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HALEAKALA NATIONAL PARK CRATER DISTRICT  
RESOURCES BASIC INVENTORY: BIRDS

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## ABSTRACT

During field surveys conducted in the Crater District of Haleakala National Park, the authors recorded 23 species of birds in 22 genera and 15 families. Five species are endemic and two contain subspecies endemic to Maui county. Of four indigenous species present, two contain subspecies endemic to the Hawaiian archipelago. Among the endemic and indigenous species and subspecies, two (the 'Ua'u, Pterodroma phaeopygia sandwichensis, and the Nēnē, Branta sandvicensis) are currently listed as endangered on the federal endangered species list. Fourteen introduced species were observed in the Crater District. Two of these species, the Japanese White-eye (Zosterops japonica) and the House Finch (Carpodacus mexicanus), were widespread and abundant, but their impact on native bird populations is unknown. Ecological relationships of the Crater avifauna and management programs for the endangered species are discussed.

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## INTRODUCTION

We began a survey of the avifauna of the Crater District of Haleakala National Park (Fig. 1) in June 1976, as part of the Resources Basic Inventory (RBI) implemented by the Cooperative National Park Resources Studies Unit at the University of Hawaii (CPSU/UH). To our knowledge it is the most comprehensive study of its kind yet undertaken in the Crater District (Fig. 2). Previous studies, especially by Dunmire (1961) and Yocom (1968), provided information on bird distribution and abundance, but were more limited in scope than the present survey.

Dunmire (1961), summarizing data collected during his tenure as Park Naturalist, listed and described the bird species present in Haleakala and Hawaii Volcanoes National Parks, including brief notes on their distribution. During July and August of 1963 Yocom (1968) made systematic notes on the numbers and distribution of birds he observed while studying feral goats in the Park. Since the publication of Yocom's work, information on the avifauna of Haleakalā has come primarily from the publication of incidental observations in the 'Elepaio, journal of the Hawaii Audubon Society, as was the case before the publication of Dunmire's (1961) work. Even though such data are fragmentary, they provide a historical perspective for the present study.

## METHODS

Our objective in this study was to determine the status and distribution of birds in the Crater District of Haleakala National Park (Fig. 2) by means of field surveys. Studies began in June 1976, and still continue; however, this paper includes only data collected through August 1978. We made at least one trip to the study area quarterly to provide a basis for assessing seasonal variation in bird numbers as well as opportunities to conduct repeated censuses. Although this survey encompassed the entire Crater District, areas where bird species richness or density were higher received more intensive study. These included scrub habitats in the eastern end of the Crater, the Palikū area, the eastern boundary of Kaupō Gap, and Pu'u Māmane. All areas were surveyed at least twice each year and some sites were visited up to seven times.

We calculated bird species densities from data collected on transect counts, using the "count x detectability" method described by Emlen (1971). In some communities where transect counts were impractical, we used the circular plot method (Ramsey and Scott, in press; Reynolds, Scott, and Nussbaum, in press) for our censuses. Some environmental conditions or bird species (e.g., House Finch, Ring-necked Pheasant) do not lend themselves

to the use of either of the above techniques. In these cases we simply counted the total number of birds, estimated our area of coverage, and calculated densities from these data.

More than half of the field work was done by one or the other author working alone, covering rather extensive areas. Under these conditions it was impossible to conduct counts at a standard time of day or in uniform weather conditions. The variability thus introduced to our data, however undesirable, was unavoidable.

### STUDY AREA

During field studies and after mapping species distributions, it became apparent that a division of the Crater District into several broad habitat types could provide a framework for the presentation and interpretation of results. Many bird species distribution patterns correspond to those of major plant communities. Birds that occupy several habitat types may show marked changes in density at plant community borders.

With the aid of Whiteaker's (1978) vegetation map, we divided the Crater District into five different habitats. Our divisions are based on geological features and vegetation physiognomy as well as Whiteaker's descriptions of the communities. The distribution of these five habitat types is shown in Figure 3. They can be characterized as follows:

- Type 1: Rock; cinders; open native scrub communities (approx. 30% cover) dominated by pūkiawe (Styphelia tameiameia) and 'ōhelo (Vaccinium reticulatum and V. berberifolium), various grasses, especially velvetgrass (Holcus lanatus, introduced) and Deschampsia australis, and the bracken fern Pteridium aquilinum. This habitat is by far the most extensive in the Crater District, covering much of its floor and parts of both inner and outer slopes.
- Type 2: Grasslands dominated by Deschampsia australis, but heavily invaded in some areas by exotic plants, including velvetgrass and gosmore (Hypochaeris radicata). Occasional pūkiawe and 'ōhelo shrubs are present. This habitat covers extensive areas above Hosmer Grove, on Kuiki, and on the northern side of Kalapawili Ridge. Other grasslands occur at Kaluanui, Palikū, Kapalaoa Cabin, and on the east central portion of the Crater floor.
- Type 3: Savannah consisting of grasses, notably Deschampsia australis and velvetgrass, and māmane (Sophora chrysophylla), with occasional pūkiawe and 'ōhelo shrubs. This habitat can be found at the base of Kalapawili Ridge inside the Crater, and on and around several of the cinder cones on the Crater floor (e.g., 'Ō'ilipu'u, Pu'u Mamane, Nāmana o ke Akua, Honokahua).

- Type 4: Closed native scrub communities with cover of at least 60%. This habitat type is characterized by pūkiawe and 'ōhelo. Other common species are 'a'ali'i (Dodonaea eriocarpa) and hinahina (Geranium multiflorum var. ovatifolium in the Crater proper, and G. cuneatum var. tridens on the outer northeast slopes). Various grasses and ferns (e.g., Deschampsia australis, Pteridium aquilinum) are frequently present. Closed native scrub is the dominant habitat type on most of the outer northwest slopes of the Crater, much of the eastern Crater floor, and in most of Kaupō Gap.
- Type 5: Native rain forest consisting of 'ōhi'a (Metrosideros collina), ōlapa (Cheirodendron trigynum), kolea (Myrsine lanaiensis), and other trees, as well as a variety of shrubs (e.g., Styphelia, Vaccinium, Rubus), herbs, and numerous epiphytes. This habitat is limited to the wettest portions of the Crater District, and is particularly well-developed at Palikū and in east Kaupō Gap.

## RESULTS AND DISCUSSION

### Species Observed

We found 23 species of birds representing 15 families during the survey. Of these, 14 (61%) are introduced species and 9 (39%) are native (Table 1). Of the native species, two (Maui 'Amakihi, Loxops virens wilsoni, and 'Alauwahio or Maui Creeper, Loxops maculata newtoni) have forms endemic to the island of Maui or Maui-nui (Maui, Moloka'i, Lāna'i), and two species (Nēnē, Branta sandvicensis, and 'Ua'u, Pterodroma phaeopygia sandwichensis) are currently listed as endangered (U. S. Fish and Wildlife Service 1979). Table 2 shows the densities of the 22 species in each of the five habitat types described above. Appendix I contains a list of the species found, including scientific, vernacular, and Hawaiian names, status, and distribution in the Crater District.

### Species Accounts

In this section each species is listed in taxonomic order (except a grouping of uncommon species), and a map of its distribution provided. In addition there is a brief discussion of factors affecting distribution and patterns of seasonal variation.

'Ua'u (Dark-rumped Petrel, Pterodroma phaeopygia sandwichensis, Fig. 4).

The largest known breeding colony of this endangered petrel is on the west-northwest wall of the Crater, extending from just above Hōlua Cabin at about 7200 feet (2195 m) to below the



Observatory at about 9600 feet (2925 m). Previous reports indicated a small breeding colony above Kapalaoa Cabin (U. S. Fish and Wildlife Service 1974). Although Conant observed birds in this area during the night of 18 June 1976 on the ridge top, an extensive daytime search failed to reveal any signs of burrows. We heard birds flying over Pu'u Māmane about an hour after sunset in June 1976 and July 1977. Teves (pers. comm.) reported hearing birds flying over the Palikū area after sunset in June, July, and August of 1977. Birds at Pu'u Māmane and Palikū were probably enroute to the breeding colony on the west-northwest rim. Kjargaard (in press) reported that 295 of the 478 burrows he has mapped were active in 1977. Excessive cold, high winds, and precipitous terrain make much-needed study of this bird difficult at best. Kjargaard (in press) and Buxbaum (1973) concur that the roof rat (Rattus rattus), as a predator, is the most serious threat to the continued survival of this species. The National Park Service's predator control program provides essential protection for this species, and deserves expansion.

The recent improvements to the Haleakalā summit road will allow large tour buses to travel regularly to the Observatory. This raises the important question of whether or not bus traffic will disturb petrels in their burrows with eggs or young. At some points along the highway (e.g., Kilohana) the road is only several meters from active burrows. Until this matter is clarified, the Park Service should consider limiting the number of buses on the road during the breeding season.

Koa'e-kea (White-tailed Tropicbird, Phaethon lepturus dorotheae, Fig. 5).

A common, though not abundant, visitor to the Crater District, this species often occurs in the eastern portions of the Crater District, near Palikū and in Kaupō Gap. Although Berger (1972: 50) reports that the species breeds on Maui, we know of no nests that have been found in the Crater District. Conant saw two birds land on a cliff face in west Kaupō Gap in June of 1976 and January of 1977, but was unable to determine if there were active nests. Previous reports list Hōlua (Dunmire 1961), Palikū (Bonsey 1951; Dunmire 1961; Yocom 1968), and Kaupō Gap (Dunmire 1961; Yocom 1968) as sighting localities for this species.

Nēnē (Hawaiian Goose, Branta sandvicensis, Fig. 6).

We have seen this bird throughout the eastern part of the Crater District, at Hōlua Cabin, and at Park Headquarters. It is particularly common in the eastern part of the Crater District near Palikū, on Kalapawili Ridge, and on Kuiki, where 41 birds were seen on 13 July 1971 (E. Andrade, pers. comm.).

Open scrub communities and grasslands provide habitat for Nēnē, which we observed feeding on velvetgrass and other grasses, gosmore, and pūkiawe and 'ohelo fruit. During early morning and late afternoon birds were usually found loafing in stands of shrubs, where they probably spend the night. Much of the Crater District appears to provide suitable habitat for the species. We attribute the concentration of birds near Palikū to their familiarity with the area and its association with food provided shortly after release and by the constant stream of hikers who feed and are amused by the "tame" birds. We strongly recommend that the Park Service post signs at the three cabins discouraging campers from feeding birds, and explaining the reasoning behind the request. Interpretive personnel should also monitor this situation and take advantage of the opportunity to explain the "plight" of this endangered bird.

Since 1962, some 489 captive-raised Nēnē have been released at Palikū by the State of Hawaii, Division of Fish and Game. We believe that most of the birds we saw are captive-raised, released individuals, because they were banded. We saw a total of only 12 unbanded birds on five occasions during our study. During each trip we searched thoroughly for Nēnē, making careful counts. We estimate the population in the Crater District to be 80-100 birds. Paul Banko (pers. comm.) who has kindly read this manuscript, remarked that this agrees with estimates based on field work done by himself, assisted by A. Medeiros, E. Andrade, M. Ueoka, and M. Daughtery.

In 1972, a "Nēnē Park" (Scott 1962; Pratt 1972b) was created at Park Headquarters. In this situation breeding adult birds are kept flightless, while their young mature, leaving the enclosure at will when they can fly. Except during 1976, a very dry year, at least one successful nesting has occurred annually in the two enclosures near Headquarters from 1972 to 1978 (Pratt 1977, and this study). According to P. Banko (pers. comm.) there is insufficient data to allow assessment of the success of this project in bolstering the wild Nēnē population.

Nesting success of the released birds in the Crater District seems to be much less promising. We know of only two (Pratt 1972a, and this study) successful nestings of released, captive-raised birds in the Crater District, although maintenance personnel (pers. comm.) have reported seeing goslings. There were some unbanded birds among Nēnē observed by A. Medeiros, E. Andrade, M. Ueoka, and M. Daughtery during early January 1979, indicating some successful breeding in the wild although some of these birds may have simply lost bands (P. Banko, pers. comm.). Our estimate of the total population, even if it is off by as much as 200%, suggests that the birds are not maintaining their numbers, much less increasing.

With the 13 July 1977 release, the State stopped releasing birds and is now monitoring existing populations to find out whether or not the birds will be able to reestablish a viable population level in Haleakalā. Careful study in the next decade should provide the answer to this question. Inasmuch as the

State is often plagued by a lack of manpower and funds for such projects as this, we feel it is important that present Nēnē research conducted by Paul Banko and supported by the National Park Service continue, and possibly be expanded, or at least be continued when Mr. Banko finishes his present research program.

Hopefully, those birds that have survived the initial years after their release will begin to breed successfully and in great enough numbers to be self-sustaining. At this point, only one conclusion seems clear: there are insufficient data to support the contention that this species can be "saved" from extinction without the intervention and assistance of man.

Chukar (Alectoris chukar, Fig. 7).

The Chukar is widely distributed and relatively common in the eastern part of the Crater District as well as on both inner and outer Crater slopes. Highest densities occurred in grasslands and open scrub on the slopes, with somewhat lower numbers in grasslands, open scrub, and savannah on the Crater floor. Of the different habitat types, closed native scrub and rain forest harbored the lowest densities of birds. We saw the greatest number of birds on the summit of Kalapawili Ridge and near Hōlua Cabin.

The Chukar, as a browser and fruit eater, may compete for food with the Nēnē. Certainly we have observed both species feeding on pūkiawe and 'ōhelo fruit and the shoots and inflorescences of various grasses. Food habits of both Chukar and Pheasant should be part of any comprehensive study of Nēnē ecology in Haleakalā.

In June and July we observed family groups usually consisting of two adults and about eight chicks. Other field biologists (Yocom 1968; Howarth, Whiteaker, Whittle, pers. comm.) have also observed adults with chicks at this time of year. Conant saw very large flocks (20-35) in January 1977, and we also saw large flocks in July 1977 and March 1978. These observations suggest that the birds begin to nest in April and May. Dunmire (1961) mentioned that the breeding season was in late spring and summer. In the winter months, Chukar sometimes move about in large groups. However, flock sizes observed during August, November, and March trips were usually less than 10 birds.

Gray Francolin (Francolinus pondicerianus, Fig. 8).

Apparently this species is expanding its range up into the Crater District from Kaupō Gap. Although it may have occurred in the Crater before the 1960's (Woodside, pers. comm.), neither Dunmire (1961) nor Yocom (1968) reported it. A ranch hand on the Kaupō Ranch told us he often saw this species on the ranch, but generally below 5000 feet (1525 m).

In June 1976, C. W. Smith (pers. comm.) saw an adult and a chick that were probably Gray Francolins, at about 5000 feet (1525 m) in west Kaupō Gap. More recently, Stemmermann observed this species as high as 5800 feet (1770 m).

Ring-necked Pheasant (Phasianus colchicus, Fig. 9).

The Ring-necked Pheasant is somewhat more widely distributed and abundant than the other common game bird, the Chukar. However, it is less obvious than the Chukar because birds travel alone or in pairs, rather than flocks, and are less vocal and more secretive. The Ring-necked Pheasant's wider distribution is accounted for by its tolerance for more mesic environments than the Chukar. It is more abundant in closed native scrub, where Chukar are sparse or sometimes absent. Although the Ring-necked Pheasant does not occur in rain forests proper, we frequently observed birds at the edge of this habitat type.

In the driest habitats, Chukar predominate, and Pheasant may be absent or very sparse. This difference in distribution is probably due to the Pheasant's apparent preference for denser cover. However, another possibility is that in the driest, least productive habitats (i.e., open native scrub) food is a limiting factor.

Schwartz and Schwartz (1951) found that gonad size (54 birds) and crowing of male Pheasants indicated a breeding season beginning in late January and ending in June. We have heard males crowing throughout the day in March 1977 and 1978 and saw tracks of pheasant chicks in June 1976. Carpenter (1959b) recorded pheasant chicks in April and May.

Kōlea (Golden Plover, Pluvialis dominica, Fig. 10).

The Plover probably occurs in all grasslands in the Crater District, although we do not have records from a few areas. This is probably because the species is absent during summer months when we did much of our field work. It is patchily distributed and sparser in savannah, open scrub, and closed scrub. We recorded the highest densities of Plover in grasslands and open scrub near Hōlua and Palikū cabins, on Kuiki, and near Pōhakupālahā.

The Plover migrates to Alaska each year to breed. Although occasional birds remain in Hawai'i during the summer, the largest numbers are present from September through March. Birds are usually solitary, but move in flocks of variable size immediately before leaving for, and after returning from, the breeding grounds.

Barn Owl (Tyto alba) and Pueo (Hawaiian Owl, Asio flammeus sandwichensis, Fig. 11).

The two owls are treated simultaneously because they can be difficult to distinguish in the field, and because known sightings indicate similar distributions for the species. We saw both Barn Owls and Pueo near Palikū Cabin and in alpine grasslands near Pōhakupālahā. Only the Pueo was recorded from the Halemau'u Trail vicinity. Both were seen near Hosmer Grove.

Of our 17 owl sightings, 11 were Pueo, 3 were Barn Owl, and 3 were unidentified. Although Pueo hunt over rain forest as well as grassland and scrub communities, we observed Barn Owls almost invariably hunting over grasslands or open scrub. While our observations suggest some differences in habitat selection and diversity, we note that the diurnal habits of the Pueo make it a more obvious bird, and this certainly affects the likelihood of sightings.

The Pueo is certainly a beautiful bird for the Park visitor to see, and, next to the Nēnē, perhaps the most striking. Shallenberger (1978) suspects the Barn Owl may be replacing the Pueo on O'ahu, and the Pueo is really a rather rare bird except on the island of Kaua'i. (It is on the State of Hawaii's list of endangered birds.) Perhaps some consideration should be given to reducing the Barn Owl population in the Park, particularly if it begins to increase or to replace its endemic relative. In a study of 87 owl (species not distinguished) pellets, H. E. Smith (1975) found no Nēnē remains; however, both owl species appear capable of taking goslings.

Skylark (Alauda arvensis, Fig. 12).

The Skylark occurs sparsely but widely in the scrub habitats outside the Crater proper, and in grasslands, scrub, and savannah habitats in the east central Crater floor. We observed occasional birds along the summit of Kalapawili Ridge. This species can be seen throughout the ranchland on the outer northeastern slopes of Haleakalā, where it is probably more common than in the Crater District.

We heard the melodious flight song of this species more in late spring and early summer (April to July) than in other months, but found no other evidence of reproductive activity.

Red-billed Leiothrix (Leiothrix lutea, Fig. 13).

Of the passerine species we recorded, the Red-billed Leiothrix showed the most marked seasonal variation in density and distribution. This seasonality was most obvious at Palikū, where its density averaged about 12 birds/40 ha from March through July, but dropped to virtually zero in January. More intensive field work would probably reveal a small number of birds present in rain forest habitats all year, but they seem to

be scarce inside the Crater proper except when the 'ākala (Rubus hawaiiensis) and Methley plum (Prunus cerasifera) are in fruit.

We recorded a small number of birds in closed, native scrub in west Kaupō Gap at 5600 to 6000 feet (1700 to 1830 m) on 2 April 1978. Although occurrence in dry scrublands is unusual, the sighting is not without precedent as we have seen this species in dry māmane (Sophora chrysophylla)--naio (Myoporum sandwicense) forest on Mauna Kea on the island of Hawai'i. Leiothrix has been reported from Halemau'u Trail, Hosmer Grove, and east of Pu'u Nianiau by H. E. Smith (1976). Carpenter (1959c) saw a flock of birds at the Observatory on 29 October 1959, and surmised they were merely passing over the area.

Mockingbird (Mimus polyglottos, Fig. 14).

The Mockingbird occurred in some drier habitats at low densities. We observed birds all along the inner faces of Haleakalā ridge and Kalahaku Pali. Mockingbirds occurred in open and closed scrub along the northwest wall, and in scrub and savannah in the east central portion of the Crater. Dunmire (1961) did not mention that this bird occurred inside the Crater, and Yocom (1968) saw what he thought to be only one bird near 'Ō'ilipu'u during his two months of summer field work. Ashmole and Ord (1963) saw a Mockingbird near 'O'ilipu'u.

We were surprised that we found no mockingbirds in closed scrub on the outer northwestern slopes, because they were present in similar habitats elsewhere. Mockingbirds have been reported from well below Park Headquarters up to 9000 feet (2740 m) (Carpenter 1959a; Anonymous 1961; Dunmire 1961). We could find no obvious explanation for what appears to be a decrease outside the Crater proper, and an increase inside it.

We heard birds singing on most trips, although song was most frequent in spring and early summer. We saw one pair of adults with a well-developed fledgling on 24 June 1977. It seems unlikely that this species will increase much, if at all, in density, as it occupies a very sparse habitat. However, its distribution in the Crater District may still be in a state of flux, as indicated by distributional changes over the last two decades. Mockingbirds were first brought to Maui in 1933 (Anonymous 1961), and apparently have not reached stable population levels in all suitable habitats.

Japanese White-eye (Zosterops japonica, Fig. 15).

The White-eye is one of the two most abundant and widely distributed birds in the Crater District (the other being the House Finch). The highest densities occurred in wet forests near Palikū and Hosmer Grove, and closed scrub near Koa Tree and the Park maintenance area west of Hosmer Grove. The previous workers also found this species widespread (Bonsey 1951; Carpenter 1959a, 1959c; Dunmire 1961; Ashmole and Ord 1963; Yocom 1968; Oris

1971). The White-eye can probably be found in all vegetated areas except large expanses of grassland.

Our observations confirm other studies (Ashmole and Ord 1963; Conant, in press) in finding that the White-eye reaches peak densities in dry and, especially, mesic forests. It is less common in scrub communities and could be said to be uncommon in very wet rain forest communities, such as those in Kīpahulu Valley and Kuiki on Maui (pers. obs.) and the Alaka'i Swamp on Kaua'i (Conant, unpublished data).

The breeding season for this species probably begins during the spring, continuing to midsummer. We saw birds carrying nest material in June 1976, and L. Stemmermann (pers. comm.) found an active nest with eggs at Palikū in June 1976.

Because this bird feeds on small insects and nectar, it may compete with native honeycreepers for food, but this problem has not been thoroughly studied. The White-eye is so numerous that it would be virtually impossible to eliminate, so it is fortunate that it is not exceedingly common in the prime rain forest habitats of native passerines.

#### Maui 'Amakihi (Loxops virens wilsoni, Fig. 16).

The 'Amakihi was abundant and widely distributed in the Crater District, exceeded in density and breadth of occurrence only by the 'Apapane, White-eye, and House Finch. It occurred in all habitat types except grasslands, although it was rare in open native scrub. We found the highest concentrations of 'Amakihi near Palikū and in east Kaupō Gap. Closed scrub habitats in east Kaupō, between Palikū and 'Ō'ilipu'u, and on the outer northwest slopes also provide good habitat for 'Amakihi. The lowest densities occurred in savannah and scrub habitats at Pu'u Māmane and in the east central Crater region.

Previous studies report 'Amakihi most frequently from Palikū (Bonsey 1951; Dunmire 1961) and Hosmer Grove (Dunmire 1961; Yocom 1968; Oris 1971). Yocom saw 'Amakihi with fledglings between 13 and 18 July in east Kaupō Gap at Palikū, and we have seen adults with fledglings as late as August. Although these observations indicate roughly when breeding is tapering off, we were unable to determine when the breeding season may begin. On the island of Hawai'i, courtship may begin as early as October (Berger 1969; van Riper 1978).

#### 'Alauwahio (Maui Creeper, Loxops maculata newtoni, Fig. 17).

The Maui Creeper is rare in the Crater District, although with persistence it can be seen in rain forests near Hosmer Grove and Palikū. Even in these locations, densities are very low. The birds near Palikū were concentrated in the rain forest above the horse pasture along the trail leading to Kuiki. In July 1977, we saw a group of three birds behind Palikū Ranger Cabin.

The Hawaiian Creeper is a rain forest bird on all the islands where subspecies occur, and it will probably never be common in the Crater District because of the limited extent of this habitat type. We found no evidence for breeding, but van Riper (1972), who found the first nest of this subspecies, thought the breeding season was January through June. Conant (unpublished data) observed adults feeding fledglings in Kīpahulu Valley during the week of 15 to 22 August 1978, indicating that the season may be slightly later than van Riper suggested.

'Apapane (Himatione sanguinea sanguinea, Fig. 18).

The 'Apapane was the most common and widely distributed native bird in the Crater District, with a distribution and abundance pattern very similar to that of the 'Amakihi. In drier habitats, the 'Amakihi was often more abundant than the 'Apapane, while the reverse can be said of mesic and wet habitats. It is probably true that both species occur wherever there are māmane (Sophora chrysophylla) or 'ōhi'a (Metrosideros collina) trees. It appears that 'Amakihi are better able to exploit 'ōhelo and pūkiawe for food, as they are usually more common than 'Apapane in the scrub habitats.

Although we do not have data from all months of the year, we can say that 'Apapane are more abundant, or at least more obvious in the middle of their breeding season (February through June) than during other months. Immature 'Apapane were present from January through August, true to the prolonged breeding season typical of this species throughout its range (Berger 1972). However, distribution patterns are consistent at all times of the year.

'I'iwi (Vestiaria coccinea, Fig. 19).

The 'I'iwi was rare in the Crater District, although not as uncommon as the Maui Creeper. The 'I'iwi is primarily a rain forest species, although it may be quite common in some parkland habitats where māmane or koa (Acacia koa) form either a continuous or broken canopy, with a matrix of grasses and native shrubs interspersed between the colonies, or under a continuous tree canopy (Conant, in press). However, in Haleakalā, the 'I'iwi had a restricted distribution, being limited almost entirely to wet forest. An occasional bird may occur outside the rain forest proper; for example, L. Stemmermann (pers. comm.) observed a single individual at 'Ō'ilipu'u, about 1 mile from the nearest forest at Palikū, in June 1976.

Virtually all previous records of this species in the Crater District are from near Palikū or in Hosmer Grove (Bonsey 1951; Carpenter 1959a; Dunmire 1961; Ashmole and Ord 1963; Yocom 1968; Oris 1971). Conant found an 'I'iwi nest under construction in a pine tree (Pinus sp.) in Hosmer Grove in March 1978, and we have observed birds in immature plumage from June through August.



House Finch (Linnet, Papayabird, Carpodacus mexicanus, Fig. 20).

No other bird in the Crater District occurs as widely as the House Finch. It is probably more abundant than the Japanese White-eye, primarily because it can feed on the seeds of grasses and herbs, as well as insects and fleshy fruits. The birds are seen almost invariably in flocks generally ranging in size from 10 to 50 birds. Rarely, exceedingly large flocks of several hundred birds travel together through grasslands feeding on seeds and probably some insects. The House Finch occurred in all habitat types except rain forest, although it is sometimes found in ecotones between rain forest and other habitats.

The flocking behavior of this species makes it difficult to estimate densities and to detect breeding activity. Immatures resemble adult females and, together, they outnumbered males most of the time, but we were unable to quantify this relationship. Van Riper (1976) found the breeding season on Hawai'i to be from March through July, and on O'ahu Hirai (1975) reported it to be from February through August. We suggest that the breeding season in Haleakalā would probably be similar to that on the island of Hawai'i because the environmental factors in Haleakalā resemble more closely those in the habitats van Riper studied.

Rare species (Fig. 21).

Five introduced species occurred in the Crater District, but were quite rare: the Rock Dove (Columba livia), the Melodious Laughing-thrush (Garrulax canorus), the Common Myna (Acridotheres tristis), the Spotted Munia or Ricebird (Lonchura punctulata), and the Cardinal (Cardinalis cardinalis).

F. Howarth (pers. comm.) found five Rock Doves roosting in a lava tube between Waikau and Hōlua cabins, and Conant saw a flock of five birds flying in Ko'olau Gap immediately east of Hosmer Grove. Both observations were made in June 1976. Stemmermann observed several individuals at the edge of Ko'olau Gap in August 1978.

We heard calls and song of the Melodious Laughing-thrush near Koa Tree at the Park borders on several occasions. Stemmermann (1976) also reported them from this area and in mesic forests to the east. The bird is more common in mesic exotic forests and some disturbed native mesic forests and rain forests elsewhere on Maui (Conant, unpublished data).

The Common Myna rarely occurs any distance from clusters of buildings at Park Headquarters and Hosmer Grove. However, Conant observed two birds on the Halemau'u Trail and one in a solitary grove of Eucalyptus sp. trees west of Kalahaku Overlook on the outer slope of Haleakalā.

The Spotted Munia occurred in two places: Palikū horse pasture and just above Koa Tree. This suggests that birds may occur in low numbers throughout eastern Kaupō Gap. The species occurs in similar habitats up to about 6000 feet (1830 m), on the east flank of Mauna Loa (Conant, in press). H. E. Smith (1976) reported Spotted Munia from Hosmer Grove and Pu'u Nianiau.

Cardinals were seen consistently near Koa Tree during this study and by Stemmermann (1976). We also saw them in closed native scrub and in exotic forests at Hosmer Grove, as did H. E. Smith (1976).

### Patterns of Distribution

Several patterns in avian distribution and diversity are apparent from our data. Species richness in the Crater is strongly affected by vegetation patterns. The number of species generally increases with increasing plant cover, with the lowest number of species occurring in the arid western region of the Crater, and the highest number occurring in mesic forests, particularly those along the eastern boundary of the Crater District. Similarly, and as altitude decreases on the outer Crater slopes, bird species richness, vegetation cover, and plant species richness all increase together.

Specific distribution patterns are reflective of the niche components (especially the feeding niche) of the birds in question. Distributions of native and non-native species are broadly separable on this basis. Exotic species generally have wide distributions; each species may have a distribution encompassing several different habitat types, and may be common throughout most of its range. This tendency towards wide distributions shown by exotics is in many cases reflective of their generalized ecologies. The broad feeding niches of many of these birds enable them to utilize diverse habitat types.

The distributions of the two most common exotics, the Japanese White-eye and the House Finch, are good examples of these patterns. Both species occur in habitat types between the extremes of arid scrub and grasslands, and wet forests. As shown in Table 2, both species occur in fairly high densities even outside their optimal habitats. The House Finch seems to have a greater ability to use marginal habitats than does the White-eye, possibly because of its feeding behavior and greater mobility.

Other exotic species have broad ranges similar to those of the White-eye and House Finch, but occur in lower densities. These species typically occur in fewer habitat types than their more abundant counterparts, and may have more specialized feeding habits. Among the species showing such distributions are the Ring-necked Pheasant, the Mockingbird, and the Skylark. Each of these birds occurs over a large area of the Crater, but as indicated in Table 2, none occurs in very large numbers in any one habitat type.

Some exotic species are rare in the Crater District, either because their ranges are expanding into the area, or because they are poorly adapted to Crater habitats. The Gray Francolin is an example of the first category: it is uncommon in the Park and has a localized distribution in the west side of Kaupō Gap. The bird is common in Kaupō ranchlands, but was not recorded in the Park prior to this study. Other exotics, mostly non-game species, such as the Melodious Laughing-thrush and the Cardinal have been sighted on a sporadic basis, generally on the periphery of the Crater District. These birds are unable to persist in Crater habitats as yet, possibly due to food limitations and an inability to cope with the climatic conditions.

Two exotic species reported by Ruhle (1959), the California Quail (Lophortyx californicus) and the House Sparrow (Passer domesticus), were not recorded during our surveys. Apparently they were never common in the Crater District and have not persisted since earlier sightings. Only Ruhle (1959) has reported the House Sparrow, but one other report of the California Quail (Carpenter 1959a) occurs in the literature.

Native species show distribution trends similar to the exotics, although they have more restricted distributions and are often uncommon outside limited areas. The dietary specificity of most native forest birds limits them to small areas of suitable habitat. Table 2 illustrates the restricted ranges of these birds. It appears that native birds, unlike exotic birds, are strongly and negatively affected by habitat changes caused by grazing feral ungulates and the invasion of exotic plants. The generalized native forest birds (e.g., the 'Amakihi and the 'Apapane) have larger distributions in the Crater District and are in less danger of extirpation from the area than the more specialized Maui Creeper and 'I'iwi. The ranges of the latter species within Haleakalā are limited and are probably highly sensitive to seasonal shifts in resource abundance, apparently more so than those of the 'Amakihi and 'Apapane.

Native non-passerines tend to have broader ranges than do the honeycreepers, but none are as abundant as the broad-ranged exotics such as the Chukar (Fig. 7) or Pheasant (Fig. 9). As illustrated in Figures 6 and 11, the ranges of the Nēnē and the Pueo are similar in many respects to those of the broad-ranged exotics, except in regard to density values. The lower densities of native non-passerines may be attributed to several factors, among them, competition between native and exotic species and the resultant exclusion of natives from sub-optimal habitats, habitat alteration, and predation by exotic mammals, all of which merit further study.

#### Structure and Ecological Relationships of the Avifauna

During our surveys, we found 5 endemic (22%), 4 indigenous (17%), and 14 exotic (61%) bird forms (including species and sub-species) in the Crater District of Haleakala National Park. Since the arrival of European man, four endemic Hawaiian forms

formerly found on Maui have apparently become extirpated (Hawaii Audubon Society 1978). Two of these, the 'A'o or Newell's Shearwater (Puffinus puffinus newelli) and the 'O'ū (Psittirostra psittacea), are likely to have been found in Haleakala National Park. Drastic changes in vegetation within the Crater District as a result of grazing by cattle (Bos taurus) and especially goats (Capra hircus) and rooting by feral pigs (Sus scrofa) have probably been responsible for eliminating several forest birds from this portion of the Park (e.g., 'Akepeu'ie or Maui 'Akepa, Loxops coccineus ochraceus; Maui Nukupu'u, Hemignathus lucidus affinis; Maui Parrotbill, Pseudonestor xanthophrys; and 'Ākohekohe or Crested Honeycreeper, Palmeria dolei). Although these birds may still be found within the National Park, they can no longer be seen in the Crater District.

Seasonal variation was observed in some species, although such variations do not appear to be particularly important. The 'Ua'u is absent during non-breeding months (November through February), and the Plover is absent during its breeding season (April through August). Chukar chicks are common during late spring and summer months, while the more secretive Ring-necked Pheasant and its offspring are less obvious during breeding months (January through July). Only two introduced passerines show marked seasonal variation. House Finches are more obvious, though probably not more abundant, in the spring and summer months because they travel in large flocks (rarely as large as 500 birds) during this time. There may be some relationship between this behavior and the fruiting times of grasses, important food sources for this species. The second such species, Leiothrix, is much more abundant in the Palikū area in late spring and early summer, undoubtedly in response to fruiting of 'ākala shrubs and exotic plum trees.

Long-established introduced species of birds form the largest contingent of the Crater District avifauna, in terms of both species composition and abundance. Changes in the structure and plant species composition of the various communities in the Crater District have undoubtedly facilitated the successful establishment of many of the exotic birds. Granivorous birds (Skylark, Spotted Munia, Cardinal, and House Finch) and frugivorous or browsing birds (Leiothrix, Chukar, Ring-necked Pheasant) are successful in the extensive grass and scrubland areas, much of which were once occupied by dry forest or savannah communities. Some species appear to be filling niches unoccupied by native forms on Maui (e.g., the seed-eater niche), but some (e.g., Chukar, Ring-necked Pheasant, Barn Owl) may have some competitive overlap with native species (e.g., Nēnē, Pueo).

A few of the exotic species are rare (Gray Francolin, Barn Owl, Rock Dove, Melodious Laughing-thrush, Spotted Munia, Cardinal) and, at present, probably have minimal impact on the native forms. Several species, however, may continue to expand their ranges if reproductive success is high (e.g., Barn Owl, Melodious Laughing-thrush, Cardinal, Spotted Munia).

Very little is known of the impact of the exotic bird species on native ecosystems, particularly the avifauna. The possibility of competition exists between at least three groups of native and exotic birds. Ground-nesting herbivores, the Chukar and the Ring-necked Pheasant, may exploit some of the same resources as the Nēnē. The Barn Owl and the Pueo undoubtedly prey on some of the same mammal and bird species and may compete for nesting sites. Two common passerines, the Japanese White-eye and the Leiothrix, and possibly the Melodious Laughing-thrush, may have some impact on native forest bird populations by competing for food or as disease vectors.

As long as ecosystems in the Crater District continue to change as a result of the continued impact of exotic biota, avifaunal structure and interspecies relationships will remain in a state of flux. While reduction of the exotic birds species is desirable for the welfare of native birds, it is impractical for many species. The native avifauna stands the best chance of restoration or survival if successional trends in the present heavily impacted ecosystems are toward climax communities of a relatively pristine nature.

#### Endangered Species Management

Two endangered Hawaiian birds breed in the Crater District of Haleakala National Park: the 'Ua'u, Pterodroma phaeopygia sandwichensis, and the Nēnē, Branta sandvicensis.

The cliffs of Haleakala Crater constitute the most important known breeding grounds of the 'Ua'u, an endemic Hawaiian form of the Dark-rumped Petrel. Perhaps the most serious threat to the continued survival of this species is predation, primarily by rats--probably Rattus rattus (Kjargaard, in press). The National Park Service has an ongoing program of rat control by means of snap traps, which is intensified during the breeding season of the 'Ua'u. It is of the utmost importance that this program be continued and intensified to ensure successful nesting of this endangered species.

The access afforded by the terrain of the 'Ua'u nesting area extending from Red Hill to above Hōlua Cabin provides a good opportunity for an urgently needed intensive study of the biology and behavior of this species. The U. S. Fish and Wildlife Service (1974) lists two 'Ua'u breeding grounds that have not been intensively surveyed in recent years: at Haupa'akea Peak (3.5 miles west of Haleakalā proper) and above Kapalaoa Cabin. These areas should be studied closely during the breeding season to determine the size of breeding populations that may still exist there, as well as their nesting success. If substantial numbers of 'Ua'u are breeding in these areas, it would be advisable to expand predator control programs to include them.

The Nēnē, which apparently disappeared from Maui in the early 1900's, is being reintroduced to Haleakalā via the release of captive-raised birds. The Nēnē restoration program has been successful in establishing populations of this species within the Haleakala Crater District (Pratt 1977). Since 1962, 489 birds have been released in Haleakalā. However, we estimated the total Crater District population to be approximately 80 to 100 birds. This situation does not indicate that breeding in the wild is adequate to ensure the species' success. While restoration programs have involved the release of larger numbers of Nēnē on Hawai'i, these populations of captive-raised birds are much less easily monitored than those on Maui because they are so much more widely distributed. For this reason, and because the State of Hawaii has been unable to carry on an intensive program to monitor nesting success of released birds, the Haleakalā population should be studied carefully. While there is no doubt that the species is now easily maintained in captivity, it is clear that breeding success of captive-raised birds in the wild is insufficient to warrant removing the species from its endangered classification.

Both Haleakala and Hawaii Volcanoes National Parks have initiated Nēnē restoration programs involving the concept of a "Nēnē Park" (Banko, in press). That is, birds are raised in the same areas as they are to be released. This program has enjoyed some success, and it offers an alternative to the State of Hawaii's program of releasing birds in areas unfamiliar to them. Fortunately, there are plans to continue both programs and to expand the "Nēnē Park" program.

Predation is probably the most serious factor hindering nesting success of Nēnē in the wild on both Maui and Hawai'i. Mongoose, pigs, cats, dogs, and rats are all likely to destroy nests, eggs, young, and adults. Although the Park Service prohibits visitors from bringing dogs and cats into the Crater, feral animals often enter independently. As with the 'Ua'u, the Park's program of predator trapping, which is intensified during breeding months, will be continued and should probably be geographically expanded. (Efforts are now concentrated in the Paliku area.) P. Banko (pers. comm.), currently conducting intensive studies of the Nēnē in both Hawaii Volcanoes and Haleakala National Parks, has some evidence that mongoose are probably the most important Nēnē predators. The results of his research should provide some important guidelines for the present Nēnē restoration project.

While the management of endangered species should be a high priority, management of ecosystems to enhance habitat quality for native birds in general is also of great importance. We suggest that management efforts in this direction be concentrated on the elimination of feral mammals, especially goats and pigs, and exotic plants. Another important priority for National Park Service Management programs related to avifauna is the support and encouragement of basic research on the biology of native bird species with emphasis on the nature of habitat requirements and factors affecting breeding success. Such studies might begin

with endangered species, particularly those most limited in their numbers and distribution. It will also be important to initiate research on some of the more successful exotic species with the objective of determining their potential for competition with native birds and their effects on other ecosystem components.

#### SUMMARY

Field surveys conducted in the Crater District of Haleakala National Park between June 1976 and August 1978 revealed the presence of 23 species of birds in 22 genera and 15 families. There were 14 introduced, 4 indigenous, and 5 endemic species. Two of the endemic species contain forms endemic to Maui, and two of the indigenous species contain forms endemic to Hawai'i. The 'Ua'u (Dark-rumped Petrel, Pterodroma phaeopygia sandwichensis) and the Nēnē (Hawaiian Goose, Branta sandvicensis), both endemic to Hawai'i, are also considered endangered. The major breeding population of 'Ua'u is found within the study area.

Greatest numbers of species and individuals were found in small, densely vegetated areas, while much of the extensive areas of volcanic cinder and ash were devoid of both plants and birds. Scrub habitats and alpine grasslands suffer serious disturbance from grazing by feral goats (Capra hircus) and rooting by feral pigs (Sus scrofa), both of which facilitate the spread of introduced plants. Ecosystem disturbance associated with the presence and activities of introduced biota obviously favors the survival of introduced birds, which were abundant and widely distributed. With the exception of the 'Apapane (Himatione sanguinea) and the Maui 'Amakihi (Loxops virens wilsoni), native passerines were uncommon with restricted distributions.

Seasonal trends in abundance and distribution were noted for some species, and are apparently influenced by fluctuations in the availability of food resources, especially seeds, fruits, and nectar-producing flowers.

Several endemic passerines which actually or probably occurred in the study area several decades ago can be found in the relatively undisturbed rain forests on the northeast slopes of Haleakalā. Their absence from the Crater District indicates the importance of negative ecological impact that has resulted from the unwise introduction of numerous plants and animals.

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TABLE 1. Number and percentage of endemic, indigenous, and exotic bird species found in the Crater District of Haleakala National Park.

BIRD FORM	NUMBER	PERCENTAGE
Endemic	5	22
Indigenous	4	19
Exotic	<u>14</u>	<u>59</u>
Totals	23	100

TABLE 2. Summary table of bird densities in five habitat types in the Crater District of Haleakala National Park (P = present at a density less than 1 bird/40 ha).

Scientific Name	Hawaiian or Vernacular Name	Habitat* Density (bird/40 ha)				
		1	2	3	4	5
<u>Pterodroma phaeopygia sandwichensis</u>	'Ua'u	P				
<u>Phaethon lepturus dorotheae</u>	Koa'e-kea	P	P	P		
<u>Branta sandvicensis</u>	Nēnē	2	5-10	1-5	1	
<u>Alectoris chukar</u>	Chukar	1-20	5	1-10	2-4	
<u>Francolinus pondicerianus</u>	Gray Francolin	P			P	
<u>Phasianus colchicus</u>	Ring-necked Pheasant	300	5	1	1-25	
<u>Pluvialis dominica</u>	Kōlea		5	5		
<u>Asio flammeus sandwichensis</u>	Pueo		2		P	P
<u>Tyto alba</u>	Barn Owl		2		P	
<u>Columba livia</u>	Rock Dove				P	
<u>Alauda arvensis</u>	Skylark		2	2	1	
<u>Garrulax canorus</u>	Melodious Laughing-thrush					P
<u>Leiothrix lutea</u>	Leiothrix				1-18	3-20
<u>Mimus polyglottos</u>	Mockingbird	P	1	1-4	1-2	

TABLE 2--Continued.

Scientific Name	Hawaiian or Vernacular Name	Habitat*				
		1	2	3	4	5
<u>Zosterops japonica</u>	Japanese White-eye	P	7	1-8	P-13	15-275
<u>Acridotheres tristis</u>	Common Myna	P				
<u>Loxops virens wilsoni</u>	Mau'i 'Amakihi			1	1-6	20-130
<u>Loxops maculata newtoni</u>	'Alauwahio				P-3	P-12
<u>Himatione sanguinea sanguinea</u>	'Apapane	P		6	P-40	4-330
<u>Vestiaria coccinea</u>	'I'iwi				P-6	1-8
<u>Lonchura punctulata</u>	Spotted Munia		P		1-6	
<u>Cardinalis cardinalis</u>	Cardinal				P-2	
<u>Carpodacus mexicanus</u>	House Finch	P	1-40	P-35	P-45	1-25

## \* Habitat types:

- 1) Rock, cinder, open native scrub; crater floor; crater slopes
- 2) Grasslands
- 3) Savannah
- 4) Closed native scrub
- 5) Native rain forest

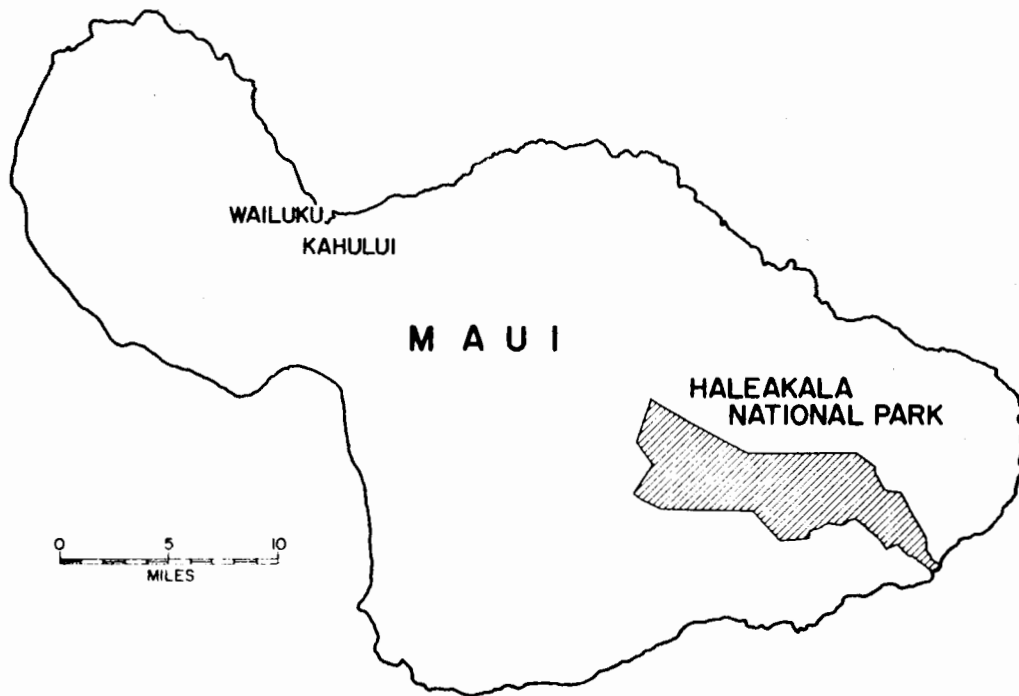
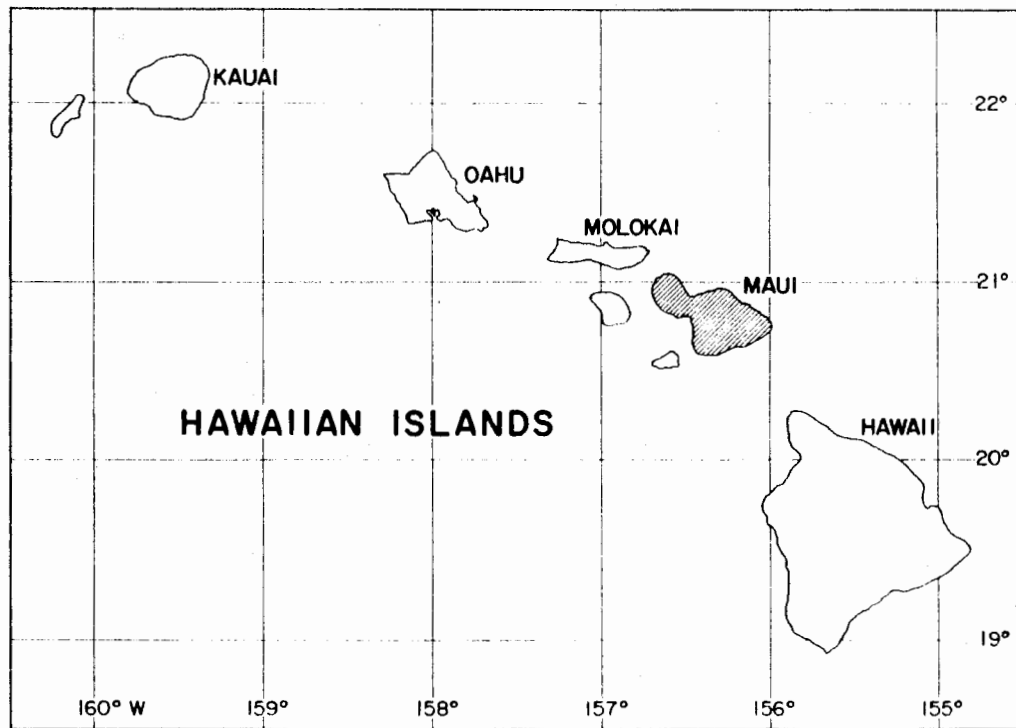


FIGURE 1. Map of the major Hawaiian Islands with enlarged view of Maui to show the location of Haleakala National Park.

# HALEAKALA NATIONAL PARK CRATER DISTRICT

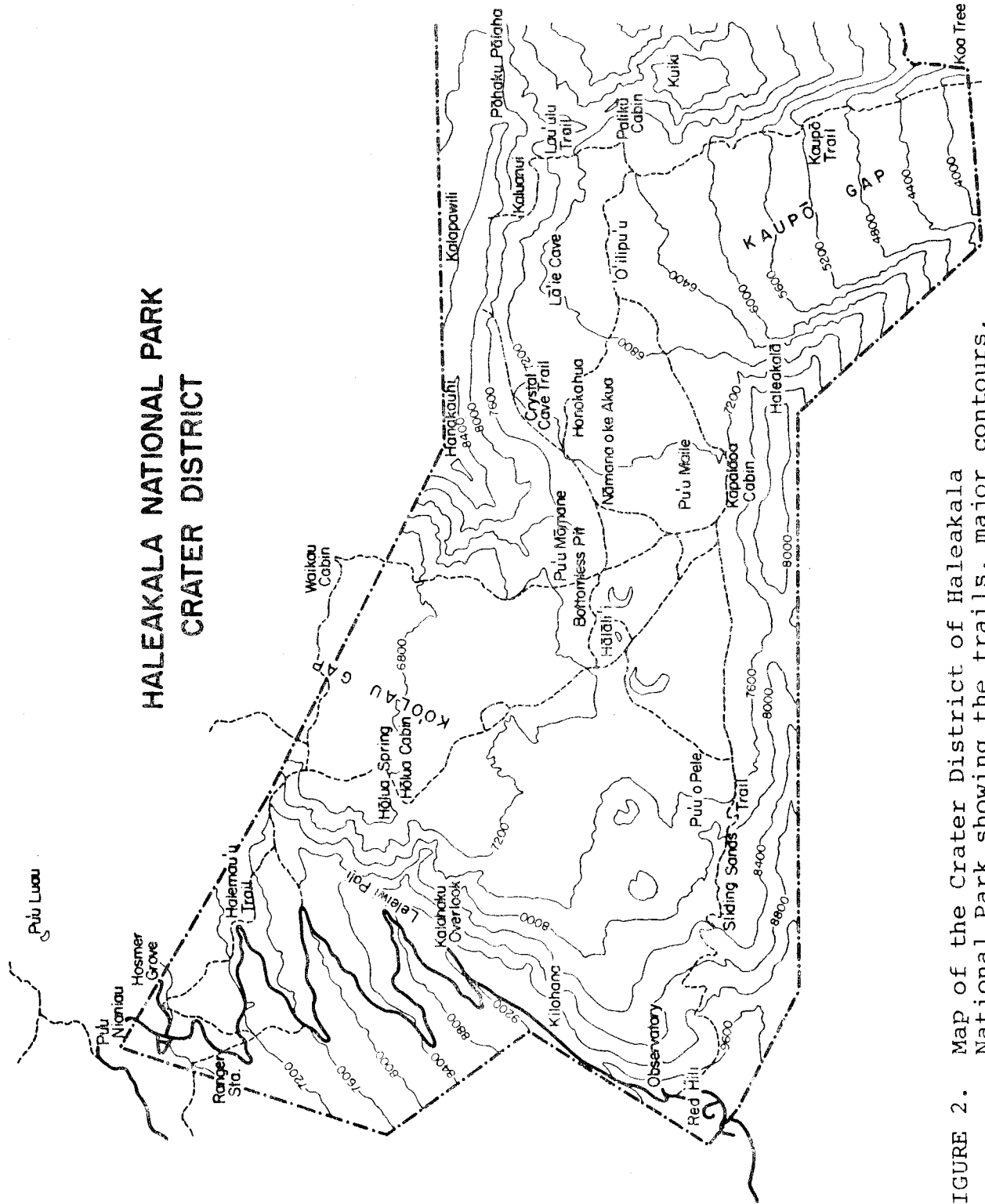


FIGURE 2. Map of the Crater District of Haleakala National Park showing the trails, major contours, and place names referred to in this report.



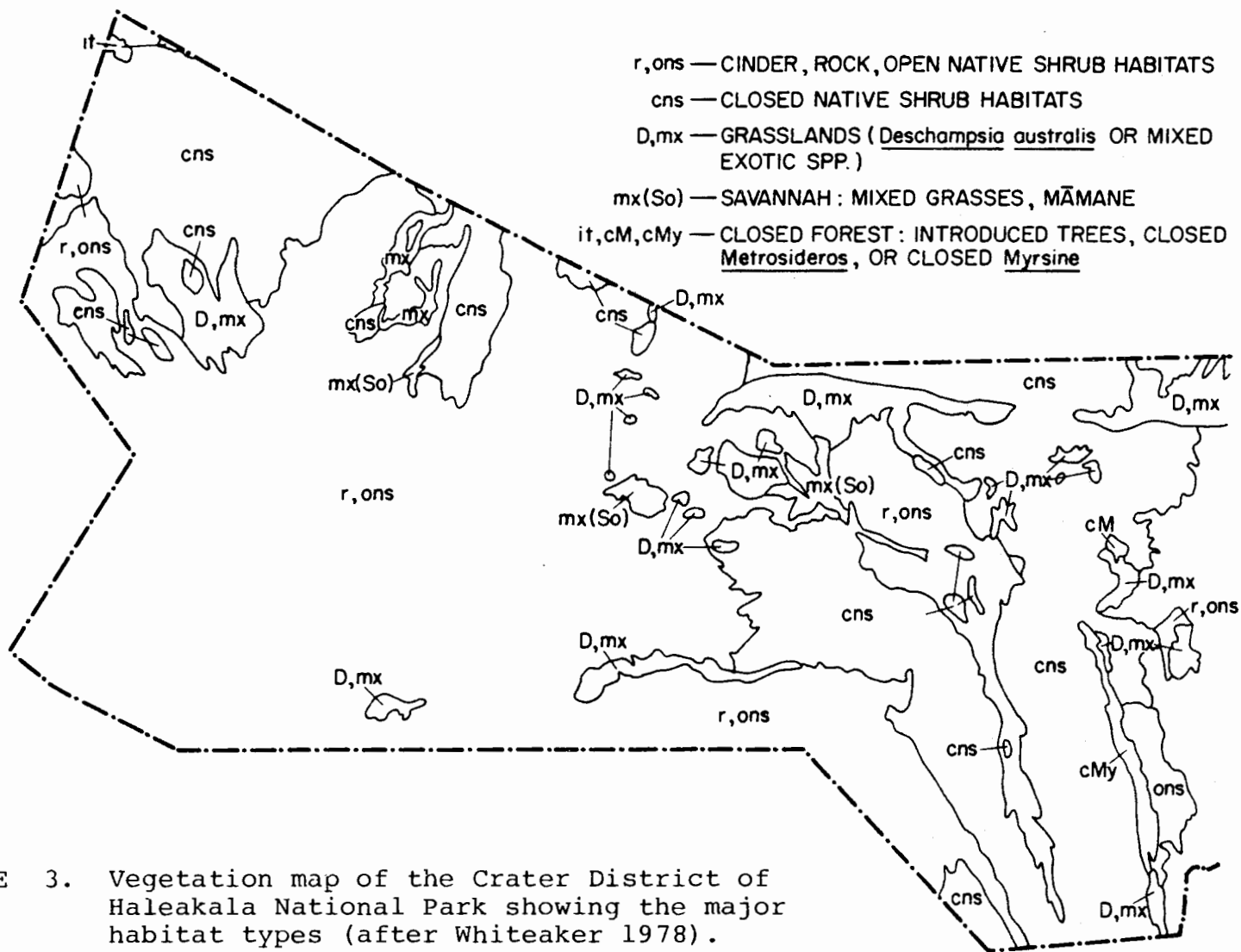


FIGURE 3. Vegetation map of the Crater District of Haleakala National Park showing the major habitat types (after Whiteaker 1978).

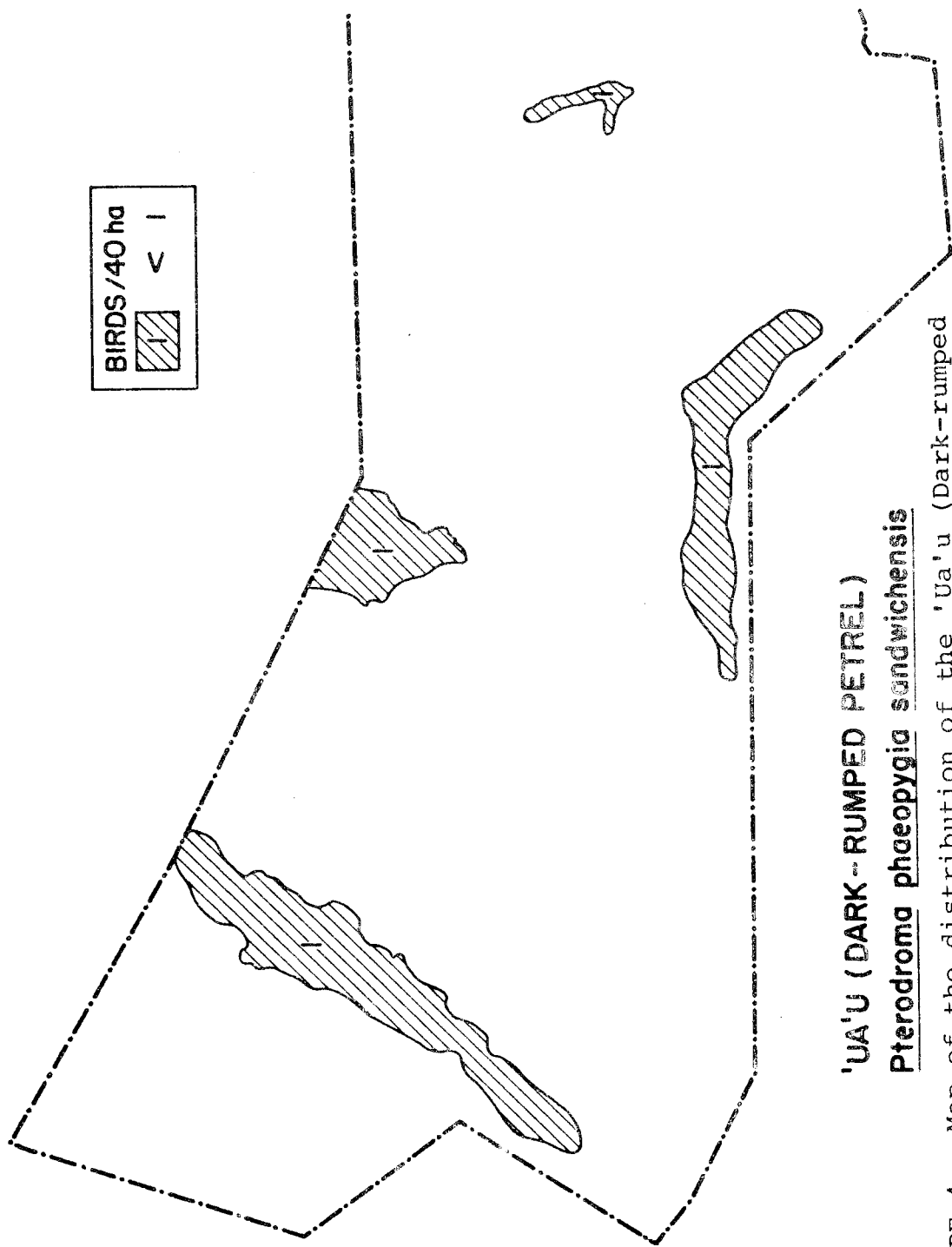
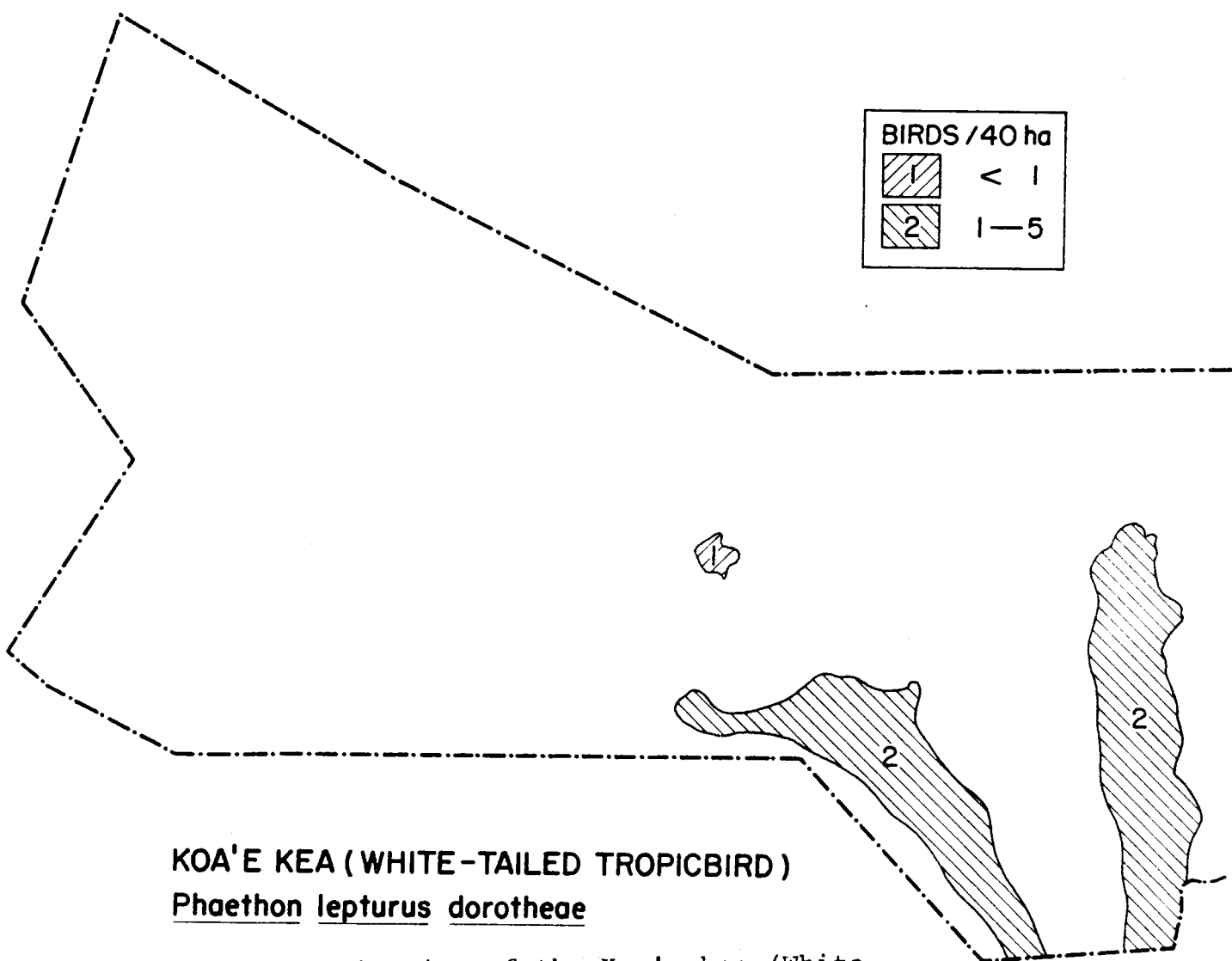
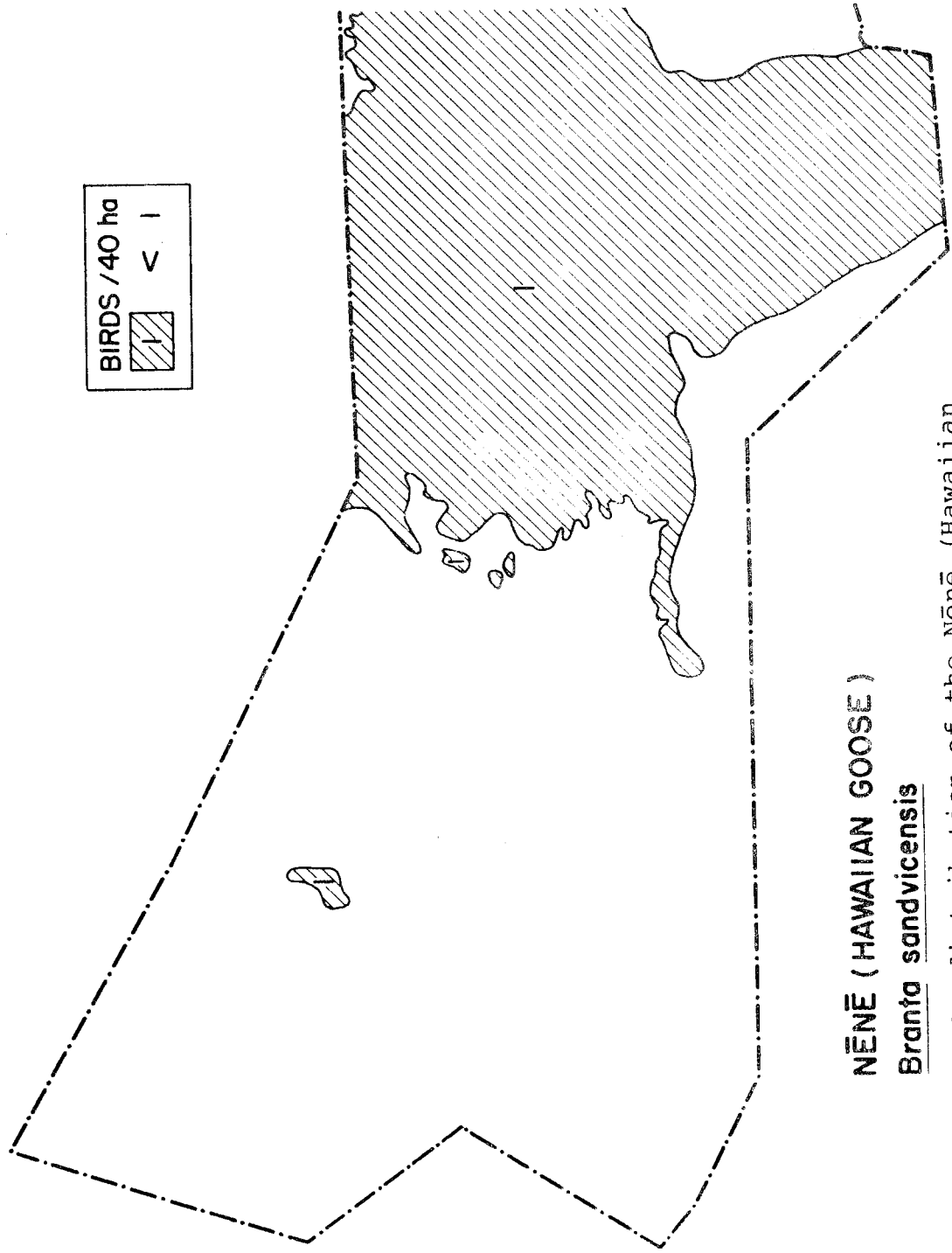


FIGURE 4. Map of the distribution of the 'Ua'u (Dark-rumped Petrel), Crater District, Haleakala National Park.



**KOA'E KEA (WHITE-TAILED TROPICBIRD)**  
**Phaethon lepturus dorotheae**

FIGURE 5. Map of the distribution of the Koa'e-kea (White-tailed Tropicbird), Crater District, Haleakala National Park.



**NĒNĒ (HAWAIIAN GOOSE)**

***Branta sandvicensis***

FIGURE 6. Map of the distribution of the Nēnē (Hawaiian Goose), Crater District, Haleakala National Park.

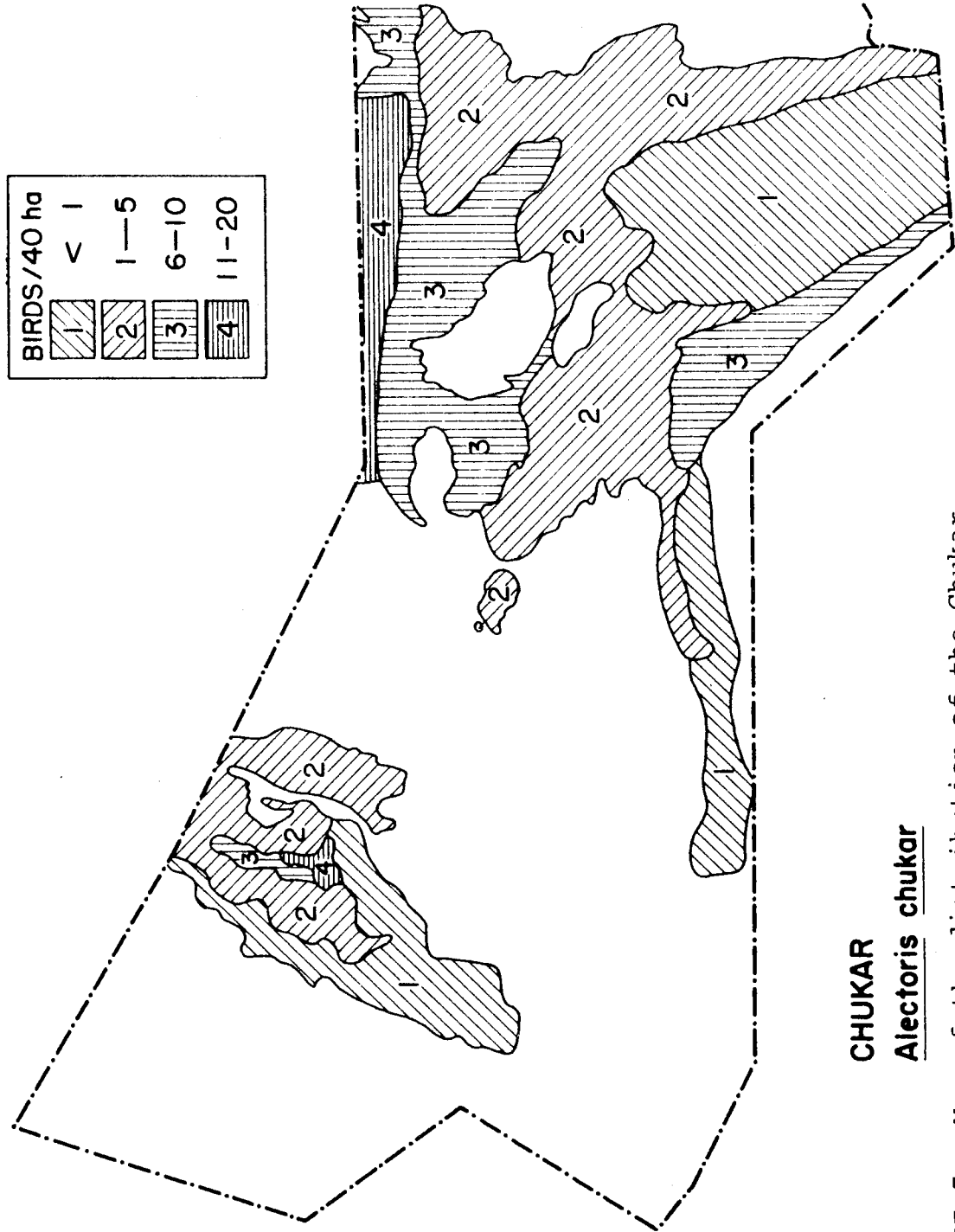


FIGURE 7. Map of the distribution of the Chukar, *Alectoris chukar*, Crater District, Haleakala National Park.

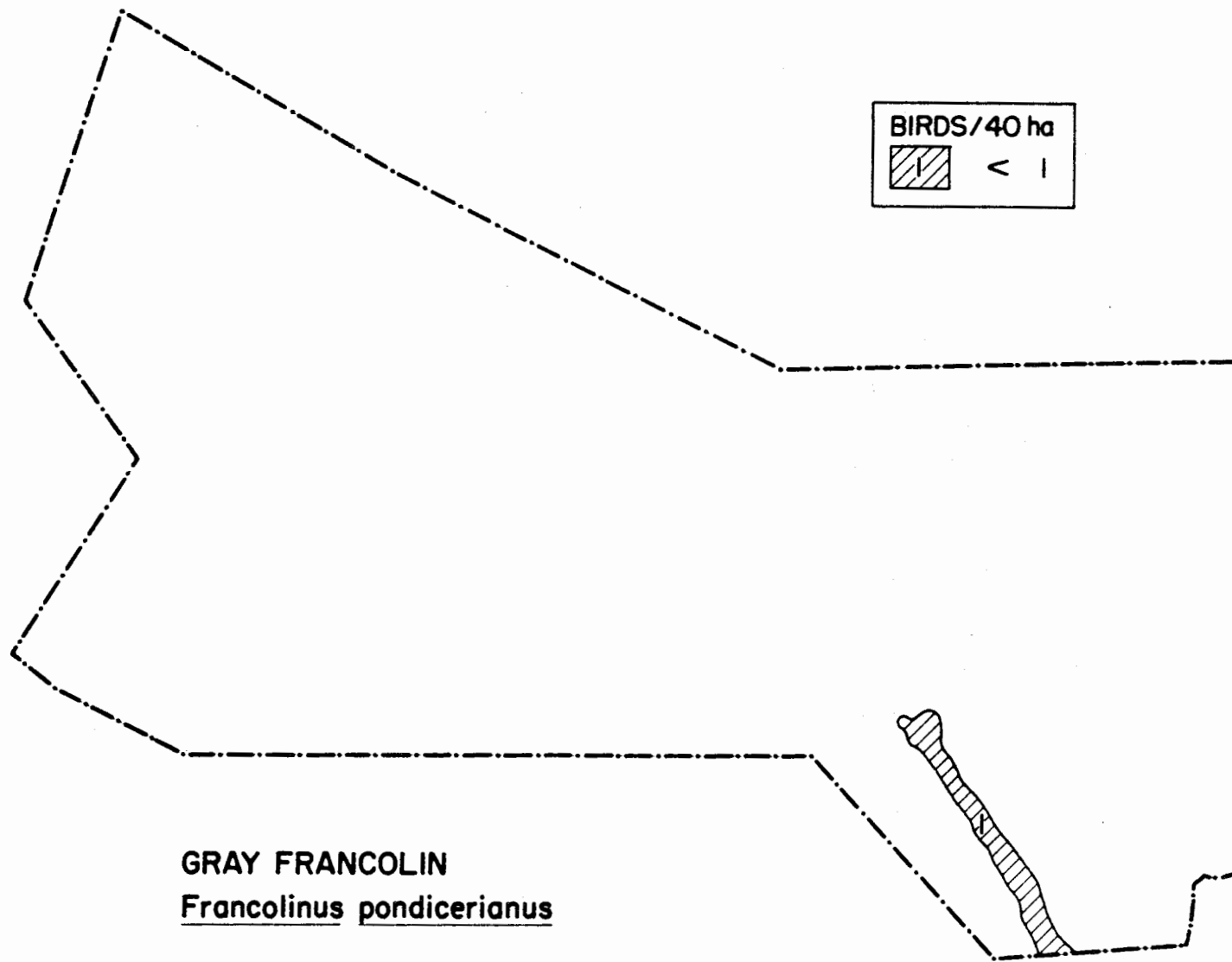
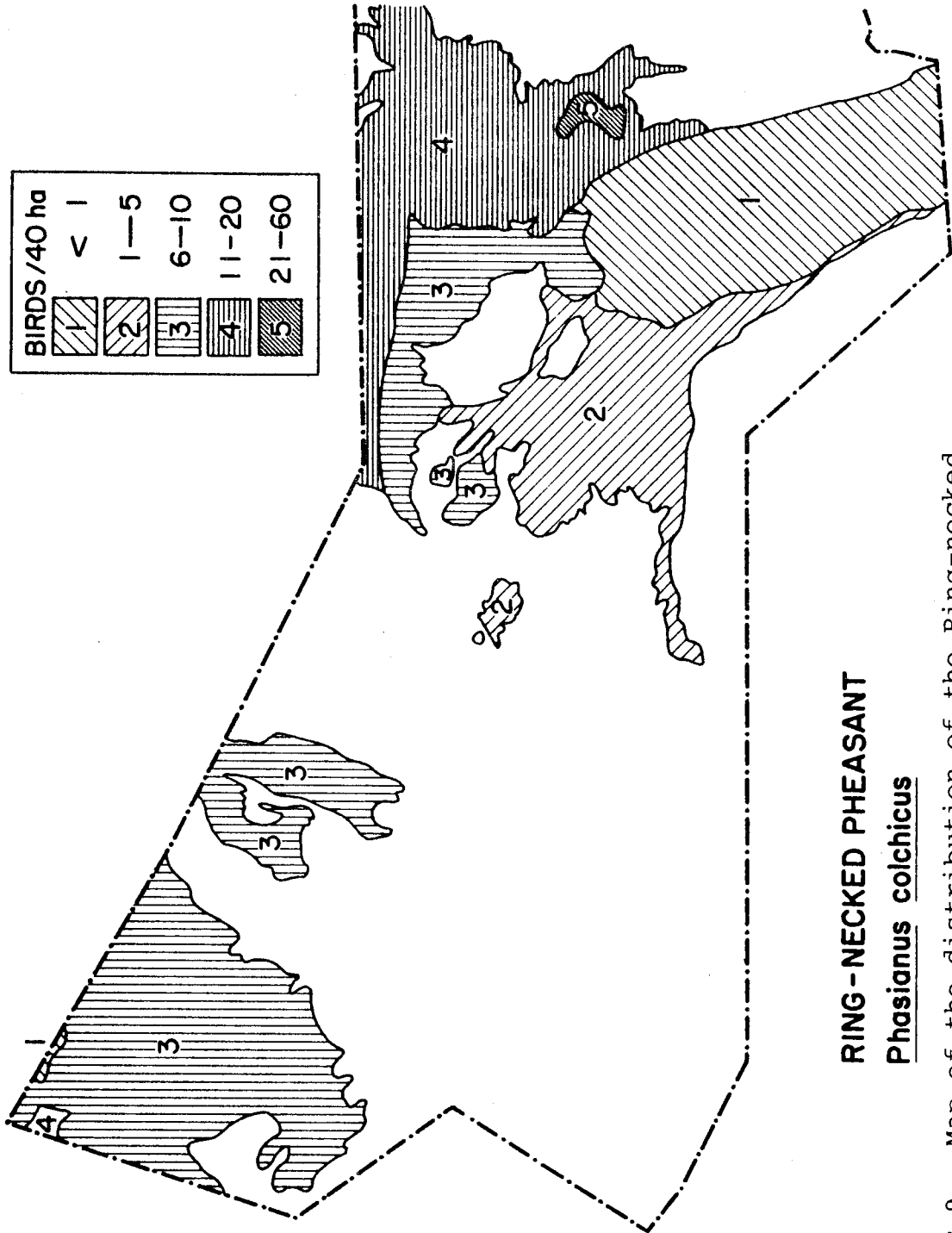


FIGURE 8. Map of the distribution of the Gray Francolin, Crater District, Haleakala National Park.



**RING-NECKED PHEASANT**  
***Phasianus colchicus***

FIGURE 9. Map of the distribution of the Ring-necked Pheasant, Crater District, Haleakala National Park.

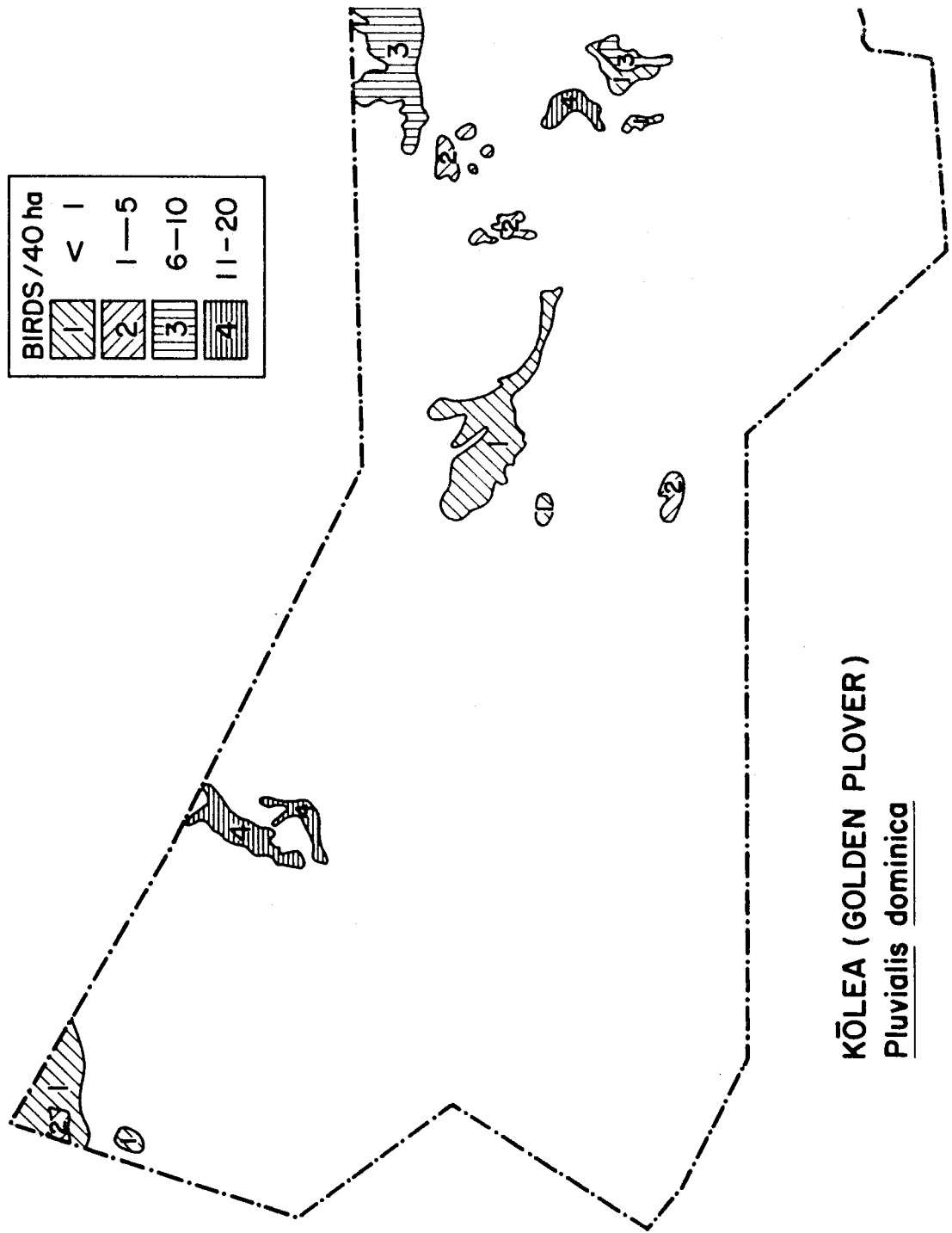


FIGURE 10. Map of the distribution of the Kōlea (Golden Plover), Crater District, Haleakala National Park.



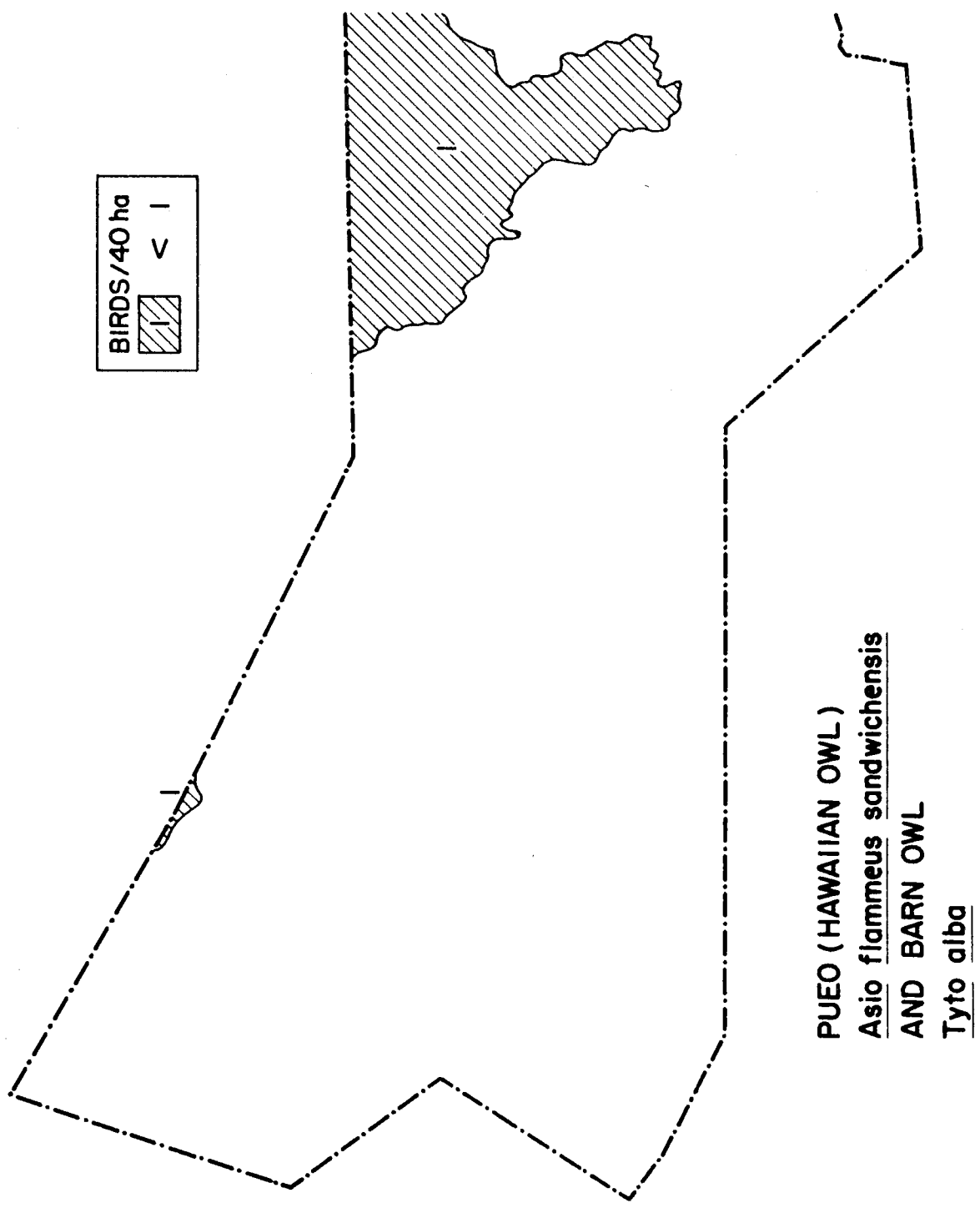


FIGURE 11. Map of the distribution of the Pueo (Hawaiian Owl) and Barn Owl, Crater District, Haleakala National Park.

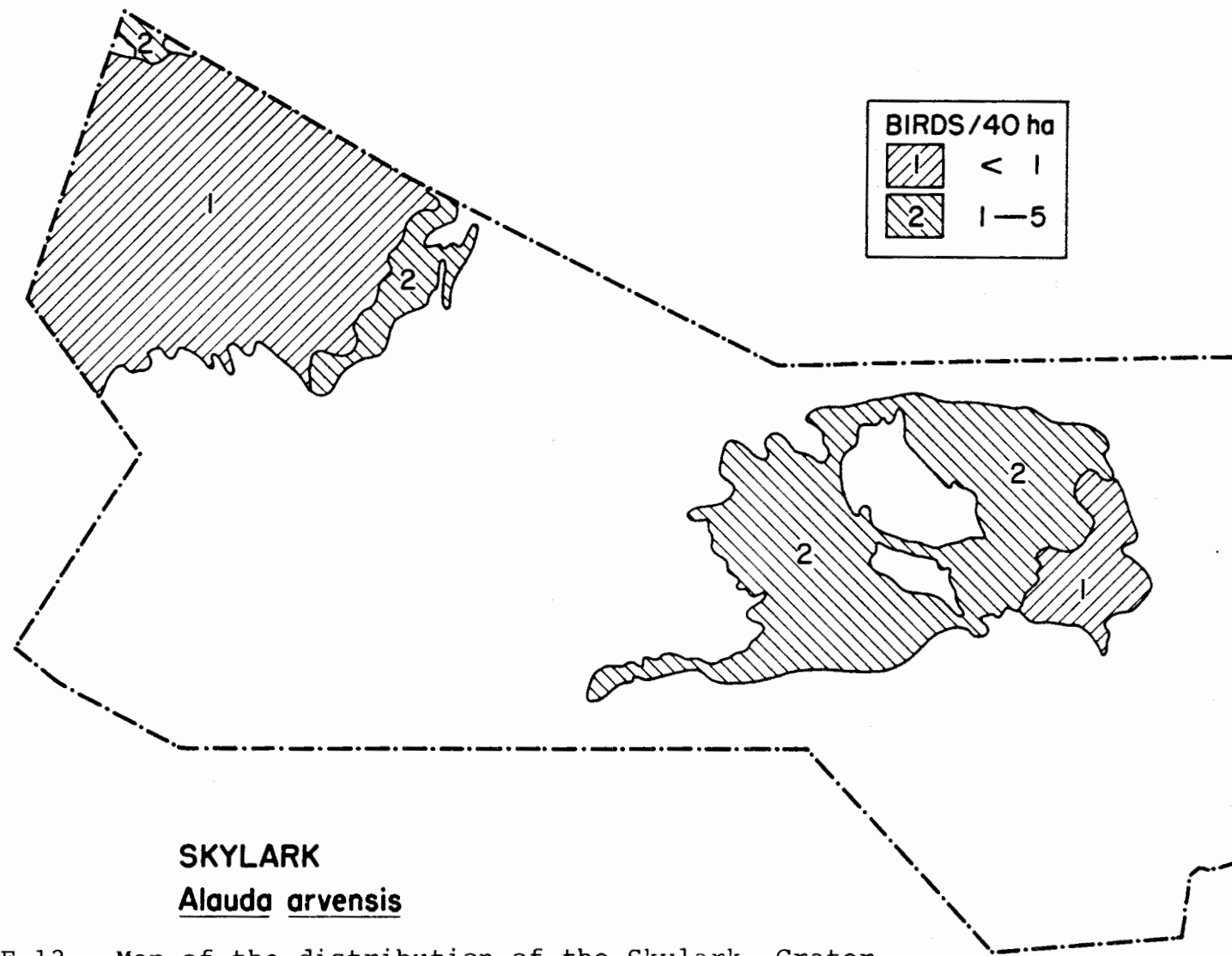


FIGURE 12. Map of the distribution of the Skylark, Crater District, Haleakala National Park.

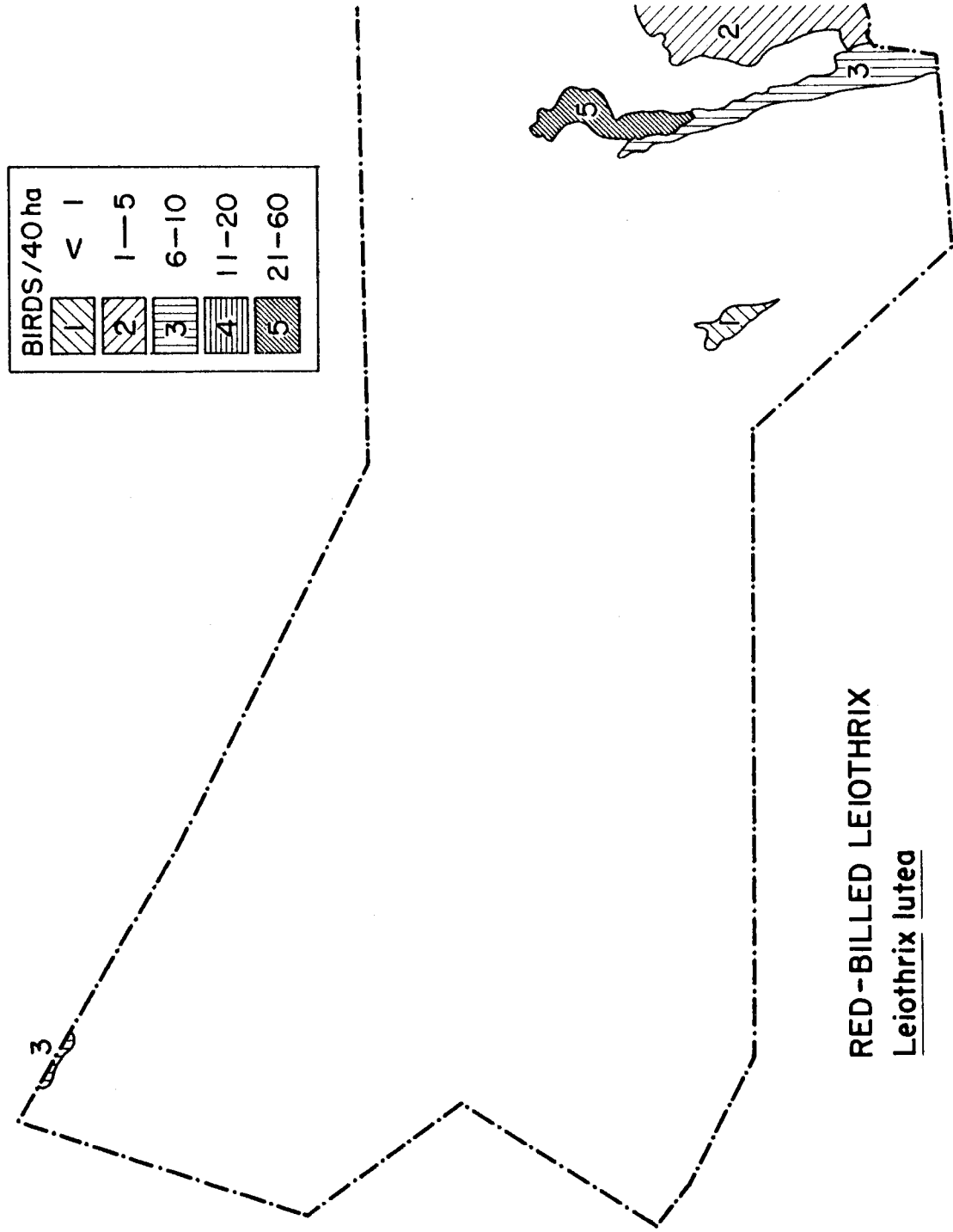


FIGURE 13. Map of the distribution of the Red-billed Leiothrix, Crater District, Haleakala National Park.

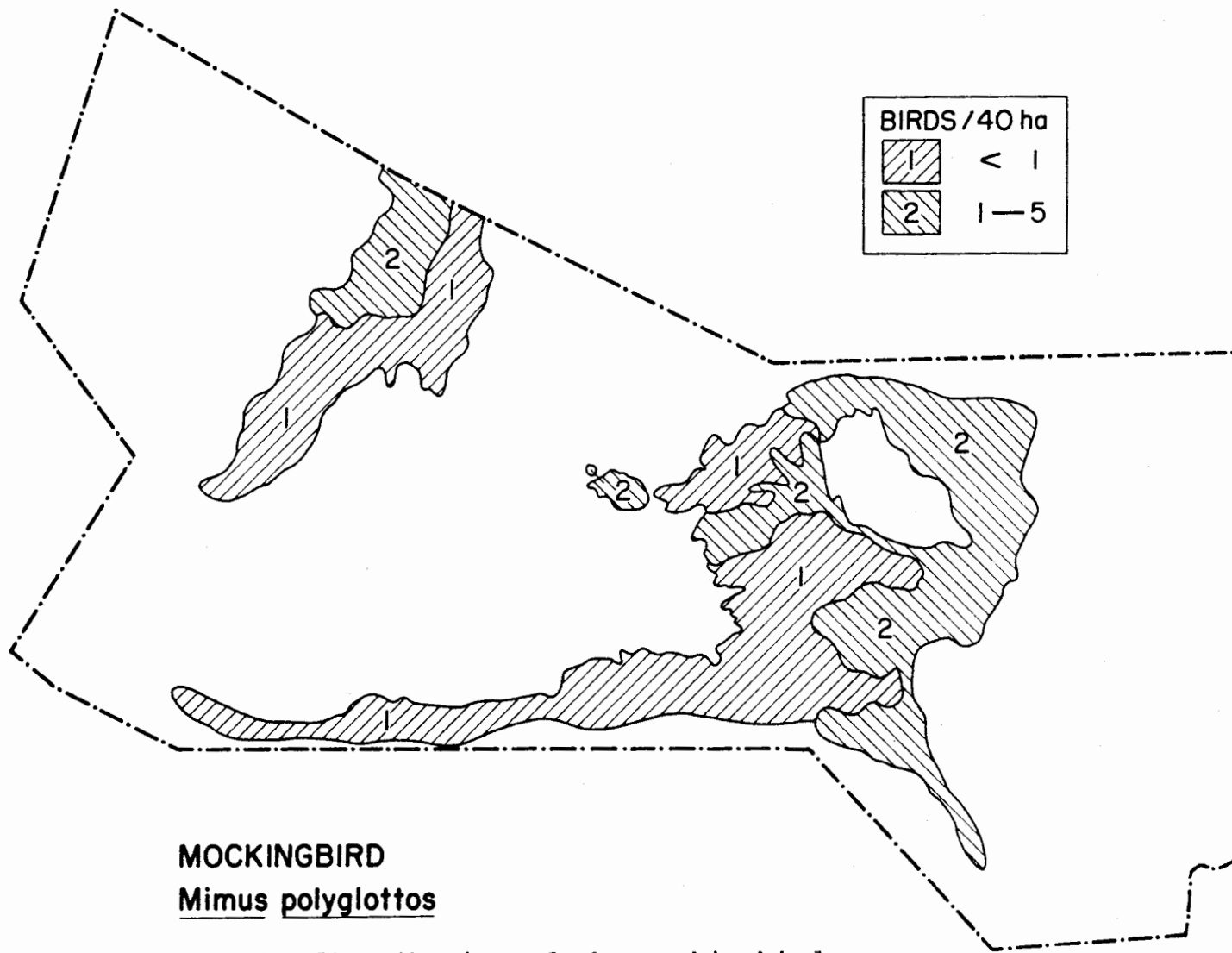


FIGURE 14. Map of the distribution of the Mockingbird, Crater District, Haleakala National Park.

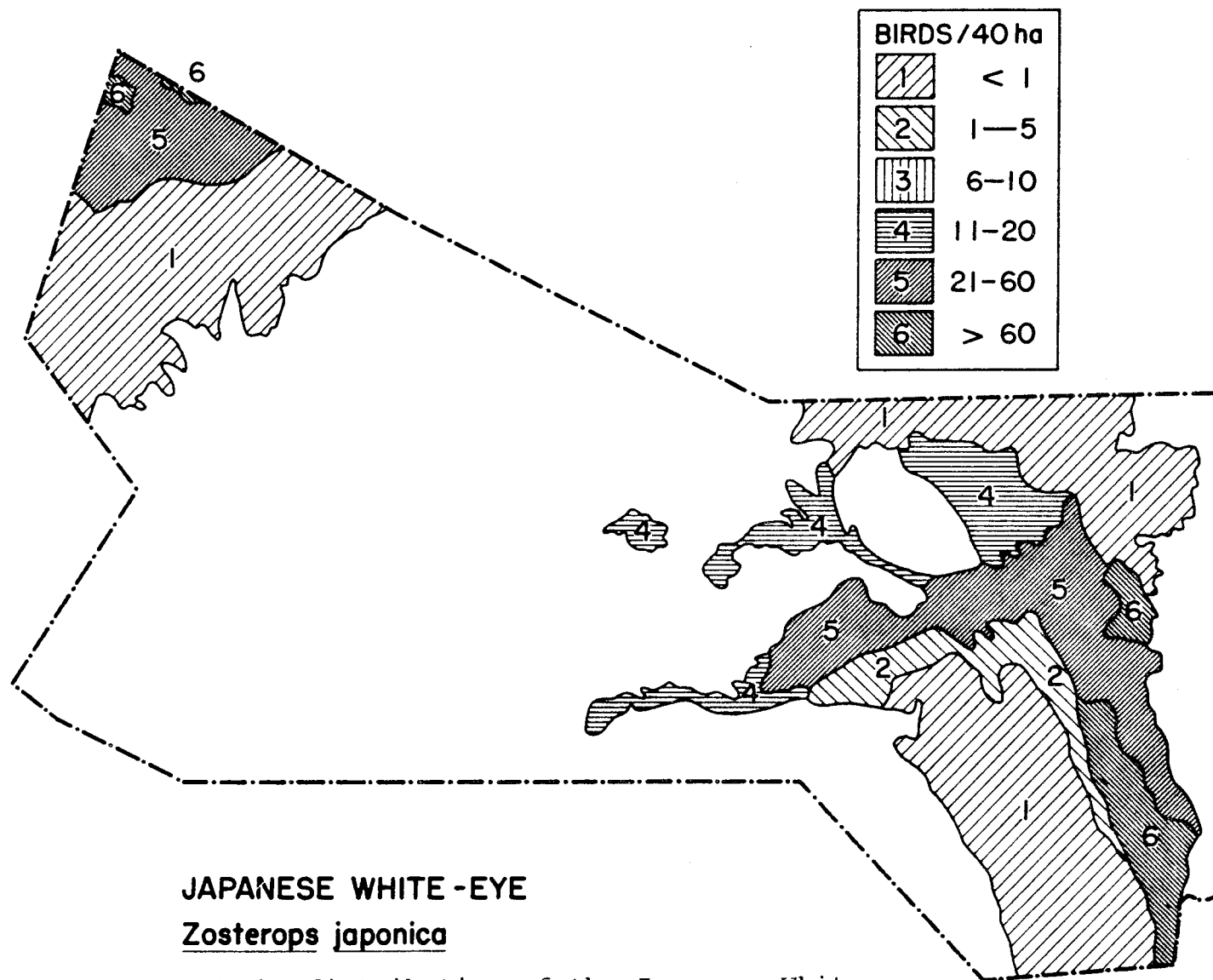


FIGURE 15. Map of the distribution of the Japanese White-eye, Crater District, Haleakala National Park.

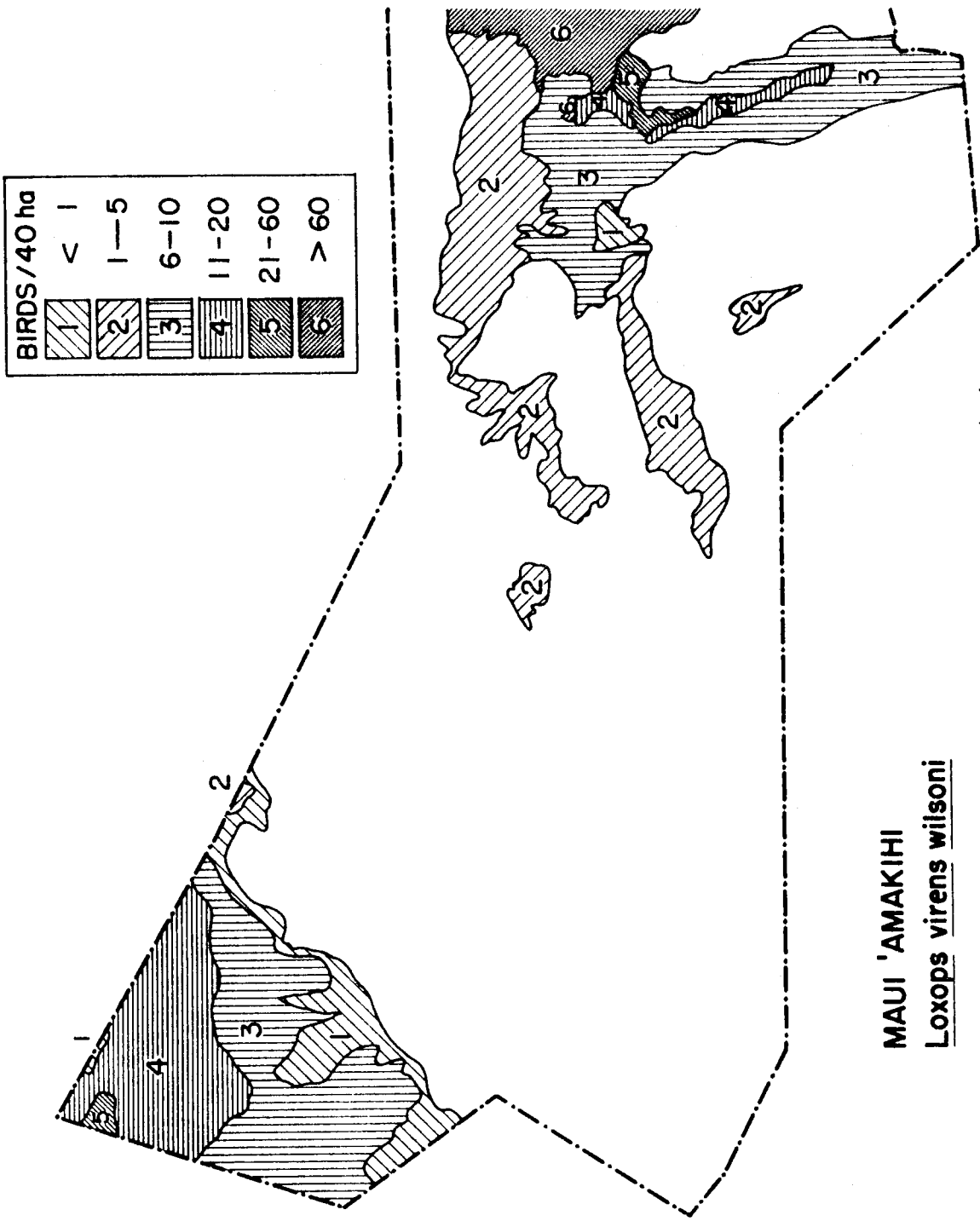


FIGURE 16. Map of the distribution of the Maui 'Amakihi, Crater District, Haleakala National Park.

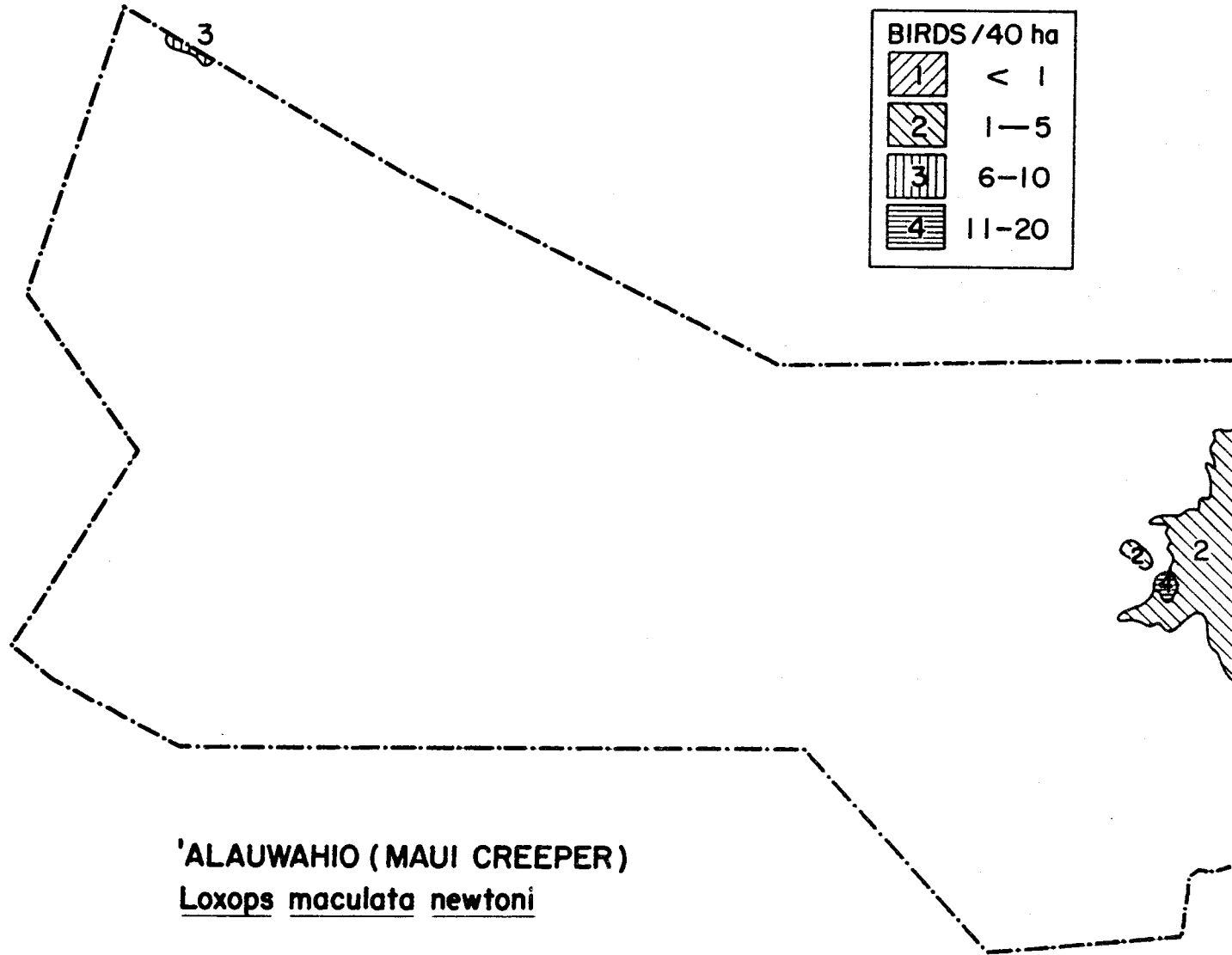


FIGURE 17. Map of the distribution of the 'Alauwahio (Maui Creeper), Crater District, Haleakala National Park.

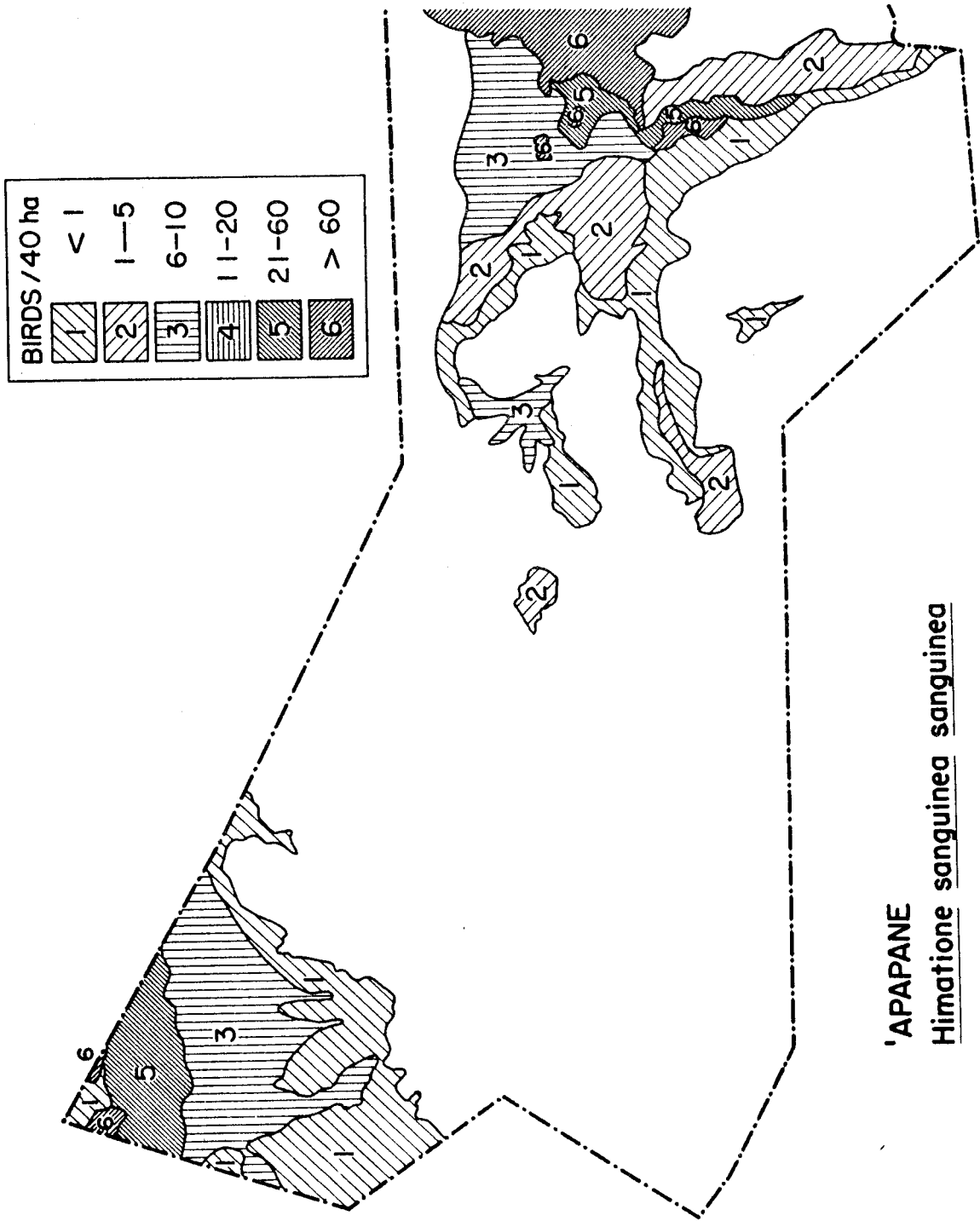


FIGURE 18. Map of the distribution of the 'Apapane, Crater District, Haleakala National Park.



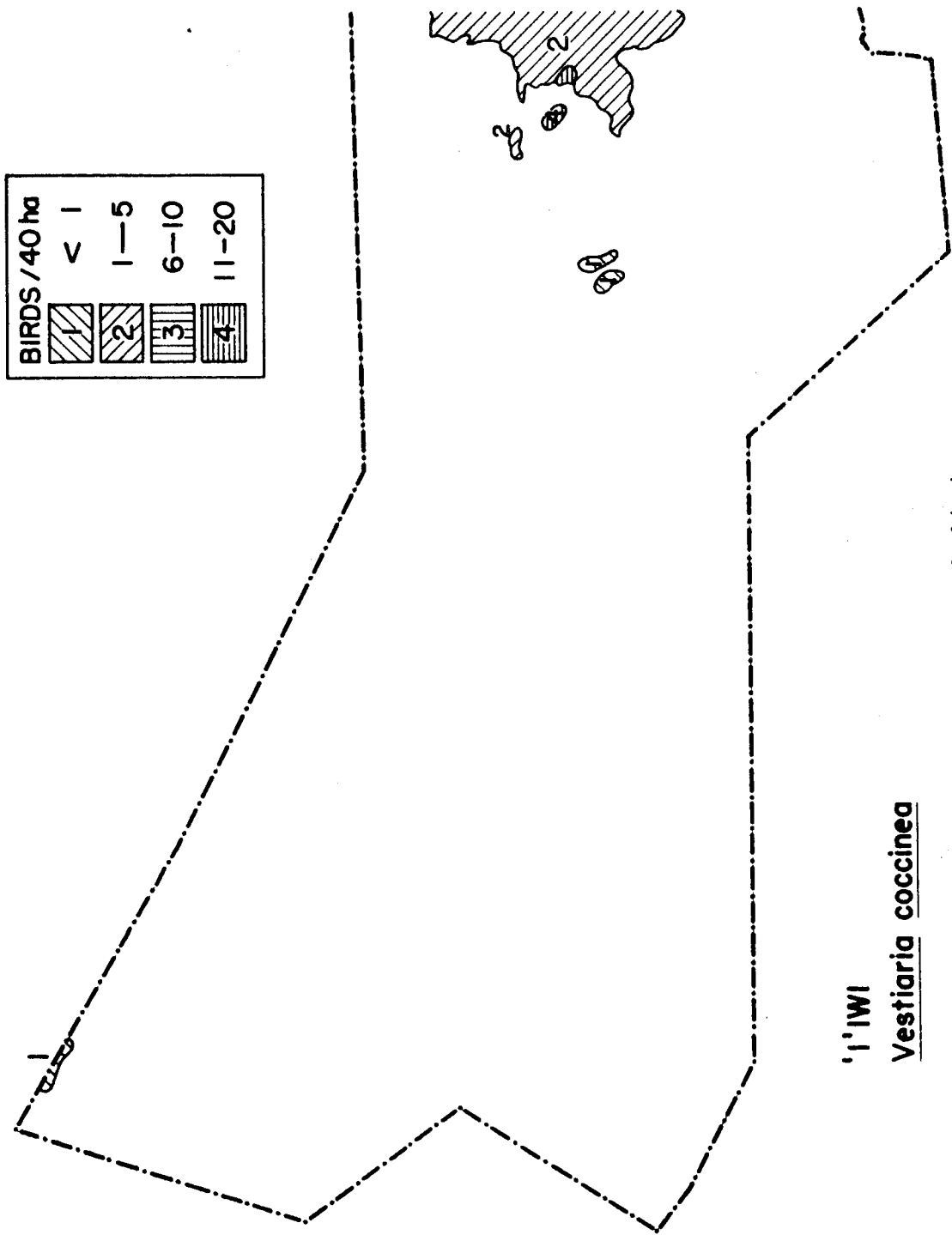
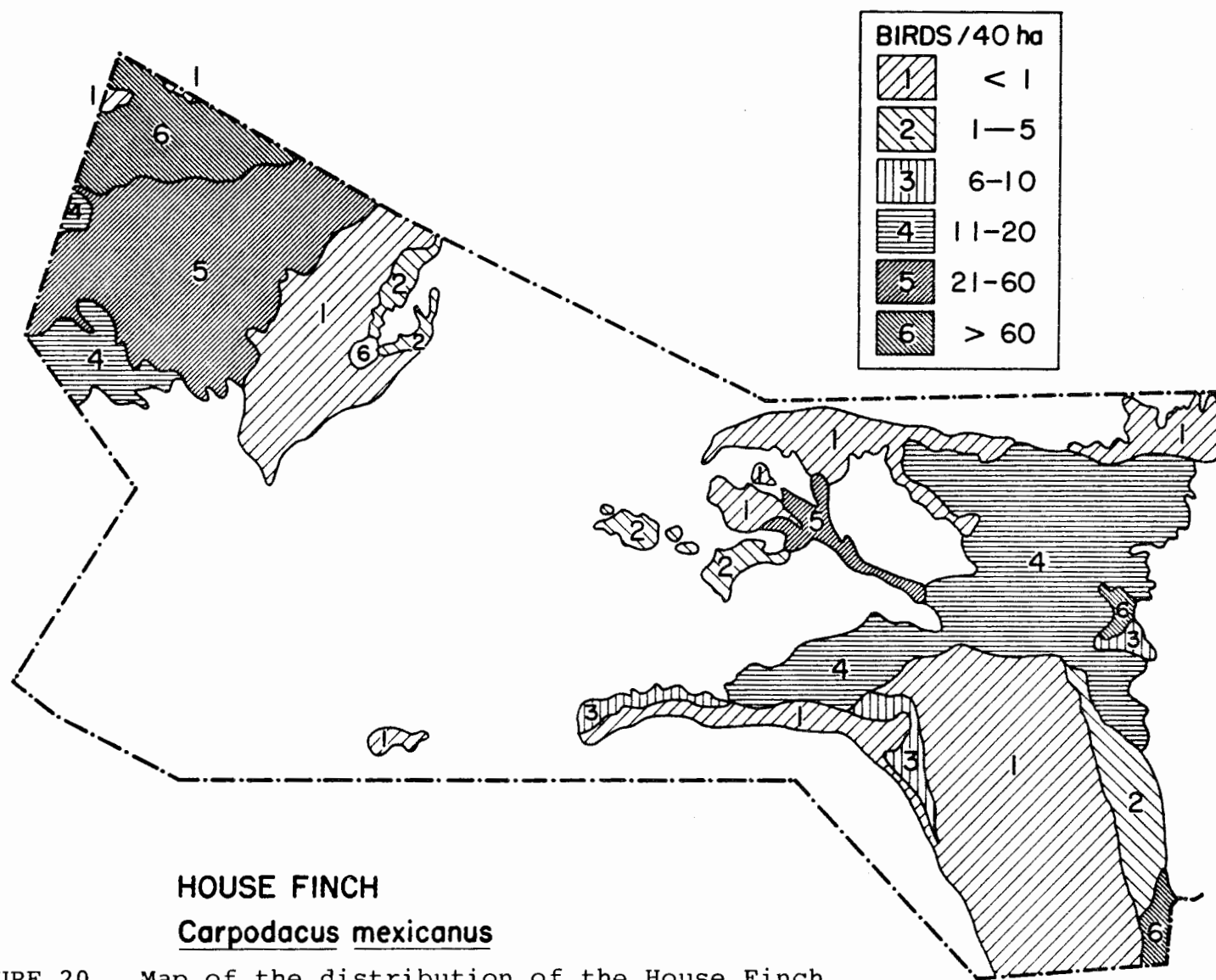


FIGURE 19. Map of the distribution of the 'I'iwi, *Vestiaria coccinea*, Crater District, Haleakala National Park.



**HOUSE FINCH**  
***Carpodacus mexicanus***

FIGURE 20. Map of the distribution of the House Finch, Crater District, Haleakala National Park.

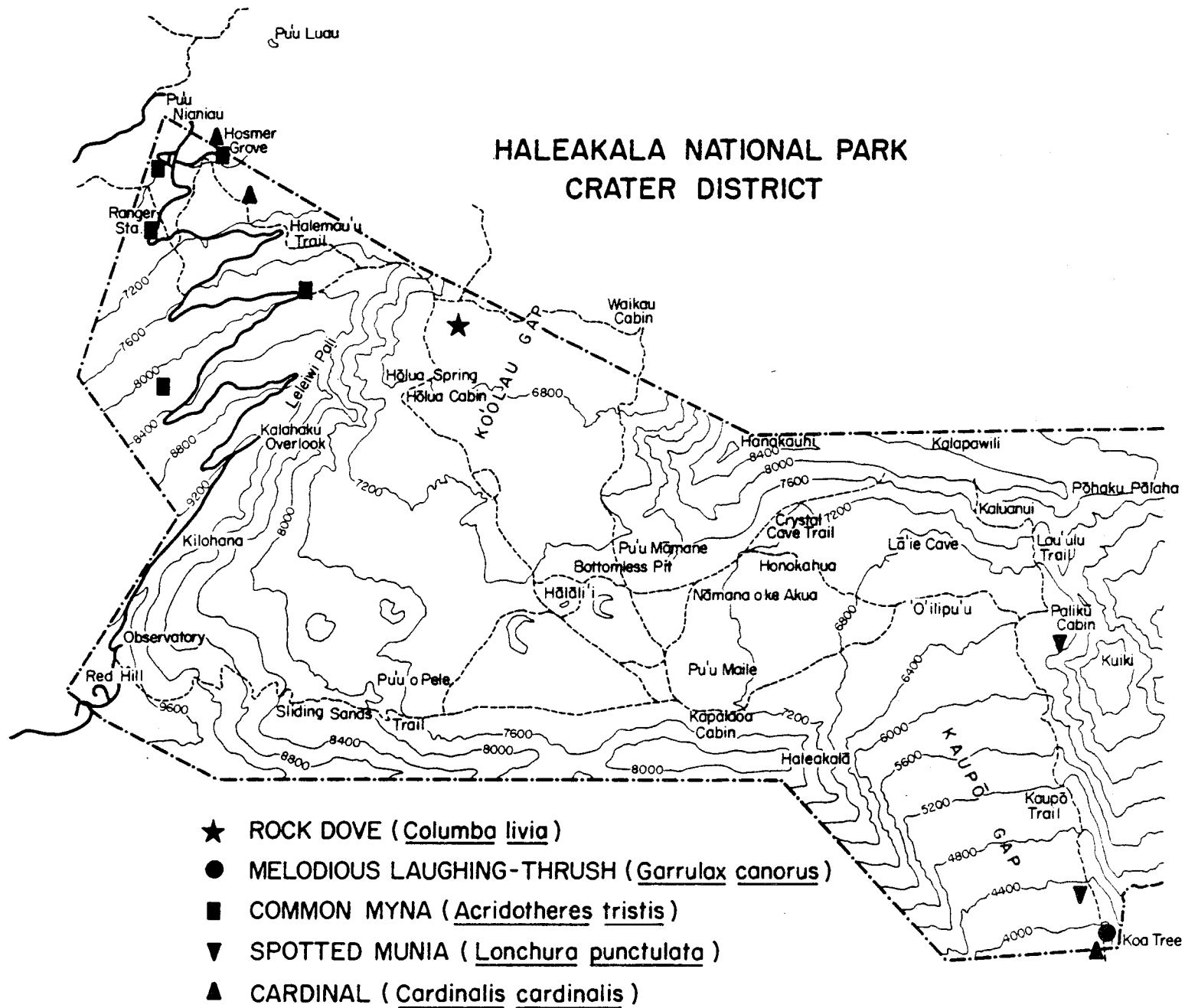


FIGURE 21. Map of the distribution of Rock Dove, Melodious Laughing-thrush, Common Myna, Spotted Munia, Cardinal--Crater District, Haleakala National Park.

## APPENDIX I

## ANNOTATED LIST OF BIRDS OF HALEAKALA CRATER, MAUI, HAWAII

This annotated list is based primarily on avian field surveys conducted in Haleakala National Park (Fig. 1) from 1976 to 1978. We also obtained information from Berger (1972), the Hawaii Audubon Society (1978), H. E. Smith (1976), and field notes published in the 'Elepaio, journal of the Hawaii Audubon Society. In addition, various biologists who have worked in Haleakala in recent years provided unpublished data.

For the sake of uniformity, the format of this list is patterned with slight modification after the Hawaii Audubon Society's "Preliminary List of Birds of Hawaii" (Pyle 1977). Vernacular and scientific names follow the American Ornithologists' Union Check-list of North American Birds, 1957 edition, including the 32nd and 33rd Supplements (AOU 1973, 1976). For species not included in the AOU Check-list, vernacular and scientific names of introduced species follow Berger (1976), and names for native Hawaiian species generally follow Hawaii Audubon Society (1978), while Hawaiian language names follow Titcomb and Gagné (1976).

The geographic scope of this list is the Crater District of Haleakala National Park (Fig. 2). Additional field work in other regions of Haleakala National Park planned for the near future should allow the expansion of this list to include the entire Park.

We have derived most species' densities from transect counts using the "count x detectability" method described by Emlen (1971) or the circular plot method of Reynolds, Scott, and Nussbaum (in press). We calculated some species' densities for which these methods are inappropriate (e.g., game birds, House Finch) by averaging census totals per unit area censused. All density values represent average numbers for similar habitat types. Separate density values are given for dissimilar habitat types.

## STATUS SYMBOLS

## RESIDENT SPECIES; NATIVE

- Re = Resident--endemic at species level;  
not extinct
- Ri = Resident--indigenous species;  
Hawaiian form not endemic
- Ris = Resident--indigenous species;  
Hawaiian subspecies endemic

## FOREIGN OR INTRODUCED SPECIES; RESIDENT

- Fl = Foreign--long-established;  
breeding for more than 25 years
- Fn = Foreign--new introduction;  
apparently established and breeding, but for  
less than 25 years

BREEDING SPECIES IN HAWAI'I; NATIVE; MOST INDIVIDUALS LEAVE  
HAWAI'I WHEN NOT BREEDING

- Bi = Breeder--indigenous species;  
Hawaiian form also breeds elsewhere
- Bis = Breeder--indigenous species;  
Hawaiian subspecies breeds only in Hawaiian  
Islands

VISITOR SPECIES; BREEDS ELSEWHERE; OCCURS IN HAWAI'I WHEN NOT  
BREEDING

- Vr = Visitor--regular migrant

## ENDANGERED SPECIES (\*)

An asterisk preceding the scientific name of the bird indicates that the species is currently on the federal list of endangered species (U. S. Fish and Wildlife Service 1979).

## ANNOTATED LIST

## FAMILY PROCELLARIIDAE (SHEARWATERS AND PETRELS)

\*Pterodroma phaeopygia sandwichensis 'Ua'u  
 Bis Hawaiian Petrel  
 (Dark-rumped Petrel)

Nesting burrows reported on west-northwest wall of Haleakala Crater District from Red Hill to directly above Hōlua Cabin, above Kapalaoa Cabin, and at Haupa'akea Peak (U. S. Fish and Wildlife Service 1974). Observations during this study include sightings on the north-northwest wall of the Crater and above Kapalaoa Cabin. Aural detections were made at Pu'u Māmane about an hour after sunset in June 1976 and June 1977. Also heard at Palikū two to three hours after sunset in June, July, and August 1977 (G. Teves, pers. comm. and this study). Data are insufficient to make a total population estimate.

## FAMILY PHAETHONTIDAE (TROPICBIRDS)

Phaethon lepturus dorotheae Koa'e-kea  
 Bi White-tailed Tropicbird

Breeds on Maui (Berger 1972: 50), but no nests reported from Haleakala National Park. One to four birds observed frequently in Kaupō Gap, especially west wall, during this study. Birds landed on cliff face of west Kaupō Gap on two different occasions (June 1976, January 1977). In July 1977, three birds were observed at Palikū and one near Nāmana o ke Akua.

## FAMILY ANATIDAE (DUCKS AND GEESE)

\*Branta sandvicensis Nēnē  
 Re Hawaiian Goose

May be seen flying throughout the Crater District, except in rain forest areas. Particularly common in eastern half of Crater, especially the Palikū area. Frequently observed in alpine grasslands on Kalapawili Ridge and Kuiki. The State of Hawaii, in cooperation with the National Park Service, has been releasing this species in Haleakalā at Palikū since 1962, and the first reported breeding was discovered July 1971 (Pratt 1972a). Successful breeding has ensued each year, except 1976 (Pratt 1977). Total population estimated at 80-100 birds in the Crater District.

## FAMILY PHASIANIDAE (QUAILS, PHEASANTS, AND FRANCOLINS)

Alectoris chukar

F1

Chukar

Frequently observed and widely distributed at an average density of 9 birds/40 ha throughout open, dry vegetated areas in the Park, including alpine grasslands.

Francolinus pondicerianus

Fn

Gray Francolin

Rare in Crater District although probably expanding its range into the xeric scrublands of the area. Observed in west Kaupō Gap twice during this study: once at about 1520 m elevation (C. W. Smith, pers. comm.), and more recently at 1770 m. Frequently observed on Kaupō Ranch (ranch hand, pers. comm.).

Phasianus colchicus

F1

Ring-necked Pheasant

Widely dispersed in all open vegetated areas in the Park and at edges of forested regions. Density = 5 birds/40 ha, higher (8 birds/40 ha) near Palikū.

## FAMILY CHARADRIIDAE (PLOVERS)

Pluvialis dominica

Vr

Kōlea

Golden Plover

Widely distributed in shrublands and grasslands of the Park, including alpine grasslands. Present August through April. Density = 5 birds/40 ha.

## FAMILY TYTONIDAE (BARN OWLS)

Tyto alba

Fn

Barn Owl

Uncommon (density < 1 bird/40 ha), in shrublands and grasslands (including alpine grasslands), especially near southeast end of Crater District and near Hosmer Grove. Difficult to distinguish from Hawaiian Owl at great distances.

## FAMILY STRIGIDAE (TYPICAL OWLS)

Asio flammeus sandwichensis

Ris

Pueo

Hawaiian Owl

Uncommon (density < 1 bird/40 ha) in shrublands and grasslands, at forest edges and in forests, especially in the eastern part of the Crater District, along Halemau'u Trail, near Park Headquarters, and Hosmer Grove. Also observed in alpine grassland on Kalapawili Ridge and Kuiki during this study.

## FAMILY COLUMBIDAE (DOVES, PIGEONS)

Columba livia

Fl

Rock Dove

Uncommon; observed in Ko'olau Gap on three separate occasions (Howarth, pers. comm., and this study).

## FAMILY ALAUDIDAE (LARKS)

Alauda arvensis

Fl

Skylark

Distributed throughout grasslands and open shrublands, including alpine regions, in the Park. Density = 2 birds/40 ha; more common within Crater than on northwest slope.

## FAMILY TIMALIIDAE (BABBLERS)

Garrulax canorus

Fl

Melodious Laughing-thrush  
(Chinese Thrush, Hwa-mei)

Uncommon; several birds observed on Kaupō Trail at about 1200 m during this study; reported from Halemau'u Trail Head by H. E. Smith (1976).

Leiothrix lutea

Fl

Red-billed Leiothrix  
(Leiothrix,  
Japanese Hill Robin)

Seasonally abundant (i.e., present in June 1976 at a density of 12 birds/40 ha, and March 1977; absent January 1977) in Palikū area. Also observed in west Kaupō Gap, in and adjacent to Hosmer Grove, and east of Pu'u Nianiau by H. E. Smith (1976). Probably present though not common in most wet forests.

## FAMILY MIMIDAE (MOCKINGBIRDS)

Mimus polyglottos

Fl

Mockingbird

Occurs in dry forest, grasslands, and shrublands, including cliff faces, throughout Crater District. Reported from Halemau'u Trail Head, Hosmer Grove, Pu'u Nianiau by H. E. Smith (1976). Density = 1 bird/40 ha.



## FAMILY ZOSTEROPIDAE (WHITE-EYES)

Zosterops japonica

Fl

Japanese White-eye  
(White-eye, Mejiro)

Common (density = 50 birds/40 ha in sparsely vegetated areas) to abundant (density = 275 birds/40 ha in forested areas) throughout the Park. Absent from grasslands and aeolian habitats. Probably the most abundant bird in the Park.

## FAMILY STURNIDAE (MYNAS AND STARLINGS)

Acridotheres tristis

Fl

Common Myna

A few birds present at occupied buildings in the Park (outside the Crater per se), Hosmer Grove, and Halemau'u Trail Head.

## FAMILY DREPANIDIDAE (HAWAIIAN HONEYCREEPERS)

## SUBFAMILY PSITTIROSTRINAE (GREEN AND YELLOW HONEYCREEPERS)

Loxops virens wilsoni

Re

Maui 'Amakihi

This subspecies is endemic to Maui, Moloka'i, and Lāna'i.

Uncommon (density = 4 birds/40 ha) in shrublands of eastern Crater; common (density = 60 birds/40 ha), though not abundant, in wet and dry forested areas of the Park, and in shrublands on northwest slope (i.e., from Park Headquarters to Pu'u Nianiau, including Hosmer Grove).

Loxops maculata newtoni

Re

'Alauwahio  
(Maui Creeper)

Uncommon (density range = 3-12 birds/40 ha) in wet forests of the Park, including Palikū region and Hosmer Grove.

## SUBFAMILY DREPANIDINAE (RED AND BLACK HONEYCREEPERS)

Himatione sanguinea sanguinea

Re

'Apapane

Present but not common (density = 1-40 birds/40 ha) in shrublands and dry forests; abundant (density = 330 birds/40 ha) in wet forest.

Vestiaria coccinea  
Re

'I'iwi

Present, though uncommon (density = 4 birds/40 ha), in wet forests. Observed at Hosmer Grove, Palikū, Kuiki, Kaluanui, and Kalapawili Ridge during this study. One bird reported from 'O'ilipu'u in June 1976 (L. Stemmermann, pers. comm.).

FAMILY PLOCEIDAE (WAXBILLS, MUNIAS, AND WEAVER FINCHES)

Lonchura punctulata

F1

Spotted Munia  
(Ricebird)

Uncommon; observed in July 1977 at Palikū and in Kaupō Gap. Also reported from Hosmer Grove and Pu'u Nianiau (H. E. Smith 1976).

FAMILY FRINGILLIDAE (CARDINALS AND FINCHES)

Cardinalis cardinalis

F1

Cardinal  
(Northern Cardinal,  
North American Cardinal,  
Kentucky Cardinal)

Uncommon; observed in Kaupō Gap during July 1977. Also reported from Hosmer Grove and Pu'u Nianiau by H. E. Smith (1976).

Carpodacus mexicanus

F1

House Finch  
(Linnet, Papayabird)

Common to abundant throughout the Park except in wet forests. By far the most abundant bird in shrublands, grasslands, and dry forests in the Crater. Density range = 50-140 birds/40 ha. Rarely observed in very large flocks (about 500 birds) in grassland areas (Conant, unpublished data).