of a fragmented population	3 years (ongoing)	*Research Institutions, *UH, USFWS, *USGS, DOFAW	6.0	2.0	2.0	2.0		
2	3	4.6.2.5	E	Determine patterns of dispersal by age and sex	3 years (ongoing)	*Research Institutions, *UH, USFWS, *USGS, NPS, DOFAW	6.0	2.0	2.0	2.0		

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	3	4.6.2.6	E	Determine seasonal patterns of movement by age and sex	3 years (ongoing)	*Research Institutions, *UH, USFWS, *USGS, NPS, DOFAW	6.0	2.0	2.0	2.0		
2	1	4.6.3	E	Conduct population and metapopulation viability analyses	2 years (ongoing)	*Research Institutions, *UH, USFWS, *USGS, NPS, DOFAW	2.0	1.0	1.0			
2	1	4.6.3.1	E	Conduct trend analysis using count data	2 years (ongoing)	*Research Institutions, UH, USFWS, *USGS, NPS, DOFAW	2.0	1.0	1.0			
2	1	4.6.3.2	E	Use demographic data for estimating lambda	2 years (ongoing)	*Research Institutions, *UH, USFWS, *USGS, NPS, DOFAW	2.0	1.0	1.0			
2	1	4.6.4	A, E	Investigate naturally occurring and alien species induced native plant species die-back phenomena affecting forest bird habitats	10 years (ongoing)	*Research Institutions, UH, USFWS, *USGS, *NPS, DOFAW	10.0	1.0	1.0	1.0	1.0	

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1	1	4.7.1	C	Evaluate effectiveness of translocations of both disease survivors and disease resistant forest birds for restoration of populations in areas with active disease transmission	4 years (ongoing)	*Research Institutions, *UH, USFWS, *USGS, DOFAW	8.0	2.0	2.0	2.0	2.0	
2	1	4.7.2	E	Determine optimal parameters for translocation efforts	3 years (ongoing)	*Research Institutions, UH, *USFWS, *USGS, NPS, *DOFAW	3.0	1.0	1.0	1.0		
3	2	4.7.3	E	Evaluate the relative costs of habitat suitability analysis vs. experimental translocation or reintroduction	3 years (ongoing)	*Research Institutions, UH, *USFWS, *USGS, *DOFAW	3.0	1.0	1.0	1.0		
2	1	4.8.1	C	Special research considerations for disease and parasitism: Determine the effects of land use changes on disease transmission	2 years (ongoing)	*Research Institutions, *UH, USFWS, *USGS, DOFAW	2.0	1.0	1.0			

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2	3	4.8.2	C	Special research considerations for disease and parasitism: Determine effects of long-term climate change on disease transmission	2 years (ongoing)	*Research Institutions, *UH, USFWS, *USGS, NPS, DOFAW	2.0	1.0	1.0			
2	1	4.8.3	C	Conduct research on the feasibility of vaccines for avian pox and malaria, methods for their delivery, and possible effects on host-parasite coevolutionary adaptations	3 years	*Research Institutions, ZSSD, *UH, USFWS, *USGS, DOFAW	4.5	1.5	1.5	1.5		
2	2	4.8.4	C	Conduct research on genetic variability, virulence, and interactions between avian pox virus and malarial parasites and how these variants interact with susceptible and resistant host genotypes	3 years	*Research Institutions, *UH, USFWS, *USGS, NPS, DOFAW	4.5	1.5	1.5	1.5		
2	3	4.8.4.1	C	Use molecular methods to identify specific markers that correlate with phenotypic differences in virulence	3 years	*Research Institutions, *UH, USFWS, *USGS, DOFAW	4.5	1.5	1.5	1.5		

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#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	1	4.8.4.2	C	Determine whether concomitant infections with pox and malaria affect virulence and transmissibility	3 years	*Research Institutions, *UH, USFWS, *USGS, DOFAW	4.5	1.5	1.5	1.5		
1	2	4.8.5	C	Determine dispersal distances of adult mosquitoes from point sources outside of recovery area.	4 years (ongoing)	*Research Institutions, *UH, USFWS, *USGS, DOFAW	6.0	1.5	1.5	1.5	1.5	
2	1	4.8.6	C	Determine the feasibility of decreasing malarial transmission through genetic manipulation of vector populations	3 years	*Research Institutions, *UH, USFWS, *USGS, DOFAW	3.0	1.0	1.0	1.0		
2	3	4.8.7	C	Determine the role that ectoparasites play in transmission of avian pox, particularly during the nesting cycle when adults may pass infections to offspring	3 years	*Research Institutions, *UH, USFWS, *USGS, DOFAW	3.0	1.0	1.0	1.0		
2	3	4.8.8	C	Determine the role that endoparasites such as Coccidea play in demography of birds	3 years	*Research Institutions, *UH, USFWS, *USGS, DOFAW	3.0	1.0	1.0	1.0		

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#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	2	4.8.9	C	Monitor long-term changes in the prevalence and transmission of avian diseases in recovery forest bird habitats	Unknown	*Research Institutions, *UH, USFWS, *USGS, NPS, DOFAW	4.0	1.0	1.0	1.0	1.0	
2	1	4.9	E	Develop and test improved survey and monitoring techniques in recovery area for extremely rare species and species difficult to monitor using standard methods	2 years (ongoing)	*Research Institutions, *UH, *USFWS, *USGS, *NPS, *DOFAW	1.0	0.5	0.5			
2	1	4.10.1	E	Determine the basis for variation in population density and termination of range	3 years (ongoing)	*Research Institutions, *UH, *USFWS, *USGS, *NPS, DOFAW	3.0	1.0	1.0	1.0		Hawai\`i. Species: Hawai\`i \`ākepa, Hawai\`i creeper, \`akiapōlā\`au
2	3	4.10.2	E	Determine the basis for low nesting success documented at Honohina Tract (wet habitat) using cameras on nests while documenting rainfall	2 years	*Research Institutions, *UH, *USFWS, *USGS, NPS, DOFAW	2.0	1.0	1.0			Hawai\`i; Hakalau Forest NWR, Honohina Tract. Species: Hawai\`i creeper

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#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	3	4.10.3	E	Determine the role of food in timing of breeding, attempts to breed, and breeding success	3 years	*Research Institutions, *UH, *USFWS, *USGS, NPS, DOFAW	3.0	1.0	1.0	1.0		Hawai`i. Species: Hawai`i `ākepa, Hawai`i creeper, `akiapōlā`au
2	1	4.10.4	E	Determine why these birds are limited to high elevations	3 years (ongoing)	*Research Institutions, *UH, USFWS, *USGS, *NPS, *DOFAW	3.0	1.0	1.0	1.0		Maui. Species: `ākohekohe, Maui parrotbill
2	1	4.10.5	E	Examine factors that determine abundance and distribution, including elevational range	2 years (ongoing)	*Research Institutions, *UH, USFWS, *USGS, NPS, *DOFAW	2.0	1.0	1.0			Kaua`i; Alaka`i Wilderness area. Species: Kaua`i creeper, Puaiohi
2	2	4.10.6	E	Determine the role of food as the basis for different densities of the bird in continuous habitat	2 years	*Research Institutions, *UH, USFWS, *USGS, NPS, *DOFAW	2.0	1.0	1.0			Kaua`i; Alaka`i Wilderness area. Species: Kaua`i creeper
2	1	4.10.7	C	Determine population response of palila to predator control efforts	2 years (ongoing)	*Research Institutions, *UH, *USFWS, *USGS, NPS, DOFAW	2.0	1.0	1.0			Hawai`i; Mauna Kea and Mauna Loa. Species: palila

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#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
1	2	4.10.8	C	Determine population response of endangered Maui forest birds to predator control efforts	2 years (ongoing)	*Research Institutions, *UH, USFWS, USGS, *NPS, *DOFAW	2.0	1.0	1.0			Maui. Species: \`ākohekohe, Maui parrotbill, po\`ouli
2	1	4.10.9	C	Determine the effect of predator control on survival of female O\`ahu \`elepaio	Complete	*Research Institutions, *UH, *USFWS, *USGS, DOFAW	0.0					O\`ahu. Species: O\`ahu \`elepaio
1	2	4.10.10	C	Measure effect of experimental test of broad-scale predator control on nest success, adult and post-fledging survival, and population trends	3 years	*Research Institutions, *UH, USFWS, *USGS, *NPS, *DOFAW	4.5	1.5	1.5	1.5		Kaua\`i; Alaka\`i Wilderness area. Species: Kaua\`i creeper, Puaiohi
2	2	4.10.11	A	Determine population response of palila to forest regeneration and restoration efforts	3 years (ongoing)	*Research Institutions, *UH, USFWS, *USGS, DOFAW	4.5	1.5	1.5	1.5		Hawai\`i; Mauna Kea and Mauna Loa. Species: palila
2	2	4.10.12	A	Determine use of regenerating/restored canopy trees as substrates for feeding	2 years (ongoing)	*Research Institutions, *UH, *USFWS, *USGS, *NPS, DOFAW	2.0	1.0	1.0			Hawai\`i. Species: Hawai\`i \`ākepa, Hawai\`i creeper, \`akiapōlā\`au

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#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	2	4.10.13	A	Determine population response of endangered Maui forest birds to forest regeneration and habitat restoration efforts	2 years (ongoing)	*Research Institutions, *UH, USFWS, *USGS, *NPS, *DOFAW	2.0	1.0	1.0			Maui. Species: \`ākohekohe, Maui parrotbill
2	2	4.10.14	A	Determine population response to experimental control of weeds (e.g., ginger)	2 years (ongoing)	*Research Institutions, *UH, USFWS, USGS, NPS, *DOFAW	2.0	1.0	1.0			Kaua\`i. Species: Kaua\`i creeper, Puaiohi
1	3	4.10.15	C	Determine if tolerance or resistance to malaria and pox virus is evolving at the lower portion of the elevational range of these birds	2 years (ongoing)	*Research Institutions, *UH, USFWS, *USGS, DOFAW	3.0	1.5	1.5			Hawai\`i. Species: Hawai\`i \`ākepa, Hawai\`i creeper, \`akiapōlā\`au
2	1	4.10.16	C	Determine if tolerance or resistance to malaria and pox virus is evolving in any of the fragmented populations	2 years (ongoing)	*Research Institutions, *UH, *USFWS, *USGS, *DOFAW	3.0	1.5	1.5			O\`ahu. Species: O\`ahu \`elepaio
2	3	4.10.17	E	Document genetic population structure of species with single populations	2 years (ongoing)	*Research Institutions, *UH, USFWS, *USGS, *NPS, *DOFAW	2.0	1.0	1.0			Maui. Species: po\`ouli, Maui parrotbill, \`ākohekohe

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	3	4.10.18	E	Document source/sink metapopulation structure and dispersal characteristics in populations along lateral and elevational gradients of density	2 years (ongoing)	*Research Institutions, *UH, *USFWS, *USGS, *NPS, DOFAW	2.0	1.0	1.0			Hawai`i. Species: Hawai`i `ākepa, Hawai`i creeper, `akiapōlā`au
2	3	4.10.19	E	Document the basis of variation in size of home range in areas of different density of the bird and in areas with different forest structure	2 years (ongoing)	*Research Institutions, *UH, *USFWS, *USGS, *NPS, *DOFAW	2.0	1.0	1.0			Hawai`i. Species: `akiapōlā`au
2	3	4.10.20	E	Determine genetic as well as morphological, behavioral, ecological, and vocal variation among core populations.	2 years (ongoing)	*Research Institutions, *UH, *USFWS, *USGS, *NPS, DOFAW	4.0	2.0	2.0			Hawai`i; Mauna Kea and Hualālai. Species: Hawai`i `ākepa, Hawai`i creeper, `akiapōlā`au
2	3	4.10.21	E	Determine genetic as well as morphological, behavioral, ecological, and vocal variation among core populations.	2 years	*Research Institutions, *UH, *USFWS, *USGS, NPS, *DOFAW	2.0	1.0	1.0			O`ahu. Species: O`ahu `elepaio
2	3	4.10.22	E	Determine patterns of dispersal by age and sex	2 years	*Research Institutions, *UH, *USFWS, *USGS, NPS, *DOFAW	2.0	1.0	1.0			O`ahu. Species: O`ahu `elepaio

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds

Priority #	Priority Tier	Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units) Total	FY 07	FY 08	FY 09	FY 10	Comments/Notes
2	2	4.10.23	E	Document dispersal and survival of juveniles	2 years	*Research Institutions, *UH, *USFWS, *USGS, NPS, *DOFAW	2.0	1.0	1.0			O`ahu. Species: O`ahu `elepaio
2	3	4.10.24	E	Conduct population and metapopulation viability analyses and calculate lambda in populations in different portions of the recovery area	4 years	*Research Institutions, *UH, *USFWS, *USGS, *NPS, *DOFAW	4.0	1.0	1.0	1.0	1.0	Hawai`i. Species: Hawai`i `ākepa, Hawai`i creeper, `akiapōlā`au
2	1	4.10.25	E	Conduct development and testing of improved survey and monitoring techniques	3 years	*Research Institutions, *UH, *USFWS, *USGS, NPS, *DOFAW	3.0	1.0	1.0	1.0		Kaua`i. Species: Kaua`i creeper, Puaiohi
1	1	5.1	E	Conduct systematic surveys of all forest bird habitat on Kaua`i, O`ahu, Moloka`i, Lāna`i, Maui, and Hawai`i at least once every five years to determine changes in distribution and population size of all native and nonnative forest birds	Ongoing	UH, *USFWS, *USGS, *NPS, *DOFAW	36.0	1.2	1.2	1.2	1.2	

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds												
Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	2	5.2.1	E	Conduct systematic surveys of māmane forest on Mauna Kea, Hawai`i, to determine annual and seasonal changes in distribution and population size	Ongoing	*USFWS, *USGS, DOFAW	6.0	0.2	0.2	0.2	0.2	Annual survey.
2	1	5.2.2	E	Conduct systematic surveys of Hakalau Forest NWR, Hawai`i, to determine annual and seasonal changes in distribution and population size	Ongoing	UH, *USFWS, USGS	6.0	0.2	0.2	0.2	0.2	Annual survey.
2	1	5.2.3	E	Conduct systematic surveys of Kona Unit, Hakalau Forest NWR, Hawai`i, to determine annual and seasonal changes in distribution and population size	Ongoing	*USFWS, USGS	3.0	0.1	0.1	0.1	0.1	Annual survey.
2	1	5.2.4	E	Conduct systematic surveys of Ka`ū Forest, Hawai`i, to determine annual and seasonal changes in distribution and population size	Ongoing	*USFWS, *USGS, *DOFAW	7.5	0.5	0	0.5	0	Every 2 years.

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds

Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	1	5.2.5	E	Conduct systematic surveys of Pu`u Wa`awa`a Forest Bird Sanctuary, Hawai`i, to determine annual and seasonal changes in distribution and population size	Ongoing	*USFWS, *USGS, *DOFAW	3.0	0.2	0	0.2	0	Every 2 years.
2	1	5.2.6	E	Conduct systematic surveys of Kūlani, Hawai`i, to determine annual and seasonal changes in distribution and population size	Ongoing	*USFWS, *USGS, DOFAW, NPS	3.0	0.1	0.1	0.1	0.1	Annual survey.
2	1	5.2.7	E	Conduct systematic surveys of Keauhou Ranch/Kīlauea Forest, Hawai`i, to determine annual and seasonal changes in distribution and population size	Ongoing	*KS, *USFWS, *USGS, DOFAW	3.0	0.1	0.1	0.1	0.1	Annual survey. Total cost based on annual cost for 30 years.
2	2	5.2.8	E	Conduct systematic surveys of Mauna Loa Strip, Hawai`i, to determine annual and seasonal changes in distribution and population size	Ongoing	USFWS, *USGS, DOFAW, *NPS	3.0	0.1	0.1	0.1	0.1	Annually/biannually. Total cost based on annual cost for 30 years.

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	1	5.2.9	E	Conduct systematic surveys of Hanawī NAR, Maui, to determine annual and seasonal changes in distribution and population size	Ongoing	USFWS, USGS, *DOFAW	7.5	0.25	0.25	0.25	0.25	Annual survey. Total cost based on annual cost for 30 years.
2	1	5.2.10	E	Conduct systematic surveys of Waikamoi Preserve, Maui, to determine annual and seasonal changes in distribution and population size	Ongoing	USFWS, USGS, *DOFAW, *TNCH	3.0	0.1	0.1	0.1	0.1	Annual survey. Total cost based on annual cost for 30 years.
2	1	5.2.11	E	Conduct systematic surveys of Kīpahulu Valley, Maui, to determine annual and seasonal changes in distribution and population size	Ongoing	USFWS, *USGS, DOFAW, *NPS	3.0	0.1	0.1	0.1	0.1	Annual survey. Total cost based on annual cost for 30 years.
2	1	5.2.12	E	Conduct systematic surveys of Wailupe Valley, O`ahu, to determine annual and seasonal changes in distribution and population size and to monitor efficacy of predator control	Ongoing	*USFWS, USGS, *DOFAW	1.6	0.2	0.2	0.2	0	Annual for 3 years, integrated with 5-year cycle. Total cost based on annual cost for 30 years.

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	1	5.2.13	E	Conduct systematic surveys of Pia Valley, O`ahu, to determine annual and seasonal changes in distribution and population size and to monitor efficacy of predator control	Ongoing	*USFWS, USGS, *DOFAW	1.6	0.2	0.2	0.2	0	Annual for 3 years, Total cost based on annual cost for 30 years integrated with 5-year cycle.
2	2	5.2.14	E	Conduct systematic surveys of Honouliuli Preserve, O`ahu, to determine annual and seasonal changes in distribution and population size and to monitor efficacy of predator control	Ongoing	*USFWS, USGS, DOFAW, *TNCH	1.6	0.2	0.2	0.2	0	Annual for 3 years, Total cost based on annual cost for 30 years, integrated with 5-year cycle.
2	3	5.2.15	E	Conduct systematic surveys of Schofield Barracks West Range, O`ahu, to determine annual and seasonal changes in distribution and population size and to monitor efficacy of predator control	Ongoing	*USFWS, USGS, DOFAW, *U.S. Army	1.6	0.2	0.2	0.2	0	Annual for 3 years, Total cost based on annual cost for 30 years, integrated with 5-year cycle.

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds

Priority #	Priority Tier	Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units) Total	FY 07	FY 08	FY 09	FY 10	Comments/Notes
2	2	5.2.16	E	Conduct systematic surveys of any other areas on O`ahu where active management is undertaken to determine annual and seasonal changes in distribution and efficacy of actions	Ongoing	*USFWS, USGS, *DOFAW	1.6	0.2	0.2	0.2	0	Annual for 3 years. Total cost based on annual cost for 30 years, integrated with 5-year cycle.
2	1	5.2.17	E	Conduct systematic surveys of "core" puaiohi habitat in Alaka`i Wilderness Preserve, Kaua`i, to determine annual and seasonal changes in distribution and population size	Ongoing	*USFWS, *USGS, *DOFAW	6.0	0.2	0.2	0.2	0.2	Annual survey.
1	1	5.3	E	Establish and support an interagency Forest Bird Monitoring Coordinator position to coordinate monitoring and provide regular reports on the status and trend of forest bird populations	Ongoing	*USFWS, USGS, NPS, *DOFAW	21.0	0.7	0.7	0.7	0.7	

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
3	1	6.1.1.1	E	Develop scenic overlook and trail with interpretive displays depicting native forest birds at Saddle Road 21 mile marker, Hawai`i	2 years	*DLNR	2.0	1.0	1.0			
3	3	6.1.1.2	E	Improve parking area and interpretive displays at Pu`u `Ō`ō Trail, Saddle Road, Hawai`i	2 years	*DLNR	1.0	0.5	0.5			
3	1	6.1.1.3	E	Develop several short loop trails at Mauna Loa Strip Road, Hawai`i Volcanoes National Park	2 years	*NPS	2.0	1.0	1.0			
2	2	6.1.1.4	E	Expand visitor use with a loop trail and interpretive displays at Hakalau Forest NWR, Hawai`i	2 years	*USFWS	2.0	1.0	1.0			
2	3	6.1.1.5	E	Establish a loop trail in palila habitat and provide interpretive signs at Pu`u Lā`au, Mauna Kea, Hawai`i	2 years	*DLNR, *USGS	2.0	1.0	1.0			
3	3	6.1.1.6	E	Work with Nā Ala Hele to add material on birds to their interpretive displays and brochure at Ainapō Trail, Hawai`i	2 years	*DLNR, *NPS	2.0	1.0	1.0			

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
3	3	6.1.1.7	E	Develop a system of trails with interpretive displays at Pu`u Wa`awa`a Forest Bird Sanctuary, Hawai`i	2 years	*DLNR	2.0	1.0	1.0			
3	3	6.1.1.8	E	Develop a system of trails with interpretive displays at Pu`u Maka`ala, Laupāhoehoe, Kīpāhoehoe, Manukā, and Pu`u O`umi NARs, Hawai`i	2 years	*DLNR	3.0	1.5	1.5			
3	2	6.1.1.9	E	Develop interpretive signs for the nature trail at Hosmer Grove Haleakalā National Park, Maui	2 years	*NPS	2.0	1.0	1.0			
3	2	6.1.1.10	E	Develop interpretive kiosk in parking area and brochures and signs for the Waiakoa Loop Trail at Polipoli State Park, Maui	2 years	*DLNR	1.0	0.5	0.5			
3	3	6.1.1.11	E	Develop access, trails, and interpretive displays at Pu`u Kukui, Maui	2 years	*Maui Land and Pineapple Co.	2.0	1.0	1.0			
3	3	6.1.1.12	E	Develop an interpretive display at Waihe`e Ridge Trail, Maui	2 years	*DLNR	2.0	1.0	1.0			

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
3	3	6.1.1.13	E	Develop an interpretive display at Kahakuloa NAR, Maui	2 years	*DLNR	1.0	0.5	0.5			
3	3	6.1.1.14	E	Develop an interpretive trail to the rim of Pēpē`ōpae Bog at Hanalilolilo Trail, Moloka`i	2 years	*DLNR	1.0	0.5	0.5			
3	3	6.1.1.15	E	Develop scenic overlook and interpretive displays at Pu`u Ali`i NAR, Moloka`i	2 years	*DLNR	1.0	0.5	0.5			
2	3	6.1.1.16	E	Develop interpretive signs and brochures at Kuli`ou`ou Trail and `Aiea Loop Trail, O`ahu	2 years	*DLNR, *USFWS	2.0	1.0	1.0			
2	2	6.1.1.17	E	Develop interpretive kiosks and signs at Kalalau and Pu`u O Kila lookouts, Kōke`e State Park, Kaua`i	2 years	*DLNR	2.0	1.0	1.0			
3	2	6.1.2.1	E	Promote increased access and interpretation programs on lands where native species are found: Hawai`i, Hakalau Forest NWR, Hakalau and Kona Forest Units	Ongoing	*USFWS	3.0	0.1	0.1	0.1	0.1	

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
3	2	6.1.2.2	E	Promote increased access and interpretation programs on lands where native species are found: Hawai`i, Pu`u Wa`awa`a Forest Bird Sanctuary	Ongoing	*DLNR, *DOFAW	3.0	0.1	0.1	0.1	0.1	
3	2	6.1.2.3	E	Promote increased access and interpretation programs on lands where native species are found: Maui, Waikamoi Preserve, The Nature Conservancy	Ongoing	* TNCH	3.0	0.1	0.1	0.1	0.1	
3	3	6.1.2.4	E	Promote increased access and interpretation programs on lands where native species are found: Maui, Makawao Forest Reserve	Ongoing	*DLNR, *DOFAW	3.0	0.1	0.1	0.1	0.1	
3	2	6.1.2.5	E	Promote increased access and interpretation programs on lands where native species are found: Maui, Hanawī NAR	Ongoing	*NAR	3.0	0.1	0.1	0.1	0.1	

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Priority #	Priority Tier	Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units) Total	FY 07	FY 08	FY 09	FY 10	Comments/Notes
3	2	6.1.2.6	E	Promote increased access and interpretation programs on lands where native species are found: Maui, Haleakalā National Park	Ongoing	*NPS	3.0	0.1	0.1	0.1	0.1	
3	3	6.1.2.7	E	Promote increased access and interpretation programs on lands where native species are found: Moloka`i, Kamakou Preserve, The Nature Conservancy	Ongoing	*TNCH	3.0	0.1	0.1	0.1	0.1	
3	2	6.1.2.8	E	Promote increased access and interpretation programs on lands where native species are found: O`ahu, Barber's Point	Ongoing	*DLNR, *DOFAW	3.0	0.1	0.1	0.1	0.1	
2	1	6.1.2.9	E	Promote increased access and interpretation programs on lands where native species are found: Honouliuli Preserve, The Nature Conservancy	Ongoing	*DLNR, *DOFAW	3.0	0.1	0.1	0.1	0.1	

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	2	6.1.3.1	E	Expand visitor awareness with development of visitor centers, displays and facilities, and public services interpretive programs: Hawai`i, Hakalau Forest NWR	Ongoing	*USFWS	34.0	10.0	10.0	0.5	0.5	
2	3	6.1.3.2	E	Expand visitor awareness with development of visitor centers, displays and facilities, and public services interpretive programs: Maui, Haleakalā National Park	Ongoing	*NPS	34.0	10.0	10.0	0.5	0.5	
2	3	6.1.3.3	E	Expand visitor awareness with development of visitor centers, displays and facilities, and public services interpretive programs: O`ahu, Honolulu Zoo	Ongoing	*HZ	34.0	10.0	10.0	0.5	0.5	
2	3	6.1.4	E	Promote the opening of State Forest reserve trails to the general public for nature walks and birding on all islands	Ongoing	*DLNR, *DOFAW	30.0	1.0	1.0	1.0	1.0	
3	2	6.1.5	E	Support the Nā Ala Hele Trail System	Ongoing	*DLNR, *DOFAW	30.0	1.0	1.0	1.0	1.0	

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#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	1	6.2.1.1	E	Institute core curriculum programs at the university level emphasizing Hawaii's native species for elementary and high school education programs	Ongoing	*UH	60.0	2.0	2.0	2.0	2.0	
2	1	6.2.1.2	E	Develop an interpretation internship program for university students specializing in the field of forest bird information and education	Ongoing	*UH	60.0	2.0	2.0	2.0	2.0	
2	1	6.2.1.3	E	Provide permanent funding for programs such as Imi Pono No Ka Aina, an Environmental Educator program at Hawai`i Volcanoes National Park that educates teachers through accredited workshops in environmental and native species issues	Ongoing	TBD	60.0	2.0	2.0	2.0	2.0	

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#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
3	2	6.2.1.4.1	E	Fund the development and distribution of educational materials: Develop forest bird posters for schools, emphasizing each of the native forest birds and keyed to each islands endemic species	2 years	TBD	2.0	1.0	1.0			
3	2	6.2.1.4.2	E	Fund the development and distribution of educational materials: Keauhou Ranch/Kīlauea Forest Reserve. Assist Kamehameha Schools with ongoing development of environmental learning opportunities	2 years	KS*, USFWS	0.5	0.25	0.25			

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	1	6.2.2.1	E	Fund and support programs for school children on each island that provide a "hands on" approach to learning about Hawaii's native species: Keokeolani Outdoor Education Program on the Big Island; Maui Outdoor Education Center on Maui; Hawai`i Nature Center on O`ahu; The Discovery Outdoor Education Center on Kaua`i; and funding for the establishment of a Moloka`i Outdoor Education Center	Ongoing	*Hawai`i Outdoor Education Centers	90.0	3.0	3.0	3.0	3.0	
2	2	6.2.2.2	E	Fund and support organizations such as `Ōhi`a Productions and Keauhou Bird Conservation Center that provide environmental educational programs to Hawaii's school children	Ongoing	TBD	30.0	1.0	1.0	1.0	1.0	

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Priority #	Priority Tier	Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units) Total	FY 07	FY 08	FY 09	FY 10	Comments/Notes
2	3	6.2.2.2.1	E	Provide funding for \`Ōhi\`a Productions to perform on other islands and to produce videos of previous performances for distribution to schools throughout Hawai\`i	Ongoing	*\`Ōhi\`a Productions	6.0	0.2	0.2	0.2	0.2	
2	3	6.2.2.3	E	Develop and support programs such as Mālama Hawai\`i, that encourage widespread awareness of conservation goals through a diverse coalition of traditional and non-traditional partnerships	Ongoing	TBD	6.0	0.2	0.2	0.2	0.2	

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	2	6.2.3.1	E	Fund, create and support continuous maintenance of an informational website focused on native species, their habitats, as well as alien species and their effects on native species, and provide up to date information that can be utilized and copied onto other web sites to spread the information	Ongoing	TBD	3.0	0.1	0.1	0.1	0.1	
3	3	6.2.3.1.1	E	Obtain funding from Gates Foundation for remote digital broadcast from O`ahu `elepaio "nest cam" to local schools through a web site	4 years	TBD	4.0	1.0	1.0	1.0	1.0	
1	1	6.2.4.1	E	Initiate and fund public outreach and information about the effect of rats and cats as vectors for human disease, agricultural pests, and their threats to native species as predators	4 years	*USFWS, *HDPH	6.0	2.0	2.0	1.0	1.0	

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Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
1	1	6.2.4.2	E	Initiate public outreach efforts to inform the public about potential human and animal diseases transmitted by mosquitoes and how source reduction can reduce those threats	4 years	*USFWS, *HDPH	6.0	2.0	2.0	1.0	1.0	
2	1	6.2.4.3	E	Inform the public as to the value of feral ungulate and weed control in native forests by providing film and video footage of the harmful effects of alien weeds and ungulates on native species and agriculture	4 years	*USFWS, *HDPH	6.0	2.0	2.0	1.0	1.0	
2	3	6.3.1	E	Conduct market research on the public's knowledge of native species and attitudes towards conservation, to provide the information to develop the most direct ways to educate the public and gain support for native species	2 years	TBD	4.0	2.0	2.0			

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#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	3	6.3.2.1	E	Assist in the development of public service announcements about native species by providing local television stations with footage of native species with natural sounds and suggest their use as background visuals or sounds during credits for local or other programming	Ongoing	TBD	6.0	0.2	0.2	0.2	0.2	
2	3	6.3.2.2	E	Use local "heroes", entertainers, sports figures, or other role models, to promote local pride in common native and endangered species	Ongoing	TBD	3.0	0.1	0.1	0.1	0.1	
3	3	6.3.2.3	E	Promote the use of prize-winning contests, with sponsors, on local radio, television stations and newspapers to promote native species awareness	Ongoing	TBD	3.0	0.1	0.1	0.1	0.1	

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#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
3	2	6.3.2.3.1	E	Sponsor and support contests such as: Forest bird website contest among high school students, forest bird essay contest in Hawaii's schools with prizes for different grade levels, forest bird photo contest, or a song writing contest with the song to be used for a theme song for a locally produced nature program	Ongoing	*HDOE	1.5	0.05	0.05	0.05	0.05	
3	2	6.3.2.4.1	E	Develop a weekly column provided to all newspapers in Hawai`i providing information on native species and ecosystem issues, with the writing shared by conservation organizations throughout the state	Ongoing	TBD	3.0	0.1	0.1	0.1	0.1	

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#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
3	2	6.3.2.4.2	E	Develop a weekly program for radio stations on all islands providing information on native species and ecosystem issues, with the writing shared by conservation organizations throughout the State.	Ongoing	TBD	3.0	0.1	0.1	0.1	0.1	
3	2	6.3.2.4.3	E	Develop a half hour weekly or monthly television nature program about Hawaii's native species and their habitat	Ongoing	TBD	12.0	0.4	0.4	0.4	0.4	
3	2	6.3.3.1	E	Promote the use of the \`i\`iwi or a caricature of \`i\`iwi as the "Poster Child" for native species in advertising and in education	4 years	TBD	1.2	0.3	0.3	0.3	0.3	

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds												
Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
3	2	6.3.3.2	E	Provide native species images and promote the use of these images in advertising by advertising agencies, local and national fast food corporations for use in advertising on tray-liners, milk cartons, and other heavily used advertising media	Ongoing	TBD	1.5	0.05	0.05	0.05	0.05	
3	2	6.3.4.1	E	Promote the hosting of special events in cooperation with major local hotels and corporations as partners for funding, and to champion native species and ecosystem awareness	Ongoing	TBD	3.0	0.1	0.1	0.1	0.1	
2	2	6.4.1.1	E	Support conservation outreach organizations to promote conservation at a “grass roots” level	Ongoing	TBD	15.0	0.5	0.5	0.5	0.5	

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds												
Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
3	2	6.4.1.2	E	Develop a “mentor” program, where natural science based professionals provide field opportunities for young people in learning about Hawaii’s native species	Unknown	*UH, *USFWS, *USGS, *DLNR, *DOFAW	6.0	0.2	0.2	0.2	0.2	
2	2	6.4.1.3	E	Support the use of volunteers in projects on State, Federal and private lands that will contribute to the enhancement of native habitat and increase the level of awareness and pride in native species within the local populace	Ongoing	*USFWS, *USGS, *DLNR, *DOFAW, *NAR, *NPS	12.0	0.4	0.4	0.4	0.4	
3	2	6.4.1.4	E	Support the development of a volunteer “clearinghouse” to provide volunteers for resource management, education, and outreach	Ongoing	TBD	3.0	0.1	0.1	0.1	0.1	

Table 19. Implementation Schedule for the Revised Recovery Plan for Hawaiian Forest Birds

Priority		Action Number	Listing Factor	Action Description	Action Duration	Responsible Parties	Cost Estimate (in $100,000 units)					Comments/Notes
#	Tier						Total	FY 07	FY 08	FY 09	FY 10	
2	2	6.4.2.1	E	Develop and maintain partnerships with Kamehameha Schools, The Nature Conservancy of Hawai`i, Hawai`i Audubon Society, Pig Hunters of Hawai`i, Hawai`i Conservation Association and other NGO's to promote environmental awareness and broaden the spectrum of a local environmentally educated populace	Ongoing	TBD	15.0	0.5	0.5	0.5	0.5	
TOTAL							24,774	947	895	806	755	

[1]Costs to secure recovery area cannot be determined at this time because numerous methods are available (conservation easement, partnership agreement, safe harbor agreement, change in land use designation, change of jurisdiction, lease, or purchase from willing seller) that vary widely in their potential cost, and it is not possible to speculate which method might be most appropriate or effective in the future. Many land parcels in question are owned by State or local governments or private interests, and the most appropriate method of securing habitat will depend on the disposition and willingness of the landowner.

[2]Costs to reduce or eliminate detrimental effects of ungulates on vegetation are approximations because locations and extent of strategic fencing are not known at this time, and/or total acreage to be fenced has not been determined.

[3]Costs to reduce or eliminate the detrimental effects of exotic plants through mechanical, chemical, or biological means and research can not be determined at this time because the distributions of exotic plants are only partly known, and in many cases the most effective means for their control have yet to be determined.

[4]Costs for this captive propagation, translocation, or related recovery action are included under recovery action number 3, and are part of the continuing captive propagation program for Hawaiian forest birds.

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VII. APPENDICES

APPENDIX A.
Land Parcels in Recovery Areas and Recovery Actions by Parcel for Protection, Reforestation, Fencing and Ungulate Control, and Predator Control

After each recovery action number is the priority number in parentheses. Refer to the recovery action narrative for a complete description of recovery actions. The general recovery action numbers are:

1.3. = Parcels in recovery areas in need of protection;
2.1. = Parcels in recovery areas needing reforestation;
2.2. = Parcels in recovery areas needing fencing and ungulate control; and
2.4.1. = Parcels in recovery areas where predator control is needed.

Island codes: H = Hawai`i; K = Kaua`i; MA = Maui; MO = Moloka`i; O = O`ahu.

Landowner acronyms: DLNR = Hawai`i Department of Land and Natural Resources, DHHL = Department of Hawaiian Home Lands, DOFAW = Hawai`i Division of Forestry and Wildlife, NARS = Natural Area Reserve System, HVNP = Hawai`i Volcanoes National Park. TMK = Tax Map Key.

Appendix A			
Island	Land Parcel, TMKs	Landowner	Recovery Actions
H	Northeastern slopes of Mauna Kea, portions of 344014002 344014003 343010002 343010008	Hawai`i DLNR, State Land Division.	1.3.1 (2); 2.1.1 (2); 2.2.1 (2); 2.4.1.1 (2)
H	Kanakaleonui Corridor, 338001009	Hawai`i DHHL.	1.3.2 (1); 2.1.2 (1); 2.2.2 (1); 2.4.1.2 (2)
H	Hilo Forest Reserve, Laupāhoehoe Section, 337001004	Hawai`i DLNR. Currently the Laupāhoehoe Game Management Area.	1.3.3 (2); 2.1.3 (3)

Appendix A			
Island	Land Parcel, TMKs	Landowner	Recovery Actions
H	Hilo Forest Reserve, Pīhā Section, 333001004	Hawai`i DLNR. Currently the Pīhā Game Management Area.	1.3.4 (2); 2.1.4 (3)
H	Hilo Forest Reserve, Laupāhoehoe and Pīhā Sections, 337001004 333001004	Hawai`i DLNR. Currently the Laupāhoehoe and Pīhā Game Management Areas.	2.2.3 (2)
H	Hilo Forest Reserve, Laupāhoehoe and Pīhā Sections, 337001002 333001004	Hawai`i DLNR. Currently the Laupāhoehoe and Pīhā Game Management Areas.	2.4.1.3 (2)
H	Hakalau Forest NWR, 337001010 329005005 333001007 329005003	U.S. Fish and Wildlife Service.	2.1.5 (1); 2.2.4 (1); 2.4.1.4 (1)
H	Kīpuka `Āinahou Nēnē Sanctuary, 338001008	Hawai`i DHHL. Leased by DOFAW and currently under annual lease.	1.3.5 (2); 2.1.6 (3); 2.2.7 (2); 2.4.1.7 (2)
H	Humu`ula, 338001002	Hawai`i DHHL.	1.3.6 (1); 2.1.7 (2)
H	Humu`ula, Portions of 338001007	Hawai`i DHHL. Parker Ranch, leased for grazing.	1.3.7 (2); 2.1.8 (2)

Appendix A			
Island	Land Parcel, TMKs	Landowner	Recovery Actions
H	Lama`ia Section and Portions of 326018002	Hawai`i DHHL. Adjacent to Hakalau Forest National Wildlife Refuge.	1.3.8 (1); 2.1.9 (2) 2.2.5 (2); 2.4.1.5 (2)
H	Pu`u `Ō`ō Ranch, 326018001	Hawai`i DLNR, State Land Division. Pu`u `Ō`ō Ranch leased for cattle grazing.	1.3.9 (1); 2.1.10 (2) 2.2.6 (2); 2.4.1.6 (2)
H	Ka`ohe Lease, 344015002	Hawai`i DLNR, State Land Division. Currently leased for cattle grazing to various lessees.	1.3.10 (1); 2.1.11 (2); 2.2.8 (2); 2.4.1.8 (2)
H	Mauna Kea Forest Reserve, 344015001	Hawai`i DLNR.	2.1.12 (1);
H	Mauna Kea Forest Reserve, 344015001 344016003 338001004	Hawai`i DLNR.	2.2.9 (1); 2.4.1.9 (1)
H	Waiākea Forest Reserve, Upper Portion, 324008001	Hawai`i DLNR.	2.2.10 (1); 2.4.1.10 (2)
H	Waiākea Forest Reserve, Lower Portion, 324008001	Hawai`i DLNR.	2.2.11 (1); 2.4.1.11 (2)

Appendix A			
Island	Land Parcel, TMKs	Landowner	Recovery Actions
H	`Ōla`a/Kīlauea Partnership, 324008009 399001007 399001004 324008025 319001001 319001007	Kamehameha Schools, Keauhou Ranch. Kūlani Correctional Facility, Pu`u Maka`ala Natural Area Reserve, Hawai`i Volcanoes National Park.	2.2.12 (1); 2.4.1.12 (1)
H	Keauhou Ranch, 399001004	Kamehameha Schools.	1.3.11 (2); 2.1.13 (3)
H	Hawai`i Volcanoes National Park, 399001002	Hawai`i Volcanoes National Park.	2.1.14 (3)
H	Kapāpala Ranch, Portions of 398001010	Hawai`i DLNR, State Land Division. Kapāpala Ranch, currently leased for cattle grazing.	1.3.12 (2)
H	Kapāpala Ranch, Portions of 398001004	Hawai`i DLNR, State Land Division. Kapāpala Ranch, currently leased for cattle grazing.	2.1.15 (2)
H	Kapāpala Forest Reserve, Portions of 398001004	Hawai`i DLNR, State Land Division.	2.2.13 (2); 2.4.1.13 (2)
H	Ka`ū Forest Reserve, 397001001	Hawai`i DLNR.	2.2.14 (1); 2.4.1.14 (1)
H	Ka`ū Forest Reserve, 397001007	Mauna Kea Agribusiness.	1.3.13 (2); 2.1.16 (3)

Appendix A			
Island	Land Parcel, TMKs	Landowner	Recovery Actions
H	Ka`ū Forest Reserve, Portions of 397001006 397001005	Kamehameha Schools.	1.3.14 (2); 2.1.17 (2)
H	Kahuku Ranch, Portions of 392001002	Samuel M. Damon Trust.	1.3.15 (1); 2.1.18 (2); 2.2.15 (1); 2.4.1.15 (2)
H	Manukā NAR, Upper portions of 391001002	Hawai`i DLNR.	2.2.16 (2); 2.4.1.16 (2)
H	Honomalino, 389006004 389006029	Scott C. Rolles Trust.	1.3.16 (2); 2.1.19 (3)
H	Pāpā, 388001001	Koa Aina Ventures.	1.3.17 (2); 2.1.20 (3)
H	TNCH, Honomalino, 389001001	The Nature Conservancy of Hawai`i.	2.1.21 (3); 2.2.17 (3); 2.4.1.17 (2)
H	Honomalino Forest Reserve, 389001002	Hawai`i State.	2.1.22 (2)
H	Yee Hop Ranch, Portions of 388001003 388001004 387012001 392001005 387012003 387012004 387001007 387001006 387001011 387001004	Yee Hop Ranch Ltd.	1.3.18 (2); 2.1.23 (2)

Appendix A			
Island	**Land Parcel, TMKs**	**Landowner**	**Recovery Actions**
H	Yee Hop Ranch, 392001005	Yee Hop Ranch Ltd.	2.2.18 (3); 2.4.1.18 (2)
H	Kona Forest NWR, 386001001	U.S. Fish and Wildlife Service.	2.1.24 (1); 2.2.19 (2); 2.4.1.19 (1)
H	`Alae Ranch, Portions of 387001014	Hawai`i DLNR, State Land Division. Currently leased for cattle grazing.	1.3.19 (3); 2.1.25 (3)
H	McCandless Ranch, Portions of 392001003 386001001	McCandless Ranch.	1.3.20 (2)
H	McCandless Ranch and E. Stack *et al.*, Portions of 392001003 386001001 385001002	McCandless Ranch and E. Stack *et al.*	2.1.26 (2); 2.2.20 (2); 2.4.1.20 (2)
H	Waiea Tract, 386001003	Hawai`i DLNR, State Land Division.	1.3.21 (2); 2.1.27 (2); 2.2.21 (2); 2.4.1.21 (2)
H	Keālia Ranch, 385001001	Kamehameha Schools.	1.3.22 (2)
H	Keālia Ranch, 385001001 and Portions of 384001001 383001001	Kamehameha Schools.	2.1.28 (2)

Appendix A			
Island	Land Parcel, TMKs	Landowner	Recovery Actions
H	Hōnaunau Forest, 384001001 384001002 383001001 383001002	Kamehameha Schools.	1.3.23 (2); 2.2.22 (2); 2.4.1.22 (2)
H	Keālia Ranch, Portions of 385001002	Elizabeth Stack *et al.*	1.3.24 (2)
H	Kealakekua Development Corp., Portions of 382001001	Kealakekua Development Corp.	1.3.25 (3); 2.1.29 (3)
H	Pu`u Lehua, Portions of 378001003 378001007 372002001 378001001	Kamehameha Schools.	1.3.26 (2); 2.1.30 (2)
H	Pu`u Lehua, Portion of 378001003	Kamehameha Schools.	2.2.23 (2); 2.4.1.23 (2)
H	Pu`u Wa`awa`a, 371001001 371001006	Hawai`i DLNR.	2.1.31 (2); 2.4.1.24 (2)
H	Hualālai Ranch, 372002001	Kamehameha Schools.	2.1.32 (2)
MA	Haleakalā National Park, 218001007	National Park Service.	2.1.33 (1); 2.4.1.29 (1)

Appendix A			
Island	Land Parcel, TMKs	Landowner	Recovery Actions
MA	Haleakalā National Park, 213001003 216001002 216001001 216001003 217004016 216010001	National Park Service.	2.2.28 (1); 2.4.1.29 (1)
MA	Ko`olau Forest Reserve, 224016003 224016004 228008001 228008007	Alexander and Baldwin, East Maui Irrigation.	1.3.27 (1); 2.2.24 (1); 2.4.1.25 (1)
MA	Ko`olau Forest Reserve, 211002002 212004005 229014001 211001050 211001044	Hawai`i DLNR.	2.2.25 (1); 2.4.1.26 (1)
MA	Hanawī NAR and Ko`olau Forest Reserve, 212004007	Hawai`i DLNR.	2.2.26 (1); 2.4.1.27 (1)
MA	Hāna Forest Reserve, 210001001 214001001 215001001	Hawai`i DLNR.	2.2.27 (1); 2.4.1.28 (1)
MA	Kīpahulu Forest Reserve, Kukui`ula, 216001007	J. Haili.	1.3.28 (3); 2.2.29 (3)
MA	Kīpahulu Forest Reserve, Kukui`ula, 216001006	Kalalau, Cleveland.	1.3.29 (3); 2.2.30 (3)

Appendix A			
Island	Land Parcel, TMKs	Landowner	Recovery Actions
MA	Kīpahulu Forest Reserve, 216001005 217001033 217002035 217004006 218001007	Hawai`i DLNR.	1.3.30 (1)
MA	Kīpahulu Forest Reserve, 216001005 217001033 217002035 217004006	Hawai`i DLNR.	2.2.31 (1); 2.4.1.30 (2)
MA	Kīpahulu Forest Reserve, 217004006	Hawai`i DLNR.	2.1.34 (2)
MA	Kīpahulu Forest Reserve, 217001032	A. Kaapana *et al.* Small parcel at lower edge of recovery area.	1.3.31 (3); 2.2.32 (3)
MA	Kīpahulu Forest Reserve, 217001024	Kaupō Ranch Ltd. Small parcel at lower edge of recovery area.	1.3.32 (2); 2.2.33 (2)
MA	Nu`u, 218001001	Kaupō Ranch Ltd.	1.3.33 (3); 2.1.35 (3); 2.2.34 (3)
MA	Nu`u, 218001002	James Campbell Est.	1.3.34 (3); 2.1.36 (3); 2.2.35 (3);
MA	Kahikinui Forest Reserve, 218001006 218001005 218001009	Hawai`i DLNR.	1.3.35 (1); 2.1.37 (1); 2.2.36 (1); 2.4.1.31 (2)
MA	Kahikinui Homelands, 219001003 219001007 219001008 219001011	Hawai`i DHHL.	1.3.36 (1); 2.1.38 (1); 2.2.37 (1); 2.4.1.32 (2)

Appendix A			
Island	Land Parcel, TMKs	Landowner	Recovery Actions
MA	Upper Auwahi, 219001006 221009001 222001001 222001034	`Ulupalakua Ranch Inc.	1.3.37 (2); 2.1.39 (2); 2.2.38 (1)
MA	Kula Forest Reserve, 222007001	Hawai`i DLNR.	1.3.38 (2); 2.1.40 (2); 2.2.39 (2); 2.4.1.33 (3)
MA	Kēōkea, 222004033	James Campbell Est.	1.3.39 (2); 2.1.41 (2); 2.2.40 (2)
MA	Waiohuli, 222005052	James Campbell Est.	1.3.40 (2); 2.1.42 (2); 2.2.41 (2)
MA	Ka`ono`ulu, 222007002 222006009 222006032 222007010	Ka`ono`ulu Ranch Co. Ltd.	1.3.41 (2); 2.1.43 (3); 2.2.42 (2)
MA	Waiakoa, 222008001	Lucky Shoji USA Inc. *et al.*	1.3.42 (2); 2.1.44 (3); 2.2.43 (2)
MA	Kamehame Nui/Kealahou, 223005002	John Zwaanstra.	1.3.43 (2); 2.1.45 (3); 2.2.44 (2);
MA	Haleakalā Ranch (Pūlehu Nui/Kalialinui), 223005003	Haleakalā Ranch Co.	1.3.44 (1); 2.1.46 (1); 2.2.45 (2); 2.4.1.34 (3)
MA	Waikamoi Preserve, 223005004	Haleakalā Ranch Co., The Nature Conservancy of Hawai`i.	1.3.45 (1); 2.1.47 (1); 2.2.46 (1); 2.4.1.35 (1)
MA	Makawao Forest Reserve, 224016001 224016002	Hawai`i DLNR.	2.1.48 (2); 2.2.47 (1); 2.4.1.36 (2)

Appendix A			
Island	Land Parcel, TMKs	Landowner	Recovery Actions
MA	West Maui NAR, Kahakuloa, 2231006001	Hawai`i DLNR.	2.1.49 (2); 2.2.48 (2); 2.4.1.37 (2)
MA	West Maui Forest Reserve, Waihe`e, 232014001	Maui Board of Water Supply.	2.2.49 (2)
MA	West Maui Forest Reserve, Kou, 232014002	Hawai`i DLNR.	2.2.50 (2)
MA	West Maui Forest Reserve, Wailuku, 233003003 235003001 236003001	Wailuku Agriculture.	1.3.46 (2); 2.2.51 (2)
MA	West Maui Forest Reserve, `Īao, 233003004,	Hawai`i DLNR.	2.2.52 (2)
MA	West Maui Forest Reserve, Kealaloloa, 236001014	Hawai`i DLNR.	2.2.53 (2)
MA	West Maui Forest Reserve, Manawainui Plant Reserve, 236001052 248001010	Hawai`i DLNR.	2.2.54 (2)
MA	West Maui Forest Reserve, Kaheawa, 248001001	Hawai`i DLNR.	2.1.50 (2); 2.2.55 (2)
MA	West Maui Forest Reserve, Ukumehame/Olowalu, West Maui NAR, Līhau, 248001002	Hawai`i DLNR.	2.1.51 (2); 2.2.56 (2)

Appendix A			
Island	Land Parcel, TMKs	Landowner	Recovery Actions
MA	West Maui NAR, Līhau, 248001002	Hawai`i DLNR.	2.4.1.38 (3)
MA	West Maui Forest Reserve, Launiupoko, 247001002	American Factors (Amfac)/JMB Hawai`i Co.	1.3.47 (2); 2.2.57 (2)
MA	West Maui Forest Reserve, Pūehuehu, 247001004	Hawai`i DLNR.	2.2.58 (2)
MA	West Maui Forest Reserve, Kaua`ula, 246025001	American Factors (Amfac)/JMB Hawai`i Co.	1.3.48 (2); 2.2.59 (2)
MA	West Maui Forest Reserve, Pana`ewa, 246025002	Hawai`i DLNR.	2.2.60 (2); 2.4.1.39 (3)
MA	West Maui Forest Reserve, Kahoma, 245022001	Kamehameha Schools.	1.3.49 (2); 2.2.61 (2)
MA	West Maui Forest Reserve, Kahoma, 245022005	Hawai`i DLNR.	2.2.62 (2)
MA	West Maui Forest Reserve, Pu`u Kī/Haakea, 245022002 245022004	American Factors (Amfac)/JMB Hawai`i Co.	1.3.50 (2); 2.2.63 (2)
MA	West Maui Forest Reserve, Wahikuli, 245022003	Hawai`i DLNR.	2.2.64 (2)
MA	Kapunakea Preserve, Amfac/JMB, The Nature Conservancy of Hawai`i, 244007001	American Factors (Amfac)/JMB Hawai`i Co., The Nature Conservancy of Hawai`i.	1.3.51 (2); 2.2.65 (2); 2.4.1.40 (2)

Appendix A			
Island	Land Parcel, TMKs	Landowner	Recovery Actions
MA	West Maui Forest Reserve, Kapāloa, 244007007	Unknown.	1.3.52 (2); 2.2.66 (2)
MA	West Maui NAR, Honokōwai, 244007004	Hawai`i DLNR.	2.2.67 (2); 2.4.1.41 (2)
MA	Pu`u Kukui Watershed Management Area, 242001001 241001017	Maui Land and Pineapple.	1.3.53 (2); 2.2.68 (2); 2.4.1.42 (2)
MA	Pu`u Kukui Watershed Management Area, 241001017	Maui Land and Pineapple.	2.1.52 (2)
MA	Moloka`i Forest Reserve, Pu`u Ali`i NAR and Waikolu, 261001002	Hawai`i DLNR.	2.4.1.43 (2)
MO	Moloka`i Forest Reserve, Kalamāula, 252014003	Hawai`i DLNR.	2.1.53 (2); 2.2.69 (2)
MO	Moloka`i Forest Reserve, Kahanui, 252014001	R. W. Myer Ltd., *et al.*	1.3.54 (2); 2.1.54 (2); 2.2.70 (2)
MO	Moloka`i Forest Reserve, Kahanui, 261001004	Hawai`i DLNR.	2.1.55 (2); 2.2.71 (2)
MO	Moloka`i Forest Reserve, Waikolu, 261001002	Hawai`i DLNR.	2.2.72 (2)
MO	Moloka`i Forest Reserve, Pelekunu Valley, 259006011	The Nature Conservancy of Hawai`i.	1.3.55 (2); 2.2.73 (2)
MO	Moloka`i Forest Reserve, Pelekunu Valley, Wawaeolepe, 259008017	Wm. Hitchcock *et al.*	1.3.56 (2); 2.2.74 (2)

Appendix A			
Island	Land Parcel, TMKs	Landowner	Recovery Actions
MO	Moloka`i Forest Reserve, Pelekunu Valley, 254003032	The Nature Conservancy of Hawai`i.	1.3.57 (2); 2.2.75 (2)
MO	Oloku`i NAR, Moloka`i Forest Reserve, Wailau Valley, 259006002	Hawai`i DLNR.	2.2.76 (2); 2.4.1.44 (2)
MO	Moloka`i Forest Reserve, Wailau Valley and Oloku`i, 259006004	G. Brown III *et al.*	1.3.58 (2); 2.2.77 (2)
MO	Moloka`i Forest Reserve, Laeokapuna, 257005027	P. Hodgins.	1.3.59 (2); 2.2.78 (2)
MO	Moloka`i Forest Reserve, Keanakoholua, 257005001	M. Hustice Trust.	1.3.60 (2); 2.2.79 (2)
MO	Moloka`i Forest Reserve, `Uala`pue, 256006026	Hawai`i DLNR, DOFAW.	2.2.80 (2)
MO	Moloka`i Forest Reserve, Kahananui, 256006014	Hawai`i DLNR.	2.2.81 (2)
MO	Moloka`i Forest Reserve, Manawai, 256006013	P. Petro Trust.	1.3.61 (2); 2.2.82 (2)
MO	Moloka`i Forest Reserve, eastern `Ōhi`a Gulch, 256006011	Hawai`i DLNR.	2.2.83 (2)
MO	Moloka`i Forest Reserve, West `Ōhi`a Gulch, 256006010	E. Wond Trust.	1.3.62 (2); 2.2.84 (2)
MO	Moloka`i Forest Reserve, Keawa Nui, 256006007	Kamehameha Schools.	1.3.63 (2); 2.2.85 (2)
MO	Moloka`i Forest Reserve, Pua`ahala, 256006002	K&H Horizons Hawai`i.	1.3.64 (2); 2.2.86 (2)
MO	Moloka`i Forest Reserve, Kumu`eli, 256006001	D. Fairbanks III Trust.	1.3.65 (2); 2.2.87 (2)

Appendix A			
Island	Land Parcel, TMKs	Landowner	Recovery Actions
MO	Moloka`i Forest Reserve, Kamalō, 255001016 255001006 255001017	Kamehameha Schools.	1.3.66 (2); 2.1.56 (2); 2.2.88 (2);
MO	Moloka`i Forest Reserve, Mākolelau, 255001015	Ashton Pitts Jr. Trust.	1.3.67 (2); 2.1.57 (3); 2.2.89 (2)
MO	Kamakou Preserve, Kawela, 2540003026	Moloka`i Ranch Ltd., The Nature Conservancy of Hawai`i.	1.3.68 (2); 2.1.58 (2); 2.2.90 (2); 2.4.1.45 (2)
MO	Moloka`i Forest Reserve, Kawela, 254003001	Kawela Plantation Homes Association.	2.2.91 (2)
MO	Moloka`i Forest Reserve, Kawela, 254003001 254003028	Kawela Plantation Homes Association.	1.3.69 (2)
MO	Moloka`i Forest Reserve, Kawela, 254003001	Kawela Plantation Homes Association.	2.1.59 (3)
MO	Moloka`i Forest Reserve, Kamiloloa, Makakupaīa, 254003025	Hawai`i DLNR.	2.1.60 (2); 2.2.92 (2)
MO	Moloka`i Forest Reserve, Kaunakakai, 253003005	Moloka`i Ranch Ltd.	1.3.70 (2); 2.1.61 (3); 2.2.93 (2)
O	Honouliuli Preserve, 92005013	James Campbell Estate. Managed by The Nature Conservancy of Hawai`i.	2.2.94 (1); 2.4.1.46 (1)
O	Lualualei Naval Magazine, 88001001	U.S. Navy.	2.2.95 (2); 2.4.1.47 (2)

Appendix A			
Island	Land Parcel, TMKs	Landowner	Recovery Actions
O	Schofield Barracks West Range, 77001001	U.S. Army.	2.2.96 (1); 2.4.1.48 (1)
O	Kahana Valley State Park, 52001001 52002001	Hawai`i State.	2.4.1.53 (1)
O	Mākaha Valley, 84002014 84002001	City and County of Honolulu.	2.4.1.54 (1)
O	Pahole NAR, 68001002	Hawai`i DLNR.	2.2.97 (2); 2.4.1.55 (2)
O	Kahanahāiki Valley, 81001012	U.S. Army.	2.2.98 (2); 2.4.1.56 (2)
O	O`ahu Forest NWR, 95004001 76001001	U.S. Fish and Wildlife Service.	2.2.99 (3); 2.4.1.57 (2)
O	Lower Ka`ala NAR, 67003025	Hawai`i DLNR.	2.2.100 (3); 2.4.1.58 (3)
O	Pia Valley, 37003073 37003033	Benjamin Cassiday, James Pflueger	1.3.71 (1)
O	Honolulu Watershed Forest Reserve (Wailupe), 36004004	Hawai`i State.	2.4.1.49 (1)
O	Lower Wailupe Valley, 36004001	City and County of Honolulu	1.3.72 (1)
O	Kūpaua Valley, 37004001 37004002	Hawai`i Humane Society.	1.3.73 (1)
O	Kuli`ou`ou Valley, 38013001	Joseph Paiko Trust.	1.3.74 (1)

Appendix A			
Island	Land Parcel, TMKs	Landowner	Recovery Actions
O	Ka`alākei Valley, 39009001	Hawai`i Kai Development Co.	1.3.75 (2)
O	Kapālama, 14015009	Julius Chung Trust.	1.3.76 (3)
O	Moanalua Valley, 11013001	Damon Estate.	1.3.77 (1)
O	Moanalua Valley, 11013001 11013002	Damon Estate.	2.4.1.51 (1)
O	North Hālawa Valley, 99011002	Kamehameha Schools.	2.4.1.50 (1)
O	South Hālawa Valley, Tripler Ridge, 99011001	Queen's Medical Center.	1.3.78 (1)
O	Waikāne Valley, 48014005	SMF Enterprises.	1.3.79 (1); 2.4.1.52 (1)
O	Waianu Valley, 48014003 48013014	Waiāhole Irrigation Co. Ltd.	1.3.80 (2)
O	Mākua Military Reservation	U.S. Army.	2.1.62 (3)
K	Halehaha, Halepā`ākai and Koai`e drainages, Alaka`i Wilderness Preserve, 414001003	Hawai`i DLNR.	2.2.101 (1); 2.4.1.59 (1)
K	Upper Mōhihi and upper Waiakoali drainages, Alaka`i Wilderness Preserve, 414001003	Hawai`i DLNR.	2.2.102 (2); 2.4.1.60 (2)
K	Alaka`i Wilderness Preserve, 4414001003	Hawai`i DLNR.	2.2.103 (2)

Appendix A			
Island	Land Parcel, TMKs	Landowner	Recovery Actions
K	Upper Kawaikōī, Alaka`i Wilderness Preserve, 459001001	Hawai`i DLNR.	2.4.1.61 (2)
K	Kōke`e State Park, 414001013 459001016 414001020 414001014 414001002 and numerous small parcels within	Hawai`i State Parks Division.	2.1.63 (3)
K	Southern Alaka`i Plateau, Portions of 417001001	Robinson Family Partners	1.3.81 (1); 2.2.104 (2); 2.4.1.62 (2)
K	Upper Wainiha Pali, Portion of 458001001	Alexander and Baldwin Hawai`i Inc.	1.3.82 (2)

APPENDIX B.
Captive Propagation Program Strategies for the Hawaiian Endangered Bird Conservation Program, Keauhou Bird Conservation Center/Maui Bird Conservation Center, and Zoological Society of San Diego

A. PROCEDURES FOR RANKING SPECIES

1. Evaluate Hawaiian avifauna recovery priority and select target species based on the following criteria:

    - Taxonomic uniqueness
    - Urgency/degree of threat
    - Cause of decline in the wild
    - Available knowledge of species' natural history
    - Status of current research/habitat management efforts in the field and potential for collaboration
    - Practical considerations (availability of funding and expertise/labor)
    - Population size
    - Population distribution (fragmentation)
    - Avicultural history/difficulty
    - Release history/difficulty
    - Availability of suitable release sites (healthy forest and habitat management)
    - Private landowner partnership agreements (habitat conservation plans, safe harbors agreements etc.)
    - Species value as basic component of the ecosystem (e.g., significance as a seed disperser or pollinator)
    - Cultural value
    - Educational value
    - Recovery priority

2. Evaluate whether captive propagation/reintroduction is necessary for recovery of the target species:

    - Is a captive propagation/reintroduction program necessary to recover the species or can alternative (more cost-effective) recovery strategies (e.g., translocation or habitat management) restore and/or protect the species in the wild?
    - Does captive propagation/release have a reasonable chance of succeeding?
    - Will the program be part of an integrated landscape level recovery effort incorporating habitat management, research, and environmental education?
    - How much time will be required for habitat research/management/restoration before acceptable, secure release sites are available?

3. Define the recovery goals for the target species:

    - Genetic and demographic stability
    - Density
    - Dispersal
    - Distribution
    - Long-term population trends and "monitoring criteria"
    - Survivorship (adult and juvenile)
    - Reproductive success (causes of failure)
    - Habitat requirements (pre-release "site preparation criteria")

4. Identify, select, evaluate, prepare, and maintain quality release sites. Develop a systematic process to establish pre-release "site preparation criteria" for target species:

    - Identify and select the release site. The goal is to select/restore habitat that fulfills year-round requirements for the species to ensure that birds remain in managed habitat (e.g., sufficient seasonal food resources, nesting and roosting sites). Preliminary site selection should include the evaluation of:

    - Species natural history information (habitat requirements for foraging, nesting and roosting, home range, presence/absence of conspecifics, ecosystem type etc.).
    - Vegetative analysis.
    - Physical qualities (size, elevation, elevational gradient, topography, edaphics, prevailing weather patterns, corridor potential, and proximity to other populations).
    - Biological limiting factors (e.g., mosquito/disease prevalence, feral ungulates, predators, alien bird species, etc.).
    - Human-made threats/hazards (e.g., land use in adjacent areas, presence of housing developments, hunting levels, etc.).
    - Current level of habitat management (e.g., predator control, alien plant control, etc.).
    - Landowner partnership agreements (e.g., habitat conservation plans, safe harbor agreements, etc.).
- Increase the involvement of stakeholders in the negotiations necessary for designing successful land management programs in selected release sites. Inform the public regarding proposed conservation activities through policy documents, conservation education programs, public relation activities, etc. Discuss and finalize partnership agreements with landowners for potential release sites (e.g., habitat conservation plans, safe harbor agreements, etc.).
- Evaluate the release site and fund landscape level research to develop habitat management techniques necessary to decrease limiting factors. Develop pre-release "site preparation criteria" that must be met before reintroduction begins.
- Fund, implement, and continue habitat management programs in accordance with pre-release "site preparation criteria."

5. Select the programmatic strategy necessary to recover targeted species (see Section B, below, for detailed definitions of these strategies):

    - No captive propagation/reintroduction program necessary
    - Translocation
    - Rear and release
    - Captive-breeding (immediate release)

- Captive-breeding (self-sustaining population)
- Captive-breeding (production for restoration)
- Emergency search and rescue
- Technology development

6. Develop programmatic techniques (if necessary).

7. Begin programmatic activity best suited to recover the target species.

8. Define recovery "monitoring criteria" for target species:

   - Survivorship (adult and juvenile)
   - Dispersal and distribution
   - Reproductive success (causes of failure)
   - Long-term population trends

9. Evaluate results.

B. DEFINITION OF PROGRAM STRATEGIES

Hawaiian Endangered Bird Conservation Program strategies are designed to contribute to recovery efforts by providing captive birds for reintroduction to reinforce or re-establish populations in the wild. Reinforcement of wild populations using captive propagation requires the development of cost-effective management programs that are designed to maintain population genetic diversity and demographic security considering the resources available. All endangered bird programs are managed following the American Association of Zoological Parks and Aquariums (AZA) – Small Population Management Advisory Group and International Union for the Conservation of Nature (IUCN) – Captive Breeding Specialist Group Guidelines (Appendix 6.2 in Foose and Ballou 1988). Captive-breeding programs need to be established before species are reduced to critically low numbers if they are to have a reasonable chance of preventing a species' extinction.

Founder Requirements for Wild Population Genetic Diversity

1 founder = 50 percent
2 founders = 75 percent
3 founders = 90 percent
10 founders = 95 percent

1. **No Captive Propagation/Reintroduction Program Necessary.**

   Captive propagation/reintroduction is an expensive recovery strategy that is not always necessary to restore or protect endangered species. If habitat preservation, protection and/or restoration will ensure species recovery, those strategies are preferable to captive propagation and reintroduction.

2. **Translocation and/or Cross Fostering**.

   This option requires moving wild eggs/birds from one field site to another. In general, cross- fostering/translocation is more cost-effective than a captive propagation program and should be considered as a recovery strategy prior to implementing captive-breeding. However, recovery strategies involving translocation/cross-fostering require: a) founder populations large enough to support collection of wild adults or eggs, b) the availability of surrogate foster species (e.g., Chatham Island Tits were used as fosters for robins), and c) site fidelity of translocated individuals to the new release area (Serena 1995). For some species, although suitable habitat may be available for translocation, some or all translocated birds may return to their site of origin, especially if the site is on the same island, as in the case of the palila (Fancy *et al.* 1997).

   Example Program: \`Ōma\`o

   In 1995, an experimental program was undertaken by the U.S. Geological Survey to evaluate translocation of wild birds vs. reintroduction of captive-reared birds as potential recovery options for endangered thrushes. The results of this study with \`ōma\`o demonstrated similar survival rates for both groups of birds, but fidelity to the release site was higher for captive-reared birds than translocated birds (Fancy *et al.* 2001).

3. **Rear and Release**.

Collection of wild eggs for artificial incubation/hand-rearing and immediate release of juveniles to the wild requires easily located, accessible, wild nests and secure habitat for reintroduction. "Rear and release" is not always more cost-effective than captive-breeding because nest search crews, helicopter time, and the establishment and staffing of temporary incubation facilities are expensive, especially if the program continues for several years. If the target species breeds readily in captivity, it is more cost-effective to develop a short-term "captive-breeding (immediate release)" program (approximately 50 percent less cost). If nests are easily accessible, the species does not breed readily in captivity, and enough birds can be hand-reared to provide an acceptable release cohort, "rear and release" is a preferable strategy.

Example Program: Hawai`i `Amakihi

20 viable wild eggs collected (hatchability = 85 percent; survivability of hand-reared chicks = 94 percent)
20 eggs × 85 percent hatchability = 17 chicks hatched
17 chicks × 94 percent survivability = 16 chicks hand-reared
16 birds released
(Kuehler *et al.* 1996).

4. **Captive-breeding (Immediate Release).**

Collection of wild eggs to establish a small captive flock that encompasses some of the genetic diversity of the wild population, and immediate release of juveniles to the wild, requires a breeding flock with enough founders to establish enough genetic diversity in captivity to produce birds for release. Juveniles produced are immediately released to the wild. Each year a few offspring would be retained in captivity to maintain the necessary genetic/demographic stability of a captive flock designed to produce birds for immediate release. This option requires maintaining fewer captive animals than a self-sustaining population.

Example Program: Puaiohi (1996 to 1999)

43 viable wild and captive eggs collected (hatchability =91 percent; survivability of hand-reared chicks = 93 percent)
43 eggs × 91 percent hatchability = 39 chicks hatched
39 chicks × 92 percent survivability = 36 chicks hand-reared
14 birds released in 1999; 5 birds due for release in 2000.

5. Captive-breeding (Self-sustaining Population).

This option should be considered as a hedge against future species bankruptcy. Birds would be maintained in captivity but not reintroduced until secure habitat was available. Management of self-sustaining captive populations would protect the genetic and demographic health of the species for many generations (e.g., target = 90 percent genetic diversity for 100 years) if further recruitment from the wild is not an option (stable population).

Example Program: Bali Mynahs

There are approximately 691 birds in over 100 institutions; no release program exists at this time. Releases failed because limiting factors were not controlled (poaching).

6. Captive-breeding (Production for Restoration).

This can be considered the "factory" option of captive propagation/release (hatch rate greatly exceeds mortality). After the avicultural questions have been answered, facilities built, personnel trained, and habitat for reintroduction is available, full-scale production of birds can be implemented to produce many birds for release into areas that are in need of support. This option would only be considered for critically endangered species (extinct in the wild) that would justify the expense of many cages and maximum labor for production of as many birds as possible.

Example Program: California Condors

There are 118 captive birds; an ongoing reintroduction program exists.

7. Emergency Search and Rescue.

The search and rescue, or last-ditch, strategy should only be considered if extinction is imminent and the strategy of captive propagation has a greater probability of recovering the species than translocation or habitat management. Although we may be saving the last few eggs/individuals by removing them from their natural habitat, we are losing an opportunity to study and protect the species in the wild. There are no guarantees that captive propagation will be successful and that production will ever outstrip mortality. This strategy is high risk, but may be the only option remaining for a few species. Ideally, captive-breeding programs need to be established before species are reduced to critically low numbers if they are to have a reasonable chance of saving a species from extinction.

<u>Example Program: Micronesian Kingfishers</u>

Twenty-nine birds were brought into captivity. For 16 years the size of the captive population has fluctuated while husbandry techniques were being developed. It currently numbers approximately 60 birds.

8. Technology Development Program.

The purpose of this strategy is to develop captive propagation and release expertise. Many of the artificial incubation and hand-rearing techniques for Hawaiian forest birds have already been developed. In the future, this strategy would be chosen primarily for those species that still require development of captive-breeding or release techniques.

<u>Example Program: \`Ōma\`o as a surrogate for Puaiohi</u>

Non-endangered \`ōma\`o eggs were collected from the wild to develop artificial incubation, hand-rearing, and release techniques for Hawaiian thrushes - prior to the implementation of a reintroduction program for puaiohi. Twenty-five chicks were hand-reared and released into Pu\`u Wa\`awa\`a Forest Bird Sanctuary.

29 viable wild eggs collected (hatchability =93 percent; survivability of hand-reared chicks = 93 percent)
29 eggs × 93 percent hatchability = 27 chicks hatched
27 chicks × 93 percent survivability = 25 chicks hand-reared
25 birds released (Fancy *et al.* 2001, Kuehler *et al.* 2001).

APPENDIX C.

Endangered and Threatened Species Recovery Priority Numbers
(adapted from Federal Register 48:51985, 15 November 1983)

Degree of Threat	Recovery Potential	Taxonomy	Priority	Conflict
High	High	Monotypic genus	1	1C 1
	High	Species	2	2C 2
	High	Subspecies	3	3C 3
	Low	Monotypic genus	4	4C 4
	Low	Species	5	5C 5
	Low	Subspecies	6	6C 6
Moderate	High	Monotypic genus	7	7C 7
	High	Species	8	8C 8
	High	Subspecies	9	9C 9
	Low	Monotypic genus	10	10C 10
	Low	Species	11	11C 11
	Low	Subspecies	12	12C 12
Low	High	Monotypic genus	13	13C 13
	High	Species	14	14C 14
	High	Subspecies	15	15C 15
	Low	Monotypic genus	16	16C 16
	Low	Species	17	17C 17
	Low	Subspecies	18	18C 18

APPENDIX D.

U.S. Fish and Wildlife Service Listing Priority System

(adapted from Federal Register 48:43098-43105, 21 September 1983)

Threat		Taxonomy	Priority
Magnitude	Immediacy		
High	Imminent	Monotypic genus	1
		Species	2
		Subspecies	3
	Non-imminent	Monotypic genus	4
		Species	5
		Subspecies	6
Low to Moderate	Imminent	Monotypic genus	7
		Species	8
		Subspecies	9
	Non-imminent	Monotypic genus	10
		Species	11
		Subspecies	12

APPENDIX E.
Summary of Comments Received on the Draft Revised Recovery Plan for Hawaiian Forest Birds

In October 2003, the U.S. Fish and Wildlife Service (Service) released the Draft Revised Recovery Plan for Hawaiian Forest Birds for review and comment by Federal agencies, State and local governments, and members of the public. The public comment period was announced in the Federal Register (68 FR 70527) on October 16, 2003 and closed on December 15, 2003. Over 250 copies of the draft plan were sent out to interested parties for review during the comment period, and it was also made available online. Six peer reviewers were contacted and agreed to provide comments on the draft plan; comments were received from the following four scientific peer reviewers:

Cathleen Natividad Bailey, Haleakalā National Park
Dr. Kirsty Swinnerton, Maui Forest Bird Recovery Project
Ron Walker, Hawai`i Division of Forestry and Wildlife (retired)
Sharon Reilly, Ducks Unlimited

We received 15 comment letters during the comment period, and some additional comments, information, and updates after the comment period ended. We carefully considered all comments received in finalizing this recovery plan. Many comments suggested additions or changes for clarification. A few comments suggested additional recovery actions. We thank all the commenters and peer reviewers for their time and interest in this recovery plan, and we feel the final Revised Recovery Plan for Hawaiian Forest Birds has been significantly improved by the comments we received.

Summary of Comments and Service Responses

Issue 1: Recovery Habitat and Critical Habitat

Comment: One commenter was concerned that inclusion of their private land in recovery habitat might eventually require a greater expenditure of time and money to implement recovery actions and that this would result in personal financial hardship. The commenter felt the inclusion of their private land in recovery habitat was unacceptable.

Response: We recognize that the term “recovery habitat” was similar to the term “critical habitat” and that this may have caused confusion. In the final plan we have used the term “recovery area” instead of “recovery habitat” to make it more clear that identification of certain areas as important for recovery of forest birds is different from designation of critical habitat. Identification of land as “recovery area” does not create or imply any legal requirement of the property owner to implement recovery actions, nor does it impose any limitation on the types of activities that the landowner may choose to engage in. Lands named here as recovery areas are those that from a purely biological standpoint have the greatest potential to provide habitats important to the recovery of the forest birds. The identification of land as recovery area should not be confused with designation of land as critical habitat, which is a separate process usually conducted during the listing of a species as threatened or endangered. Designation of land as critical habitat does not require the landowner to implement recovery actions or to manage the land in a certain way, but it does require the landowner to consult with the Service if they undertake projects that entail Federal funding or permitting. This requirement does not apply to what we have identified here as recovery areas.

Comment: One commenter felt that enough protected areas are already available for recovery, and that recovery actions should be focused on areas that are already managed by the U.S. Fish and Wildlife Service, the National Park Service, the State of Hawai`i, the Hawai`i counties, The Nature Conservancy, and other conservation agencies or groups.

Response: We believe the recovery areas described in this plan are necessary to recover the species addressed in this plan. We agree that there is much work still to do on lands that are managed principally for the benefit of native species. However, we feel that to recover all the species described here, recovery actions will be needed throughout recovery areas, including some lands that are privately owned.

Comment: One commenter said that a portion of a privately owned land parcel included in a recovery area is very remote, zoned for conservation, pristine in nature, and does not require fencing, greater effort to remove ungulates, or predator control. The commenter felt the parcel should be excluded from recovery area because the area is well managed already, additional management is expensive, and some types of management suggested could harm the land.

Response: We are glad to hear that the section of the land parcel described is well managed and that the owner intends to continue to maintain its pristine condition. However, it is likely that fencing and ungulate removal and predator control would further enhance and protect this and other recovery areas for the benefit of listed species. Although expensive, recovery actions described in this plan will contribute significantly to species recovery and can be conducted in a manner to minimize damage caused to habitat areas, at the same time maximizing habitat benefits. As noted above, these actions are recommendations and we believe they are necessary to achieve recovery of the forest birds, but they are not required. In addition, we recognize that conditions vary from site to site, and the actions recommended here are of necessity relatively broad in nature. If there is any question as to whether the management actions we have suggested would possibly harm the land under some circumstance, or if the landowner would like to explore possible alternative approaches to management for the suggested habitat conditions, we recommend that the landowner seek advice specific to their particular situation from either the Service or the Hawai`i Department of Land and Natural Resources.

Comment: One commenter felt it should be made clear why critical habitat is designated for O`ahu `elepaio and palila and not for the other 19 species in the plan.

Response: We clarified on page 3-7 that listing of all species in the plan except the O`ahu `elepaio (listed in 2000), palila (listed in 1977) and Hawai`i creeper and po`ouli (listed in 1975) preceded the legal requirement in the Endangered Species Act of 1973 to consider the designation of critical habitat at the time of species' listing.

Issue 2: Criteria for Downlisting and Delisting

Comment: One commenter felt that the process for delisting because of extinction should be described.

Response: We have added a description of the types of information needed to consider delisting because of extinction to the plan in the Recovery Criteria section on page 3-4. This issue is also addressed in Section 3-i of the Rare Bird Discovery Protocol on page 3-18.

Comment: One commenter felt that search effort should be considered as a factor when determining the designation "potentially extinct" in the Rare Bird Search Protocol section of the plan.

Response: We agree and have included search effort as a factor when determining the designation "potentially extinct" in the Rare Bird Search Protocol.

Comment: One commenter thought it was not clear how the 15- and 30-year criteria were established, respectively, for downlisting and delisting.

Response: We have tried to clarify in the Recovery section of the plan the reasons for the time frames chosen, which are based on biological time-frames over which population trends data can be analyzed meaningfully, and on our ability to survey forest birds on the five main Hawaiian islands on a rotating basis.

Comment: One commenter suggested the recovery criteria for downlisting and delisting include amount of habitat area occupied.

Response: Although we would have liked to be able to describe more precisely the geographic extent and specific habitat areas occupied by species for downlisting and delisting, this was not possible, in part because our current understanding is limited as to the numbers of individuals that can be supported by different habitat types and the areas of habitat needed for viable populations. Therefore the approach we have taken in the plan is to base recovery criteria both on measurable population and on demographic parameters, such as the numbers of individuals, population trends, population stability, and intrinsic growth rate, as well as metapopulation, habitat, and criteria for threats removal and threats reduction.

Comment: One commenter felt the term “viable” in the Recovery Criteria section needed to be defined more explicitly. The commenter suggested that modeling results should show the taxon to be viable as defined in terms of its ability to sustain itself numerically and with no loss of genetic variability for a period of 1,000 years.

Response: We feel that the definition of viability in the plan, in terms of the taxon’s population characteristics as stable or increasing, by population trend analysis and/or stable or increasing intrinsic growth rate over a 15- and 30-year period, is adequate for downlisting and delisting, respectively, in conjunction with other metapopulation, habitat, and threats reduction downlisting and delisting criteria.

Comment: One commenter suggested defining recovery accomplishments in terms of stabilization and the prevention of species extinction, because successes may be better measured in these terms for some species.

Response: Unless and until a formal redefinition of recovery is approved, in order to legally downlist or delist a species we must create the biological conditions under which a listed species is no longer vulnerable to extinction or threatened with becoming vulnerable to extinction (in other words, in which the species no longer meets the definition of threatened or endangered according to the Endangered Species Act). Recovery actions needed to stabilize a species or prevent extinction are of key importance to achieving the conditions where species can be downlisted or delisted.

Issue 3: Recovery Plan Utility

Comment: One commenter felt that the plan would be more useful if accompanied by short-range plans for each species describing immediate actions that have a reasonable chance for completion given current funding limitations and which can be used as an easy guide for resource managers.

Response: During completion of the Draft Revised Recovery Plan for Hawaiian Forest Birds in 2002, the Hawaiian Forest Bird Recovery Team recommended that key near-term recovery actions for each species be described in "Five-Year Recovery Work Plans." Several of these work plans have been completed and appear at the back of this plan as Appendices F through L. Each work plan lists 10 to 15 key recovery actions that can be completed in the next 5 years. These work plans are available from the Pacific Islands Fish and Wildlife Office in Honolulu, Hawai`i, or from the following website maintained by the Hawai`i Division of Forestry and Wildlife: http://www.dofaw.net/fbrp/projects.php. We anticipate that work plans for additional species will be completed in the near future.

Comment: One commenter felt that the plan would be more useful if it highlighted actions that benefit several species simultaneously.

Response: Tables 7, 8, 9, 11, and 14 list individual species benefiting from recovery actions. In many cases the actions described in these tables are directed at more than one species. Also benefiting multiple species are recovery actions for avian disease research and monitoring, measures to prevent the introduction of new avian diseases to Hawai`i, and actions to prevent the introduction of invasive plant and animal species to Hawai`i, among others.

Comment: In addition to threat, population status, and other biological factors, one commenter suggested that the captive propagation recovery priority rankings in Appendix B should be based on the probabilities of successfully recovering the species, with consideration of geopolitical and social and financial realities.

Response: Although social, financial, and geopolitical factors will likely affect the success of recovery actions, we have based our captive propagation recovery rankings on biological factors. This is because we consider all the listed species in this plan to be recoverable and we are required by law to develop recovery strategies for all listed species based on their biological needs.

Comment: One commenter suggested it would be helpful to provide a step-down outline before the recovery action narrative.

Response: We have added a simplified Step-down Outline, or overview of the major recovery action categories, before the Step-down Narrative to assist users of this plan.

Comment: One commenter felt the Recovery Actions Narrative section was too general and failed to describe specific recovery actions.

Response: Tables 7, 8, 9, 11, and 14 describe recovery actions to be carried out on specific land parcels and specifically identifies which species they are designed to benefit. In some cases a specific recommendation was not made for how to conduct the action and several possible implementation methods are mentioned. We feel this is appropriate because it is important to allow land managers and others who will implement recovery actions the latitude to use the most effective methods and approaches for individual conditions, which may be difficult to determine based on available information and may change over time.

Comment: One commenter felt the link between research results and management actions could be improved.

Response: We have modified the introduction to the research actions section of the Step-down Narrative to make clear that research results need to be translated into on-the-ground management.

Issue 4: Feral Ungulate Control

Comment: One commenter felt that the plan would benefit from a more complete discussion of methods to control feral ungulates, and that the plan should address conflicts between sustained yield game management approaches versus complete removal of ungulates from fenced areas, and the relative effectiveness of the two approaches for habitat recovery.

Response: A complete treatment of the approaches and methods of feral ungulate control in Hawai`i would be very lengthy and is beyond the scope of this plan. There are several approaches to management of feral ungulates, ranging from sustained yield game management to complete eradication, and several methods of removing ungulates from areas, including fencing, public hunting, drives, and snaring. The plan identifies land parcels where control of feral ungulates is needed, but does not attempt to provide a complete discussion of the advantages and disadvantages of the various methods available for doing this. In general, and as described under Recovery Action 2.2, we feel the most effective approach for protecting and restoring habitat for native forest birds is fencing and removal of all feral ungulates. However, the most appropriate strategy and methods also may depend on land ownership and other factors.

Comment: One commenter felt that costs to maintain ungulate fencing and to remove ungulates if a breach in an exclosure fence occurs should be included with the costs for fencing and ungulate removal.

Response: We agree that there will be costs to maintaining fences to ensure that areas remain ungulate-free. These costs are discussed in the Implementation Schedule and are included in costs for fencing and ungulate removal.

Issue 5: New Threats Information

Comment: One commenter recommended recent information be included in the plan concerning "die-back" of over 60 percent of the koa (*Acacia koa*) tree canopy in Kīpahulu Valley, Maui. The commenter thought the die-back was likely caused by the native moth, *Scotorythra paludicola* and the wilt-causing fungus, *Fusarium oxysporum f.sp koae*.

Response: We have included this recent information in the section for research needs in Recovery Action 4.6.4 on page 4-106.

Comment: One commenter felt that the description in the plan was inadequate for the potential impacts of alien bird species on native forest birds; the commenter provided some new information regarding these impacts.

Response: We have included in the Executive Summary a description of the possible impacts of alien birds on native forest birds. Recovery Action 4.2.10 on page 4-99 also addresses the need for research into the potential impacts of alien birds.

Comment: One commenter felt the small Indian mongoose (*Herpestes auropunctatus*) is a greater threat to forest birds than was indicated in the draft plan.

Response: Mongooses are often assumed to be a lesser threat to forest birds than feral cats or rats because of their limited climbing ability. We agree, however, that the small Indian mongoose may be more of a threat to forest birds in certain areas than was indicated in the draft plan. We have revised Recovery Action 2.4 on page 4-52, which deals with control of alien mammalian predators, to reflect this.

Comment: Two commenters noted that recent research on global warming has documented shifts in distribution patterns of flora and fauna to higher latitudes and elevations to "escape" increasing temperatures, and suggested that a recovery action should be included to address global warming and local climate change, which threaten Hawaiian forest birds by reducing the amount of high elevation habitat area free of mosquito vectors.

Response: Global warming and local climate change are a significant threat to avian species in Hawai`i, as noted in the plan. A complete discussion of global warming and local climate changes is beyond the scope of this recovery plan, but we have added a recovery action to the plan (Action 2.5.1.4) calling for active participation to curb global warming and climate change.

Comment: One commenter felt the priority numbers for Recovery Actions 4.6.3 - Conduct population and metapopulation viability analyses, 4.6.3.1 - Conduct trend analysis using count data, and 4.6.3.2 - Use demographic data for estimating lambda; should be elevated from priority 2 to priority 1, because these actions measure population trends, and ultimately, the effectiveness of management actions.

Response: We agree. In the plan the priority numbers for these recovery actions have been elevated from priority 2 to priority 1.

Comment: One commenter was concerned that direct transmission of disease by bird-to-bird contact and handling of multiple birds by researchers is not adequately addressed in the plan.

Response: Researchers follow protocols adequate to prevent transmission of avian disease, such as washing hands and disinfecting mist-nets and measuring tools, which are required for permits issued for research activities. Currently there is no method of preventing possible transmission of avian disease through bird-to-bird contact in the wild.

Issue 6: Captive Propagation and Reintroduction

Comment: One commenter recommended that a thorough habitat assessment be made at release sites, including food availability and disease potential, and examination of the reasons for a species not occurring at sites, including historical habitat modification and the cultural practices of pre-contact Hawaiians, before captive introductions are attempted. The commenter also suggested establishing species in areas outside the historical range to increase forest bird populations.

Response: Recovery Action 3.3 in the plan calls for the development of methods for evaluating, selecting, and preparing sites for releases and/or translocation of endangered birds. We have revised this action to include consideration of habitat modification by historical land uses and practices of pre-contact Hawaiians. Although it is preferred that species be introduced into their historical range it is possible that habitat outside known historical range could be suitable or preferable. We have clarified Recovery Action 3.3 to reflect that habitat outside historical range will be considered when evaluating sites for releases and/or translocations, if necessary.

Comment: One commenter suggested pursuing the establishment of captive propagation programs of nearly extinct species by means other than collecting eggs from the wild, particularly when no wild breeding pairs are known to exist.

Response: We agree that methods of establishing captive propagation programs under circumstances where egg collection from the wild is not an option should be included in the plan, and we have revised Recovery Action 3.2.1 to include creating pairs in the wild through translocation and bringing wild birds into captivity.

Comment: One commenter felt captive propagation of the po`ouli is the only remaining option to save this species from extinction.

Response: We agree that bringing the remaining po`ouli into captivity for captive propagation is the most effective approach for recovering the po`ouli at this time, since field efforts to form a wild breeding pair through translocation recently failed. We have updated Recovery Action 3.2.2 accordingly.

Comment: One commenter suggested that the captive propagation program be expanded and that it should include non-listed native Hawaiian forest birds that may be declining. The commenter also thought greater support should be provided to species in Table 13 that are assigned lower captive breeding priority rankings. The commenter felt this greater emphasis on captive propagation is necessary given the magnitude of the threats Hawaiian forest birds face, the low numbers of some species, and patterns of rapid species declines in Hawai`i.

Response: We would like to expand the captive propagation program to include additional species, especially for all species listed in Table 13 with breeding priorities rankings of 1 and 2. Unfortunately, such expansion is not possible at this time due to limited funding. As stated in Recovery Action 3.1, we periodically evaluate and identify species that will require captive propagation for recovery.

Comment: One commenter suggested when doing translocations that young of the year should be used instead of adult pairs with established territories, because young of the year have a higher mortality rate generally, are the typical dispersers in bird populations, and are less likely to return to the locations from which they are taken.

Response: We agree that these factors are likely true, however, there may be some instances where a combination of young birds and non-breeding adults can create a more normal social dynamic or where because of logistical constraints some non-breeding adults may need to be translocated.

Issue 7: Partners Participation in Recovery Planning and Implementation

Comment: One commenter felt that the National Park Service's responsibilities and accomplishments were not adequately credited in the plan.

Response: We agree that the National Park Service plays a key role in conservation of endangered species and has made significant achievements in the recovery of Hawaiian forest birds. We have attempted to make this more clear by revising the Implementation

Schedule to reflect the interest, planning involvement, achievements, and implementation responsibility the National Park Service has had and will continue to have for recovery of many of the species in this plan.

Comment: One commenter suggested consideration should be given to providing incentives for private landowners to participate in forest bird habitat protection and enhancement, such as tax breaks, partnership financial rewards, and planting assistance.

Response: We agree those types of incentives can enhance habitat protection, and have included these suggestions in the plan under Recovery Action 1.3 (secure recovery area) and other recovery action categories where these approaches would be useful.

Comment: One commenter felt the plan suggested governmental agencies might exercise control over lands the commenter owns and uses and the plan intrudes on private property and landowners' rights.

Response: As discussed above in response to the first comment, the identification of land as "recovery area" is intended as a biological assessment of those lands that have the potential to contribute high quality habitat for the recovery of Hawaiian forest birds, and implies no legal obligation of the landowner to participate in any recovery actions, and does not indicate a desire by the government to control the land or impinge upon the landowners' rights. As discussed under Recovery Action 1.3, agreements for access to private lands and the implementation of recovery actions are with willing partners only, as are any potential acquisitions. We have added to the Introduction to the Implementation Schedule a statement further describing our wish to work with all willing partners towards species recovery.

Comment: One commenter suggested the Service should more actively discuss with the State of Hawai`i Department of Land and Natural Resources, Land Division, changes in land use designations as a way to provide greater protection to recovery areas.

Response: Already included in the plan is consideration of change in land use designation for parcels owned by the State of Hawai`i as an option to secure recovery areas.

Issue 8: Cost Estimates

Comment: One commenter felt that the cost for recovery was excessive and taxpayers' dollars should be spent instead on social programs directly benefiting the public well-being. A second commenter felt that the costs in the plan to protect and/or restore Hawaiian birds were excessive considering the many other public needs on which money could be spent.

Response: The estimated minimum time for delisting any of the species addressed in this plan is 30 years, so we revised the estimated total cost for recovery to encompass this time-frame, which resulted in a reduction in the estimated total cost to $2,477,395,000. As described in the Introduction to the Implementation Schedule on page 5-4, it is difficult to estimate the eventual cost of certain actions, such as ungulate removal and predator control, because the actual area of each parcel in which the action must be conducted cannot be determined at this time, and because we anticipate that improved and more cost-effective methods will become available in the future. Therefore, the actual costs for many of these actions may be lower than the estimates provided in this plan. Although substantial, we feel these costs are necessary and reasonable over the 30-year time period required to recover the species addressed in this plan.

Comment: One commenter felt that the plan lacked the focus and direction needed to justify the planned budget. The commenter suggested that the plan should focus on the most cost-effective recovery actions and those that will be most beneficial in the near-term.

Response: The priority ranking system provided in the Implementation Schedule is intended to help focus efforts on the most urgent and most beneficial actions. One of the criteria for ranking an action as high priority was benefit to multiple species and cost-effectiveness. We have attempted to clarify the explanation of the priority ranking system in the Executive Summary. The Five-year Recovery Work Plans, provided as Appendices F through L of this plan, provide key recovery actions to focus on in the near-term.

Comment: One commenter was concerned that because the plan presents a total dollar figure for recovery, for all species, including all recovery actions, the public and legislative response will be negative to the high total recovery cost. The commenter suggested it would be better to perform a cost/benefit analysis for recovery actions and to focus only on the most cost effective and highest priority recovery actions.

Response: In the Executive Summary we broke costs down by priority to allow the reader to see the costs to implement all priority 1 recovery actions. Many of these recovery actions benefit multiple species, particularly habitat based actions. In Tables 7, 8, 9, and 11 of the plan, all the species benefiting from habitat-based recovery actions are listed. In general, most recovery actions that benefit all or most of the species in this plan received a priority 1 ranking. Therefore, the plan is focused generally on the most cost effective actions. However, as required, we also have presented in the plan all other recovery actions. We have taken a combined approach focusing on those recovery actions that are most cost-effective and that will benefit most species, and that need to be taken immediately to prevent the extinction or the irreversible decline of the species.

APPENDIX F.

O`AHU `ELEPAIO FIVE-YEAR RECOVERY WORK PLAN

Prepared by O`ahu `Elepaio Working Group and Hawaiian Forest Bird Recovery Team

Male O`ahu `Elepaio. Photo © Eric VanderWerf

Purpose. The long-term recovery goals, delisting criteria, recovery strategy, and a comprehensive list of recovery tasks for the O`ahu `elepaio are provided in the Hawaiian Forest Bird Recovery Plan, which covers 21 species (USFWS 2005). The purpose of this five-year work plan is to identify interim recovery objectives for the O`ahu `elepaio that can be realized within five years, and to describe succinctly the actions needed to reach those interim objectives. Identification of interim recovery objectives and actions will help ensure that initial conservation efforts by different agencies or groups are focused on the same ultimate goals, facilitate efficient use of limited recovery resources, and provide milestones that can be used to track and evaluate progress toward recovery. Realization of these milestones will measure progress toward eventual recovery. Failure in realizing these milestones may indicate that additional resources are needed, or that the current recovery strategy is not effective.

Species Summary. The O`ahu `elepaio (*Chasiempis sandwichensis ibidis*) is a monarch flycatcher endemic to O`ahu. Other `elepaio subspecies occur on Kaua`i and Hawai`i but are not endangered. `Elepaio are nonmigratory, and pairs defend year-round territories averaging 1.2-2.0 hectares (3.0-4.9 acres) in size, depending on habitat structure (Conant 1977, VanderWerf and Smith 2002, VanderWerf 2003). O`ahu `elepaio are adaptable and occur in a variety of forest types, but they are most common in valleys with tall riparian forest and a dense understory (VanderWerf *et al.* 1997). Forest structure is more important to `elepaio than species composition, and `elepaio forage and nest in a variety of trees, including many alien species. `Elepaio are versatile foragers and prey on a variety of invertebrates, including nonnative taxa such as mosquitoes and fruit flies. The nest is a freestanding cup placed in a fork or on a horizontal branch 2-24 meters above the ground (VanderWerf 1998). Clutch size is 1-3, usually 2, and eggs hatch in 18 days. The parents share incubation during the day, but only the female incubates at night and develops a brood patch. The chicks are fed by both parents and fledge in 16 days. Juveniles are fed by their parents for another 1-2 months after leaving the nest, and remain on the natal territory for up to 9 months. Usually only one chick is fledged, but in good years more pairs fledge two chicks and a few pairs may raise two broods (VanderWerf and Smith 2002). The nesting season usually extends from February to May, but active nests have been found from November to July (VanderWerf 1998).

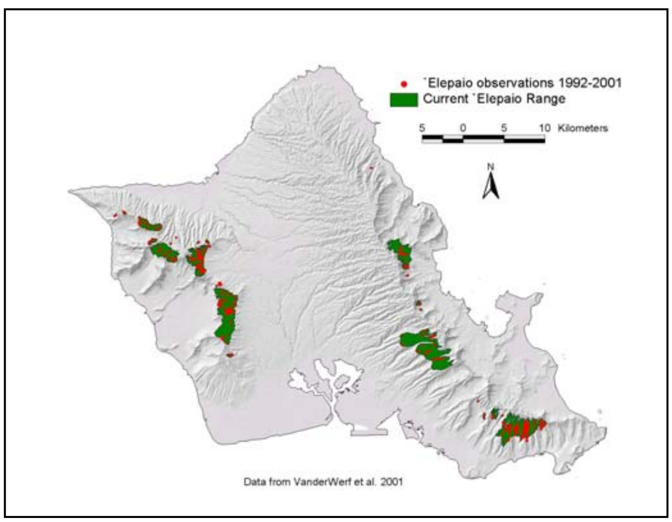

Table 1. Sizes of `Elepaio core populations.

Population	Total Birds	Breed-ing birds	Occupied Area (ha)
Southern Ko`olau	493	450	1132
Central Ko`olau	226	207	1396
Waikāne-Kahana	265	242	523
Southern Wai`anae	464	423	1231
Schofield West Range	342	312	538
Mākaha-Wai`anae Kai	123	113	459
All other populations	95	54	518
Total	2008	1801	5797

`Elepaio were once the most abundant forest bird on O`ahu and probably occupied much of the 127,000 hectares of forest that existed on the island before humans arrived. By 1975 the range of O`ahu `elepaio had declined to 20,900 hectares, and `elepaio currently occupy only 5800 hectares, or less than 4% of their original range (Shallenberger 1977, VanderWerf *et al.* 2001). The total current population is approximately 2000 birds, but the breeding population is only about 1800 birds due to a male-biased sex ratio (VanderWerf *et al.* 2001). The majority of remaining birds is distributed in six large subpopulations of 100-500 birds each (Table 1), with the remainder in numerous small fragments, some of which contain only males. The current distribution superficially appears to constitute a metapopulation, but the amount of dispersal among subpopulations and the genetic population structure are unknown. Natal dispersal distances in `elepaio are usually less than one kilometer (0.62 miles) and adults have high site fidelity (VanderWerf 2003). There may be some exchange among subpopulations within each mountain range, but dispersal across the extensive urban and agricultural lands that separate the Wai`anae and Ko`olau mountains seems unlikely, and most subpopulations probably are isolated.

Primary Threats. Much of the historical decline in distribution of the `elepaio was caused by clearing of forest for human development and agriculture, but most areas currently occupied by `elepaio are zoned conservation, and today habitat loss is a threat only in certain locations, such as at Schofield Barracks through fires caused by military training.

`Elepaio have continued to decline even in areas of intact forest due to a combination of poor reproduction and low adult survival. The primary causes of nest failure and adult mortality are introduced nest predators and diseases carried by the introduced southern house mosquito (*Culex quinquefasciatus*), particularly avian pox virus (*Poxvirus avium*) and possibly avian malaria (*Plasmodium relictum*). Both predation and disease are serious threats, but predation has a larger negative effect on `elepaio populations than disease and is a more serious threat (Table 2). Cameras placed at artificial nests showed that black rats (*Rattus rattus*) are the most important nest predator in `elepaio habitat (VanderWerf 2001). From 1996-2000 ground-based rodent control, using snap traps and diphacinone bait stations resulted in average increases in `elepaio reproduction of 112% and in survival of female `elepaio of 66% (VanderWerf and Smith 2002). Predation is greater on females because only females attend the nest at night, when rats are most active. Rodent control has been conducted by the Hawai`i State Division of Forestry and Wildlife in the Honolulu Watershed Forest Reserve since 1997, by the U.S. Army Environmental Division at Schofield Barracks West Range and Mākua Military Reservation since 1998, by The Nature Conservancy of Hawai`i at Honouliuli Preserve since 2000, and by the U.S. Navy in Lualualei since 2002. These programs have been successful on a small scale, but are labor intensive and expensive. Recovery of the O`ahu `elepaio will require rodent control on a larger scale, and this can

Table 2. `Elepaio population growth with and without predation and disease. Lambda >1.0 indicates growth. (from VanderWerf 2002).

Predator control?	Disease removed?	Growth rate (lambda)
Yes	Yes	1.04
Yes	No	0.98 ± 0.05
No	Yes	0.83
No	No	0.76 ± 0.04

be achieved more efficiently through aerial broadcast methods. Registration of aerial broadcast of diphacinone for rodent control with the U.S. Environmental Protection Agency should be actively pursued and supported, and public outreach and education about the importance and benefits of controlling rodents and the safety of diphacinone is needed before aerial broadcast can be applied. Reproduction of `elepaio with active pox virus infections birds is 69% lower than reproduction of healthy birds, and survival of infected birds is 24% lower than survival of healthy birds, but the prevalence of pox varies among years, and on average 14% of birds have active infections each year (VanderWerf 2002). Avian malaria is a serious threat to many Hawaiian forest birds, but its effect on `elepaio has not been investigated. Currently there is no environmentally safe and effective and method of controlling mosquitoes in forested areas, and it is not practical to vaccinate wild bird populations because any immunity would not be heritable. Controlling rodents also may lessen the threat from disease by providing birds that have greater natural immunity a greater chance of reproducing (VanderWerf and Smith 2002).

Recovery Strategy. The ultimate recovery goal for O`ahu `elepaio is to restore viable populations or metapopulations on both the windward and leeward sides of the Ko`olau and Wai`anae Mountains (USFWS 2005). The number of birds remaining is sufficiently large that *in situ* habitat management of wild birds currently is the most cost-effective recovery strategy. Rodent control is the most effective method of stabilizing `elepaio populations. Recovery efforts should focus first on protecting and managing the six large "core" populations, because management in these areas will benefit the largest number of birds. These core populations are distributed throughout most of the original historical range, have the greatest chance of long-term persistence because their larger sizes make them less susceptible to stochastic events, and they probably have lost less genetic diversity than smaller populations. All six core populations should be conserved to preserve as much genetic, morphological, and behavioral (vocal) variation as possible. Smaller populations should be addressed next if there are sufficient resources or interested parties. If management actions are effective, the core populations eventually may serve as sources of dispersing individuals that can help support smaller populations or recolonize areas where `elepaio have disappeared. If habitat management alone proves insufficient to allow recovery, captive propagation and/or rear and release of O`ahu `elepaio may become necessary, and would be especially valuable if genetically disease-resistant birds can be identified for use as breeding stock.

Interim Recovery Objectives. In order to meet the long-term recovery goals for the O`ahu `elepaio, the following short-term goals should be accomplished first:

- Stabilize numbers of birds in the six remaining core populations through rodent control.
- Prevent any further loss of forest habitat supporting the six remaining core populations.

If these objectives are met within five years, then new interim recovery objectives will be identified to continue to guide progress toward full recovery. If these objectives are not met within five years, then the causes for failure should be identified and rectified if possible. If it is not possible to correct the causes for failure and the current strategy is deemed ineffective, then a new strategy will be developed and new actions identified.

Five-year Recovery Actions (2004-2008). In order to realize the interim recovery objectives described above, the following actions are necessary:

- Ensure/encourage continued support for ongoing rodent control programs and expand these programs.
    - Honolulu Watershed State Forest Reserve in Wailupe Valley (Hawai`i DOFAW)
    - Honouliuli Preserve (The Nature Conservancy of Hawaii)
    - U.S. Army Schofield Barracks West Range (U.S. Army)
    - Lualualei Naval Magazine (U.S. Navy)

- Begin public outreach about importance and benefits of controlling rodents and safety of diphacinone.
- Conduct large-scale rodent control by aerial broadcast of diphacinone in at least one site and compare efficacy and cost with ground-based methods. Possible sites include Honouliuli Preserve, Schofield Barracks West Range, and Mākua Military Reservation.
- Contact landowners and initiate rodent control in unmanaged areas within core populations, through safe harbor agreements, partnerships, technical support, and collaboration.
  - Moanalua Valley (Damon Estate)
  - North Hālawa Valley (Kamehameha Schools)
  - South Hālawa Valley (Queen Emma Foundation)
  - Wiliwilinui Gulch (Kamehameha Schools)
  - Waikāne Valley (SMF Enterprises)
  - Pia Valley (Hawaii Humane Society and J. Pflueger)
  - Mākaha Valley (City and County of Honolulu)
- Complete an effective fire management plan at Schofield Barracks West Range, ensure that Army provides adequate resources to implement that plan and responds to fires in a timely manner (U.S. Army).
- Ensure access to Honouliuli Preserve for management by The Nature Conservancy of Hawaii. May require coordination with U.S. Army over condemnation of lands in northern portion of Preserve, and negotiation of lease or conservation easement with a new owner if land comprising the remainder of the Preserve is sold by Campbell Estate.

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APPENDIX G.

PUAIOHI FIVE-YEAR RECOVERY WORK PLAN

Prepared by Puaiohi Working Group and Hawaiian Forest Bird Recovery Team

Purpose. The long-term recovery goals, delisting criteria, recovery strategy, and a comprehensive list of recovery tasks for the Puaiohi are provided in the Final Revised Recovery Plan for Hawaiian Forest Bird, which covers 21 species (USFWS 2005). The purpose of this five-year work plan is to identify interim recovery objectives for the puaiohi that can be realized within five years, and to describe succinctly the actions needed to reach those interim objectives. Identification of interim recovery objectives and actions will help ensure that initial conservation efforts by different agencies or groups are focused on the same ultimate goals, facilitate efficient use of limited recovery resources, and provide milestones that can be used to track and evaluate progress toward recovery. Realization of these milestones will measure progress toward eventual recovery. Failure in realizing these milestones may indicate that additional resources are needed, or that the current recovery strategy is not effective.

Captive Puaiohi with chicks. Photo © Jack Jeffrey.

Species Summary. The puaiohi, or small Kauai thrush (*Myadestes palmeri*), is a medium-sized thrush endemic to the island of Kauai. Adult puaiohi are olive-brown above, gray below, with a white-eye-ring and pinkish legs. Juveniles have distinctive spots and scalloping on the breast and wings. Puaiohi feed on insects and the fruit of several native plants, particularly \`ōlapa (*Cheirodendron trigynum*), lapalapa (*C. platyphyllum*), \`ōhi\`a ha (*Syzygium sandwicensis*), kanawao (*Broussaisia arguta*), \`ōhelo (*Vaccinium* spp.), pa\`iniu (*Astelia* spp.), pūkiawe (*Styphelia tameiameiae*), kāwa\`u (*Ilex anomala*), and pilo (*Coprosma* spp.). Puaiohi nest in cavities or ledges concealed by mosses and ferns on cliff faces, or more rarely in secondary cavities formed in trees (Snetsinger *et al.* in prep.). Nesting occurs from March to mid-September, with a peak from April to June (Snetsinger *et al.* in prep). The female alone builds the nest, and incubates and broods the young. Clutch size is almost always two. Eggs hatch after 13 to 15 days. Both parents share responsibility for provisioning the chicks, but after fledging the male assumes primary responsibility for feeding chicks while the female frequently initiates another nesting attempt. Occasionally (8 percent of nests), second-year and hatch-year birds assist in nest defense and feeding of nestlings and fledglings. Recently fledged young often remain within 2 meters of the ground for 2 to 4 days after fledging, where they may be particularly vulnerable to predation by introduced mammalian predators. A breeding season of up to 132 days and high nest success rates of up to 90% result in productivity in some years of up to 4.9 fledglings/pair. El Niño conditions can shorten the breeding season to 51 days and lower nest success to 42 percent,

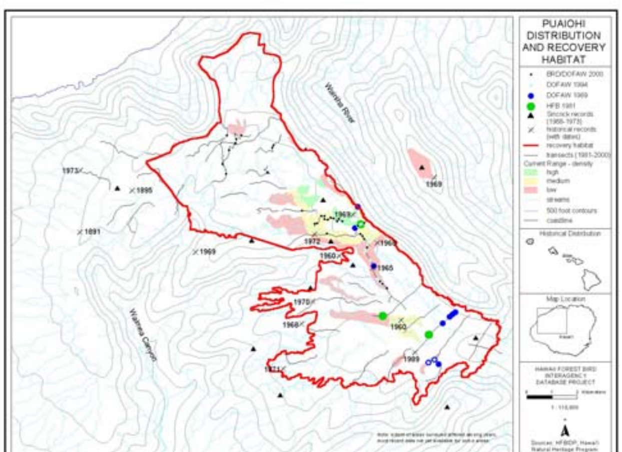

Figure 1. Puaiohi Distribution and Recovery Area.

leading to productivity of only 0.4 young per pair per year. Dispersal frequency and distances appear to be small but are poorly known. Adult survival is estimated at 74% and juvenile survival at 25% (T. Snetsinger pers. comm.).

The total population of puaiohi is estimated to be 300-400 birds, which occur in wet (>6,000 mm rain/year) montane forest in stream valleys and associated ridges above 1,050 meters (3,450 feet) elevation on the southern and central plateau of the Alaka`i Wilderness Preserve (Scott *et al.* 1986, Snetsinger *et al.* 1999, USGS and DOFAW unpubl. data). The breeding population is restricted to an area of < 20 square km, and 75 percent of the breeding population occurs in only 10 square kilometers (Figure 1). The puaiohi exists in high densities (up to 11 breeding pairs per linear kilometer of stream) in three adjacent drainages; the Upper Mōhihi, Upper Waiakoali, and the northeastern upper Kawaikōī (the "core" or "Mōhihi/Waiakoali" population; Table 1). Densities decline with elevation about 1,050 meters (3,450 feet) in these drainages (T. Snetsinger pers. comm.). The upper reaches of the Halehaha and Halepā`ākai drainages contain a medium-density population of approximately 5 pairs per linear km, and low-density populations exist in the lower Waia`alae/unnamed drainage (1.25 pairs/km; Pratt *et al.* 2002) and lower Kawaikōī/Kauaikinanā (0.5 pairs/linear km). Two small, low-density populations were detected during State forest bird surveys in 1994 on private lands along the Halekua and Waiau streams at the southern edge of the species' range, but neither population was detected during surveys in March 2000 (T. Telfer pers. comm.). Surveys in March 2000 confirmed the existence of a small population along the upper reaches of a tributary to the Koai`e Stream, although its size and extent remain to be documented (J. Foster/USGS unpubl. data).

A captive propagation and release program has been implemented for the puaiohi, and a total of 77 birds have been released in 2 sites since 1999 (Kuehler *et al.* 2000; The Peregrine Fund 1999; The Peregrine Fund and ZSSD 2000; ZSSD 2001, 2002, 2003; ZSSD unpubl. data). Captive-bred released puaiohi readily paired with both captive and wild birds, and bred in the wild in the first season following their release. For releases conducted from 1999-2002, thirty-six of forty-two (85.7%) released birds survived to 30 days post-release, and survival during the subsequent 40-50 day post-independence period ranged from 67% in 1999 to 71% in 2001 and 83% in 2002. However, only 20-43% of released birds established breeding territories in the target drainage each year, and the majority of released birds dispersed several km away, frequently in the direction of high-density populations (Tweed *et al.* 1999, Monahan *et al.* 2001, Pratt *et al.* 2002). Although released birds have survived well and reproduced, the efficacy of captive releases at establishing new, disjunct populations has yet to be demonstrated.

Table 1. Densities of Puaiohi populations in drainages of the Alaka`i region of Kauai.

Drainage	Density (pairs/km)
Mōhihi	High
Waiakoali	High
Kawaikōī	High
Halehaha	Medium
Halepā`ākai	Medium
Kawaikōī/Kauaikinanā	Low
Waia`alae/unnamed	Low

Primary Threats. Predation by alien rats (*Rattus* spp.) may be a serious limiting factor on puaiohi populations. Although their habit of nesting on steep cliff faces may provide some protection from nest predation, data from 1998 and 1999 showed that 14 percent and 22 percent of nests, respectively, failed due to rat predation. Eggs, nestlings, and incubating females all have been depredated by rats. Snetsinger *et al.* (in prep.) demonstrated that nests protected by rat bait stations fledged significantly more birds than untreated nests. In addition, the tendency of young puaiohi to remain close to the ground for several days after fledging probably makes them particularly vulnerable to predation by feral cats.

Only five wild puaiohi have been tested for disease, of which one had antibodies to malaria but none had active infections, suggesting that at least some puaiohi may survive malaria infection (Atkinson *et al.* 2001). However, disease likely limits puaiohi from inhabiting the lower reaches of stream drainages with suitable nesting cliffs.

The disruption of seedling regeneration of beneficial plants, the invasion of nonnative weeds, and soil erosion are some of the many forest management problems within the remaining puaiohi range. Feral pigs and goats have had long-term damaging effects upon native forests by opening space for weeds and transporting weed seeds into the forest. Hurricanes in 1982 and 1992 also severely disturbed areas of native forest and made space for the germination and expansion of alien plants. Habitat degradation resulting from the invasion of many nonnative weeds has drastically changed the forest structure and integrity.

The population size of 300 to 400 birds in several subpopulations falls below the effective population size of 500 individuals recommended for long-term maintenance of genetic diversity (Soulé 1987).

Recovery Strategy. Several tools exist that can be used to manage puaiohi populations, including captive propagation and release, predator control, use of rat-resistant artificial nest boxes, and fencing and ungulate control. All of these tools are likely to be important components of the long-term recovery strategy for puaiohi, but knowing which tool is most effective will allow more efficient short-term use of limited conservation resources. In addition, the most appropriate conservation strategy and the most urgent management needs of the puaiohi depend on the size, distribution, and trend of the population, and these parameters are only partly known. If the population is relatively large and stable, then management of wild birds may be most effective and releases of small numbers of captive-bred birds are not needed. On the other hand, if unoccupied areas of suitable habitat can be identified that are isolated from the existing population, then it may be preferable to decrease the threat from local catastrophes by creating additional disjunct populations through release of captive birds. If the population is stable, then there is time to investigate the efficacy of different tools; if it is declining, then it may be necessary to augment simultaneously the population through release of captive birds. Until this information is known, it is prudent to continue existing management programs that have shown some degree of success, such as captive propagation and release (Kuehler *et al.* 2001), and ground-based predator control around nest sites (Snetsinger *et al.* 1999).

Interim Recovery Objectives. In order to meet the long-term recovery goals for the puaiohi, the following short-term goals should be accomplished first:

- Investigate management tools for stabilizing/increasing the puaiohi population and determine which is most effective.
- Determine the total current population size and distribution.
- Determine the puaiohi population trend.

If these objectives are met within five years, then new interim recovery objectives will be identified to continue to guide progress toward full recovery. If these objectives are not met within five years, then the causes for failure should be identified and rectified if possible. If it is not possible to correct the causes for failure and the current strategy is deemed ineffective, then a new strategy will be developed.

Five-year Recovery Actions (2004-2008). In order to realize the interim recovery objectives described above, the following actions are necessary:

- Compile and summarize existing survey data (USGS).
    - Complete surveys in additional areas (State DLNR field crew)
- Identify a new release site that fulfills the criteria of providing high quality habitat, zero or low density of wild puaiohi, sites for the erection of release towers, and helicopter access (State DLNR field crew).
- If a release site is identified, relocate the release infrastructure (towers, cages, weatherport, etc.) to new release site (ZSSD/USFWS/DOFAW).
- Use landsat images and geographic and biological data to model puaiohi habitat with GIS and identify additional potential habitat (USGS).
- Conduct large-scale rodent control by aerial broadcast of diphacinone. Possible treatment sites include upper Mōhihi, and Halepā`ākai. Treatment of both a high-density site and

a medium-density site might provide valuable comparison. In order to implement and fully evaluate the efficacy of an aerial broadcast, the following actions also are needed:

- Collect baseline data on survival and reproduction of puaiohi for comparison, from a spatial control, a temporal control, or both.
- Begin public outreach about importance and benefits of controlling rodents and safety of diphacinone.
- Collect before and after data on water quality and possible contamination of game species if these are deemed necessary to obtain public support.

- Evaluate efficacy of rat-resistant artificial nest boxes at reducing predation.
  - Test different designs of nest boxes, with wild birds, captive birds, or both (graduate student and ZSSD).
  - Compare nest success and female survival in natural nests vs. artificial nest boxes (graduate student).
  - Fledge captive birds from artificial nest boxes so they recognize and use artificial nest boxes after release (ZSSD).
- Measure survival and dispersal of adult and juvenile puaiohi, through mist-netting, banding, resighting, and radio tracking, for use in demographic modeling and determination of population trend (graduate student).
- Model puaiohi population to determine whether it is stable and the effect of management tools (graduate student).

Annual Workplan - 2005. The following tasks are planned for 2005:

- Release 12 captive-bred hatch year birds at the Halepā`ākai hack site and 6 captive-bred hatch year birds at a newly established hack site near Koai`e stream. The release at the Koai`e stream is planned to test survival and dispersal of captive-bred birds released into suitable habitat in which there are few wild resident birds.
- Document dispersal and survival of all released birds for the life of the transmitters using ground based or helicopter access as needed.
- Conduct systematic surveys in drainages not yet surveyed using methodology described in Pratt *et al.* 2002.
- Begin demography studies and prepare for predator control actions by banding as many birds as possible in two drainages and monitoring as many nests in the two drainages as possible.
- Perform basic statistical analyses on release data compiled from 1999-2004.
- Puaiohi Working Group meet in June to discuss results of releases at the two hack sites and future hack site locations.
- Report due 30 September 2005.

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APPENDIX H.

PALILA FIVE-YEAR RECOVERY WORK PLAN

Prepared by Palila Working Group and Hawaiian Forest Bird Recovery Team

Male Palila. Photo © Jack Jeffrey

Purpose. The long-term recovery goals, delisting criteria, recovery strategy, and a comprehensive list of recovery tasks for the Palila are provided in the Hawaiian Forest Bird Recovery Plan, which covers 21 species (USFWS 2005). The purpose of this five-year work plan is to identify interim recovery objectives for the Palila that can be realized within five years, and to describe succinctly the actions needed to reach those interim objectives. Identification of interim recovery objectives will help ensure that initial conservation efforts by different agencies or groups are directed toward the same ultimate goals, encourage efficient use of limited recovery resources, and provide milestones that can be used to track and evaluate progress toward recovery. Realization of these milestones will provide evidence that progress is being made toward eventual recovery. Failure in realizing these milestones may indicate that additional effort and funding are needed, or that the current recovery strategy is not effective.

Species Summary. The palila (*Loxioides bailleui*) is a finch-billed Hawaiian honeycreeper (subfamily: Drepanidinae) from the island of Hawai`i, and is one of the larger Hawaiian honeycreepers with an overall length of 15.0 to 16.5 centimeters (6.0 to 6.5 inches) and an adult weight of 38 to 40 grams (1.3 to 1.4 ounces). Adult palila have a yellow head and breast, greenish wings and tail, and are gray dorsally and white ventrally (Jeffrey *et al.* 1993). Fossil remains of palila have been found at sea level on O`ahu (Olson and James 1982a, b), suggesting that the species once occurred over a much larger range pre-historically.
Historically, the palila is known only from the island of Hawai`i, were it occurred in māmane (*Sophora chrysophylla*)/naio (*Myoporum sandwicense*) forests on the upper slopes of Mauna Kea, the northwestern slope of Mauna Loa, and probably the southern and eastern slopes of Hualālai Volcanoes (Figure 1). In the 1890s, Perkins (1903) found the palila to be "extremely numerous" in the māmane belt of the Kona region between 1,210 and 1,830 meters (4,000 to 6,000 feet) elevation. Palila were still locally common in the 1940's between 2,360 and 2,530 meters (7,800 to 8,350 feet) on the western and northeastern slopes of Mauna Kea (Richards and Baldwin 1953). However, the range of palila apparently shrank relatively quickly in the early 1900s to the current small area on the upper slopes of Mauna Kea, and Munro (1944) determined that the species was in danger

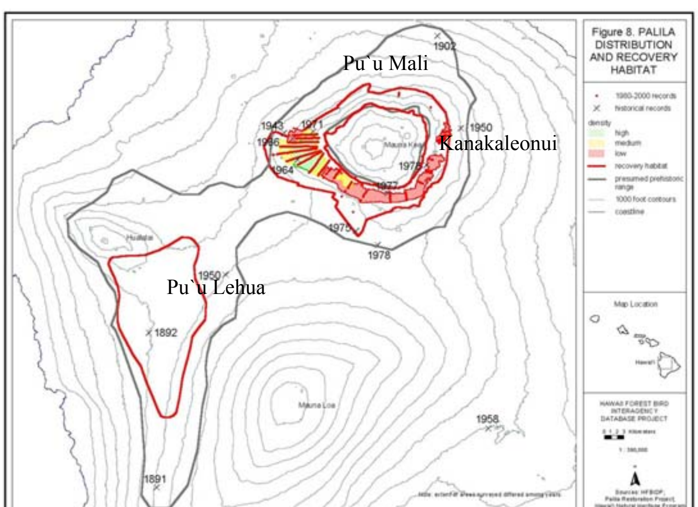

Figure 1. Palila Distribution and Recovery Area

of extinction. Palila numbers have varied over the last 25 years from approximately 1000 to 5000 birds (Figure 2), 96% of which population occurs on the southwestern slope of Mauna Kea, where the elevation range of the forest and habitat quality is greatest (Scott *et al.* 1984, 1986; Jacobi *et al.* 1996; Banko *et al.* 1998; Gray *et al.* 1999). Highest densities of palila occur in areas of greater crown cover, taller trees, and higher proportion of native shrubs near 2,300 meters (7,550 feet) elevation (Scott *et al.* 1984, 1986). Recent releases of captive-reared palila near Pu`u Mali on the north slope of Mauna Kea in 2003, and translocation of palila from the western slope to near Pu`u Mali in 2004 appear to have resulted in some increase in the numbers of resident palila on the north slope of Mauna Kea (ZSSD and USGS unpubl. data).

The palila is a food specialist, preferring māmane seeds in green pods, but also will eat māmane flowers, buds, and leaves, and naio berries, especially when other foods are in short supply. Annual and seasonal density of birds is strongly related to māmane pod availability (Scott *et al.* 1984, 1986; Hess *et al.* 2001). Most nesting occurs in māmane trees (Pletschet and Kelly 1990), while naio is more frequently selected for roosting (USGS unpubl. data). The elevation range of forest was the most important variable in an analysis by Scott *et al.* (1984) of response of palila to available habitat. A wide elevational range of māmane forest results in more consistent availability of seeds within the range of daily movements typically made by palila, especially during the breeding season.

Peak nesting usually occurs in May or June, but may begin in March and May and continue through August or mid-September (van Riper 1980, Pletschet and Kelly 1990, Pratt *et al.* 1997, USGS unpubl. data), while the number of nesting attempts each year is strongly influenced by the availability of green māmane pods. Mean length of the egg-laying season is 113 ± 25.1 days (range = 53–205; USGS unpubl. data). Nesting density varies with habitat composition, averaging 6 ± 2 nests/100 hectares in māmane-dominated forest, and 4 ± 1 nests/100 hectares in mixed naio/māmane forest (USGS unpubl. data). Preferred nest sites are in forks near the ends of higher branches in medium to large māmane trees. Modal clutch size is 2 eggs (range 1 to 3). Eggs require 16 to 17 days to hatch, and nestlings fledge at 25 days (Pletschet and Kelley 1990). Palila may re-nest after failure, and some palila are able to successfully raise two broods during the same year. Palila are monogamous, but other adult males often help the pair by feeding the female and chicks (Pratt *et al.* 1997; Miller 1998).

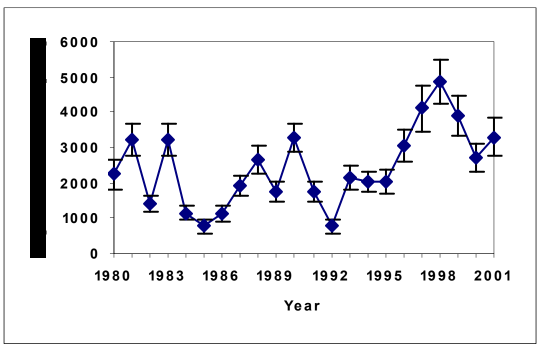

Figure 2. Palila Population Trend. Data from Paul Banko.

Primary Threats. Habitat loss and modification, avian disease, and predation by introduced mammals are thought to have caused the palila population to become endangered, and these factors continue to limit the palila population today (Scott *et al.* 1984, 1986; Jacobi *et al.* 1996, Pratt *et al.* 1997). Heavy browsing by feral sheep during the first decades of the 1900s effectively lowered tree line and reduced tree density in some areas on Mauna Kea (Bryan 1937, Scowcroft and Giffin 1983, Scott *et al.* 1984), and although the substantial populations of feral sheep were greatly reduced, ungulate browsing by feral sheep, goats, mouflon sheep (*Ovis musimon*), and browsing and rooting by feral pigs on Mauna Kea continues to negatively impact māmane trees and saplings and reduce habitat quality (USFWS 2005). Habitat modification by introduced nonnative plants and grasses and increased fire threat and introduced nonnative invertebrate species that eat native insects used as food by palila are also significant threats.

Recovery Strategy: The recovery strategy for the palila is to better understand and optimize management of threats, provide habitat protection within the entire current range, restore habitat, and increase the species' range by establishing additional viable populations on Mauna Kea and

Mauna Loa. The tools available for this work are population research, predator control using broad-scale methods, fencing and ungulate control, and captive propagation and release and translocation to reintroduce palila into areas of former range.

Interim Recovery Objectives. In order to meet the long-range recovery goals for palila, the following short-term goals should be accomplished first:

- Prevent any habitat loss in the core palila population on the southwest slope of Mauna Kea, and restore māmane/naio forest in adjacent areas on Mauna Kea and on Mauna Loa to allow expansion of the core population.
- Reduce the risk of catastrophic fire to the core population.
- Establish a second population in a disjunct area on Mauna Kea to decrease the risk from catastrophes.

If these objectives are met within five years, then new interim recovery objectives should be identified that will continue to guide progress toward full recovery. If these objectives are not met within five years, then the causes for failure should be examined and rectified if possible. If it is not possible to correct the causes for failure and the current strategy is not considered effective, then a new strategy should be developed.

Recovery Actions. In order to realize the interim recovery objectives described above, the following actions are necessary:

- Protect Existing Habitat
    - Develop a comprehensive ungulate management plan for Mauna Kea including fencing and ungulate removal from palila critical habitat (DLNR/USFWS).
    - Continue/complete removal of feral ungulates from palila critical habitat on Mauna Kea (DLNR).
    - Fence and remove ungulates from māmane/naio forest (>6,000 acres) at Pu`u Lehua, North Kona (KS/USFWS).
    - Protect and restore māname/naio forest at Kanakaleonui on the east slope of Mauna Kea (DHHL/DLNR/USFWS).
    - Design and implement an effective fire-management plan for the Mauna Kea/Saddle Road area (USGS/DLNR/DOD)
    - Begin public outreach about importance and benefits of controlling rodents and safety of diphacinone and importance of feral cat control (USGS/DLNR/USFWS).
    - Conduct large-scale rodent control by aerial broadcast of diphacinone in at least one site and monitor population and individual-level responses. Possible sites include Pu`u Mali and Pu`u Lehua (KS/USFWS/DLNR)
- Continue Research to Document Distribution, Threats, and Habitat Needs.
    - Continue basic research on palila biology and māmane/naio forest ecology (USGS).
    - Continue māmane phenology on Mauna Kea (USGS) and Pu`u Lehua area, North Kona (KS/USGS).
- Restore New Habitat.
    - Begin long-term restoration and management at Pu`u Mali (>5,000 acres) on the north slope of Mauna Kea for palila habitat (USGS/USFWS/DOFAW/FHWA).
- Continue to Develop Captive Propagation and Translocation Reintroduction Programs
    - Investigate best methods to re-establish wild palila populations by release of captive-raised birds and/or translocation (USGS/ZSSD).
    - Release captive bred or translocated birds into restored habitat. Continue releases of captive bred and translocated birds at Pu`u Mali and begin at least one additional release at Pu`u Lehua or Kanakaleonui if habitat is ready (USGS/ZSSD/USFWS/DLNR).

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APPENDIX I.

MAUI PARROTBILL FIVE-YEAR RECOVERY WORK PLAN

Prepared by Maui Parrotbill Working Group and Hawaiian Forest Bird Recovery Team

Male Maui Parrotbill. Photo © Eric VanderWerf

Purpose. The long-term recovery goals, delisting criteria, recovery strategy, and a comprehensive list of recovery tasks for the Maui parrotbill are provided in the Hawaiian Forest Bird Recovery Plan, which covers 21 species (USFWS 2005). The purpose of this five-year work plan is to identify interim recovery objectives for the Maui parrotbill that can be realized within five years, and to describe succinctly the actions needed to reach those interim objectives. Identification of interim recovery objectives will help ensure that initial conservation efforts by different agencies or groups are focused on the same ultimate goals, encourage efficient use of limited recovery resources, and provide milestones to track and evaluate progress toward recovery. Realization of these milestones will provide evidence of progress being made toward eventual recovery. Failure in realizing these milestones may indicate that additional resources are needed, or that the current recovery strategy is not effective.

Species Summary. The Maui parrotbill is an insectivorous Hawaiian honeycreeper that uses its massive hooked bill to dig, tear, crack, crush, and chisel the bark and wood on a variety of native shrubs and small to medium-sized trees, especially `ākala (*Rubus hawaiensis*), kanawao (*Broussaisia arguta*), and `ōhi`a (*Metrosideros polymorpha*). Parrotbills also pluck and bite open fruit in search of insects, particularly kanawao. Especially preferred are larvae and pupae of various beetles and moths (Perkins 1903, Mountainspring 1987, Simon *et al.* 1997). Maui parrotbills are socially monogamous, non-migratory, and defend year-round territories averaging 2.3 hectares (5.7 acres) in size (Pratt *et al.* 2001). However, the Maui Forest Bird Recovery Project recently found at least 18 individuals in a 12 hectare area and have documented dispersal over 1.5 km, suggesting there may be more movement and variation in sociobiology than currently realized (MFBRP unpubl. data). Parrotbills frequently occur in family groups, due to the prolonged dependency of fledglings on their parents (Simon *et al.* 1997).

The ecology of the Maui parrotbill has been little studied, but recently Lockwood *et al.* (1994) and Simon *et al.* (1997) investigated aspects of reproductive biology. The open cup nest is built by the female an average of 12 meters (40 feet) above the ground in a forked branch just inside the outer canopy foliage. Simon *et al.* (1997)

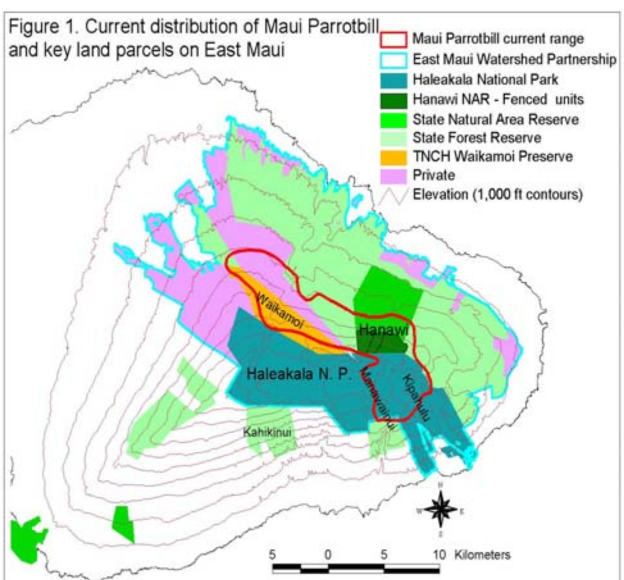

Figure 1. Current distribution of Maui Parrotbill and key land Parcels on East Maui.

reported only single egg clutches, but there are reports of two-chick broods. Re-nesting occurs only after nest failures, and pairs will not raise more than one brood in a season. Development of the large bill and specialized feeding techniques proceed slowly, and fledgling dependency on parental care lasts 5 to 8 months.

Currently the Maui parrotbill is found only on Haleakalā Volcano in East Maui, in 50 square kilometers (19 square miles) of wet montane forests from 1,200 to 2,350 meters elevation (4,000 to 7,700 feet; Scott *et al.* 1986, Mountainspring 1987, Simon *et al.* 1997). The current range forms an arc from the Waikamoi Drainage west of Ko`olau gap to Haleakalā National Park lands in Kīpahulu Valley and the Manawainui Drainage (Figure 1). The current geographic range is much restricted compared to the known prehistoric range, which included dry leeward forests and low elevations (200 to 300 meters, 660 to 1,000 feet) on East Maui as well as Moloka`i, based on collections of subfossil bones (James and Olson 1991). Distribution and densities in the Waikamoi and Manawainui range edges are not well documented.

The number of Maui parrotbills was estimated to be 500 ± 230 (95 percent CI) birds at an average density of 10 birds per square kilometer (0.39 square miles) in 1980 by the Hawai`i Forest Bird Survey (Scott *et al.* 1986). Repeat surveys of the same transects conducted in 1992 (Hawai`i Department of Land and Natural Resources 1995) and limited surveys conducted from 1995 to 1997 by U.S. Geological Survey biologists indicated approximately the same densities of birds, but with perhaps some range constriction at lower elevations.

A captive propagation program has successfully bred, hatched and reared Maui parrotbill, both from wild collected eggs and from pairs established in captivity, and anticipates producing enough offspring to provide the cohorts necessary for pilot releases (The Peregrine Fund and ZSSD 2000; Kuehler, *et al.* 2001; ZSSD 2002, 2003).

Primary Threats. Maui parrotbill are restricted to higher elevation forests due to the presence of mosquito-borne diseases at lower elevations, and are restricted at upper elevations due to destruction of forest habitat. Within their present range, the factors that limit densities are not well known. Feral cats (*Felis catus*) and Barn Owls (*Tyto alba)* are known to prey on birds at Hanawī (Kowalsky *et al.* 2002), and black (*Rattus rattus*) and Polynesian (*R. exulans*) rats, both of which are serious predators on adults and nests of other Hawaiian forest birds, are abundant in parrotbill habitat (Malcolm *et al.* 2002), but direct evidence of predation on parrotbills is lacking and recent work suggests that predation rates may be low (Sparklin *et al.* in prep.) and that the population may be limited by food availability (Simon *et al.* 2000). Maui parrotbills were reported to strongly favor koa for foraging (Perkins 1903). Widespread habitat destruction from logging and ranching has greatly reduced parrotbill range, and has been particularly severe in more mesic areas that formerly supported high densities of koa. The current range is restricted to wet forest areas in which koa densities are relatively low. Habitat within the current range thus may be suboptimal compared to portions of the former range. Within its current range, habitat damage by feral pigs to the understory vegetation may be a significant factor contributing to reduced food availability, large territories, and low reproduction. Similar impacts in unoccupied potential habitat may make those areas unsuitable for reestablishment of parrotbill. Habitat degradation and marginal suitability may exacerbate the negative effects of severe weather events such as rainstorms, which are common in East Maui and have been linked to failure of parrotbill nests (Mountainspring 1987, Simon *et al.* 2000).

Recovery Strategy. The recovery strategy for the Maui parrotbill is to better understand and optimize management of threats to population stability, to provide habitat protection within the entire current range, and to increase its range and establish a second viable population. The tools available for this work are population research, predator control using broad-scale methods, fencing and ungulate control, and captive propagation and reintroduction.

Interim Recovery Objectives. In order to meet the long-range recovery goals for the Maui parrotbill the following short-term goals should be accomplished first.

- Maintain Existing Stable Population.
- Increase Distribution and Abundance of Existing Population.

- Begin habitat protection and restoration work to secure >1200 acres of koa forest habitat at Kahikinui (see map above).

If these objectives are met within five years, then new interim recovery objectives will be identified to continue to guide progress toward full recovery. If these objectives are not met within five years, then the causes for failure should be identified and rectified if possible. If it is not possible to correct the causes for failure and the current strategy is deemed ineffective, then a new strategy will be developed and new actions identified.

Five-year Recovery Actions (2004-2008). In order to realize the interim recovery objectives described above, the following actions are necessary:

- Protect Existing Habitat
    - Maintain existing fences in Hanawī NAR, Waikamoi, and Haleakalā National Park (NPS, USFWS, TNC, and DOFAW).
    - Complete fencing of lower Hanawī NAR (EMWP).
    - Begin public outreach about importance and benefits of controlling rodents and safety of diphacinone (USFWS/DOFAW).
    - Conduct large-scale rodent control by aerial broadcast of diphacinone in at least one site and monitor population and individual-level responses. Possible sites include Hanawī and Kīpahulu Valley.
- Continue research to document distribution, ecology, threats, and habitat and management needs.
    - Complete long-term population trend analysis and habitat suitability modeling (Interagency Database Project, USFWS, NPS, DOFAW, and BRD).
    - Investigate movement patterns of adults and dispersal of juveniles through mist-netting, resighting, and radio tracking.
    - Document and publish response of Maui parrotbill distribution to habitat protection in Kīpahulu Valley.
    - Complete surveys in the Waikamoi and Manawainui areas (MFBRP/USFWS/DOFAW/NPS).
    - Carry out habitat use research in the Manawainui area (NPS).
    - Complete pilot nest predation study in Hanawī NAR (MFBRP/USFWS/DOFAW).
- Restore New Habitat
    - Complete fencing and ungulate eradication of DOFAW Kahikinui parcel TMK# 218001009 and portions of DHHL parcels TMKs 219001011, 219001007, and 219001003 west of Kahikinui (see Fig. 1). Begin outplanting of koa and understory species in select areas. The community group LIFE holds a 20-year lease on the DHHL parcel and is currently fencing portions of the parcel for the purpose of restoration. Once restored, these parcels will together provide approximately 1200 acres of protected koa forest habitat. DOFAW and USFWS are currently funding this work.
    - Support the formation of a Leeward Maui Watershed Partnership.
- Develop a Captive Propagation and Reintroduction Program.
    - Continue captive propagation and optimization of methods.
    - Assess suitability of potential release sites in Waikamoi and Manawainui.
    - Conduct two years of experimental releases into suitable habitat to develop and optimize reintroduction methods.

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- visit http://www.mauiforestbird.org; or
- visit http://www.dofaw.net/fbrp/projects.php.

APPENDIX J.

`AKIAPŌLĀ`AU FIVE-YEAR RECOVERY WORK PLAN

Prepared by Akiapōlā`au Working Group and Hawaiian Forest Bird Recovery Team

Male `Akiapōlā`au. Photo © Eric VanderWerf

Purpose. The long-term recovery goals, delisting criteria, recovery strategy, and a comprehensive list of recovery tasks for `akiapōlā`au are provided in the Final Revised Recovery Plan for Hawaiian Forest Birds, which covers 21 species (USFWS 2005). The purpose of this five-year work plan is to identify interim recovery objectives for `akiapōlā`au, that can be realized within five years, and to succinctly describe the actions needed to reach those interim objectives. Identification of interim recovery objectives will help ensure that initial conservation efforts by different agencies or groups are focused on the same ultimate goals, encourage efficient use of limited recovery resources, and provide milestones to track and evaluate progress toward recovery. Realization of these milestones will provide evidence that progress is being made toward eventual recovery. Failure in realizing these milestones may indicate that additional effort and funding are needed, or that the current recovery strategy is not effective.

Species Summary. The `akiapōlā`au is a specialized insectivorous Hawaiian honeycreeper that uses its unusual dimorphic bill as two tools deployed separately or together to extract insect larvae and spiders from crevices or insect borings (Pratt *et al.* 2001). Moth larvae are the most common food item in `akiapōlā`au fecal samples, followed by spiders and long-horned beetle larvae (Ralph and Fancy 1996). Lichen-covered and dead branches are preferred as foraging substrates. Tree species preferred for foraging include koa (*Acacia koa*), kōlea (*Myrsine* spp.), māmane (*Sophora chrysophylla*), and naio (*Myoporum sandwicense*), while `ōhi`a (*Metrosideros polymorpha*) is not favored. This species also takes sap from small wells it drills in the bark of `ōhi`a trees. It is not clear how these sap trees are selected, and the prevalence of this behavior and the importance of this nutritional source are not known. `Akiapōlā`au often join mixed species foraging flocks. Home range size varies from approximately 5 to 40 hectares (12 to 100 acres). The factors that influence the range in territory size, and therefore population size, are unknown. Recently, `akiapōlā`au have been observed foraging and nesting in young koa plantations (L. Pejchar, unpubl. data), suggesting that this species may not be restricted to old growth as previously assumed. `Akiapōlā`au also inhabited wet montane forest dominated by `ōhi`a, with no koa. Some birds are still found in that habitat at middle elevations in Hāmākua. `Akiapōlā`au are found in

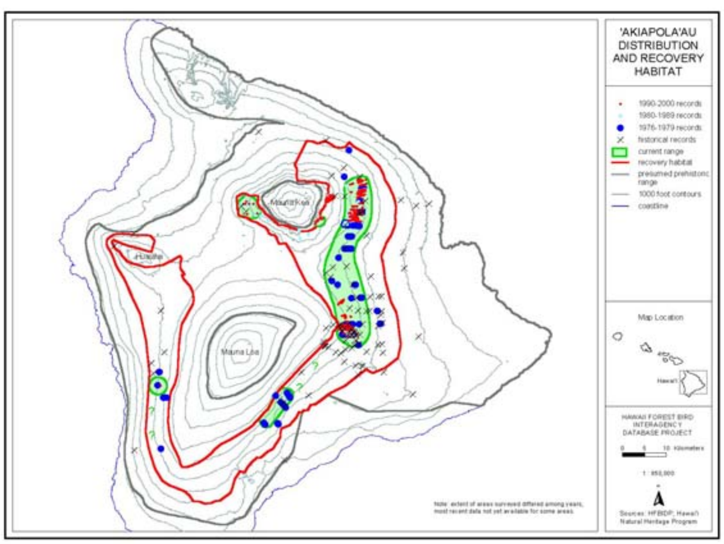

Figure 1. `Akiapōlā`au Distribution and Recovery Area

four disjunct populations inhabiting koa-dominated montane forests (Hāmākua south across the upper Waiākea kīpuka to Kūlani and Keauhou, in Ka`ū and Kapāpala, in southern Kona, and in central Kona; Figure 1). Until recently, a fifth population occupied subalpine dry forest on Mauna Kea. Originally these populations were all connected, but they have been isolated mainly because of loss of forest habitat due to the grazing. The current population estimate, based on surveys in 1990 to 1995, is 1,163 birds, with a 90 percent confidence interval of 1,109 to 1,217 birds (Fancy *et al.* 1995).

Primary Threats. `Akiapōlā`au are apparently restricted to higher elevation forests due to the presence of mosquito-borne diseases at lower elevations (van Riper *et al.* 1986, Atkinson *et al.* 1995), and are restricted at upper elevations due to destruction and degradation of forest habitat (Scott *et al.* 1986). Habitat fragmentation may isolate the remaining populations, decrease the effective population size, and hinder recolonization of areas that were formerly inhabited. Within their present range, the factors that limit densities are not well known. Predation by introduced mammals and owls may play a role, but direct evidence for this is scarce. Recent surveys indicate rat densities are high at Hakalau Forest National Wildlife Refuge, which contains a significant portion of the largest remaining `akiapōlā`au population (Lindsey *et al.* 1999). Juvenile `akiapōlā`au may be especially vulnerable to predators during the post-fledging period because their loud, persistent begging call makes them easy to locate. Predation may impact `akiapōlā`au more than other native birds because of their low reproductive rate (Ralph and Fancy 1996). Habitat degradation and food availability also may limit populations within their current range. Habitat within most of the current range of `akiapōlā`au has experienced significant degradation of canopy and understory structure.

Recovery Strategy. The recovery strategy for the `akiapōlā`au is to better understand its habitat use and needs in order to optimize habitat and threat management, to provide habitat protection within the entire current range, and to increase its range. The tools available for this work are population research, predator control using broad-scale methods, fencing and ungulate control, and captive propagation and reintroduction.

Interim Recovery Objectives. In order to meet the long-range recovery goals for `akiapōlā`au the following short-term goals should be accomplished first.

- Maintain Stable Existing Populations
- Increase Distribution and Abundance of Existing Populations
- Establish New Population(s)

If these actions are met within five years, then new interim recovery objectives will be identified to guide progress toward full recovery. If these actions are not met within five years, then the causes for failure should be identified and rectified if possible. If it is not possible to correct the causes for failure and the current strategy is deemed ineffective, then a new strategy should be developed and new actions identified.

Five-year Recovery Actions (2004-2008). In order to realize the interim recovery objectives described above, the following actions are necessary:

- Protect Existing Habitat
    - Maintain existing fences and ungulate control in Hakalau Forest National Wildlife Refuge, Keauhou, and Kapāpala.
    - Repair fences and maintain ungulate control at Pu`u Wa`awa`a (currently funded by USFWS and DOFAW).
    - Fence additional areas and remove ungulates in Waiākea kīpuka to Kūlani and Keauhou, Ka`ū and Kapāpala, and southern and central Kona.
    - Begin public outreach about importance and benefits of controlling rodents and safety of diphacinone.

- Conduct large-scale rodent control by aerial broadcast of diphacinone in at least one site and monitor population and individual-level responses. Possible sites include Hakalau, Keauhou, and Kapāpala.

- Continue research to document distribution, threats, and habitat needs.
  - Complete habitat use research at Hakalau, Keauhou, and Kapāpala (currently funded by DOFAW and UC Santa Cruz) in old and new growth forests.
  - Begin comparative demography study in forests of different age and structure.
  - Begin food availability study in forests of different age and structure, drawing from results from comparative habitat use study.
  - Complete intensive surveys in the Kapāpala area (currently funded by DOFAW, USFWS, and BRD).
  - Carry out surveys in Pu`u Wa`awa`a and south and central Kona.
  - Complete long-term population trend analysis and habitat suitability modeling (currently funded by USFWS, NPS, DOFAW, and BRD)
- Restore New Habitat
  - Continue reforestation of upper Hakalau and adjacent DHHL lands.
  - Continue reforestation of Kamehameha Schools lands in Keauhou.
  - Begin restoration at Pu`u Mali and Ka`ohe (currently funded by DOFAW and USFWS).
- Develop a Captive Propagation and Reintroduction Program.
  - Begin captive propagation and optimization of methods.
  - Assess suitability and select release sites.
  - Conduct two years of experimental releases into suitable habitat to develop and optimize reintroduction methods.

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APPENDIX K.

PO`OULI FIVE-YEAR RECOVERY WORK PLAN

Prepared by Po`ouli Working Group and Hawaiian Forest Bird Recovery Team

Po`ouli. Photo by Paul Baker, Maui Forest Bird Recovery Project.

Purpose. The long-term recovery goals, delisting criteria, recovery strategy, and a comprehensive list of recovery tasks for the po`ouli are provided in the Final Revised Recovery Plan for Hawaiian Forest Birds (USFWS 2005), which covers 21 species. The purpose of this five-year work plan is to identify interim recovery objectives for the po`ouli, and to succinctly describe the actions needed in the next five years to reach those interim objectives. Identification of interim recovery objectives will help ensure that initial conservation efforts by different agencies or groups are focused on the same ultimate goals, encourage efficient use of limited recovery resources, and provide milestones to track and evaluate progress toward recovery. Realization of these milestones will measure progress being made toward eventual recovery. Failure in realizing these milestones may indicate that additional resources are needed, or that the current recovery strategy is not effective.

Species Summary. The po`ouli (*Melamprosops phaeosoma*) is a critically endangered Hawaiian honeycreeper, and is perhaps the rarest bird in the world, with only three known individuals (Baker 2001). It is a stocky, medium-sized (26 g), bird with short wings, a short tail, stout legs, and a short straight bill, and is easily recognized by its gray crown, white cheek patch, and black "lone ranger" mask (Baker 1998). Remarkably, the po`ouli was apparently unknown to the Hawaiians and was first discovered in 1973 (Casey and Jacobi 1974). Morphological and genetic evidence indicates that the po`ouli forms a unique lineage within the Hawaiian honeycreepers, and it comprises its own monotypic genus (Fleischer *et al.* 2001). Only two nests of the po`ouli have ever been found, in March and April 1986, both from the same pair (Kepler *et al.* 1996). The second nest successfully fledged one of the two young, which spent 21 days in the nest. The female alone incubated the eggs and brooded the chicks, but both parents fed the chicks. Both nests were an open cup composed of twigs and mosses and lined with thin fern rootlets (Engilis *et al.* 1996), and were hidden among the foliage 8 meters (26 feet) high in tall `ōhi`a trees (Kepler *et al.* 1996). Po`ouli forage by gleaning, probing, and excavating for small invertebrate prey in moss, lichen, and bark, primarily in the subcanopy and understory. They seem to prefer kanawao (*Broussaisia arguta*), kāwa`u (*Ilex anomala*), and `ōhi`a as foraging

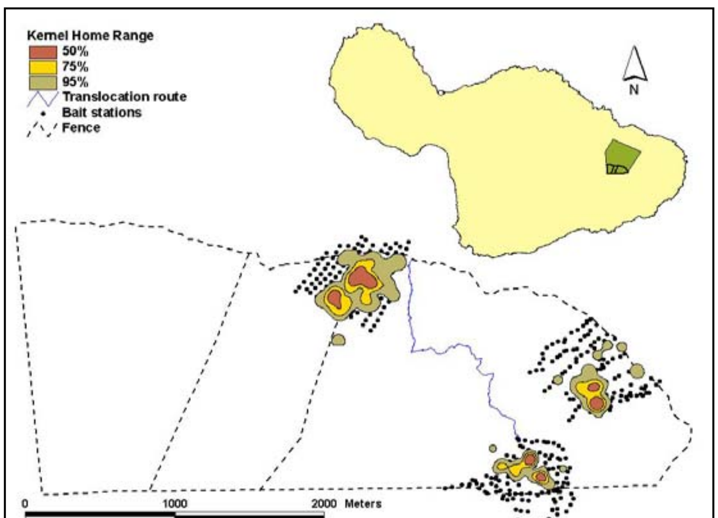

Figure 1. Location of Po`ouli home ranges in Hanawī NAR. Map by Bill Sparklin, Maui Forest Bird Recovery Project.

substrates (Mountainspring *et al.* 1990, Pratt *et al.* 1997). Prey consist mainly of native snails, adult and larval beetles, and Lepidoptera larvae (Baldwin and Casey 1983, Mountainspring *et al.* 1990, Kepler *et al.* 1996). Po`ouli often associate with mixed-species foraging flocks of other insectivorous honeycreepers, especially Maui parrotbills (*Pseudonestor xanthophrys*) and Maui `alauahio (*Paroreomyza montana*). Po`ouli are unusually quiet, and their calls closely resemble parrotbills calls. Female po`ouli have been seen interacting with and even feeding juvenile parrotbills (T. Malcolm pers. obs.).

Historically, po`ouli have been confined to a 1,300 hectare (3,200 acre) area of wet montane forest on the northern and eastern slopes of Haleakalā (Mountainspring *et al.* 1990), but fossil evidence indicates po`ouli once inhabited drier forests at lower elevation on the leeward slope of Haleakalā (James and Olson 1991). The population was estimated at 140 ± 280 (Scott *et al.* 1986), but estimates of population size and density are imprecise because of the species' low density and cryptic behavior. Numbers and range declined from 1976-1985 (Mountainspring *et al.* 1990), and surveys in 1994-1995 found six po`ouli at four locations, while surveys from 1997-2000 located only three birds (Reynolds and Snetsinger 2001). No other po`ouli have been located since these three birds were color-banded in 1997 and 1998 (Hawai`i DLNR, unpubl. data). The last three birds, thought to consist of one male and two females, occur in separate, non-overlapping home ranges between 1,500 meters (5,000 feet) and 1,950 meters (6,500 feet) elevation in Hanawī Natural Area Reserve (Figure 1). There are no known breeding pairs, and the last documented reproduction occurred in 1995 (Reynolds and Snetsinger 2001). Conservation efforts for the po`ouli have included creation of the 3,035 ha (7,500 acre) Hanawī Natural Area Reserve to provide additional protection for lands encompassing the known range; fencing of 800 ha (2000 acres) in the upper portion of Hanawī by 1996 and removal of all ungulates by 1997 (Bill Evanson, Maui DOFAW, pers. comm.); protection of adjacent forest through acquisition and protection of lands by the National Park Service and formation of the East Maui Watershed Partnership; and ground-based predator control in the home ranges of the three known birds (Malcolm *et al.* 2002). Ecological and life-history research was carried out under the direction of the USGS-Biological Resources Discipline during 1994-1996 (Baker 2001).

Primary Threats. The range of the po`ouli coincides with high population densities of other honeycreeper species, a distribution believed to be delimited by suitable habitat and disease-bearing mosquitoes prevalent at elevations below 1,500 meters (5,000 feet; Scott *et al.* 1986). Po`ouli are associated with low levels of disturbance to soil and vegetation by feral pigs, and habitat damage by feral pigs is thought to be an important cause of the decline in po`ouli numbers (Mountainspring *et al.* 1990). Other threats have not been directly linked to the po`ouli, but both black and Polynesian rats are abundant in po`ouli habitat (Malcolm *et al.* 2002), and these animals are known to prey on adults and nests of other Hawaiian forest birds and also on native land snails, which are an important food for the po`ouli (Baldwin and Casey 1983).

Recovery Strategy. Alternative strategies for recovery of the po`ouli were outlined previously in an Environmental Assessment (USFWS and Hawai`i DLNR 1999). Based on that EA and subsequent public comments, it was decided that the best strategy was continued habitat management, including predator control, in conjunction with translocation of a female into the home range of the last male, in hopes that they would form a breeding pair and nest. That translocation was successfully carried out in April of 2002, but the translocated female subsequently returned to her own home range after one day (Groombridge *et al.* 2002, 2003). Although no breeding pair was created by the translocation, the female showed signs of potential positive acclimation to captivity, reacting passively to its holding cage and readily consuming food items including a native *Succinea* snail and several waxworms (Groombridge *et al.* 2002, 2003).

With a known population of only three birds, the last documented breeding of po`ouli in 1995, and no known breeding pairs, the most urgent aspect of the recovery strategy for the po`ouli must be to facilitate pair formation and reproduction among the three known individuals (VanderWerf *et al.* 2003). The various recovery strategies for achieving this goal were revisited in June of 2002 by the Po`ouli Recovery Working Group, which consists of representatives from the USFWS, Hawai`i DOFAW, Hawai`i NARS, Hawaiian Forest Bird Recovery Team, the Zoological Society of San Diego, the Maui Forest Bird Recovery Project, and the University of Hawai`i. It was not possible to arrive at a strategy that was unanimously supported, but two options had broad support; capture of all three birds and removal to captivity, and capture of all three birds and placement in a field aviary. These strategies may be equally viable and both were considered to have advantages and disadvantages, but in November 2002 the USFWS and Hawaii DOFAW decided that removal to captivity was preferable because that option could be implemented more quickly, which is important due to the advanced ages of the birds and their unknown lifespan, and provided greater ability to ensure the safety of the birds from severe weather, predators, and vandals (VanderWerf *et al.* 2003). The ZSSD agreed subsequently with reservations to undertake care and attempt captive propagation of the po`ouli at the Maui Bird Conservation Center (ZSSD 2002). A series of trips from February-April 2003 failed to catch any of the three known birds for removal to captivity. Another series of trips is scheduled for October-December 2003.

The ultimate goal of recovery efforts is to release offspring of the remaining birds back into the wild and restore a self-sustaining wild population. It is therefore extremely important that the species' habitat continue to be protected and managed to ensure that reintroduction to the wild remains an option. Although much of the suitable habitat on east Maui has been surveyed for po`ouli (Reynolds and Snetsinger 2001), it is difficult to say with certainty that no more than three birds exist due to the rugged terrain and cryptic nature of the species. Continued habitat protection and management also may benefit any wild po`ouli that have not been located and are not part of captive propagation efforts. The scale of management should be increased through actions such as additional fencing, ungulate control, and aerial broadcast of diphacinone to control rats. Surveys for additional wild po`ouli should be undertaken in order to provide more options for recovery.

In the event of a death of a po`ouli, various tissues should be collected for cell culture and possible future cloning, and immediately sent to both the Zoological Society of San Diego Center for the Reproduction of Endangered Species and the Audubon Nature Institute Center for Research on Endangered Species.

Interim Recovery Objectives. In order to meet the long-range recovery goals for the po`ouli, the following short-term goals should be accomplished first.

- Facilitate production of at least one young po`ouli.
- Conduct large-scale rodent control at Hanawī NAR by aerial broadcast of diphacinone.
- Complete fencing of lower Hanawī NAR and adjacent areas.
- Locate any additional wild po`ouli through additional surveys.

If these objectives are met within five years, then new interim recovery objectives will be identified to continue to guide progress toward full recovery. If these objectives are not met within five years, then the causes for failure should be identified and rectified if possible. If it is not possible to correct the causes for failure and the current strategy is deemed ineffective, then a new strategy will be developed and new actions identified.

Five-year Recovery Actions (2004-2008). In order to realize the interim recovery objectives described above, the following actions are necessary:

- Facilitate production of at least one young po`ouli.
  - Safely capture remaining birds and transport them to MBCC.
  - Acclimate birds to captivity and get them to eat supplemental food.
  - Use captive breeding techniques to facilitate pair formation and breeding.
  - If reproduction does not occur in captivity after 30 months, consider moving birds to an outdoor aviary in a more natural setting. Possible sites include Waikamoi and Hanawī.
- Protect and Manage Existing Habitat.

- Maintain existing fences in Hanawī NAR, Waikamoi, and Haleakalā National Park (currently funded by NPS, USFWS, TNC, and DLNR).
- Complete fencing of lower Hanawī NAR and adjacent areas (in progress by EMWP).
- Begin public outreach about importance and benefits of controlling rodents and safety of diphacinone.
- Conduct large-scale rodent control by aerial broadcast of diphacinone in Hanawī and monitor population and individual-level responses of the avian community.

- Conduct surveys to locate additional wild po`ouli. Areas to survey include Hanawī, Haleakalā National Park, and State Forest Reserves.
- Collect indeterminate germ cells from all three birds to establish cell cultures for use in possible future cloning.

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- Visit http://www.dofaw.net/fbrp/projects.php

APPENDIX L.

`ĀKOHEKOHE FIVE-YEAR RECOVERY WORK PLAN

Prepared by `Ākohekohe Working Group and Hawaiian Forest Bird Recovery Team

Adult `Ākohekohe. Photo © Eric VanderWerf

Purpose. The long-term recovery goals, delisting criteria, recovery strategy, and a comprehensive list of recovery tasks for the `Ākohekohe are provided in the Hawaiian Forest Bird Recovery Plan, which covers 21 species (USFWS 2004). The purpose of this five-year work plan is to identify interim recovery objectives for the `Ākohekohe, and to succinctly describe the actions needed in the next five years to reach those interim objectives. Identification of interim recovery objectives and actions will help ensure that initial conservation efforts by different agencies or groups are focused on the same ultimate goals, facilitate efficient use of limited recovery resources, and provide milestones that can be used to track and evaluate progress toward recovery. Realization of these milestones will provide evidence of progress toward eventual recovery. Failure in realizing these milestones may indicate that additional resources are needed, or that the current recovery strategy is not effective.

Species Summary. The `Ākohekohe, or crested honeycreeper (*Palmeria dolei*), is a primarily nectarivorous Hawaiian honeycreeper that also feeds on caterpillars (Lepidoptera), spiders, and other arthropods (Perkins 1903, Carothers 1986, Berlin and VanGelder 1999). Nectar is primarily sought from flowers of `ōhi`a (*Metrosideros polymorpha*), but also from several subcanopy tree and shrub species (Berlin and VanGelder 1999, Berlin *et al.* 2001). Insects are taken mostly by gleaning `ōhi`a foliage, buds, and flower clusters (Berlin and VanGelder 1999). `Ākohekohe are highly aggressive and dominate resources over other nectarivorous birds (Carothers 1986).

`Ākohekohe defend relatively discrete feeding and nesting territories throughout the year by chasing and calling (VanGelder and Smith 2001, Pratt *et al.* 2001). The species appears to be monogamous for more than one breeding season, with pair formation starting in October, nesting occurring mainly between November and May, and some pairs raising two to three successful broods in a season (VanGelder and Smith 2001). They begin breeding by their second year (Simon *et. al*. 2001). `Ākohekohe nests were an average of 14 meters (46 feet) above ground in the terminal ends of branches below the canopy foliage of `ōhi`a trees (Berlin and VanGelder 1999, VanGelder and Smith 2001). The open cup nest is built by the female, who lays one to two eggs. Incubation by the female lasts 17 days, and the chicks fledge after 3 to 4 weeks. Chicks can forage independently after 10 to 14 days, or longer when the chicks are from the last brood of the season (Berlin and VanGelder 1999). Independent juveniles flock in small groups and disperse to the edge of the species' range (Scott *et al.* 1986). Weather appears to be the most important factor in nest success, which is thus highly variable from year to year (36 - 87 percent success rate) (Simon *et. al*. 2001, VanGelder and Smith 2001). Vocalizations of the `Ākohekohe include various guttural clucking gurgles, raspy croaks, buzzing sounds, and clear upslurred whistles (Perkins 1903, VanGelder 1996, Berlin and VanGelder 1999).

`Ākohekohe currently are found only in 58 square kilometers (22 square miles) of wet and mesic montane forest dominated by `ōhi`a (*Metrosideros polymorpha*) on the northeastern slope of Haleakalā Volcano in east Maui. Their elevational range has been reported to be 1,100 to 2,300 meters elevation (3,600 and 7,550 feet), but nearly all birds occur from 1,500 to 2,100 meters (5,000 to 6,600 feet), with some nonbreeding birds wandering further down slope (Conant 1981, Scott *et al.* 1986, Hawai'i Division of Forestry and Wildlife unpubl. data). `Ākohekohe occur from just west of the Waikamoi Drainage in the Nature Conservancy's Waikamoi Preserve east through the Ko`olau and Hāna Forest Reserves and around to Haleakalā National Park lands in Kīpahulu Valley and southeast of Kuiki to Manawainui Valley. The current geographic range is much restricted compared to the known historical range, which also included native wet forests of the island of Moloka`i (Perkins 1903, Banko 1987). On Moloka`I the species was not known to have survived later than 1907, and was found at 1,200 meters (4,000 feet) on the high forested plateau between Wailau and Pelekunu valleys (Bryan 1908). On Maui, the species was first collected in the 1890's on the western slopes of Kula in mesic koa (*Acacia koa*)/`ōhi`a forest, but by 1920 it was already absent due to deforestation caused by logging and cattle-ranching. `Ākohekohe now inhabit only 5 percent of the estimated historical range of 1,015 square kilometers (385 square miles) on Maui and none of the 262 square kilometers (100 square miles) on Moloka`i Island (Scott *et al.* 1986). Fossil bones found in caves at low elevation on the southwestern slopes of Haleakalā suggest the species once inhabited very different dry forest habitat at much lower elevations (James and Olson 1991).

The total number of `ākohekohe was estimated to be 3,800 ± 700 (95 percent confidence interval) birds in 1980 by the Hawai`i Forest Bird Survey (Scott *et al.* 1986). Surveys of the same transects in 1992 (Hawai'i Department of Land and Natural Resources 1995) and limited surveys 1995 to 1997 by U.S. Geological Survey biologists indicated approximately the same densities of birds within the same range. `Ākohekohe adults show high site tenacity, which may be expected from a behaviorally dominant nectivore (Pratt *et. al.* 2001). In addition, adult survivorship in Hanawi over a three year period was high (95%; Simon *et .al.* 2001).

Primary Threats. `Ākohekohe are restricted to higher elevation forests due to the presence of mosquito-borne diseases at lower elevations, and are restricted at upper elevations in some areas by destruction of forest habitat. `Ākohekohe may be particularly vulnerable to mosquito-borne diseases because they migrate altitudinally in response to varying `ohi`a flowering phenology, potentially increasing their exposure to mosquitoes at lower elevations. Avian malaria was recently isolated from an `ākohekohe in Hanawī Natural Area Reserve (Feldman *et al.* 1995). Laboratory challenge experiments have shown that the `i`iwi (*Vestiaria coccinea*), which is closely related to the `ākohekohe but is more common and has a wider distribution, is extremely vulnerable to avian malaria, with 90 percent of experimental birds dying after being bitten by infected mosquitoes (Atkinson *et al.* 1995). Black and Polynesian rats are serious predators on adults and nests of Hawaiian forest birds and are abundant in `Ākohekohe habitat (Sugihara 1997, Malcolm *et al.* 2002), and Simon *et al.* (2001) found rat predation on an `Ākohekohe adult and egg, as evidenced by rat droppings and bird remains in the nest. The remains of an `Ākohekohe were found in a Barn Owl pellet from Hanawi, and feral cat scats also contained remains of other native forest birds (Kowalsky *et al.* 2002). Damage by feral pigs to understory vegetation may deplete nectar resources needed during times of year when `ōhi`a bloom is less available.

Conservation Efforts. Conservation efforts for the `Ākohekohe have included creation of the 3,035 ha (7,500 acre) Hanawi Natural Area Reserve in 1986; fencing of 800 ha (2000 acres) in the upper portion of Hanawi by 1996 and removal of all ungulates by 1997 (Bill Evanson, Maui DOFAW, pers. comm.); protection of adjacent forest through acquisition and management of lands by the National Park Service and formation of the East Maui Watershed Partnership (DLNR 1996). Ecological and life history research has been conducted since 1992 (Simon *et al.* 1998, 2001; Berlin *et al.* 2001; Pratt *et al.* 2001; VanGelder and Smith 2001).

Recovery Strategy. The recovery strategy for the 'Ākohekohe is to protect habitat within the entire current range, increase the amount of suitable habitat and establish a second viable population, and to better understand threats to the species in order to optimize management methods. The tools available for this work are fencing and ungulate control, predator control using broad-scale methods, population research, and translocations. Captive propagation and reintroduction are also an option, but initial attempts at getting birds to breed in captivity were unsuccessful due to the aggressive nature of this species (ZSSD 2001).

Interim Recovery Objectives. In order to meet the long-range recovery goals for the 'Ākohekohe the following short-term goals should be accomplished first.

- Maintain the existing population, which appears to be stable.
- Increase the size and distribution of the existing population, particularly in leeward east Maui.
- Determine habitat suitability and disease status of West Maui and Molokai for establishment of a second population.

If these objectives are met within five years, then new interim recovery objectives will be identified to continue to guide progress toward full recovery. If these objectives are not met within five years, then the causes for failure should be identified and rectified if possible. If it is not possible to correct the causes for failure and the current strategy is deemed ineffective, then a new strategy will be developed and new actions identified.

Five-year Recovery Actions (2003-2007). In order to realize the interim recovery objectives described above, the following actions are needed.

- Protect Existing Habitat.
    - Maintain existing fences in Hanawi NAR, Waikamoi, and Haleakalā National Park (NPS, FWS, TNC, and DOFAW).
    - Complete fencing of lower Hanawi NAR (EMWP).
    - Begin public outreach about importance and benefits of controlling rodents and safety of diphacinone (FWS/DOFAW).
    - Conduct large-scale rodent control by aerial broadcast of diphacinone in at least one site and monitor population and individual-level responses. Possible sites include Hanawi and Kipahulu.
- Continue research to document distribution, threats, and management needs.
    - Complete population trend and distribution analysis and habitat suitability modeling (Interagency Database Project, BRD, FWS, NPS, DOFAW).
    - Document distribution in the Waikamoi and Manawainui areas (MFBRP, FWS, DOFAW, NPS).
    - Further document effects of ungulate removal and predator control on demography in Hanawi NAR (MFBRP, FWS, DOFAW).
    - Investigate disease prevalence and dispersal and altitudinal migration as a mechanism of exposure to mosquito borne disease.
- Investigate/Improve Habitat Suitability in West Maui, leeward East Maui and Moloka`i.
    - Follow-up on `I`iwi translocation to West Maui if possible, including survival and dispersal.
    - Continue fencing and removal of ungulates from potentially suitable habitat on West Maui, leeward East Maui, and Moloka`i (TNCH, Maui Land and Pine, Hawaii DLNR, NPS).
    - Monitor mosquito abundance, disease prevalence, and `ohi`a flowering phenology to determine readiness for translocation.
    - Support the formation of a Leeward Maui Watershed Partnership and local habitat restoration efforts.

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