'ELEPAIO

Journal of the
Hawaii Audubon Society

HAWAII AUDUBON SOCIETY

For the Protection of
Hawaii's Native Wildlife

VOLUME 45, NUMBER 7 JANUARY 1985

Notes on the Breeding Biology of the Hawaiian Race of the American Coot

by G. Vernon Byrd[1], Richard A. Coleman[2], Robert J. Shallenberger[3], and Carl S. Arume[4]

The Hawaiian race of the American Coot *(Fulica americana alai),* referred to hereafter as "Hawaiian Coot", is one of four species of endangered waterbirds in the Main Hawaiian Islands. Loss of habitat and depredation by introduced predators are the suggested major reasons for the decline of these once plentiful birds (Berger 1981).

Few specific details on the reproductive biology and breeding habitat preferences of the Hawaiian Coot have been published, although at least cursory observations have been made by a number of ornithologists in the state. General summaries of information have been compiled (Hawaiian Waterbird Recovery Team 1977, Shallenberger 1977), but the actual data on which such summaries are based exist mostly in field diaries of various observers and in unpublished reports.

Recently the U.S. Fish and Wildlife Service has begun to develop habitat on five wetland National Wildlife Refuges (NWR) in Hawaii to benefit endangered waterbirds including coots. The need for data on the distribution, timing of breeding, nest site preferences, and other aspects of the natural history of the coot prompted us to collate available information and observe nesting coots at four sites on Oahu and one site on Molokai. This paper summarizes the information we accumulated, compares data on Hawaiian Coots with data on coots elsewhere, and includes management recommendations.

METHODS

From October 1980 to August 1982 all coot nests found opportunistically during regular wetland work were recorded on Oahu at Kii and Punamano units of James Campbell NWR and nearby Amorient Aquafarm, Crow Bar Ranch in Mokuleia, Honouliuli unit of Pearl Harbor NWR, and Hamakua Marsh in Kailua; and on Molokai during periodic surveys at Kakahaia NWR (Figure 1.) The following information was recorded at each nest site: number of eggs, size of eggs, stage of incubation (from float test, cf Westerkov 1950), nest material, size of nest, water depth, and description of surrounding cover. In addition, we reviewed published and unpublished literature on coots.

RESULTS AND DISCUSSION

Nesting Habitat

In Hawaii, coots reportedly breed in scattered small ponds, reservoirs, and irrigation ditches (Udvardy 1960, Hawaiian Waterbird Recovery Team 1977, Shallenberger 1977). Nevertheless, only about 15 regular nesting locations are currently known (Table 1). These areas have in common robust emergent plants interspersed with open, fresh water which is usually less than 1 m deep.

Habitats used by nesting coots in Hawaii are structurally similar to those used by coots elsewhere. In North America, optimum nesting habitat includes a thorough interspersion of clumps of robust emergent plants (e.g., *Scirpus, Typha*) and open water (Gullion 1954, Miller and Collins 1954, Ryder 1961, Vaa et al. 1974) reaching an overall ratio of approximately 50:50 (Weller and Fredrickson 1974). Nests are usually found in open water settings where nest foundations (such as mats of algae) are available, or in clumps of emergent plants, but always near the alternate type (i.e., water nests near cover and vice versa). In a Calfornia study, Gullion (1954) found that most coot nests built in emergents were within 1 m of open water, a result we likewise discovered in Hawaii. In contrast, nests were found up to 5 m from open water in a South Dakota study area (Vaa et al. 1974). Studies show that the size of open water areas in ponds is important. Suitable habitat includes ponds sufficiently large (0.1 to 0.2 ha) for coots to take off and land (Weller and Spatcher 1965), but not so large that protection from wind is lost (Fredrickson 1977, Harris and Marshall 1957). Interconnecting waterways with larger ponds make smaller open water areas more useful (Weller and Spatcher 1965). This principal was demonstrated in Hawaii at Kealia Pond where coot nesting declined drastically in a *Batis* area after interconnecting waterways became overgrown (Ueoka pers. comm.).

Water salinity also appear to be important. Coots in Hawaii and North America prefer fresh water areas for nesting. Fredrickson (1977) states that nesting coots may be restricted to fresh water because of their inability to excrete excess salt at an efficient rate.

Nesting Density

Nesting densities of coots in Hawaii have seldom been recorded, but available data from Kii and Kakahaia provide examples of low and high density nesting sites respectively. Recorded densities at Kii are roughly similar to those found at most study areas in North America (Table 2). In contrast, Kakahaia's density is similar to that found in the optimum nesting habitats in North America (Table 2).

Hawaiian Coot.

Photo by R.J. Shallenberger

Table 1. Peak nest counts[1] of Hawaiian coots in primary nesting areas.

Area	Peak Nest Count	Date of Count	Source
OAHU			
Kii	12	June 1971	Kridler (1971)
Amorient	5	May-June 1982	This study
Punamano	6	Feb. 1981	This study
Crow Bar Ranch	5	Mar. 1982	This study
Hamakua	3	Feb. 1982	This study
Honouliuli	3	Mar. 1982	This study
Waipio	2	Feb. 1982	This study
MAUI			
Kealia	14	Apr. 1976	Ueoka et al. (1976)
Kanaha	2	May 1979	Ueoka et al. (1979)
HAWAII			
Aimakapa	1	Dec. 1980	Shallenberger (pers. comm.)
Mohouli Ponds	1	Sep. 1975-June 1977	Scott (pers. comm.)
NIIHAU[2]			
Halalii Lake	–	Late 1970's-	Telfer
Haao Dam	–	early 1980's	(pers. comm.)
Puu Alala Pond	–		
MOLOKAI			
Kakahaia	8	July 1981	Coleman (pers. comm.)

[1]Maximum number of nests with eggs reported at any one time in the past 10 years.

[2]Probable nesting areas on Niihau; no counts available.

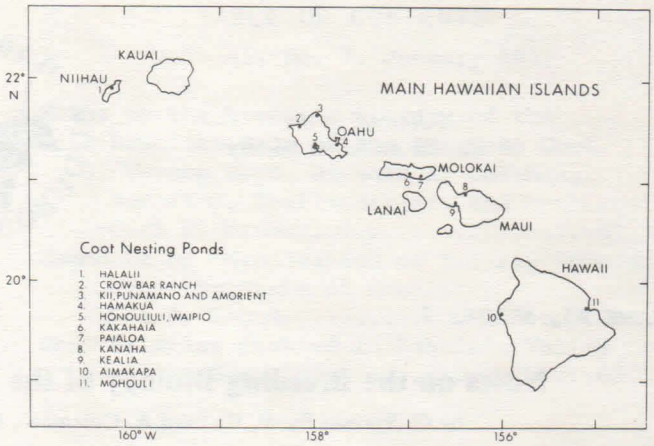

Figure 1. Map of the Main Hawaiian Islands showing the distribution of primary coot nesting areas.

Nearest-neighbor-distances provide another measure of density. At Kealia Pond in 1976 and 1978, 27 m and 25.5 m were the average distances between active coot nests (equating to densities similar to Kakahaia), and nests were found as close together as 7 m and 13.5 m in the two years of the study (Ueoka et al. 1976, Dougherty et al. 1978). In comparison, Sugden (1979) found an average nearest-neighbor-distance of about 50 m for 577 coot nests in a study area in Saskatchewan.

The average size of territories also provides information on nesting densities. Gullion (1953) found that the average territory in his California study area was 0.4 ha, and Cramp (1947) determined that 0.4 ha was the average area the coot *(Fulica atra)* defended in England. Cramp observed that pairs with territories smaller than 0.2 ha did not nest successfully.

Nest Sites

Coot nests have been found in several different types of situations in Hawaii. Floating nests in open water are typical at Kakahaia where the open pond is surrounded by dense bulrush *(Scirpus californicus* and *S. lacustris.)* Nests at this site are anchored to dense algal mats (Coleman 1978). Semi-floating nests anchored beside or in clumps of bulrush, cattail *(Typha angustata),* fleabane *(Pluchia indica),* or pickleweed *(Batis maritima)* are the most common types found elsewhere (Table 3). These nests are usually adjacent to open water in the sparse edge of dense clumps of emergents. Nests on mats of water hyssop *(Bacopa monnieri)* and Hilo grass *(Paspalum sp.)* have been observed regularly at Kii, and two nests were discovered adjacent to the water on spoil islands at the Crow Bar Ranch Pond.

We have noticed that coots avoid particularly dense clumps of robust emergent plants. For example coot nests at Punamano were found at the edge of the bulrush fringe where the stem density was relatively low. To describe this feature of coot nest sites, we specified the stem density near a sample of coot nests in different vegetation types (Table 3). For every type except fleabane (the plant with the least stem density) it appeared that nests were placed in spots with relatively low stem density. Height of cover varied considerably depending on the vegetation type (Table 3).

Hawaiian Coots build fairly substantial nest platforms (Table 4) from buoyant stems of nearby emergent plants, particularly *Scirpus* where it is available. *Batis, Brachiaria,* and *Pluchea* are also

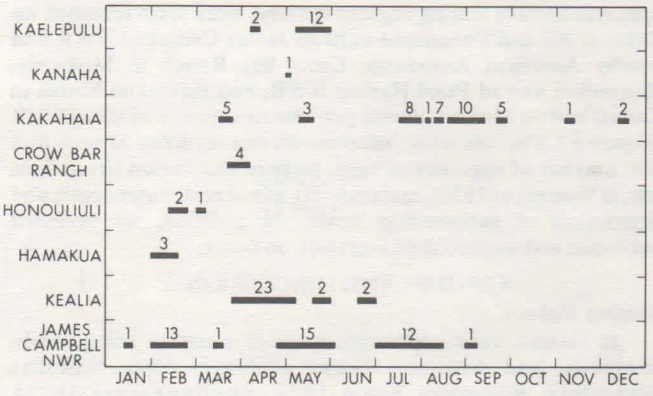

Figure 2. Distribution of estimated laying dates for Hawaiian Coot clutches found during opportunistic searches of various locations. Numbers above lines indicate the number of nests (e.g. 23 clutches were initiated at Kealia from late March to early May). Peaks may only indicate peaks of observation.

Table 2. Nesting density of coots at various locations in Hawaii and North America.

Average Nests/hectare	Size of Study Area (ha)	Location	Reference
Hawaii			
12.5[1]	0.4	Kakahaia	Coleman (1978)
1.6[2]	92.0	Kii	Shallenberger (1977)
2.5	2.4	Kii	Coleman (unpubl. data)
North America			
4.3	22.0	S. Dakota	Vaa et al. (1974)
1.3	40.0	Minnesota	Harris and Marshall (1957)
3.8	1.2	California	Gullion (1953)
1.3	4.8	California	Gullion (1953)
4.5	0.8	California	Gullion (1953)
0.4	2736.0	Saskatchewan	Sugden (1979)
0.8-1.5	75.0	Manitoba	Kiel (1955)
9.5[3]	1.0	Manitoba	Kiel (1955)
3.5-11.3[4]	80.4	Utah	Ryder (1961)

[1]Calculation based on open water area where most nesting occurs. If dense bulrush is included in habitat area (increasing total habitat to 1.6 ha), density would be 0.6 nests/ha.

[2]Calculated from count of 30 nests in 1971 if it is assumed wetlands covered about 50 percent of the basin at the time of the observation.

[3]Peak density in overall study area of Kiel. He considered this area saturated.

[4]Density increased as plant:open water ratio approached 50:50 in the study area.

used. This behavior is similar to the North American coot (Guillon 1954, Provost 1947, Ryder 1961). At Kakahaia, where floating nests are found in open water, the outside diameter of nests was significantly larger (t test, $p < .001$) than elsewhere, although other measurements were similar. The broad base probably improved nest stability and may have reduced effects of wave action.

The average depth of water at coot nests was similar at Kahahaia, Kii, and Punamano (33.5 cm), but deeper (60.8 cm) at the Amorient Aquafarm's steep-sided ponds (Table 4). Water depth in most favorable nesting sites in North America ranged from 36 to 91 cm (Vaa et al. 1974, Weller and Spatcher 1965, Weller and Fredrickson 1974). The water probably provides some protection from mammalian predators.

Nesting Chronology

Shallenberger (1977) reports that coot nests are found in all months of the year in Hawaii. Coleman (1978) detected two peaks in breeding behavior at Kakahaia: November to February and June to October. We plotted all observed or reported egg dates (Figure 2) to show the distribution, but since continuous year-round observations are not available, peaks may reflect only periods of relatively intense observations. The timing of nesting peaks may vary from year to year depending on the condition of the nesting habitat; i.e., in North American studies nesting occurs when sufficient rainfall raises water levels or otherwise creates proper nesting conditions (Sugden 1979, Weller and Spatcher 1965). In North America coots lay eggs from April through June depending on the location (Crawford 1975, Fredrickson 1970, Harris and Marshall 1957, Hunt and Naylor 1955, Kiel 1955, Ryder 1961, Sugden 1979, Vaa et al. 1974.)

Eggs

The average size of 146 eggs ($x \pm SE = 48.3 \pm 0.2$mm x 33.7 ± 0.1mm) measured in six different locations in Hawaii is similar to eggs of North American coots (Gullion 1954, Crawford 1975). Sixty-two clutches found in various stages of incubation during during our study averaged 4.9 (SE=0.3) with a range of 1 to 10 eggs. Similar small clutches have been reported in other Hawaiian studies in contrast to larger clutches reported for coots in North America (Table 5).

Incubation

Incubation periods are difficult to measure in coots because incubation may begin after the first eggs is laid or it may be delayed until after the second or subsequent eggs are laid (Gullion 1954, Sooter 1941). Shallenberger (1977) points out that the incubation period for coots in Hawaii is poorly known, but he provides a tentative range of 23 to 27 days. Recent studies at Kealia Pond (Ueoka et al. 1976, Dougherty et al. 1978) report average incubation periods of 25 and 24.7 days in two differemt years. In California, Gullion (1954) was able to determine exact incubation periods for individual eggs of 23 to 25 days. Fredrickson (1970) used a less exact method to determine a 23 to 27 day incubation period.

Renesting

The American Coot lays replacement clutches if early nests are destroyed (Fredrickson 1977, Gullion 1954, Harris and Marshall 1957, Ryder 1961, Sooter 1941, Vaa 1972). Some pairs raise two broods per year in Utah (Ryder 1961) and in California (Guillion

Table 3. Stem density and height of cover at Hawaiian Coot nests.

Species of Plant	Stems Within 50 cm of the Nest	Average Height[1] of Stems (cm)
Pickleweed	76± 3.6 (4)[2]	34.4± 7.4 (5)
Fleabane	15± 4.0 (7)	40.3± 7.2 (7)
Bulrush	51±15.4 (8)	93.3±14.7 (9)
Cattail	14± 4.1 (7)	120.0±12.6 (7)

[1]Height of emergence above water surface

[2]Mean±standard error (sample size)

Table 4. Characteristics of coot nests at various study areas in Hawaii.

Location	Size of Nest Platforms (cm)			Water Depth at Nests (cm)
	Outside Dia.	Inside Dia.	Depth	
Kakahaia (n=6)	5.3±2.9[1]	18.1±2.4	5.3±1.1	
Elsewhere in Hawaii (n=31)	30.8±0.9	17.0±0.8	6.1±0.4	
Amorient Aquafarms (n=6)				60.8±6.6
Elsewhere in Hawaii (n=26)				33.5±2.1

[1]Mean±standard error

1954), but not in the Great Plains (Fredrickson 1977). We have a single record in Hawaii of a pair raising two broods at the same site at Amorient Aquafarms in the same year. The mild climate in Hawaii might make multiple brood rearing an acceptable strategy.

Productivity

Nesting Success (number of nests hatching ≥ 1 egg). We were not able to follow nests closely enough to determine nesting success, but others have reported high nesting success for Hawaiian Coots. At Kealia Pond all 15 active coot nests hatched at least one egg in 1976, 10 of 11 (92%) were successful in 1978, and both nests were successful at Kanaha Pond in 1977 (Dougherty et al. 1978, Ueoka et al. 1976, 1977). Similar high nesting success has been recorded at most areas in North America (Table 6).

Hatching Success (percent of eggs laid that hatch). At Kealia 83.6 percent of 56 eggs hatched in 1976, and 79.6 percent of 54 eggs hatched in 1978 (Dougherty et al. 1978, Ueoka et al. 1976). At Kanaha 8 of 12 (66.6%) hatched in 1977 (Ueoka et al. 1977). If the samples from all three years are combined, 80 percent of 122 eggs hatched. This success is much lower than that recorded in most areas of North America (Table 6).

Fledging Success. Five coot broods were monitored at Amorient in 1982. Within 14 days of hatching, every brood was drastically reduced; average mortality was 76 percent of the chicks per brood. Although no quantitative assessment was made, extremely high chick loss was also observed at Kakahaia. During monthly observations there from 1977 to 1980, we seldom saw chicks more than two weeks old. In 1983, however, two months after the completion of habitat improvements at Kakahaia (e.g., bulrush stands were subdivided by dredged channels), coot broods seemed to be larger and a greater number of fledglings was

Table 5. A comparison between clutch sizes of coots in Hawaii and North America.

Average Clutch Size	Sample Size	Location	Year	Reference
Hawaii				
4.9	33	Hawaii[1]	1980-1982	This study
4.3	13	Kealia	1976	Ueoka et al. (1976)
4.9	11	Kealia	1978	Dougherty et al. (1978)
6.0	2	Kanaha	1979	Ueoka et al. (1979)
4.3	3	Kii	1971	Olsen (1971)
6.1	15	Kaelepulu	1949	Schwartz and Schwartz (1952)
North America				
8.7	136	Utah	1956	Ryder (1961)
8.9	135	Utah	1957	Ryder (1961)
8.7	115	S. Dakota	1970	Vaa et al. (1974)
8.1	73	S. Dakota	1971	Vaa et al. (1974)
7.9	141	California	1952	Miller & Collins (1954)
9.0[2]	8	California	1949-1950	Gullion (1954)
6.4[3]	5	California	1949-1950	Gullion (1954)
8.6[2]		Iowa	1936-1937	Sooter (1941, 1942)
6.0[3]	224	Iowa	1936	Sooter (1941, 1942)
6.6[3]		Iowa	1937	Sooter (1941, 1942)
8.8		Iowa	1946	Provost (1947)
9.0	281	Iowa	1963-1966	Fredrickson (1970)
7.9	85	Iowa	1972-1974	Crawford (1975)
8.9	20	Minnesota	1957	Harris & Marshall (1957)
8.1	19	California	1954	Hunt & Naylor (1955)
7.4	123	California	1953	Hunt & Naylor (1955)
10.0	10	Idaho & Utah	1951	Wolf (1955)

[1]All our study areas combined
[2]First clutches
[3]Second clutches

Table 6. Nesting[1] and hatching success[2] of coots at various locations in North America.

Percent	Sample Size	Location	Year	Reference
Nests Successful				
94	157	Utah	1956	Ryder (1961)
88	161	Utah	1957	Ryder (1961)
95	63	Utah	1951	Wolf (1955)
98	115	S. Dakota	1970	Vaa et al. (1974)
89	73	S. Dakota	1970	Vaa et al. (1974)
95	149	California	1952	Miller & Collins (1954)
95	20	California	1951	Hunt & Naylor (1955)
97	143	California	1953	Hunt & Naylor (1955)
97	388	Manitoba	1951	Kiel & Hawkins (1953)
91	104	Iowa	1936	Sooter (1941)
77[3]	347	Iowa	1937	Sooter (1941)
93	43	Iowa	1971	Weller (1971)
Eggs Successful				
79.6[4]	33	Iowa	1972-74	Crawford (1975)
88.0[5]	29	Iowa	1972-74	Crawford (1975)
99.5[6]	17	Iowa	1972-74	Crawford (1975)
100.0[7]	6	Iowa	1972-74	Crawford (1975)
88-97	Variable	Iowa	1963-66	Fredrickson (1970)
98	1114	California	1952	Miller & Collins (1954)
71	41	California	1949-50	Gullion (1954)
99	1394	Manitoba	1951	Kiel & Hawkins (1953)

[1]Nesting success is the percentage of nests hatching at least 1 egg
[2]Hatching success is the percentage of eggs hatching in successful nests
[3]This was a year of very high nesting density and unusually high water levels
[4]1 year old females
[5]2 year old females
[6]3 year old females
[7]4 year old females

observed. Chick survival may vary at other sites in Hawaii in some years (Table 7).

Mortality Factors

At Kealia Pond in 1976 and 1978, 14.3 percent and 20.0 percent respectively of the coot eggs were "addled" (Ueoka et al. 1976, Dougherty et al. 1978). A review of other coot breeding studies revealed only one area where infertility accounted for over five percent of egg mortality. In that study, Gullion (1954) attributed the high rate of egg failure to partial sterility due to senility in one of five pairs he observed.

There was apparently little loss of eggs to predators or flooding at Kealia although these factors were important in North America (Gullion 1954, Harris and Marshall 1957, Miller and Collins 1954, Ryder 1961). The high chick mortality in Hawaii referred to above probably resulted from predation by introduced mammals (e.g., mongoose, dog, and cat) and possibly Black-crowned Night-Herons *(Nycticorax nycticorax).*

MANAGEMENT RECOMMENDATIONS

Habitats managed for coots in Hawaii should be manipulated to produce conditions similar to those considered optimum for coots in North America. Ponds containing a 50:50 ratio of sparse robust emergent cover and open ponds should be the goal. Water depths should be about 30 cm to provide safety from most mammalian predators.

Because of rapid plant growth in Hawaii, it may be necessary to mechanically and chemically control dense plants to maintain a proper interspersion of vegetation and open water, but modification of water depth, where possible, may also be a useful method of controlling plants. With proper habitat, average nesting densities of at least 5 nests per hectare could be expected.

The nexting season in Hawaii needs to be more clearly understood so that periods of reduced nesting activity, if they exist, may be used for maintenance of marshes, e.g., vegetation control, drawdowns for nutrient recycling, etc. Nests should be censused regularly at as many known nesting localities as possible. A larger sample of clutches should be observed in early incubation to determine the overall annual egg production at different sites.

Brood counts should be recorded as often as possible, but care should be taken to always record the number of chicks with each adult since each parent may have part of the brood. Broods should be aged using criteria given by Gullion (1954). Frequent and regular counts at specific sites will also provide useful information about brood survival.

The nesting, hatching, and fledging success of coots should be monitored annually and compared with habitat characteristics (e.g., salinity, water depth, percent cover of robust emergents, etc.) to determine the relative habitat quality. These data may be used to improve habitats that are not optimum and to further evaluate the suitability of North American management techniques for Hawaiian Coots.

Table 7. A comparison between coot brood counts from Hawaii and North America (ages of broods often not specified so all ages lumped).

Brood Size	Sample Size	Location	Year	Reference
Hawaii				
1.6	5	Kii	1982	This study
2.0	2	Kanaha	1976	Ueoka et al. (1976)
3.0	2	Kealia	1978	Dougherty et al. (1978)
2-4[1]	8	Kealia	1976	Ueoka et al. (1976)
4.4	5	Kii	1971	Kridler (1971)
North America				
2.6	16	Iowa	1972-74	Crawford (1975)
6.1	12	Iowa	1972-74	Crawford (1975)
7.2 $\bar{x}$=4.8[2]	6	Iowa	1972-74	Crawford (1975)
9.0	1	Iowa	1972-74	Crawford (1975)
1.9	?	Iowa		Sooter (1941)
4.3	18	Utah	1956	Ryder (1961)
5.7	30	Utah	1957	Ryder (1961)
6.1	21	S. Dakota	1970-71	Vaa et al. (1974)
5.3	13	California	1952	Miller & Collins (1954)
5.1 (3.4)[3]	16	California	1949-50	Gullion (1954)

[1]Only a range given

[2]In sequence, Crawford's data are for 1 year old through 4 year old females

[3]5.1 was total a pair produced in a year, 3.4 was average per brood

Mortality factors, especially chick predation, should be monitored, and serious factors should be controlled if possible. Special attention should be given to methods of reducting the loss of chicks to predators. Attention should also be focused on potential disease problems.

Little is known about coot food habits and brood rearing habitat. These factors need to be carefully evaluated if optimum habitat is to be created and managed.

Finally, the movement of adult and juvenile coots within and between habitats needs further study. It would be advantageous to develop an improved population monitoring scheme for coots in Hawaii.

ACKNOWLEDGMENTS

Dan Moriarty and Dave Woodside assisted us in the field. Mike Scott, Tom Telfer, and Dave Woodside allowed us to use their unpublished data for coots on the islands of Hawaii, Niihau, and Oahu respectively. The following people kindly reviewed the manuscript: Phil Bruner, Tim Burr, Cameron Kepler, Tom Telfer, Meyer Ueoka, Ron Walker, and Fred Zeillemaker.

LITERATURE CITED

Berger, A.J. 1981. Hawaiian Birdlife. The University of Hawaii Press, Honolulu, Hawaii. 260 pp.

Coleman, R.A. 1978. Coots prosper at Kakahaia refuge. Elepaio. 38:130.

Cramp, S.A. 1947. Notes on territory in the coot. British Birds 40:194.

Crawford, R.D. 1975. Breeding biology of American coots in relation to age. Ph.D. Thesis, Iowa State Univ. Ames.

Dougherty, M., M.L. Ueoka, L. Harai, and T.C. Telfer. 1978. Pittman-Robertson report for the job: Limited study of nesting by stilt on islands of Maui, Oahu, and Kauai. Proj. No. W-18-R-3, Job No. R-III-C.

Fredrickson, L.H. 1970. Breeding biology of American coots in Iowa. Wilson Bull. 82:445-457.

Fredrickson, L.H. 1977. American coot *(Fulica americana)*. Pp 120-147 in Sanderson, G.C. ed. Management of migratory shore and upland game birds in North America. The Intern. Assoc. of Fish and Wildl. Agencies, Wash., D.C.

Gullion, G.W. 1953. Territorial behavior of the American coot. Condor 55:169-185.

Gullion, G.W. 1954. The reproductive cycle of American coots in California. Auk 71:366-412.

Harris, S.W. and W.H. Marshall. 1957. Some effects of a severe windstorm on coot nests. J. Wildl. Mgmt. 21:471-473.

Hawaiian Waterbird Recovery Team. 1977. Hawaiian Waterbird Recovery Plan. U.S. Fish and Wildlife Service, Wash., D.C.

Hunt, E.G. and A.E. Naylor. 1955. Nesting studies of ducks and coots in Honey Lake Valley. Calif. Fish and Game 41: 295-314.

Kiel, W.H. 1955. Nesting studies of the coot in southwestern Manitoba. J. Wildl. Mgmt. 19:189-198.

Kiel, W.H. and A.S. Hawkins. 1953. Status of the coot in the Mississippi flyway. Trans. N. Amer. Wildl. Conf. 18: 331-322.

Kridler, E. 1971. Waterbird censuses at Kahuku Pond - June 10, 1971. Elepaio 32:12.

Miller, A.W. and B.D. Collins. 1954. A nesting study of ducks and coots on the Tule Lake and Lower Klamath National Wildlife Refuges. Cal. Fish and Game 40:17-37.

Olsen, D. 1971. Nesting activity of Hawaiian stilts and coots at Kii Pond, Kahuku. Elepaio 32:11.

Provost, M.W. 1947. Nesting of birds in marshes of northwest Iowa. Amer. Midl. Nat. 38:485-503.

Ryder, R.A. 1961. Coot and duck productivity in northern Utah. Twenty-sixth North American Wildlife Conference 26: 124-147.

Schwartz, C.W. and E.R. Schwartz. 1952. The Hawaiian coot. Auk 69:446-449.

Shallenberger, R.J. 1977. An ornithological survey of Hawaiian wetlands. Ahuimanu Productions. Prepared for U.S. Army, Engineer District, Honolulu under Contract DACW 84-77-C-0036.

Sooter, C.A. 1941. Ecology and management of the American coot *(Fulica americana americana* Gmelin). Ph.D. Thesis, Iowa State Col.

Sugden, L.G. 1979. Habitat use by nesting American coots in Saskatchewan parklands. Wilson Bull. 91:599-607.

Udvardy, M.D.F. 1960. Movements and concentrations of the Hawaiian coot on the island of Oahu. Elepaio 21:20-22.

Ueoka, M.L., J.S. Dalrymple, and T.C. Telfer. 1976. Pittman-Robertson Report for the job: Limited study of nesting stilt on the islands of Maui, Oahu, and Kauai. Proj. No. W-18-R-1, Job No. R-III-C.

Ueoka, M.L., L. Harai, T.C. Telfer, M. Dougherty, and R.S. Saito. 1979. Pittman-Robertson Report for the job: Limited study of nesting by stilt on the islands of Maui, Oahu, and Kauai. Proj. No. W-18-R-4, Job No. R-III-C.

Vaa, S.J. 1972. Use of waterfowl production areas by ducks and coots in eastern South Dakota. M.S. Thesis, S. Dakota State Univ. Brookings.

Vaa, S.J., K.L. Cool, and R.L. Linder. 1974. Nesting by American coots in South Dakota. Proc. S.D. Acad. Sci. 53:153-156.

Weller, M.W. 1971. Experimental parasitism of American coot nests. Auk 88:108-115.

Weller, M.W. and L.H. Fredrickson. 1974. Avian ecology of a managed glacial marsh. Living Bird 12:269-291.

Weller, M.W. and C.E. Spatcher. 1965. Role of habitat in the distribution and abundance of marsh birds. Iowa Agric. Home Econ. Exp. Sta. Spec. Rep. No. 43.

Westerkov, K. 1950. Methods for determining the age of game bird eggs. J. of Wildl. Manage. 14:56-67.

Wolf, K. 1955. Some effects of fluctuating and falling water levels on waterfowl production. J. Wildl. Manage. 19: 13-23.

[1]Byrd
Aladdin Rt. Box 160E
Colville, WA 99114

[2]Coleman
U.S. Fish and Wildlife Service
Division of Refuge Management
Branch of Resource Management
Washington, D.C. 20240

[3]Shallenberger
U.S. Fish and Wildlife Service
300 Ala Moana Blvd. Box 50167
Honolulu, HI 96850

[4]Arume
Biology Dept.
Brigham Young Univ., Hawaii
Laie, HI 96762

COMMENTS ON "ERADICATION OF TRI-FLY COMPLEX FROM THE STATE OF HAWAII"

This Draft Environmental Impact Statement (DEIS) is a proposal by the U.S. Department of Agriculture (USDA) to eradicate three species of fruit flies from the Hawaiian Islands, *viz:* Med Fly (*Ceratitis capitata*), Oriental Fruit Fly (*Dacus dorsalis*) and the Melon Fly (*Dacus cucurbitae*). The USDA's goal (complete eradication of these flies from the State) is of paramount concern to every resident because of its massive scope, duration, impacts to non-target organisms (including endangered species), and potential impact to human health from aerial bait sprays containing malathion, as well as the increased sensitivity of residents to present pesticide contamination.

The DEIS is dated 14 November, 1984. The comment period deadline is 16 January, 1985. Send your comments to: E.J. Stubbs, Senior Staff Officer, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, USDA, Federal Building, Hyattsville, Maryland 20782. (I have yet to see any mention of this project in the Office of Environmental Quality Control Bulletin!).Public hearings are scheduled for 18-20 December, 1984, on Oahu, Maui, and Hawaii (but not on Kauai!!). This is particularly unsettling in that the preferred option is to begin the eradication program on Kauai, and then progress to the other islands.

A program alternative proposes to start intensively in smaller areas (e.g.: "about 125 square miles of Kona coffee on the Island of Hawaii, and fruit and vegetable areas of Kula, Maui"). The statement that "malathion bait sprays may be required before SIRM (sterile insect release method) could be used successfully against the Medfly" indicates to me that should such initial eradication attempts fail, and my assessment is that this potential is high, the area to be sprayed will have to be increased, since these flies are firmly entrenched in agricultural and forest ecosystems alike, and have been so for many years, on all of the main islands. The DEIS further states that "Regardless of the Program Alternative or the option chosen, a total state-wide eradication effort should take about 6 years if no reinfestations or delays due to weather, etc., were encountered" and at a cost of as much as $163 million. In conjunction with this, a massive, airtight inter-island quarantine would have to be in-

stituted to prevent reinfestation of islands where eradication (if that is possible) was attained.

I consider the project to be, in reality, a massive experiment to be foisted upon Hawaii primarily because of pressure from California-based agrobusiness to try to reduce the perceived threat of Med Fly (especially) reinvasion to California, even though this species is firmly entrenched in the Caribbean, Mexico, Central and South America, Australia, and the South Pacific, having spread there from its native Africa. The Melon and Oriental Fruit Flies are also widespread in Asia and the South Pacific.

I also believe that an environmentally safe technology is not yet at hand to conduct such an operation without severe impacts on Hawaii's native biota and other beneficial organisms, as well as major disruptions to our populace. Some of the consultants to the DEIS have suggested (in another document available to me) that Hawaii and other areas where the Med Fly has long been present "may offer worthwhile examples and ideas on how they have learned to adjust, control, and live with this [the Med Fly] pest". To which I would add "Amen".

The DEIS also indicates that non-target organisms, especially insects and other arthropods, will be negatively impacted. In a separate section of this DEIS are listed the endangered Hawaiian avifauna, with short descriptions of their food habits. A number of them are insectivorous. But, what is not connected are the potential impacts on these birds (even primarily frugivorous birds often need insects during their life cycles, especially to feed nestlings) if this primary food source were to be permanently or temporarily decimated by malathion treatments.

Is it more than just a coincidence that the insectivorous 'Amakihi became extinct on Lanai about the time that pilot sprayings of that island with malathion were carried out during the 1970's to field test this aspect of the Tri-fly program? Were there similar declines of insectivorous avifauna in the Bonin Islands and the Northern Marianas where fruit fly eradication attempts were ultimately frustrated?

Whether the program starts on Kauai ("option one") or upon the Big Island ("options two and three") we are confronted with a costly project that has high potential of turning into an environmental monster, especially if political pressure mounts to keep it going in the face of potential failure.

To give you an idea of the tenacity of the Med Fly alone, consider the following: the Med Fly infestation in California during 1980-82 occupied an area approximately the size of Oahu, some of which had to be aerially sprayed over 20 times, including agricultural and urban areas much less complex geographically and biologically than the Hawaiian Islands, and this cost over $100 million. Although the benefits have been much touted by agrobusiness, the less familiar detrimental aspects (e.g., destruction of natural and biological controls, with resultant secondary pest outbreaks, poisoning of adjacent apiaries, and even corrosion of car paint) are now appearing in the scientific literature. Will reason prevail here, or are we potentially destined to repeat something akin to the boondoggles associated with the trial boll weevil and fire ant eradication attempts during the 1970's in the southeastern U.S. mainland?

I urge that the search continue for environmentally safe, socially acceptable, economically feasible, species-specific eradication techniques that will only impact these fruit fly pests alone. Meanwhile, Californians should expect to continue their monitoring to detect reinvasions and Hawaiians will need to treat their exported fruit appropriately. There is no quick fix.

Wayne C. Gagné

PAY YOUR 1985 DUES

All local and subscriber memberships expired on 31 December, 1984. Dues for local Hawaii members or non-resident subscribers should be paid immediately, in order to retain 1985 membership and to continue receiving the *'Elepaio*. Mail your $6.00 1985 dues to: Hawaii Audubon Society, P.O. Box 22832, Honolulu, Hawaii 96822.

Do not send us a check if you have paid 1985 joint membership dues ($30.00) to National Audubon, since our local chapter dues are included in that amount.

WELCOME TO NEW DIRECTORS

Congratulations to the new Hawaii Audubon Board of Directors, who were elected at the 17 December annual meeting. They are: Dr. Sheila Conant, President; Phillip Bruner, 1st Vice President; Peter Stine, 2nd Vice President; Norris Henthorne, Treasurer; Keith Fukumoto, Recording Secretary; Suzan Harada, Corresponding Secretary; and Dave Boynton, Carl Christensen, George Campbell, Carl McIntosh, Ray Tabata, and Rick Warshauer, Directors.

GRAY SWIFTLET SIGHTED IN KAHALU'U VALLEY

G. Allan Samuelson

One Gray Swiftlet, *Aerodramus Vanikorensis*, was observed during the morning of 26 November 1984 in Kahalu'u Valley, O'ahu. This individual made several passes overhead at ca. 12-20 m above the ground during a 5-min period (0655-0700 hrs). At that time, I was observing a swarm of flying ants (specimens not yet identified) above the shiny aluminated roof of our house. The swiftlet seemed to pass well above the main body of the ant swarm, although it is likely that some of the insects were that high. The swallow-like appearance of the bird, its small size, entirely dusky coloration as seen from below, and flight led me to conclude that this bird was a swiftlet. Its flight was jerking with rapid wingbeats, somewhat reminiscent of the flight of a Black Witch Moth, *Otosema odora (L.)*. Swiftlets were not seen during recent observations of ant swarms under similar conditions (29 Oct. and 13 Nov. 1984).

The location was in the mauka part of the valley near the end of Ahuimanu Road at 120 m eleveation and ca. 1-2 km from the summit line of the Ko'olau Range. At the observed time, direct sun had not occurred at ground level because of clouds to the east. High cloud movement observed overhead was generally from the west, but surface winds were nil. The ground was quite wet from rains during the night; humidity was 100% and temperature was 20° C at 0655 hrs.

This was my first sighting of the Gray Swiftlet; we have resided in Kahalu'u Valley since July 1971.

Bishop Museum
P.O. Box 19000-A
Honolulu, HI 96817

ALOHA TO NEW MEMBERS

We welcome the following new members and encourage them to join in our activities:

Local: Patrick Ching, Honolulu; Donna DeHaan, Honolulu; Ron Dowling, Boulder Creek, CA; Michael Duddy, Honolulu; Valerie Foster, Honolulu; Mark Fowler, Meadow Vista, CA; Max Guenther, Kailua-Kona; Winifred Hepburn, Culdesac, ID; Jane Hershman, New York, NY; Thane Johnson, Citrus Heights, CA; Eileen Kiera, Honolulu; Dave Koenig, Chico, CA; Phil Kwiatkowski, Kamuela; Kathleen Laboyteaux, Honolulu; Anna Maria Lea, Camarillo, CA; Lance Lee, Pacific Palisades, CA; Lori Linebarger, Wilmington, CA; Helen O. Marston, Honolulu; Hal Michael, Olympia, WA; Keith Miller, Lafayette Hill, PA; A.D. Moscotti, Honolulu; Joy E. Murphy, Ewa Beach; Maura O'Connor, Honolulu; Allen Paolella, Volcano; Thomas Rennard, Brooklyn, NY; Louis A. Rose, Kailua; Ann L. Rothe, Anchorage, AK; Christopher Steadman, Maunaloa; Charles P. Stone, Hawaii National Park; Naomi S. Svenningsen, San Francisco, CA; Timm Timoney, Honolulu; William Warren, Kailua; Richard C. Wass, Kailua; Carren Weddle, Honolulu; Joann Wozniak, Portland, OR.

Joint with National: Daryl V. Akamichi, Inglewood, CA; Jeri E. Anderson, Hon.; R. Balidoy, Hon.; QMI-SS Robert Barry, Pearl Harbor; Francis Bettencourt, Kamuela; Lee Carpenter, Kamuela; Julia Cash, Hon.; C. Castleton, Hon.; S.K. Chun, Hon.; Lewis D. Consiglieri, Hon.; A. Curry, Hilo; Merton Davalos, Lihue; Robert Davis, Hon.; Kathy Dorn, Pahoa; Mr. Thomas Duffy, Ewa Beach; Drs. Fern and Renate Duvall, Hilo; Paul Epstein, Hon.; C.M. Farin, Waianae; F. Flores, Hon.; Jonathan P. Gaskins, Hon.; Susan K. Gilbert, MD, Hilo; Ms. Wendy Guyer, Kaneohe; Stuart J. Hayashi, Kaneohe; Miss Cecelia D. Hill, Hon.; Mr. and Mrs. J. Dominis Holt, Hon.; Karin Hoppe, Kamuela; Mr. Donald K. Horio, Hon.; Mr. Bob Horn, Kailua; Douglas Huang, Laie; Michael T. Ikeda, Aiea; L. Ito, Kaneohe; Dr. Janet M. Kalus, Aiea; Edna F. Kaneshiro, Pahoa; Colleen Kelley, Hon.; D.C. King, Hon.; Lorrie Koontz, Ewa Beach; Susan M. Kosasa, Hon.; R. Kunimura, Hilo; John Leversque, Mililani; Johnny Li, Hon.; Ms. D. Liddicote, Lahaina; Robert Lipshutz, Aiea; Marlene A. Lyons, Kailua; Perrin Marrero, Kula; Mrs. Marybeth Y. Maul, Kualapuu; LTC. Mary M. McCarthy, Kaneohe; Holly A. Moffat, Hon.; Heinz Naef, Kihei; A. Napihaa Jr., Hon.; Michael S. O'Reilly, Waipahu; Dr. Rand Pellegrino, Hon.; Pamela Quayle, Mt. View, HI; Martha A. Reed, Pearl Harbor; R. Sagucio, Hon.; G. Schattauer, Captain Cook; Dunlap C. Shannon, Kaneohe; Ms. Jill Shimabukuro, Hon.; Ms. Ginny Siewertsen, Lihue; Madeline R. Smith, Laie; S. Steven Sofos, Hon.; Ms. M.A. Sullivan, Hon.; Ms. Joy Sweetgrass, Hon.; Mrs. L. Tempel, Paia; James P. D. Thropp, Paauilo; and C. A. Willoughby, Kihei.

Kammy Wong and Susan Schenck

JANUARY PROGRAM: NATURAL HISTORY OF THE SACRAMENTO VALLEY

Andrew Engilis, Jr., Vertebrate Zoologist at Bernice P. Bishop Museum, will present a pictoral essay on the flora and fauna of the Sacramento Valley of California entitled "A Change of Seasons". The variety of habitats and mild winters makes the Sacramento Valley one of North America's outstanding inland bird areas in terms of both species richness and total numbers of birds. Andrew has spent the last ten years looking at the complex bird distribution patterns in many of the valley's unique and remnant habitats. The program will cover the valley's riparian and oak woodlands, wetlands and unique vernal pools. Andrew will show and discuss many of the endemic and indigenous species of birds, mammals, and reptiles, as well as take a special look at their habitats as they progress through the seasons. Once a vast perennial grassland and wetland, the valley has been tilled and altered by humans so much that only 10% of its natural vegetation remains. Andrew will include a discussion of current conservation and research trends that are helping to maintain the final 10% for future generations.

The meeting will be held at the McCully-Moiliili Library, 2211 S. King St., Honolulu, beginning at 7:30 p.m. on Monday, 21 January. Everyone is welcome to attend!

HAWAII TROPICAL BOTANICAL GARDEN OPENS

On 1 August 1984, the Hawaii Tropical Botanical Garden opened to the general public. It is located on the Hamakua Coast outside of Hilo on the Island of Hawaii, and is situated in the lush tropical valley of Onomea. This new Botanical Garden and Wildlife Sanctuary promises to be one of the 50th State's most beautiful attractions. Natural paths lead the visitor along ocean-lapped coastline, through tropical forest settings, through collections of rare and exotic plant life, and to vistas overlooking beautiful waterfalls and streams.

Bird life within the Garden boundaries has increased significantly during the six years this Garden has been under development. Declared a preservation area, the employees of the Garden work hard to ensure the safety and well-being of both land and sea animals that occassion the grounds. Plans for a detailed bird description and inventory are underway, and await only the assistance of a well-qualified volunteer.

Developing the Garden as a well-functioning nature preserve is the task of Garden Curator, Gary A. Powell and Operations Manager, Terence Takiue. "Establishing a Garden that will function as a center for research, and the preservation of tropical flora and fauna, and developing the infrastructure that will carry this organization far beyond our present generation," are the goals set by Dan and Pauline Lutkenhouse, founders of the Garden.

Persons interested in learning more about this non-profit foundation are invited to write to: Hawaii Tropical Botanical Garden, RR 143-A, Papaikou, Hawaii 96781.

JANUARY FIELD TRIP: BISHOP MUSEUM

The Oahu field trip on January 13th will be a special, behind-the-scenes visit to the Bishop Museum to see some of its large collection of scientific specimens. Emphasis will be on Hawaiian birds, with opportunities to see examples of long-extinct species, of which only a very few specimens now exist in the world. Most of the Hawaiian land bird specimens were acquired more tham 75 years ago. The collection has a good representation of marine birds of the Pacific, and of land birds and mammals from the southwestern Pacific area, particularly Birds-of-Paradise from New Guinea.

Meet at the Bishop Museum at 9 a.m. in the staff parking lot. Drive in the main Museum entrance at 1525 Bernice Street, take the first right turn up to the first parking area on the left. Guides for the trip will be Bob Pyle and Andrew Engilis, Jr., staff members of the Vertebrate Zoology Division at the Museum. For more information, please call Bob Pyle at 262-4046.

HELP WITH 'ELEPAIO

The February issue of the *'Elepaio* will be put together 26 January (Sat.) at 1415 Victoria, beginning at noon. Call Marie at 533-7530. Help is always needed and welcome! Proofreaders and typists are especially needed to help out prior to the 26th.

MAUI FIELD TRIPS: KANAHA AND WAIKAMOI

There will be two field trips in early 1985 on Maui. The first will be on February 10 to Kanaha Pond. Dr. Cameron Kepler, U.S. Fish and Wildlife representative on Maui will lead the group into the refuge between Kahului and the Kahului Airport. The meeting place will be at the observation hut at 9 a.m. The second outing will be into the Nature Conservancy's Waikamoi Preserve, "Maui's Forest Bird Heartland". Reservations are required for this March 10 trip, as the number of participants must be limited. Call Terry Quisenberry, Preserve Manager 575-2747 or Mary Evanson 572-9724 to save a spot.

IF NOT A MEMBER, PLEASE JOIN US

JOINT MEMBERSHIP
(National and Hawaii Audubon Societies)

Individual	$ 30.00
Family	38.00
Sustaining	50.00
Supporting	100.00
Contributing	250.00
Donor	500.00
Life (single payment)	1500.00
Dual Life (single payment)	2000.00

Special rates for full-time students and Senior Citizens (65 years of age or older) are available. Please write for application form.

LOCAL MEMBERSHIP
(Hawaii Audubon Society only)

Regular	$ 6.00
Junior (18 and under)	3.00
Subscriber (non-Hawaii residents)	6.00
Life (payable in three equal annual installments)	150.00

All Local Memberships and Subscriptions are for a calendar year January through December. New Local Members and late-renewing members who send in dues through September may obtain all previous issues of 'Elepaio in that calendar year, upon request and reimbursement to the Society for mailing costs. Dues received after September are applied to membership extended through the following calendar year, but do not include previous issues of 'Elepaio in the current year.

HAWAII AUDUBON SOCIETY

BOARD OF DIRECTORS

President	Dr. Sheila Conant	948-8241
1st V.P.	Phillip Bruner	293-3806
2nd V.P.	Peter Stine	395-2191
Treasurer	Norris Henthorne	395-0422
Rec. Secy.	Keith Fukumoto	
Cor. Secy.	Suzan Harada	839-5334
Directors	David Boynton	335-5008
	George Campbell	941-1356
	Carl Christensen	847-3511
	Carl McIntosh	
	Ray Tabata	948-8191
	Rick Warshauer	967-7476

COMMITTEES

Conservation	Carl Christensen	847-3511
	Wayne Gagné, Mike Hadfield, Ray Tabata, Rick Warshauer,	
Education	Vacant	
'Elepaio	Peter Galloway	
	Marie Morin	533-7530
Mailing	George Campbell	941-1356
	Alan Ziegler	247-5318
Field Trips	Peter Donaldson	456-5662
Finance	Norris Henthorne	734-7562
	Mike Ord, George Campbell,	
Grants	Dr. Sheila Conant	948-8241
	Bob Kinzie, Cliff Smith, Causey Whittow, Phillip Bruner	
Mail Distrb.	Leilani Pyle	262-4046
Membership	Dr. Robert Pyle	262-4046
	Susan Schenck	488-4974
	Kammy Wong	
Programs	Phillip Bruner	293-3806
Publicity	Vacant	
Sales	George Campbell	941-1356
	Richard Smith	262-4784

'ELEPAIO

Editors.....Marie Morin, Peter Galloway
(Send articles to Marie Morin, 1415 Victoria St. #1515, Honolulu, Hawaii 96822)

Production Committee.....
Lee Bauer, Susan Schenck, Bob Pyle, and Joel Simasko.

ISLAND REPRESENTATIVES

Hawaii	Sheila Doyle	
Maui	Mary Evenson	572-9724
Lanai	Peter Connally	565-6242
Kauai	Dave Boynton	335-5008

CALENDAR OF EVENTS

Jan. 13 (Sun.) Field trip to Bishop Museum. See page 66. Call Bob Pyle (262-4046) for info.

Jan. 14 (Mon.) Board meeting at S. Conant home at 7:00 pm.,3663 Alani Dr. Call Sheila at 948-8241.

Jan. 21 (Mon.) General meeting at McCully-Moiliili Library at 2211 S. King St. Speaker is Andrew Engilis on Sacramento Valley wildlife. See page 66. Meeting starts at 7:30pm

Feb. 10 (Sun.) MAUI. Field trip to Kanaha Pond. See page 67. Call Cam Kepler for info (878-1418).

Mar. 10 (Sun.) MAUI. Field trip to Waikamoi Preserve. See page 67. Call T. Quisenberry (575-2747) or M. Evanson (572-9724) for info.

TABLE OF CONTENTS

Vol. 45, No. 7, January 1985

By-laws available by request.

HAWAII AUDUBON SOCIETY
P.O. Box 22832
HONOLULU, HAWAII 96822

3F50
SEP85
MR DAN A DAVIS
3218 MELEMELE PL
HONOLULU HI 96822

HAWAII AUDUBON SOCIETY