

STATUS AND DISTRIBUTION OF THE PO'OU LI IN THE HANAWĪ NATURAL AREA RESERVE BETWEEN DECEMBER 1995 AND JUNE 1997.

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Abstract: The Po'ouli (*Melamprosops phaeosoma*), a critically endangered Hawaiian honeycreeper first discovered in 1973 on east Maui, Hawai'i, is on the brink of extinction. The population was estimated at 140 ± 280 (95% CI) in 1980, but has since declined rapidly. No birds were seen between 1989–1993, but sightings in 1993–1994 prompted the development of this study. Aims were to locate all remaining Po'ouli and other critically endangered forest birds, to identify causes of decline, and to develop and implement management to help the recovery of the species. Intensive searching and revisiting (752 person-days) of 700 ha including most of the historical distribution, between December 1995 and June 1997, resulted in 81 sightings and one audible contact of Po'ouli involving five birds: three males, one female, and one immature (possibly female) in three home ranges. One other male was heard singing in a fourth home range but was never seen. Playbacks were used to assist detection of critically endangered birds on 171 occasions. In the first six months of 1997, only three Po'ouli could be found (two males, one possible female), one bird in each of the three home ranges. These birds are believed to be the last of their species. No individuals of two other critically endangered forest bird species, the Maui 'Ākepa (*Loxops coccineus ochraceus*) and Maui Nukupu'u (*Hemignathus lucidus affinis*), were found in the study area.

Key Words: distribution; endangered; Hawaiian honeycreeper; *Melamprosops phaeosoma*; Po'ouli.

One of the most secretive and elusive of the Hawaiian honeycreepers (Fringillidae: Drepanidinae), the Po'ouli (*Melamprosops phaeosoma*) was discovered in the remote, montane cloud forest of northeastern Maui in 1973 (Fig. 1; Casey and Jacobi 1974, Mountainspring et al. 1990). At that time, several pairs were found between the east and west Hanawī streams (Unit 1; Fig. 2) and two were collected so the species could be described (Casey and Jacobi 1974). The Hawaiian name Po'ouli literally translates as "black-headed," but it has been interpreted as meaning black-faced (Casey and Jacobi 1974).

The first Hawai'i Forest Bird Survey in 1980 estimated the population at 140 ± 280 (95% CI), calculated from three sightings of Po'ouli along one transect (Scott et al. 1986). Intermittent field work documented the decline of the Po'ouli over the next 15 years. Mountainspring et al. (1990) estimated the population density in Hanawī to be 76 birds/km² in 1975, but by 1985 they noted a decline to only 8 birds/km². These authors offered circumstantial evidence suggesting that the decline of the Po'ouli was related to the increase in feral pig (*Sus scrofa*) activity in the area (431% during 1975–1985), resulting in extensive damage to the understory and ground layer.

Only two Po'ouli nests were ever found and monitored; both were constructed in 1986 by the same pair of birds just east of the east Hanawī stream at 1,800 m (Kepler et al. 1996). Po'ouli were next seen in 1988, when five were encountered between the east Hanawī stream and the eastern boundary of the Hanawī Natural Area

Reserve (Hanawī NAR; Engilis 1990). The last sightings near the Hanawī streams were in September 1993; one at the former nest site, the other just 400 m to the west across the east Hanawī stream (U.S. Geological Survey, USGS, unpubl. data). No Po'ouli were found during four years of intensive field work (1994–1997) between the Hanawī streams (USGS, unpubl. data).

In 1994–1995, the Biological Resources Division of the U.S. Geological Survey (then known as the National Biological Service) led searches for critically endangered birds on Maui. The known distribution of the Po'ouli (U.S. Geological Survey, unpubl. data) was included and the searches resulted in sightings of five Po'ouli between the upper watersheds of the Kūhiwa and Helele'ike'ōhā streams, involving two adults and a dependent juvenile, and single adults in two other locations. Thus, prior to our field work the Po'ouli had disappeared from its type locality, but a small number remained 1–2.5 km to the east. All well-documented sightings of Po'ouli have been between 1,400–2,100 m elevation in approximately 13 km² on northeastern Maui (Scott et al. 1986, Mountainspring et al. 1990).

As a result of this recent survey, Hawaiian conservation agencies in November 1994 produced a three-point plan to investigate the decline of this species and assist any recovery (U.S. Fish and Wildlife Service, USFWS, unpubl. data). Two other critically endangered species, the Maui 'Ākepa (*Loxops coccineus ochra-*



FIGURE 1. Adult male Po'ouli in the Hanawā Natural Area Reserve in 1997. Photo by Paul E. Baker.

ceus) and Maui Nukupu'u (*Hemignathus lucidus affinis*) were to be included in the project if encountered. Objectives of the plan were to (1) locate (by surveys) and continuously monitor all remaining individuals through banding and observation of known birds; (2) investigate the population ecology of the bird, abundance and diversity of invertebrate food resources, and effects of avian diseases on the population; and (3) control small, nonnative mammalian predators in Po'ouli home ranges by means of approved techniques. Consequently, U.S. Geological Survey was contracted for two years (1995–1997) to conduct the work. This paper reports the results of the primary goal of the project, namely the intensive search of the historical distribution of the Po'ouli and nearby areas to determine the current distribution and number of birds.

METHODS

STUDY SITE

Most of the historical distribution of the Po'ouli lies within the Hanawā NAR, which is managed by the State of Hawai'i Department of Land and Natural Resources, Division of Forestry and Wildlife (DOFAW). The reserve was established in 1986 to protect a diversity of native ecosystems, and rare and endangered plant and bird populations. The reserve also preserves

Maui's most important watershed. The Hanawā NAR is 3,036 ha of mesic to wet cloud forest between 610–2,286 m elevation on northeastern Maui in the Hana district (described in Mountainspring 1987, Wagner et al. 1990a,b). Haleakalā National Park (HNP) lies to the south and southeast (Kīpahulu Valley) of the Hanawā NAR, while the Hanā and Ko'olau Forest reserves lie to the east and west (Fig. 2).

Extensive habitat degradation by feral pigs in the Hanawā NAR prompted a large-scale fencing and pig removal program by DOFAW to restore habitat and exclude pigs in the most pristine upper reaches of the reserve. Fencing and pig removal was completed in three stages important to the partitioning of the study area: Unit 1 (198 ha) by 1991; Unit 2 (172 ha) in 1993; and Unit 3 (405 ha) in 1996 (Fig. 2). The resulting ungulate-free zone of 775 ha between 1,584–2,286 m included almost all of the historical distribution of the Po'ouli. Adjacent forest to the south in HNP was fenced in 1989 and was almost pig free during our study (part of Unit 5). The remainder of Unit 5 to the east of the Hanawā NAR and the forest below the NAR fence to the north (Unit 4) both had pigs and were managed by DOFAW.

To locate Po'ouli, 'Ākepa, and Nukupu'u, all suitable habitat within the historical distribution of the Po'ouli and some adjacent areas were systematically searched (Fig. 2), except as noted below. The eastern two-thirds of Unit 2, all of Unit 3, as well as forest bordering the fences in Units 4 and 5 were searched. Also, approximately 100 ha to the south in HNP's por-

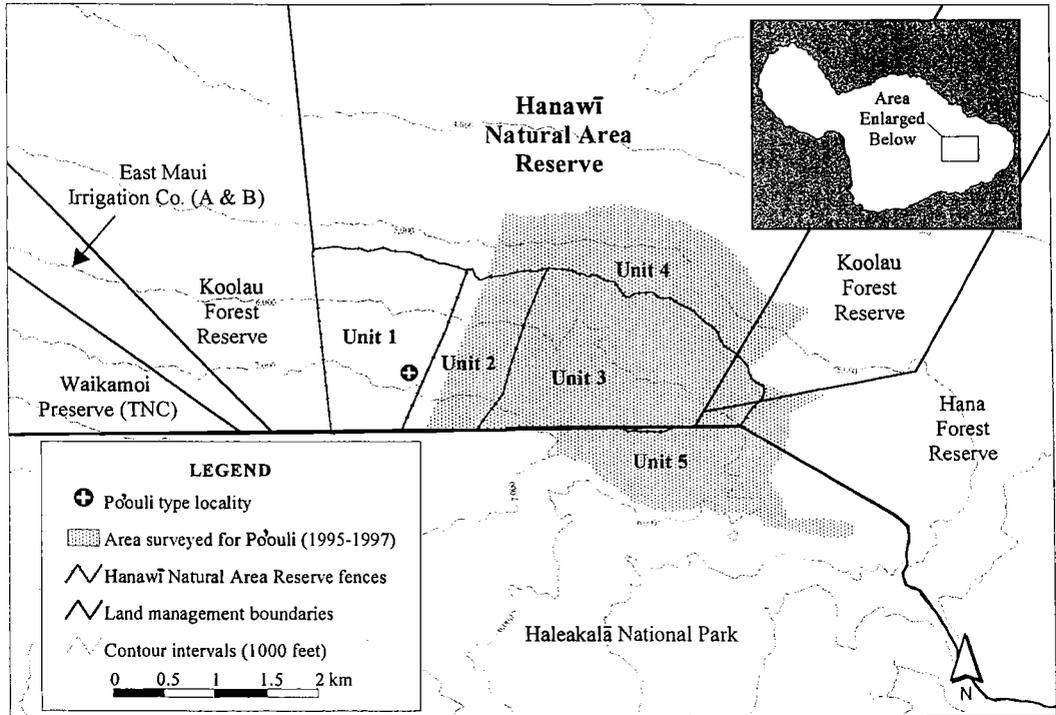


FIGURE 2. The Hanawā Natural Area Reserve showing Po'ouli type locality, study area units, and total area searched.

tion of Unit 5 were searched, which included mostly land that had never been searched for the focal species before. Despite the former presence of Po'ouli down to 1,400 m elevation, the searches only went to 1,432 m, because below that point the severely degraded habitat was infested with nonnative weeds that I did not want to spread. The area between the Hanawā streams (including Unit 1) was not searched because the 1994–1995 survey failed to find the three focal species at that location, and because the above-mentioned research project of 1994–1997 was concurrently conducting intensive surveys there with the same result (U.S. Geological Survey, unpubl. data).

TRAINING

All survey participants were trained to recognize the appearance, calls, and songs of all Hawaiian honeycreepers and nonnative passerines inhabiting the study area. Training involved playing and identifying recorded vocalizations and field identification sessions until everyone was competent at identification. Vocalizations of Maui 'Ākepa and Maui Nukupu'u have never been recorded, so recordings of the most closely related taxa (Hawai'i 'Ākepa, *L. c. coccineus*; 'Akiapōlā'au, *Hemignathus munroi*; and Maui Parrotbill, *Pseudonestor xanthophrys*) were used. Perkins (1903) commented that the calls and song of Maui Parrotbill were virtually identical to those of the Maui Nukupu'u.

SEARCHES

The subdivision of the Hanawā NAR into fenced units greatly facilitated searches, reducing the study area into manageable sections. Main trails were marked with flagging in each unit. The terrain was very rugged and the study area remote, so for safety reasons survey participants worked in pairs. All teams carried first aid kits, compasses, radios, and emergency locating transmitters (ELT/EPIRB). Teams used main trails to access areas quickly, then slowly searched through dense vegetation off the trail or used minor trails while looking for birds. Several teams worked in the same unit simultaneously to facilitate communication and detection of birds. Trail maps, fences, and use of compasses ensured complete coverage of each unit.

Searches began in Unit 2, then moved eastward into Units 3, 4, and 5. Each unit was searched twice for the presence of Po'ouli, Maui Nukupu'u, and Maui 'Ākepa. Additional searches were done at a different time of year, in case these species were less detectable during certain months. All vocalizations sounding similar to Maui Parrotbill were investigated, as were all "chip" calls and any unknown or unusual vocalizations. 'Tiwi (*Vestiaria coccinea*) and 'Apapane (*Himatione sanguinea*) were generally ignored, as they are not known to associate with the critically endangered species. All other native birds were observed for any associating focal species by using 10 x 42 binoculars.

TABLE 1. PERSON-DAYS SPENT SEARCHING FOR PO'OULI IN EACH UNIT ON MAUI, NUMBER OF BIRDS FOUND, AND NUMBER OF BIRDS RELOCATED DURING SUBSEQUENT VISITS TO EACH LOCALITY

	Unit 2	Unit 3	Unit 4	Unit 5	Total
Person-days searching	46	200	40	32	318
No. times Po'ouli found while searching	1 ^a	10 ^a	1 ^{a,b}	1 ^a	13
Person-days resighting	90	336	8	0	434
No. times Po'ouli resighted	3 ^{a,c}	66 ^a	0	0	69
Actual no. of individual Po'ouli located	1 ^d	5 ^d	1 ^b	1 ^e	5(+1 ^b)

^a Sightings were: 21 in home range 1, 1 near home range 1, 46 in home range 2, 13 in home range 3, plus 1 audible contact in home range 4.

^b Bird heard singing and was not seen.

^c All sightings occurred in home range 3.

^d Home range 3 straddled Units 2 and 3, so the bird in Unit 2 is also one of the Unit 3 birds.

^e Unit 5 bird is probably one of the birds from home range 1 in Unit 3 to the north, because of the proximity to this home range.

Whenever Po'ouli were found, observers took detailed descriptions of the appearance and behavior of the bird and I later compared these with published descriptions of birds to determine the age and sex of each bird (Casey and Jacobi 1974, Engilis et al. 1996). Following initial detections, the surrounding forest (up to 70 ha) was searched repeatedly to relocate the bird. These visits were made each day, beginning when possible with the day after discovery and continuing for a week. If no bird was seen, at least 18 follow-up visits would be made over a period of a month. If a bird was found again, further visits were made each month to study it. During 19 months of surveying and monitoring, we spent 729 person-days searching and revisiting areas. A person-day was defined as 8–11 hours of searching by each person in a pair (i.e., two person-days per pair on one day), because each person often searched independently while in the same area. Searches were discontinued during periods of poor weather that reduced detectability of birds.

PLAYBACKS

Playbacks of recorded calls and songs of Hawai'i 'Ākepa, Maui Parrotbill, 'Akiapōlā'au, Po'ouli, and Maui 'Alauahio (*Paroreomyza montana newtoni*) were used on a total of 171 occasions during searches to help locate critically endangered forest birds. Recordings were obtained from various U.S. Geological Survey personnel in Hawai'i, or made by participants using a Sony PBR-330 parabolic reflector and Sony Walkman recorder. Calls and songs recorded on 3-min endless loop cassette tapes were broadcast from 5-watt speakers. Playbacks were used most frequently between December to May during the breeding season of the honeycreepers on Maui when their response to playback was greatest (P. Baker and H. Baker, pers. obs.). During favorable weather conditions of good visibility and no wind or rain, teams would stop when "chewee" calls were heard and would play either Maui Parrotbill or 'Akiapōlā'au calls and song to attract the bird for identification. This call is given by Maui Parrotbill, Po'ouli, and Maui Nukupu'u. Hawai'i 'Ākepa calls and song were played in areas where audible contact with Maui 'Ākepa had been reported by biologists previously working in the reserve (U.S. Geological Survey, unpubl. data). Calls and songs of Maui Parrotbill, 'Akiapōlā'au, and Hawai'i 'Ākepa were also played where Po'ouli had been seen to determine which individual birds and species would re-

spond. Po'ouli calls were played only in areas where Po'ouli had been seen, as were Maui 'Alauahio "chip" calls. Both Maui 'Alauahio and Maui Parrotbill make a "chip" call similar to that of the Po'ouli.

MAPPING SIGHTINGS OF PO'OULI

A Rockwell PLGR 96 Federal Global Positioning System unit (GPS unit), accurate to < 10 m, was used to obtain coordinates for Po'ouli locations. These locations were mapped with Arcview software. The area within a cluster of sightings, which probably represented the home range of a Po'ouli, was determined by the minimum convex polygon method.

RESULTS

SEARCHES

Between September 1995 and October 1996, 700 ha were searched for Po'ouli during 318 person-days (Fig. 2). Six Po'ouli were found on 13 occasions in four areas during searches. In addition, between December 1995 and June 1997, Po'ouli were found on another 69 occasions during 434 person-days that were spent revisiting three areas to study five of the six birds found (Table 1). No Maui 'Ākepa or Maui Nukupu'u were found during these searches.

An adult male and an immature of unknown sex, possibly female by the small size of the facial mask, were found at 1,908 m elevation in the Hanawī NAR. These birds were found within 100 m of the Hanawī NAR/HNP boundary fence in March and April 1996, respectively. This area was designated home range 1 (Fig. 3). The immature's plumage was not typical of either adult or juvenile as described by Engilis et al. (1996) and did not resemble any adult Po'ouli I had personally observed. I determined that this bird (pers. obs.) was definitely an immature by comparison with the holotype specimen and the photographs of the paratype (Casey and Jacobi 1974). This suggests that the bird was hatched in 1995, indicating successful breeding by one pair in that year. No adult female was seen with either the male or the immature. One or both birds were seen 18 times in

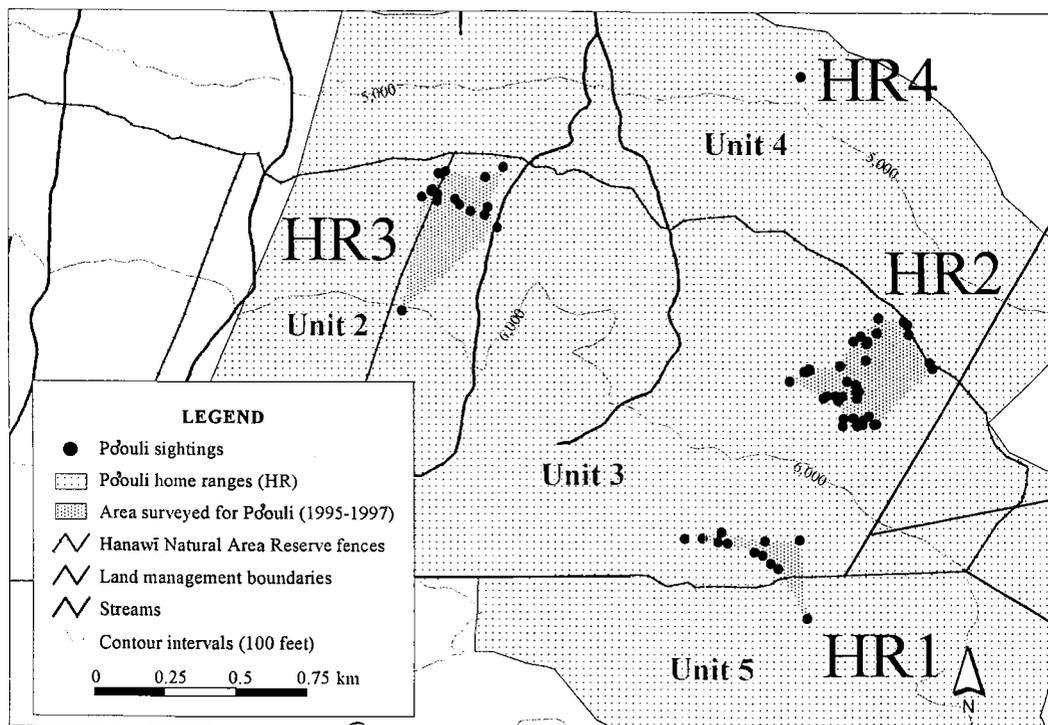


FIGURE 3. Po'ouli home ranges showing all sightings in each area.

home range 1 until July 1996, but they were never seen together. There were no more sightings in this area until February 1997, when one bird, possibly an adult female, was seen. An adult bird was then seen once each month in April and May 1997 in this same area, but the sex was not determined.

A pair of Po'ouli was found in an area between 1,768 and 1,584 m within Unit 3, north of home range 1, in an area designated as home range 2 (Fig. 3). The adult male was found in March 1996 and seen 10 times during March and April, but the female was only seen twice, in June–July 1996, and both times with or near the male. The male was seen 24 times during 1996. It was captured and banded in January 1997 (Baker 1998), and was then seen 22 times between January and the end of May 1997; no other Po'ouli were seen in this area.

A single bird, probably male based on plumage, was located in December 1995 at 1,866 m and then at 1,816 m in the vicinity of the boundary fence between Units 2 and 3. I designated this area home range 3 (Fig. 3). Revisiting this area on 90 person-days between December 1995 and May 1997 (with thorough searching) produced only 11 more sightings. An adult, possibly male, was relocated in this area twice on one day in February 1997 at 1,860 m (T. Snetsinger,

pers. comm.). There were also two sightings of a single male in March 1997 at 1,880 m (west of the fence) and 1,860 m (east of the fence). A single adult bird (male) was seen several times in this same area in late May and early June 1997, giving a total of 13 sightings in home range 3. (This bird was seen flying away at a distance on two occasions, enabling further estimation of home range size, hence Figure 3 has 15 points rather than 13.) No pair was ever confirmed visually.

Po'ouli song was heard once at 1,493 m on transect # 9 in Unit 4 during March 1996. This locality was designated home range 4 (Fig. 3). Re-searching this area produced no more contacts.

There were no definite sightings of Po'ouli in Unit 5, but a bird that may have been a Po'ouli was glimpsed near transect # 10 on HNP land, and it may have been from home range 1.

PLAYBACKS

No Po'ouli were attracted to either recorded Po'ouli "song" or calls. I discovered that the recording previously thought to be song (H. D. Pratt, pers. obs.) was actually the alarm call of the Po'ouli, and I observed two different individuals give these calls when distressed. Recorded Po'ouli "chip" calls were played (on

TABLE 2. NUMBERS OF HAWAIIAN HONEYCREEPERS LURED BY PLAYBACK OF THEIR OWN AND OTHER SPECIES' CALLS AND SONGS

Species lured	Playback tape used (song and calls)				
	Po'ouli	Maui Parrotbill	'Akiapōlā'au	Hawai'i 'Ākepa	Maui 'Alau-ahio
Po'ouli	0	1	1	1	0
Maui Parrotbill	0	30	13	6	0
Maui Nukupu'u	0	0	0	0	0
Maui 'Ākepa	0	0	0	0	0
Number of times playback tried	6	78	38	41	8

three occasions) to an adult male Po'ouli that was very responsive to calls of other species (see below) and elicited no interest or response at all. I also tried the same calls in home range 1, and did not attract any Po'ouli either. Playbacks of Po'ouli calls were not used again.

The male Po'ouli in home range 2 was very attracted to playback of Maui Parrotbill "chew-ee" calls and song. He was also attracted to playback of 'Akiapōlā'au song and Hawai'i 'Ākepa calls and song. Playback of Maui Parrotbill was used unsuccessfully to try to attract Po'ouli in the other areas where we had found them, and elsewhere (Table 2).

Maui Parrotbill, 'Akiapōlā'au, and Hawai'i 'Ākepa playback attracted most species of honeycreeper at least briefly but were a strong attractant for Maui Parrotbill. Maui Parrotbill were attracted to Hawai'i 'Ākepa song and calls in both areas where possible Maui 'Ākepa were reported, as well as in four other areas. Playback would be a useful census tool to locate Maui Parrotbill. Prior to using playback, we had mapped all Maui Parrotbill located during our searches. Playback did not attract pairs in any areas, other than where we had known them to be based on our mapping. From these findings, the current known population of Po'ouli in 1997 is three individuals in 7 km². Despite intensive searching no other Po'ouli were found, or are known from elsewhere on Maui, so we presume the Po'ouli to be on the brink of extinction.

MAPPING PO'OULI HOME RANGES

All sightings of Po'ouli during this study between December 1995 and June 1997 are illustrated in Figure 3. Using Arcview to determine distances between sightings of Po'ouli within each home range, we were able to determine minimum home range sizes of 3.2 ha for home range 1, 11.2 ha for home range 2, and 10.2 ha for home range 3. Unfortunately, there was only a single audible (song) contact in home range 4,

so no estimation of home range size could be made (Fig. 3).

The longest linear distance (determined using Arcview) between two sightings in each home range was 548 m in home range 1, 537 m in home range 2, and 672 m in home range 3. Linear distances between home ranges were: 469 m between home ranges 1 and 2, 1,382 m between home ranges 1 and 3, 1,817 m between home ranges 1 and 4, 1,247 m between home ranges 2 and 3, 961 m between home ranges 2 and 4, and 1,170 m between home ranges 3 and 4.

DISCUSSION

NUMBER AND DISTRIBUTION OF PO'OULI

In 1996, there were six Po'ouli in the Hanawī NAR, which were confined to four distinct home ranges 0.45–1.81 km apart. The banded bird was only seen in home range 2 despite intensive searching by my crew beyond its home range area, suggesting Po'ouli are sedentary. Although Po'ouli may have home ranges of > 10 ha, they do not use the area equally. Po'ouli seem to use intensively particular areas, perhaps as small as 4 ha, then, after some time, they may move and use another area within the home range and occasionally visit the previous area (pers. obs.). This observation is supported by this survey, in which Po'ouli were located in each of the three general areas, but not at the same places where the 1994–1995 survey had found them. The apparently small size of home range 1 is probably due to such behavior. Initially, birds were found in the eastern portion of home range 1, but all recent sightings have been on the western "edge" bordering an area that is inaccessible to survey crews due to steep terrain and deep gulches. This inaccessible area is only about 200 m east of where a Po'ouli family had been seen prior to this study, but the birds were never found there despite many days of searching during this project, suggesting periodic changes in the use or position of a home range. From observations of Po'ouli behavior, it is unlikely that Po'ouli are sensitive to disturbance on the ground by humans and, in fact, they often approach closely showing curiosity.

Given a fairly sedentary nature and the long distances between home ranges, it is unlikely that the remaining Po'ouli in the Hanawī NAR may wander into each other's home ranges. Distances moved by birds within and between home ranges calculated with Arcview do not take into account the rugged terrain but only the linear distance between points or areas. The extremely rugged terrain may also reduce the distances moved by Po'ouli because they may prefer the habitat found in gulches or low lying areas rather than that on ridges.

Many other Hawaiian honeycreeper species are easy to locate as pairs during the breeding season. In the 1980s, Po'ouli were frequently found in pairs (Scott et al. 1986; B. Gagne, pers. comm.). Only one pair of Po'ouli were observed during this study, on two occasions in 19 months of intensive field work. Adult female Po'ouli were seen only three times. There has also been no evidence of successful reproduction based on nest building or dependent fledglings since 1995. I believe that all remaining Po'ouli and their home ranges within the known historical distribution of the species have now been located, and it is highly unlikely that any were overlooked; so no viable pairs currently exist in this study area. Therefore, a great problem is that the remaining birds cannot find each other and attempt to breed.

Although it is unlikely that Po'ouli are to be found elsewhere on Maui, it is remotely possible that there are birds outside the study area. Parts of Kīpahulu Valley have been searched, but large areas remain to be thoroughly searched. Habitat that may be suitable for Po'ouli also lies all along the northern flank of east Maui from Hanawī, as far west as the Waikamoi Preserve near Makawao, where there was one record of Po'ouli in 1983 (Mountainspring et al. 1990). There have been no other records despite several surveys on established transects throughout the area by biologists from the Hawai'i Forest Bird Survey and the Nature Conservancy of Hawai'i. Much of this habitat where Po'ouli may occur has been damaged by pigs (Scott et al. 1986). Even so, this does not account for the current critically low number of Po'ouli, or their distribution, because much relatively undamaged habitat remains within the Hanawī NAR and elsewhere that should be suitable for Po'ouli.

OTHER CRITICALLY ENDANGERED MAUI FOREST BIRD SPECIES

No Maui Nukupu'u were seen during this study, despite over 90 person-days of searching the area where a bird was reported in 1995 (U.S. Geological Survey, unpubl. data), as well as all the other searching through the Hanawī NAR. Playback of both Maui Parrotbill and 'Akiapōlā'au was utilized, especially during the breeding season. The tapes attracted Maui 'Amakihi (*Hemignathus virens wilsoni*), Maui 'Alauahio, 'I'iwi, and Maui Parrotbill (nine Maui Parrotbill

were captured in mist nets in the immediate area where the Maui Nukupu'u was reported to have been because they responded to the playback).

Possible audible contacts of Maui 'Ākepa have been reported several times in the Hanawī NAR since 1994 (T. Snetsinger and T. Casey, pers. comm.), but my crew was unable to confirm their presence. Three of my crew experienced with Hawai'i 'Ākepa all reported hearing and seeing Maui Parrotbill producing song and "chewee" calls that they believed could be mistaken for that of the Hawai'i 'Ākepa. Maui Parrotbill are resident in each area where Maui 'Ākepa contacts were reported. These were the only 'Ākepa-like vocalizations heard by the crew. I have noticed a lot of individual variation in pitch and intonation for different Maui Parrotbill, from the usual sounding birds to those that make high-pitched, squeaky vocalizations rather like Hawai'i 'Ākepa. The USGS crew in Unit 1 of the Hanawī NAR has not reported any definite sightings of either Maui Nukupu'u or Maui 'Ākepa from 1994–1997. No viable populations of Maui Nukupu'u and Maui 'Ākepa now exist within the 700 ha study area in the Hanawī NAR.

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