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'ELEPAIO

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Distribution, Abundance, and Conservation of O'ahu 'Elepaio in the Southern Leeward Ko'olau Range

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Figure 1
Adult Male O'ahu 'Elepaio from Kuli'ou'ou Valley
Photograph by E.VanderWerf

Introduction

The O'ahu 'elepaio (*Chasiempis sandwichensis gayi*), a subspecies of monarchine flycatcher endemic to the island of O'ahu, has recently undergone a serious population decline. Williams (1987) demonstrated that data from Honolulu Christmas bird counts show a consistent decline in number of 'elepaio found per party hour, beginning in at least the early 1960s. Conant (1977) remarked that "since 1968...densities, though not range, of the O'ahu 'elepaio have decreased." The decline apparently has continued, and 'elepaio are now absent from many portions of their former range (Conry 1991, VanderWerf 1993b, Pratt 1994, Cowell 1995, VanderWerf and Rohrer 1996). The most recent population estimate for O'ahu 'elepaio is 200-500 birds (Ellis et al. 1992), but this estimate was based on very few surveys and actual observations, and the current range is poorly known. The O'ahu subspecies of 'elepaio is being considered for listing under the Endangered Species Act (Conant 1995). Contrary to a recent article (Hawaii Audubon Society 1995), the U.S. Fish and Wildlife Service did not decide that more information is needed before proceeding with the listing process, but all listing had been halted by a Congressional moratorium.

The causes of the decline of O'ahu 'elepaio are unknown, but there are several possible contributing factors: introduced diseases such as avian malaria (*Plasmodium relictum*) and avian pox virus (*Avipox* sp.), (Warner 1968, van Riper et al. 1986, Atkinson et al. 1995); predation by introduced mammals (Atkinson 1977, Amarasekare 1993, Snetsinger et al. 1994); competition for food or space with introduced birds (Mountainspring and Scott 1985, Williams 1987); habitat loss and alteration; and population fragmentation. However, 'elepaio have been able to thrive at some highly disturbed sites containing entirely alien forest (Conant 1977, Shallenberger 1977, Shallenberger and Vaughn 1978), but have disappeared from many areas of native forest in the northern Ko'olau Range (VanderWerf 1993b, VanderWerf and Rohrer 1996), suggesting that habitat loss or alteration is not the cause of the decline. 'Elepaio are also extremely versatile and flexible in their foraging behavior, and they use all available vegetation types and substrates (VanderWerf 1993a, 1994). The disappearance of a species so generalized and adaptable in its habitat requirements and foraging behavior is perplexing.

One area where 'elepaio have been found recently and consistently on O'ahu is the leeward (west) side of the southern Ko'olau Mountains, particularly in Pia and Kuli'ou'ou Valleys (Honolulu Christmas Bird Counts, Hawaii State Division of Forestry and Wildlife unpublished 1991 O'ahu forest bird survey, McCafferty 1994, Sherwood 1995). However, no more than three or four individuals have been reported from any location in this area. As part of an effort to determine the overall distribution and population size of O'ahu 'elepaio (see Cowell 1995), we surveyed the southern leeward Ko'olau Range from Manoa to Kalama (Figure 2). During the surveys we recorded data on topography, elevation, and habitat at locations where we observed 'elepaio. Our objectives were to provide a better estimate of the number of 'elepaio remaining in this region of O'ahu, to understand their current distribution and habitat requirements, and to gain some insight on the possible causes of the recent decline of O'ahu 'elepaio that might be useful in their conservation and help guide future research.

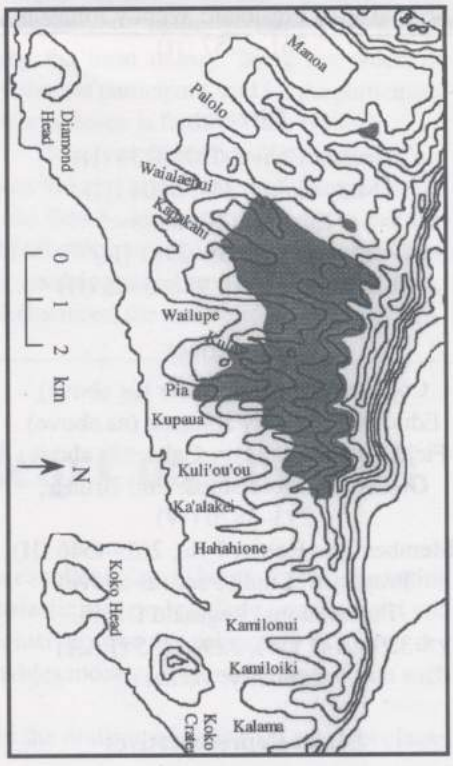

Figure 2

Map of southeastern O'ahu with names of all valleys surveyed for 'elepaio. Elevation is shown in 100 meter interval contour lines. Current range of 'elepaio determined during this study is represented by the shaded area.

Methods

Surveys were conducted by one to four people, and were made by walking up a valley or ridge and actively looking and listening for 'elepaio. This type of single-species search relies on prior familiarity with the study area and with the behavior and ecology of the species concerned (Bibby et al. 1992, p.131). 'Elepaio often respond aggressively to a tape recording of their song by singing and approaching the speaker. We used playbacks of recorded O'ahu 'elepaio songs to increase our efficiency at finding birds (Johnson et al. 1981, Marion et al. 1981). We occasionally made detours up adjacent ridges and side-valleys to search more thoroughly.

Pairs of 'elepaio defend all-purpose, year-round territories against other 'elepaio (Conant 1977, VanderWerf 1993a, van Riper 1995). Counting territories is thus an accurate and relatively easy method of estimating size of the breeding population for 'elepaio. During surveys we therefore recorded the number of territories and used this as a measure of the number of 'elepaio pairs. To increase the accuracy of our estimate of the number of territories, we used playbacks to map territories and determine territory boundaries (Falls 1981). If we could not determine a territory boundary with playbacks, we considered successive observations to represent different territories if neighboring pairs could be distinguished by plumage differences based on age (MacCaughey 1919, Pratt et al. 1987, VanderWerf unpubl.), or if the observations were so far apart that it was unlikely that both could be in the same territory. Conant (1977) found that territory size of O'ahu 'elepaio in Manoa averaged 2.0 hectares (range=1.2 to 2.9). On the island of Hawaii, van Riper (1995) found average territory size to be 1.08 hectares (range=0.65 to 1.46) for *C.s. bryani* at Pu'u La'au, while VanderWerf (unpubl.) found an average territory size of 0.94 hectares (range=0.63 to 1.18) for *C.s. ridgwayi* in dense forest at Hakalau Forest National Wildlife Refuge. We used approximately 140 meters (one side of a square territory that is two hectares in size) as a minimum intervening distance for successive observations to represent different territories.

We arrived at a population estimate by assuming each territory contained a pair of birds. Unless the sex ratio was highly skewed, it is unlikely that many territory holders were unable to obtain a mate. In 'elepaio populations on the island of Hawaii, few territorial birds are unable to attract a mate, and unmated birds usually act as "floaters" (VanderWerf unpubl.). This estimate thus excludes non-territorial, floating individuals and recent fledglings that were observed on their natal territory. In areas with very few 'elepaio we made special effort to ascertain whether each bird had a mate. If after searching we could not find a second bird in a territory, we assumed there was no mate and used the actual number of birds observed as the population estimate.

We were not able to survey the entire length of certain valleys because they were too large and we had limited time (Waialaenui, Kapakahi, Wailupe). In these cases we assumed that elevations above the point where we stopped surveying were potentially suitable and that the remainder of the valley contained an equal density of

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territories as the area we had surveyed. By examining topographic maps we determined the proportional length of the valley that we had covered, and extrapolated to obtain an estimate for the entire valley. We believe this approach is valid because in all valleys that we did survey entirely (Kului, Pia, Kupaua, Kuli'ou'ou, Ka'alakei), once we encountered the first 'elepaio they occurred continuously at higher elevations all the way to the end of the valley. Most ridges had trails and were generally easier to survey than valleys, and we surveyed the entire length of each ridge.

At each location where we observed 'elepaio we recorded the elevation, classified the terrain (valley, slope, or ridge), estimated canopy height, categorized understory vegetation density (none, sparse= easy to see through, continuous= possible to walk through, dense= difficult to walk through), and recorded the dominant plant species in the overstory (>3 meters tall) and in the understory (<3 meters tall). Elevations were read from an altimeter in most cases, but for a few locations the elevation was determined from a topographic map.

Results

We observed 'elepaio in all valleys and on most ridges surveyed between Manoa and Ka'alakei, but the number of birds varied considerably among locations (Table 1). Our estimate of the total breeding population for this area is 270 birds. Valleys in the center of the study area contained larger populations, while numbers declined toward the east and west. Pia Valley had the largest population, while Palolo and Manoa had only a single individual each, neither of which appeared to have a mate. We found no 'elepaio east of Ka'alakei (Figure 2). Most 'elepaio occurred between 200 and

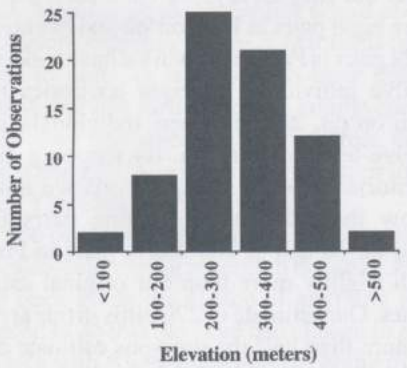


Figure 3. Frequency distribution of 'elepaio observations by elevation.

Table 1. Abundance of 'elepaio in valleys and ridges of the southern leeward Ko'olau Range of O'ahu, from west to east. An asterisk (*) next to the population estimate indicates the entire valley was not surveyed and the estimate was obtained by extrapolation (see Methods). Numbers of individuals, territories, and population estimates for valleys where more than one visit was made are a composite of observations from all visits.

Location	Date(s)	no. indiv. observed	no. territories observed	estimated population
Manoa Valley[1]	2 May 93	1	1	1
	7 Oct 94	1	1	
	24 Oct 95	1	1	
Palolo Valley	20 Feb 95	1	1	1
Mau'umae Ridge (Lanipo)	2 Nov 96	0	0	0
Waialaenui Gulch	4 Dec 95	6	3	*22
Waialaenui Ridge	4 Dec 95	5	3	6
Kapakahi Gulch	20 May 95	9	6	*44
Wiliwilinui Ridge	20 May 95	5	4	8
Wailupe Gulch (Aina Haina)	3 Sep 94	3	2	*38
	15 Oct 94	7	5	
	15 Jul 96	9	6	
	12 Aug 96	6	3	
Kului Gulch	14 Jan 96	23	16	36
	19 Jan 96	6	4	
Hawaiiloa Ridge	14 Jan 96	5	3	12
	19 Jan 96	6	4	
Pia Valley (w. Niu)	21 Jul 94	19	11	60
	5 Mar 95	25	14	
	2 Mar 96	14	8	
	5 May 96	23	15	
	26 May 96	26	14	
Kupaua Valley (e. Niu)	16 Aug 94	13	6	12
Kuli'ou'ou Valley	28 Aug 94	12	7	18
	14 Aug 95	5	3	
	22 Aug 95	8	5	
	10 Sep 95	14	7	
	28 Oct 95	13	7	
Kuli'ou'ou Ridge	25 Apr 93	3	2	8
	7 Nov 95	3	3	
Ka'alakei Valley[2]	22 Oct 94	3	2	4
Hahaione Valley	1 Oct 95	0	0	0
Kamilonui Valley	1 Oct 95	0	0	0
Kamiloiki Valley	1 Oct 95	0	0	0
Kalama Valley	1 Oct 95	0	0	0
				total=270

[1] including Wa'ahila Ridge and Woodlawn Trail.

[2] including Mauna o Ahi Ridge

400 meters elevation (Figure 3). Elevation of the lowest observation varied among valleys, from 90 meters in Pia to 315 in Ka'alakei. In some valleys the lowest observation coincided with the lowest remaining mesic forest (Wailupe, Pia, Kupaua), while in others 'elepaio did not occur until partway into the forested area (Waialaenui, Kapakahi, Kului, Kuli'ou'ou, Ka'alakei). Once the first 'elepaio were encountered in a valley, they occurred in contiguous territories at higher elevations all the way to the cliffs at the head of the valley.

Most locations where we observed 'elepaio were in valleys (59% of 70 total locations), with fewer on slopes (27%), and the least on ridges (14%). Density of territories was also higher in valleys (5.8±1.6 per km, n=7) than on ridges (2.5±0.7 per km, n=4, Mann-Whitney test, p=0.011), indicating the numbers of birds we found was not just an artifact of sampling effort in each terrain type. The forest canopy was relatively tall at most locations (Figure 4,

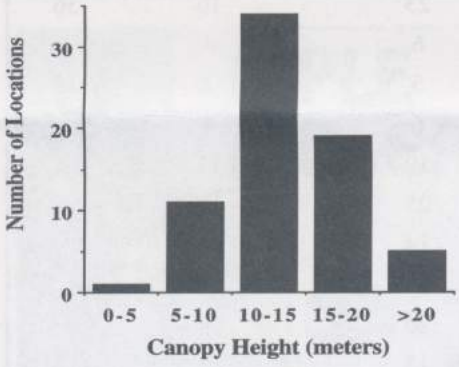
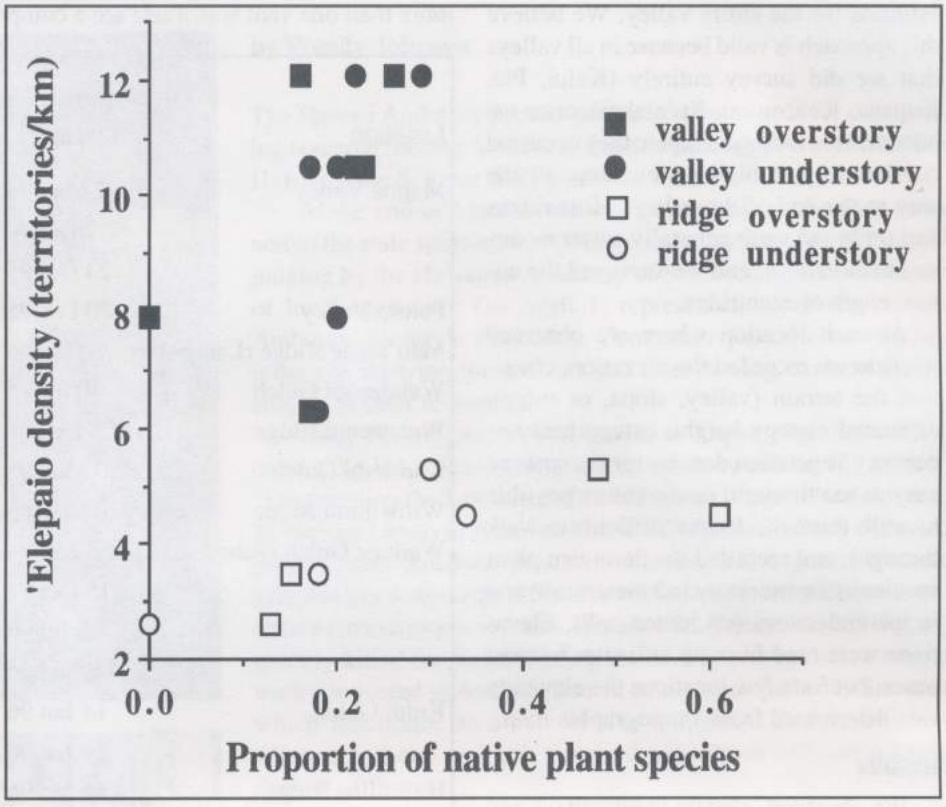


Figure 4. Forest canopy height at locations where 'elepaio were observed.

mean= 12.7 m). Density of the understory vegetation was most often continuous (67% of 70 total locations), with some locations dense (19%), and some sparse (14%), but we never found 'elepaio where there was no understory.

A variety of native and introduced plant species were present in the overstory and the understory at locations where we observed 'elepaio (Appendix 1, p. 106). Many plant species were found at only one or two sites. Introduced plant species were generally more common than native species and dominated the overstory and understory at most locations. Several introduced plants were particularly widespread, including common guava (*Psidium guajava*), strawberry guava (*Psidium cattleianum*), kukui

Figure 5. Density of 'elepaio territories in relation to proportion of native plant species. Points are averages of values from all sites at a given ridge or valley. Valleys (closed symbols) should be compared separately from ridges (open symbols). Squares represent overstory and circles represent understory. A positive slope would have indicated an association of 'elepaio with native vegetation, but neither the slope for valleys nor that for ridges was different from zero (see Results).



(*Aleurites moluccana*), and ti (*Cordyline terminalis*). The most abundant native plants in the overstory were koa (*Acacia koa*) and papala kepau (*Pisonia umbellifera*). In the understory, mamaki (*Pipturus albidus*) and 'ie'ie (*Freycinetia arborea*) were the most common native plants. The overstory consisted entirely of introduced species at 49% of sites, while 50% had a mixture of native and introduced species. Only one of 70 locations, or 1%, had an overstory consisting entirely of native species. In the understory, 44% of locations had only introduced species, 56% had a mixture of native and introduced species, and none had only native species. Multiple regression of 'elepaio territory density on proportion of native plant species in the overstory and understory showed that 'elepaio abundance was not related to amount of native vegetation either on ridges (Figure 5, R-squared=0.50, F=2.49, p=0.41) or in valleys (R-squared=0.15, F=1.45, p=0.36).

Discussion

Our estimate of the 'elepaio breeding population in the southern leeward Ko'olau Range is 270 birds, not counting floaters and recent fledglings. This number is probably an underestimate of the actual breeding population. It is very unlikely that we found every pair of 'elepaio in the areas we surveyed, and additional birds probably occur on steep slopes that we did not cover. We verified the accuracy of our methods by mist-netting and color-banding part of the population in Kuli'ou'ou and Pia Valleys. After our first surveys we concluded there were eight pairs in Kuli'ou'ou and twenty–eight pairs in Pia. Since then we have banded twelve individuals in eight territories in Kuli'ou'ou, and nineteen individuals in twelve territories in Pia. By mapping the territories of these banded birds we now know there are actually nine pairs in Kuli'ou'ou and at least thirty pairs in Pia, both slightly more than our original estimates. Our estimate of 270 birds in this area is more than half the previous estimate of 200-500 for the entire island (Ellis et al. 1992).

The center of 'elepaio abundance in the

southern leeward Ko'olau Range is from Waialaenui Gulch to Kuli'ou'ou Valley (Figure 2). 'Elepaio populations in this area are relatively large and quite dense, with contiguous territories for most of the length of each valley. Although the number of individuals in each valley is small compared to populations on Kaua'i and Hawai'i (Scott et al. 1986), the habitat in most valleys appears to be nearly saturated with 'elepaio territories. It seems unlikely that these valleys could support much larger populations.

Numbers of 'elepaio decline from the center towards both the east and west, but the patterns of decline and their probable causes are quite different. 'Elepaio decline gradually toward the east, beginning in Kupaua Valley, and the eastern limit to 'elepaio distribution appears to be a natural climatic range boundary determined by moisture. Lower moisture may limit distribution of 'elepaio by causing vegetation to be less dense and forest to be less extensive. Mean annual rainfall decreases as one proceeds eastward in the southern Ko'olaus, from 4000mm in Manoa, to 2000mm near Kapakahi, 1500mm at Pia, and 1000mm east of Hahaione (Giambelluca et al. 1986, p.138). The easternmost valley where we observed 'elepaio, Ka'alakei, is fairly dry, and mesic forest is limited to a narrow riparian corridor. Only a few 'elepaio occur in the uppermost, wettest portion of the valley where the vegetation is tallest and most dense. Hahaione Valley, immediately east of Ka'alakei, contains only two small patches of mesic forest. The valleys east of Hahaione are even drier and have little forest of any kind.

In contrast to the gradual decline seen in the east, numbers of 'elepaio drop sharply west of Waialaenui Gulch. Palolo and Manoa Valleys each had only a single bird, neither of which appeared to have a mate. Moreover, Manoa supported at least eleven pairs of 'elepaio in the 1970s (Conant 1977), but they are now almost gone. For three years in a row we found only a lone male at the same location in Manoa. The western limit to 'elepaio distribution in this area has thus been recently truncated by unknown causes.

It is possible that certain valleys or groups of valleys represent discrete populations isolated from others by steep, dry intervening ridges, but the amount of dispersal among valleys and over ridge tops is unknown. Dispersal and gene flow were undoubtedly higher in the past when forest habitat was continuous at lower elevations (Hawaii Heritage Program 1991). Whether 'elepaio move among valleys could have important impacts on effective population size, loss of genetic variation, and inbreeding, and should be considered in management plans.

Figure 6.

Typical O'ahu 'elepaio habitat at 300 meters elevation in Kuli'ou'ou Valley. Note the tall forest canopy and dense understory.

Photograph by E. VanderWerf

In the southern Ko'olau Range 'elepaio are most abundant in valleys from 200-400 m elevation where there is mesic forest with a tall canopy and a well-developed understory (see Figure 6). They also inhabit shorter, drier forest on slopes and ridges, but are less common in this habitat. This pattern of abundance was also apparent historically. Seale (1900) said of the O'ahu 'elepaio that "its usual haunt is the densely wooded cañons at an elevation of from 800 to 1300 feet" (244-396 meters). MacCaughey (1919) concluded that the 'elepaio "is most plentiful in the protected wooded ravines and on the valley slopes." Valleys may support more 'elepaio because they contain thicker, taller forest that is more humid and protected from desiccating winds and large temperature fluctuations. The most effective and accurate method of estimating 'elepaio populations on O'ahu is to survey valleys and determine the number of pairs by territory mapping. Survey methods traditionally used on O'ahu have concentrated effort on ridges, which is useful for other native forest bird species, but is likely to detect only a small fraction of 'elepaio.

The elevational distribution of 'elepaio appears to be determined by a combination of three factors: 1. the higher density of 'elepaio in valleys; 2. the pattern of habitat destruction by humans; 3. the topography of the area. Most valleys in this area have been heavily developed below 100 meters, and contain no 'elepaio in that range. Mesic forest begins and 'elepaio are first encountered in most valleys from 100-200 meters. Disturbance declines and forest structure improves as one ascends, and the number of 'elepaio increases, reaching a peak from 200-400 meters. Most valleys in this area become very steep and narrow at about 400 meters, causing the amount of valley habitat and thus the number of 'elepaio to diminish. Most observations above 400 meters were on slopes and ridges, where density of 'elepaio is lower.

'Elepaio are generalized and adaptable in their habitat requirements. Forest structure and density appear to be more important to 'elepaio than plant species composition. Abundance of O'ahu 'elepaio was not related to proportion of native plant species in the overstory or understory, indicating 'elepaio are not dependent on native vegetation. Introduced plants outnumbered native plants at nearly all sites, and many sites had no native plants. However, this does not necessarily imply that 'elepaio have a preference for introduced plants, and may simply reflect the abundance of invasive alien plant species in mid-elevation valleys where most 'elepaio occur. Hawaii 'elepaio preferred foraging sites with denser than average vegetation at all heights, but used all available tree species to some extent and were very flexible in their use of foraging sites and behaviors (VanderWerf 1993a, 1994).

Habitat loss has undoubtedly decreased the original ranges of all native forest birds on O'ahu, but it is not the primary cause of the recent decline of O'ahu 'elepaio. Palolo and Manoa, where 'elepaio have recently declined, are more heavily developed than valleys farther east, but development has not increased substantially during the pe-

riod when 'elepaio have declined. 'Elepaio have also disappeared from large sections of the northern Ko'olau Range that still have primarily native forest (VanderWerf 1993b, VanderWerf and Rohrer 1996), so habitat loss cannot explain the current distribution.

'Elepaio also appear to be less vulnerable to habitat alteration than most native Hawaiian birds. Like the O'ahu 'amakihi (*Hemignathus chloris*), 'elepaio can thrive in introduced forest, and both species are generalized in their foraging behavior (Berger 1981, Scott et al. 1986). The adaptability of 'elepaio was already apparent to early naturalists in Hawaii. Henshaw (1902) predicted that "so long as any woodland at all is left the 'elepaio will hold its own." Perkins (1903) believed that "to the changes wrought by civilization they are less susceptible than any other bird, and they may be seen feeding and even nesting in dense thickets of the introduced guava, or amongst masses of the prickly lantana, as contentedly as amongst the native vegetation." Shallenberger and Vaughn (1978) found the highest incidence of 'elepaio in areas of mixed alien-native forest, particularly those with kukui and guava.

Evidence from banded birds indicates an epizootic of disease, possibly avian pox virus, is occurring now and may have played an important role in the decline of 'elepaio on O'ahu. Nine of twelve birds banded in Kuli'ou'ou and twelve of nineteen birds banded in Pia Valley had cutaneous lesions on the feet and toes typical of those produced by pox virus (Warner 1968, see Figure 7). A conclusive diagnosis of pox virus currently can be made only through histopathology, which we have not done, so we can only say that these birds were suffering from some disease, and that pox virus is perhaps the most likely. Lesions and swellings on some birds were large (up to 9 by 12 mm), bleeding or covered with crusty scabs, and limited the bird's ability to perch and hop. Lesions on other birds were small and did not seem to be a hindrance. Several birds no longer had active swellings or lesions, but had deformed or missing toes. Pox is thought to be a serious threat to native Hawaiian birds, but its importance is less well known than malaria (Warner 1968, van Riper et al. 1986, Atkinson et al. 1995), and its mortality rate and effect on ability to reproduce are unknown. We plan to investigate these issues by monitoring these banded populations.

Other potential threats to O'ahu 'elepaio include: competition for food or space with introduced birds such as the Japanese white-eye (*Zosterops japonicus*), red-vented and red-whiskered bulbuls (*Pycnonotus cafer* and *P. jocosus*) and the white-rumped shama (*Copsychus malabaricus*); predation by introduced mammals such as cats (*Felis domesticus*), Small Indian mongooses (*Herpestes auropunctatus*), and black, Polynesian, and Norway rats (*Rattus rattus*, *R. exulans*, and *R. norvegicus*); population fragmentation; and inbreeding depression. Mountainspring and Scott (1985) found a negative correlation between abundance of Hawaii 'elepaio and the Japanese white-eye, but they presented no evidence of actual competition. Both species of bulbuls are larger than 'elepaio and generally aggressive, and bulbuls and white-eyes have increased in abundance during the same time when 'elepaio have declined (Williams 1987), but amount of dietary overlap between these alien species and 'elepaio is unknown and interactions between them appear to be rare. Conant (1977) found low nesting success of O'ahu 'elepaio and suspected nest predation might be one of the causes. Snetsinger et al. (1994) found remains of an adult 'elepaio in a feral cat scat from Pu'u La'au, Hawaii, and C. Mostello (pers. comm.) found adult 'elepaio bones in a barn owl (*Tyto alba*) pellet from Hakalau Forest National Wildlife Refuge, demonstrating that predation is not limited to eggs and nestlings. To determine the importance of these factors in limiting populations of O'ahu 'elepaio, further studies are necessary that examine nesting success and causes of failure, mortality of adults and fledglings, dispersal, disease prevalence, and genetic variation and population structure.

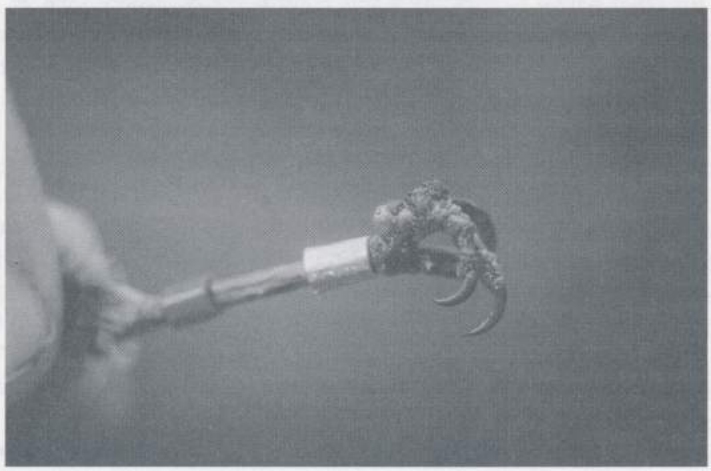


Figure 7.

Cutaneous lesions, possibly caused by pox virus, on the foot of an 'elepaio from Kuli'ou'ou, 28 October 1995.

Photograph by E. VanderWerf

Summary and Conclusions

We conservatively estimate the breeding population of 'elepaio in the southern leeward Ko'olau range to be 270 birds. Valleys from Waialaenui to Pia contained large populations, with numbers declining gradually to the east in association with lower rainfall and sharply to the west for unknown reasons. Most 'elepaio occur from 200-400 meters elevation, density of territories is twice as high in valleys as on ridges, and most areas where 'elepaio are found have a tall forest canopy and a continuous understory.

'Elepaio are generalized and adaptable in their habitat requirements, and habitat loss and alteration are not the cause of the recent decline of O'ahu 'elepaio. Forest structure is more important to 'elepaio than plant species composition. 'Elepaio are not more common where there is more native vegetation, and most areas where 'elepaio occur are dominated by introduced plants. Future surveys for 'elepaio should concentrate effort in valleys and should not be limited to areas of native forest.

Introduced diseases, particularly avian pox virus, may have played an important role in the decline of O'ahu 'elepaio. Twenty–one of thirty–one 'elepaio banded in Pia nd Kuli'ou'ou Valleys had cutaneous lesions on the feet and toes typical of those produced by pox virus. Unless a practical method becomes available for controlling pox in the field, the best management strategy for conserving O'ahu 'elepaio may be to control predators, especially rats, so birds that might be naturally more disease-resistant have a better chance of reproducing. Although their decline has been serious and rapid, we are hopeful that additional studies will reveal methods of conserving wild populations of O'ahu 'elepaio, symbol of the Hawaii Audubon Society and namesake of its journal.

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Editor's note: See page 106 for Appendix 1.

T-shirts for Sale

The Hawaii Audubon Society has a stock of T-shirts designed to spread the Audubon message. Not only are they attractive personal apparel, but they make excellent presents as well.

T-shirts bearing the Society's 'Elepaio logo are available in blue spruce and forest green. We also have a few in ash (gray). In addition, the "hot" Kolea (Pacific Golden Plover) T-shirts are also available. This T-shirt is white with a three-color design of the Kolea and native hibiscus. Proceeds from the Kolea T–shirt sales support research on the kolea.

Send check made payable to HAS with order ($12 plus $2.00 shipping) to Yvonne Izu, 1957 Alai Place, Wahiawa, Hawai'i 96786.

Appendix 1.

Overstory plant species	proportion of sites (n=70)	Understory plant species	proportion of sites (n=70)
common guava *(Psidium guajava)*	0.67	common guava (*Psidium guajava*)	0.61
kukui (*Aleurites moluccana*)	0.60	ti (*Cordyline terminalis*)	0.60
strawberry guava (*Psidium cattleianum*)	0.27	christmasberry (*Schinus terebinthifolius*)	0.33
koa (*Acacia koa*)*	0.23	mamaki (*Pipturus albidus*)*	0.27
christmasberry (*Schinus terebinthifolius*)	0.23	'ie'ie (*Freycinetia arborea*)*	0.23
papala kepau (*Pisonia umbellifera*)*	0.20	strawberry guava (*Psidium cattleianum*)	0.23
mango (*Mangifera indica*)	0.11	Koster's Curse (*Clidemia hirta*)	0.21
umbrella tree (*Schefflera actinophylla*)	0.11	hapu'u (*Cibotium* sp.)*	0.20
'ohi'a (*Metrosideros polymorpha*)*	0.10	coffee (*Coffea arabica*)	0.16
mamaki (*Pipturus albidus*)*	0.09	papala kepau (*Pisonia umbellifera*)*	0.14
lama (*Diospyros sandwicensis*)*	0.09	awapuhi (*Zingiber zerumbet*)	0.13
papala (*Charpentiera obovata*)*	0.07	kukui (*Aleurites moluccana*)	0.09
ironwood (*Casuarina* sp.)	0.07	papala (*Charpentiera obovata*)*	0.07
gunpowder Tree (*Trema orientalis*)	0.07	uluhe (*Dicranopteris linearis*)*	0.07
alahe'e (*Canthium odoratum*)*	0.06	noni (*Morinda citrifolia*)	0.07
lonomea (*Sapindus oahuensis*)*	0.04	lonomea (*Sapindus oahuensis*)*	0.04
Norfolk Island pine (*Araucaria excelsa*)	0.04	umbrella tree (*Schefflera actinophylla*)	0.04
'ie'ie (*Freycinetia arborea*)*	0.03	mango (*Mangifera indica*)	0.04
kopiko (*Psychotria mariniana*)*	0.03	cayenne vervain (*Stachytarpheta urticaefolia*)	0.04
eucalyptus (*Eucalyptus* sp.)	0.03	lantana (*Lantana camara*)	0.04
silk oak (*Grevillea robusta*)	0.03	'ohi'a (*Metrosideros polymorpha*)*	0.03
chinese banyan (*Ficus microcarpa*)	0.03	lama (*Diospyros sandwicensis*)*	0.03
rose apple (*Syzygium jambos*)	0.03	passion flower (*Passiflora* sp.)	0.03
mountain apple (*Syzygium malaccense*)	0.03	rose apple (*Syzygium jambos*)	0.03
bird's nest fern (*Asplenium nidus*)*	0.01	mountain apple (*Syzygium malaccense*)	0.03
sandalwood (*Santalum freycinetianum*)*	0.01	pukiawe (*Styphelia tameiameiae*)*	0.01
coffee (*Coffea arabica*)	0.01	akoko (*Chamaesyce multiformis*)*	0.01
Java plum (*Syzygium cumini*)	0.01	maile (*Alyxia oliviformis*)*	0.01
fiddlewood (*Citharexylum caudatum*)	0.01	ilima (*Sida fallax*)*	0.01
koa haole (*Leucaena leucocephala*).	0.01	kopiko (*Psychotria mariniana*)*	0.01
		hahala (*Cyrtandra cordifolia*) *	0.01
		ulei (*Osteomeles anthyllidifolia*)*	0.01
		hala (*Pandanus tectorius*)*	0.01
		taro (*Colocasia esculenta*)	0.01
		black bamboo (*Phyllostachys nigra*)	0.01
		Norfolk Island pine (*Araucaria excelsa*)	0.01
		thimbleberry (*Rubus rosifolius*).	0.01

Proportional occurrence of plant species in the overstory and understory at locations where 'elepaio were observed. Common and scientific names follow Wagner et al. (1990). An asterisk (*) indicates plants that are native to Hawaii.

Jack Jeffrey Recognized for Accomplishments

by Hugh Vickery

At a reception March 17, at the 62nd annual North American Wildlife and natural Resources Coference, the National Wildlife Refuge Association and the National Audubon Society recognized Jack Jeffrey, a wildlife biologist at Hakalau National Wildlife Refuge in Hilo, Hawai'i, as refuge employee of the year.

Jack Jeffrey has been a long time friend of the society. He has donated the usage of numerous photographs to our publications, chief among them *Hawaii's Birds*, the cover shot on the latest edition is one of Jack's superb images. He has also has led field trips, and has given several highly entertaining slide show presentations at our program meetings. Jack's dedication and volunteer help on behalf the society reflects the best tradition of our concerned members. We salute his award — and strongly feel that he richly deserves the accolade.

Jeffrey is working to establish a "Friends" group at Hakalau and is partly responsible for the refuge's active volunteer tree planting and weed control programs.

Kahuku — 1997 Paradise Pursuits Champions

By Sylvianne Yee

For the second year in a row, Kahuku has captured the Paradise Pursuits championship! The team of Benjamin Cheney, Daniel Evans, Le'a Minton, and Kaitlin Palmer (a completely different group from last year's winners) - went buzzer to buzzer with the best and brightest of Hawaii's students. Congratulations to the runners-up, Kaua'i's Waimea High team of Ronald Camarao, Natalie Domingcil, and Tysen Okihara. Other semifinalists were the team from Hilo (Nina Yuen Emery Sagucio, Tania Fulks, Megal Lloyd, and Lauren Reyes) and Maui (Bryantt Bernardo, Orrin Brown, Jayson Garcia, Jennifer Proveaux, and Shelley Onnagan). Mahalo to the hard working coaches, Anne Zellinger (Kahuku), Deborah Chaffin (Waimea), Ron Lau (Maui), and Suzanne Cama (Hilo).

Play off games with John Harrison, HAS First Vice President, as Host, April 11, at 'Olelo

Kahuku Team with HECO Representative Elena Seu, Paula Akana, Host, and Anne Zelliger, Coach

The challenge to see who would be the 1997 Paradise Pursuits Champions began in February with the preliminary rounds. Of the thirty teams, eight won the right to compete in the play off games held on Friday, April 11 at 'Olelo The Corporation for Community Television. Four teams emerged from these games and competed in the semifinal and final rounds at KITV–4 on Saturday, April 12 with Kahuku emerging as the victor in three close and exciting games. Congratulations, Kahuku, and hats off to all of the thirty teams who participated in the 1 997 Paradise Pursuits games. You are all winners!

March 29, Field Trip to Makapuu Lighthouse

by David Watson

The March 29, field trip had several blessings. At meeting time the skies blessed us with a downpour that wet many hikers but hurt no feelings.

Everyone huddled in their cars until roused by Lance Tanino, the leader, and started up the easy road to the Makapuu lighthouse. Immediately, it stopped raining, and Bob Pyle was there to share his immense knowledge.

Our second blessing was the animals. On the way up we saw small groups of nutmeg mannikins, a tiny brown seed eater, and one female magnificent frigate bird — a huge soaring pirate of other birds' food. Later, we saw red-footed boobies, wedge-tailed shearwaters, brown boobies, brown noddies, sooty terns and red-tailed tropicbirds. Really large whales breached in the waves

There were plenty of ilima in full bloom, and several patches of *Stapelia sp.* — an African succulent with brown fingers — thrust up from rocky ledges. They have huge purple flowers that smell awful and are pollinated by flies. The seeds of these plants were probably carried over from Koko Crater Botanical Garden.

At the windy top, we held onto our hats while Dr. Gail Grabowsky-Ka'ai'ali'i told us about the Laysan albatross project, designed to lure albatross to breed on the flat island that lies in front of Rabbit Island. This island is covered with decoys of albatross. Volunteers to the project spend several hours watching to see if real birds are lured to nest. So far, no birds have been fooled, but one bird-watching couple confided they had spied the decoys from the beach and gleefully added them to their life list. "You mean, they're wood?"

The final blessing was a small boy with his mom celebrating his eighth birthday. He had been given his choice of anything he wanted to do that day, and had chosen to go birding with Audubon instead of going to a ball game or shopping at the mall. That made us all feel good about the future.

Thank You, Paradise Pursuits Sponsors

By Sylvianne Yee

There would be no Paradise Pursuits program without the generous and enthusiastic support of so many individuals, businesses, and organizations. The outpouring of donations from so many has been overwhelming and we'd like to take this opportunity to recognize each and every one of them:

Major funding:	**Hawaiian Electric Company, Inc.**
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	Hawaii Department of Land and Natural Resources
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	Phyllis W. Lee
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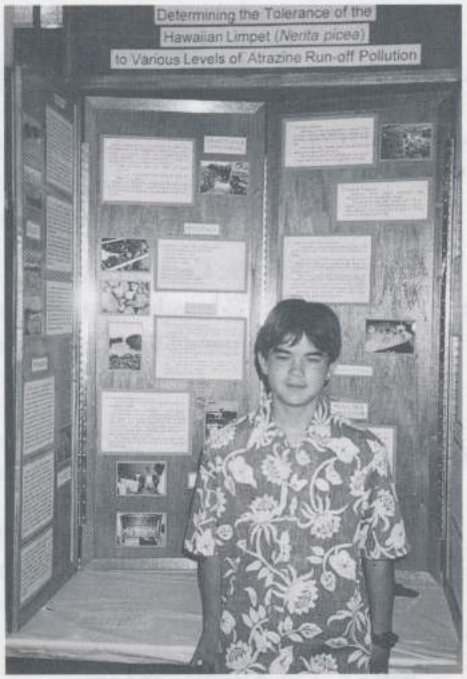
Waikiki Aquarium
Zippy's Restaurants

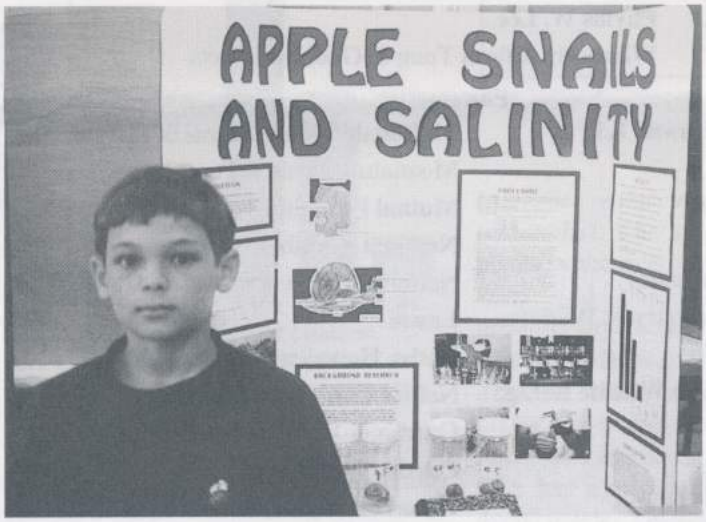
From the Paradise Pursuits staff, the students, and all the present and future generations enjoying this environment known as Hawaii, MAHALO NUI LOA!

HAS Awards for Student Research Presented



Cody Hashimoto, with his project which was judged HAS Senior Research Award Winner at the annual Hawaii State Science & Engineering Fair.

The HAS award for outstanding Junior Division research went to sixth grader, Frederick Reppun, from Waiahole Elementary School.



by Wendy Johnson

The Hawaii Audubon Society presented two awards for outstanding research relating to Hawaii's natural history at this year's 40th Hawaii State Science & Engineering Fair.

At the end of March, intermediate and high school students across the state submitted over 450 science projects for review and judging by the Hawaiian Academy of Science and a wide variety of local agencies. On April 1, representatives of the Hawaii Audubon Society's Education Committee joined other agency judges in studying the exhibits and interviewing students on the subject of their research.

Cody Hashimoto, a ninth-grader at Kapaa High School, received the HAS Senior Division research award for his project, "Determining the Tolerance of the Hawaiian Limpet (*Nerita picea*) to Various Levels of Atrazine Run-Off Pollution". Cody collected pipipis from Anahola Beach on Kaua'i, and exposed discrete samples to a wide range of Atrazine (a common herbicide) concentrations in a seawater solution. High levels of Atrazine (2,500 ppm) quickly killed the limpets being tested. Pipipi population counts were conducted at Anahola Beach, an undeveloped coastline area which functioned as a control site, and Anini Beach, which is adjacent to hotel and golf course development and had a lower density of limpets.

The HAS award for outstanding Junior Division research relating to Hawaii's natural history went to Frederick Reppun, a sixth grader from Waiahole Elementary School. His project, titled "Apple Snails and Salinity", combined laboratory work with field observations to define introduced apple snails as a potential threat to taro plants farmed in Waiahole Valley. Frederick has an impressive understanding of aquatic ecosystems, and his research was well designed, providing conclusive and useful information.

Like all good scientists, both award winners were able to identify further research questions raised by their studies. To encourage and congratulate these students, HAS was pleased to present each of them with a plaque honoring their achievement, a year's membership to the Society including a subscription to the *'Elepaio*, and a copy of our publication, *Hawaii's Birds*.

Hakalau Forest National Wildlife Refuge Needs Your Help

It's tree planting season and volunteers are needed to help with the Refuge's reforestation program. Since 1989, volunteers have planted over 170,000 koa trees in the abandoned pastures in the upper portion of the Refuge. Starting this year, about 2,500 other native forest trees including ohia, olapa, pilo, kolea and others grown in pots at the Refuge greenhouse, will be outplanted by volunteers to help further restore native forest habitat.

The Memorial Day weekend of May 24-26 has been reserved for Hawaii Audubon members and friends to assist with the reforestation project. Transportation to and from Hilo Airport and lodging at the Hakalau Forest NWR Cabin will be provided. Schedule will include time to take advantage of being in one of the Big Islands' most fabulous birding spots — who will spot an 'akiapola'au?

Participants will need to arrange flights that get them to Hilo Airport by 9 a.m. on May 24 and can plan to be back at Hilo Airport by 4 p.m. on May 26 for return flights. Volunteers must provide their own food, sleeping bags, and rain gear.

Trip minimum is six people, with a maximum of ten. For reservations, call the HAS office at 528-1432 not later than May 22. If no one's in, leave the requested information in voice mail box 4.

Lana'i Field Trip, A Special Time

by Brenda Becker

On February 15th five members of HAS, three from Honolulu and two part-time Lana'i residents, were treated to a grand tour of The Nature Conservancy's only preserve on Lana'i at Kanepu'u, one of the few remaining examples of the olapua/lama native dryland forest. Typically, two-hour tours are given by docents, but we were extremely fortunate to have Gaylien Ko'ohalahala, the preserve manager, give us a personalized tour. Many generations of Gaylien's family have lived on Lana'i, and he spent his youth exploring the area which is now the preserve. Gaylien's extensive knowledge of the Hawaiian legends and history associated with the areas we visited also complemented our nearly four-hour tour, which included the "Garden of the Gods."

We saw several enclosures in the preserve which prevented grazing and rutting damage caused by the axis deer. An incredible amount of the preserve management effort is keeping the entire area fenced to prevent deer damage and poisoning to kill the rats which enjoy munching on the seeds of the rare plants. We saw three endangered plant species: nau'u, the native Hawaiian gardenia with less than twenty plants remaining in the wild; 'iliahi, sandalwood; and the vine *Bonamia menziesii*, a member of the morning glory family. Although our primary focus was the native windswept habitat, we did encounter introduced birds: the song of a mockingbird, a ring-necked pheasant, and a small nest with four eggs, probably those of a Japanese white-eye.

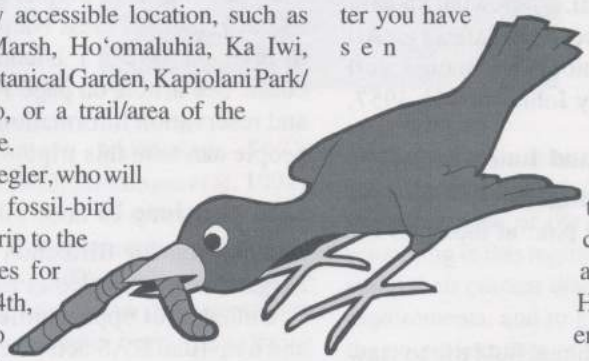
Waimea High School's Team, 1997 Paradise Pursuits Runners Up receiving their trophy at KITV–4 on April 12

Birdathon for 1997: "Put a Feather in your Father's Cap"

by Susan Elliott Miller

Saturday, June 14, 1997 (the day before Father's Day), you are invited to have some family fun at a fund-raiser! Birdathoners of all ages will ask sponsors to make monetary pledges for every species seen during one of a number of walks or hikes being scheduled for that day. The activities will either be at a specific easily accessible location, such as Kawai Nui Marsh, Ho'omaluhia, Ka Iwi, Koko Head Botanical Garden, Kapiolani Park/ Honolulu Zoo, or a trail/area of the leader's choice.

Dr. Alan Ziegler, who will be leading a fossil-bird hunting field trip to the Ewa sink holes for HAS on the 14th, has agreed to have his trip designated as a "Birdathon" trip. Even if you've done Birdathons before, this one will be different!



The annual Birdathon is a traditional Audubon Society activity in which half the proceeds support a National Audubon Society activity (in this case protection of Important Bird Habitats) and half the proceeds go to an activity of Hawaii Audubon Society. This year organizers have chosen to support "Paradise Pursuits" - a program now in its sixth year.

Participants can sign up through the HAS office for a trip of their choice and pledge forms will be sent to them. (You don't have to be an Audubon member to be a Birdathoner.) Then the fun begins! Get your mother, your spouse, your neighbor, your boss, your co-workers to pledge. After you have seen enjoyed your chosen trip, your leader will sign a certificate as to the number of species you saw. Take that back to your sponsors, collect the money and turn it into the HAS office by the end of June.

Your support (and that of your sponsors) will be noted in the August-September *'Elepaio*. Also, prizes will be offered for seeing the most species, raising the most money, being the oldest or youngest participant, and for the participant whose home is farthest from Hawai'i.

The ad hoc Birdathon "Committee" (Susan Miller, Lynnea Overholt, Margo Owen, and Dan Sailer) encourage you to call the HAS office at 528-1432 NOW to sign up as a participant and get your pledge forms. Remember, the early bird gets the worm!

Your Bequest Can Help Conservation

A bequest to the Hawaii Audubon Society is an excellent way to help in our conservation efforts. For example, George C. Munro, enthusiastic and tireless field ornithologist and naturalist, provided for a fund to be used exclusively for the protection of native dry forests. Today, the George C. Munro Fund provides money for research projects on such forests.

Although an attorney should be consulted in the drafting of your will, a model clause for bequests is set forth below.

"I hereby give, devise, and bequeath to the Hawaii Audubon Society, Honolulu, Hawai'i, the sum of _____ dollars (or set forth a description of property), to be used for the general purpose of said organization."

For more information and assistance, contact the Hawaii Audubon Society, 850 Richards Street, Suite 505, Honolulu, HI 96813–4709, (808) 528-1432.

Calendar of Events

Monday, May 5 and June 2

Regular first Monday of the month meeting of the **Conservation Committee**, 6 p.m., at the U.H. Environmental Center (Crawford Hall, Room 317, 2550 Campus Road). All are welcome. For more information call chairperson Dan Sailer, 455–2311.

Thursday, May 1 and June 5

Monthly meeting of the **Education Committee**, 7 p.m. at BaLe Sandwich Shop in Manoa Marketplace (near Safeway). All are welcome. For more information, call chairperson Wendy Johnson, 261-5957.

Monday, May 12 and June 9

HAS Board meeting, (always open to all members) 6:30 p.m. at the HAS office.

Saturday, May 24

Our more-or-less annual field trip to view the red-footed booby bird colony at Marine Corps Base Hawaii on Ulupau Head on the Mokapu peninsula. Meet at 8:30 a.m. at the H-3 gate of MCBH Kaneohe. Participants will be asked to sign a "hold harmless" agreement and to carpool from the gate to the colony. Wear walking shoes, bring water and sun protection, and don't forget binoculars. Reserve by May 14th with Mary Gaber at 247-0104. Requested donation, $2.00/person.

Saturday-Monday, May 24-26

Tree planting over Memorial Day weekend at Hakalau Forest National Wildlife Refuge on Hawai'i Island's Hamakua coast. See article on page 108 for details and reservation information — ten lucky people can take this trip!

Saturday, June 14

Join the fun for Birdathon 1997! Alan Ziegler's Ewa Sink Holes trip will be one of a number of opportunities to have fun and help fund HAS activities. See article on page 109 for details.

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