

DISTRIBUTION AND ABUNDANCE OF
HAWAII'S ENDEMIC LAND BIRDS:
CONSERVATION AND MANAGEMENT STRATEGIES

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ABSTRACT

Hawaiian forest birds are currently limited in habitat, diversity, range, and numbers by numerous past and present stresses. The 6-year U.S. Fish and Wildlife Service Hawaii Forest Bird Survey has provided information on status, distribution, habitat relationships, and many limiting factors. These are summarized for Hawaiian birds in this paper. In order to restore and maintain viable populations of Hawai'i's native birds, application of one or more of 6 management actions is necessary, depending on the seriousness or immediacy of the threat to the species or group of species. The actions are as follows: 1) Legal protection of natural habitats; 2) Elimination of introduced plants and animals in native habitats; 3) Physical restoration of native habitats through reforestation; 4) Intensive manipulation of birds in natural habitats; 5) Translocation of endangered species; 6) Captive propagation. Specific management recommendations are made for a number of areas in Hawai'i. Cooperation with private landowners is emphasized.

INTRODUCTION

The native Hawaiian birds have suffered catastrophic losses since man arrived about 400 A.D. (Kirch 1982). Recent fossil evidence suggests that only 25% of the original taxa still survive (S.L. Olson, pers. comm.). A minimum of 40 species was lost in a first extinction wave induced by Polynesian man and his commensals. These losses were the result of widespread habitat destruction at elevations below 1,000 m (Kirch 1982), predation by introduced dogs and rats, and killing for food (Stone, this volume).

A second extinction wave began with the arrival of western man in 1778 and has continued unabated as newly introduced cattle (Bos taurus), goats (Capra hircus),

and sheep (Ovis aries) placed added pressure on native forests. Many birds were lost in the 19th and early 20th century as mid-elevation mesic forests were converted to agricultural lands, and as introduced diseases and rats (Rattus rattus) spread into native forests (Atkinson 1977; Berger 1981). Introduced species acted as competitors (Mountainspring and Scott, in press), reservoirs for disease (Warner 1968; van Riper et al., in press; van Riper and van Riper, this volume), predators (Atkinson 1977), and severe modifiers of native habitats (Scott et al. 1984; Scott et al., in press; Warshauer et al. 1983). The effects of introduced species have continued into the late 20th century. These stresses, combined with direct habitat destruction by man and his commensals (Scott et al., in press), continue to place pressure on native birds, particularly those now restricted to ranges representing mere fractions of their former distributional areas. The history of the native Hawaiian avifauna has been and continues to be one of loss of diversity, numbers, and habitat.

Imagine a species that was found from the dry coastal woodlands to the dry subalpine shrublands at 3,000 m on Mauna Kea, and which reached its greatest numbers in the mid-elevation mesic forests. Its range was severely truncated with the loss of lowland habitat up to about 1,000 m as the result of Polynesian agricultural practices (Kirch 1982). Ungulates introduced by Captain Cook and others further degraded the remaining dry habitats and initiated the process in the middle and upper elevation moist and wet forests beginning in the early 19th century. The dramatic increase in predators in the 1800's and 1900's (Atkinson 1977) and the introduction of avian diseases during this same period resulted in further losses. The greatest impact of diseases was on birds restricted to elevations below 1,000 m (Warner 1968; van Riper et al., in press). In the 20th century further exploitation continued in the upland forests: the moist koa (Acacia koa)-'ohi'a (Metrosideros polymorpha) forests on Maui and Hawai'i, subjected to logging and cattle grazing, disappeared in many areas. Wet 'ohi'a forests were denuded by an expanding feral pig (Sus scrofa) population. Avian malaria may have been introduced for the first time in the 1930's (van Riper et al., in press), resulting in further declines in numbers of individuals. The end result, then, is a severely diminished range occupied with but a fraction of the pre-Polynesian population.

This scenario has been repeated over and over again. Many species have been lost, and those that remain occupy but a very small percentage of their original ranges. In some cases these are relict in the extreme. The po'ouli (Melamprosops phaeosoma), large

Kaua'i thrush (Phaeornis obscurus myadestina), and palila (Loxioides bailleui) occupy less than 10% of their historical ranges (Scott et al., in press). Work by 20th century ornithologists indicates that reduction in ranges and decreases in population sizes are continuing. The forest birds on Kaua'i and Moloka'i are perhaps the best examples that we have of this ongoing extinction process (Sincock et al. 1984; Scott et al., in press). However, additional examples can be found on Hawai'i. The 'akepa (Loxops coccineus coccineus) and Hawai'i creeper (Oreomystis mana) have disappeared from Hawai'i Volcanoes National Park, and the 'o'u (Psittirostra psittacea) has declined too. All this has occurred in the last 50 years.

Although there were many questions concerning distribution, abundance, and limiting factors of Hawai'i's birds in 1974, 30 Hawaiian birds were listed as endangered or threatened (U.S. Fish and Wildlife Service 1983). Public and private conservation agencies were justifiably reluctant to commit to major recovery efforts without solid information on where birds were found or what was responsible for their low numbers. During the 10 years that have elapsed, much new information has been obtained. Intensive studies were undertaken on the Hawaiian goose, Nesochen sandvicensis (Banko and Manuwal 1982), palila (van Riper 1978; van Riper, Scott, and Woodside 1978; Scott et al. 1984), Hawaiian hawk, Buteo solitarius (C. Griffin, unpubl. data), and Hawaiian crow, Corvus hawaiiensis (S.L. Temple, unpubl. data). Exhaustive surveys of Hawai'i, Maui, Moloka'i, Lana'i, Kaua'i, and parts of O'ahu were conducted (Scott et al., in press); Shallenberger and Vaughn 1978); a major effort to understand the role of disease was completed (van Riper et al., in press); and an extensive review of the literature (Banko 1980-1983) was conducted.

The status, distribution, habitat relationships, and many limiting factors for most of Hawai'i's native forest birds were extensively documented during the 6-year U.S. Fish and Wildlife Service (FWS) Hawaii Forest Bird Survey (HFBS) (Scott et al. 1984; Scott et al., in press). The HFBS data base, combined with those of the U.S. Forest Service (USFS), U.S. National Park Service (NPS), and others can be used to review the status and legal standing of a species, prioritize conservation efforts, and make management recommendations. Based on this documentation, specific management actions have been proposed for many species (Berger et al. 1977; Burr et al. 1982; Scott et al. 1983; Sincock et al. 1984; Kepler et al. 1984). If the proposed actions are implemented, the long-term survival chances of many endangered Hawaiian birds should be enhanced.

We are fully aware that the various stresses faced by avian species will cause the status of each to fluctuate, and that the continual influx of alien species of plants and animals introduces additional challenges to the long-term survival chances of native organisms (Smith, this volume; Howarth, this volume; Stone, this volume). With this in mind, we offer the following review of the status of native Hawaiian land birds.

SPECIES ACCOUNTS

Hawaiian Goose (*Nesochen sandvicensis*)

The Hawaiian goose, or nene, probably numbered fewer than 30 birds in 1951 (Smith 1952). A State and federally funded captive propagation effort was initiated in 1949. Two decades later the nene appeared to be recovering (Kear and Berger 1980; Stone et al. 1983). Recent surveys (Devick 1981a, 1981b), however, indicate that the population cannot be sustained without a release program. Possible explanations for the decline have been reviewed (Stone et al. 1983) and include predation and inadequate food. It has been suggested that the best and largest breeding areas of the nene formerly occurred in the lowlands, and that the upland parts of its range were marginal for breeding and rearing young (Henshaw 1902; Perkins 1903). It has been further suggested that habitat alteration and high predator densities have left the formerly suitable lowland areas incapable of supporting a self-sustaining nene population (Stone et al. 1983). Ongoing research is attempting to more precisely determine those factors that limit natural reproduction. For the present, the chances of survival of this species are secure through captive propagation. It remains to be determined if a wild population can be maintained without man's assistance.

Hawaiian Hawk (*Buteo solitarius*)

This species is resident only on Hawai'i. It is unique among Hawai'i's forest birds in that it is still found throughout almost all of its historical range (Scott et al., in press). It occurs in alien as well as native forests, feeding extensively on introduced vertebrates, and has no apparent reproductive problems (C. Griffin, unpubl. data). Although no population estimates are available, densities, distribution, and reproduction clearly indicate a healthy population in no danger of extinction. Observers should, however, continue to be aware of the threats posed by pesticides and especially herbicide applications.

Hawaiian Rail (*Porzana sandwichensis*)

This species is definitely known only from Hawai'i, although fossil evidence suggests that closely related flightless rails were found on the other large

islands in historical times (Olson and James 1982). It was last seen on Hawai'i about 1884 (Berger 1981) and is considered extinct (Scott et al., in press).

Short-eared Owl (*Asio flammeus sandwichensis*)

Studies show well-established populations on all the main islands (Berger 1981). We know, however, almost nothing about reproduction and survival of this subspecies. The periodic but unexplained "die-offs" among the introduced common barn owl (*Tyto alba*) have not been recorded for short-eared owls (L. Pank, pers. comm.). Although Scott et al. (in press) found it in a wide variety of habitats on Hawai'i, Maui, Moloka'i, Lana'i, and Kaua'i, no attempts were made to estimate population sizes. Short-eared owls are less frequently seen on Hawai'i than the endangered Hawaiian hawk, probably because of behavioral differences.

Hawaiian Crow (*Corvus hawaiiensis*)

This is one of the rarest of the endemic Hawaiian species. Its population was estimated at 76 in 1978 (Scott et al., in press). Since that time it is known to have declined (Giffin 1983; J.G. Giffin, unpubl. data). The historical status of the crow was recently reviewed (Banko and Banko 1980; Scott et al., in press). Avian malaria has been found in captive and wild Hawaiian crows and is suspected to be a significant limiting factor (C. van Riper, pers. comm.).

The leeward forests of Kona where the crow is found are steadily declining in quality as crow habitat because of logging, grazing, and urban development. This development brings with it increased disturbance at nest sites and increased loss of birds through incidental shooting. Recent studies have indicated that the best remaining habitat is undisturbed koa-'ohi'a forest (J.G. Giffin, unpubl. data). While parts of State Conservation Districts in Kona are zoned "Preserve", "No prime habitat, no alala nest and only 1% of high grade secondary habitat fell within this subzone" (J.G. Giffin, unpubl. data). Recent logging operations in what is considered to be the center of the crow's range further threaten the long-term survival chances for this species. State and Federal biologists have embarked upon a conservation program (Burr et al. 1982).

'Elepaio (*Chasiempis sandwichensis*)

This species is widespread and abundant on Hawai'i (200,000 birds) and Kaua'i (63,000) and uncommon on O'ahu. Two subspecies of 'elepaio on Hawai'i (*C. s. ridgwayi* and *C. s. sandwichensis*) appear to be healthy (Scott et al., in press). A third subspecies that was recently described, *C. sandwichensis bryani* (Pratt 1980), is found only in mamane (*Sophora chrysophylla*)

and naio (Myoporum sandwicense) forest on Mauna Kea, where it occupies 70% of the range of the palila. The population size of C. sandwichensis bryani, 2,500, is similar to that of the endangered palila. The quality of mamane forest within 'elepaio range has improved with the recent removal of most of the feral sheep and goats (Scott et al. 1984). However, continued browsing and grazing by mouflon sheep (Ovis musimon), which are expanding their range, threaten to reverse the trend toward habitat improvement (Scowcroft and Giffin 1983; Giffin 1982; Scowcroft and Sakai 1983).

The occurrence of 'elepaio in the lowlands on windward Hawai'i, O'ahu, and Kaua'i suggests that this species may have evolved some resistance to diseases that are thought to limit the range and numbers of other Hawaiian species.

Hawaiian Thrush (Phaeornis obscurus)

Five subspecies of this bird are known from the Islands (Berger 1981). Although the subspecies on Hawai'i (P. o. obscurus) seems most secure, with a population estimated at 160,000 birds (Scott et al., in press), puzzling gaps in its distribution exist. It is almost totally absent from the leeward forests, and was extirpated from the windward forests of Kohala Mountain years ago (van Riper and Scott 1979; van Riper 1982; Scott et al., in press). On the bright side, high numbers have been recorded below 1,500 m in parts of the windward forests of the Puna and Hamakua coasts (Scott et al., in press). High numbers at lower elevations suggest that, as with the 'elepaio, some resistance to avian malaria and/or pox may be developing in those populations.

Intensive surveys in the late 1970's failed to locate any Hawaiian thrushes on Maui (Scott et al., in press). Recently found subfossil remains indicate that it commonly occurred there within the last 1,000 years (S.L. Olson, pers. comm.).

The Moloka'i subspecies (P. o. rutha) is extremely rare. Two individuals were observed in 1975 (Scott, Woodside, and Casey 1977). Estimates based on a recent survey indicate a population of 19 birds (Scott et al., in press). Acquisition and management of the 28 km² Kamakou Preserve by The Nature Conservancy increases the chances of long-term survival of prime habitat on Moloka'i. We are not, however, optimistic that such a small population, subjected to avian malaria and pox, can long survive.

The Kaua'i subspecies (P. o. myadestina) has declined steadily since the turn of the century (Sincock et al. 1984). Intensive coverage of its range

resulted in a population estimate of 24 birds in 1981, down from 200 in 1968-75. This decline has occurred despite legal protection of its entire range and no obvious changes in habitat quality. Although a few birds may remain in areas outside those surveyed during the HFBS, chances for the long-term survival of a naturally reproducing population of P. o. myadestina seem bleak.

Small Kaua'i Thrush (*Phaeornis palmeri*)

The population of the small Kaua'i thrush from 1968-1973 was estimated at 100 in the heart of its range (Sincock et al. 1984). More recent surveys indicate a population of only 20 (Scott et al., in press). Two recently discovered nests have both resulted in young birds fledging (Kepler and Kepler 1983; Ashman, Pyle, and Jeffrey 1984). As with the Hawaiian thrush, a few birds may occur outside recently surveyed areas. However, the numbers and distribution of this species clearly indicate a population which is precariously small and declining (Scott et al., in press).

Kaua'i 'O'o (*Moho braccatus*)

Once common throughout Kaua'i, this species has undergone a steady decline since its rediscovery in 1960 (Richardson and Bowles 1964). Despite intensive searches, no indications of breeding activity have been noted since 1981 (J.L. Sincock, pers. comm.). Searches in the spring of 1983 and again in the fall of 1984 resulted in the observation of only one bird (presumably a male) in the Alaka'i Swamp (J.L. Sincock, pers. comm.). Unless heretofore unsuspected numbers of this species are found, it may be beyond the point where even a captive propagation effort could save it.

O'ahu 'O'o (*Moho apicalis*)

This species was found only on O'ahu and has not been reported in more than a century (Berger 1981). It is considered to be extinct.

Bishop's 'O'o (*Moho bishopi*)

Despite intensive searches this species has not been recorded from Moloka'i since 1904 (Munro 1944; Pratt 1974; Scott, Woodside, and Casey 1977). The most recent searches in 1979 and 1980 failed to find it even on the remote Oloku'i Plateau (Scott et al., in press).

An unidentified black bird putatively regarded as Bishop's 'o'u has been reported from Maui (Sabo 1982). It remains to be determined if this represents a relict population of M. bishopi, some previously undescribed species, or a misidentified bird.

Hawai'i 'O'o (*Moho nobilis*)

There are no recent records for this species. It was not located during the HFBS (1976-1979), nor were

any unidentified black birds reported during that survey (Scott et al., in press). "Black bird" sightings have been reported from Hawai'i, but none have the documentation needed to determine what species they represent (Banko and Banko 1980). If M. nobilis still exists on Hawai'i, the population must be small indeed (Scott et al., in press).

Kioea (*Chaetophila angustipluma*)

There are no records for kioea since the 19th century. It is widely considered to be extinct (Scott et al., in press).

'O'u (*Psittirostra psittacea*)

This species has become rarer in recent years on both Hawai'i and Kaua'i, the only 2 islands where it still occurs (Berger 1981). This is the only endangered passerine still found in Hawai'i Volcanoes National Park. The population on Hawai'i has been estimated to be 300 (Scott et al., in press). During the HFBS it was determined to be absent from many forests on Hawai'i where it was abundant at the turn of the century (Scott et al., in press). The low numbers and recent withdrawal from forests occupied in the 1940's and 50's (Richards and Baldwin 1953) do not bode well for its long-term survival. As with other Hawaiian species, avian malaria is thought to have played a major role in its decline. However, its low numbers and restricted distribution cannot be attributed to a single cause (Atkinson 1977; Scott et al., in press).

The Kaua'i population was estimated to be less than 10 birds in 1981 (Scott et al., in press), although this estimate may be low. There have been few recent records of 'o'u on Kaua'i. Like Kaua'i's other endangered forest birds, the 'o'u occurs in precariously low numbers.

Palila (*Loxioides bailleui*)

The palila is perhaps the best studied of the endangered Hawaiian passerines (van Riper 1978, 1980; van Riper, Scott, and Woodside 1978; Scott et al. 1984). The numbers of this species have varied from 1,600-6,400 birds since the first count in 1975. A major threat to its habitat was removed when most feral sheep were taken off Mauna Kea in 1982. Mouflon sheep pose an equally serious threat (Giffin 1983) and must be removed if the integrity of the palila's habitat is to be maintained. Introduced plants (particularly fountain grass *Pennisetum setaceum* and German ivy *Senecio mikanoides*) threaten to seriously modify the montane habitat of this species and increase the threat of fire (Berger et al. 1977; Scott et al. 1984).

Lesser Koa-finch (*Rhodacanthis flaviceps*)

One of the 6 large finch-billed species extant on the main islands when Cook discovered Hawai'i in 1778, the lesser koa-finch was known only from the koa forests of the upper leeward slopes of Mauna Loa (Munro 1944). There are no records of this species since Munro and Palmer collected their specimens in 1891, and it is undoubtedly extinct (Berger 1981; Scott et al., in press).

Greater Koa-finch (*Rhodacanthis palmeri*)

The largest of the historically known Hawaiian honeycreepers, the greater koa-finch sometimes flocked with the lesser koa-finch, and like the lesser fed extensively on the seeds of the koa tree as well as on other seeds and lepidopteran larvae (Perkins 1903).

Munro (1944) reported 2 unverified records of greater koa-finches that had been heard but not seen, one as late as 1937. We know of no other recent records and there appears to be little chance that this species survives on Hawai'i (Scott et al., in press).

Kona Grosbeak (*Chloridops kona*)

The Kona grosbeak, also known as the grosbeak finch, fed almost exclusively on hard naio seeds which its powerful jaws were well adapted to crack (Perkins 1903). This species has not been reported since the 1890's (Munro 1944), and it is doubtful that it still exists (Scott et al., in press).

Maui Parrotbill (*Pseudonestor xanthophrys*)

Maui parrotbills are found only in Maui's upper elevation forests, where they have been seen by almost every observer to visit their restricted range since this species was rediscovered in 1967 (Banko 1968; Scott and Sincov 1977). Subfossil remains have been found below 500 m on Maui and Moloka'i (S.L. Olson, pers. comm.). The species was widespread in prehistoric times; its present distribution is a small fraction of its former range. In the past its optimum habitat may well have been koa forests, most of which have been destroyed or severely degraded. Reforestation of upper montane koa-'ohi'a forest remnants would greatly enhance the survival chances of this species. The 1980 parrotbill population was estimated at 500 (Scott et al., in press). Almost the entire range of this species enjoys some form of legal protection. The principal threats are a severely truncated range at lower elevations, probably due to the occurrence of avian malaria, and the degradation of habitat by pigs, goats, and cattle. The browsing, grazing, and rooting activities of these animals are destroying native plants and accelerating erosion on the steep slopes of windward Haleakala.

Common 'Amakihi (*Hemignathus virens*)

This species is widespread and common on Maui, Hawai'i, and Kaua'i. It is rarer and its distribution more restricted on O'ahu and Moloka'i. It was last seen on Lana'i in 1977 (Hirai 1978) and is now believed to be extremely rare or extinct on that island. The population on Maui was recently estimated at 47,000, of which 3,000 were found on West Maui (Scott et al., in press). Lower densities were found in the drier forests on Maui than on Hawai'i.

On Hawai'i, where it is numerous, common 'amakihi are found as low as 300 m. In contrast to the situation on Maui, higher densities were found in drier forests at both high and low elevations. The population was estimated at 870,000 birds for the entire Island (Scott et al., in press).

The Moloka'i population of common 'amakihi has been estimated to be 1,800 birds. Interestingly, it is rare in the upper elevation native forests and common in the mixed native-exotic mesic forests below 1,000 m in the windward valleys (Scott, Woodside, and Casey 1977; Scott et al., in press). This is suggestive of a population resistant to whatever factors have eliminated native birds in extant lowland forests.

O'ahu has not been systematically surveyed like the other main islands. However, recent observations indicate that the common 'amakihi, while still uncommon there, is repopulating lowland areas (R.J. Shallenberger, pers. comm.).

Common 'amakihi, thought to number 2,300 in the Alaka'i Swamp in 1981 (Scott et al., in press), may have increased since the late 1960's (J.L. Sincock, unpubl. data). Common 'amakihi are very common in the koa and 'ohi'a forests of the Koke'e region, where they appear to thrive on the nectar of the introduced banana poka (*Passiflora mollissima*). The densities on Kaua'i were lower than those observed on either Maui or Hawai'i (Scott et al., in press).

'Anianiau (*Hemignathus parvus*)

This species is found only on Kaua'i, where it is widespread and common in the upper-elevation forests and, at least in the Alaka'i Swamp, appears to have not changed in abundance since the 1960's (Richardson and Bowles 1964; Scott et al., in press). 'Anianiau populations were estimated to be 5,500 in 1968-75 (J.L. Sincock, pers. comm.) and 6,000 in 1981. The entire Island population was estimated at 24,000 birds in the 1960's. This species appears to be in no danger of extinction.

Greater 'Amakihi (*Hemignathus sagittirostris*)

The greater 'amakihi was not observed during the intensive HFBS. It was last recorded in 1901 and is generally considered to be extinct (Berger 1981; Scott et al., in press).

Hawaiian 'Akialoa (*Hemignathus obscurus*)

This species was known from the islands of Hawaii, Lana'i, and O'ahu. There are no recent records (Berger 1981). It was not found during the HFBS, and is probably extinct (Scott et al., in press).

Kaua'i 'Akialoa (*Hemignathus procerus*)

Rediscovered in 1960, the Kaua'i 'akialoa was considered rare at that time (Richardson and Bowles 1964). It was last reported in 1965 (Huber 1966), and was not seen by J.L. Sincok in his intensive searches of the forest, nor found by the observers during the 1981 HFBS (Scott et al., in press). The lack of sightings, as well as the failure of numerous other professional ornithologists to locate the bird during their visits to the Alaka'i Swamp (Sincok et al. 1984), suggest that this species must be rare if not extinct (Scott et al., in press).

Nukupu'u (*Hemignathus lucidus*)

This species has been found on Maui, O'ahu, and Kaua'i. It is considered extinct on O'ahu and is extremely rare on Kaua'i and Maui. J.L. Sincok saw only 2 birds during his 15 years of field work on Kaua'i. It was not found on Kaua'i during the 1981 HFBS. The Maui subspecies is very rare and has been reported less than 10 times since its rediscovery in 1967 (Banko 1968; Berger 1981). The population was estimated at 30 birds in 1980 (Scott et al., in press).

'Akiapola'au (*Hemignathus munroi*)

The 'akiapola'au is found only on the island of Hawaii, where it was formerly widespread and abundant. It is now absent from lower elevation forests, is no longer found in the Kohala mountains, and is extremely rare in leeward forests. The present population has been estimated at 1,500 birds (Scott et al., in press). It is most frequently found in koa-'ohi'a forests where it is threatened by land-clearing as well as grazing and browsing by domestic cattle. The long-term chances of survival for this species and the syntopic 'akepa and Hawaii'i creeper would be increased significantly by reforestation of high elevation pasturelands as well as protection and management of extant upland forests.

Kaua'i Creeper (*Oreomystis bairdi*)

This species was abundant in and near the Alaka'i Swamp in the 1960's (Richardson and Bowles 1964). The

most recent survey of the Alaka'i Swamp, by HFBS 1981, indicated a population of 1,600 birds, which is not statistically different from the 2,300 birds estimated for this same area by J.L. Sincok (Scott et al., in press). During the HFBS we found the Kaua'i creeper rarer than both the common 'amakihi and the 'anianiau, whereas previously it was 2-3 times more common than these species. The Kaua'i creeper appears to be undergoing a decline in numbers and range even in the relatively undisturbed Alaka'i (Scott et al., in press).

Hawai'i Creeper (*Oreomystis mana*)

The status of this species has been clouded in the past by the inability of observers to accurately identify it (Scott, Conant, and Pratt 1979). Nevertheless, it is clear that the numbers and range of the Hawai'i creeper were reduced in the late 1930's and 1940's (Dunmire 1961). Today 98% of the 12,000 Hawai'i creepers estimated on Hawai'i are found in the Island's windward and Ka'u forests (Scott et al., in press). The biggest threats to the species' long-term survival are disease, logging, grazing, and urban development. Badly needed is the establishment and management of preserves in the upper montane koa-'ohi'a forests in which this and other endangered forest bird species are found, and reforestation of former 'ohi'a-koa forest now in pasture.

Maui Creeper (*Paroreomyza montana*)

This once-common species is no longer found on Lana'i (Munro 1944; Berger 1981), and was last reported in West Maui by Perkins (1903). In 1980 the population was estimated at 35,000 birds. Although it has a relatively large and dense population and has colonized in a forest of introduced species (Polipoli) over 15 km from the edge of its primary range, it has a sharply defined lower elevational limit at about 1,500 m over most of its range. In essence its large population masks a distribution similar to that of the crested honeycreeper and Maui parrotbill, suggesting that it is sensitive to the same constellation of stresses that has reduced populations of these endangered species.

Moloka'i Creeper (*Paroreomyza flammea*)

Despite intensive searches (Richardson 1949; Pratt 1974; Scott, Woodside, and Casey 1977; Scott et al., in press), this species has not been observed since the early 1960's (Pekelo 1963a, 1963b). Recent establishment of a Nature Conservancy preserve where this species was last recorded may enhance its chances of survival if it is still extant.

O'ahu Creeper (*Paroreomyza maculata*)

This species is considered to be rare on O'ahu (Shallenberger and Vaughn 1978; Berger 1981). As with

the Hawai'i creeper, accuracy of field records has been a problem (Shallenberger and Pratt 1978), and its true status is not clear.

'Akepa (*Loxops coccineus*)

Originally, the 'akepa was known to occur on Hawai'i, Maui, O'ahu, and Kaua'i. It is considered extinct on O'ahu, although a bird recently reported with "all the markings of a female 'akepa" (Shallenberger and Vaughn 1978) may be indicative that it still exists there in very small numbers.

The Hawai'i population of this species has been estimated at 14,000, with 95% of these birds occurring in the windward forests of that island (Scott et al., in press). It has not been found in the Kohala mountains since the turn of the century (Berger 1981; van Riper 1982; Scott et al., in press). There have been few sightings in the last 40 years (Richards and Baldwin 1953; Casey 1973; Scott and Sincok 1977).

It has been estimated that fewer than 230 'akepa remain on Maui (Scott et al., in press), where the species has a fragmented distribution. As with the other rare species on Maui, the biggest threats to survival are avian diseases and habitat deterioration as the result of grazing and browsing by pigs and goats (Scott et al., in press).

The Kaua'i subspecies of 'akepa was estimated to number 1,700 birds in the Alaka'i Swamp in 1981 (Scott et al., in press). This is greater than the 600 birds estimated by Sincok for this same area during the period 1968-73. In addition, the 'akepa occurs in koa-'ohi'a forests adjacent to the Alaka'i Swamp, although a past estimate of population size indicated that 86% of the population occurs in the Alaka'i Swamp (J.L. Sincok, unpubl. data).

'Ula-'ai-hawane (*Ciridops anna*)

This species has not been observed since 1892 (Perkins 1903) and is widely considered to be extinct (Berger 1981; Scott et al., in press).

'I'iwi (*Vestiaria coccinea*)

This species was formerly abundant on all the main islands. It is now thought to be extinct on Lana'i (Hirai 1978), very rare on O'ahu (Shallenberger and Vaughn 1978), and to have a population of less than 100 birds on Moloka'i (Scott et al., in press).

The population of 'i'iwi on the island of Hawai'i was estimated at 340,000 birds (Scott et al., in press). It occurs in a wide variety of native forest types there but is very rare at lower elevations. This

may be indicative of its susceptibility to avian diseases (van Riper et al., in press; Scott et al., in press). On Maui the 'i'iwi population was estimated at 19,000 birds in 1980, with 94% of these birds on East Maui. A localized population on West Maui has persisted within the same small area for many years (Scott et al., in press), suggesting a resident population.

In Kaua'i's Alaka'i Swamp the 'i'iwi population was estimated to be 5,000 in 1981. This is not statistically different from the 8,000 estimated for this same area by J.L. Sincock in 1968-75 (Scott et al., in press). 'I'iwi are commonly found in mixed native-exotic forests in the Koke'e region, where they feed extensively on the nectar of banana poka. Sincock has estimated that 70% of the population was found outside the Alaka'i during his studies.

Hawai'i Mamo (*Drepanis pacifica*)

This species has not been seen since 1898, and is considered to be extinct (Berger 1981; Scott et al., in press).

Black Mamo (*Drepanis funerea*)

The black mamo has not been reported since 1907 (Bryan 1908) despite extensive searches (Munro 1944; Richardson 1949; Pratt 1974; Scott, Woodside, and Casey 1977) and is considered to be extinct (Scott et al., in press).

Crested Honeycreeper (*Palmeria dolei*)

Although this species is extinct on Moloka'i and West Maui, a population of about 3,800 birds still resides in the upper elevation rain forests of windward Haleakala (Scott et al., in press). Although the crested honeycreeper is much more common than previously thought (Greenway 1958), it still faces problems. It occupies a relict range stressed by feral goats and pigs, and its range is abruptly truncated at lower elevations, suggesting that it is susceptible to introduced diseases. The establishment of The Nature Conservancy's Waikamoi Preserve should improve the long-term chances of survival for this species. The population will continue to be stressed until major portions of its essential habitat on State-owned land, east of the Preserve, are managed.

'Apapane (*Himatione sanguinea*)

The 'apapane was formerly abundant and widespread on all the main islands (Berger 1981). It remains abundant on Hawai'i and Maui, with 1 million and 110,000 birds, respectively (Scott et al., in press). There are about 39,000 'apapane on Moloka'i and 500 on Lana'i.

The Alaka'i Swamp population of 'apapane was estimated at 30,000 birds in 1981 (Scott et al., in press). This compares favorably with the 43,000 estimated for this same area in the late 1960's (J.L. Sincock, pers. comm.). The entire population of the Island was estimated at 163,000 in 1968-75 (J.L. Sincock, unpubl. data). Not only do 'apapane still occur in large numbers on most islands, but their occurrence down to 200 m elevation in some areas suggests that they are disease-resistant and gives occasion for optimism for this colorful member of an otherwise beleaguered group.

Po'ouli (*Melamprosops phaeosoma*)

This recently discovered species is known only from the island of Maui (Casey and Jacobi 1974). A population of about 140 birds is restricted to an area of less than 2,000 ha in the upper-elevation 'ohi'a forest of windward Maui (Scott et al., in press). The po'ouli's very restricted distribution is but a fraction of its probable range prior to man's arrival (Olson and James 1982; Scott et al., in press), and it is severely stressed by feral pigs. Its survival into the 21st century may well depend upon the reduction or elimination of pigs within its highly relictual range.

CONSERVATION STATUS

Much effort has gone into preparing recovery plans for the birds of Hawai'i. Plans exist for all forest bird species on the islands of Hawai'i, Kaua'i, Maui, and Moloka'i. No plan exists for the O'ahu creeper or O'ahu 'akepa (table 1). Whereas many of the actions called for in those plans have been implemented, much remains to be accomplished. However, we believe that too often in Hawai'i, as elsewhere, we think only of what we have failed to accomplish rather than what we have done. We can point with pride to success stories by State agencies (e.g. removal of feral sheep and goats from Mauna Kea, establishment of Natural Area Reserves); private groups (establishment of 3 forest bird preserves and one seabird preserve); and Federal agencies (goat control program at Hawai'i Volcanoes National Park, initiation of introduced plant control programs, establishment of waterbird refuges by the FWS). The current public education efforts by Federal, State, and private groups are heartening.

However, we are at a crossroads in Hawai'i. Much more needs to be accomplished if we are to increase the chances of survival of Hawai'i's endemic avifauna. A solid information base exists on which to make sound management actions. Much has been done to legally protect endangered forest bird habitat, but critical gaps in protection exist, especially at upper elevations on

Table 1. Status of recovery plans for endangered and threatened land birds of the Hawaiian Islands.

Recovery Plan Title	Status	Species Covered
Nene	Approved 2/14/83	<u>Nesochen sandvicensis</u>
Hawaiian Hawk	Approved 5/9/84	<u>Buteo solitarius</u>
`Alala (Hawaiian Crow)	Approved 10/28/82	<u>Corvus hawaiiensis</u>
Hawaiian Forest Birds	Approved 2/3/83	<u>Psittirostra psittacea</u> <u>Hemignathus munroi</u> <u>Oreomystis mana</u> <u>Loxops coccineus coccineus</u>
Palila	Approved 1/23/78	<u>Loxioides bailleui</u>
Kaua'i Forest Birds	Approved 7/29/83	<u>Phaeornis obscurus myadestina</u> <u>Phaeornis obscurus palmeri</u> <u>Moho braccatus</u> <u>Psittirostra psittacea</u> <u>Hemignathus procerus</u> <u>Hemignathus lucidus hanapepe</u>

Recovery Plan Title	Status	Species Covered
Maui-Moloka'i Forest Birds	Approved 5/30/84	<u>Phaeornis obscurus rutha</u> <u>Pseudonestor xanthophrys</u> <u>Hemignathus lucidus affinis</u> <u>Paroreomyza flammea</u> <u>Loxops coccineus ochraceus</u> <u>Palmeri dolei</u> <u>Melamprosops phaesoma</u>
Leeward Islands	Approved May 1984	<u>Telespyza cantans</u> <u>Telespyza ultima</u> <u>Acrocephalus f. familiaris</u> <u>Acrocephalus f. kingi</u>

the island of Hawai'i, where native bird densities are greatest or could be expected to be high if perturbations by introduced species were removed. Legal protection is, however, only a first step (Kepler and Scott, in press). Also needed is vigorous implementation of management programs identified in recovery plans and elsewhere.

We believe that many of the major limiting factors for Hawai'i's native species have been identified. Some, such as avian malaria, while very important, have been shown to be geographically limited in their impact (van Riper et al. 1982). This makes design of preserves easier. Other limiting factors, such as browsing by feral ungulates (e.g. deer, cattle, goats, and pigs), are less restricted but may be easier to control. With the identification of major limiting factors has also come the identification of needed management actions.

The types of management that we feel must be implemented if we are to restore and maintain viable populations of Hawai'i's native birds are as follows:

1. Legal protection of natural habitats.
2. Elimination of introduced plants and animals in native habitats.
3. Physical restoration of native habitats through reforestation.
4. Intensive manipulation of birds in their natural habitats.
5. Translocation of endangered species into new, or improved former, habitats.
6. Captive propagation with release into the wild.

The 6 items are ranked in an order that we believe is indicative of our hope of successful use of management to protect or restore a species or community. Thus, for species with large populations and broad distributions that include low elevations and/or introduced vegetation (i.e. 'apapane, Hawaiian hawk), no specific actions need to be taken. The opposite extreme is represented by a species unable to survive in the wild without a continuing captive propagation effort (e.g. Hawaiian goose, Hawaiian crow). Many species in Hawai'i require several management actions simultaneously (table 2).

In a very real way, the position a species occupies on the list tells us where we are in our efforts to protect it. We have arrived with help "early" if we need only address item 1, and very late if we have to initiate captive propagation efforts.

Table 2. Suggested management actions needed to increase survival chances of Hawai'i's endangered land birds.

Species	Management Actions					
	Legal Protection of Natural Habitats	Elimination of Exotics	Physical Restoration of Habitats	Intensive Manipulation of Birds	Translocation of Endangered Species	Captive Propagation with Release
Hawaiian Goose		X		X		X
Hawaiian Hawk	X	X				
Hawaiian Crow	X	X	X	X	X	X
Hawaiian Thrush		X				
Small Kaua'i Thrush		X				X
Kaua'i 'O'o		X				X
'O'u	X	X			X	X
Palila	X	X	X		X	
Maui Parrotbill	X	X	X			
Common 'Amakihi (Moloka'i)		X			X	
Kaua'i 'Akialoa		X				X
Nukupu'u		X				X
'Akiapola'au	X	X	X			

Table 2. Continued.

Species	Management Actions					
	Legal Protection of Natural Habitats	Elimination of Exotics	Physical Restoration of Habitats	Intensive Manipulation of Birds	Translocation of Endangered Species	Captive Propagation with Release
Hawai'i Creeper	X	X	X			
Moloka'i Creeper	X	X			X	X
O'ahu Creeper	X	X	X			
'Akepa	X	X	X			
Crested Honeycreeper	X	X	X		X	
Po'ouli		X				

While there have been many captive propagation efforts that have augmented wild populations, to our knowledge none of them, with the possible exception of the peregrine falcon effort, has yet successfully re-established a naturally reproducing wild population (Fyfe 1977; Carpenter and Derrickson 1982; Carpenter 1983). Translocation efforts with wild birds or eggs have been more successful, and a number of species have been restored to former ranges and their numbers increased significantly with this technique. The trumpeter swan (Cygnus buccinator), bald eagle (Haliaeetus leucocephalus) and wild turkey (Meleagris gallopavo) rank among the success stories. Another species, the saddleback (Creadion carunculatus) of New Zealand, has been unequivocally saved by translocation from one island to another (Merton 1975).

Translocation and captive propagation require long, labor-intensive efforts focused on a single species. Furthermore, they require that land be legally protected, managed, and sometimes restored before re-introduction efforts can be initiated (see papers in Temple 1978 for examples of what has been done). Unfortunately in Hawai'i, many of the bird species are at the point where only clinical management (actions 4-6) will save them (table 2). However, in seeking to save what remains, we must not lose sight of what is possible. Heroic rescue operations such as required for the Hawaiian crow should not cause us to lose sight of the fact that restoration or protection and management of communities may result in far more species surviving for less money, and with far greater chances for success (Jacobi and Scott, this volume). We must try to anticipate future problems as well as deal with the present ones. Using the data presently available to us, we believe that we can take actions that will minimize the numbers of endangered species 100 years from now.

SPECIFIC MANAGEMENT RECOMMENDATIONS

We believe that sufficient information is available to make some specific management recommendations for Hawaiian birds. These are listed and discussed below.

Hawai'i

Hakalau Preserve. The upper elevation forests of windward Hawai'i harbor the core populations of the 'akiapola'au, Hawai'i creeper, and palila. Scientists and managers have identified this area as a potential forest bird preserve (Scott et al. 1983). The preserve would include relatively intact native forest as well as disturbed forest, which could be reforested. A major feature of the preserve would be 2 proposed

corridors to link the koa-'ohi'a forests with the mamane forests of the Mauna Kea Game Management Area.

Ka'u-Kapapala corridor. The Kapapala Forest Reserve above about 1,500 m would serve to link Ka'u populations of endangered species with windward populations through Keauhou Ranch to Kilauea Forest Reserve. If established, this corridor would do much to increase the chances of survival of any endangered species that may repopulate the rapidly improving koa forests in the Mauna Loa strip of Hawai'i Volcanoes National Park.

Hualalai crow preserve. The Alala Recovery Plan calls for the establishment of a forest preserve of unspecified size on the northern slope of Hualalai. Small populations of 'akepa and Hawai'i creeper are known to occur in this area as well. We believe that the establishment of this preserve is crucial if the crow is to have any chance of survival.

Control of ungulates. Feral sheep, goats, and pigs, and feral and domestic cattle have caused serious damage to many of the plant communities in which endangered forest birds occur on Hawai'i. The numbers of these animals should be controlled in order to improve the habitat quality within the essential habitat of these birds. Emphasis should be placed on those areas above 1,500 m in elevation.

Banana poka. Banana poka poses a serious threat to the koa forest in the windward slopes of Mauna Kea and has recently spread to Volcano Village. It also is firmly established throughout northern Kona. These plants threaten the integrity of the native forests and should be controlled. USDA, NPS, and DLNR scientists are working toward this end by exploring many options, including biocontrol. These efforts deserve continued support.

Maui

Goats and pigs are serious threats to the integrity of the rain forests of Maui. Their activities have accelerated the erosion process on the steep slopes of Haleakala. Control of these animals should result in significant habitat improvement. Detailed plans for doing this are given in the Maui-Moloka'i Forest Bird Recovery Plan (Kepler et al. 1984).

The East Maui Irrigation Co. and State-owned land to the east of The Nature Conservancy's recently established Waikamoi Preserve are valuable habitat for no fewer than 5 species of endangered forest birds. This large area should be managed to protect the critical watersheds and the endangered species that reside there.

Axis deer. A population of the highly destructive Axis deer (Axis axis) is established on the low elevation slopes of west and south Haleakala. These animals should be eradicated before they become established in essential forest bird habitat on Haleakala's north or east slopes.

Moloka'i

Oloku'i. The magnificent Oloku'i is covered by pristine native forest, and the absence of ungulates is marked by a luxuriant carpet of native strubs, herbs, and bryophytes. In order to ensure the continuation of perhaps the only ungulate-free forest in Hawai'i, fencing is needed at the 600 m elevation level on the seaward ridge to it from Wailau Valley, to prevent pigs and axis deer from ascending the slopes.

Kamakou Preserve. The Nature Conservancy has acquired Kamakou Preserve on Moloka'i and has begun an ambitious management program. Lands adjacent to Kamakou should be similarly managed to protect the essential forest bird habitat that remains on East Moloka'i.

Kaho'olawe

This small island has no value for forest birds. Conservationists would be well advised to direct their efforts to preserve other more important areas in Hawai'i.

Kaua'i

The Alaka'i Swamp on Kaua'i has been dedicated as a Natural Area Reserve. If we are to maximize the chances of survival of the endangered species found there, we need to ensure that alien species are not introduced and that the numbers of pigs are reduced and goats eliminated from the area. In addition, we strongly recommend that alien species on the edge of the reserve (e.g. Rubus argutus and Passiflora mollissima) be controlled and that other alien plant species be prevented from becoming established.

In concluding, we wish to emphasize that many of the management actions we have recommended are dependent upon the cooperation of landowners. It is critical that we work with private, as well as public, landowners and consider their needs in attempts to maintain nearly native ecosystems. This strategy should reduce the chances for further extinctions and reduce the decline of common species to threatened or endangered status.

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LITERATURE CITED

- Ashman, P.R., P. Pyle, and J. Jeffrey. 1984. A second nest of the small Kauai thrush. Elepaio 45:33-34.
- Atkinson, I.A.E. 1977. A reassessment of factors, particularly Rattus rattus L., that influenced the decline of endemic forest birds in the Hawaiian Islands. Pac. Sci. 31(2):109-133.
- Banko, P.C., and D.A. Manuwal. 1982. Life history, ecology, and management of nene (Branta sandvicensis) in Hawaii Volcanoes and Haleakala National Parks. Final Rep., Natl. Park Serv. Contract CX-8000-8-0005. Seattle: Univ. Wash. Coop. Natl. Park Resour. Stud. Unit.
- Banko, W.E. 1968. Rediscovery of Maui nukupuu, Hemignathus lucidus affinis, and sighting of Maui parrotbill, Pseudonestor xanthophrys in Kipahulu Valley, Maui, Hawaii. Condor 70:265-266.
- Banko, W.E. 1980-1983. History of endemic Hawaiian birds. Part 1. Population histories -- species accounts. Univ. Hawaii Coop. Natl. Park Resour. Stud. Unit, Avian Hist. Rep. 4-8. Honolulu: Univ. Hawaii.
- Banko, W.E., and P.C. Banko. 1980. History of endemic Hawaiian birds. Part 1. Population histories -- species accounts: alala or Hawaiian raven/crow. Univ. Hawaii Coop. Natl. Park Resour. Stud. Unit, Avian Hist. Rep. 6b. Honolulu: Univ. Hawaii.
- Berger, A.J. 1981. Hawaiian birdlife. 2nd ed. Honolulu: Univ. Pr. Hawaii.
- Berger, A.J., E. Kosaka, J.M. Scott, P. Scowcroft, C. Wakida, D. Woodside, and C. van Riper, III. 1977. Palila recovery plan. U.S. Fish Wildl. Serv., Portland, Ore.
- Bryan, W.A. 1908. Some birds of Molokai. B.P. Bishop Mus. Occ. Pap. 4:133-176.
- Burr, T., P.Q. Tomich, E. Kosaka, W. Kramer, J.M. Scott, E. Kridler, J. Giffin, D. Woodside, and R. Bachman. 1982. Alala recovery plan. U.S. Fish Wildl. Serv., Portland, Ore.
- Carpenter, J.W. 1983. Species decline: a perspective on extinction recovery and propagation. Zoo Biol. 2:165-178.

- Carpenter, J.W., and S.D. Derrickson. 1982. The role of captive propagation in preserving endangered species. In Nongame and endangered wildlife symposium, ed. R.R. Odum. Georgia Dep. Nat. Res. and Georgia Chapt. Wildl. Soc.
- Casey, T.L.C. 1973. Preliminary report on the birdlife in Waihoi Valley, Maui. Elepaio 34:46-50.
- Casey, T.L.C., and J.D. Jacobi. 1974. A new genus and species from the island of Maui, Hawaii (Passeriformes: Drepanididae). B.P. Bishop Mus. Occ. Pap. 24(12):215-226.
- Devick, W.S. 1981a. Status of the nene population on the island of Hawaii between 1975 and 1980. Hawaii Dep. Land Nat. Resour., Honolulu. Typescript.
- Devick, W.W. 1981b. Status of the nene population on the island of Maui between 1975 and 1980. Hawaii Dep. Land Nat. Resour., Honolulu. Typescript.
- Dunmire, W.W. 1961. Birds of the national parks in Hawaii. Honolulu: Hawaii Nat. Hist. Assn.
- Fyfe, R.W. 1977. Reintroducing endangered birds to the wild. In Endangered birds: management techniques for preserving threatened species, ed. S.A. Temple, 323-329. Madison, Wis.: Univ. Wisconsin Pr.
- Giffin, J.G. 1982. Ecology of the mouflon sheep on Mauna Kea. Final Rep., Hawaii Dep. Land Nat. Resour. Pittman-Robertson Proj. W-17-R, Stud. R-3.
- Giffin, J.G. 1983. Alala investigations. Final Rep., Hawaii Dep. Land Nat. Resour. Pittman-Robertson Proj. W-18-R, Stud. R-II-B (1976-1981).
- Greenway, J.C., Jr. 1958. Extinct and vanishing birds of the world. Am. Comm. Internatl. Wildl. Protect. Spec. Pub. 13. New York.
- Henshaw, H.W. 1902. Birds of the Hawaiian Islands, being a complete list of the birds of the Hawaiian possessions with notes on their habits. In Hawaiian Almanac and Annual for 1902, 54-106. Honolulu: Thos. G. Thrum.
- Hirai, L.T. 1978. Native birds of Lanai, Hawaii. West. Birds 9:71-77.

- Howarth, F.G. Impacts of alien land arthropods and mollusks on native plants and animals in Hawaii. [This volume]
- Huber, L.N. 1966. Field notes. Alakai Swamp, Kauai; March 1965. Observations of akialoa. Elepaio 26:71.
- Jacobi, J.D., and J.M. Scott. An assessment of the current status of native upland habitats and associated endangered species on the island of Hawaii. [This volume]
- Kear, J., and A.J. Berger. 1980. The Hawaiian goose: an experiment in conservation. Vermillion, S. Dakota: Buteo Books.
- Kepler, C.B., and A.K. Kepler. 1983. A first record of the nest and chicks of the small Kauai thrush. Condor 85:497-499.
- Kepler, C.B., T.A. Burr, C.B. Cooper, D. Dunatchik, J. Medeiros, J.M. Scott, M. Ueoka, and W. Wong. 1984. Maui-Molokai forest bird recovery plan. U.S. Fish Wildl. Serv., Portland, Ore.
- Kepler, C.B., and J.M. Scott. In press. Conservation of island ecosystems. In Proc. 18th World Conf. Internatl. Counc. Bird Preserv. Cambridge, England.
- Kirch, P.V. 1982. The impact of the prehistoric Polynesians on the Hawaiian ecosystem. Pac. Sci. 36:1-14.
- Merton, D. 1975. The saddleback: its status and conservation. In Breeding endangered species in captivity, ed. R.D. Martin, 61-74. New York: Academic Pr.
- Mountainspring, S., and J.M. Scott. In press. Interspecific competition among Hawaiian forest birds. Ecol. Monogr.
- Munro, G.C. 1944. Birds of Hawaii. Honolulu: Tongg Pub. Co.
- Olson, S.L., and H.F. James. 1982. Fossil birds from the Hawaiian Islands: evidence for wholesale extinction by man before Western contact. Science 217(4560):633-635.
- Pekelo, N., Jr. 1963a. Some notes from Molokai. Elepaio 23:64.

- Pekelo, N., Jr. 1963b. Some notes from Molokai. Elepaio 24:17-18.
- Perkins, R.C.L. 1903. Vertebrata. In Fauna Hawaiiensis, ed. D. Sharp, Vol. 1, Pt. IV, 365-466. Cambridge, England: The Univ. Pr.
- Pratt, H.D. 1980. Intra-island variation in the elepaio on the island of Hawaii. Condor 82: 449-458.
- Pratt, T. 1974. Plant communities and bird distribution in east Molokai. Elepaio 33:66-70.
- Richards, L.P., and P.H. Baldwin. 1953. Recent records of some Hawaiian honeycreepers. Condor 55: 221-222.
- Richardson, F. 1949. Status of native land birds of Molokai. Pac. Sci. 3:226-230.
- Richardson, F., and J. Bowles. 1964. A survey of the birds of Kauai, Hawaii. B.P. Bishop Mus. Bull. 227.
- Sabo, S.R. 1982. The rediscovery of Bishop's 'o'o on Maui. Elepaio 42:69-70.
- Scott, J.M., J.K. Baker, A.J. Berger, E. Kosaka, L. Landgraf, C.J. Ralph, D. Woodside, R. Bachman, and T. Burr. 1983. Hawaii forest bird recovery plan. U.S. Fish Wildl. Serv., Portland, Ore.
- Scott, J.M., S. Conant, and H.D. Pratt. 1979. Field identification of the Hawaiian creeper on the island of Hawaii. West. Birds 10:71-80.
- Scott, J.M., S. Mountainspring, F.L. Ramsey, and C.B. Kepler. In press. Forest bird communities of the Hawaiian Islands: their dynamics, ecology, and conservation. Stud. Avian Biol.
- Scott, J.M., S. Mountainspring, C. van Riper III, C.B. Kepler, J.D. Jacobi, T.A. Burr, and J.G. Giffin. 1984. Annual variation in the distribution, abundance and habitat of the palila. Auk 101:647-664.
- Scott, J.M., and J.L. Sincock. 1977. Recent observations on the birds of the Koolau Forest Reserve, Maui. West. Birds 8:113-116.
- Scott, J.M., D.H. Woodside, and T.L.C. Casey. 1977. Observations of birds in the Molokai Forest Reserve, July 1975. Elepaio 38:25-27.

- Scowcroft, P.G., and J.G. Giffin. 1983. Feral herbivores suppress mamane and other browse species on Mauna Kea, Hawaii. J. Range Manage. 36:638-645.
- Scowcroft, P.G., and H.F. Sakai. 1983. Impact of feral herbivores on mamane forests of Mauna Kea, Hawaii: bark stripping and diameter class structure. J. Range Manage. 36:495-498.
- Shallenberger, R.J., and H.D. Pratt. 1978. Recent observations and field identifications of the Oahu creeper. Elepaio 38:135-140.
- Shallenberger, R.J., and G.K. Vaughn. 1978. Avifaunal survey in the central Koolau range, Oahu. Honolulu: Ahuimanu Prod.
- Sincock, J.L., R.E. Daehler, T. Telfer, and D.H. Woodside. 1984. Kauai forest bird recovery plan. U.S. Fish Wildl. Serv., Portland, Ore.
- Smith, J.D. 1952. The Hawaiian Goose (nene) restoration program. J. Wildl. Manage. 16:1-9.
- Smith, C.W. Impact of alien plants on Hawaii's native biota. [This volume]
- Stone, C.P. Alien animals in Hawaii's native ecosystems: toward controlling adverse effects of introduced vertebrates. [This volume]
- Stone, C.P., R.L. Walker, J.M. Scott, and P.C. Banko. 1983. Hawaiian goose management and research -- where do we go from here? Elepaio 44:11-15.
- Temple, S.A. 1978. Endangered birds: management techniques for preserving threatened species. Madison, Wis.: Univ. Wisconsin Pr.
- U.S. Fish and Wildlife Service. 1983. Republication of lists of endangered and threatened species. Fed. Register 50 CFR 17.11 and 17.12.
- van Riper, C., III. 1978. The breeding biology of the amakihi (Loxops virens) and palila (Psittirostra bailleui) on Mauna Kea, Hawaii. Ph.D. Diss., Univ. Hawaii, Honolulu.
- van Riper, C., III. 1980. Observations on the breeding of the palila (Psittirostra bailleui) of Hawaii. Ibis 122:462-475.

- van Riper, C., III. 1982. Censuses and breeding observations of the birds on Kohala Mountain, Hawaii. Wilson Bull. 94:463-476.
- van Riper, C., III, and J.M. Scott. 1979. Observations on distribution, diet and breeding of the Hawaiian thrush. Condor 81:65-71.
- van Riper, S., and C. van Riper III. A summary of known parasites and diseases recorded from the avifauna of the Hawaiian Islands. [This volume]
- van Riper, C., III, J.M. Scott, and D. Woodside. 1978. Distribution and abundance patterns of the palila on Mauna Kea, Hawaii. Auk 95:518-527.
- van Riper, C., III, S.G. van Riper, M.L. Goff, and M. Laird. 1982. The impact of malaria on birds in Hawaii Volcanoes National Park. Univ. Hawaii Coop. Natl. Park Resour. Stud. Unit Tech. Rep. 47. Honolulu: Univ. Hawaii.
- van Riper, C., III, S.G. van Riper, M.L. Goff, and M. Laird. In press. The epizootiology and ecological significance of malaria in Hawaiian landbirds. Ecology.
- Warner, R.E. 1968. The role of introduced diseases in the extinction of the endemic avifauna. Condor 70:101-120.
- Warshauer, F.R., J.D. Jacobi, A. LaRosa, J.M. Scott, and C.W. Smith. 1983. The distribution, impact and potential management of the introduced vine Passiflora mollissima (Passifloraceae) in Hawaii. Univ. Hawaii Coop. Natl. Park Resour. Stud. Unit Tech. Rep. 48. Honolulu: Univ. Hawaii.