AN ORNITHOLOGICAL SURVEY

OF

HAWAIIAN WETLANDS

BY

AHUIMANU PRODUCTIONS

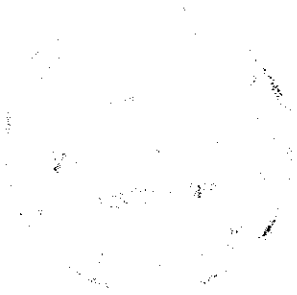
FOR

U.S. ARMY, ENGINEER DISTRICT, HONOLULU

UNDER CONTRACT DACW 84-77-C-0036

PRINCIPAL INVESTIGATOR: ROBERT J. SHALLENBERGER, Ph.D.

DECEMBER, 1977



VOLUME TWO

SITE DISCUSSIONS

KAUAI

OAHU

MOLOKAI

MAUI

HAWAII

TABLE OF CONTENTS

VOLUME ONE

VOLUME TWO

LIST OF TABLES

VOLUME ONE

LIST OF FIGURES

VOLUME ONE

VOLUME TWO

SITE DISCUSSIONS

INTRODUCTION TO SITE DISCUSSIONS

In this section of the report, results of field studies and literature search on specific wetlands are presented. Of 78 wetland areas discussed in this section, 50 are treated using a standardized format. Another 28 wetlands are discussed more briefly, because of their marginal significance to waterbirds and/or because they were similar in most respects to several other sites, all of which were discussed as a unit to avoid unnecessary redundancy.

The standardized format is explained as follows:

SITE NAME: Hawaiian names of wetland sites, if known, are indicated here with proper use of the glottal stop (') and macron (¯) as found in Place Names of Hawaii (116).

In some cases where Hawaiian names were undetermined, or for wetlands that were not specifically identified, reference to nearby prominent landmarks, or property on which the wetland site was located, were used as the site name. Variation in names of various wetland sites provided a source of confusion in accumulation of historical data relevant to this study. It is recommended that all wetlands in the State be identified in publication to minimize future confusion.

LOCATION: All wetland sites were identified here by district and island.

TOPOGRAPHIC MAP: The name of the most recently prepared U.S. Geological Survey topographic map is identified here to aid the reader in location of specific sites. We chose not to use renditions of topographic maps for site illustration because of the wide variability in accuracy and currency of available maps. The actual boundaries of several wetland sites in Hawaii are poorly represented on topographic maps, and some sites are not portrayed at all.

DATES OF SURVEY: Wetland sites were surveyed by participants of this study on the dates indicated. In nearly all cases, the most intensive survey was accomplished on the first date indicated. Several references are made within site discussions to particular survey days.

PHOTO: Aerial photos are included for most survey sites to aid in interpretation of data and to allow reference in discussion to specific areas within each wetland site.

WETLAND DESCRIPTION: Together with the accompanying photograph, a narrative description of each wetland provides the reader with an understanding of the site that facilitates interpretation of data on waterbird abundance and distribution. Relevant information is provided on wetland topography, water condition, vegetation and, where relevant, a brief picture of current human use of the habitat. For a more thorough descriptive treatment, the reader is referred to publications referenced within the site discussion, particularly the report of a wetland vegetation survey conducted simultaneously with our research (95).

NON-AVIAN WILDLIFE: No attempt was made during field survey to make a thorough study of non-avian wildlife. However, incidental observations on vertebrate and invertebrate species were noted, particularly of those species that play a role in determining the condition of the wetland as waterbird habitat. Emphasis is directed to potential waterbird prey and to those species that inhibit waterbird use by

their impact on habitat. The reader is referred to published results of more thorough studies of non-avian wildlife where such data are available.

NON-WATERBIRD AVIFAUNA: The scope of work on this contract called for a record of all birds observed on survey, but directed emphasis to obligate wetland species. None of the bird species treated in this section of the site discussion are confined in distribution to wetland areas. Most of the exotic birds mentioned here are widespread and occur in a variety of habitats, including wetlands. As a rule, these species have little effect on wetland ecology and were not considered in the evaluation of waterbird habitat.

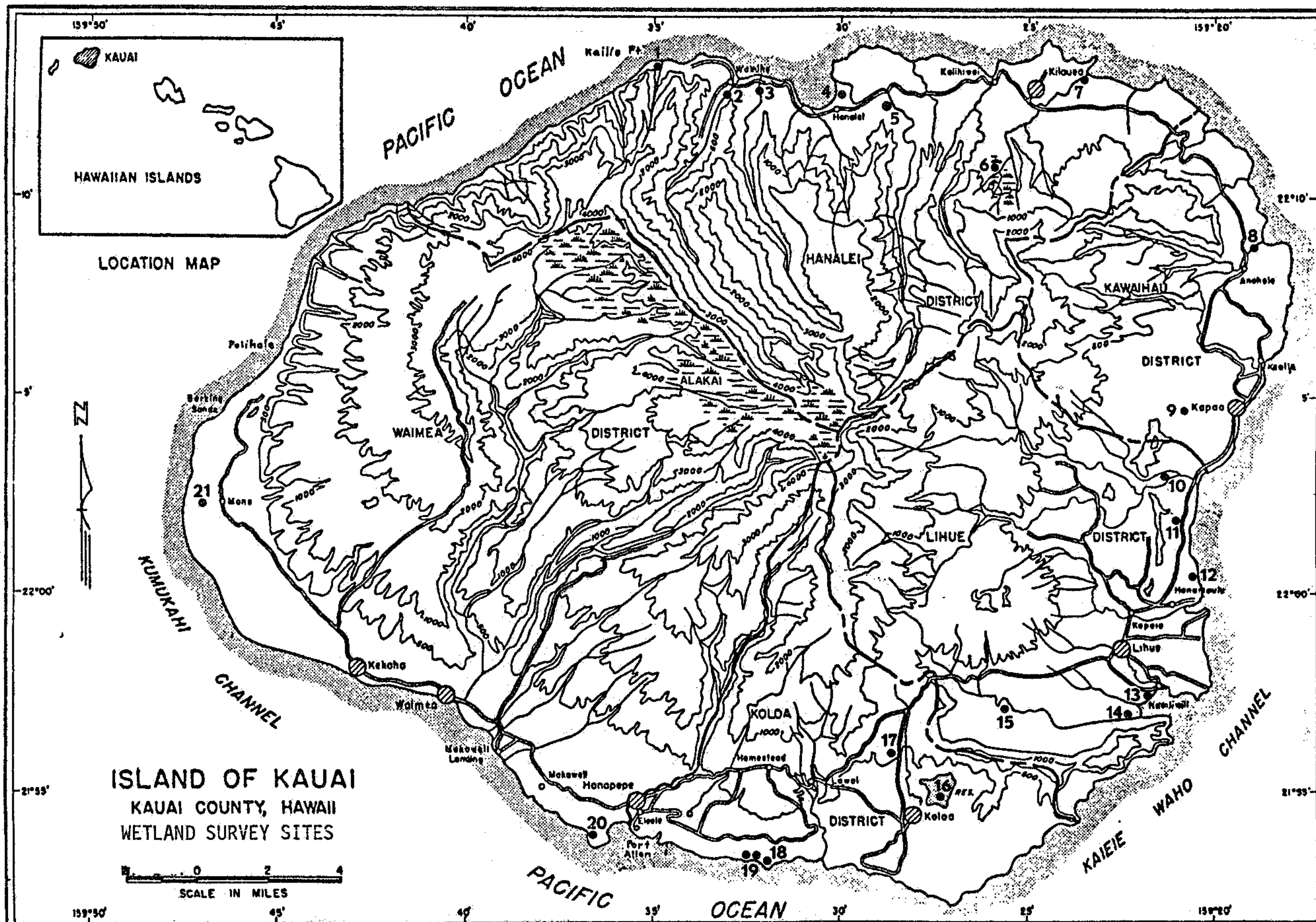
WATERBIRDS OBSERVED: Beginning with a discussion of endemic species, a treatment of past and present waterbird abundance and distribution is included in this section of the site discussion. Data are derived from published and unpublished reports of earlier surveys and from our field work during summer, 1977. For the most part, these data are interpreted in a way that provides a pattern of waterbird use rather than a simple tabulation of numbers. Where data are available, a more thorough picture is presented of how each species uses the available habitat within a wetland site. In some cases, this is further illustrated by reference to the site photograph. In discussion of sites for which there are little or no historical data, an estimation of predicted waterbird use is based on evaluation of habitat condition and knowledge of habits and distribution patterns of waterbirds on each island. Such predictions, and available historical data, are the primary basis for discussion of migratory waterfowl and migratory shorebird species, most of which are uncommon or absent in the Islands in the months during which our survey was conducted.

HABITAT EVALUATION: Each wetland site is evaluated as to its current and potential importance to different waterbird species. Those natural and man-related factors that affect habitat condition are also discussed. Attempt is made to relate the importance of a site to the condition of other habitat on the same island, and, where relevant, to habitat elsewhere in the State. Some recommendations to maintain or improve the condition of waterbird habitat are discussed in this section.

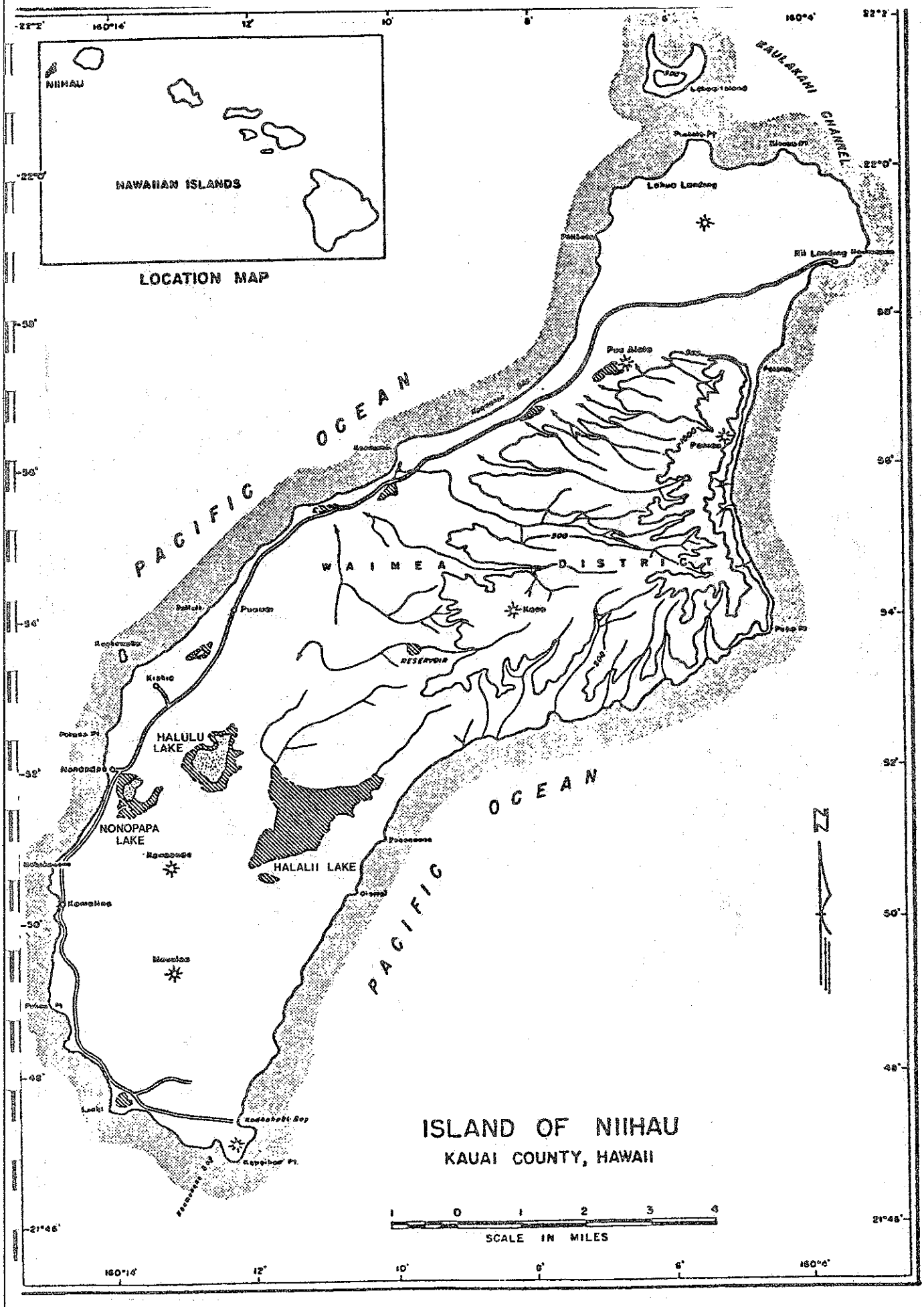
POTENTIAL IMPACT OF DREDGE/FILL ACTIVITIES: To aid in the evaluation of Section 404 permit applications by Corps of Engineers personnel, a brief discussion of predicted impact of dredge/fill activities is presented. In some cases, this is based on an evaluation of past or ongoing filling operations. In other wetlands, it involves an evaluation of anticipated site modification (i.e. refuge development, housing construction, aquaculture pond construction, etc.). It is impossible to accurately predict the nature of future dredge/fill operations in each wetland, and the impact of such activity on waterbird resources in a particular wetland will vary with location in the wetland, scope and duration of the project, time of year and dozens of other variables. The reader is referred to the introductory section on Effects of Dredging and Filling on Waterbird Habitat (page 19) for an overview of this subject that applies to some degree in all wetland areas.

KAUA'I

WETLAND AREAS SURVEYED



ISLAND OF KAUAI
KAUAI COUNTY, HAWAII
WETLAND SURVEY SITES


NIIHAU
NAWAIIAN ISLANDS
LOCATION MAP
PACIFIC OCEAN
KAULAKAHI CHANNEL
WAIMEA DISTRICT
HALULU LAKE
NONOPAPA LAKE
HALALII LAKE
PACIFIC OCEAN
ISLAND OF NIIHAU
KAUAI COUNTY, HAWAII
SCALE IN MILES
0 1 2 3 4

KAUAI

INTRODUCTION: Geologically, Kauai is the oldest of the main islands, and its age is reflected in its topography. The island is a collapsed volcanic dome, characterized by deep canyons, sheer cliffs, abundant streams and a large, high elevation forested bog. The northwest, south and east slopes are, for the most part, fertile agricultural land. Rainfall on Kauai varies from less than 10" to more than 500" per year. (Mount Waialeale on Kauai is the world's wettest spot.)

The Alakai Swamp, more accurately a forested bog, lies at 4,000' on a plateau surrounded on three sides by precipitous cliffs. The Alakai Swamp was not included on this survey, but the lower elevation Kalihiwai forested bog was visited briefly. Other principal wetlands on the island of Kauai include estuaries, stream valleys, freshwater marshes, ephemerally flooded pastureland, reservoirs, salt ponds, fish ponds, taro fields and sugar cane waste water settling basins. The 1976 winter HDF&G/USF&WS waterbird survey included nearly 130 Kauai sites, of which more than 60% were reservoirs. To these sites, one must add many miles of irrigation ditches, and drainage canals, to develop a true picture of the diversity and distribution of waterbird habitat on Kauai. Our survey included 21 wetland areas, some of which involved more than one actual site. Only three of our areas were reservoirs. Two additional sites (Kekupua Valley spring pond and Poopueo Reservoir) on our original list were not surveyed because access was denied by the landowner.

It is appropriate here to mention the wetland areas on the island of Niihau, west of Kauai. Three lakes, varying in size from 370-850 acres, provide important habitat for waterbirds, particularly stilt and coots. Water is derived from runoff and direct rainfall, although the lakes may dry completely during part of each year. The landowner has not permitted ground survey of these wetlands by State or Federal biologists, so much of the historical evidence relating to waterbird use is based on occasional aerial surveys and upon the cyclic pattern of habitat use by stilt and coots on Kauai. It is believed that most young produced by Kauai populations of stilt and coots are hatched in nesting habitat on Niihau.

Two wetland areas on Kauai are now protected as national Wildlife refuges (Hanalei NWR, and Huleia NWR). State biologists are investigating the possibility of managing Mana ponds as a State waterbird sanctuary. The draft HWRP (346) lists the lakes on Niihau and five areas on Kauai (Hanalei, Mana, Lumakai, Wilcox Ponds, Puu Ka Ele Reservoir) as "essential" habitat for stilt, coots and/or gallinule. Of these, only the Niihau wetlands and Puu Ka Ele Reservoir were not included in our survey.

WATERBIRDS ON KAUAI: Kauai is the only main island on which all of the native bird species known to the island, with the possible exception of the Dark-rumped Petrel, are still extant. However, several of these, including both forest birds and waterbirds, are in danger of extinction and are listed as either "endangered" or "threatened" by Federal law.

Recent collection of a dead mongoose by HDF&G biologists and unconfirmed sightings of mongoose at widely distant locations on Kauai raise serious concern among biologists about the future of Kauai's endemic birds, particularly the ground nesting waterbirds and Newell's Shearwater. A trapping program by HDF&G and USF&WS biologists is underway to prevent successful establishment of mongoose on Kauai. Although we are aware of funding constraints involved, in our opinion this eradication program has not yet been given the extremely high priority it deserves.

One species that appears to illustrate the role of the mongoose on Hawaiian wetland ecology is the Hawaiian Duck or Koloa. Kauai is the only island where this species has continued to breed successfully in the wild unaided by the repeated release of captive-reared birds, presumably because until recently Kauai was the only main island to which mongoose had not been introduced. Koloa occupy a wide variety of natural and man-made habitats on Kauai, and although HDF&G/USF&WS count coverage on Kauai is broad, it is certain that many birds in streams, irrigation ditches and flooded pastures are missed on survey.

Hawaiian Stilt counts on Kauai have increased considerably in recent years, presumably due to the combined influence of habitat improvement,increased breeding success and more thorough habitat coverage on surveys. Although not confirmed by ground survey, most biologists believe that the majority of stilt observed on Kauai breed in wetlands on Niihau. In most years, the majority of stilt on Kauai appear to leave the island during fall months and return in the spring with young birds. The pattern may vary under abnormally dry weather conditions, causing stilt to remain on Kauai through the winter. Nesting by small numbers of stilt on Kauai has been observed at Hanalei Valley, Lihue Settling Basins and at Mana.

Hawaiian Coots appear to follow an annual pattern of migration between Kauai and Niihau, similar to stilt. The distinct variation in summer and winter populations is evident in HDF&G/USF&WS count records (page 117). Nesting by coots on Kauai has been confirmed only at Kipu and Kolo Reservoir (530). Concentrations of over 1,000 birds have been observed at Waita Reservoir.

Hawaiian Gallinule appear to be far more sedentary than coots or stilt, and do not seem to follow an annual migration pattern. In the draft HWRP (346), the gallinule population on Kauai was estimated at $\pm$ 500 birds, but HDF&G/USF&WS count records to date do not reflect real population size due to the wide population distribution and secretive nature of this species. It is clear, however, that Kauai is by far the most important stronghold for this species.

Black-crowned Night Herons are also widely distributed on Kauai, but by far the greatest numbers are observed regularly at taro fields in valleys along the northern coast, particularly Hanalei. Cattle Egrets did not appear on HDF&G/USF&WS count records on Kauai until 1972, and the population did not show a marked increase until 1975. They are most common in the Kilauea-Hanalei area of Kauai.

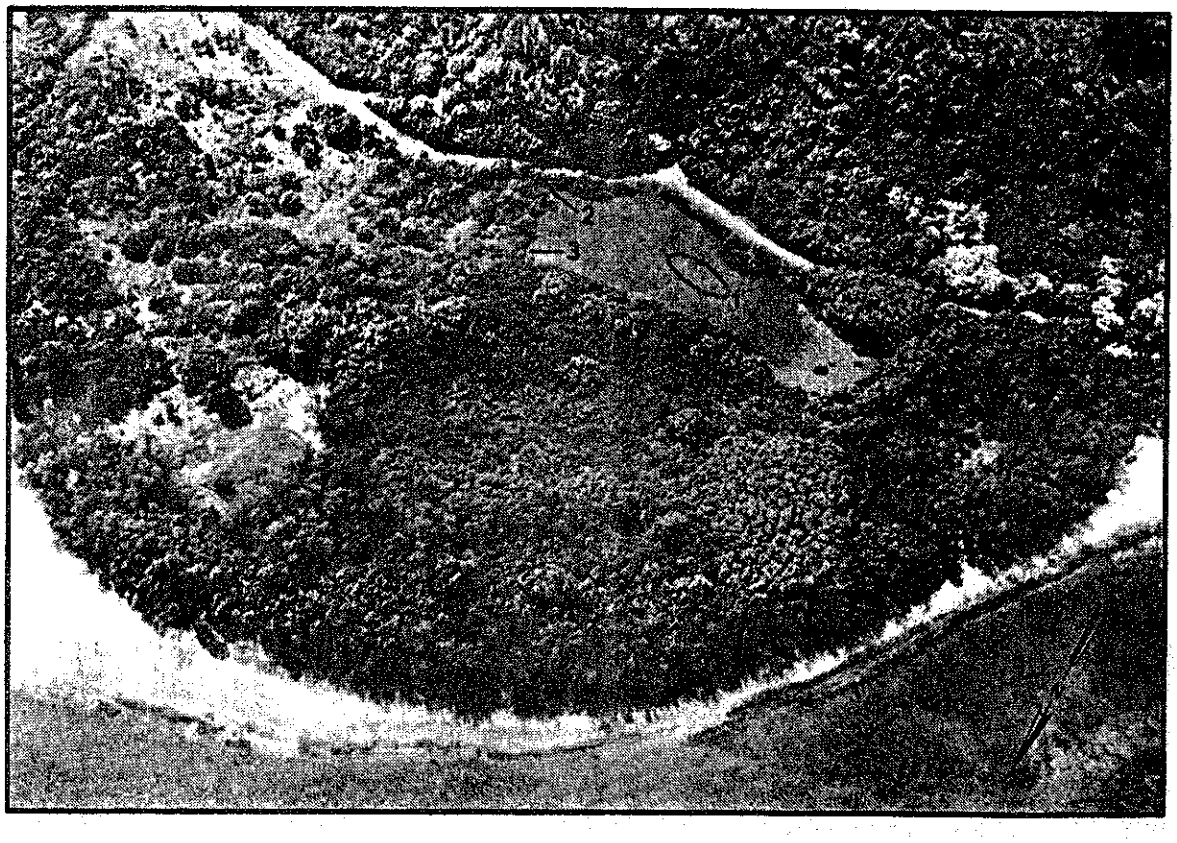
The recorded Kauai population of migratory shorebirds has rarely exceeded 10% of the statewide HDF&G/USF&WS count total. However, several uncommon migrants have been noted in recent years, particularly in Hanalei NWR. The migratory waterfowl counts on Kauai have also been comparatively low, but occasionally approach 20% of the statewide count totals. Although these birds are often widely dispersed on Kauai, large concentrations have been noted on reservoirs, particularly Waita and Kipu.

SITE NAME: Hā'ena Marsh

LOCATION: Hanalei District, Kaua'i

TOPOGRAPHIC MAP: Hā'ena

DATES OF SURVEY: 20 May, 21 July, 1977



1. open water area
2. stream inlet (dry)
3. 'ape
4. Waikanaloa Wet Cave

WETLAND DESCRIPTION: This small fresh water marsh is badly encroached by grasses (principally honohono), leaving only a small (10' x 20') oval of open water. The water is shallow and stagnant. Surrounding lands that slope gently into the marsh area are covered with a dense growth of hau, guava and Koa haole. A small patch of 'ape, a close relative of taro and a food of early Hawaiians, still remains in the northeast corner. A dry streambed inlet is also found in that corner. The depth and amount of open water in the habitat probably increase markedly after heavy rains, but it is likely that encroachment of grasses is rapid as the area dries.

NON-AVIAN WILDLIFE: Bullfrogs were heard in the marsh area during survey. No fish were seen during a brief examination of the open water area. The ephemeral nature of the site and stagnant conditions presumably inhibit the development of diverse aquatic fauna.

NON-WATERBIRD AVIFAUNA: Small numbers of Spotted Munia, Common Myna, Spotted and Barred Dove were observed during survey. Other exotic birds (Northern Cardinal, Shama, Japanese White-eye, House Finch) are probably common in forested habitat adjacent to the wetland site. White-tailed Tropicbird were seen flying in the area and roosting on steep cliffs across the road, but their presence bears no relationship to the wetland.

WATERBIRDS OBSERVED: No waterbirds were observed during two visits to the site. I am unaware of any records of wetland birds in this habitat. The resident USF&WS biologist (534) reported that he had never observed waterbirds using this marginal habitat. It is doubtful that the area could sustain continued use by any waterbird species, although some birds may visit the site temporarily after vegetation is cleared by prolonged rains. All five resident native species and the Cattle Egret are possible temporary visitors in very small numbers.

HABITAT EVALUATION: The habitat in its present condition is of little or no value to waterbirds. Extensive clearing of encroaching grasses would increase the potential habitat, but some means to improve the water supply would be required. Possibly this wetland site was in taro cultivation historically, at which time it would have been of greater value to waterbirds. However, the habitat is very small and considerable distance from the nearest wetland inhabited by native waterbirds. It is unlikely that waterbirds regularly approach the site from the east as there is nothing beyond to the west but the steep cliffs and valleys of the Napali coast. If the site were improved as waterbird habitat, extensive public use of the Waiakanaloa Wet Cave across the road would probably create enough disturbance to preclude continuing occupation of the habitat by waterbirds. The site should be visited after prolonged rains to determine if increased open water attracts waterbirds to the area.

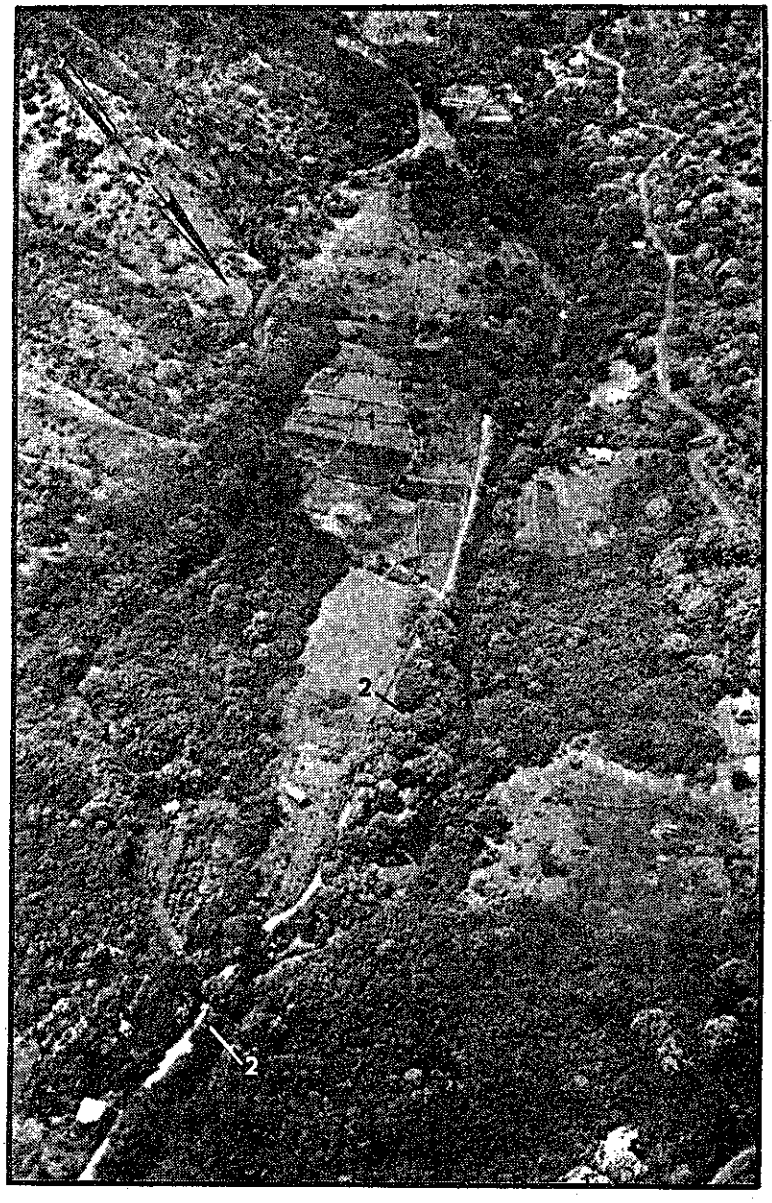
POTENTIAL IMPACT OF DREDGE/FILL OPERATIONS: As the site in its present condition is of little or no significance to waterbirds, there is considerable room for site improvement through clearing of vegetation, dredging of accumulated silt and impoundment of surface water. On the other hand, the site could be filled for other use and there is little probability that waterbird populations on Kauai would be affected.

SITE NAME: Wai-niha Valley

LOCATION: Hanalei District, Kaua'i

TOPOGRAPHIC MAP: Hā'ena

DATES OF SURVEY: 20 May, 22 July, 1977



1. taro fields
   (stilt & heron on survey)

2. heron observed

WETLAND DESCRIPTION: Wainiha Valley provides a wide variety of wetland habitat for Kauai's waterbirds that includes a large estuarine area, flowing fresh water stream, ephemeral flooded pastures and taro fields. Wainiha River splits and rejoins at several points in the valley, and a portion of the flow has been diverted for taro fields in the lower portions of the valley. The stream is lined with a dense growth of hau for most of its length. Some depressions in the grass in the upper reaches of the valley mark a site where a former prawn-rearing operation was located. Presumably these areas flood regularly when stream flow is high, as there is some scattered bulrush away from the stream. The main road crosses the stream at the lower estuarine portion of the valley (not pictured). Water in the estuarine area flows quite slowly, as evidenced by scattered patches of water hyacinth along the shores. The shallow sloping stream bottom in this area illustrates the long term effects of siltation during heavy stream flow. The stream above the bridge is more than 100' across, but tapers quickly to an average of less than 30' for most of its length in the valley.

NON-AVIAN WILDLIFE: The most evident aquatic animals at the time of the survey were bullfrog tadpoles, particularly in the shallower portions of the estuarine area. They were widely distributed and more abundant than observed in any other wetland area visited during this study. Schools of aholehole were also seen in the shallow waters below the bridge. Presumably mullet, milkfish, o'opu and tilapia are also common seasonally in the lower reaches of the stream. Tadpoles were also abundant in most taro fields examined, as were a variety of molluscs and water beetles.

Dogs were seen at several locations in the valley. Although only one cat was seen, they are probably widely distributed as well. Cattle and horses were grazed in the upper grassland portions of the valley.

NON-WATERBIRD AVIFAUNA: Most of the stream drainage is densely forested, providing habitat for a wide variety of exotic birds. Northern Cardinals, Japanese White-eyes, House Finch, Spotted Munia and Common Mynas were abundant while Shama and Melodious Laughing-thrush were uncommon but widely distributed in the valley. Common mynas were more conspicuous than other species, particularly in association with cattle or horses. Barred Doves were common in the valley.

WATERBIRDS OBSERVED: Hawaiian Stilt were widely distributed in taro fields throughout the valley. A maximum of 14 birds was counted on the two survey days, including one flock of seven in a recently planted field. They were feeding actively when observed and did not appear disturbed by workers harvesting taro in nearby fields. Wainiha was only added to the list of wetland sites regularly censused by USF&WS and DF&G biologists in the last 3 years, so there are few comparative data. No more than 2 stilt have been noted on these earlier counts. Presumably there is some movement of birds between this valley and more extensive habitat in Hanalei Valley, so numbers of stilt probably vary considerably with condition of taro fields. No evidence of stilt nesting was noted, but the survey was too brief and too late in the nesting season to be certain that nesting does not occur.

Hawaiian Coots were confined, for the most part, to the lower stream and estuarine area. One bird was seen farther upstream, where it was feeding upon one of several floating guavas. Below the bridge (not pictured), 12 coots were observed on the first visit and eight on the second. Most were feeding in shallow water along the shore, diving repeatedly. One bird caught a full grown bullfrog tadpole and carried it under the overhanging hau along the water's edge. Other coots were loafing and preening on logs or sticks that protruded from the stream bottom. No coots were seen in the taro fields visited, but it is certain that they visit these areas to feed. Coots have been recorded at Wainiha on waterbird counts in the past, but in smaller numbers than seen on this survey.

Gallinule were observed feeding in taro fields on the first survey day but not on the second. Five birds were counted, although it is likely that some were missed in the high taro. One farmer reported seeing gallinule chicks earlier in the year, but no evidence of nesting was noted during our brief surveys.

Only one Koloa was seen on the stream, just above the highway crossing. However, several other Koloa were seen in flight while we were surveying the valley taro fields. Taro farmers reported that Koloa eat their taro, particularly if the fields are not well flooded. Muscovy duck were seen at several locations, but for the most part they were associated with residences in the valley.

Six 'Auku'u were observed on the first survey, and four on the second. All were solitary birds, searching for food along the stream, in taro fields and in the tall grass high in the valley. The hau branches above the flowing stream provided convenient roosting sites for this species. Finally, four Cattle Egret were associated with a few grazing cows in the upper pasture areas.

HABITAT EVALUATION: Wainiha Valley provides a diversity of feeding habitat that accomodates all the native waterbirds, albeit in relatively low numbers. Although not verified by count records, the estuarine area and some taro fields probably also support a small number of migratory ducks in winter months. There is little shorebird feeding habitat, other than taro fields, although there may be some exposed bottom mud during periods of abnormally low stream flow. There is very little public use of the roads within the valley and waterbirds appeared to be undisturbed by the small amount of resident traffic and other activity. As long as taro remains a viable crop in the valley and if the stream continues to run free of pollutants, the valley will remain suitable for the small number of waterbirds it now accomodates. The estuarine area is small by comparison to several other stream valleys east of Wainiha, and subject to continuing disturbance by traffic along Kuhio Highway. Continuing use of this habitat by native waterbirds, particularly coots, is dependent upon perpetuation of water quality and limited human disturbance.

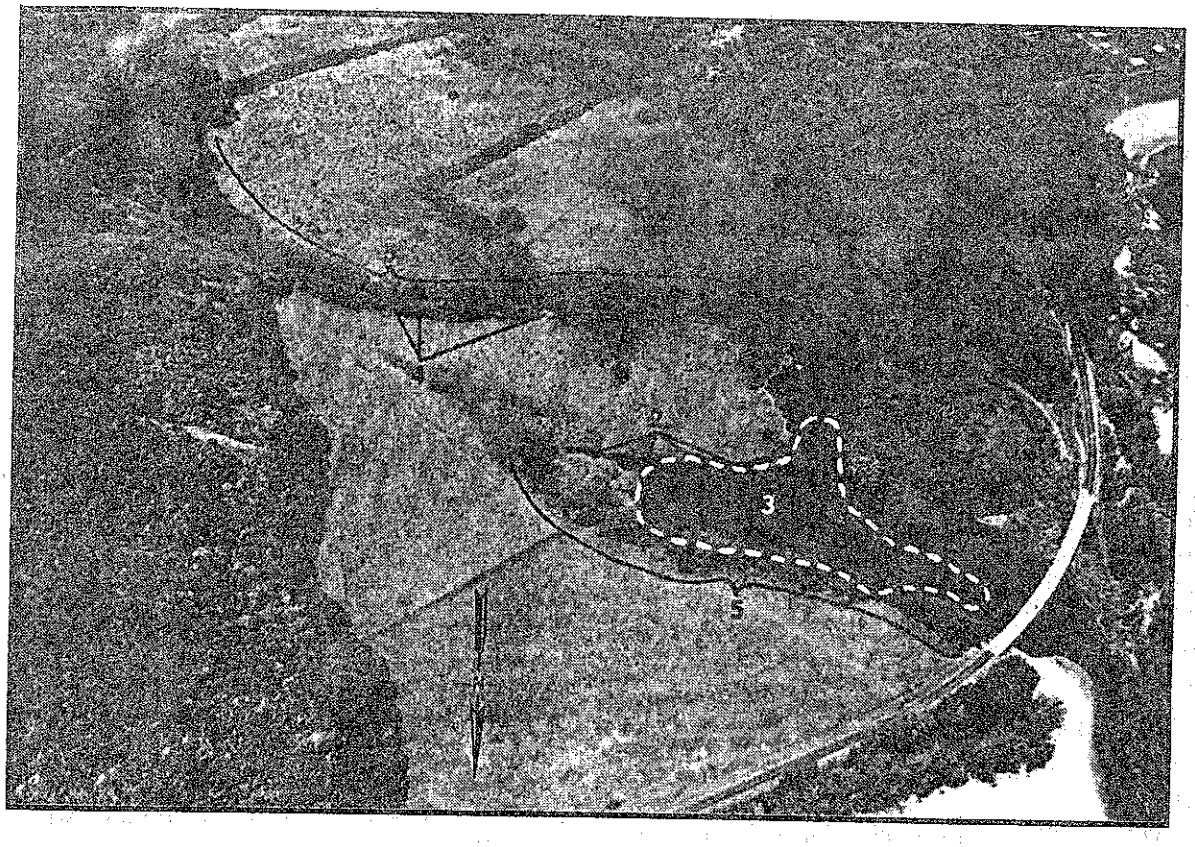
POTENTIAL IMPACT OF DREDGE/FILL ACTIVITIES: As long as taro is grown in the valley, diversion of Wainiha Stream water for agricultural use will be required. In addition, future aquaculture projects can probably be anticipated. In either case, some dredging and deposition of fill material will inevitably be involved. Emphasis in evaluating such projects should be placed on means to insure maintenance of stream flow throughout its course and methods to avoid excessive siltation of stream water. Any use of chemicals that may have deleterious effects in aquatic ecosystems, particularly upstream in the valley, should be avoided.

SITE NAME: Lumaha'i Valley

LOCATION: Hanalei District, Kaua'i

TOPOGRAPHIC MAP: Hanalei

DATES OF SURVEY: 20 May, 21 July, 1977



1. exposed mudflat during low tides
2. bulrush
3. primary coot distribution
4. koloa observed on survey
5. hau

WETLAND DESCRIPTION: The lower reaches of Lumahai Valley provide a large amount of relatively undisturbed waterbird feeding, loafing and, possibly, nesting habitat. The estuarine portion of the stream is larger than in any of several other streams that enter the ocean on the north shore of Kauai. Its shores are lined with a dense growth of hau and guava. The overhanging hau provides abundant cover for waterbirds. Growth of bulrushes is confined, for the most part, to an area of slow stream flow south of the bridge. The stream and estuary are bordered by expansive flat meadow land, portions of which are probably flooded during heavy rains and increased stream flow. The amount of open water in the estuary varies with tidal conditions, exposing a large mudflat on the west side of the estuary when the tide is out. Water depth ranges from more than 10-15 feet in the center of the estuary to a foot or less upstream beyond the point of tidal influence. The upper portions of the stream run quite clear, although the estuarine waters (slightly brackish) below the bridge are turbid as a result of slack tidal water. The meadows bordering the stream are grazed by cattle. There is currently no housing or other construction in the lower valley.

NON-AVIAN WILDLIFE: An exhaustive aquatic survey was beyond the scope of this study, but it is likely that the stream and estuary support a diverse macrofauna, providing a large variety of food for waterbirds using the habitat. The lack of developed housing in the lower valley reduces the probability that dogs and cats present a significant problem for waterbirds.

NON-WATERBIRD AVIFAUNA: As most of this survey was conducted from the highway and from a boat in the stream and estuary, one can assume that some terrestrial bird species may have been missed. House Finch were common in the ironwood forest north of the highway. Common Mynas, Barred Doves and Spotted Doves were also common along the highway and were seen in smaller numbers in the wetland pastures. Japanese White-eye were also observed in the hau along the stream. Presumably, Melodious Laughing-thrush, Shama and Northern Cardinal are also widely distributed in the forested slopes of Lumahai Valley. Greater-necklaced Laughing-thrush have also been reported in neighboring forest (534).

WATERBIRDS OBSERVED: All native (resident) waterbirds except the gallinule were observed during both highway and on-water surveys of this site. Coots were found in greatest numbers (105 total) in the estuarine area above the bridge. They were widely distributed, even in the deepest waters, but were observed feeding only along the hau-covered shoreline and near the bulrushes. This estuary has been of considerable interest to the USF&WS in recent years because of its value for coots (534). Monthly USF&WS counts between August, 1974 and April 1977 show coot numbers ranging from six to 275, with an average of nearly 90 birds. The greatest numbers have been recorded during the last six months of the calendar year, when adult and juvenile birds return from breeding areas, presumably on Niihau.

Hawaiian stilt find little feeding habitat of value in Lumahai estuary in its present state. Two birds were counted on the May survey, when they were seen feeding on mudflats during a particularly low tide. The species appears on only one of the 46 USF&WS counts in recent years, however an attempt to schedule these trips around periods of low tide probably would have resulted in greater numbers.

Gallinule were not seen during our two survey days, but the species appears (one bird each count) on five monthly USF&WS counts in recent years. Probably several birds were missed on these roadside counts, as dense hau and bulrushes provide sufficient cover in which to hide. However, relatively deep water and limited growth of floating-leaved vegetation in the estuarine area reduces the value of this habitat for gallinule.

Five Koloa were seen on our May survey and seven during July. Nearly all of the ducks seen on the later trip were flushed from emergent grasses along the upper length of the stream as we passed by in a boat. Abundant cover probably prevented observation of additional ducks that may have been present. Temporarily flooded pasture provides additional habitat for this species. Although no young birds were seen on this survey, observation of a female Koloa with a brood of four downy young in April 1976 (534) confirms use of the area for breeding. Koloa were seen on 23 of 46 USF&WS trips during 1974-1977, but never more than eight birds were recorded from the roadside observation site. These birds appear to use the estuary and stream year-round.

Three 'Auku'u were recorded on our May survey, and two in July. Dense overgrowth of hau prevented continuation of our boat survey far upstream, but it is almost certain that 'Auku'u are widely distributed along the stream where water is shallow enough to permit feeding. Cattle Egrets were observed in low numbers (n=14,10) on both surveys and were associated with cattle on flat pastureland bordering the stream. Recent USF&WS counts of this species have averaged less than eight birds per trip.

Data from USF&WS records for recent years indicates that Lumahai stream and estuary provide little suitable habitat for migratory waterfowl. Pintail ducks were noted on only one recent survey (two birds). Several sightings of a lesser Scaup and a Pied-billed Grebe in the estuary were made during winters of 1974-75 and 1975-76 respectively. It is likely that both series of observations involved individual birds that spent the entire winter season at the estuary.

HABITAT EVALUATION: It is clear from our survey and USF&WS count records that Lumahai estuary currently provides high quality feeding and loafing habitat for coots, and limited feeding and nesting habitat for Koloa, but it is of less value to other waterbirds in the State. The draft HWRP (346) recognizes the area and recommends its acquisition and development as a refuge by the USF&WS. The land is presently owned by the Bishop Estate and human disturbance is minimal. Cattle grazing appears to present little threat to waterbirds at this time. Bulrush habitat might be overgrazed and trampled by cattle if lowered water makes this area accessible. Submergent plant life (Leafy pondweed) in shallower portions of the estuary provides one important source of food for native waterbirds (particularly coots).

Flat pasture lands bordering the stream and estuary were used for taro production, and possibly rice, in the past. Remains of old dikes and a diversion ditch can be found. The USF&WS has surveyed the site in recent years with an eye towards possible acquisition as a National Wildlife Refuge (75). In their land acquisition study, the USF&WS recommended reconditioning of water supply ditches onto the flat meadows, and construction of water

impoundments to increase available waterbird habitat. As is the case in nearby Hanalei Valley, this might involve planting of taro. The USF&WS also recommended that stilt habitat be improved. Although these improvements would likely increase waterbird use of the site, the present quality of the site will probably be perpetuated if the present landowner restricts future use to limited cattle grazing.

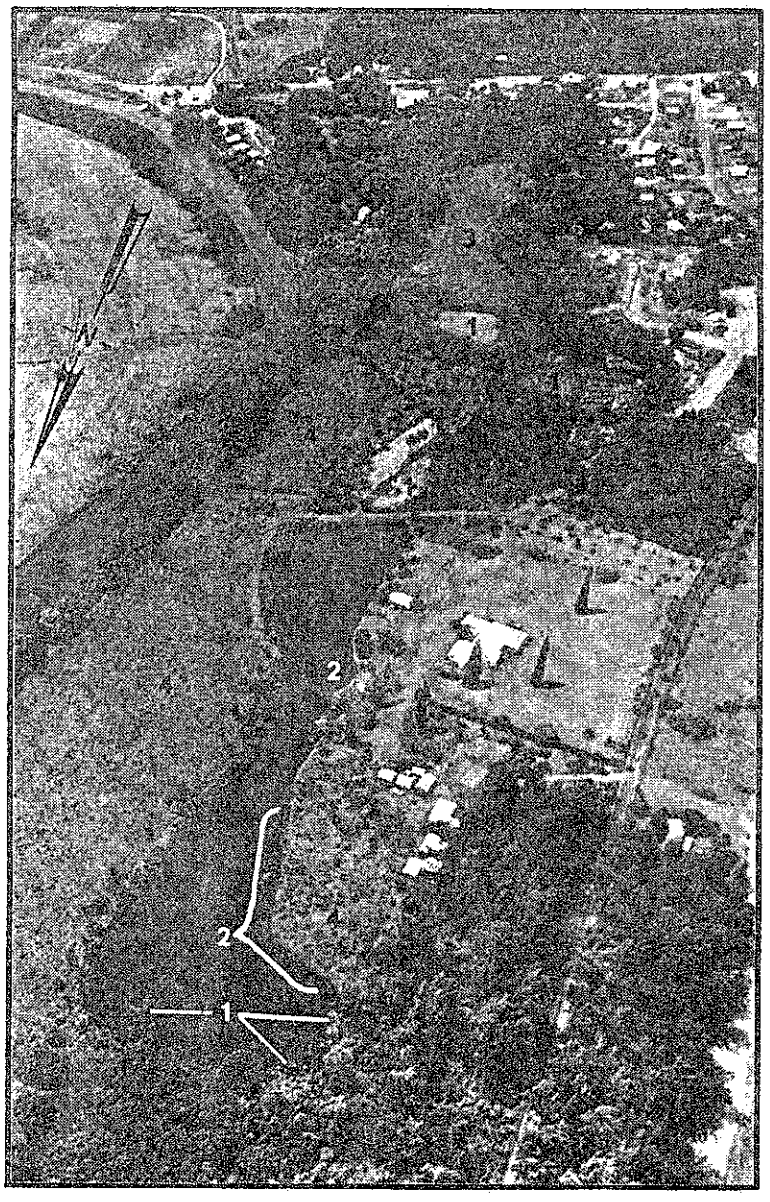
POTENTIAL EFFECTS OF DREDGE/FILL ACTIVITIES: Acquisition and habitat development by the USF&WS would involve considerable dredging and deposition of fill, although this work would be confined primarily to flat, pasture land that is presently of little use to native waterbirds. If this land alteration can be accomplished without long-term siltation of the estuary, it is likely that provision of additional water impoundments would result in a significant increase in use of the site by all native waterbirds. On the other hand, the present landowner may choose to modify the area in a way that may be detrimental to waterbirds in the long term. Low, flat pasture land bordering a permanent water source such as Lumahai River is ripe for aquaculture development, and it is no surprise that this possibility has been considered for the Valley. One proposal in 1974 involved the construction of a Malaysian Prawn hatchery that would include several hundred acres of ponds. Although this activity would attract some waterbirds, it is likely that depradation of prawns by birds would be discouraged. In addition, the dredging and fill operation associated with pond construction could have long term effects on estuarine ecology and waterbird use. Excessive siltation beyond that naturally occurring would cover available submergent vegetation and allow the encroachment of aggressive grasses towards the deeper waters of the estuary. Diversion of stream waters would also lower present estuarine value for waterbirds. Construction disturbance may have adverse impact of waterbirds in the area, although they could accommodate rapidly to low disturbance levels.

SITE NAME: Wilcox (Kanoa) Ponds

LOCATION: Hanalei District, Kaua'i

TOPOGRAPHIC MAP: Hanalei

DATES OF SURVEY: 21 May, 1 June, 22 July, 1977



1. water lilies
2. bulrush
3. california grass & papyrus
4. pasture

WETLAND DESCRIPTION: This inland freshwater pond system consists of two ponds, totalling almost 13 acres, with connection to Hanalei River (112). The ponds are on privately owned land and current human disturbance is minimal. Cattle are grazed around the ponds, particularly along the north and east sides. Madden & Paulsen (112) noted that the ponds are not in current use for aquaculture but have excellent potential for production of mullet and milkfish. They noted also that the ponds have good algal species diversity, in part due to nutrients derived from grazing cattle. The perimeter of the ponds is either vertical rock wall or sloping pasture land that is grazed to the water's edge. It appeared on survey that much of the pasture on the east side of the ponds would flood when stream flow is high.

The resident (531) at the site during survey indicated that the ponds were created in part by natural drainage, although they were modified considerably by dredging and wall construction in the 1930's. Both are approximately four feet deep over most of the bottom. A narrow fringe of bulrush is present along portions of the shore in the north pond. An extensive growth of water lilies is present in both ponds, but is particularly abundant in the south pond. Several coconut palms, mango trees and patches of California grass, bulrush, and umbrella sedge line the ponds' edges.

NON-AVIAN WILDLIFE: Madden and Paulsen (112) found that the pond complex in its present state contained large numbers of tilapia, gobies and mollies. In their discussion of aquaculture potential, they recommended that all of these species be poisoned or harvested to improve conditions in the ponds for mullet and milkfish production. We also observed small schools of aholehole in the pond. Unidentified crabs were noted in both trips to the site as well. Numerous insects, including damselflies and dragonflies, were present in the ponds, particularly within the bulrush and water lilies.

NON-WATERBIRD AVIFAUNA: Non-wetland species recorded during survey included Common Mynas, House Finch, Spotted Munia, Japanese White-eyes, and Western Meadowlark. Only the last of these species was uncommon. Presumably Northern Cardinals, Shama and Melodious Laughing-thrush also visit the surrounding forest, but they were not noted during our surveys. Barred and Spotted Doves were common on the resident's lawn and in the surrounding neighborhood.

WATERBIRDS OBSERVED: Three endemic waterbird species were recorded during our visits to this site. Hawaiian Coots were by far the most numerous of these. On three consecutive visits, we recorded 63, 42 and 28 coots. These data suggest that there is regular movement of coots between these ponds and other habitat, presumably the taro fields within Hanalei Valley. As many as 77 coots (1/22/74) have been recorded on the Wilcox ponds on HDF&G/ USF&WS counts. We found the birds feeding in all parts of the ponds, diving repeatedly to obtain algal or invertebrate food off the bottom. Water lily and bulrush were also attractive to this species. Several incidences of courtship display were noted at the ponds, particularly in May. However, no other evidence of possible nesting was noted. There are no published records of nesting by coots at this site. Perhaps the ponds are too deep and the shoreline too steep to provide adequate nesting sites. Between 10 and 13% of the coots recorded at Wilcox ponds on our survey were the red-shielded variety, and one bird seen both in May and in July was believed to be a mainland coot by the differences in plumage and frontal shield morphology.

Gallinule were observed on all three visits to the ponds (between 2-7). Pairing of birds was evident on the later visits, but a brief examination of the bulrushes and other vegetation surrounding the ponds revealed no nests or evidence of earlier nesting. Also there was little observed aggression between gallinule and coots. Such behavior is typical in sites where gallinule are nesting. A more thorough survey earlier in the year would provide a more reliable foundation for evaluating use of the area for nesting. Gallinule were feeding within and on top of the water lilies, although they did leave the pond and feed on the lawn immediately after it had been mowed. Overhanging vegetation along the shore of the ponds probably concealed additional birds that were not counted.

A single pair of Koloa was flushed from the heavily grazed shoreline on the south pond during our last visit to the site. As many as 11 Koloa have been recorded on previous visits by State and Federal biologists to the site. A brood of six downy young in January, 1975, verified that the site was used for nesting, but I am unaware of any other nesting observations before or since this record. At least a dozen historical, and several recent, observations of Koloa nesting have been made elsewhere in Hanalei Valley. Trampling of pasture bordering the Wilcox ponds probably inhibits more frequent use of this habitat for nesting.

Earlier count records do not indicate use of the ponds by migratory ducks, although the landowner confirmed that some "mainland ducks" (not identified) visit the ponds during winter months (531). The only migratory shorebird listed in HDF&G/USF&WS count records for the site is the Golden Plover, a species that probably finds the well-groomed lawns that border the pond very attractive as a source of insect food.

Less than a dozen Cattle Egrets were observed on each of our three visits to the ponds, although as many as 37 birds have been recorded recently (1/15/74). Numbers of this species in the Kilauea-Hanalei region of Kauai have increased dramatically in recent years (534).

HABITAT EVALUATION: The draft HWRP (346) lists the Wilcox ponds as a "primary area" for endangered waterbirds in need of protection and cooperative habitat management. For its size, the Wilcox pond system probably supports more coots on a regular basis than any other habitat on Kauai, if not the State. Available evidence suggests that coots annually leave Kauai to nest elsewhere (probably Niihau) so it is questionable whether or not improvements would induce coots to nest in significant numbers at these ponds. However, there is room for improvement of the area as a feeding and loafing site. Use of neighboring pasture by cattle may increase the nutrient level in the pond, but grazing probably inhibits use of the shoreline by coots and other waterbirds. Artificial loafing platforms within the ponds could make up for this deficiency. It is also important that human disturbance on neighboring lands be kept to a minimum, preferably through establishment of a surrounding buffer zone. A subdivision now in development along the west shoreline will probably create a continuing source of disturbance. Growth of waterlilies is attractive to both coots and gallinule, but if not controlled, could eventually choke the ponds and inhibit the development of submergent vegetation. The landowner currently "mows" the water lilies on a regular basis.

If the landowners decide to "improve" the pond for aquaculture use, it would be necessary to "remove and restrict further encroachment of ponds by vascular water plants which limit productivity" (112). Aquaculture development may also require clearing of shore vegetation (112). Both changes in vegetation would diminish available food and cover for waterbirds. Reduction of some fish populations (i.e. tilapia) for culture of other species would reduce one source of food for waterbirds, but this is probably of limited significance in comparison with the standing algal crop and other vegetation.

A further deterrent to waterbird use with expanded aquaculture would be the increase in human disturbance levels associated with this activity. It appears that the site is too small to support active aquaculture development and still retain its prime value for waterbirds. As an alternative, this site could be managed primarily for waterbird use under cooperative agreement between State or Federal wildlife agencies and the landowner.

POTENTIAL IMPACT OF DREDGE/FILL ACTIVITIES: Increasing turbidity in the Wilcox ponds as a result of fill deposition would lower the quality of a valuable waterbird site by inhibiting the growth of submergent vegetation and reducing the availability of bottom invertebrates. Although not necessary for continued use by waterbirds, there is some room for pond expansion through selective dredging, particularly at the southern end of the site. Such expansion could probably be accomplished with little or no long-term disturbance of the area. Certainly some form of repetitive control of floating vegetation will be required to maintain the quality of the site.

SITE NAME: Hanalei Valley (includes Hanalei National Wildlife Refuge)

LOCATION: Hanalei District, Kaua'i

TOPOGRAPHIC MAP: Hanalei

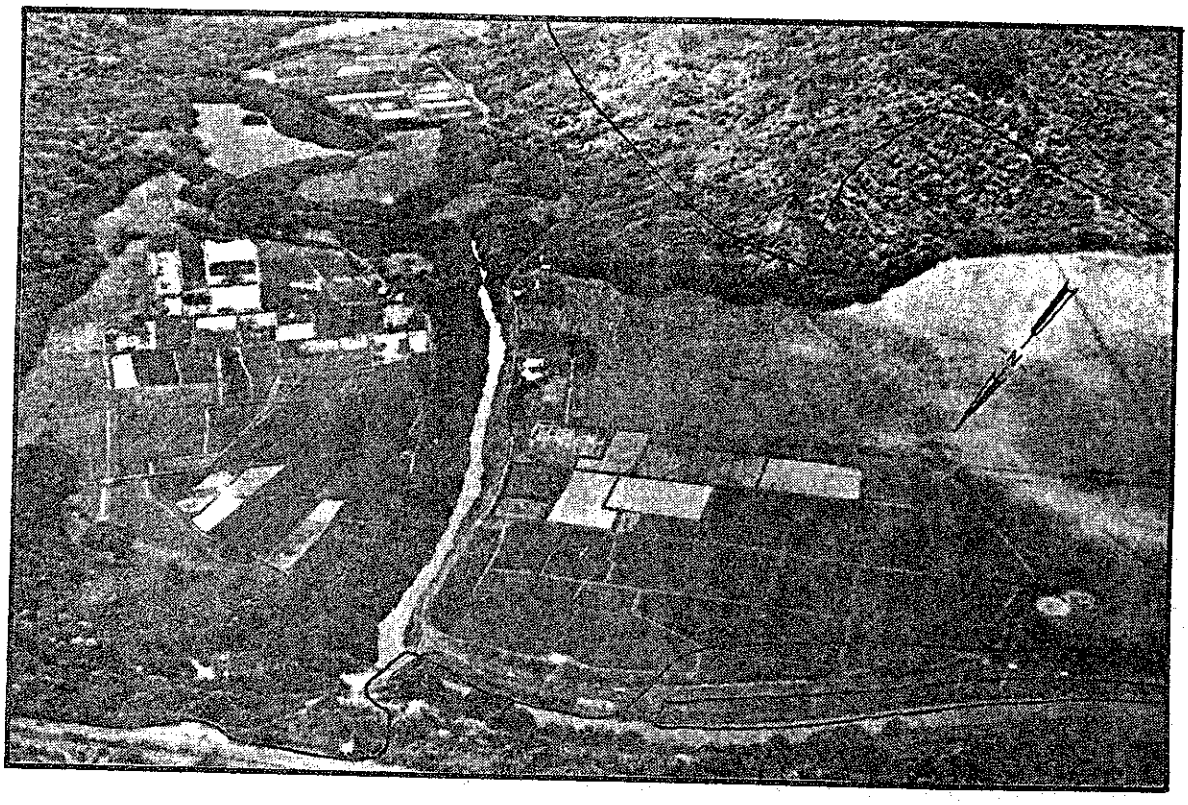
DATES OF SURVEY: 19,31 May, 18,21 July, 1977

WETLAND DESCRIPTION: It is probable that Hanalei Valley, with its expansive flatlands and abundant water supply, was one of the first areas colonized and developed for its agricultural potential by the early Hawaiians. At least 350 acres of the upper valley alone was in taro and rice production in the 19th Century. Most of the flatland in the lower valley was also developed for wetland agriculture. It is probably the long history of intermittent flooding of the Hanalei River that has limited the urbanization of most of the valley, but much of the original taro land is now grassland or ephemerally flooded pasture. The forested valley slopes are dominated by guava, kukui, mango, pandanus, silk oak, java plum, and some native ohia. The banks of the Hanalei River are lined with hau in the upper reaches, and long stretches of California grass and other grasses in the lower valley. The water runs turbid after heavy rains, and the tidal influence is felt into the upper valley.

State and Federal biologists have been interested in the Hanalei Valley for several years, because waterbirds have regularly inhabited the taro fields, flooded pastureland and river. The water diversion and supply ditches to the fields also provide important habitat. Recognizing the possibility that taro farming and waterbird management were potentially compatible, the USF&WS began consideration of wildlife refuge status in the valley more than a decade ago. In 1972, the USF&WS purchased 917 acres of land in the upper and central valley. Of this land, 142.5 acres are now producing taro (102.5 actual crop acres) and another 187 acres are used for grazing purposes. Taro farmers on the refuge lands are working under permit from the USF&WS and are cooperating with Federal biologists (under regulation) to insure that farming activities are compatible with waterbird management. The USF&WS is presently evaluating the possibility of expanding available waterbird habitat by reconditioning former taro fields and possibly by creating new taro fields on other flatlands. USF&WS biologists feel there is potential for as much as 325 actual acres of taro fields and other water impoundments.

Additional taro acreage in the lower Hanalei Valley (see photograph) is not on refuge lands. These farms are visited by waterbirds for habitat, but the areas are not managed under supervision of USF&WS biologists. Fluctuations in USF&WS count data suggest considerable movement of waterbirds between these farms and refuge taro fields, and between these valley sites and other habitat on Kauai and Niihau.

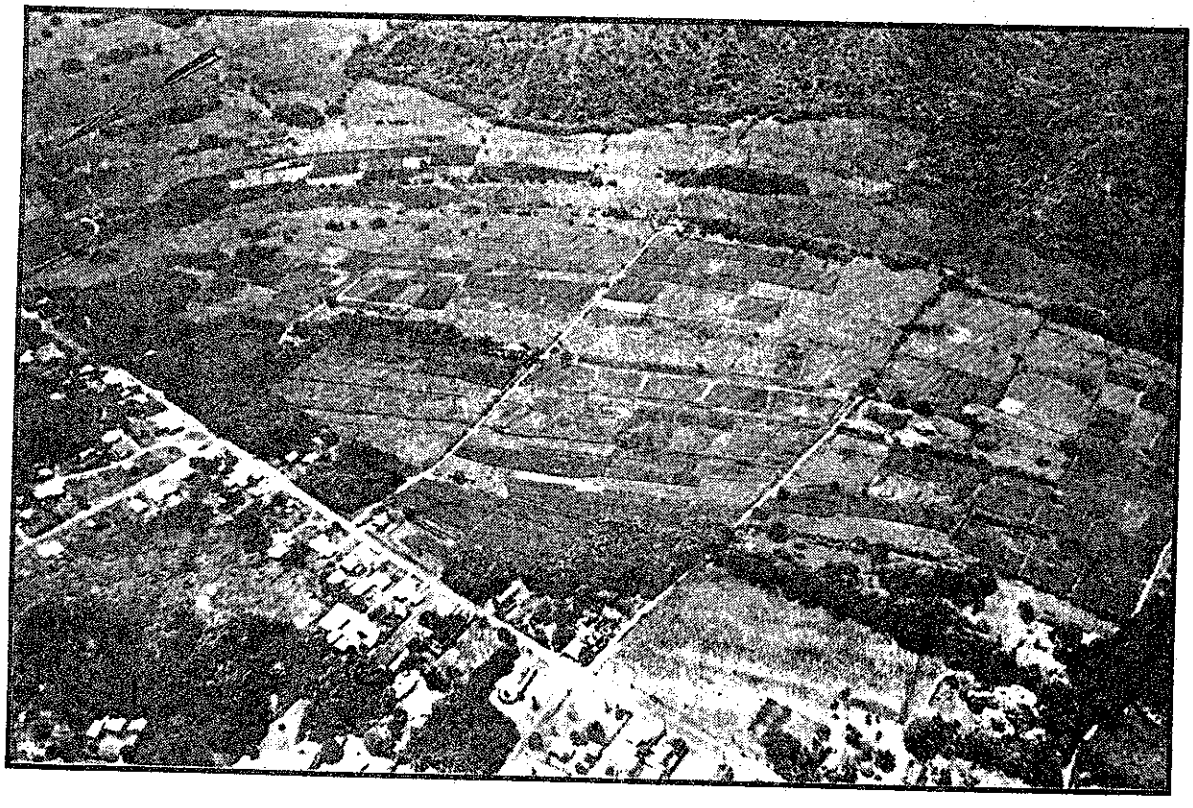
Other wetlands within Hanalei Valley include Wilcox (Kanoa) Ponds, Princeville marshland and artificial ponds on Princeville Golf Course. The Wilcox ponds are treated separately in this report (page 150). Princeville marshland is so encroached by California grass and patches of bulrush that



Upper Hanalei Valley

——— Hanalei National Wildlife Refuge boundaries (approximate)

Lower Hanalei Valley taro fields



there is little open water. Heavy rains and resultant flooding of the small stream that feeds this site may increase the amount of open water and provide at least temporary habitat for waterbirds. However, in its present state, it is of little value to waterbirds.

NON-AVIAN WILDLIFE: Taro fields support a diverse aquatic fauna, much of which provide important food for waterbirds. A thorough aquatic survey by USF&WS biologists has been proposed for Hanalei NWR taro fields, but it is not yet underway. We found the aquatic fauna of different taro fields to vary somewhat with schedule of planting and harvest and, hence, drying and flooding. Gastropod molluscs were abundant in some ponds. Both native (Melania sp.) and exotic (Viviparous sp.) forms were represented, in all size classes. Aquatic insects, including dytisid water beetles, were widespread. Tadpoles of at least two amphibians (Rana rugosa and Bufo sp.) were well distributed and locally abundant. Bullfrogs (Rana catesbrana) are also found in the taro fields (534). Observed fishes included various poeciliids (i.e. swordtails, guppies) and localized populations of tilapia. Hanalei River attracts numerous fishermen in search of gobies (o'opu) and prawns. Mullet, milkfish, barracuda and tilapia are probably present as well, but were not confirmed on this brief survey.

NON-WATERBIRD AVIFAUNA: A rather long list of non-wetland birds has been compiled at Hanalei since 1973, largely due to prolonged survey by a USF&WS biologist, Fred Zeillemaker. Ring-necked Pheasant appear regularly in recent waterbird count records, in numbers as high as nine per count. Taro farmers in lower Hanalei Valley complained that pheasants cause considerable damage to freshly planted taro. Common (Japanese) Quail are rare in the refuge area.

The list of uncommon birds recorded at the site by USF&WS biologists includes Red Junglefowl, Barn Owl, Hawaiian Owl, Western Meadowlark, House Sparrow, and Greater Necklaced Laughing-thrush. The last of these is more common at Huleia National Wildlife Refuge, southwest of Lihue. Several species of non-wetland birds are common at Hanalei at all times of the year, including Barred Dove, Spotted Dove, Melodious Laughing-thrush, Shama, Japanese White-eye, Common Myna, Northern Cardinal and House Finch (534). All of the common species were recorded on our brief survey of Hanalei NWR, but only doves, white-eyes and mynas were seen in the lower Hanalei Valley taro fields. It is virtually certain that all the species recorded as common in the refuge are also well distributed in forest on the slopes throughout the valley. Spotted Munia were observed at several locations in the valley, in both taro fields and surrounding pasture lands. Birds heard during our boat survey of the Hanalei River included Japanese White-eye, House Finch, Spotted Munia, Barred Doves, Common Mynas and Melodious Laughing-thrush. Most of the other bird species listed above could be expected in the hau forest along the river as well.

WATERBIRDS OBSERVED: Opportunity for thorough survey of Hanalei NWR was limited by failure to secure permission for independent access from the USF&WS. Federal biologists cooperated by escorting us on a brief survey around the site in conjunction with other refuge business. The taro fields and portions of the surrounding forest were surveyed on foot. Portions of the Hanalei River were surveyed by boat. Although records were kept of bird

abundance and distribution, a review of more detailed and repetitive surveys by the Assistant Refuge Manager (Fred Zeillemaker), over the last three years, is of considerably more relevance in an evaluation of this habitat. Based on weekly count records, average populations for each month of the year were calculated. The following table represents population averages from the monthly data:

Monthly Count Averages (1974-1977)		Stilt	Coot	Gallinule	Koloa
1974	July - Dec. =	48	64	23	25
1975	Jan. - June =	26	20	38	17
1975	July - Dec. =	96	185	31	26
1976	Jan. - June =	33	42	40	28
1976	July - Dec. =	129	187	51	47
1977	Jan. - June =	118	227	50	41

High and Low Counts	Stilt	Coot	Gallinule	Koloa
high monthly average	151 (Sept.'76)	305 (Aug. '75)	57 (Nov. '76)	66 (Aug. '76)
low monthly average	9 (May '75)	4 (May '75)	18 (Sept.'74)	5 (June '75)

Hawaiian Coots were found to be widely distributed in Hanalei Valley at the time of our survey. In one taro field that had just recently been harvested, 34 coots were counted. Farmers both in and outside the refuge have complained about depradation on young taro by coots. Low fencing around freshly planted fields seems to deter the depradation (534). Coots were not common in mature fields that are covered with a dense mat of floating vegetation (azolla). The birds appeared to be more accustomed to the presence of humans than usual, but still sought cover in the taro when approached.

Coots have not been recorded nesting at Hanalei NWR despite intensive survey throughout the year by USF&WS refuge personnel (534). On typical years, coots leave the Hanalei area (presumably for nesting areas on Niihau or elsewhere) in January or February and return to Kauai in early summer with their young offspring. When the winter is abnormally dry most or all of the birds may remain on Kauai. The stimulus to leave Kauai is possibly the onset of the winter rain. In the absence of these rains, the wetlands on Niihau remain dry and unable to sustain nesting waterbirds (530). The winter of 1976-1977 exhibited this atypical pattern, and the data on coot population at Hanalei NWR reflect this. The data also demonstrate a significant increase in average monthly population since the beginning of weekly surveys three years ago.

The recorded count data do not provide a complete picture of coot numbers in taro fields elsewhere in the valley and in the river itself. As many as 38 coots have been counted on recent HDF&G/USF&WS counts at taro fields outside the refuge. We counted nearly a dozen coots in a brief and cursory examination of Hanalei River by boat. Coots and gallinule were inconspicuous within the dense hau forest that overhangs most of the river

bank. Zeillemaker (534) indicated that variations in numbers from day to day in the taro fields nearby might be explained by movements to and from habitat within the river. We found coots feeding on guavas and pecking into assorted flotsam that had collected on the upstream side of branches in the water.

Hawaiian Gallinule are less conspicuous, but occasionally more abundant, than coots at Hanalei NWR (534). Gallinule also cause damage to freshly planted taro. We observed at least three gallinule carrying taro shoots at Hanalei. Some of the taro shoots are used for nest building (534). Gallinule do not leave the refuge with coots and stilt each year, but instead find suitable nesting habitat within the taro fields. Recent count data reflect a striking increase in gallinule population under refuge management (pg). We only found two gallinule in our brief survey of lower Hanalei taro fields, but as many as five have been counted in these fields during recent HDF&G/USF&WS surveys. Although these birds are probably disturbed more by farmers in this area in the absence of refuge supervision, it is likely that actual numbers of birds are considerably higher than the count data indicate. We found the species to be common and widely distributed in the hau forest along the river (nine were counted). Several birds were feeding on floating guavas. It would be valuable to thoroughly survey this river habitat simultaneously with the taro fields, to determine what the percentage of the refuge coot and gallinule population inhabit the river.

Hawaiian Stilt are the most conspicuous of the endemic waterbirds that inhabit Hanalei Valley. However, unlike the other species, they are almost totally restricted in distribution to the artificial habitat created by taro fields. In years of normal rainfall patterns, most stilt leave the valley in January or February and head for breeding sites elsewhere on Kauai and probably Niihau (534). A small number nest each year within the Hanalei NWR. Like the coots, nearly all stilt remain throughout the winter and spring in abnormally dry years, presumably because wetland habitat on Niihau is dry (534). Stilt have shown a dramatic increase in population at Hanalei NWR under refuge management (pg157). They do not damage or eat the taro, and appear to tolerate the presence of taro farmers in the fields. They chase small fish and probably tadpoles in the shallow water, and probe for invertebrates in the mud. During our refuge survey, several stilt were feeding and probably nesting in former taro fields along the Hanalei River. We observed a six to eight week stilt chick hiding in the grass of a drainage ditch near these fields. These fields are partially flooded, but encroached by California grass.

Stilt are widely distributed throughout the taro fields of Hanalei Valley. A major deterrent to increased nesting activities outside the refuge is the problem of flooding. Movement of water in and out of fields can be controlled on the refuge to the best advantage of the birds, but outside the area there are no such controls. Predation levels by dogs and cats are probably less serious on refuge lands due to an ongoing program to control these animals.

Hawaiian Duck (Koloa) find suitable feeding, loafing and nesting habitat within Hanalei NWR and in neighboring lands. Since recent thorough surveys of the refuge have provided more accurate counts of this species, HDF&G biologists have suggested that Hanalei NWR is the single most important lowland habitat on Kauai for this species. Recent count records also indicate

that refuge management has significantly improved the conditions for this species (pg. 157). Zeillemaker (534) believes that Koloa seek remote locations on and off the refuge to nest. He also reported an apparent winter pairing between a hen Koloa and a drake Cinnamon Teal. Although the teal disappeared later in the spring, this observation and repeated observations of Mallards in the refuge taro fields, provides additional basis for concern regarding the possibility of interbreeding and consequent dilution of the native duck species.

Three Koloa were flushed from the California grass lining the river during this survey. Presumably the ephemerally flooded pasture land, both on and off the refuge, provides important habitat for Koloa as well. We did not see any Koloa in the lower Hanalei Valley taro fields, but they do appear in past count records for the area.

Records of HDF&G/USF&WS waterbird counts indicate that Black-crowned Night Heron ('Auku'u) are more common at Hanalei NWR than at any other wetland habitat in the State except Kealia Pond on Maui. The latter site has become particularly attractive to herons only since a fish farm was built at the pond. Herons are widely distributed throughout Hanalei Valley taro fields, so it is likely that the total numbers for the valley must range considerably higher than refuge data indicate. The species has been counted on virtually every weekly USF&WS census in the last three years, in numbers averaging greater than 30. Although the count is highly variable, often from day to day, it rarely dips below 15 birds and has ranged to as high as 90.

Herons probably nest in the valley, however, no nest observations have been reported. Taro farmers in the lower valley indicated that groups of herons frequently roost in trees along the lower ridge slopes south of their fields, but they were not certain if nesting had occurred. We observed herons in taro fields, where they were stalking and capturing tilapia, and presumably, frogs as well. At least eight herons were counted on our brief river survey. Most were perched on hau branches near the riverbank. The runoff from taro fields appeared to be an important attractant for these birds, presumably because of the fish and amphibians that would be found in this water. The main body of the river is too deep and the shore too steep in most locations to provide much assessible food for herons.

Of the many migratory ducks that have been recorded on earlier HDF&G/ USF&WS counts at Hanalei NWR, Pintails are by far the most common. Northern Shoveler, Mallards, Green-winged Teal and American Wigeon have been less common. The Shoveler count has averaged less than five per cent of the number of pintails observed. As many as 203 Pintails have been counted on recent winter surveys. Other ducks that have been noted on earlier HDF&G/USF&WS surveys at the area include Blue-winged Teal, Cinnamon Teal, Garganey Teal, Redhead, and Bufflehead.

The migratory shorebird list for Hanalei NWR is even more impressive, largely due to the recent repetitive survey efforts by the Assistant Refuge Manager (Fred Zeillemaker). Shorebirds find the recently harvested taro fields particularly attractive as a source of food. The weekly USF&WS count average for Golden Plover in the refuge during winter months is nearly 50 birds. Wandering Tattler, Ruddy Turnstone and Pectoral Sandpiper are far less common, but appear on nearly all count records during their wintering period

in the Islands. The rare and straggler species of shorebirds recorded at Hanalei NWR include Black-bellied Plover, Common Snipe, Bristle-thighed Curlew, Lesser Yellowlegs, Spotted/Common Sandpiper, Sharp-tailed Sandpiper, Dunlin, Western Sandpiper, Long-billed Dowitcher, Bar-tailed Godwit and Sanderling.

Great Frigatebirds and White-tailed Tropicbirds are occasionally seen over Hanalei Valley as well. Frigatebirds roost on Moku'ae'ae Island, off Kilauea Point, while White-tailed Tropicbirds are widely distributed along cliffs and valleys on the north shore of Kauai.

Cattle Egrets have been regular inhabitants of Hanalei Valley for several years, but the Hanalei-Kilauea region of Kauai has experienced an unexplained population explosion of this species over the last three to five years (534). Recent count records for Hanalei NWR show an average of nearly 50 birds per count with numbers occasionally exceeding 150. Many of the egrets on the refuge associate with grazing cattle, but drained taro fields are also attractive to these birds. On our survey, we found egrets in small numbers throughout Hanalei Valley. As long as there are grazing animals in the valley, egrets are likely to spend a portion of their time sharing the wetland taro with the true waterbirds.

HABITAT EVALUATION: Hanalei National Wildlife Refuge is one of two federal refuges on the island of Kauai. It provides habitat for four endangered waterbird species. The average populations of Koloa, stilt, coot and gallinule at Hanalei NWR represent, respectively, 1.2%, 3.9%, 5.1%, and 7.5% of the estimated statewide populations of these species (unpublished USF&WS data). All these species have responded to recent habitat management programs with impressive increases in population (pg. 157). USF&WS biologists estimate that populations of all four species would continue to increase more than 300 per cent if all the lowland areas within refuge boundaries were "fully developed" (325 actual acres of taro and ponds). Their estimates include less than ten per cent expected increase in carrying capacity (birds per acre of taro). Alternative habitat expansion programs of less magnitude are also being evaluated by the USF&WS.

There are several interrelated factors that will affect the outcome of habitat development at Hanalei. It is probably safe to assume that the carrying capacity for all four waterbirds at Hanalei has not yet been reached. However, the total needs (feeding, loafing and nesting habitat) are met at Hanalei NWR for only gallinule and Koloa. In the case of the Koloa, it is possible that availability of nesting habitat off the refuge has contributed to the recent population increase at Hanalei. Although stilt have nested in small numbers within refuge boundaries, we believe it is likely that most stilt and coots will continue to follow what appears to be traditional migration routes to nesting areas (probably Niihau). We further believe that it may be unrealistic to suggest that stilt and coot populations at Hanalei are limited only by the acreage and condition of taro fields. There is no evidence that traditional nesting areas can produce significantly greater numbers of young or that birds which normally leave Hanalei NWR each year can be attracted to nest in the refuge just by improving habitat conditions.

Problems with depradation by coots and gallinule on young taro plants suggests the need for some reevaluation of the compatibility of taro farming and waterbird habitat management. If populations of these species did increase by 300 per cent or more as the amount of taro in the refuge tripled, depradation problems may increase at an even greater rate. If taro shoots are a preferred food item of these species, larger flocks of these birds may move around the refuge following the planting schedule of the farmers. Depradation levels would probably increase at a greater rate than bird populations. Zeillemaker (534) reports that all growth stages of taro are used by Koloa, coot and gallinule, so it would be difficult to manage fields on a schedule that would alleviate the problem. However, one compromise would involve creation of suitable habitat within separate impoundments that are managed exclusively for birds, while continuing the development of additional taro fields as a source of food and potential nesting habitat. Zeillemaker (534) suggests that each farmer should be given 25% more land than he could farm, maintaining this extra wetland in a "natural" state. By rotating these areas with farmed ponds, exotic plants that would choke the unused areas could be controlled.

Recent increases in bird populations within refuge boundaries provide evidence of the value of managing taro to the best advantage of the waterbirds. At the same time, it suggests the possibility that waterbird use of extensive taro elsewhere in Hanalei Valley could be expanded through proper management. It is not likely that the refuge will expand beyond its present boundaries, so there will be little opportunity for direct control over off-refuge farming practices. Expanded farmer education is the most appropriate management tool on non-federal lands, but some attempt at predator control may also be possible.

POTENTIAL IMPACT OF DREDGE/FILL ACTIVITIES: Alternative development plans under consideration by USF&WS biologists for Hanalei NWR range from repair and maintenance of existing taro acreage to a "full development" plan, calling for as much as 325 acres of taro fields and other water impoundments. Even the least ambitious plan will require road repair, rehabilitation of main water supply ditches to taro fields, and construction of additional dikes, supply ditches, distribution ditches and discharge channels. Some former taro fields that border the operating farms could easily be improved as waterbird habitat by clearing of accumulating silt and vegetation.

In the absence of a rehabilitation effort, the existing water supply, containment and discharge capability of taro fields within the refuge will probably continue to deteriorate to an unworkable condition. Site improvements should proceed on a gradual schedule that permits the continued use of habitat by birds in the refuge during development. Alterations in water flow that would cause birds to abandon their nests or feeding areas should be avoided or scheduled to minimize the impact. Improvement of the present water transfer system and construction of additional fields and impoundments should be accomplished in a way that maximizes opportunity for rapid and efficient control of water levels and water quality. This will allow the refuge manager to provide the maximum amount and diversity of habitat and will facilitate prevention and control of potentially serious outbreak of avian disease.

An intensive limnological study of the taro fields would aid in the design of water impoundments of maximum value to birds. An investigation of the food habits and nesting requirements of the endangered birds in taro fields would provide complimentary management data. The potentially adverse impacts of increased turbidity associated with deposition of fill during development should be evaluated.

SITE MAP: Ka-lihi Wai Bog (not pictured)

LOCATION: Hanalei District, Kaua'i

TOPOGRAPHIC MAP: Hanalei

DATES OF SURVEY: 2 June, 1977

WETLAND DESCRIPTION: Kalihiwai forested bog lies at the base of a steep ridge (Kamookoa). The dominant tree in this marshy forest is ohia, but kukui and guava are also abundant. A dense ground cover of uluhe (false staghorn fern) makes it difficult to walk through the area. Several streams and smaller tributaries penetrate the forest, but the muddy soil underneath the uluhe cover is wet throughout. Much of the habitat is being used by cattle. A large reservoir (Kalihiwai Reservoir) is fed, in part, by a stream from the forested bog. The reservoir was not included in our survey.

NON-AVIAN WILDLIFE: Other than cattle, no terrestrial mammals were seen within the site, although the habitat was not covered extensively on survey. Presumably feral dogs and cats are present within the forest. No attempt was made to assess the aquatic fauna within the streams or little pools in the area. They were heavily silted and probably supported little aquatic life.

NON-WATERBIRD AVIFAUNA: Within the forest Shama, Melodious Laughing-thrush, Northern Cardinals and Japanese White-eyes were common. Birds observed in low numbers within cane fields near the site included Ring-necked Pheasants, Spotted Munia, Japanese Quail, Western Meadowlarks and Common Mynas. One female Erckel's Francolin was sighted.

WATERBIRDS OBSERVED: A single Koloa was sighted as it flew above the trees in the forested bog. The amount of suitable habitat for this species must vary considerably with rainfall, as the runoff from neighboring slopes would collect in pools and flood the flat lands bordering the small streams in the site. Thomas Telfer (530) reported that he had flushed small flocks of Koloa from this forest on several helicopter trips over the area, but he was unable to provide any estimate on how many ducks might inhabit the forest. One large flock of 60-70 Cattle Egrets was observed at the edge of the forested habitat. They were not close to cattle in the area at the time and they flew in a flock to nearby trees when approached by the observer.

Recent HDF&G/USF&WS waterbird surveys have included Kalihiwai River and Reservoir. As many as 13 coots have been counted on the Kalihiwai Reservoir. A single heron was observed at the reservoir during the August, 1976 survey. It is unlikely that either species would be found within the forested bog in significant numbers, although herons may search for food in Pohakuhonu Stream

before it reaches the reservoir.

HABITAT EVALUATION: The duration of this survey was insufficient to fully document the abundance and distribution of Koloa within this large forested site. The cover is so dense and the birds of this species are so inconspicuous that it is doubtful than an accurate assessment of habitat use could be made. Based on the earlier observations of HDF&G personnel, it is reasonable to assume that Koloa are widely distributed and possibly breed along stream courses through the site. Continuing use of the open portions of the forested bog by cattle may increase the silt load of water moving through the site, but this adverse impact on potential duck habitat may be compensated for in part by the increased fertility of water.

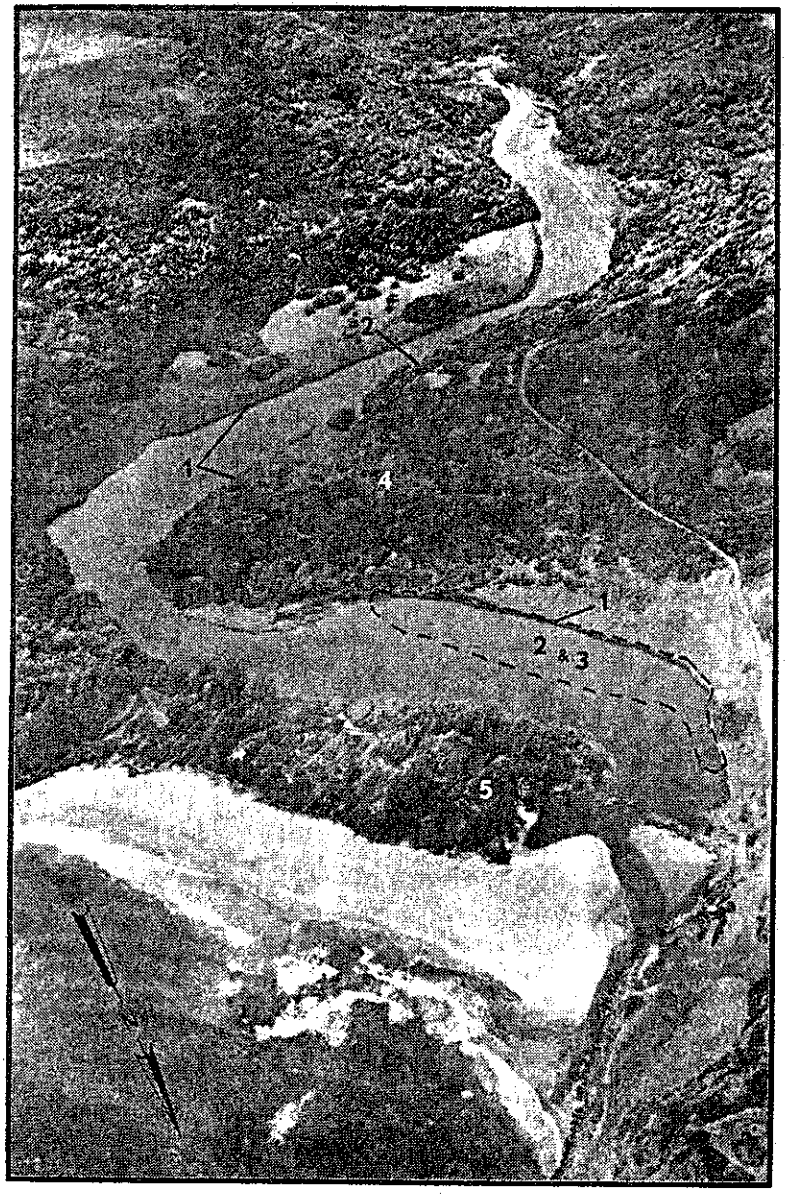
POTENTIAL IMPACTS OF DREDGE/FILL ACTIVITIES: Although use of the forested site by waterbirds is probably limited, any project involving significant alteration of water path or flow through the site should be evaluated for its potential effect on Koloa. The effects of increased silt load would probably be felt within the forested bog and possibly in Kalihiwai Reservoir as well. It is likely that the unstable soil conditions and dense vegetation will make this site unattractive for construction in the near future.

SITE NAME: Kī-lau-ea Valley

LOCATION: Hanalei District, Kaua'i

TOPOGRAPHIC MAP: Anahola

DATES OF SURVEY: 20 May, 23 July, 1977



1. bulrush fringe
2. coots observed
3. gallinule observed
4. grazing livestock
5. ironwood forest

WETLAND DESCRIPTION: The lower reaches of Kilauea Stream open into a large estuarine area, although flow to the ocean is partially restricted by an extensive sand bar. Ironwood forest separates the main body of the estuary from the beach below. The lower stream is lined for much of its length with a thin fringe of bulrushes, backed by flat grasslands that are probably flooded during periods of high stream flow. Extensive growth of hau trees reach the edge of the stream at several points along its length. The water along the shore at the first major bend in the stream is four feet or more in depth at the bulrush edge. The bottom is soft mud at this point, turning to a firm sand bottom closer to the estuary mouth. The thin fringe of bulrushes attests to the relatively steep edge of the estuary for much of its length.

NON-AVIAN WILDLIFE: Fish we observed in the lower estuarine portion of the stream course included tilapia, aholehole and mullet. Some young boys were laying gill nets in the estuary as we left the site, but we were unable to discover what they were attempting to catch. Presumably 'o'opu and other fishes that regularly move between salt water and fresh water are regular occupants of the estuarine portion of this site. Less than a dozen cows and horses were grazing on flat grassland behind the bulrushes. Residents of the valley are all living upstream of the estuary, so it is not surprising that dogs were not seen during the surveys. Some pets may visit the area with people that come to fish or picnic at the stream mouth.

NON-WATERBIRD AVIFAUNA: Common Myna, Spotted Dove and House Finch were common species in ironwoods and hau trees along the stream. Roosters (possibly Jungle Fowl) were heard crowing higher in the valley, but these may have been associated with residences. A wide variety of other exotic birds probably inhabit the forested slopes of this valley (Japanese White-eye, Shama, Melodious Laughing-thrush). Hawaiian Owls are seen regularly in the abandoned cane and corn fields just outside this valley to the west (534).

WATERBIRDS OBSERVED: The site was surveyed for waterbirds from the road to the beach and by boat in the stream. Eight coots were observed on the May survey and four in July. All were feeding within open water of the lower estuary or were seen at the edge of hau thickets above the first turn in the stream. Feeding birds were diving for extended periods in water that was at least 3 feet deep. Two gallinule were feeding at the edge of the lowest bulrush patch in May, and others were heard calling from within the same patch in July. No evidence of nesting was noted. Small numbers of Auku'u (four or less) were seen on both survey days. All were roosting in hau trees along the stream. Two Koloa were observed on the May survey, but none were seen in July. There is considerable grassland along the stream where birds of this species could nest successfully, although grazing livestock probably inhibit nesting. One Wandering Tattler was feeding at the stream mouth in May. A maximum of 12 Cattle Egret were observed in the flat grasslands bordering the stream on both survey days, and were closely associated with cows and horses.

Kilauea estuary has been included in HDF&G/USF&WS semi-annual waterbird surveys only in the last three years. No more than two coots and two Koloa have been noted on these surveys, although the present study suggests that a boat is required to enable thorough coverage of the site.

HABITAT EVALUATION: In many respects, the Kilauea estuary is similar to Lumahai Stream valley to the west. Yet the latter site appears to support a far greater number of waterbirds, particularly coots. Water in the Kilauea estuary appeared to be flowing at a more rapid rate, perhaps explaining the comparative lack of submergent and floating vegetation. Deeper water at the shoreline results in less food available for waterbirds, particularly the surface feeding or shallow-diving forms. Bulrush habitat is limited to a narrow growth along the shore at Kilauea estuary, and even this habitat has been infringed upon by cattle and horses in the area. Although coots may nest in the bulrush patches, fluctuating water levels in the estuary could limit productivity by flooding nests of this species. The estuarine portions of Lumahai and Kilauea streams are both relatively undisturbed by surrounding development or land use, but Kilauea is subjected to frequent visitation by fishermen and other beach users. The proximity of the parking area to the best bulrush habitat may inhibit use by native waterbirds. The shores of the stream mouth provide potential shorebird (and stilt) feeding habitat at low tide, but this too would be inhibited by human use of the area. This estuary is close to a large seabird nesting area at Kilauea Point. It is not believed that seabirds play a significant role in the ecology of the estuary, although Great Frigatebird and Black Noddy may drink or feed in the open water.

POTENTIAL EFFECTS OF DREDGE/FILL ACTIVITIES: Deposition of fill materials into the stream course upstream of the estuary probably would have only temporary impact on the aquatic ecosystem during periods of normal stream flow, as there is rapid stream movement and interchange with the ocean. This regular interchange of water is important to the continued distribution and recycling of nutrients in the estuary. The effects of increased turbidity beyond that naturally occurring could be serious during low water. On the other hand, silting of the stream edges would increase the growth of bulrushes, at least temporarily. Construction on lands along the estuary shores would increase disturbance of waterbirds at the site, but habitat could be improved through the impoundment of water and increase in the amount and distribution of shallow water feeding areas.

SITE NAMES: Anahola Valley

LOCATION: Ka-wai-hau District, Kaua'i

TOPOGRAPHIC MAP: Anahola

DATES OF SURVEY: 21 May, 23 July, 1977

1. bulrush fringe
2. pasture
3. ironwood forest
4. bridge

WETLAND DESCRIPTION: Anahola Stream Valley is similar in many respects to Kilauea and Lumahai Valleys, although the stream course to the sea is more direct, and the estuarine portion of Anahola is considerably smaller. The bottom lands bordering the stream show evidence of flooding during high stream water and heavy lowland rains. The water downstream of the bridge is lined with a narrow bulrush fringe, much like the Kilauea estuary. Surrounding pasture lands are dominated by California grass and show evidence of more intensive grazing in the past. Housing development in the valley is concentrated south of the stream, although there are some small farms along the stream, just below the highway bridge. An extensive ironwood forest borders the south edge of the stream near the beach. At the time of survey, contact between the stream and the sea was limited to a small meandering watercourse across the sand. The channel to the sea probably widens considerably during heavy rains.

NON-AVIAN WILDLIFE: No attempt was made during survey to sample aquatic organisms downstream of the road, although it is assumed that fauna of all the estuaries along the north shore show many similarities. Bullfrogs were heard and large tadpoles were abundant in the shallow stream waters below the highway bridge. Cows were in pasture at several points along the stream. Dogs were observed in farms near the highway and along the southeast shore of the stream.

NON-WATERBIRD AVIFAUNA: The list of recorded birds included Shama, Melodious Laughing-thrush, Japanese White-eye, Common Myna, House Finch and House Sparrow. All but the first two were common throughout the developed portions of the valley. Small flocks of Spotted Munia were also seen along the stream.

WATERBIRDS OBSERVED: No stilt were seen during survey of Anahola, but it is likely that they visit temporarily flooded pastures and small taro fields in the upper portions of the valley. One coot was observed feeding among shore grasses in the stream below the highway bridge. The species is probably more widely distributed among bulrushes in the estuarine area not covered by boat. One gallinule was observed in the lower area in May. One was also recorded during a HDF&G/USF&WS waterbird count in January, 1976. A single Koloa was flushed from a wet pasture near the stream during the May survey. It is likely that this and other native waterbirds make use of flooded pastures after heavy rains. Egrets were observed in small numbers in association with cattle and horses at several locations in the valley. Although the surveys were made during summer months, two migratory shorebird species of interest were recorded. A Wandering Tattler and a Black-bellied Plover were observed on the sand near the river mouth on 20 May, 1977. Two 'Auku'u were observed in flight over the stream mouth on the same day.

HABITAT EVALUATION: The extensive but narrow fringe of bulrush along the lower length of Anahola Stream provides cover and feeding habitat for native waterbirds, but several interrelated factors make this area relatively insignificant by comparison to other estuaries on the north and east shores of Kauai. The straight stream course has carved out a drainage that is relatively deep on its shores and lacking in still water characteristic of meandering water courses. There is little development of submergent or floating-leaved vegetation as well. Access to the stream shore by cattle is unrestricted for much of its length, and disturbance in the estuarine portion of the stream is greater by virtue of nearby development than in

most other estuaries nearby. Although all native waterbirds may visit the site, it is doubtful that this valley, in itself, is of long-term significance to any wetland bird species. It is, however, one of several sites that, together, provide a diversity of habitat for these species.

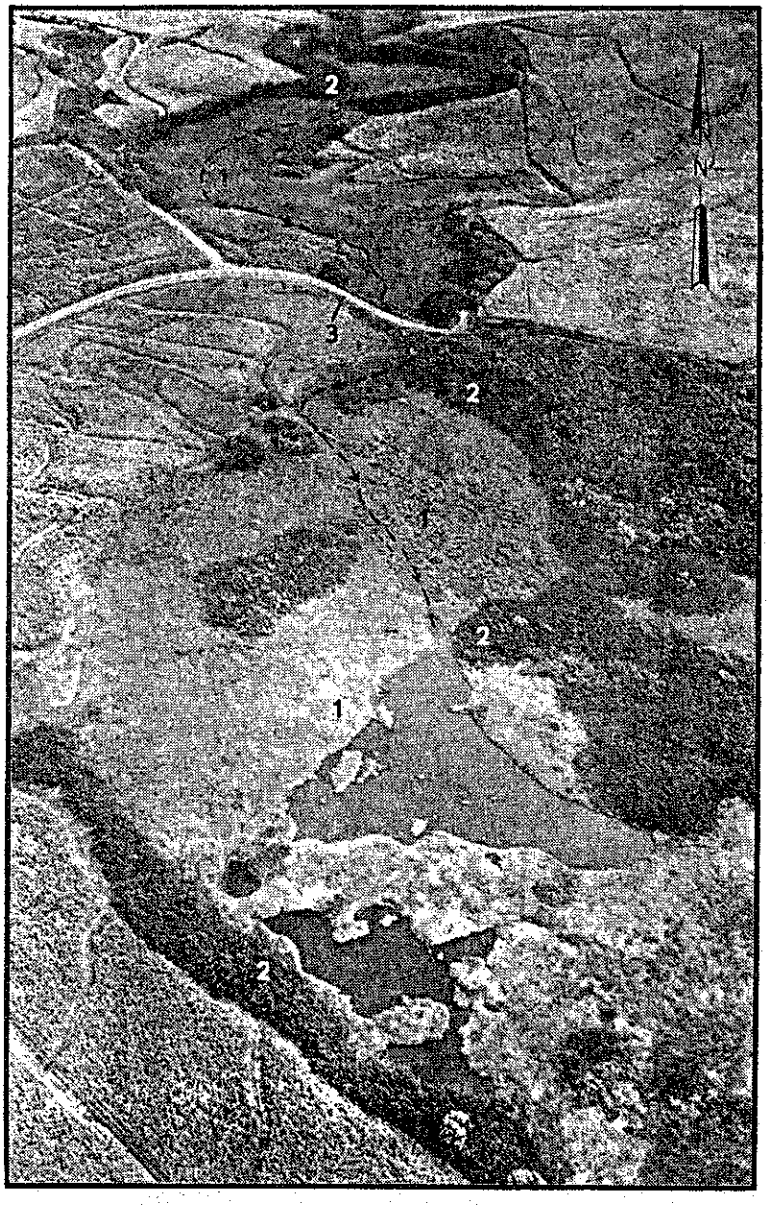
POTENTIAL EFFECTS OF DREDGE/FILL ACTIVITIES: If the jurisdictional boundary for this "wetland" is extended to include pasture lands bordering the stream, it is likely that dredge/fill activities in the valley will come up for review in the future. Open lands along the stream may be considered for aquaculture and other projects that will require some stream diversion and water impoundment. Although it is probably not justified by low populations of waterbirds and existing disturbance levels, there is considerable room for improvement of waterbird habitat by expansion of taro farming or other forms of wetland agriculture. The pasture lands along the stream show evidence of earlier diking and water channelization, probably associated with taro or rice crops earlier in this century. Any increase in the amount of available shallow water feeding habitat for waterbirds would more than compensate for the short term adverse impact of increased stream siltation and water diversion.

SITE NAME: Ka-pa'a Marsh

LOCATION: Ka-wai-hau District, Kaua'i

TOPOGRAPHIC MAP: Ka-pa'a

DATES OF SURVEY: 19 May, 21 July, 1977



1. flooded grassland
2. hau
3. cane haul road

----→ stream course

WETLAND DESCRIPTION: This wetland habitat, located due west of Kapaa, is a drainage basin of a small fresh water stream that includes extensive flooded grassland. It is surrounded on all sides by sugar cane fields, and access is only by cane haul roads. Large bodies of open water are scattered through grass fields (primarily California grass), also permeated by underlying water. A dense overgrowth of hau separates cane fields from flooded marsh. There is a slow detectable flow within the small stream as it crosses under the cane haul road, but water in the open grasslands does not appear to be moving. There is very little surface or submergent vegetation, and only very localized patches of emergent bulrush and other sedges. The marsh is fed by the stream and by extensive cane field runoff. Presumably the extent and location of open water changes appreciably with variations in rainfall. Depth in the stream where surveyed varied from 1-2', although open water areas within the open grasslands were as deep as 5-6' with a very soft mud bottom. Access to these areas was made very difficult by equally soft mud within the surrounding hau vegetation.

NON-AVIAN WILDLIFE: Bullfrogs and Japanese Wrinkled Frogs (Rana rugosa) were observed in small numbers in the stream drainage. Various small fishes, including mollies and tilapia, were observed in the stream and in the shallow water within the hau forest. Water in the open grasslands was too turbid to detect other aquatic species. Unidentified small molluscs were also seen in the stream.

NON-WATERBIRD AVIFAUNA: Birds observed in the hau forest and along the stream drainage included Shama, Melodious Laughing-thrush, House Finch, White-eye, Barred Dove, Spotted Dove and Spotted Munia. All were common except the Melodious Laughing-thrush which was sparsely distributed. Ring-necked Pheasants are common in cane fields and neighboring grasslands on Kauai and are surely found in this area. One Hawaiian Owl (Pueo) flew from a perch in the border hau forest when approached during the July survey.

WATERBIRDS OBSERVED: Only two waterbird species were recorded at the site during this study. A single 'Auku'u flew from a hau tree on the edge of the stream during the May survey. Gallinules were heard during May and four were seen during July within pockets of water in California grass. We were unable to walk to the largest areas of open water, and we were unable to get a good visual perspective of the site while on the ground. Gallinule, coots and Koloa could all have been present during survey, but there was no way to be certain. Thomas Telfer (HDF&G District Biologist) was unaware of the extent of open water in this area until he was shown the accompanying aerial photograph. He indicated that the site had not been included on HDF&G/USF&WS semi-annual waterbird counts. During a botanical survey in June, 1977, unidentified "ducks" were observed at this site (95).

HABITAT EVALUATION: Although our survey coverage was inadequate to derive an accurate waterbird count, it is unlikely that the marsh site supports a large number of waterbirds on a long-term basis. Water outside the stream was very turbid and supported little obvious submergent or floating-leaved vegetation. The stream, on the other hand, was surprisingly clear. Open water ponds may be attractive to migratory ducks, but it is doubtful that they would find sufficient food to stay in the area for a significant length of time. Also, the condition of the habitat probably varies radically with stream flow and irrigation schedules in neighboring cane fields. Pesticides

or other chemicals used on cane would drain directly into the flooded grassland and stream, and could inhibit waterbird use or affect birds more indirectly through the food chain. The Kapaa topographic map, made in 1963, indicates the greatest extent of marsh vegetation upstream of the major cane haul road. However, at the time of this survey, virtually all the open water was downstream of the cane haul road (see photograph).

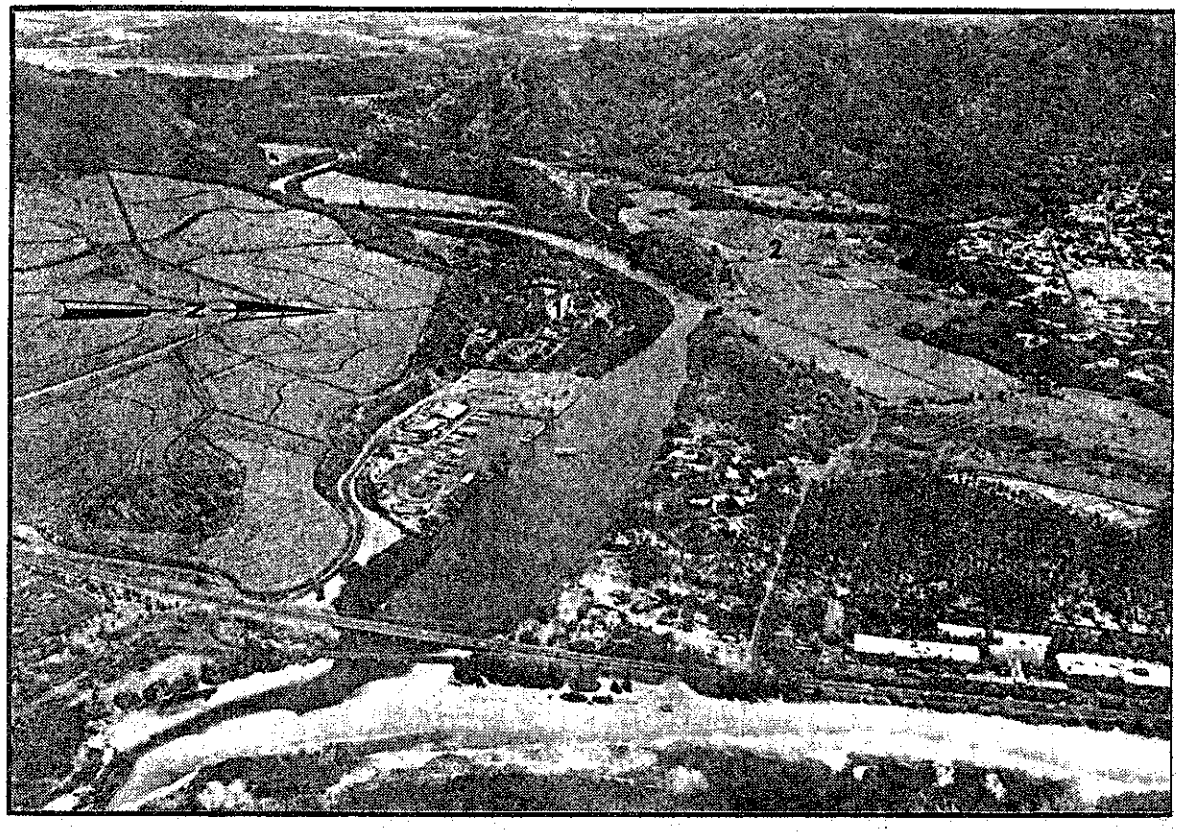
POTENTIAL EFFECTS OF DREDGE/FILL ACTIVITIES: It is not likely that the stream or flooded grassland areas will be altered by dredging or filling operations, as long as the surrounding land is managed solely for cane production. The wetland itself is obviously too wet (at least seasonally) to grow sugar cane. Drier portions of the wetland site are used for cattle grazing but this area appears to be marginal for that purpose. As much of the wetland area is already heavily silted, it is unlikely that deposition of dredge materials into the open grassland would have an adverse impact on any waterbirds that might use the area. On the other hand, low-lying grasslands could be improved as waterbird habitat through dredging for water impoundment. In the event that an extensive dredge/fill operation is proposed, a more exhaustive survey (by boat) of the open water portions of the site would be required.

SITE NAME: Wai-lua River /Opaekaa River Valley

LOCATION: Ka-wai-hau District, Kaua'i

TOPOGRAPHIC MAP: Ka-pa'a

DATES OF SURVEY: 16 May, 18 May, 31 May, 23 July, 1977

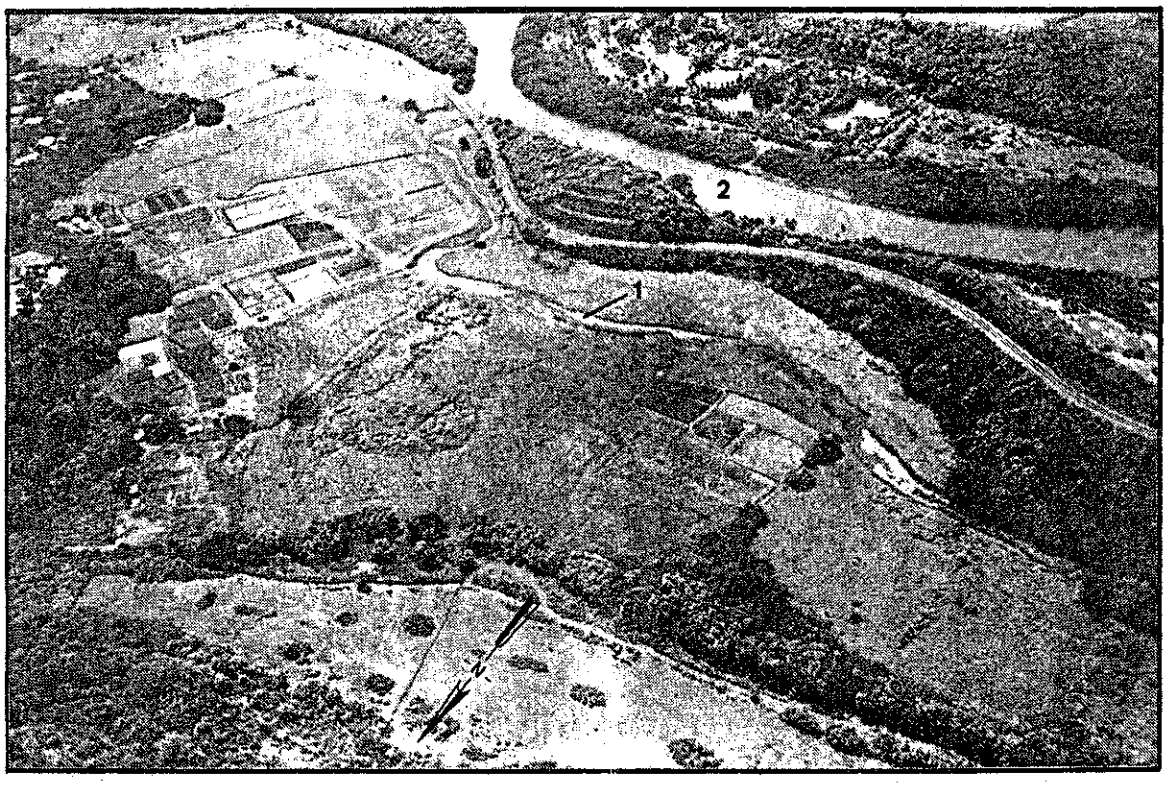


1. Paradise Pacifica

2. Opaekaa taro fields & pastureland

Paradise Pacifica.

Opaekaa taro fields & pastureland. 1. Opaekaa Stream; 2. Wailua River



WETLAND DESCRIPTION: Wailua River and Opaekaa Stream run parallel to one another, separated by a narrow ridgeline, until the smaller stream joins the river at a point approximately 1/2 mile west of the river mouth. Opaekaa Stream is bordered for most of its length below Opaekaa Falls by extensive pasture land, some of which is flooded during heavy rains. Most of this flatland was in rice production early in the century (406). Less than ten years ago the site was virtually all pastureland (406). More recently, some experimental taro fields have been constructed. Flat pasture lands border the downstream portions of Wailua River although most of the sloping hillsides are heavily forested. A dense overgrowth of hau lines the river's edge for much of its length. The shores of the river drop steeply towards the center. The lowest flatland along Wailua River, once a tidal marsh, was modified considerably in the 1960's by the construction of a tropical botanical garden (Paradise Pacifica), containing seven shallow ponds. A portion of the undeveloped marshlands can still be found adjacent to the Paradise Pacifica boundary.

NON-AVIAN WILDLIFE: Although we did not survey the aquatic fauna, one can assume that the aquatic fauna in the downstream portion of Wailua River is probably similar to other estuaries on the coast of Kauai. Presumably tidal influence extends beyond the portion of stream covered by this survey. Tilapia and mollies were observed within the Opaekaa taro fields and within the ponds at Paradise Pacifica. Bullfrogs, toads, gastropod molluscs, and a variety of aquatic insects were also present in both sites. Mules, cows and horses were all grazing in pasture land surrounding Opaekaa taro fields. Dogs and cats were seen in this area as well.

NON-WATERBIRD AVIFAUNA: Several bird species were abundant in areas where human activity was intensive. These included Common Myna, Japanese White-eye, House Finch, House Sparrow and Barred Dove. Western Meadowlark, Ring-necked Pheasant and Spotted Dove were less common and confined, for the most part, to open pastureland. Within hau forest bordering the streams and in other forested lands Shama, Melodious Laughing-thrush and Northern Cardinal were common. All of these species appeared to be unusually common within Paradise Pacifica, although this probably reflects their tameness rather than actual numbers. We found it easier to approach these birds within the botanical garden than is usually the case in areas less frequented by people. Individual Melodious Laughing-thrush chicks were seen begging from adult birds on a least three occasions. Chickens were observed feeding alongside coots, gallinule and Koloa in fallow Opaekaa taro fields. Whether or not these were domestic or feral birds was not determined.

WATERBIRDS OBSERVED: The various wetland areas in the Wailua-Opaekaa River bottoms provide a diversity of waterbird habitat. We surveyed the site by visiting the taro fields along the Opaekaa Stream, traveling on the Wailua River Fern Grotto cruise, and by two foot surveys throughout Paradise Pacifica. Until recently, HDF&G/USF&WS count records for the area have included only the "Opaekaa Valley Rice Center". Paradise Pacifica has been included on these surveys in the last two years only.

Coots were common within Opaekaa taro fields and in Paradise Pacifica, but very few were seen within Wailua River or Opaekaa Stream. During our July trip, ten coots were feeding within taro fields, particularly in fields that were either newly planted or left fallow. Six were counted within

Paradise Pacifica on the same day. No courtship behavior or other evidence of nesting was noted, and no immature birds were observed. Coots in Paradise Pacifica were confined to open water ponds, in contrast to gallinule that seemed to prefer smaller bodies of water partially choked with water lilies. Coots dove frequently to the bottom of the ponds, feeding on algae and possibly invertebrates.

Gallinule were widely distributed in the river bottoms. Three were seen in May as they fed within the overhanging hau on Wailua River. It is likely that several birds are undetected in this habitat. On the same day, a pair of gallinule with two downy young was seen in the Opaekaa Stream opposite the upper taro fields. They were all feeding within emergent California grass along this slowly flowing stream. Patches of bulrushes in this area provide the most likely nesting sites for this species. In July, three adult gallinules were observed in the taro fields, feeding alongside coots and Koloa with no apparent interaction. This species has often been absent on earlier HDF&G/USF&WS counts of the Opaekaa Valley Rice Center.

It was Paradise Pacifica that proved most suitable for gallinule during our survey. Fifteen were counted at the site in May and 17 in July. An earlier HDF&G/USF&WS survey of Paradise Pacifica (8/3/75) recorded 21 gallinule. At least four different broods, of widely varying age, were represented in our July survey. However, no equal age broods of more than two chicks were seen. In two different ponds, adult gallinule were seen feeding both downy young and older juvenile birds, suggesting that they had adopted young from other broods or had nested more than once in a single season. Before the botanical gardens are opened in the morning to visitors, several gallinule were seen foraging on the freshly cut lawns. Others were swimming in ponds (all but the largest pond) or walking across the water lilies in search of food. One bird was ripping into a lily flower bud with its bill. Both gallinule and coots were tamer than in any other place where we have observed these species. It is not likely that the well-manicured vegetation surrounding the ponds provides much suitable nesting habitat for gallinule, but the undeveloped marshlands adjacent to the facility probably provide a convenient refuge for nesting only a short distance from abundant food within Paradise Pacifica.

Hawaiian Stilt were not seen at Paradise Pacifica, nor along Wailua River. There is little or no suitable feeding habitat for this species in those areas. Stilt appear only on recent HDF&G/USF&WS count records for Opaekaa Valley, but in low numbers (3 or less). We have observed stilt on several earlier visits to the Opaekaa taro fields, and during this survey. Seven stilt were feeding together in one taro field on our July count.

No more than ten Koloa were observed on our surveys of this site, and none were sighted outside the Opaekaa taro fields. All Koloa sightings were of feeding or flying birds. Six Koloa were browsing within a fallow taro field, alongside coots, chickens and gallinule. Two others were feeding within emergent California grass in a drainage ditch when first observed. One apparent "courtship" flight was observed in May, but no other evidence of nesting was noted. The Opaekaa pasture land was one of the last rice growing areas in the State, but was largely idle pasture land at the time of an earlier Koloa survey by Swedberg (406). He noted that Koloa were common

in the area up until rice growing was discontinued. He also reported having sighted a hen with four downy young in 1966. A comparison of our more recent photograph with one that appeared in Swedberg's earlier publication reveals that expansion of taro farming in this valley has created extensive habitat that was not available to waterbirds a decade ago. Koloa survey data gathered by HDF&G biologists between 1970-75 show an average of only 0.4 birds per trip to the site.

Black-crowned Night Heron were observed at widespread locations within this large site during both visits. They were feeding within taro fields and in smaller ponds within Paradise Pacifica. Birds in the latter site had apparently accomodated somewhat to the presence of people, because they were much tamer than usual. A maximum of seven birds was recorded on our July survey that included taro fields and the botanical gardens. The depth and steep shoreline contours of Wailua River provide little feeding habitat for this species. Cattle Egrets were abundant in the Opaekaa pasture lands during our surveys. Over 130 egrets were counted in May and nearly 80 were seen in July. All were associated with cattle and other livestock.

Recent HDF&G/USF&WS surveys in the Wailua River-Opaekaa area did not record any migratory waterfowl or shorebirds in this habitat. However, it is likely that the more common migratory waterbirds visit the area, particularly the taro fields, in winter months. A Horned Grebe was sighted and photographed on the Wailua River in April (534) and was recorded again during our survey. As far as we are aware, this represents the first record for the species in Hawaii.

HABITAT EVALUATION: The draft HWRP (346) lists the Opaekaa-Wailua Wetlands as a "secondary area" and recommends acquisition of lands that are not already owned by the State and development of a State waterbird sanctuary. The value of the site for waterbirds when it was in rice production, and the apparent increase in waterbird use within recently constructed taro fields, suggests that the site could become of considerable importance to Kauai's waterbirds if managed effectively. Water supply does not appear to be a problem. Predator control would be required, although this could be accomplished in part through construction of a moat around the sanctuary. Although habitat could be developed specifically for waterbirds, it may be more economically feasible to improve the site through a cooperative taro farming program, as is now in progress within Hanalei National Wildlife Refuge.

Across the river, Paradise Pacifica provides important habitat for a variety of waterbirds. We observed more gallinule per acre of habitat in Paradise Pacifica than in any other habitat in the state. It is entirely man-made, and through its regular operation, the waterbirds in the area are subject to almost continual presence of humans. A great deal about gallinule habitat management could be learned from a thorough study of the aquatic ecosystem in the ponds at Paradise Pacifica. It would be valuable to determine why so many gallinule are attracted to the site but also why fledging success appears to be so low. Certainly there is little protection against predation outside the ponds, and the marshland habitat adjacent to the site may be even more vulnerable.

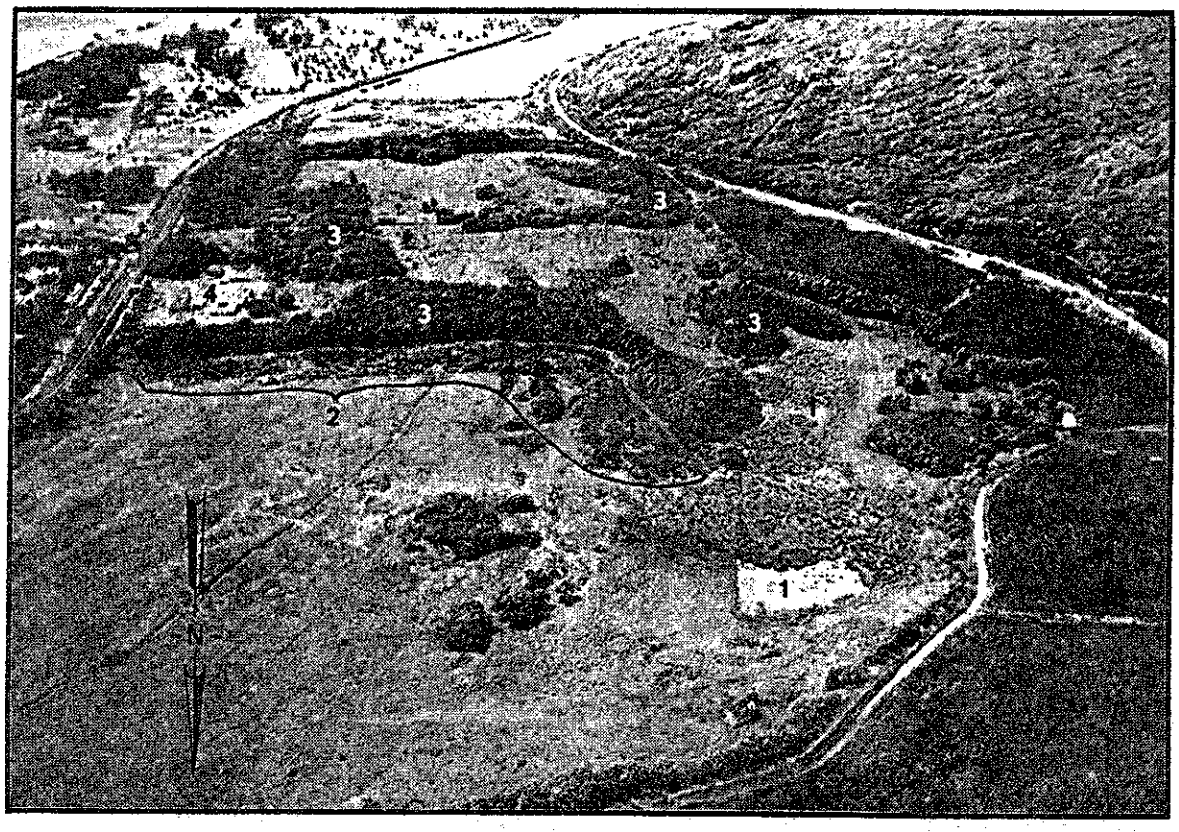
POTENTIAL IMPACT OF DREDGE/FILL ACTIVITIES: In its present state, Opaekaa pasture land is of little value to waterbirds, except when heavy rains provide ephemeral feeding habitat. Waterbird use of Opaekaa Stream is inhibited by encroaching grasses, and by water that stagnates during periods of low flow. Dredging of the stream drainage to clear vegetation and restore flow would improve conditions for waterbirds, as would the creation of additional artificial habitat on unused pasture lands. Dredging of a moat around the site would aid in predator control. Shallow water impoundments could be constructed where grassland now stands. Similar pasture lands along Wailua River could be improved as waterbird habitat in the same way. The possibility of artificial waterbird habitat development in marshland adjacent to Paradise Pacifica could be investigated. A cooperative waterbird management program should be initiated with the owners and staff of Paradise Pacifica.

SITE NAME: Wai-lua Jail Marsh

LOCATION: Lī-hu'e District, Kaua'i

TOPOGRAPHIC MAP: Ka-pa'a

DATES OF SURVEY: 18 May, 21 July, 1977



1. open water
2. primary bulrush area
3. hau
4. Wailua Jail

WETLAND DESCRIPTION: Although the Kapaa topographic map shows a large wetland area near the Wailua Jail, the site is now largely pasture. Yet stagnant water permeates much of the grassland, particularly beyond the hau forest, in the northwest corner of the site. Water was generally less than one foot in the wettest portions of the site, and the surface scum and stench attested to the lack of water movement. Dense growth of bulrushes, and water to 3' or more, mark the areas of deeper, more permanent marsh north of the jail. The dominant tree around the jail and bordering most of the wetland is hau. Pasture lands on both sides of the marsh area probably flood in heavy rains, but probably drain quickly into the areas of stagnant water. Sloping cane fields border the pasture on all sides. The site is grazed by cattle, but the landowner indicated that it was only marginal for that purpose because the water is too brackish (526).

NON-AVIAN WILDLIFE: Bullfrogs and toads were seen at the edge of the marsh bordered by hau forest. They were less common in the most stagnant portions of the site. Tilapia were common in the wetland, and several were found floating dead in the surface scum in stagnant water.

NON-WATERBIRD AVIFAUNA: Birds observed within the hau forest on the site included Shama, Melodious Laughing-thrush, Northern Cardinal, House Finch and Common Myna. Greater Necklaced Laughing-thrush were also heard and seen in the forest, but were less common than the other species. Spotted Munia, Western Meadowlark, Barred Dove and Spotted Dove were common species in the open pasture. Frigatebirds passed over the site during the survey, but it is unlikely that they visit the area to feed or drink.

WATERBIRDS OBSERVED: 'Auku'u and Cattle Egret were observed on both visits to the site. All the 'Auku'u were roosting in hau or in other trees on site. Three 'Auku'u were seen on the May visit in the area of stagnant water and one in the deeper marsh. Although the abundant hau growth could have supported nesting activities in the area, it is not likely that the available feeding habitat could sustain a large population of herons on a long-term basis. Tilapia, however, may be more easily captured by 'Auku'u when shallow pools are left after periodic rainfall.

Koloa were observed (maximum=7) within the marsh, as they flushed as individuals or pairs from the base of bordering hau trees. They circled several times after taking flight but did not return to the area. Use of this site by cattle would inhibit nesting in the area where these birds were seen. If Koloa did nest here, it is likely that it would go undetected as the marshy areas of the pastureland are rarely visited by anyone, including ranch personnel (529). Although "Wailua Jail Swamp" was included in the 1976 HDF&G/USF&WS waterbird counts, no waterbirds were counted at this site.

HABITAT EVALUATION: This site is currently of minimal value to waterbirds due to the relatively small amount of suitable nesting or feeding habitat, and the stagnant condition of marsh water. Access to the best marsh areas by cattle also inhibits the growth of plants important as cover and nesting sites. The canal along Kuhio Highway that appears to drain the site was also filled with very stagnant water during May survey. An irrigation water drainage canal follows the perimeter of the marsh and pasture, but it is possible that some cane runoff may enter the marsh itself. Infiltration of brackish water into the site is probably due to excessive pumping of ground water for irrigation of nearby sugar cane fields and a golf course across the highway.

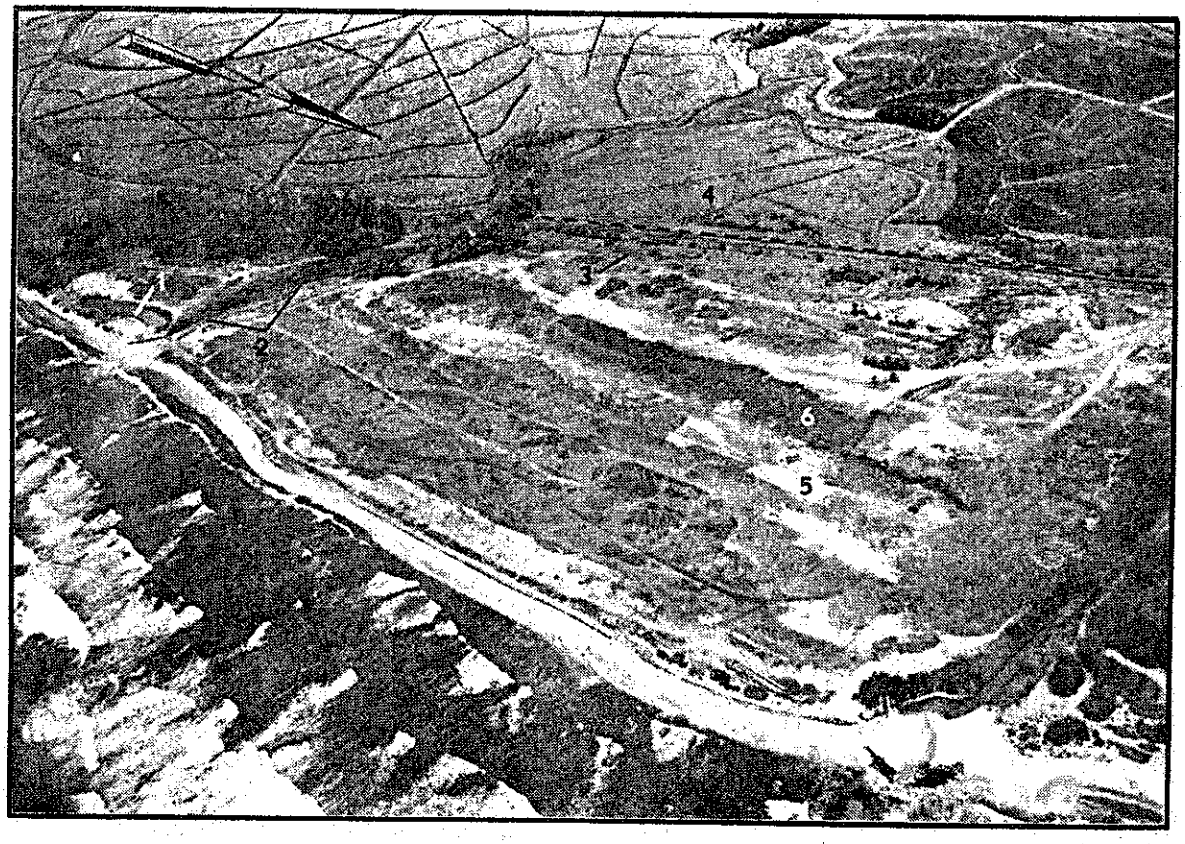
POTENTIAL IMPACT OF DREDGE/FILL ACTIVITIES: If all marshland at this site was completely filled with dredged material, it is unlikely that there would be little, if any, long term impact on Kauai's waterbird populations. On the other hand, waterbird use could be improved considerably by clearing of encroaching vegetation and improvement of water quality. Restoration of efficient drainage would be necessary to eliminate stagnant water and develop a diverse aquatic macrofauna and flora. On-going construction activities in the Wailua Jail area are of little significance to waterbird habitat elsewhere on the site.

SITE NAME: Ka-wai-loa Flats (Hanamā'ulu)

LOCATION: Lī-hu'e District, Kaua'i

TOPOGRAPHIC MAP: Ka-pa'a

DATES OF SURVEY: 17 May, 21 July, 1977



1. brackish pond
2. canal with hyacinth & bulrush
3. bulrush patch
4. koloa observed (17 May)
5. stilt observed (17 May)
6. fill dirt mounds

- - - - - canal (along old railroad grade)

WETLAND DESCRIPTION: Most of this site is only a wetland ephemerally, after prolonged rains. Water collects in depressions on the flat lands, but runoff and evaporation dry the site quickly, at least during the months of this survey. More permanent water is found in irrigation drainage canals, most of which are choked with California grass, bulrush and water hyacinth. An additional brackish pond at the south end of the site drains directly into the ocean. The source of this water is unclear. Scattered stands of ironwoods and hau border the large area. A small number of horses and cows are grazed on the site, and several fishermen were visiting the beach area during our survey. A long mound of bare earth material suggests that some development and fill activity is underway or anticipated, but this was not confirmed on survey.

NON-AVIAN WILDLIFE: Other than horses and cows at scattered locations in the site, no terrestrial mammals were observed. Dogs and possibly feral cats could probably be found during prolonged survey. No aquatic life was apparent in the ephemeral rain pools during the May survey, and all of the water had evaporated before the July trip to the site. In contrast, the brackish pond in the south end of the area contained a dense population of mosquito fish (to 2") and tilapia (up to 7-8"). Bullfrogs, Japanese Wrinkled Frogs and toads were seen in the vegetated drainage canals.

NON-WATERBIRD AVIFAUNA: The open lands at this site provide relatively little habitat for birdlife. Western Meadowlark, Barred Dove and Spotted Dove were the only species that were common throughout the area. Several species were recorded in bordering forest (Common Myna, Mockingbird, Northern Cardinal, Melodious Laughing-thrush, Shama, House Finch and Japanese White-eye). Hawaiian Owl (total = 3) and Ring-necked Pheasant (including chicks) were seen on both trips to the site.

WATERBIRDS OBSERVED: The importance of rainfall patterns in creation of waterbird habitat at this site was illustrated by the difference in May and July surveys. In May, four Hawaiian Stilt were seen feeding in shallow pool on the open central portion of the site. Two Hawaiian Coots were flushed from a small body of open water at the downstream end of the main drainage canal (north end). Kridler (519) reports that residents near the site have seen young of both coot and gallinule in this area. Nearly 15 Koloa were flushed from wet pasture land west of the main site. There may have been more within the narrow canal that borders this pasture. Three Golden Plover and one Wandering Tattler were observed on the wet soil near the dirt mounds. None of these waterbird were observed on the July survey, by which time the standing open water had drained or evaporated. The July survey of pasture lands and neighboring canals was not as thorough as in May, but it was evident that the amount of suitable habitat was clearly reduced by lack of rain. Cattle Egrets were recorded on both survey days, but in small numbers (less than 10).

HABITAT EVALUATION: Suitability of Kawailoa Flats for waterbirds is,in large part, dependent on patterns of rainfall. Only the ditches that drain neighboring cane fields provide semi-permanent habitat. Encroaching vegetation (particularly California grass and water hyacinth) has eliminated some potential nesting and feeding habitat, although heavy winter rains probably open up these drainage channels. The reported (519) evidence of coots and gallinule

and possible nesting by Koloa in the canals and ditches suggests the need for more thorough survey in spring months. The brackish pond on the south end of the site is partially choked with water hyacinth. Despite the abundance of small fish and submergent vegetation, no waterbirds were seen at this site. The open flat lands provide temporary waterbird habitat because of the tendency to catch rain water, but they are probably of little long term significance to the abundance and distribution patterns of waterbirds on Kauai.

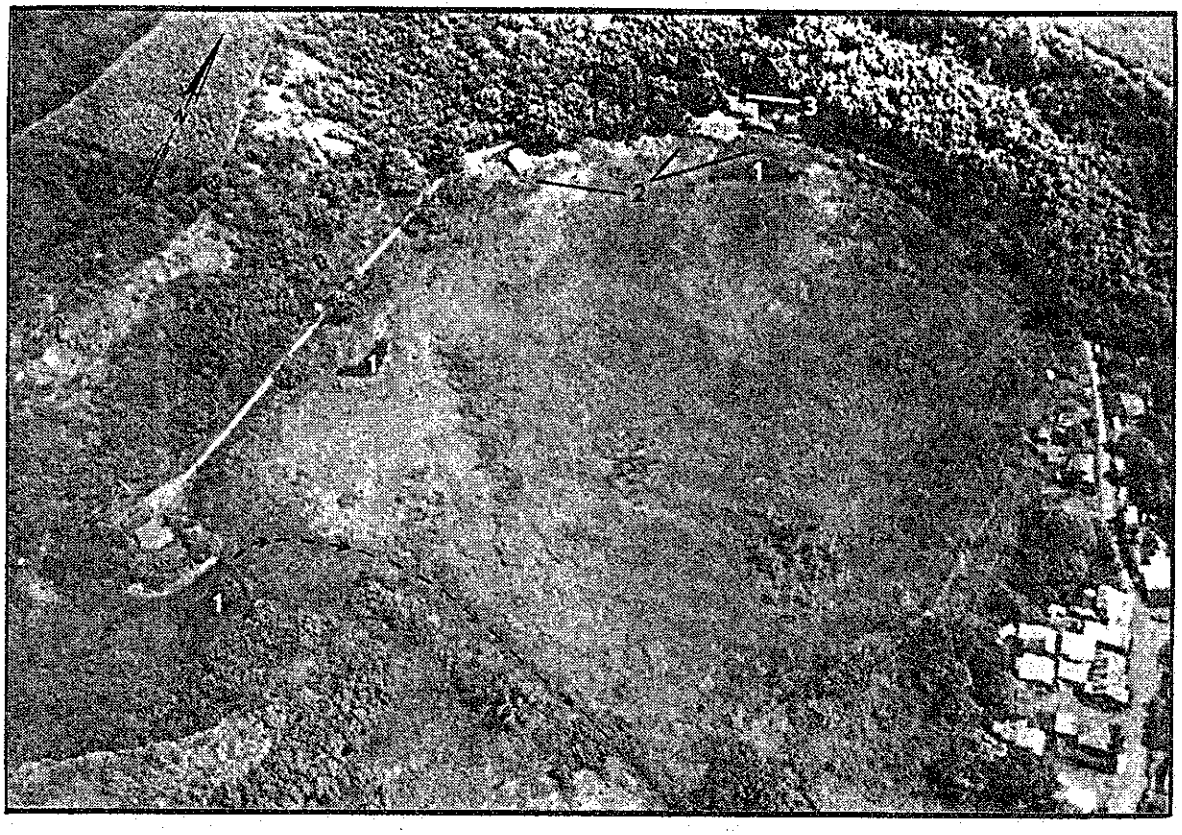
POTENTIAL IMPACT OF DREDGE/FILL ACTIVITIES: Accumulation of fill materials on the site between the two survey dates suggests that the area is already under development, but the nature of this project is undetermined. It is not likely that development of the flat lands would have a significant impact on current waterbird populations. On the other hand, dredging of shallow water impoundments would attract more birds to the site. In addition, partial clearing of vegetation in drainage canals would probably also increase use of these areas by waterbirds, particularly coots, gallinule and Koloa.

SITE NAME: Niu-malu Marsh

LOCATION: Lī-hu'e District, Kaua'i

TOPOGRAPHIC MAP: Lī-hu'e

DATES OF SURVEY: 19 May, 20 July, 1977



1. open water
2. taro
3. spring inlet

---→-- Puali Stream

WETLAND DESCRIPTION: This grassland marsh is situated within a small crater that opens on one side. Puali Stream runs through the southern edge of the marsh and then drains into Nawiliwili Bay. Most of the site is presently overgrown with California grass, and scattered patches of bullrush and taro. Although most of the marsh is permeated by water, the largest open water areas are found along the north edge (where taro is grown and harvested by the nearby resident) and on the southwest edge, where the stream enters the site. At the time of survey, the entire stream course through the marsh was choked with California grass and bulrushes. However, the landowner near the stream entrance indicated that heavy winter rains invariably clear out most of the encroaching vegetation along the stream and open larger areas of exposed water within the marsh (516). There was some disagreement among landowners as to the location of freshwater springs in the center of the marsh, although we did observe a small flowing spring that enters the open water on the north edge of the marsh. The crater slopes around the marsh are densely forested with a large variety of exotic trees, including kukui, guava, java plum, eucalyptus, and others.

NON-AVIAN WILDLIFE: Residents at the site did not wish us to enter the open water areas on the site so no survey of aquatic fauna was made. Tilapia were observed from shore and one resident reported that catfish, mollies and mosquito fish are also found within the marsh. Bullfrogs were heard during survey as well. Dogs and cats are numerous in the crater. Horses and cows were grazing on the edge of the wetland in small numbers, although footprints further into the marsh indicate the grazing animals are more widely distributed at other times. One tenant reported seeing wild pigs at the edge of the site (516).

NON-WATERBIRD AVIFAUNA: The list of birds recorded in the neighboring forest includes Melodious Laughing-thrush, Common Mynas, Barred Doves, Spotted Doves, Japanese White-eyes, and Shama. One tenant reported that Ring-necked Pheasants are frequently seen in the center of the crater (516). Spotted Munia were common in small flocks throughout the area during one survey.

WATERBIRDS OBSERVED: The most obvious waterbird in the site during both days of survey was the Hawaiian Gallinule. Four adult gallinule were observed in May and a pair of adult birds with two chicks in July. The age of the two chicks was estimated at one week and 7-8 weeks. Both were seeking food from the adult birds, suggesting that either a chick from another brood had been "adopted" or a single pair had renested after hatching the first clutch. The gallinules were feeding within taro plants on the north pond. The tenant complained that gallinule eat too much of his taro (513). He indicated that damage had increased in recent years with expanding gallinule population. He confirmed that the gallinule regularly nest within or at the edge of his taro patch, but were far less common in the open water where the stream enters the marsh.

None of the residents consulted had seen coots in the area, although they appeared to be each familiar with the bird. All reported small numbers of herons ('Auku'u) occasionally feeding on small fish in the taro patches or along the stream. Koloa, Shoveler and Pintail ducks are regular visitors to the site, according to two residents familiar with these species. Mr. William Ellis (516) reported that Koloa have nested on slopes bordering Puali Stream on several occasions during the 21 years he has lived at the site. He was surprised that these nests were most often several feet above the stream. He raises both Peking and Muscovy ducks, and showed us birds that he claimed had interbred with

both Koloa and Mallards. Although this was not confirmed, the possibility that Koloa are regularly interbreeding with domesticated ducks is reason for serious concern. Less than a dozen Cattle Egrets were counted on each survey day. They were closely associated with cows and horses on the periphery of the marsh.

HABITAT EVALUATION: In its current condition, the Niumalu Marsh provides very little suitable feeding or nesting habitat for waterbirds, yet it is apparent that a variety of waterbirds do take advantage of what little habitat is available. The area could be improved by clearing some of the encroaching vegetation. Gallinule appear largely undisturbed by the human activity associated with ongoing taro farming at the site but they are certainly threatened by the current attitude of at least some farmers towards waterbirds in general, and gallinule in particular.

The site has been used for various purposes historically, including rice, taro and cattle grazing (516). Tenants informed us that the entire crater is planned for urban/industrial development by the Kanoa Estate and that most residents are fighting the development vigorously. The residents would like to expand the taro farming into the center of the bog.

Current (and future) value of the site for waterbirds is limited by the number and distribution of dogs in the area. However, one resident indicated that dogs rarely ventured far into the wetland because of the treacherously soft mud and deep sink holes (519). The accomodation of gallinule to taro farming activities suggests that the human disturbance factor is probably of little significance, particularly in the center of the marsh.

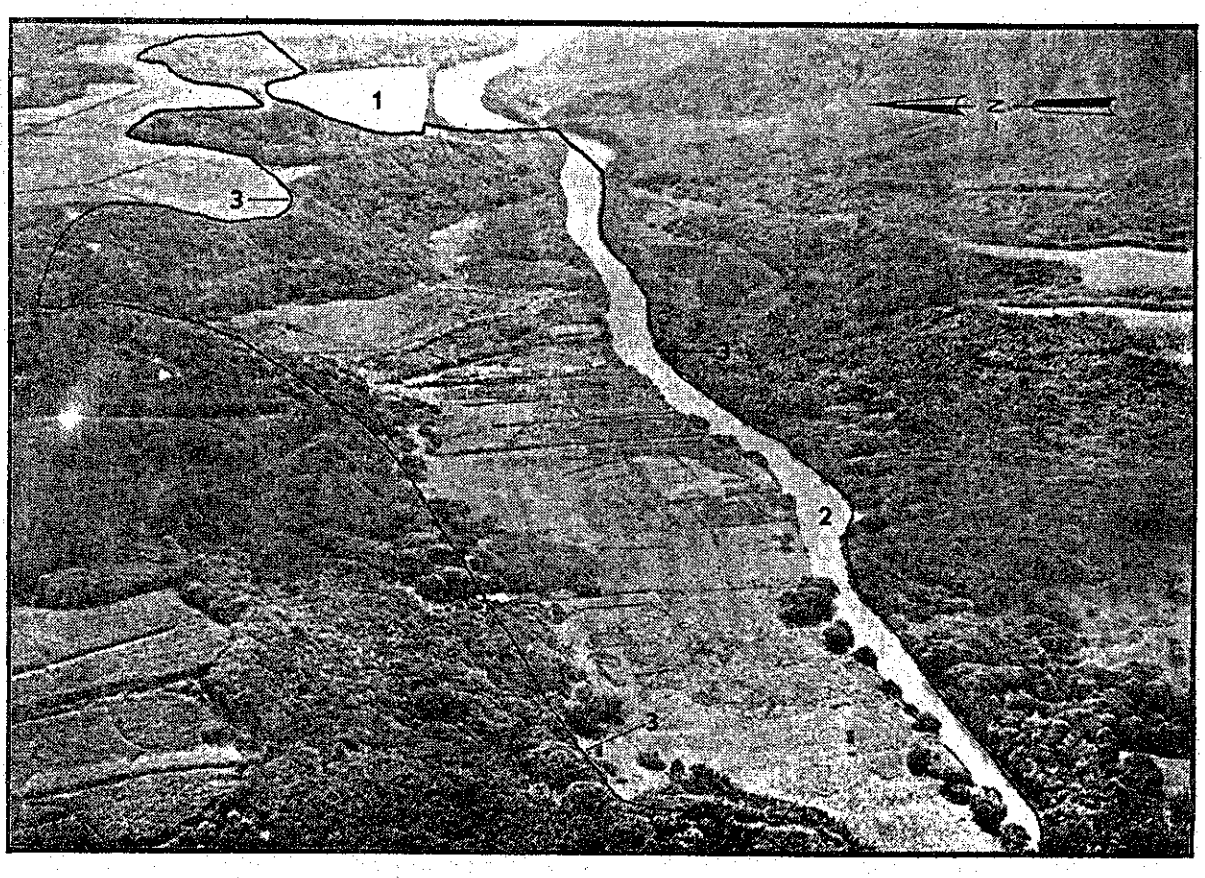
POTENTIAL IMPACT OF DREDGE/FILL ACTIVITIES: Filling of the site would be required for anticipated urban development. This would eliminate waterbird nesting and feeding habitat of limited present value, but of considerable potential importance. Channelization of the stream in the event of urban development in the marsh would lower the quality of the wetland for waterbirds considerably. On the other hand, reuse of the open marsh for taro farming or other water-associated agriculture would improve habitat for species that now use the site, and probably attract others (stilt, coot) to the area. It is uncertain whether the existing springs, together with Puali Stream, could provide enough water on a year around basis to maintain larger water impoundments. Excessive dredging in the marsh would probably lead to siltation of Nawiliwili Bay, although this could be minimized by scheduling work in periods of low stream flow. Removal of encroaching vegetation along the stream course in the marsh would increase waterbird use of the area. Some diking or dam structures might be required at the stream outlet to retain water in the marsh if an attempt was made to increase the amount of permanent wetland.

SITE NAME: Huleia Valley (Huleia National Wildlife Refuge and Menehune Fishpond)

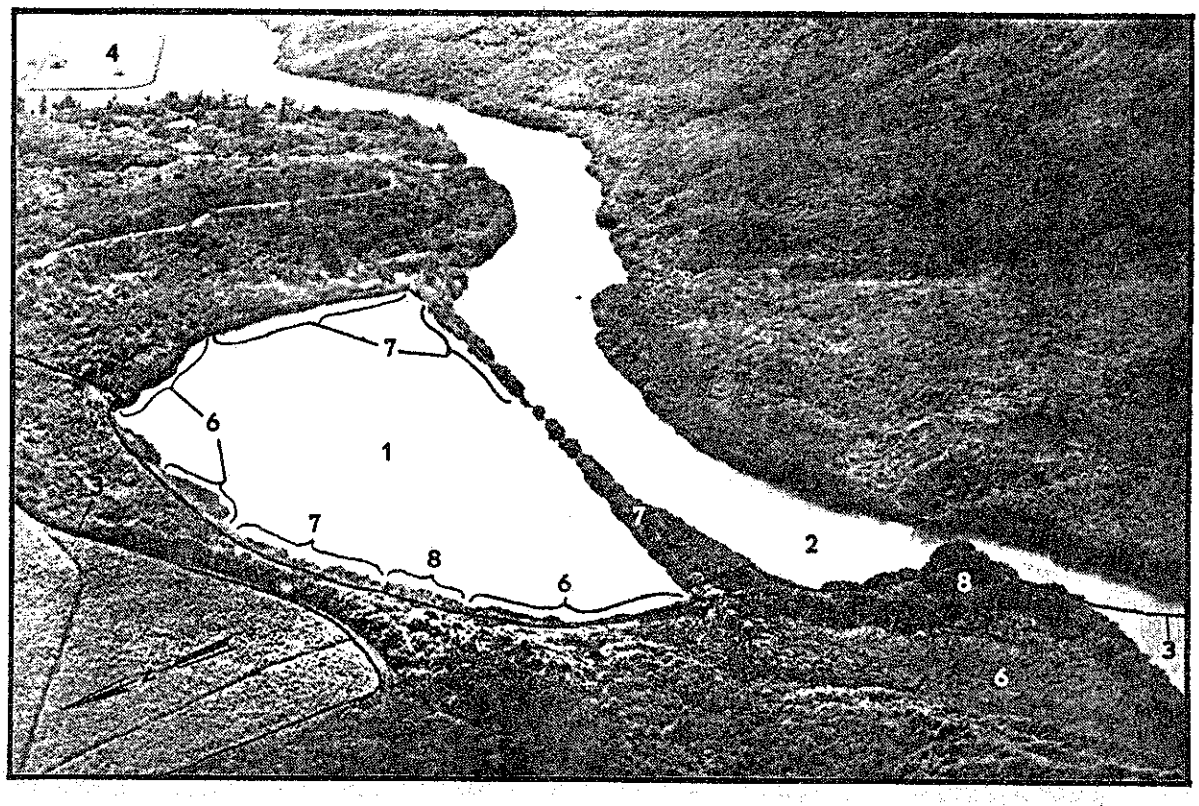
LOCATION: Lī-hu'e District, Kaua'i

TOPOGRAPHIC MAP: Lī-hu'e

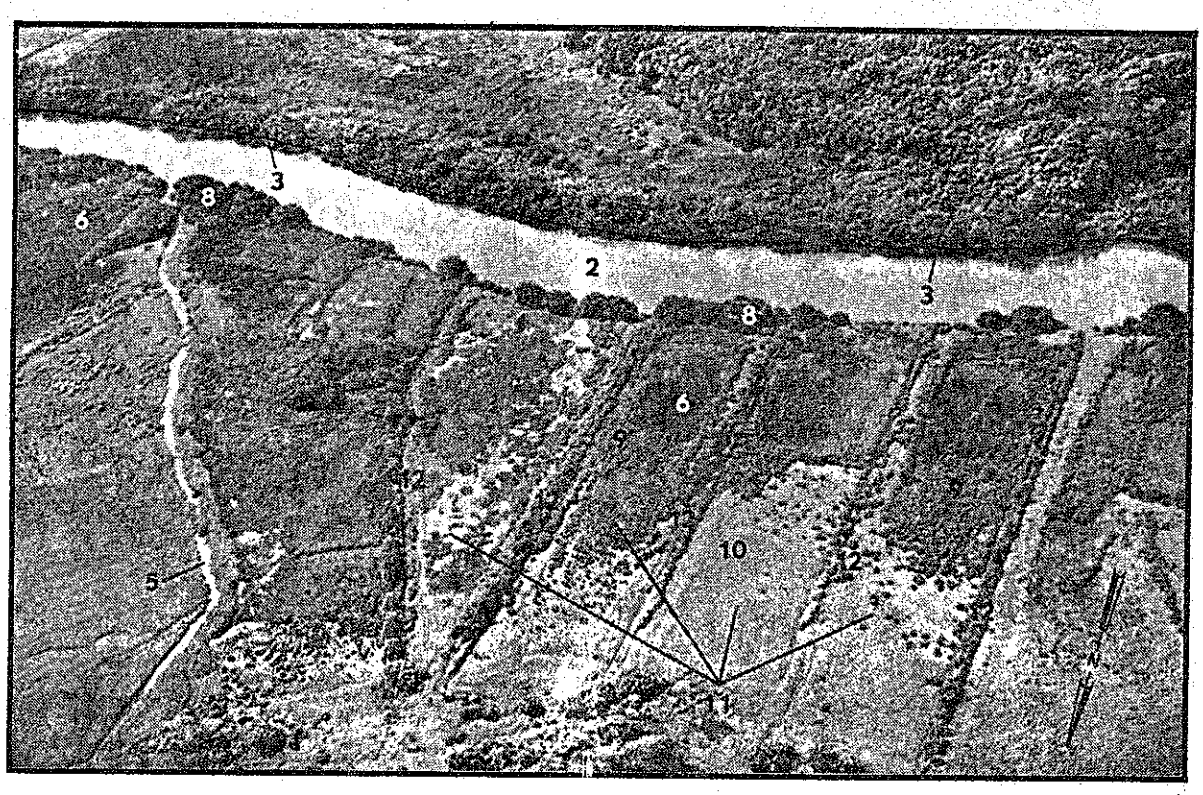
DATES OF SURVEY: 16 May, 19 May, 19 July, 1977



1. Menehune Fishpond
2. Huleia Stream estuary
3. Huleia National Wildlife Refuge boundary (approximate)



1. Menehune Fishpond
2. Huleia Stream estuary
3. Huleia NWR boundary (approximate)
4. Nawiliwili Harbor
5. Papakolea Stream
6. bulrush
7. mangrove
8. hau
9. pluchea
10. California grass
11. former rice fields
12. former drainage ditches



WETLAND DESCRIPTION: For the purposes of discussion, two wetland areas are included here: (1) pasture lands bordering Huleia Stream (lower photo, pg.190) and (2) Menehune or Alekoko Fishpond (upper photo, pg.190), downstream of the pasture lands. Approximately 240 acres of the Huleia Stream bottom lands and the wooded slopes are now included within the Huleia National Wildlife Refuge, established by the USF&WS in 1973. Nearly 150 acres of the refuge are currently used as grazing land, although remnants of dikes and water channels are evidence of former use for rice and taro production. The fields are now largely overgrown with various grasses, pluchea, bulrush and other sedges. Water flows onto the flat pasture lands from Huleia Stream, Papakolea Stream and through other small drainages from surrounding cane lands. The forested slopes are dominated by large exotic trees, including java plum, albizzia, mango, guava and monkey pod. Huleia Stream is lined with a dense overgrowth of hau and American (red) mangrove, and in some areas extends more than 20 feet over the surface of the water from the shore. The tidal influence in Huleia Stream extends beyond the flat pasture lands, to the upstream edge of the refuge (521).

Menehune Fishpond lies in a natural basin, formed by walling off a portion of Huleia Stream. Historically, the site was used for mullet production (112). The pond was declared a Registered National Historic Landmark in 1973, and was proposed for acquisition by the U.S. Fish and Wildlife Service as part of the Huleia National Wildlife Refuge. The shoreline of the fishpond is overgrown with mangrove and hau, although a dense growth of round-stem bulrush covers the marshy area at the west end of the pond. The pond itself is almost 40 acres in size, with two small nursery ponds (each less than one acre) constructed at the east end(112). A rock wall, now in a state of disrepair, separates the pond from Huleia Stream.

Menehune Fishpond is referred to as an estuarine pond in recent literature (112). Three small fresh water streams feed the pond from the inland side (65). Yet, the water in the pond is brackish due to infiltration of tidal waters from Huleia Stream. The pond varies in depth from two to five feet, although a soft silt bottom makes accurate measurements difficult. The water level in the pond may vary nearly two feet with tidal patterns (112). The unstable bottom restricts the growth of submergent vegetation, but there is reported to be an abundance of zooplankton and phytoplankton in the water (65). The pond has been subject to increasing siltation levels in recent years during winter floods that breach the fishpond wall and as a result of erosion on adjacent slopes. Kridler (519) reports that the pond supported a large amount of leafy pondweed prior to deposition of silt over the wall during periods of heavy rain in 1971-72. Mangrove seedlings have encroached into shallow water, particularly in the eastern end of the pond.

NON-AVIAN WILDLIFE: Huleia Stream has a diverse aquatic fauna, including many species that are attractive to local fishermen. Species recorded in the stream include mullet, tilapia, barracuda, aholehole, ulu, milkfish, mullet, manini and samoan crabs (65). We observed both bullfrog tadpoles and mullet at the upstream boundary of the refuge. With the continuing degradation of the fishpond wall, it is certain that most if not all of these species are also found within the pond. Although not surveyed, it is unlikely that the suspended silt bottom in the pond supports a diverse or abundant invertebrate fauna. Shallow water within stands of bulrush and on flooded pasture lands within the refuge support a wide variety of aquatic insects as well.

NON-WATERBIRD AVIFAUNA: The forested slopes within Huleia Valley provide diverse habitat for several songbirds. Those species recorded during our surveys include Northern Cardinal, Melodious Laughing-thrush, House Finch, Japanese White-eye, Shama, Common Myna, Jungle Fowl, Spotted Dove and Barred Dove. We have observed Greater Necklaced Laughing-thrush on earlier trips to Huleia NWR, particularly within the forest at the upstream end of the refuge, but we did not record the species on our short visit during this study. USF&WS biologists have noted at least five other species in the area as well: Ring-necked Pheasant, Barn Owl, Hawaiian Owl, Red-crested Cardinal, and Western Meadowlark (534).

WATERBIRDS OBSERVED: Count records for the Huleia Stream Valley include several years of semi-annual surveys by HDF&G (Menehune Fishpond only until 1975) and monthly surveys by USF&WS biologists beginning in August, 1974. However, most of the counts have been made from overlooks above the fishpond, preventing the detection of some birds hidden by vegetation either within the pond or within the stream.

Hawaiian Coots have been observed by HDF&G/USF&WS biologists regularly at Menehune Fishpond. Coots were common in the fishpond during counts prior to 1970, with 25-50 birds appearing repeatedly in count records. One count in July, 1969 turned up 855 coots, although this was recognized as an abnormally high concentration. A count this high is not uncommon in recent years at Waita Reservoir, less than six miles southwest of the fishpond. The abnormal record at the Menehune Fishpond may have represented an influx of coots from this reservoir. Alternatively, it could have been a group of mainland coots (Fulica americana americana). Although even larger concentrations have appeared at times on Oahu as well, there has been no verification of mainland coots in Hawaiian wetlands. Coot numbers in recent years at the fishpond have been considerably lower than earlier records indicate. In 26 monthly counts by USF&WS biologists during 1974-76, the average number of coots at the pond nas been less than 6 birds (range 0-19). We counted only 3 coots on each of two trips to the fishpond in summer, 1977. Greatest numbers in the past have generally been recorded between August and October, corresponding to the return of adult coots with young from nesting areas (believed to be on Niihau). The species is far less common in the pasture lands upstream of Menehune Fishpond, although at least one source (346) reports nesting of this species in the Huleia National Wildlife Refuge. Decreasing use of the fishpond by coots has been attributed to excessive siltation and consequent loss of submergent vegetation and bottom invertebrate fauna (534), but the decline in numbers is so recent that a more complex reason may be involved.

Of 26 monthly counts by USF&WS biologists between 1974-76, gallinule were seen at Menehune Fishpond (or in adjacent nursery ponds) on only two days. The largest number of gallinule recorded at the fishpond in recent years is two. In spite of the scarcity of birds, an earlier report stated that "gallinules, as well as coots, nest in a marsh at the west (upstream) end of the wall" (65). It is not known upon whose observations this statement was made. As this species is far more secretive than the Hawaiian Coot, and more likely to be hidden in shoreline vegetation, it is entirely possible that some birds were missed on earlier counts. However, there is little suitable plant material to sustain gallinule in the fishpond, and the open water wetland is not characteristic of this species. It is likely,

however, that gallinule were quite common in the upper valley when the flat pasture land was in rice and taro production, and it is probable that they could be attracted to the site again if suitable water impoundments were constructed and a food source developed. No gallinule were seen either at Menehune Fishpond (and adjacent nursery ponds) or within Huleia National Wildlife Refuge during our survey.

Hawaiian Stilt have been recorded irregularly and in small numbers at the fishpond and in flooded pasture lands upstream by HDF&G/USF&WS biologists. Six birds were recorded within Menehune Fishpond on a survey in October, 1976. Presumably the increasing siltation of the pond, particularly in the eastern end, has created shallow feeding habitat where there was once deeper water. However, the infrequency with which stilt are observed in this site suggests that the availability of food in the suspended silt is quite limited. A thorough limnological investigation of this pond has been recommended, and would aid considerably in the interpretation of bird sightings and in the planning of future management programs (346). Experimental clearing of pluchea in pastureland within Huleia National Wildlife Refuge has opened up some stilt feeding habitat. Rapid response of stilt already to this new habitat indicates that the species can be expected to increase in numbers at the site as habitat improvement programs are implemented (534).

Quarterly HDF&G counts of Koloa at Menehune Fishpond between 1970-75 produced an average of 1.75 birds per trip. In USF&WS monthly counts (1974-76) Koloa have been seen more regularly and in greater numbers at Menehune Fishpond than any other endemic waterbird. The species has appeared on virtually every USF&WS count, averaging nearly 7 birds per trip. Similar numbers have been counted more recently on the pasture lands or in drainage ditches within Huleia National Wildlife Refuge. This species has responded to ongoing programs to clear overgrowth of pluchea and is attracted readily to flooded pastureland. One source indicates that adults with young have been sighted at the fishpond but the source of the information was not clear (65). Swedberg (406) reports earlier observations of nesting birds at higher elevations on Huleia Stream. Kridler (519) observed a brood of three Koloa ducklings above the bridge (upstream refuge boundary) in 1972. We are unaware of any confirmed records of Koloa nesting within the refuge or at the fishpond. Surprisingly large numbers of Koloa have been recorded in small reservoirs only a short distance west of this site (see Kipu, pg. 196). We counted only a single Koloa at the Menehune fishpond in May, and another bird was flushed from the Papakolea Stream drainage during a brief survey in mid-July.

Black-crowned Night Heron ('Auku'u) sightings at Menehune Fishpond by State & Federal biologists have ranged between 1-3 birds in recent years. However, a roosting heron is easily missed during a quick survey, so it is possible that there are more birds in the area than count data lead us to believe. We counted four adults and one juvenile bird at Menehune Fishpond during a May visit, and three adult birds at the west end of the pond in mid-July. Presumably concentrations of tilapia within adjacent nursery ponds provide a source of food, but the fishpond in its present condition is of relatively little value. One can expect to find herons feeding in the shallows of Huleia Stream at the upstream end of the refuge as well.

Cattle Egret have been seen in the Menehune Fishpond area in increasing numbers in recent years. Telfer (530) reports that between 300-400 birds roosted in 1977 in mangrove trees at the west end of the Menehune Fishpond wall. They were not in this area at the time of survey, but we did count over 40 birds with cattle in pastureland along Huleia Stream. Mr. William Ellis (516), a resident at Niumalu, reported that egrets pass over his house each morning on their way to feed. Until recently, he worked at Menehune Fishpond every day, and indicated that the rapid growth of the egret colony has taken place within the last two years. The greatest number of egrets we observed on this wetland survey was at Kipu reservoirs, west of Huleia National Wildlife Refuge.

Our recorded shorebird list for Huleia National Wildlife Refuge (and presumably Menehune Fishpond) includes Golden Plover, Wandering Tattler, and Ruddy Turnstone. Development of water impoundments (i.e. taro fields) in the existing pastureland within the refuge will probably attract greater numbers of these species, and some less common species as well. We observed a single tattler at the fishpond in May, but we (RJS, HDP) have seen tattlers on several occasions in the shallow upstream portion of the refuge. Of the three shorebirds mentioned, Golden Plovers have been recorded most often and in greatest numbers in the area. A small group of Pintail duck were recorded by USF&WS biologists at Huleia National Wildlife Refuge in January, 1976, and a hen shoveler on one earlier occasion (534). Numbers of ducks on the refuge pasturelands in winter can be expected to rise significantly if permanent water impoundments are constructed and if the growth of submergent and floating leaved vegetation is encouraged through proper management.

A final bird to add to the list for the Huleia region is the White-tailed Tropic bird (Phaethon lepturus dorotheae). At least four tropic-birds were soaring near cliffs south of Huleia Stream during our July survey, and USF&WS biologists report that they are seen regularly in the area. Some have landed in trees on the refuge during earlier observations by USF&WS biologists (534).

HABITAT EVALUATION: Although not confirmed in literature survey, former taro and rice fields on flatlands along Huleia Stream probably supported far greater numbers of waterbirds than now inhabit the area. Yet it has been many years since this type of waterbird habitat has been available here. Certainly the greatest value of the flat pasture land within Huleia National Wildlife Refuge lies in its potential for improvement, and not in its current condition. In 1970, Huleia marsh and pasture was recommended as a "key area" to be preserved and developed as a wildlife refuge (343). The draft HWRP (346) lists Huleia National Wildlife Refuge as a "secondary area" in need of pond development. The remnants of former water impoundments, dikes and diversion channels are still present, and reconditioning will not be difficult for much of the site. The major current deterrent to waterbird use is the overgrowth of vegetation (particularly pluchea and grasses) and lack of permanent water. Also, continued use of the pastureland by cattle does not appear compatible with habitat management goals. Not only have cattle trampled most of the site, but they have also grazed heavily on food and cover plants important to waterbirds (i.e. arrowhead, bulrush). Unfortunately, cattle seem to avoid pluchea as a source of food, and consequently this plant grows rampant throughout most of the flat pasturelands. The loss of ground cover where cattle trails have developed creates unnecessary erosion and siltation in streams and drainage canals that cross the pastureland.

Menehune Fishpond was also recommended as a "key area" in 1970 (343) and as a "secondary area" for waterbirds in 1977 (346). The causes of declining waterbird use in recent years are not fully understood, and it appears to us that more investigative work is needed before habitat management plans are developed and implemented. There is some question as to whether or not the USF&WS will acquire the site for inclusion into Huleia National Wildlife Refuge. If not, it is unlikely that steps will be taken to improve the condition of the habitat for waterbirds. Although recommended for aquaculture development, the reconstruction costs may be prohibitive (112). It is certain that the pond will be subject to continuing siltation unless the wall is restored and unless effective erosion control techniques are implemented on surrounding hillsides. Also, mangrove will continue to encroach on the shallower parts of the pond.

There is some concern among waterbird biologists that if the site is reconditioned for aquaculture purposes, that fishing activities may be incompatible with use by waterbirds (519). Actually, it is possible that all would benefit by an active program to restore the suitability of the pond for fish culture. It would require control of mangrove, removal of accumulating silt, and reconstruction of the fishpond wall(112). The high population of tilapia in the pond now contributes to the high turbidity levels and lack of submergent vegetation by continued disturbance of the bottom, so it would be in the best interest of both waterbirds (except perhaps herons) and aquaculture to reduce the population of this and other competitive fish species. However, the effort would be wasted until the wall was reconstructed and the control gates put into working order. It may be necessary to actually drain the pond to eliminate competitive fish and to remove accumulated silt. While such a plan would reduce the number of birds at the site during the pond restoration, it will eventually result in a greater availability of submergent plant foods and improved water quality.

POTENTIAL IMPACT OF DREDGE/FILL ACTIVITIES: Some dredging and deposition of fill material will be required to develop pasture lands within Huleia National Wildlife Refuge to their full potential as waterbird habitat. Most of this habitat improvement can be accomplished on relatively dry land by moving earth from one place to another. Although this will probably increase the silt load in streams and drainages that cross the pasture land, the effect should be temporary and of little or no long-term significance.

Restoration of Menehune Fishpond for aquaculture would require considerable attention to the possibility of adverse impact on pond and estuary ecology. Silt removed from the pond should be taken from the site in a way that would avoid a sudden increase in turbidity within Huleia estuary. If contemplated, dredging within the pond should be timed to avoid complications due to flooding of the stream over the fishpond wall.

SITE NAME: Kīpū Reservoirs

LOCATION: Lī-hu'e District, Kaua'i

TOPOGRAPHIC MAP: Lī-hu'e, Kō-loa

DATES OF SURVEY: 18 May, 20 July, 1977

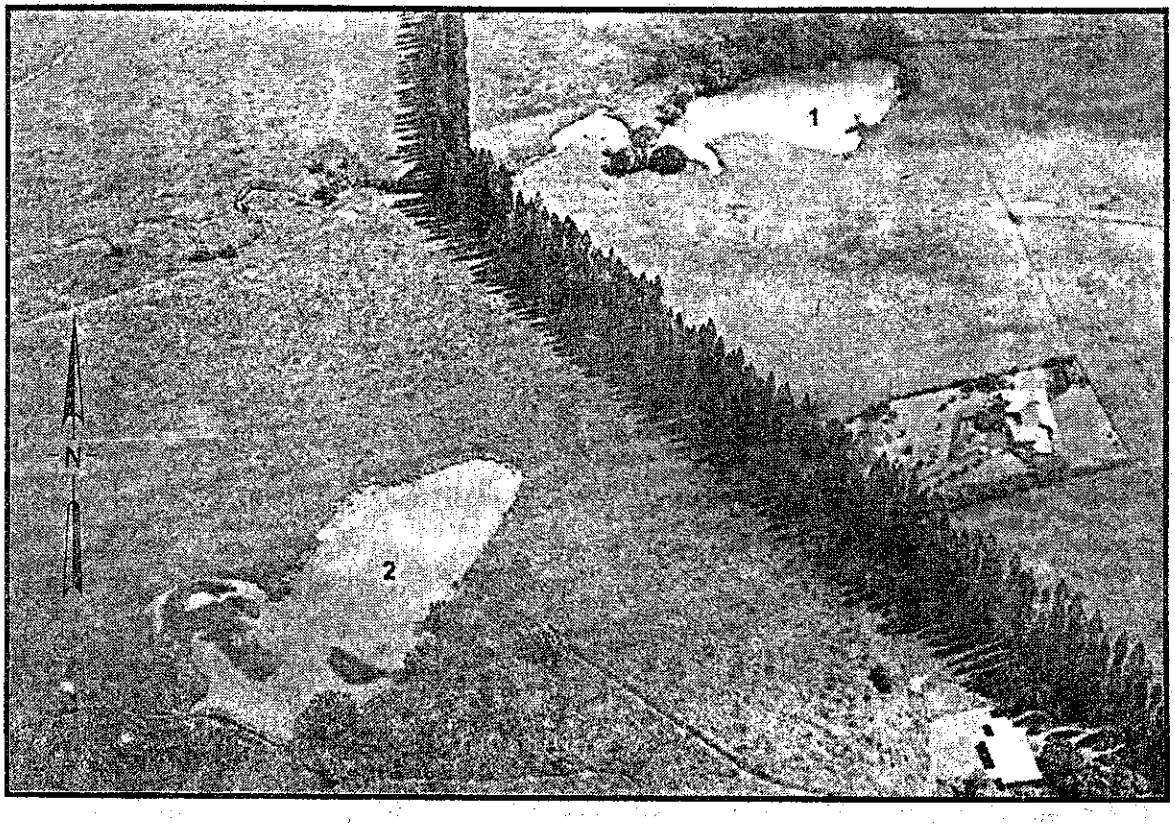
WETLAND DESCRIPTION: This site is largely open pasture, with several natural reservoirs that provide water for cattle and habitat for waterbirds. The four largest reservoirs support a limited amount of bulrush marsh in their shallowest parts, although they may range in depth to eight feet or more. Tall trees border only one of the reservoirs (Res. #1). The pasture lands and reservoirs are fed and drained by small streams that eventually drain into Huleia Stream east of the site. Parts of the stream drainages are fast flowing. The primary use of the site is cattle ranching, so large herds of cattle are widely distributed throughout the pasture as well as within and around each of the reservoirs. The landowner (Mrs. Patricia Rice) asked us to remain within the car during our survey to avoid disturbance of her cattle, but we were able to drive to the edge of the most important wetland areas.

NON-AVIAN WILDLIFE: Our inability to leave the car at the four major reservoirs prevented even a brief evaluation of aquatic fauna. However, the ranch foreman indicated that the reservoirs contain both bass and tilapia (529). Telfer (484) described a variety of invertebrates (Hemiptera, Odonata, Crustacea) during a brief aquatic survey of reservoir #4 (see pg.197). He also recorded bullfrogs, toads, mosquito fish and small-mouthed bass. Cattle, horses, dogs and cats were also observed on survey and the owner reported recently observing feral pigs.

NON-WATERBIRD AVIFAUNA: Several non-wetland birds were seen, despite the request by the landowner for us to remain in our car. Common to abundant species included Western Meadowlark, Northern Cardinal, Japanese White-eye, House Finch, House Sparrow and Common Myna. Several other species were less common and were restricted, for the most part, to forest bordering pasturelands and near Reservoir #1 (Melodious Laughing-thrush, Shama, Greater Necklaced Laughing-thrush, Red-crested Cardinal). Also seen at scattered locations were Spotted Munia, Ring-necked Pheasant, feral chickens and guinea fowl (near ranch buildings). Two Hawaiian Owls were recorded on our first trip to the site. Mrs. Rice reported observing a single Golden Eagle over her property in recent years.

WATERBIRDS OBSERVED: Three native waterbird species were recorded at this site during our brief field work (Coot, Koloa, 'Auku'u), but in much lower numbers than were recorded during repetitive HDF&G surveys in recent years. Coots have generally been widely distributed in different reservoirs with total numbers for the four reservoirs ranging from 9-41 birds in recent counts. Telfer (530) reports that pond #4 is one of two sites (the other is Kolo Reservoir) on Kauai where he has found newly hatched coots. The bulrush stand on this reservoir and on Reservoir #3 is rather extensive and provides good cover for this and other species.

Kipu reservoirs (Wm. Hyde Rice Ranch)



(pond numbers as indicated by HDF&G in their waterbird surveys)

Gallinule have been recorded less frequently on HDF&G/USF&WS counts at Kipu reservoirs than coots, but numbers as high as 11 birds (July, 1971) have been noted in recent years. Birds of this species are far more secretive and likely to be concealed within vegetative cover during survey. Also, it is possible that the semi-annual surveys in January and July (or August) will miss nesting activities of this species. No gallinule were sighted during our brief surveys.

We saw no Hawaiian Stilt in Kipu reservoirs, although it did appear that changing water levels would result in a limited amount of available feeding habitat along the shorelines. Mrs. Rice reported that at least one pair of stilt nested successfully in pond #1 in recent years. Although 3-4 stilt were recorded in pond #4 in 1975-76 HDF&G/USF&WS counts, the species did not appear on count records at Kipu for several years prior to this time. Potential nesting habitat for this species is limited in the reservoirs at this time, but it would appear that construction of artificial islands in the bigger reservoirs would provide attractive nesting sites.

According to HDF&G count records for recent years, Koloa are by far the most common waterbird at the Kipu reservoirs. Count records indicate that, with the exception of Hanalei, the Kipu reservoir #4 "had the greatest frequency and degree of use by Koloa" in recent years (478). Reservoir #2 has also supported several Koloa in the past. The January, 1972 HDF&G/USF&WS count for all Kipu reservoirs was 42 birds, more than 70% of the Koloa recorded on Kauai during that survey. Over a five year period (1970-75) the average total number of Koloa recorded in quarterly counts a Kipu reservoirs has been greater than 11 birds, with little variation on a seasonal basis (478). Mrs. Rice reports that Koloa nests are found quite frequently along the streams that feed and drain the reservoirs (526).

Rarely has more than one 'Auku'u been recorded at the Kipu reservoirs in the past, presumably because of the depth of the ponds and limited distribution of potential roosting trees nearby. Very low water in the ponds, and resulting concentration of fish in relatively shallow water, probably is attractive to herons on a temporary basis. We recorded a total of 5 adult birds during our May survey, although none were seen during a briefer investigation in July. Cattle Egrets, on the other hand, were more abundant at Kipu than at any other wetland on Kauai during this survey. Over 130 birds were counted in July as they roosted in Norfolk pine trees near the owner's house and then flew to a single large tree near Reservoir #2. Although nesting by this species was not confirmed at the Kipu site, Mr. William Ellis (516) reports that a colony is established at the east end of Menehune (Alekoko) Fishpond, less than 5 miles east of the Kipu reservoirs. Zeillemaker (534) reported to us that there was no evidence of nesting in the Menehune colony as of July, 1977. It is no surprise that the large herds of cattle on this ranch prove attractive to this species.

Migratory waterbirds that appear in HDF&G/USF&WS records for Kipu reservoirs, but were not seen during our summer survey, include Pintails, Shoveler, Wandering Tattler, Golden Plover and Ruddy Turnstone. The HDF&G/USF&WS counts for migratory shorebirds have always been low, presumably because of the shortage of shallow water feeding habitat suitable for small wading migratory species. Migratory waterfowl counts at Kipu have been relatively low as well, but the results of at least one count were staggering. The average number of Pintails counted on Kauai over the last five years is

slightly over 200 birds, yet 400 birds were seen on a HDF&G/USF&WS survey at Kipu Reservoir #4 on January 15,1976. This represented 92% of the migratory waterfowl counted on the entire island during that day. When flushed, the birds flew to Waita Reservoir, suggesting that interchange between these two habitats may be a regular occurrence. Mrs. Rice reported that reservoirs on her property were particularly attractive to large flocks of Pintail when drought conditions left other bodies of water low or dry (526).

HABITAT EVALUATION: On a prolonged basis, the apparent greatest waterbird value of Kipu reservoirs is to Koloa, as feeding, loafing and nesting habitat. It is of secondary importance to coot, gallinule and stilt, but could be improved considerably for these species through proper management. It is doubtful that any one (or all) of the Kipu reservoirs could sustain a large migratory waterfowl population over an entire winter season, but verification of this would require more frequent monitoring of the site. The value of the reservoirs to support these waterfowl during periods when other sites are in poor condition seems clear from HDF&G/USF&WS count records and from information supplied by the landowner.

A brief investigation of Reservoir #4 by Telfer (484) indicated the presence of a variety of vertebrate and invertebrate animals suitable as food for waterbirds known to inhabit the site, but no floating-leaved or submergent vegetation was recorded. Manipulation of water conditions to encourage the growth of a greater abundance and diversity of waterbird food plants could improve the habitat for birdlife. Allowing access of cattle only to portions of the habitat of little or no significance to waterbirds would encourage the growth of food and cover plants including those submergent species that are inhibited in germination and growth by constant trampling and increased turbidity. The effect of defecation by cattle on nutrient levels in the water could be investigated, as it may play a role in the condition of these aquatic ecosystems.

POTENTIAL IMPACT OF DREDGE/FILL ACTIVITIES: Elimination of any of the Kipu reservoirs through filling would have a direct impact on waterbird populations, but clearly the most significant impact would be on Koloa. Although earlier waterbird surveys probably have recorded only a small percentage of this widely distributed population, the concentration of birds in the Kipu reservoirs is valid evidence that the site is of critical importance to this species on Kauai. Effective habitat management could increase the use of these reservoirs by Koloa and other waterbirds, so perhaps their greatest long-term value lies in their potential.

Based on the cooperation and interest of the landowner, it is doubtful that she will intentionally do anything to existing habitat that would diminish its value to waterbirds. Mrs. Rice also expressed an interest to learn how she could help. She would probably cooperate on habitat improvement projects that would not conflict with her need to maintain these reservoirs as a source of water for cattle.

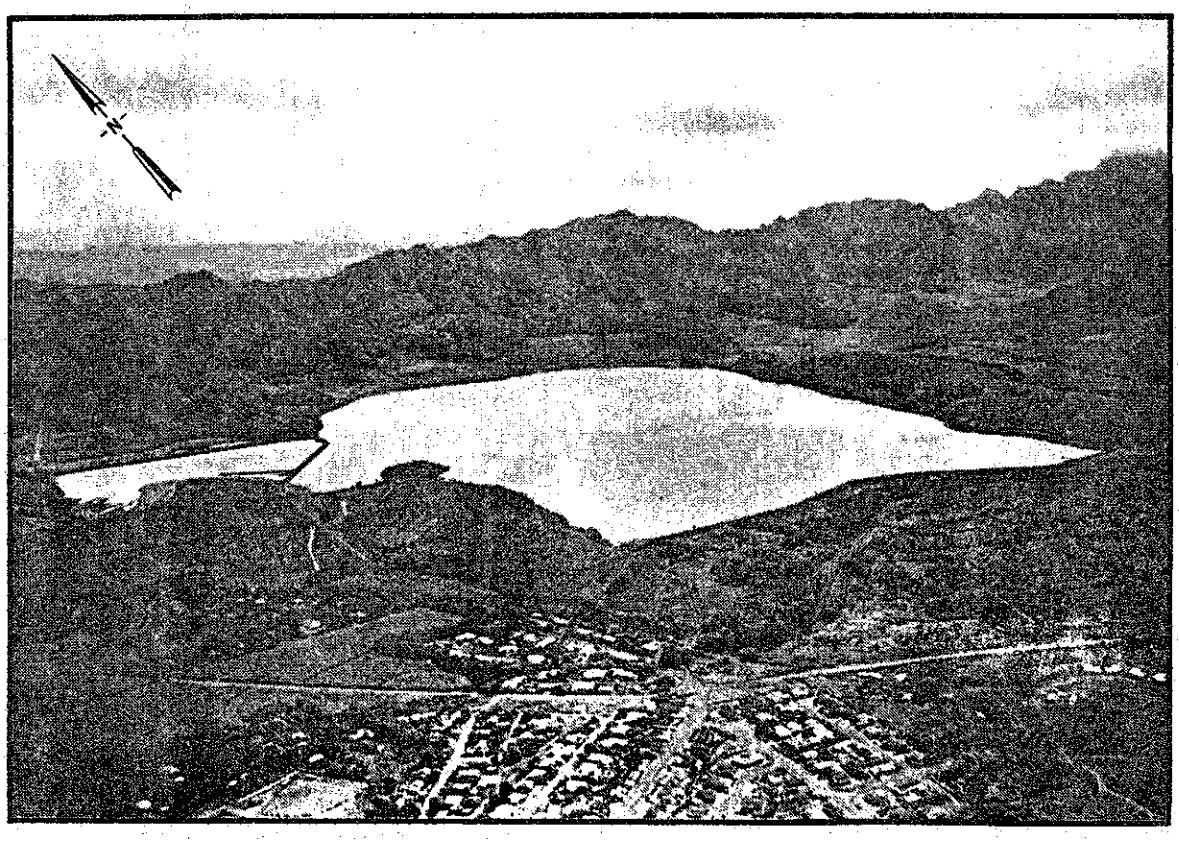
Any deposition of fill material that reduces the size of the available habitat, particularly the marsh vegetation and feeding areas, should be discouraged. Some experimentation with nesting island construction may prove valuable in the larger bodies of water.

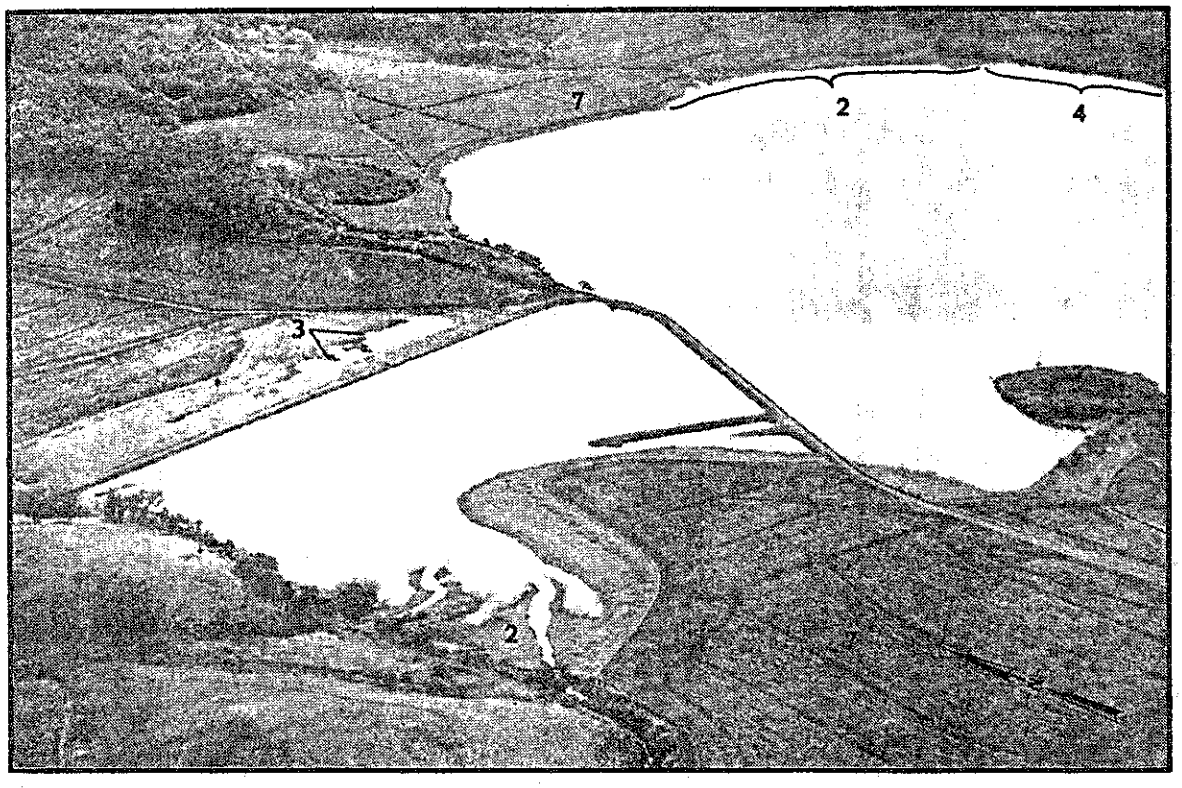
SITE NAME: Waita Reservoir

LOCATION: Kō-loa District, Kaua'i

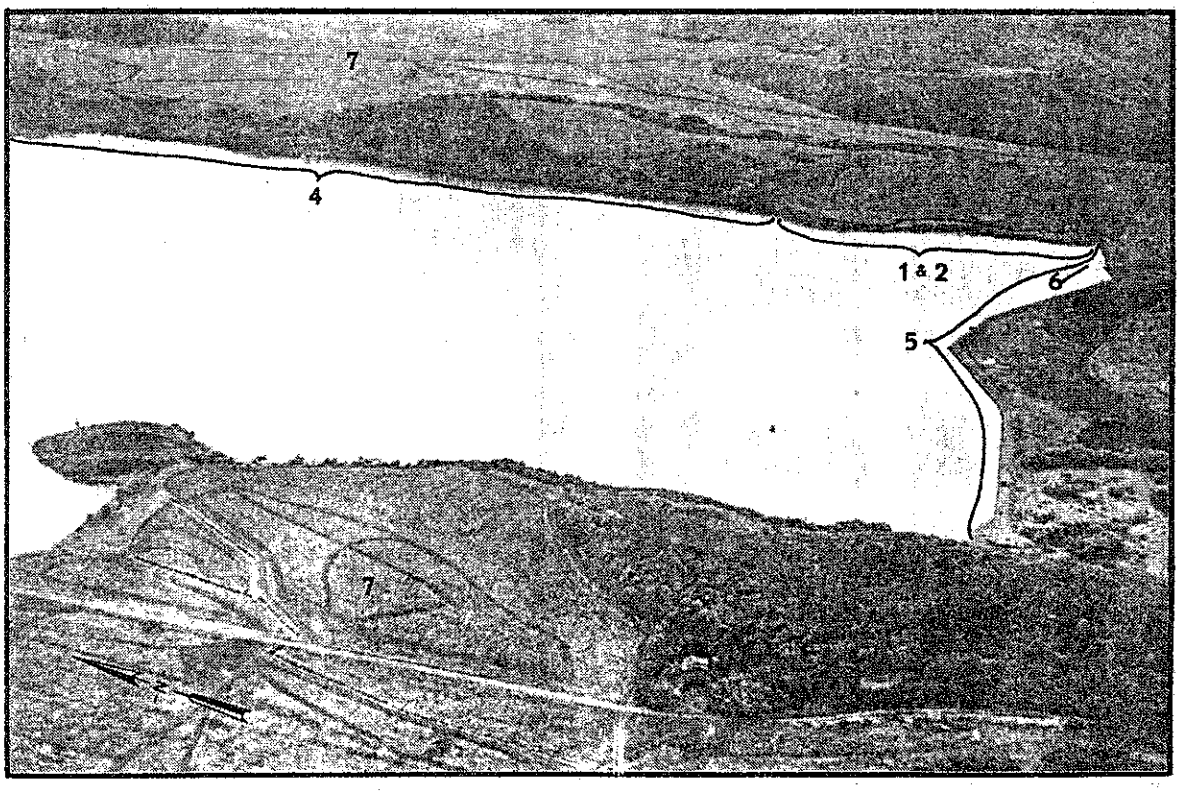
TOPOGRAPHIC MAP: Kō-loa

DATES OF SURVEY: 16 May, 18 May, 20 July, 1977





1. coot loafing and feeding
2. emergent California grass
3. cattails
4. hau
5. dike
6. water level gauge
7. sugar cane



WETLAND DESCRIPTION: Waita is the largest fresh water reservoir on Kauai. It is privately owned and used for sugar cane irrigation. Before the turn of the century, three separate reservoirs occupied the site, but a large dike built in 1903-06 now retains more than 2 billion gallons of water, covering over 420 acres (518). The reservoir is surrounded on nearly all sides by cane fields, although emergent grasses line the edge when water level is high. A depth gauge at the southern dike indicated 23' in May and 19' during our July survey. Normal depth at this point during July is approximately 13'(518). During drought conditions, water level may recede to less than 5' at the depth gauge. Low water exposes many acres of muddy shoreline. The northern shore and the marshland west of the dike road provide gently sloping bottom attractive to waterbirds.

NON-AVIAN WILDLIFE: Waita Reservoir appears to support a greater abundance and diversity of fishes than smaller reservoirs in the same vicinity. Telfer (484) recorded the several genera (Gambusia, Tilapia, Micropterus, Lepomis, Cyprinus and Ictalurus). Channel catfish may run to 10 pounds or more. Tilapia and mosquito fish were most common during our survey with the shallow water (in emergent California grass) west of the dike road. Bullfrogs (adults and tadpoles), toads and Japanese Wrinkled Frogs (Rana Rugosa) were recorded on our survey in all shoreline surveyed. Small numbers of horses and cows were grazing in grassland, particularly along the northern shoreline. Dog tracks were seen at several locations along the shore as well.

NON-WATERBIRD AVIFAUNA: Grassland along the shores of Waita Reservoir supports only a small diversity of birdlife, but those species recorded in this habitat were common (Western Meadowlark, Spotted Munia, Japanese White-eye, Common Myna, Barred Dove, Spotted Dove, House Finch). Black-headed Munia were ovserved in May along the north shoreline, providing the first confirmed record of the species on Kauai. Uncommon species noted on the survey included Melodious Laughing-thrush, Shama, Hawaiian Owl, House Sparrow, and Ring-necked Pheasant. A brood of pheasant chicks was observed in May.

WATERBIRDS OBSERVED: Approximately 1000 coots were observed at Waita Reservoir on May 16, 1977, but the number had dropped to less than 600 by May 18. The July count was 680 birds. HDF&G records of coots at this site show radical variations over the last several years, often from day to day. This suggests a regular movement of birds between this site and several other reservoirs on Kauai, as well as the presumed movement between Kauai and Niihau. An average of 138 coots during winter and summer censuses, and a single winter high of 1,100 coots is reported for Waita (346). Our high early summer count was made during a atypical year, when lack of water in habitat on Niihau was probably responsible for abnormally large numbers of coots that remained on Kauai throughout the entire nesting season. During our survey, the coots were widely distributed in open water (northern half of Waita reservoir) and along the southweast shore, just above the main drainage. Survey of the habitat by boat revealed that the emergent California grass was heavily browsed by coots. Very little leafy material remained, particularly on new sprouts. The emergent California grass and other vegetation also provided important cover and loafing sites for coots. Feeding birds were diving in the shoreline vegetation and more than 100 yards offshore. The source of food in deeper waters should be investigated.

Gallinule were recorded on both May and July surveys, but in very low numbers (n=2,6). One bird in each survey was an immature, suggesting that the site does provide breeding habitat for this species. It is certain that several other gallinule were missed on this and other surveys of Waita, as they are very inconspicuous within the emergent vegetation. No more than 3 gallinule have been recorded on recent semi-annual surveys by HDF&G or USF&WS biologists.

Stilt are generally not common in the reservoir, although 17 were recorded during the 1975 summer HDF&G/USF&WS survey. Only two were seen on our surveys, in a mud puddle below the southern dike. Abnormally high water levels this summer prevented the exposure of extensive shoreline mud that is usually available as feeding habitat for stilt during summer months. There is no suitable nesting habitat for this species at Waita. Rapidly changing water levels would flood nests or expose them to predation if they attempted to nest along the shoreline at Waita Reservoir.

Records show that Koloa are even less common than stilt at Waita, averaging less than a single bird per visit during quarterly HDF&G/USF&WS surveys between 1970-75. Twelve Koloa were counted during the May survey but none were seen in our July trip to Waita. Koloa were feeding along the northeast shoreline. Swedberg (406) reported that the western bay area was of particular importance to Koloa at Waita, although use of the site diminished significantly during periods of high water. He also observed a brood of downy young in January, 1963.

A dozen 'Auku'u were also recorded on our May trip, but they were more widely scattered along the entire northern shoreline. Five herons were wading in flooded California grass near the northwest inlet during the July trip. At least two of these birds were successful in capturing tilapia while under observation. All but two of the herons observed in May were adults.

Although number of migratory waterfowl have varied radically in recent years, Waita has often provided valuable habitat for these species, particularly Pintail. In the highest recorded Pintail count for Kauai (January, 1973), 510 of 515 birds were seen at Waita. This was an abnormally dry winter, however, and many smaller habitats were dry. In the 1976 winter HDF&G/USF&WS count, 400 pintails were observed first at Kipu Reservoir #4 and then they flew to Waita Reservoir where a total of 425 birds were counted. Numbers of Shoveler on Kauai have typically been less than 10% of the Pintail recorded, and Waita Reservoir has been one of several sites where these birds have been found on past surveys.

The migratory shorebird species list for Waita Reservoir includes Wandering Tattler, Golden Plover and Ruddy Turnstone, but recorded numbers of each species have been relatively low. One would expect that exposed shorelines during abnormally dry winter months would attract large numbers of these species, but the count records do not reflect this.

Great Frigatebirds were flying over the reservoir during the May and July surveys. At least two birds were seen drinking from shallow water in the northwest inlet, as they flew over the water surface. It was uncertain at the time whether or not they were searching for fish as well. I am unaware of any known frigatebird nesting or roosting sites in the area other than Kilauea Point and Kaula Islet, beyond Niihau.

HABITAT EVALUATION: Waita Reservoir was recognized as an "area of secondary or complementary value" to waterbirds in 1970 (343) and more recently as a "primary area" (346). The change in status is presumably the result of abnormally high coot and pintail counts that have occurred in the interim between the two reports. There is no question that the site is of considerable value as feeding and loafing habitat for coots, and of less value to stilt, Koloa, gallinule and herons. The reservoir is subject to little disturbance. Although the fluctuation of water levels reduces the potential value of the site as nesting habitat for endangered waterbirds, it does increase the amount of accessible feeding habitat for some species. The size of the reservoir insures that some feeding area will be available even in the worst draught conditions, when many other sites are dry or nearly so. Emergent California grass appears to be of considerable value to waterbirds at Waita Reservoir and at other habitats where more typical waterbird food plants are limited in availability.

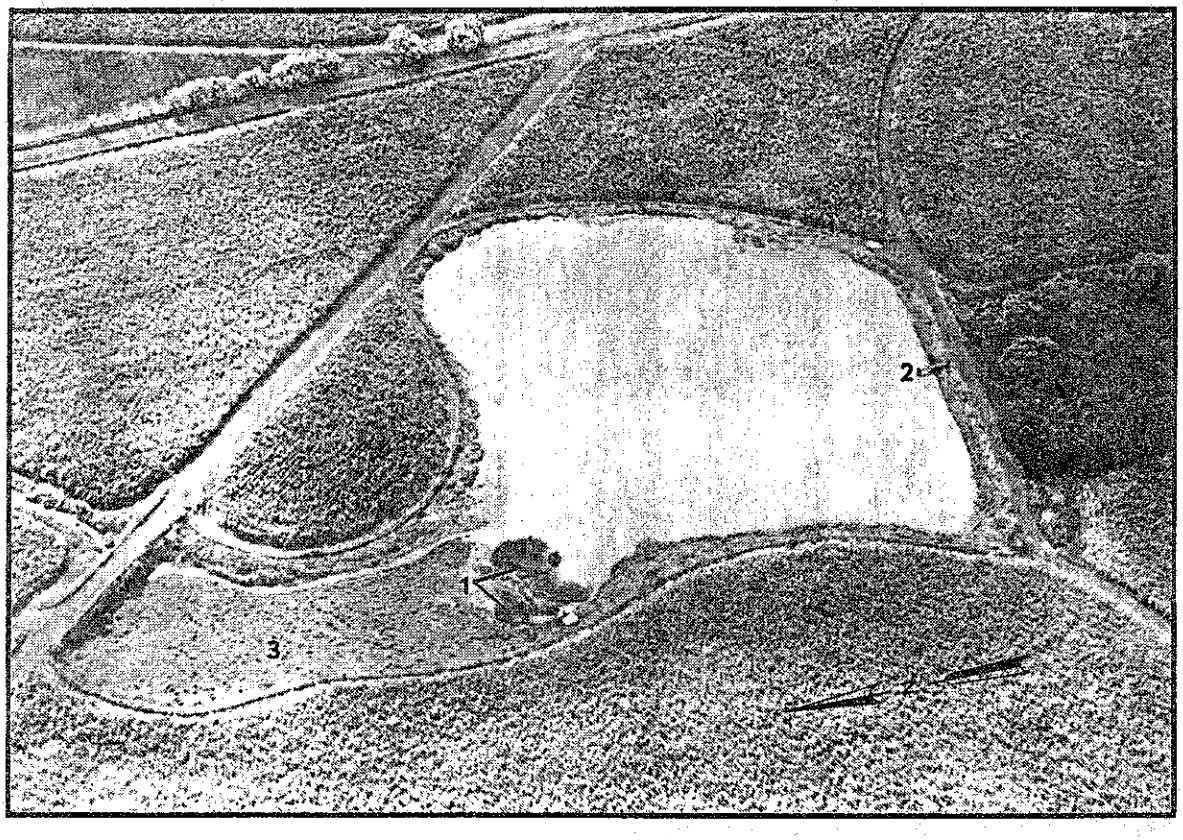
POTENTIAL IMPACT OF DREDGE/FILL ACTIVITIES: The sheer size of Waita Reservoir insures that the effects of any increased turbidity due to dredging or deposition of fill materials will be short-lived and localized. Elimination of cover and feeding habitat along the southern corner and northwest shallow marsh would have more serious impact on waterbirds than elsewhere in the reservoir, but it is not likely that this activity would be contemplated under present management. In view of the size of this area, the potential impact of each proposed dredging or filling operation should be evaluated independently. A cooperative management program with the landowner could involve measures to insure that feeding and loafing habitat is not disturbed unnecessarily.

SITE NAME: Pia Mill Reservoir

LOCATION: Kō-loa District, Kaua'i

TOPOGRAPHIC MAP: Kō-loa

DATES OF SURVEY: 16 May, 20 July, 1977



1. bulrush
2. drainage system and water level gauge
3. flooded California grass

WETLAND DESCRIPTION: This fresh water irrigation reservoir is not unlike several dozen similar reservoirs on Kauai that were not included in this survey, and based on previous HDF&G/USF&WS count records appears to be representative of these areas in its value to wetland birds. The site is nearly surrounded by cane fields, although a small grove of trees borders the drainage on the south side. California grass surrounds the open water, providing some cover and food for waterbirds at the site. The north (inlet) side of the reservoir is not in cultivation as the area is permeated with water. However, bulrush is limited to a relatively small patch at the water's edge, indicating that periodic low water conditions cause the higher ground behind the bulrushes to dry and allows the encroachment of grasses.

NON-AVIAN WILDLIFE: The reservoir was quite turbid during survey but tilapia were visible in shallow water. Although not observed, it is likely that mosquito fish are well established also. Bullfrogs (adults and tadpoles) were heard and seen at the site. Small gastropod molluscs, dragonfly (nymphs and adults) and a variety of aquatic insects were also seen, particularly within the bulrushes.

NON-WATERBIRD AVIFAUNA: Spotted Munia and Common Mynas were common in the surrounding vegetation. Barred and Spotted Doves were seen on the roads near the site. Melodious Laughing-thrush, House Finch and Japanese White-eyes, were heard in the forest drainage. Of particular interest was a small flock of Black-headed Munia observed in the surrounding California grass. These observations, together with additional sightings of birds at Waita Reservoir soon before, represent the first confirmed records of the species on Kauai. Mammals seen at the site include 6-8 cattle and horses that graze on the California grass bordering the reservoir.

WATERBIRDS OBSERVED: Only three waterbird species were recorded at the site during our surveys. Of these, coots were the most common. Fifteen coots were seen during our May visit and eight in July. Of particular interest on the second trip was the sighting of a single juvenile bird, attended closely by a pair of adult coots. There was an almost constant interchange of call notes between adults and young. A relatively thorough investigation of the bulrush stand did not reveal the remains of a nest. It was not determined during observations whether or not the young bird was capable of flight. The "emergent" California grass surrounding the reservoir could have provided sufficient cover for this pair to nest. As far as I am aware, this is the only juvenile coot that appeared in a July HDF&G/USF&WS survey. The site has been included on the HDF&G/USF&WS semi-annual survey only recently, but coots have been recorded here in small numbers both summer and winter.

A single 'Auku'u was observed at the site in May, when it flew from shoreline feeding roost. The relatively steep shoreline provides very little suitable feeding habitat for this species. Cattle Egrets were observed on our surveys (n=2,5) in close association with cattle at the edge of the site.

A pair of gallinule were recorded in this reservoir during the January, 1976 HDF&G waterbird count. It appears that the bulrush stand would provide attractive nesting habitat for this species, but continuing disturbance by

cattle only a few feet away may preclude this possibility. The fence that separated the cattle from the bulrushes was in poor condition and presumably would not restrain the animals when low water made the bulrushes accessible as a source of additional food.

There is very little suitable stilt or migratory shorebird habitat at this site, although we did see a pair of stilts pass over the area during the July survey. Golden Plover were recorded by State biologists at this site in 1976. Koloa were not recorded at this reservoir, but it is probable that they occasionally visit the area in small numbers.

HABITAT EVALUATION: Like any of the numerous small reservoirs that are scattered through cane lands in this area of Kauai, Pia Mill, by itself, provides habitat for only a small number of waterbirds. However, taken together, these sites provide several hundred acres of feeding, loafing and nesting habitat that is critical to the continued survival of Kauai's waterbirds. The value of any individual reservoir varies with the condition of nearby sites.

Pia Mill would provide more secure habitat if conflicting use by cattle was eliminated or restricted to portions of the area that are less attractive to waterbirds. The marsh area at the north side of the reservoir could be improved as waterbird habitat if a higher constant water level was maintained, but water levels vary as a function of agricultural need and rainfall, so it is not likely that this or any other sugar cane reservoir will be managed to meet the habitat needs of wetland birds.

POTENTIAL IMPACT OF DREDGE/FILL ACTIVITIES: As the site is already quite turbid, it is unlikely that additional siltation due to limited deposition of fill material would reduce the waterbird value of this site significantly. On the other hand, elimination of the bulrushes through dredging or filling would decrease the availability of cover, and would diminish the supply of food organisms associated with this vegetation. Some additional deposition of fill along the edges of the ponds may encourage the development of a bottom fauna that is accessible and attractive to stilt and other wading birds. A greater development of submergent and floating vegetation is necessary to attract large numbers of gallinule, Koloa and migratory waterfowl.

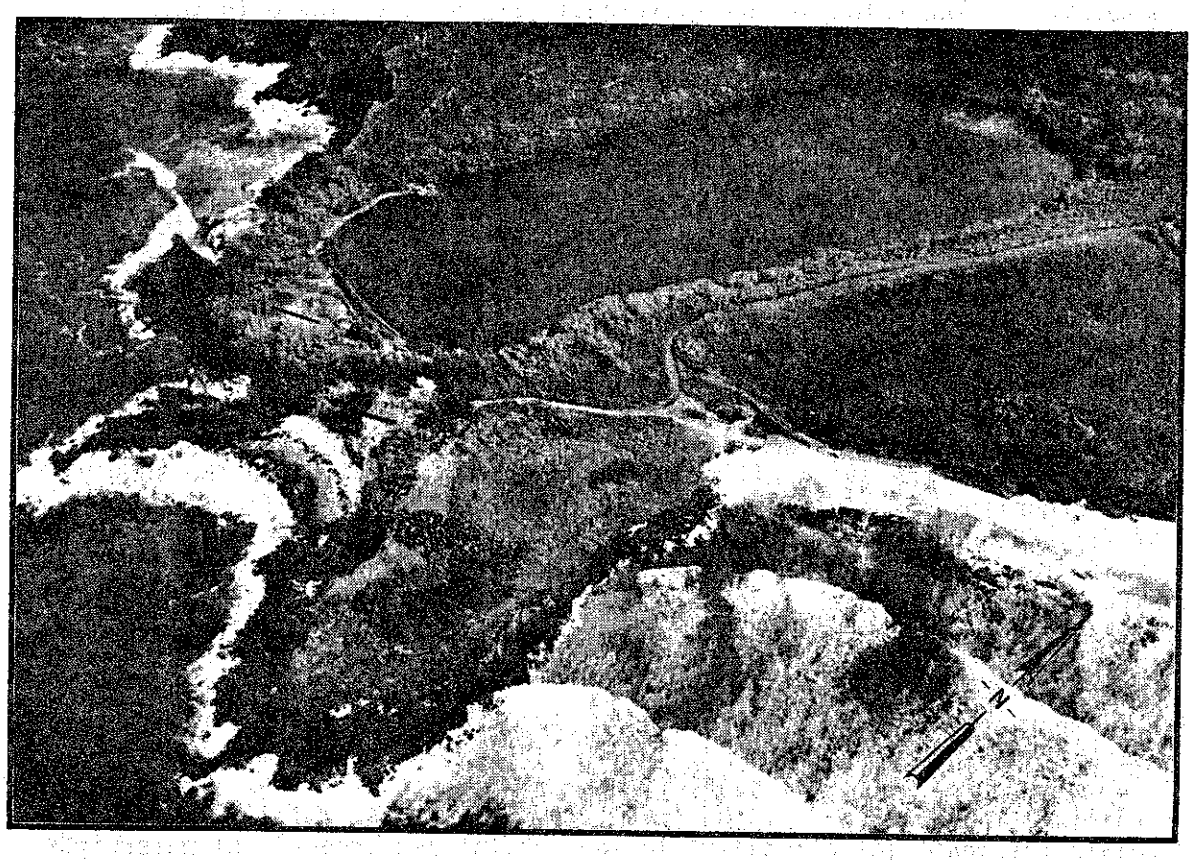
Much of the above discussion may be irrelevant, as it is reasonable to assume that this and other reservoirs will continue to be managed for a single purpose: irrigation water for sugar cane. It is not likely that the draining schedule and modifications through dredging or filling will ever relate (at least intentionally) to the habitat requirements of waterbirds.

SITE NAME: Nōmilu Fishpond

LOCATION: Kō-loa District, Kaua'i

TOPOGRAPHIC MAP: Kō-loa

DATES OF SURVEY: 1 June, 1977



1. salt pond

2. fishpond

WETLAND DESCRIPTION: Nomilu Fishpond is an inland marine pond of approximately 20 acres, formed by salt water filling a cinder cone (112). The pond is saline, and exceeds 15' in depth in some areas. Residents at the site indicated that a neighboring pond had been used for salt production in the past, but not in recent years. The small pond is highly saline, and is no greater than 1' deep at any point. A dense growth of koa haole and kiawe covers the slopes of the cinder cone and shoreline area. Many of the trees overhang the surface of the deep fishpond.

NON-AVIAN WILDLIFE: The small salt pond was red in color from the dense concentration of brine shrimp. No other aquatic species were noted in the salt pond. The landowner currently harvests fish in the large fishpond for his own use, and the site has been strongly recommended for production of mullet and milkfish (112). Both dogs and cats were loose near the residence at the site.

NON-WATERBIRD AVIFAUNA:Common species in the Nomilu Fishpond area at the time of survey included Japanese White-eye, House Finch and Spotted Munia. Also noted, but in smaller numbers, were Ring-necked Pheasant, Shama and Melodious Laughing-thrush.

WATERBIRDS OBSERVED: One Hawaiian Stilt, one Ruddy Turnstone and one Wandering Tattler were observed at the site on June 1, 1977, but we were unable to visit the salt pond on the second trip to the area. The shallower parts of the main fishpond probably attract stilt, herons and more shorebirds on occasion. The area is not on semi-annual waterbird surveys by HDF&G and USF&WS biologists, so there are no comparative records available.

HABITAT EVALUATION: It is not likely that either the large fishpond or the salt pond are of any long-term importance to endemic or migratory waterbirds. The fishpond is highly productive, and shows considerable potential for aquaculture development (112), but in its present state it is too deep to provide suitable feeding habitat for a significant number of waterbirds. If, as recommended, the suitability of the site for mullet and milkfish culture is improved, and the pond goes into increased production, one can expect that herons, and perhaps other species, will visit the site more regularly. The small salt pond may provide some food for migratory shorebirds and stilt, but the salinity of the water is much higher than that found in habitat preferred by these species. The site may be more attractive to waterbirds when diluted by heavy rainfall.

POTENTIAL IMPACT OF DREDGING/FILLING ACTIVITIES: The salt pond at Nomilu could be filled with little or no long-term significance to waterbirds. Anticipated expansion of aquaculture activity in the fishpond may attract more birds to the site, but it is likely that increased use of the area by herons will be discouraged by pond managers and the overall effect will be nil. The size of the pond, and particularly the potential waterbird feeding area is too small to expect that both expanded aquaculture and increased waterbird use will be accomodated successfully.

SITE NAME: Kā-la-heo Gulches (not pictured)

LOCATION: Kō-loa District, Kaua'i

TOPOGRAPHIC MAP: Hanapēpē

DATES OF SURVEY: 16 May, 20 July, 1977

WETLAND DESCRIPTION: A series of forested gulches, east of Hanapepe, drain the surrounding cane fields and collect small bodies of water in numerous depressions. The Kalaheo Gulch complex was included in this inventory because of small wetland areas that have developed within them. The ponds, each less than 1/2 acre at the time of survey, are very turbid and appeared to support no submergent or emergent vegetation. California grass surrounds several of the sites and has taken over depressions that formerly held water. The depressions show signs of former diking, suggesting the gulches have been used for collection of irrigation water or drinking water for cattle. Presumably, the more recently constructed reservoirs at higher elevations now fill that need. Dominant trees in the gulches include eucalyptus, koa haole and silk oak.

NON-AVIAN WILDLIFE: The most obvious aquatic animals in the numerous ponds were bullfrogs (Rana catesbiana). As many as a dozen bullfrogs were counted in shallow, muddy ponds less than 15 yards across. Herons wading in the ponds in search of food appeared to ignore adult bullfrogs less than 10' away. Presumably they were after tilapia that were concentrated by low water levels.

Cows and horses were grazing in the gulches, and distribution of footprints suggested that the areas have had more intensive use by these animals in the past. Fishermen along the shore at the bottom of the largest gulch had loose dogs with them during the survey.

NON-WATERBIRD AVIFAUNA: Forested land surrounding the small ponds provide habitat for Spotted Munia, House Finch, Melodious Laughing-thrush, Shama, Spotted Dove, Barred Dove, Mockingbird, Myna, Cardinal and Japanese White-eye. A single Hawaiian Owl and three Ring-necked Pheasants were seen also.

WATERBIRDS OBSERVED: Three waterbird species were recorded on various small ponds during two visits to the area (Hawaiian Stilt, Koloa, 'Auku'u). Stilt were feeding alongside 'Auku'u in ponds less than 4-6" deep. A maximum of 4 stilt and 5 'Auku'u were seen in all ponds taken together. A pair of Koloa was flushed from an extremely turbid pond, after which the birds circled and landed in a neighboring gulch. There was no evidence of nesting by any of these species. There are no HDF&G/USF&WS records of former surveys in these areas that would provide comparative data. However, Hanapepe Salt Ponds to the west of these gulches provides some habitat for stilt and Koloa, particularly during winter months. There may be some exchange of birds between these habitats.

HABITAT EVALUATION: The turbid ponds within the Kalaheo gulch complex probably are of little long-term significance to waterbirds, because of their ephemeral nature and lack of a diverse aquatic fauna and flora. Survey at other times of the year would provide a more adequate foundation for evaluating the habitat. Taken together with numerous small sites that provide temporary feeding and loafing habitat, these ponds surely play a role in the continued success of Kauai's waterbirds. This may be particularly true when lack of rainfall leaves many other sites (i.e. Hanapepe) dry or nearly so.

POTENTIAL IMPACT OF DREDGE/FILL ACTIVITIES: It is not likely that dredge or fill operations in the Kalaheo gulch complex would have an adverse impact on available waterbird habitat unless it resulted in the complete elimination of standing water. The ponds are already turbid, and the gulches have been used as a dumping site for a variety of solid waste materials for several years. Unless water quality is seriously degraded through runoff of pesticides or other wastes from surrounding cane fields, these small ponds will continue to provide ephemeral waterbird feeding habitat.

SITE NAME: Hanapēpē Salt Pond

LOCATION: Wai-mea District, Kaua'i

TOPOGRAPHIC MAP: Hanapēpē

DATES OF SURVEY: 17 May, 20 July, 1977

1. salt pans
2. pickleweed
3. Salt Pond road
4. canefield pond
5. Salt Pond Park
6. dike road

WETLAND DESCRIPTION: This 18 acre site has been developed for salt production in flat pans. Two separate ponding basins are separated by a road through the site. The habitat is dry during most of the year, and derives its temporary water supply from heavy rains and runoff from canefields. Presumably the salinity varies considerably with evaporation in dry periods and dilution of water during heavy rains. Relatively little rain is needed to create a large coverage of water, all less than 3-4" deep. The dominant ground cover vegetation in the salt pond area is pickleweed. A more permanent wetland north of the salt pond road is created by a check dam that the sugar company has installed to keep dirty water out of the salt ponds (530). Emergent California grass and sugarcane are found in this pond. Use of neighboring lands include Port Allen airport, sugar cane fields and the Salt Pond Park, a public use facility.

NON-AVIAN WILDLIFE: Two prominent invertebrates found in this habitat when water is present are brine shrimp (Artemia sp.) and water boatmen (Cymatia sp.) (484). These are thought to be the primary food for birds that feed in the site. In addition, a small number of mosquito fish and probably tilapia may enter the area in runoff from nearby fields. The cane field pond north of the road has a large population of bullfrogs and tilapia. Dog tracks are evident throughout the site, and a dead cat was found lying next to a bag of warfarin-baited oatmeal near the ponds.

NON-WATERBIRD AVIFAUNA: The site itself provides little habitat for non-wetland birds, although several species were recorded in surrounding lands. These included House Sparrow, House Finch, Western Meadowlark, Mockingbird, Shama, Melodious Laughing-thrush, Japanese White-eye, Barred Dove, Spotted Dove, Cardinal, Ring-necked Pheasant and Hawaiian Owl.

WATERBIRDS OBSERVED: Visiting this site during both May and July made it possible to see wetland under different conditions. Early May rains left the salt pond with far more water than is usual for a summer month. However, no waterbirds were recorded on the day of survey. Some tracks in the wet mud appeared to be those of a Wandering Tattler or Golden Plover. The salt pond was almost entirely dry during the July survey. Two stilt, two coots and one heron were observed on the July visit. All were feeding in the shallow cane field pond north of Salt Pond Road. The coots took cover in the emergent California grass.

The list of birds recorded on HDF&G/USF&WS counts at Hanapepe in past years includes stilt, coot, Koloa, Golden Plover, Wandering Tattler, Sanderling, Turnstone and Shoveler. Telfer also reports having seen gallinule in the canefield pond north of the road (530). The salt pond site was recognized in 1970 as an "area of secondary or complementary value" to waterbirds, principally the Hawaiian Stilt (343). This species has been recorded at the site primarily during the winter months. Count records for recent years show as many as 26 stilt in the salt ponds. Stilt at Hanapepe have accounted for as much as 35% of the island total for the species on the count days. When one considers that this species may be recorded at less than a half dozen habitats on winter counts, the long range significance of Hanapepe for stilt on Kauai becomes apparent. The salt pond site is of little use to coot, although our sighting of birds in the cane field pond suggests that more birds of this species could be attracted to the area with proper habitat management. Koloa have used the

salt ponds as a loafing and feeding area in past years, but Swedberg (406) noted that use by this species decreased as the amount of irrigation water released into the ponds diminished. No Koloa were recorded at the site during quarterly HDF&G surveys between 1970-75. No migratory waterfowl have been recorded at the site in recent years, but Shoveler have been reported in small numbers in the past.

Migratory shorebirds find the shallow water attractive as feeding habitat, but they have never been recorded in large numbers. Golden Plover and Sanderling appear on recent winter records, but Ruddy Turnstone are curiously absent. Hanapepe has not been a particularly good site for recording straggler species, but a single Bonaparte's Gull was recorded at the site in January, 1973 (471).

HABITAT EVALUATION: The value of the salt ponds to waterbirds, particularly stilt, is directly linked to patterns of rainfall and cane field runoff. In spite of continuing, if not expanding, levels of human disturbance associated with salt production, stilt find the site attractive as feeding and loafing habitat in winter months. HDF&G/USF&WS records of stilt using the site in summer months, when abnormal rains or cane field drainage provides temporary water, indicate that year-around use by this species could be encouraged with effective management. However, without development of means to retain water in the ponds for a longer period, and in the face of anticipated demand for other uses of this valuable shoreline area, it is likely that the site will become of less and less value to this species. It is already marginal for other wetland birds. Further, it is not likely that the State Department of Transportation, the agency in control of the land, will be receptive to wetland management that increases the population of birds in habitat so close to an active airport (105). Elimination of this site for alternative development will force stilt to seek feeding habitat elsewhere. This may be in conflict with the Federal Endangered Species Act of 1973 (519). Also, there is no valuable stilt habitat on Kauai, other than Hanalei National Wildlife Refuge, that is presently assured of future protection. Hanapepe is mid-way between two stilt nesting and feeding areas (Kekaha-Mana and Lihue Settling Basins) and provides a continuum of habitat between these areas. Hopefully, cooperative management programs can be developed between wildlife biologists and respective landowners of these sites.

POTENTIAL IMPACT OF DREDGE/FILL ACTIVITIES: The major deterrent to expanded use of Hanapepe Salt Ponds by waterbirds is the impermanence (and irregularity) of the fresh water supply. Thus it is likely that development of means to secure and retain water at the site on a year-around basis would lead to greater bird populations, and could conceivably encourage nesting by Hawaiian Stilt. The cane field pond north of the road could provide a source of water, as would construction of a permanent well at the site. An alternative solution, and one that would certainly involve considerable dredging, would be to dig out part or all of the existing basin to the level of the water table (530). Further dredging of a deep water moat, and deposition of fill to create small nesting islets, would increase the chance that stilt would nest successfully at the site. If current salt production activities do not expand appreciably, such habitat improvement could be accomplished on the unused portions of the site. Alternatively, salt production could be confined either east or west of the dike road, and the opposite side managed

exclusively for waterbirds. Whatever method of habitat improvement is chosen, temporary siltation as a result of minor dredging or fill operations would be more than compensated by long term benefits of better habitat.

Because of concern by Department of Transportation officials regarding presence of waterbirds in airport areas, and in light of competing demands for valuable near shore lands, it is more likely that alternative uses of Hanapepe salt ponds will be contemplated in the future. The impact of site modification for other land use should be evaluated in relationship to both the existing and the potential long-term value of this habitat for waterbirds, particularly stilt.

SITE NAME: Mānā Ponds

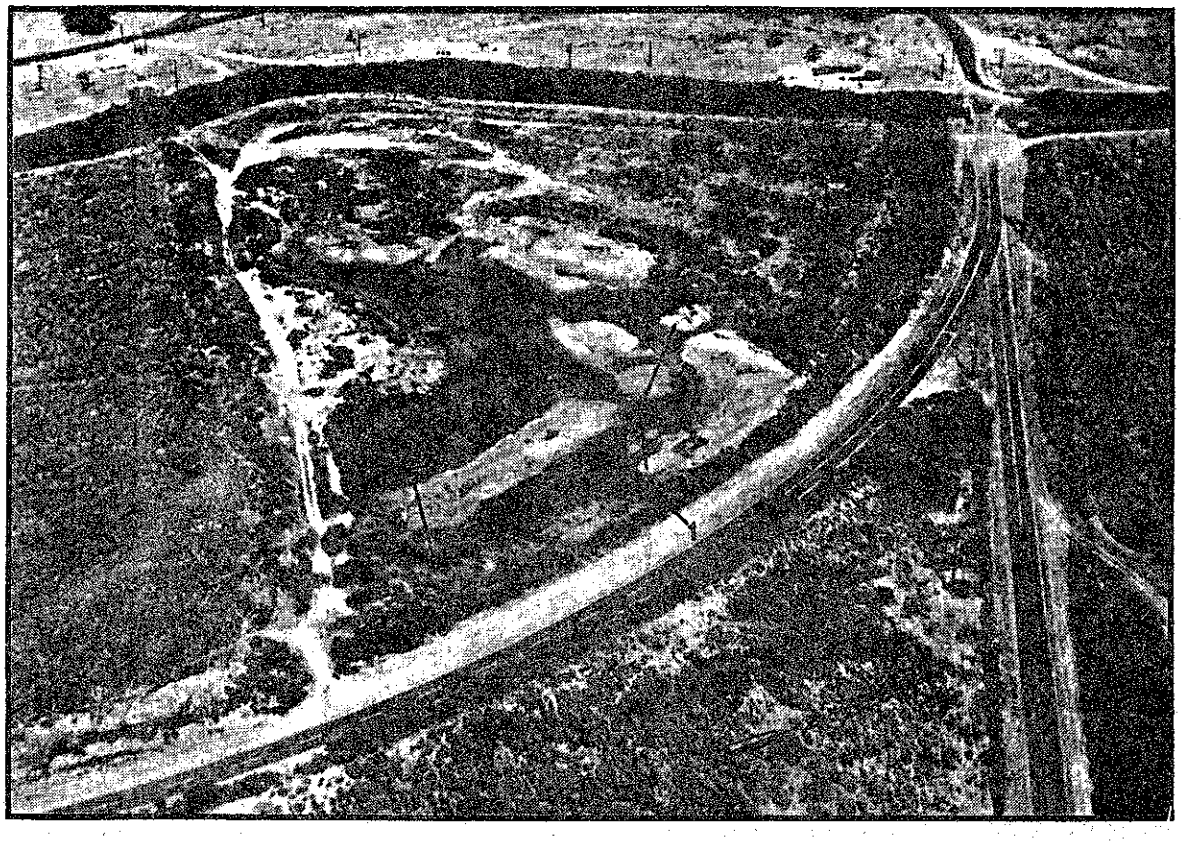
LOCATION: Wai-mea District, Kaua'i

TOPOGRAPHIC MAP: Ke-kaha

DATES OF SURVEY: 16 May, 19, 20 July, 1977

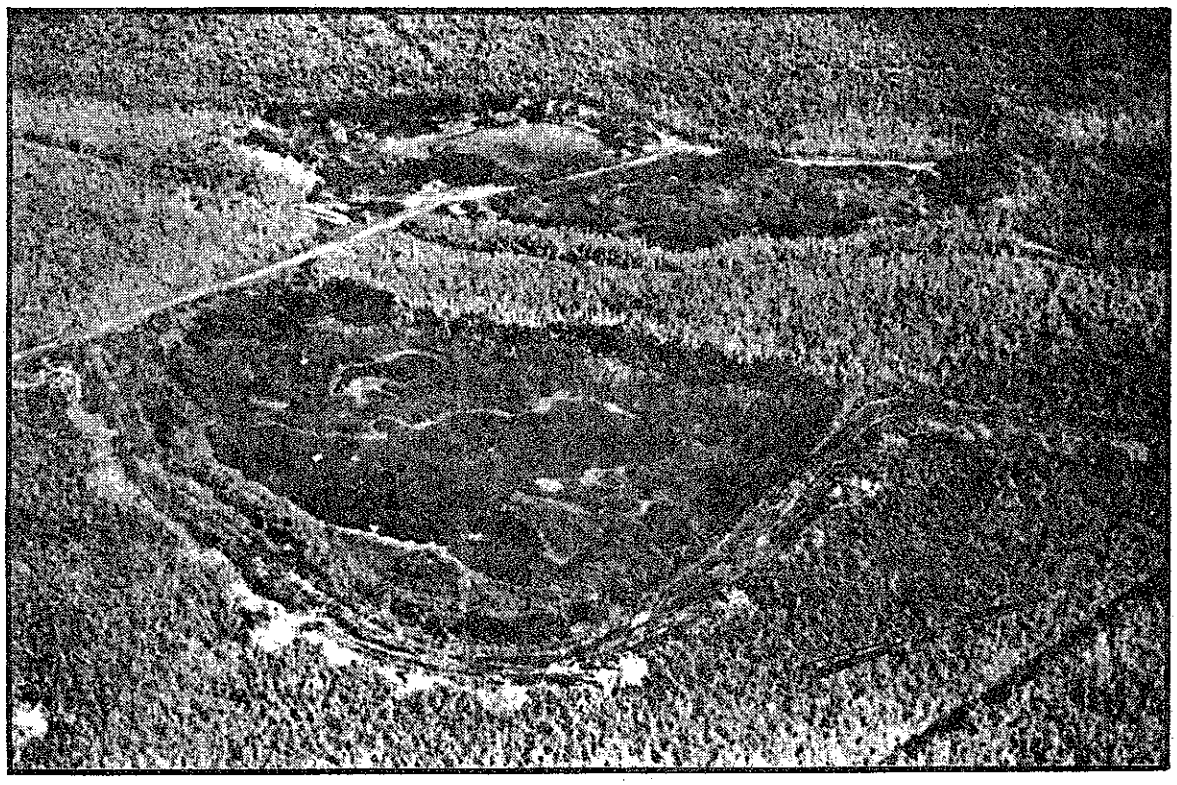
1. Base Pond

2. Brackish Ponds



Base Pond: 1. irrigation ditch connection; 2. bulrush; 3. stilt nesting sites

Brackish Pond



WETLAND DESCRIPTION: The Mana marshlands are said to have occupied 2,000 acres of land in the Kekaha region of Kauai (346). Most of this wetland habitat was drained for agricultural purposes in the 1920's (484). Mana Brackish Pond is apparently a remnant of the original marshland. Actually this site consists of two small ponds immediately adjacent to one another. Water is supplied by storm runoff or through the exposed water table. According to Telfer (484), "The brackish water table of the Mana flat lands is depressed by pumping the water from deep drainage ditches into the ocean. Fresh water is applied via surface ditches to irrigate the sugar cane produced there. During heavy storms, the pumping system cannot keep up with the runoff, and the water level rises in the pond abruptly". Mana Brackish Pond is surrounded by sugar cane lands. The crop was burned and harvested in this area during the July survey. Emergent grasses line the pond. The coral sand bottom is covered with a thick ooze layer of suspended silt (484).

Mana Base Pond is located a few hundred yards southwest of Mana Brackish Pond. The Base Pond is an artificial site, created as a result of excavation of coral sand to a level below the water table (484). This pond is directly connected to the agricultural land drainage system, so that water levels in the pond vary according to levels in the ditch system. Surrounding vegetation includes pickleweed, pluchea, sea purslane and other plants. Small patches of bulrush are also found at the pond's edge, particularly in the southeast corner.

NON-AVIAN WILDLIFE: The most common vertebrate species in both ponds at the time of survey was tilapia. Virtually the entire bottom of Mana Base Pond was excavated by tilapia redds (nests). Fish to 8" were seen in both ponds, and dense schools of fish less than 1/2 to 1 inch indicated a recent hatch. Mosquito fish (Gambusia) were present at both sites but were less common. Bullfrogs were calling near the Brackish Pond during our July visit. The dominant invertebrate was an unidentified gastropod mollusc, common in both ponds. Live crayfish were sighted only in the Brackish Pond, but crayfish remains were evident at both sites. Other invertebrates of potential importance to waterbirds as food, including dragonflies and damselflies, were not common at either site.

NON-WATERBIRD AVIFAUNA: Although virtually all of the land surrounding the ponds is in cane production, the list of non-wetland species recorded in the area was surprisingly long. Mockingbird and Melodious Laughing-thrush were far less common than other songbirds. Japanese White-eye, House Sparrow, House Finch, Northern Cardinal and Spotted Munia were common at both sites, as were both Spotted and Barred Dove. Three Ring-necked Pheasants and a single Hawaiian Owl were seen near the Brackish Pond. Burning of surrounding cane fields at the time of our July survey may have disturbed some species of birds, but it attracted well over a hundred Myna to the area in search of insect food driven out by the flames.

WATERBIRDS OBSERVED: The HDF&G has displayed considerable recent interest in these ponds with the hope that they soon can be managed as a state waterbird sanctuary. Waterbirds observed at the site in the past by State biologists have included stilt, coots, gallinule, Koloa, herons, tattlers, plovers, Sanderlings, turnstones, and Pintails. Both ponds have provided nesting habitat for Hawaiian Stilt in recent years (530). Artificial

nesting sites designed by HDF&G personnel to minimize nest loss due to changing water levels, were used by stilt at these ponds as well. However, fledging success of all nests observed has been strikingly low, particularly in the Brackish Pond (483). Telfer has speculated that the relatively steep shoreline and consequent absence of suitable feeding habitat for stilt may be in part responsible for the losses (484). He also suggested that burning of vegetation around the Brackish Pond in 1975 during cane harvest may have been responsible for low fledging success observed that year. Although cane workers were burning the fields around this pond during our July survey, the vegetation immediately bordering the pond was left intact. Accumulation of ashes on the water surface during the fire may have an adverse impact on pond ecology. Stilt were observed at both ponds during our survey, with the maximum number (n=5) seen at the Base Pond. One pair was defending a nest site in this pond during our July trip to the site. Telfer (530) informed us that two chicks had hatched from the nest site two weeks earlier, although we did not see the chicks at the pond. Feeding stilt in the Base Pond spent most of their time in pursuit of small fish during our survey.

No coots were observed at the ponds during our survey, but the species does appear infrequently in HDF&G/USF&WS count records for the site, particularly in the Base Pond. Several miles of drainage ditches and numerous small reservoirs provide preferred habitat for this species. There is little submergent vegetation in either pond, although Telfer (484) reports discovery of a road-killed coot in the vicinity whose gizzard contained seeds of bulrush (Scirpus robustus), found at the Base Pond. He also indicated that he has observed coots browsing on a small spikerush (Eleocharis sp.) in the Brackish Pond. Unless bottom conditions are modified in a way that encourages the development of suitable submergent and emergent vegetation for waterbird food and cover, it is doubtful that this species will frequent the ponds in significantly greater numbers in the future.

Gallinule also appear in HDF&G/USF&WS count records for both ponds, although no more than two birds have been seen on a single count in recent years. Two gallinule were observed during our May survey of the Base Pond, where they appeared to be gleaning food off the submerged stems of bulrushes along the shore. There is considerable room for improvement of the ponds for this species as well, although the frequent fluctuation of water levels would complicate management.

Schwartz (399) quotes an early estimate of Koloa concentration prior to draining of the Mana swamp at 400 ducks per square mile in the Kekaha area. His 1946-47 estimate was five ducks per square mile. Swedberg (406) indicated that the more recent estimate was too high during his survey. Temporary habitat is still provided by miles of drainage ditches and several hundred acres of flooded pastureland in nearby Kekaha, where small diked fields have been flooded for cattle. These areas are currently used regularly by Koloa and other waterbirds as well. Koloa have been observed by State biologists during all seasons in both the Brackish and Base ponds, although the former site is favored. Between 1970-75, as many as 14 Koloa were seen in the ponds (combined) during quarterly HDF&G/USF&WS surveys, with a number per visit average of 3.4 birds. An adult with five downy young was observed in the Base Pond in April, 1975 by State biologists, but we discovered no other records of nesting at the site. Although we observed six Koloa in flight over the ponds during the May survey, ducks were not seen on the water at either site.

The Black-crowned Night Heron, or 'Auku'u, also appears on recent count records for the Mana ponds, but never more than two birds have been sighted on a single recent visit. We saw an immature heron feeding in the limited shallow water of the Brackish Pond on 20 July, 1977. Heron pellets (regurgitated) near the pond contained the remains of crayfish. On the same day, we found a dead adult heron along the ditch that drains the Base Pond. The cause of death was not determined. Both an adult and a juvenile heron were feeding in the Base Pond during our May survey. The concentration of tilapia in small pools as water recedes in the Base Pond would appear likely to attract greater numbers of heron than appear on count records.

No migratory shorebirds were observed at either pond during our summer survey. Count records for recent years include tattlers, plovers and Sanderling, but never in large numbers. Presumably the limited variety of burrowing invertebrates in the Base Pond and the relatively deep water in the Brackish Pond provides little suitable feeding habitat for these species.

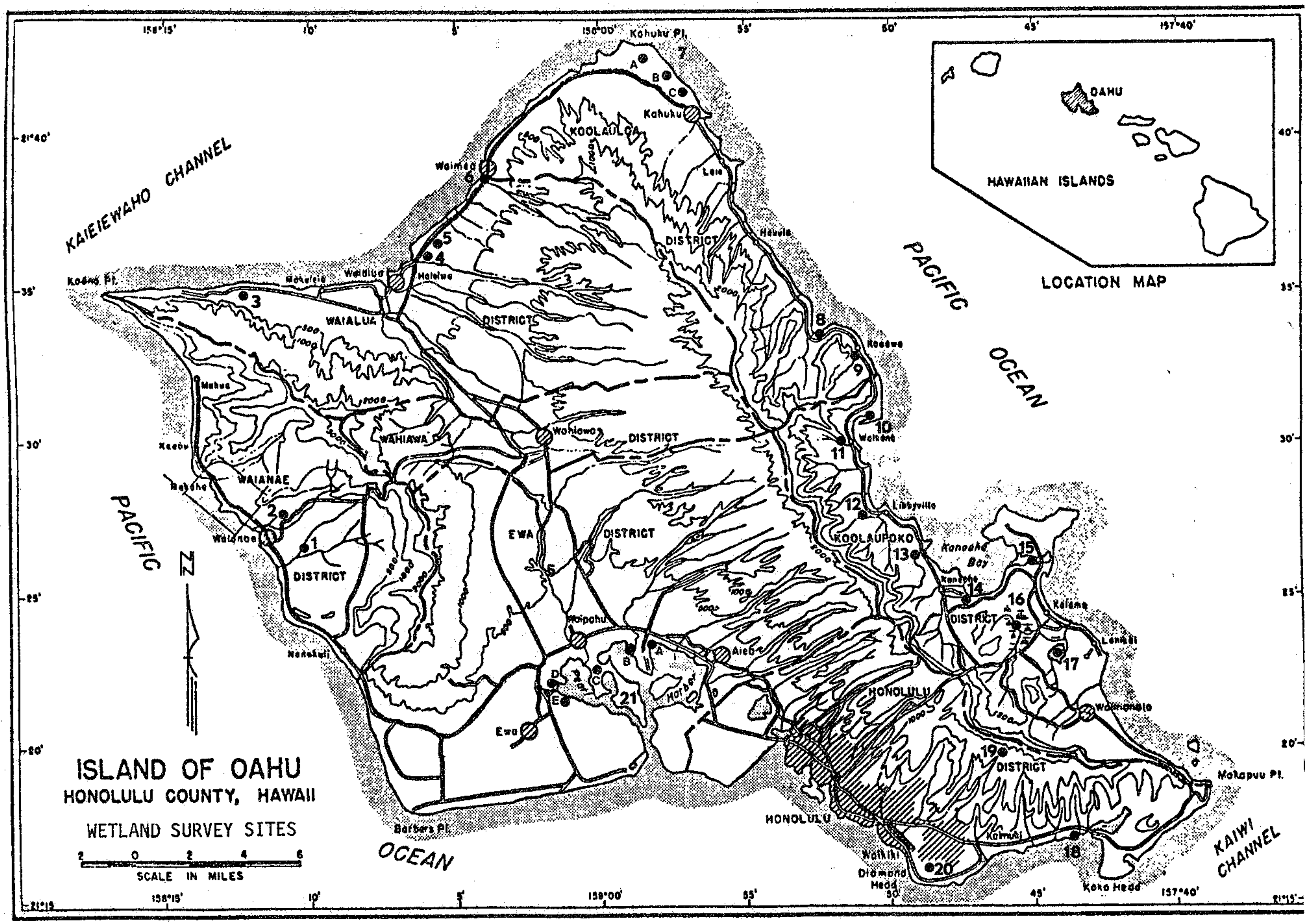
HABITAT EVALUATION: The Mana swamp area was of major importance to waterbirds, particularly Koloa, prior to its draining early in this century (406). Now the pond sites we surveyed, together with drainage ditches, reservoirs and flooded pastures provide only a small fraction of the original habitat. Yet, taken together they are important to the continued survival of Kauai's wetland birds, particularly the Hawaiian Stilt. The HWRP (346) lists this site as a "primary area" and recommends management as a State waterbird sanctuary. Although available evidence suggests that the Kauai population of Hawaiian Stilt nests principally on Niihau, it now appears that only three major habitat areas provide alternative nesting sites on Kauai (Mana-Kekaha, Lihue Settling Basin and Hanalei). Telfer (483) has suggested that availability of suitable nesting sites is a severe limiting factor to stilt production of Kauai, as evidenced by use of artificial nesting sites at Mana ponds. The potential value of the Mana area could be realized through maintenance of water levels, predator control and reduction of human disturbance in the nesting areas. The last of these requirements may be difficult to achieve as long as the land immediately surrounding the ponds is in cane production. Provision of an undisturbed buffer zone, particularly around the Brackish Pond, would reduce this problem.

The suitability of the site for other wetland birds could be improved if managed to provide greater cover and food plants. This would require more effective control of water levels (and varying salinity). It may also involve dredging of accumulated silt, particularly in the Brackish Pond.

POTENTIAL IMPACT OF DREDGE/FILL ACTIVITIES: Any substantial reduction in size of either Mana pond as a result of fill deposition would lower the value of the site to waterbirds significantly. In fact, even with stabilized water levels and effective predator control, the production of young by Hawaiian Stilt would be limited by territoriality of nesting birds and the lack of suitable feeding habitat in the Brackish Pond. Controlled dredging could prove to be an effective tool to increase the amount of feeding habitat, to remove accumulated silt to encourage growth of submergent vegetation and to enlarge the nesting area. Use of the Base Pond by stilt and other waterbirds demonstrates how artificial habitat can play an important role in waterbird conservation, and suggests the need to create additional feeding and nesting habitat in the Mana area.

O'AHU

WETLAND AREAS SURVEYED


ISLAND OF OAHU
HONOLULU COUNTY, HAWAII
WETLAND SURVEY SITES
SCALE IN MILES
LOCATION MAP
HAWAIIAN ISLANDS
OAHU
PACIFIC OCEAN
KAIEIEWAHO CHANNEL
KAIWI CHANNEL
KOOLAULOA DISTRICT
WAIALUA DISTRICT
WAHIAWA DISTRICT
WAIANAE DISTRICT
EWA DISTRICT
KOOLAUPOKO DISTRICT
HONOLULU DISTRICT
Kahuku Pt.
Kahuku
Laie
Hauula
Waimea
Waialua
Haleiwa
Kaena Pt.
Mokuleia
Makua
Keaau
Waianae
Nanakuli
Barbers Pt.
Ewa
Waipahu
Pearl Harbor
Aiea
Wahiawa
Kaaawa
Waikane
Libbyville
Kaneohe Bay
Kaneohe
Kailua
Lanikai
Waimanalo
Makapuu Pt.
Koko Head
Kamuki
Waikiki
Diamond Head
HONOLULU

OAHU

INTRODUCTION: Oahu is the second oldest of the main islands. Geologically it is characterized by a flat plateau separating two parallel mountain ranges (Koolau, Waianae) running northwest to southeast. Rainfall on the island ranges from less than 10" per year to more than 250". It is the most urbanized of the Hawaiian Islands, supporting more than 80% of the State's population. It is, therefore, not surprising that wildlife habitat on the island, especially wetlands, has been radically altered by man.

The diversity of natural and man-made wetlands on Oahu is very large. Included in our survey were freshwater marshes, brackish marshes, estuaries, tidal lagoons, ephemerally flooded pastureland, taro fields, reservoirs, cane water settling basins, sewage ponds, fishponds and natural crater bogs.

In all, 21 wetland areas on Oahu were surveyed, although some of these areas contain numerous smaller sites (i.e. Pearl Harbor, Kahuku). Wetland areas of significance to water birds that were not surveyed include Keehi Lagoon, Fort Kamehameha Tidal Flats, Nuuanu Reservoirs, Bellows AFS marshland, Salt Lake and the Lualualei Naval Ammunition Depot at Waianae (Niulii Reservoir). All but the last of these are treated in earlier publications (343,346). The Lualualei NAD reservoir has been declared a Navy Wildlife Refuge because it regularly attracts coots and gallinule, and, in smaller numbers, stilt, heron, Koloa and migratory waterfowl. Some additional wetlands have been destroyed (Moanalua ponds, Waikiki ponds) or so radically altered (Kuapa Pond) that they are no longer of value to birds.

Several wetland areas on Oahu are under various forms of protective status. National Wildlife Refuges on Oahu include James Campbell NWR (Kii and Punamano Ponds) and Pearl Harbor NWR (Honouliuli and Waiawa units). Paiko Lagoon is a State Wildlife Sanctuary, while the ponds at Kaneohe Marine Corps Air Station are managed by the U.S. Marine Corps as a wildlife refuge. Lualualei N.A.D. pond (Niulii Reservoir) is designated as a U.S. Navy wildlife refuge.

WATERBIRDS ON OAHU: Hawaiian Stilt find suitable feeding habitat on Oahu at widely distant wetlands, often taking advantage of tidal mudflats, ephemerally-flooded pastureland and sugar cane waste water settling ponds. In recent HDF&G/USF&WS counts, Oahu wetlands have supported between 30-60% of the State's population of stilt. Occasional radical fluctuations in numbers counted can probably be explained by the combined influence of inter-island movement, inadequate habitat coverage, and variable nesting productivity. The prime stilt nesting areas on Oahu are the KMCAS ponds and the Pearl Harbor wetlands. Kii Pond was also an important stilt nesting site prior to the closing of Kahuku Sugar Mill in 1972, and may again become very important under refuge status. Stilt habitat on Oahu has been treated in detail in earlier HDF&G publications (480).

Hawaiian Coots have been recorded in many fresh and brackish water wetlands on Oahu, with greatest numbers regularly observed in Kahuku wetlands, Kawainui Marsh, Kaelepulu Pond, Nuuanu Reservoirs, Salt Lake and Lualualei N.A.D. Past HDF&G/USF&WS count records show occasional abnormally high concentrations of coots in

Oahu's wetlands. It has not been determined whether these counts reflect a temporary influx of the mainland birds or patterns of interisland movement of Hawaiian birds. With these exceptions, recent coot counts on Oahu have remained relatively constant, with slight variations easily explained by difference in weather conditions and habitat coverage on count days.

Gallinule appear to be more restricted in distribution on Oahu than are stilt or coots, but HDF&G/USF&WS count records to date do not accurately reflect gallinule populations because of the secretive nature of the species. Our experience indicates that surprisingly large numbers of gallinule may be found in small wetlands (i.e. Haleiwa, Ukoa Pond, Heeia Marsh) with a more thorough survey than is possible on the one day semi-annual counts. The draft HWRP (346) estimates the Oahu gallinule population at $\pm$ 250 birds.

Black-crowned Night Herons and Cattle Egrets are widely distributed on Oahu, often sharing the same habitat. Principal nesting areas for both species are in Pearl Harbor, Kaneohe MCAS and Kahuku. An additional heron nesting area is found in kiawe forest behind Sea Life Park, in Waimanalo. Herons are also seen less frequently feeding and roosting along inland streams on Oahu.

Migratory waterfowl appear to prefer a limited number of varied wetlands. Greatest numbers are typically seen in Pearl Harbor and Kahuku wetlands, with smaller concentrations at Kawainui Marsh, KMCAS, Kaelepulu Pond, Bellows AFS, Salt Lake and other small sites. Pintails and Northern Shovelers are the most common migratory waterfowl found on Oahu, with Pintails almost invariably the more abundant of the two. Many other species have been recorded as well, though in fewer numbers than Pintail and Shoveler. The migratory waterfowl count on Oahu typically accounts for 5-15% of the statewide total.

Migratory shorebirds on Oahu are found in greatest numbers in Pearl Harbor wetlands, Kahuku wetlands and at KMCAS. HDF&G/USF&WS counts of the most common shorebird species show the great importance of Oahu wetlands to these birds (page 119). It is no surprise that, at least until recently, most of the rare migratory shorebirds and waterfowl were recorded in Oahu wetlands, due to the larger number of birdwatchers that frequently visit these areas.

OAHU WETLANDS OF MARGINAL VALUE TO WATERBIRDS

The wetland sites surveyed on Oahu included several areas that were determined to be of little or no value to wetland birds in their present condition. Several other similar sites were not surveyed. These areas are diverse in their origin, but have several characteristics in common. There is generally very little open water available to waterbirds, at least at the time of our survey. The sites included ephemerally flooded pastures, former marshlands that have been choked with vegetation, stream drainages and natural craters. Grazing is the dominant current use on many of these marginal sites. These areas will be discussed here only briefly, while wetlands of more significance to waterbirds will be treated in detail in the following pages.

Lualualei Reservoir

Survey: 19 August, 1977

This depressed flood plain was formerly a large reservoir, that has been completely choked by encroaching California grass. The site is fed by springs and storm runoff. It was originally diked around the entire periphery, and dammed at the downstream end to provide water storage capability. It has since been opened, and is now drained after heavy rains by a large channelized stream. Ground water near the surface keeps the grassland green all year around. It holds some water for a short time after flash floods and Kona storms. The surrounding dike is covered with koa haole, Christmas berry and hau. The lessee at the site indicated that small stands of bulrush formerly grew at the edges of the reservoir when permanent water was present. The grassland is now used only as grazing pasture-land, although the lessee expressed a desire to dig a well in the center of the site.

Cattle, mongoose and dogs were seen on survey of the site. There was no standing water to support a diverse aquatic fauna, but tilapia, mosquito fish and other fishes can be expected at the site during the period it retains water. Non-wetland birds observed at the site included Northern Cardinals, Common Mynas, Barred Doves, Spotted Doves and House Finch. Cattle Egrets were common (50+) in the prime grazing areas. The lessee reports that migratory ducks occasionally visit the reservoir when it is holding water temporarily after storms. At these times, the reservoir may be more than three feet deep.

Kawiwi Stream Wetland (not pictured)

Survey: 19 August, 1977

This inland depression along Kawiwi Stream was at one time a site that must have flooded regularly during Kona storms. With the construction of an extensive channelized drainage, some of the ephemerally flooded lands have become inhabitable and several small farms have moved onto the site. Most of the open lands that still flood in heavy rains are grazed by small herds of cattle. The dominant ground vegetation is California grass, although much of the area is bare soil. There was no standing water on the site at the time of survey, and it is certain that runoff is rapid after storms.

We observed a single Wandering Tattler feeding in mud that had accumulated within the channelized drainage. One resident commented that "wild ducks" occasionally landed at the site after heavy rains. I suspect that a few Hawaiian Stilt would also seek food on flooded mud flats. As many as nine stilt have been counted on a recent HDF&G/USF&WS survey at small reservoirs in nearby Makaha Valley. Presumably there is some movement of birds between these reservoirs and ephemerally flooded flatlands along the Waianae coast when conditions are suitable. However, on a long-term basis, the Kawiwi Stream pastureland is of little value to waterbirds. Given the present levels of human disturbance and lack of permanent water, the site has very little potential for improvement as waterbird habitat.

Dillingham Airfield Wetland (not pictured) Survey: 5 May, 1977

Approximately 400 acres of land at Dillingham Airfield in Mokuleia are now leased for cattle grazing. The primary grazing area includes extensive mudflats that are flooded during heavy rains. Vegetative cover on these mudflats depends, in part, on the frequency of grazing and on the amount of time that has passed since the last rainfall and runoff from the steep slopes of the Waianae Range. Lantana and pluchea cover the open pasture land, but a tall growth of guava, monkeypod, java plum and kiawe is also found on the periphery of the mudflats. As many as 110 head of cattle are grazed within this single fenced pasture, so much of the ground is heavily trampled, with well-used pathways throughout.

This site was visited during this survey and during an earlier study by the Principal Investigator (402). At both visits, a small amount of turbid standing water was present, but even the deepest puddles were less than six inches deep. Yet, adults and Rana rugosa tadpoles were observed on each trip. Mongoose were seen throughout Dillingham Airfield during the present survey. Rat runways and burrows were observed in the pastureland. The most abundant invertebrate in this area was the African snail. Non-wetland birds observed on both surveys included Red-crested Cardinals, Northern Cardinals, Japanese Bush-warblers, Barred Doves, Spotted Doves, Japanese White-eyes, House Finch, House Sparrows, and Common Mynas. On the earlier study, Mockingbirds, Spotted Munia, Ring-necked Pheasant and Erckel's Francolins were also recorded (402).

The ephemeral nature of the Dillingham airfield "wetland" provides little waterbird habitat. Although Golden Plovers were common during the earlier survey of this site, most were confined to abandoned taxiways and open grassland elsewhere in the airfield. A single Black-crowned Night Heron was observed on each of two trips to the mudflats during the earlier survey (December, 1976; March, 1977). Although these birds were perched in trees at the edge of the mudflat, the only obvious source of food in the general area were frogs in the puddles. Numerous fishponds and taro fields in the Haleiwa area provide more suitable habitat for herons but it is not uncommon for these birds to range widely in search of temporarily abundant food. Total elimination of the marginal habitat at Dillingham Airfield would probably have no noticeable impact on the population of this or any other waterbird on Oahu.

Wai-mea River Wetland Survey 5 May, 1977

The lower reaches of Waimea River are bordered by extensive grassland and small patches of bulrush that are flooded only when prolonged rainfall raises the level of the river. The river maintains a connection with the ocean in Waimea Bay most of the year, but heavy storm surf can build up a sand dune that blocks the river flow for short periods. The resulting back-up of water may increase the breadth and depth of the river so that all the neighboring grassland is flooded.

Presumably, all of the typical estuarine fishes inhabit the lower reaches of Waimea River. We observed only tilapia, mullet and mosquito fish on our survey. The aquatic fauna probably also includes freshwater prawns and the typical complement of amphibians. There is little habitat for non-wetland birds below the highway bridge. We recorded Northern Cardinals, Common Mynas, Japanese White-eyes, Barred Doves, Spotted Doves and Spotted Munia during our survey of the wetland above the highway. The waterbird count included a single Black-crowned Night Heron below the bridge, two Golden Plovers near the channel into the ocean, and a pair of Mallard ducks above the highway bridge. Several species of exotic ducks have been released by the management at Waimea Falls Park, located less than 500 yards above the bridge. In addition, 11 Koloa were released by HDF&G biologists at the park in May, 1974, and 20 in February, 1977. Whether or not these captive-reared birds are breeding successfully in the area has not been determined. An employee at the park reported infrequent observations of Hawaiian Coots in the stream.

The ephemeral wetland along the lower portion of Waimea River provides only marginal waterbird habitat because of frequent fluctuations in water level and due to the encroachment of grasses to the edge of the river. Also, the river is subject to continuing human disturbance associated with the beach park and Waimea Falls Park. Dogs, cats and mongoose are common in the area and presumably inhibit nesting along the river by either exotic or native waterbirds. Although partial damming of the lower portion of the river would allow better control of water levels, it would not be justified solely on the basis of potential improvement of waterbird habitat.

Ka-'a'awa Valley Wetland Survey: 7 May, 31 July, 1977

Approximately one-half mile south of the Kaaawa Stream drainage, a partially flooded pastureland is identified on the Kahana topographic map as marshland. Presumably the site receives its water from underground springs and possibly a connection with Kaaawa Stream. The pasture is covered with California grass and patches of hau, bulrush and a few ironwood trees. Standing water under the grass varies between 4-12 inches deep, and the soft mud bottom is between 6-14 inches to harder substrate. The site is part of Kualoa Ranch property and is heavily grazed by cattle.

Although a large number (60-70) of Cattle Egrets were counted during our survey, the site is clearly of very limited value to native waterbirds because of the limited water, dense vegetation, and grazing cattle. One gallinule was heard and then seen as it ran through the California grass. Our coverage of the

site was complete enough to feel confident that very few other waterbirds could have been missed. If the grass cover opens somewhat during heavy rains, a greater number of waterbirds might visit the site, but the density of vegetation and a poorly developed aquatic fauna prevent the site from being more than marginal habitat.

Wai-a-Kāne Wetland (not pictured) Survey: 7 May, 31 July, 1977

A low-elevation marshland is shown on the Kaneohe topographic map at the base of Waiakane Stream. On survey, the site proved to be a combination of ephemerally-flooded grassland and mangrove swamp. Most of the grassland is above Kamehameha Highway. The site is dominated by California grass, with scattered patches of bulrush. At the time of survey, water was between two to four inches deep in the grass. Parts of the land are now used for cattle grazing.

Non-wetland bird species observed along the stream drainage and open grassland included Shama, Melodious Laughing-thrush, Red-crested Cardinal, Spotted Dove, Barred Dove and Japanese White-eye. As many as a dozen Cattle Egrets were associated with the few cattle in the pasture land. On one visit two Black-crowned Night Herons were roosting in mangrove trees near the highway. Fishes and crustaceans in the stream drainage provide a regular source of food for this species, but continual disturbance from cars and people on the highway and at nearby houses probably inhibits greater use of the area.

Shortly after periods of stream flooding, the pastureland above the highway probably attracts greater numbers of herons and other waterbirds. The value of the area for waterbirds has surely declined in this century, as nearly 60 per cent of the normal flow in Waiakane Stream has been diverted for agriculture and other purposes (82).

Kaha-lu'u Wetland Survey: 8 May, 1977

A small, intermittent stream feeds water to another small marshland along Kamehameha Highway. The site is west of Kahaluu Fishpond. The marshland is choked with bulrush and a lesser amount of California grass. Water in the marsh was between four to six inches deep when surveyed, but a one-to-two foot thick layer of mud and organic ooze lay under the water. The land is presently used for cattle grazing, and is subject to considerable noise disturbance from nearby residences and businesses.

Cattle, dogs and mongoose were all observed within the marsh. Judging from the distribution of tracks on patches of exposed mud, there is no part of the existing wetland that is inaccessible to these species. The shallow water supports a surprisingly high density of mosquito fish, crayfish and gastropod molluscs. Two gallinule were flushed as we walked through the area, and some others may have been missed. To the extent that the site would hold additional water after heavy rains, there is some chance that greater numbers of waterbirds may inhabit the marsh intermittently. However, the neighboring human disturbance and accessibility of the site to a large number of people, predators and cattle prevents the wetland from being of more than marginal significance to waterbirds.

Kāwā Stream Wetland Survey: 7 May, 1977

Kawa Stream and Kaneohe Stream enter Kaneohe Bay at a point where numerous fishponds were located until late in the last century. Only one major fishpond can still be found, between these two streams. Both of the streams pass through densely urbanized lands, and both have been the subject of extensive channelization in recent years. The lower portion of Kawa Stream (3800') will probably be channelized within the next few years (82). The "wetland" along Kawa Stream that we surveyed is an ephemerally-flooded grassland. Although four to six inches of water covers much of the lower-elevation portions of this site, there is no open water at this time. It is likely that proposed channelization will cause the "wetland" to dry out completely.

USF&WS biologists sampled Kawa Stream beyond the flooded grassland and found crayfish, Chinese catfish, guppies, swordtails and mollies (82). Of these, we found crayfish and guppies in the shallow water in the grassland. Presumably all these species, and probably tilapia as well, are present in the flooded grassland after heavy rains. Non-wetland birds recorded at the site included Red-crested Cardinals, Northern Cardinals, Common Mynas, Rock Doves (pigeons), Barred Doves, Spotted Doves, House Sparrows and Spotted Munia. Dogs were seen at the nearby golf course and near the fishpond, but none were observed on the grassland.

The only waterbird observed at the site was a single Black-crowned Night Heron. The operator of the nearby fishpond indicated that herons visit his facility as well, but did not remember ever seeing migratory ducks. Presumably Cattle Egrets visit the sewage treatment plant behind the fishpond on occasion, but they were not seen during our survey. They were observed during a recent botanical survey of the area (95). It is clear that the entire Kawa/Kaneohe lower stream drainage is of little current significance to waterbirds.

Diamond Head Crater Wetland Survey: 22 May, 1977

A spring near the center of Diamond Head Crater supplies water to an open pond that has varied in size historically. At the present time, an elaborate pumping system has been established to prevent any increase in the amount of open water. The small pool that remains is less than two feet deep. At the time of survey it was covered with a thin oil scum and smelled foul. Surrounding vegetation is a combination of California grass, Kikuyu grass and a variety of small shrubs. Scattered koa haole, kiawe and ilima trees are also found in the crater floor. A larger, more permanent body of water has supported a more extensive wetland flora in the past, and this could be restored with little effort at containment. Presumably the presence of mosquitoes and the smell associated with stagnating water are the primary reasons for the ongoing pumping program.

Non-wetland birds recorded within the crater included Spotted Doves, Red-crested Cardinals, Northern Cardinals, Japanese White-eyes, Spotted Munia, House Finch and Common Mynas. On previous trips by the Principal Investigator to the site, exotic cage finches that are well-established on the north slopes of Diamond Head have also been observed within the crater. No waterbirds were seen within the small, polluted pond during the present survey. However, the site has a history of waterbird use. Munro (490) reported hearing from others in 1903 that people shot ducks "in a lagoon in the crater of Diamond Head". Munro recommended that it be declared a sanctuary, believing that the "lagoon" would attract migratory ducks. The most recent sighting of Koloa in the crater pond was in

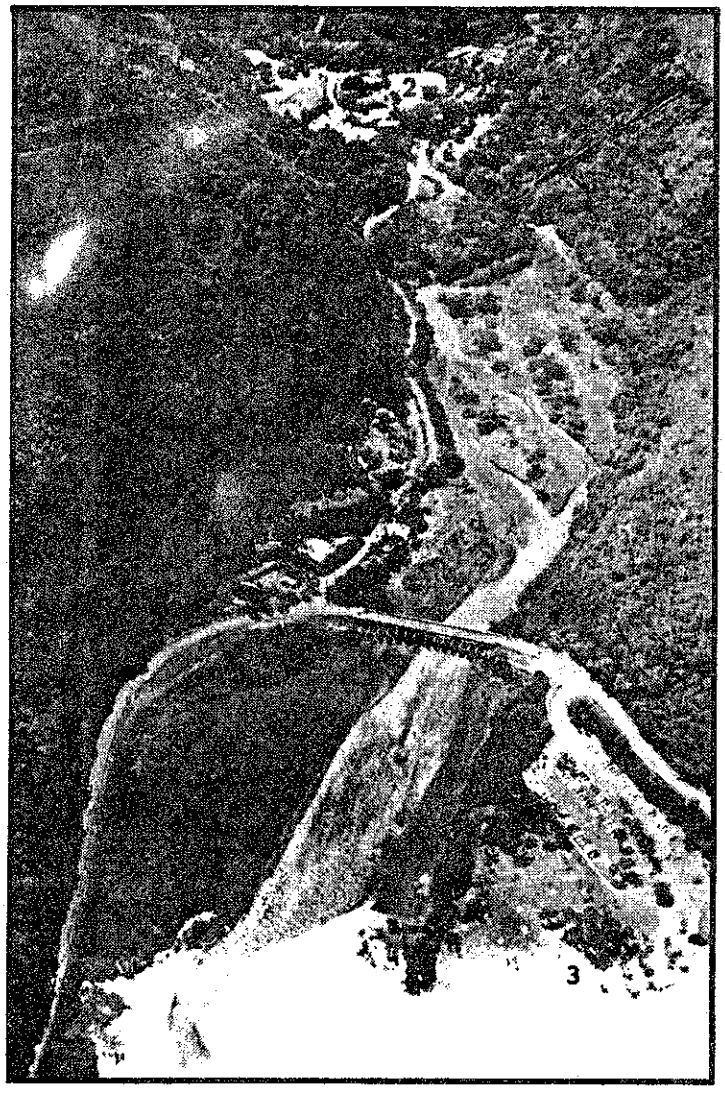
the 1968 Christmas Count. This pair of birds may have come from hand-reared stock at the Honolulu Zoo. Although observations since this record have been infrequent, it is apparent that the site is currently of little value to waterbirds. It is not likely that Federal and State agencies involved in the management of Diamond Head Crater lands would look favorably upon any plans to expand the open water in the hope that greater numbers of waterfowl might be attracted to the site.

Ka'au Crater (not pictured) Survey: 17 August, 1977

Kaau Crater is located above Palolo Valley, near the leeward summit of the Koolau mountain range. Although the crater floor is less than 1600 feet in elevation, the steep pali slopes that border the northeast edge of the crater rise to nearly 2400 feet. The site is almost always in the clouds, and hence derives much of its water from fog drip as well as rainfall. The flat bog on the crater floor is densely vegetated with grasses, bulrush, hau, ohia, strawberry guava, and other shrubs. The crater floor is nearly 1500 feet across, but less than two per cent of the bog was actually open water at the time of survey. Depth of water in the open pools ranged from 6-18 inches. Presumably long periods of heavy rain will expand the amount of open water considerably. Palolo Water Tunnel drains from the crater floor, supplying fresh water for parts of Palolo and Kaimuki.

Both tadpoles and adults of the Japanese Wrinkled Frog were seen in the open water pools, along with small gastropod molluscs and some aquatic insects. Dogs were seen on the trail above Palolo and probably are found at the crater site occasionally. The surrounding ohia forest supported an impresive concentration of native forest birds ('Apapane, 'Amakihi) as well as exotic Japanese White-eyes and Spotted Doves. Hikers we met on the trail indicated that "wild ducks" and Hawaiian Stilt had visited the crater in the past. There were no suitable feeding areas for stilt at the time of our survey, but it is likely that falling water levels after periods of heavy rain leave shallow water and mudflats. We saw one pair of Koloa and three Hawaiian Coots in small pools within the crater. The Koloa circled the crater several times before landing, suggesting the possibility that overhanging power lines may present a hazard to these and other birds. Possibly Hawaiian Gallinule would also find suitable cover and food within the crater wetland, but changing water levels and predators (particularly mongoose, rats, feral cats) probably inhibit successful nesting by these species. The Koloa that were observed were probably from hand-reared birds (or their progeny) that were released on the windward side and at the Honolulu Zoo. There is one record of a Koloa observed in Manoa Stream that had been released shortly before on the windward side of the Koolau Range (533).

There is little opportunity to manipulate in Kaau Crater for the benefit of waterbirds because the site provides fresh water for Palolo and Kaimuki. For the same reason, it is unlikely that the area will be modified by the Board of Water Supply in a way that will adversely impact on the limited use of the habitat by waterbirds. Our observations of Koloa and coots, and the reports of stilt in the crater, suggest the need for repetitive surveys at different times of the year to more adequately evaluate the area.



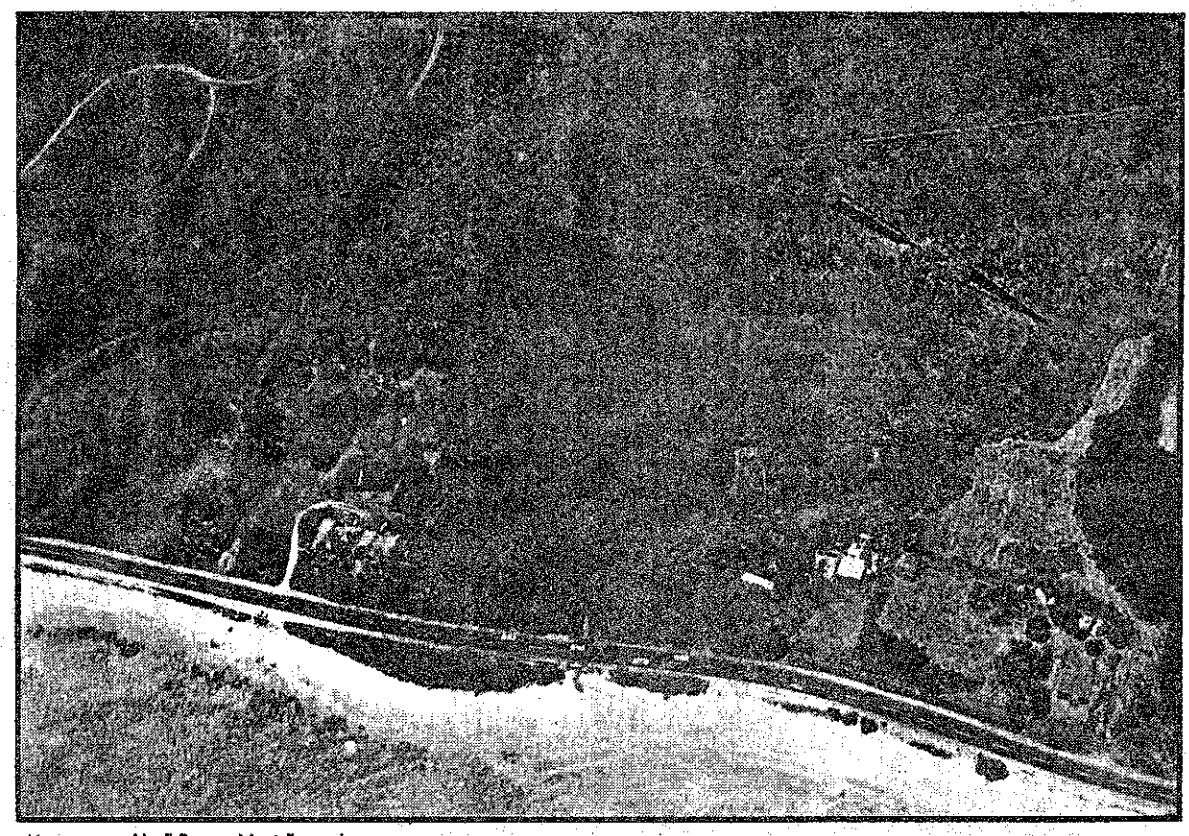
Lualualei Reservoir:

1. channelized drainage

Waimea River:

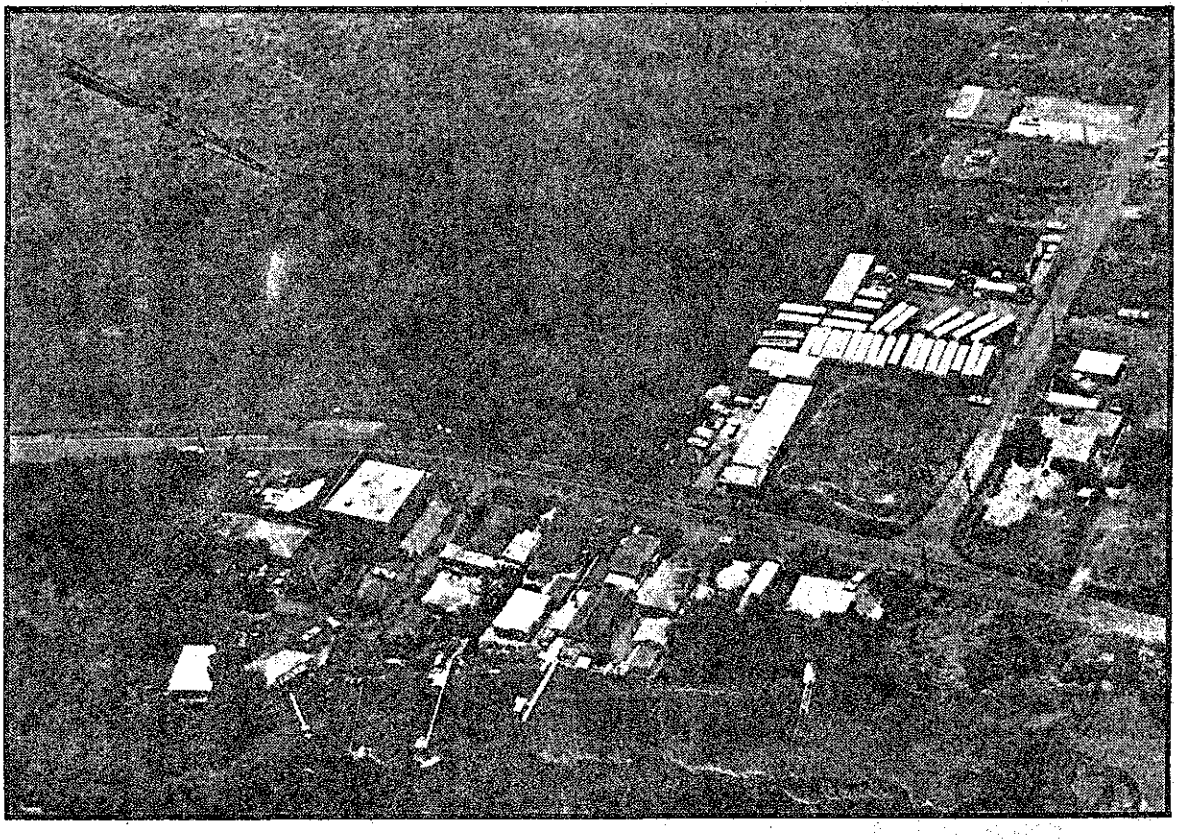
2. Waimea Falls Park

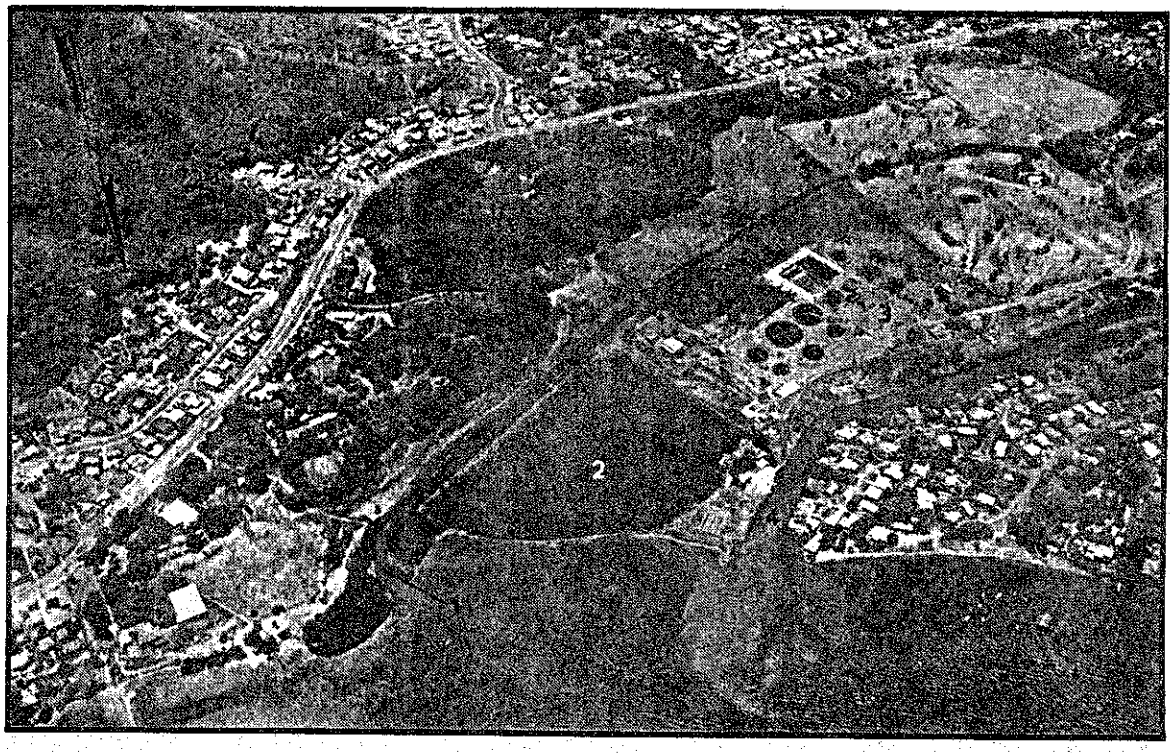
3. Waimea Bay Beach Park



Kaaawa Valley Wetland

Kahaluu Wetland



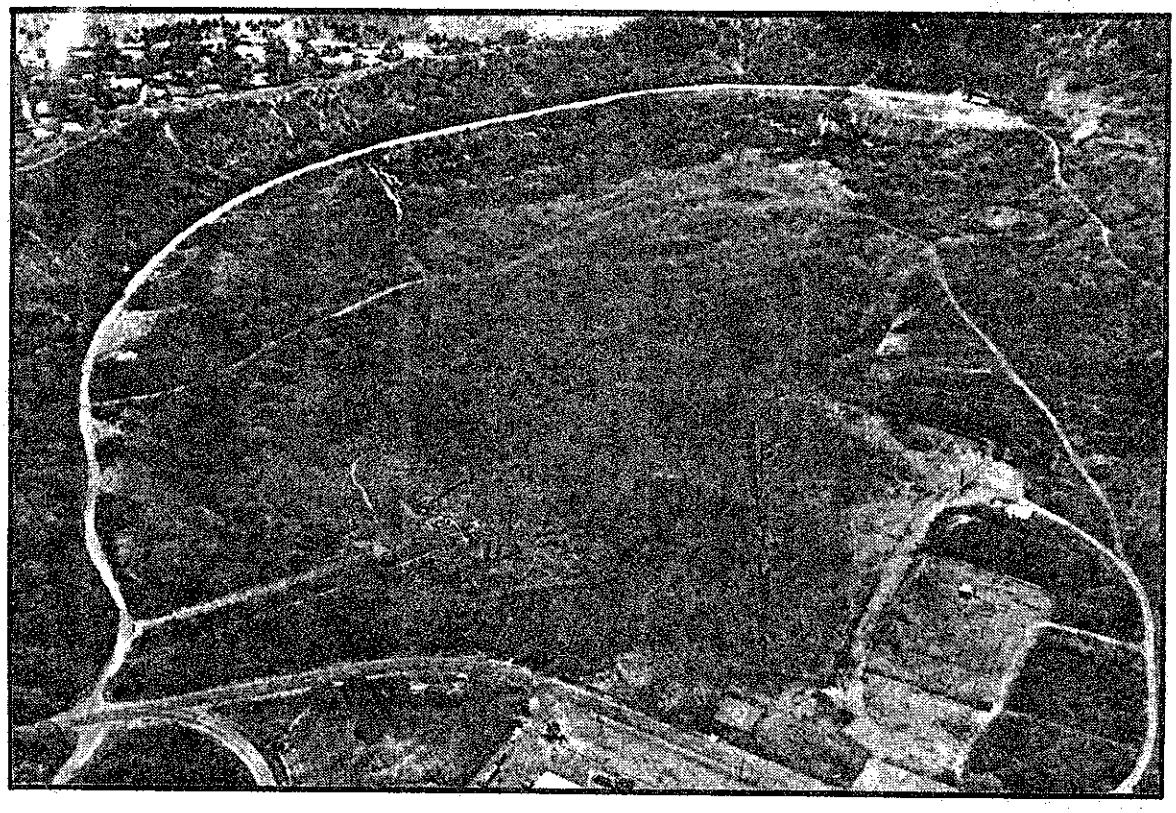


Kawa Stream wetland.

1. Kawa Stream
2. fishpond
3. sewage treatment plant
4. Kaneohe Stream
5. Kaneohe Bay

Diamond Head Crater.

1. wetland area (and pump)

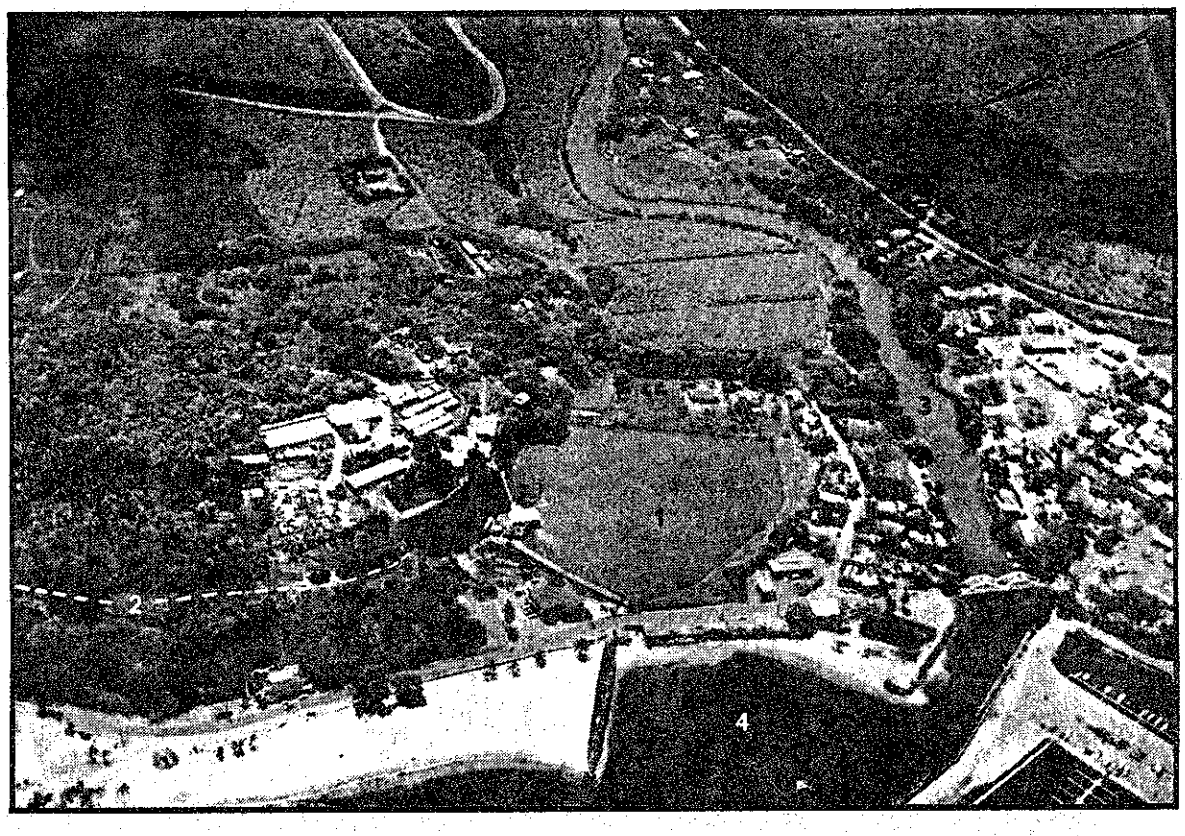


SITE NAME: Hale-'iwa Wetlands

LOCATION: Wai-a-lua District, O'ahu

TOPOGRAPHIC MAP: Hale-'iwa

DATES OF SURVEY: 5 May, 23 August, 1977



1. Loko Ea Pond
2. former connection to Ukoa Pond
3. Anahulu River
4. Haleiwa Harbor

WETLAND DESCRIPTION: Early in the present century, much of the Haleiwa lowlands between Anahulu and Kaukonahua streams were developed for wetland agriculture, primarily rice and taro. A map prepared just before World War II illustrates more than 150 separate water impoundments in this area. On the most recent topographic map, this area is illustrated as marshland. In fact, most of this wetland agriculture has succumbed to housing development and the expansion of sugar cane fields. The relatively few taro and lotus fields that remain now provide important habitat for waterbirds, but there is little left that could be called "natural" wetland, except along the stream banks. Some additional small inland ponds have been constructed for aquaculture purposes as well.

The taro and lotus (hasu) fields are fed by springs, wells and the perennial streams, depending upon their location. Some additional wetland habitat is created by canals that accomodate irrigation runoff from cane fields. The largest "natural" pond is Loko Ea, immediately north of the mouth of Anahulu Stream. Open water formerly connected this pond with Ukoa Pond, but encroaching vegetation has choked the original channel.

NON-AVIAN WILDLIFE: The shallow water in taro and lotus fields in the Haleiwa area support aquatic fauna typical of wetland agriculture throughout the islands. Amphibians recorded on the survey included Bufo marinus, Rana catesbiana, and Rana rugosa. Tadpoles of the latter species were abundant in some ponds. Mosquito fish and tilapia were the most common fishes in taro fields, but mollies, mullet and swordtails were also seen. Gastropod molluscs, crayfish and various aquatic insects were also widely distributed in taro and lotus fields. Dogs, cats and mongoose were all common and virtually unrestricted from access to most sites.

NON-WATERBIRD AVIFAUNA: The most common non-wetland birds recorded on survey were Spotted Doves, Barred Doves, Spotted Munia, House Sparrows and Common Mynas. Freshly drained taro fields were particularly attractive to mynas. Red-crested Cardinals, Northern Cardinals and House Finch were all observed but were far less common than the other species.

WATERBIRDS OBSERVED: There are few comparative data on waterbirds in this area of Oahu, although Loko Ea appears on some early Hawaii Audubon Society field trip reports. Udvardy reported observations in October 1958 of a Snow Goose at this site, as well as Wigeon, Pintails, coots and gallinule (496). On the most productive day of our survey, we observed nine gallinule and heard calls of at least eight more, all within less than 50 per cent of the taro and lotus fields in the Haleiwa area. Most of these fields provide perfect cover for this species, but little open water that would be attractive to other endemic or migratory waterbirds. The gallinule were extremely wary, but were feeding on grassy dikes and within the wetland crops when observed. Landowners were familiar with the bird, and one person reported that some were shot occasionally because of their taro-eating habits.

Black-crowned Night Herons were observed in small numbers at two taro fields and along a drainage ditch that had become partially choked with water hyacinth. Landowners that manage fishponds with young mullet and freshwater prawns often find this bird to be a pest, and it is likely that some are shot in this area. We counted more than 50 Cattle Egrets as we moved from site to site. Landowners felt that they were increasing in numbers in the Haleiwa area. They were frequently attracted to taro fields during harvest or planting.

It is not surprising we did not see any migratory ducks, because of the scheduling of our survey, but several landowners confirmed that the inland fish ponds and drainage canals are attractive to these birds. Some ducks are said to visit the lotus and taro fields immediately after harvest when ponds are open and food organisms are trapped in puddles left by falling water levels. We observed a flock of 15 Ruddy Turnstones resting on a mud dike during the May visit. In winter months, they would also be attracted to fields with shallow water and exposed mud. Several landowners we visited had small numbers of domestic Peking and Muscovy Ducks, some of which ran loose on their land and within their wetland fields.

HABITAT EVALUATION: It is clear that taro and lotus fields, as well as the growing number of inland fishponds in the Haleiwa area collectively provide important habitat for Oahu's waterbirds, particularly the endangered gallinule. These areas have been missed on most HDF&G/USF&WS surveys of waterbirds on the island because of the extra manpower involved in conducting an adequate count of all this habitat and problems with access on private lands. Based on our brief survey, it is probably safe to say that the various fields and ponds of the Haleiwa area, not including Ukoa Pond, provide feeding habitat for a minimum of 30 gallinule, and possibly twice that number. We observed no concrete evidence of nesting, but the harvest cycle of taro and other wetland crops is long enough to permit successful completion of nesting without disturbance of the vegetative cover. The expressed negative attitude of some farmers towards this bird suggests that nesting would be discouraged within the fields. Whether or not the other waterbird species suffer as an indirect result of this attitude is uncertain. The habitat appears to be of only marginal significance to these other birds in any event.

A more thorough and repetitive survey of this artificial habitat would provide valuable information on patterns of waterbird use over the year. Any expanded effort at public education regarding waterbird conservation should include the landowners in this area. Perhaps this program would be better received if a cooperative effort was undertaken to minimize bird damage in a way that had minimal impact on the birds themselves.

POTENTIAL IMPACT OF DREDGE/FILL ACTIVITIES: It is certain that considerable alteration of taro fields and fishponds will continue to occur on private land that will not be affected by recently published regulations. The trend appears to be away from wetland agriculture and into development of aquaculture capability in the Haleiwa area. Depending upon the methods of fish farming and the degree to which waterbird use is discouraged by farmers, the adverse impact on birdlife of this shift in habitat will vary considerably. Gallinule will favor the traditional planted fields, while herons, coots, and ducks will prefer more open water and access to dense concentrations of pond-reared crustaceans.

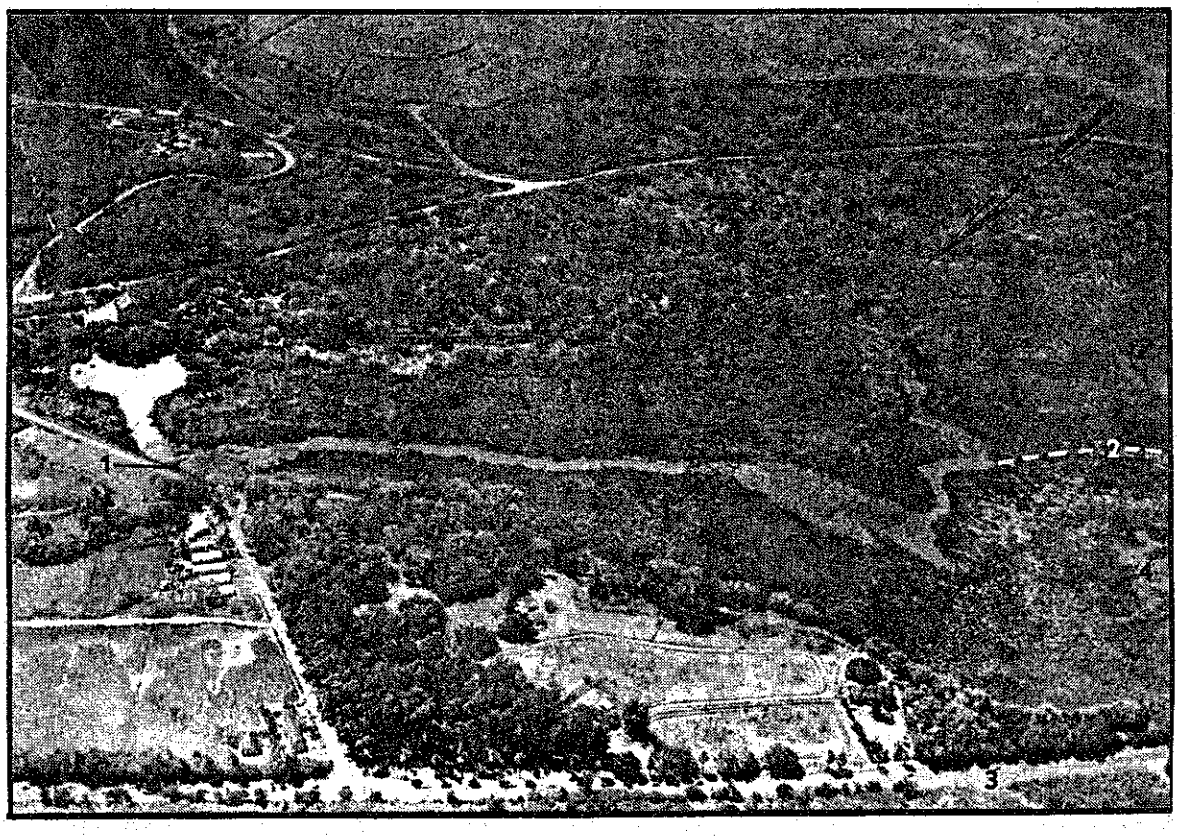
Clearing of encroaching water hyacinth in drainage canals will improve the quality and quantity of feeding habitat for most waterbirds. Variation in turbidity and water levels associated with normal wetland farming practices are problems to which waterbirds have adjusted. There is considerable room for improvement through creation of additional habitat where land is now undeveloped. At the same time, an educational program (or incentives) to encourage farmers to manage their fields and ponds in concert with recommended bird habitat management objectives will produce positive results. Predator control will probably continue to be the most insurmountable problem if land remains in the hands of numerous owners.

SITE NAME: ʻUkoʻa Pond

LOCATION: Wai-a-lua District, O'ahu

TOPOGRAPHIC MAP: Hale-'iwa

DATES OF SURVEY: 5 May, 27 May, 23 August, 1977



1. open water
2. former connection to Loko Ea Pond
3. Kamehameha Highway
4. HDF&G observations of heron, stilt, coot and migratory ducks (3/1/77)

WETLAND DESCRIPTION: This spring-fed coastal marsh is owned by Bishop Estate. Although the Haleiwa topographic map illustrates marshland more than 250 acres in size, the actual land with standing water is less than a third this size. A topographic map prepared before World War II shows an open-water connection across the marshland to Loko Ea Fishpond, and from there an opening to the sea. The same map includes a large area of former taro or rice fields south of the main body of water. Since that map was published, much of the water supplied to this site has been tapped and pumped away for sugar cane irrigation. The shape of the body of water has not changed appreciably but the water level has dropped. Much of the northern section of the original marshland has been eliminated by Kawailoa Landfill (95). California grass has encroached into the area and left much of the former "marsh" now essentially dry land. The water body is surrounded by a dense stand of bulrush that in some places is more than 50-75 feet thick. All of the bulrush is permeated with water, particularly after heavy rains. The large water body is generally less than three to four feet deep, somewhat deeper at the east end. More than 95 per cent of the open water surface is covered with a dense mat of water hyacinth and water lettuce. The former channel to Loko Ea is choked with California grass, bulrush and other vegetation, but there is still probably some movement between the two sites during heavy rains.

The marshland is now used for cattle grazing and as a source of water for irrigation. The draft HWRP (346) has recognized the site as a "primary" area for waterbirds and has recommended acquisition by the State for development as a wildlife sanctuary.

NON-AVIAN WILDLIFE: The most obvious fish in Ukoa Pond at the time of survey were tilapia, some of which reached more than 8" in length. Mollies were also observed. Madden and Paulsen (112) have indicated that access of these two species into Loko Ea Fishpond conflicts with recommended expansion of mullet and milkfish aquaculture projects in that pond. The largest fish observed in Ukoa Pond were carp (koi), some exceeding 20-24". Adults and tadpoles of both Rana catesbiana and Rana rugosa were also recorded. Turtles were seen from a distance at the pond but were not identified. Several small molluscs and small aquatic insects were attached to the leaves and stems of water lettuce. The largest crustaceans seen in any abundance were Tahitian prawns. Several partially eaten prawns were found in the marsh vegetation, presumably left there by Black-crowned Night Herons.

Cattle sign was evident throughout the marsh, although grazing animals at the time of survey were confined to the periphery of the site. Much of the bulrush, even up to the edge of the open water, had been trampled and some had been partially grazed. Mongoose were seen in the "dry" land outside the bulrush, and surprisingly, one animal was observed as it ran across the top of the water lettuce. It appears that no area in this marsh is inaccessible to these predators. No dogs or feral cats were observed within this site, but they are well-distributed throughout the area and must enter the wetland from time to time.

NON-WATERBIRD AVIFAUNA: The most common birds within the wetland were Common Mynas. Many were feeding on the surface of the water lettuce. Spotted Doves, Barred Doves, and Northern Cardinals were more common in trees that surround the wetland. House Finch were less common but widely distributed in the surrounding lands. Two Hawaiian Owls (Pueo) flew over the site during our first day of survey.

WATERBIRDS OBSERVED: We found this wetland to be good habitat for the Hawaiian Gallinule. A minimum of 18 gallinule were counted on the first trip to the area. The actual number in the area was probably as much as 50 per cent higher. Most of the birds were feeding on the surface of the water lettuce when first observed. They were probing within and under the leaves. Some appeared to be paired by their tendency to remain together as they fed, but no young birds were seen. Walking through the bulrush along the water's edge provoked considerable contact calling between birds, but the distinct high pitched calls of young chicks were not heard and nests were not found. As we covered only a small amount of the surrounding bulrush to avoid undue disturbance, it is likely that we missed nest sites that were actually there. On the second trip to the site, we observed eight gallinule and heard at least four others without even entering the bulrush. The group of eight birds were all located near the open water in the mid-portion of the pond. The most recent evidence of gallinule nesting at Ukoa Pond was an observation of young chicks in 1965 (498). I suspect if the pond was not such a long distance from Honolulu, there would have been several more recent reports of nesting. Recent HDF&G/USF&WS semi-annual count records for Ukoa Pond include between one to seven gallinule per count, but no attempt has been made on these earlier surveys to cover the habitat completely.

The draft HWRP (346) indicates that this site is of value to coot and stilt as well, yet semi-annual surveys by State and Federal biologists do not reflect this. On a recent field trip to the area, one coot and 26 stilt were observed east of the pond, in an open area flooded by previous rainfall (512). If some of the surface vegetation were removed, the site probably would attract greater numbers of coots. The pond is shallow enough that they could feed both in the surface vegetation and off the bottom. In its present condition, the area provides only ephemeral feeding habitat for stilt, but use by this species could be increased by creation of permanent shallow water impoundments.

Black-crowned Night Herons are the only other resident waterbirds that appear on recent count records for the pond. We observed six herons (four immature) on our first trip and four (one immature) on the second. Most of the herons were stalking food on the hyacinth or water lettuce. One was observed feeding on a prawn it captured from its perch on the edge of the water hyacinth. Another heron was standing motionless within the edge of the bulrush. The third trip to the site produced the most interesting heron observations. Fourteen birds (eight immature) were all together in the area where stilt had been reported by HDF&G biologists in March, 1977 (512). They were standing in a large muddy area (created by cattle) in which several thousand recently hatched tilapia were stranded in puddles.

The last "wetland" bird observed at Ukoa Pond was the Cattle Egret. A maximum of 62 birds were observed, but other counts were less than 20. These birds were observed with cattle at the edge of the site and in areas that had been trampled earlier. Earlier count records have recorded less than a half dozen egrets in recent years.

Migratory waterfowl or shorebirds do not appear on recent HDF&G/USF&WS semi-annual count records for the Ukoa marsh. However, Burr (512) reports having observed Pintails (n=9), Green-winged Teal (n=4), Northern Shovelers (n=1), Golden Plovers (n=61), Sanderlings (n=3) and Ruddy Turnstones (n=26) on March 1, 1977. They were feeding in the ephemerally flooded pastureland east of the pond.

Wintering ducks could be expected to visit open water at the site if much of the surface vegetation was cleared off. Numbers of shorebirds at the site probably vary considerably with periods of rainfall and availability of invertebrate prey on flooded mudflats.

HABITAT EVALUATION: If our survey of the pond and associated bulrush revealed a gallinule count that is typical for the pond, then Ukoa Marsh is among the most important, if not the most important, habitat for this species on Oahu. It also lends more weight to our suspicion that floating vegetation in biologically productive waters may be very important to this species. It provides access to plant and animal foods that would normally be unavilable to a species that rarely dives for food. Equally large concentrations of gallinule at Paradise Pacifica on Kauai, where water lilies cover many of the small ponds, is additional evidence of the relationship between this species and floating vegetation.

Any plans to clear a significant amount of the surface vegetation should await a more thorough evaluation of its importance to gallinule and other birds. It is probable that gallinule nest, or at least attempt to nest, at Ukoa Marsh. However, the observation of a mongoose on the surface vegetation is alarming in its implications. An intensive predator control program at the site would be advisable. If the site is developed as a waterbird sanctuary, a wide moat around the perimeter of the site would improve conditions. However, some control of encroaching surface vegetation in the moat would be required to make it effective.

Under optimum conditions, management of the site as a sanctuary would require a significant reduction in pumping of water from the pond. On the basis of this brief survey, it appears more advisable to route surplus water into additional impoundments or potholes elsewhere on the wetland. The site has tremendous potential for a substantial increase in habitat for gallinule, coot, stilt and migratory waterbirds, if water supply is adequate to supply additional shallow water impoundments.

Before any plans for habitat manipulation are implemented, it would be advisable to protect portions of the wetland from continuing destruction by cattle. Fencing of the ponded areas would be sufficient at this stage, but any efforts to expand the habitat may require total exclusion of cattle from the marsh.

POTENTIAL EFFECTS OF DREDGE/FILL ACTIVITIES: Any reduction in size of the existing pond in Ukoa Marsh through the deposition of fill material would have significant adverse impact on the population of gallinule that inhabit the area. Accumulation of fill or dredged materials elsewhere on the site may lead to excessive siltation of the pond during rainfall runoff. Even alteration of the remnant connection with Loko Ea fishpond may result in stagnation of the pond. It should be determined to what extent there still is water movement between the two sites before any deposition of fill material is permitted within the drier portions of this marsh.

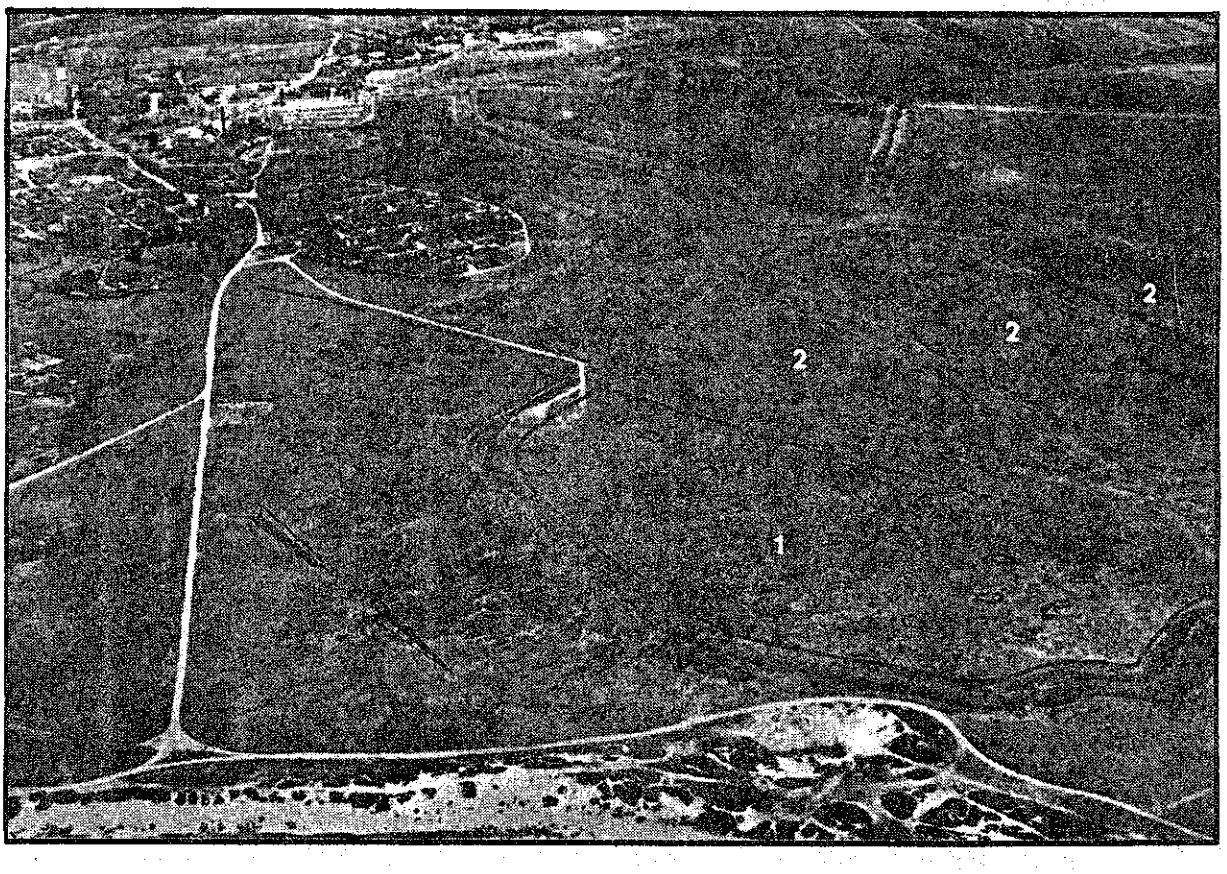
Proposals to enlarge the size of the present pond or to create additional water impoundments should be evaluated on the basis of their potential impact on existing habitat. There may be insufficient water available to supply additional habitat, and further lowering of the existing pond could reduce its value as waterbird habitat. Until a more thorough investigation of pond ecology is undertaken, it would be unwise to alter habitat that is already functioning and of prime importance to survival of gallinule on Oahu. Clearing of floating vegetation and creation of additional openings in the marsh at this time would be premature.

SITE NAME: Ka-huku Wetlands (James Campbell National Wildlife Refuge)

LOCATION: Ko'olau Loa District, O'ahu

TOPOGRAPHIC MAP: Ka-huku

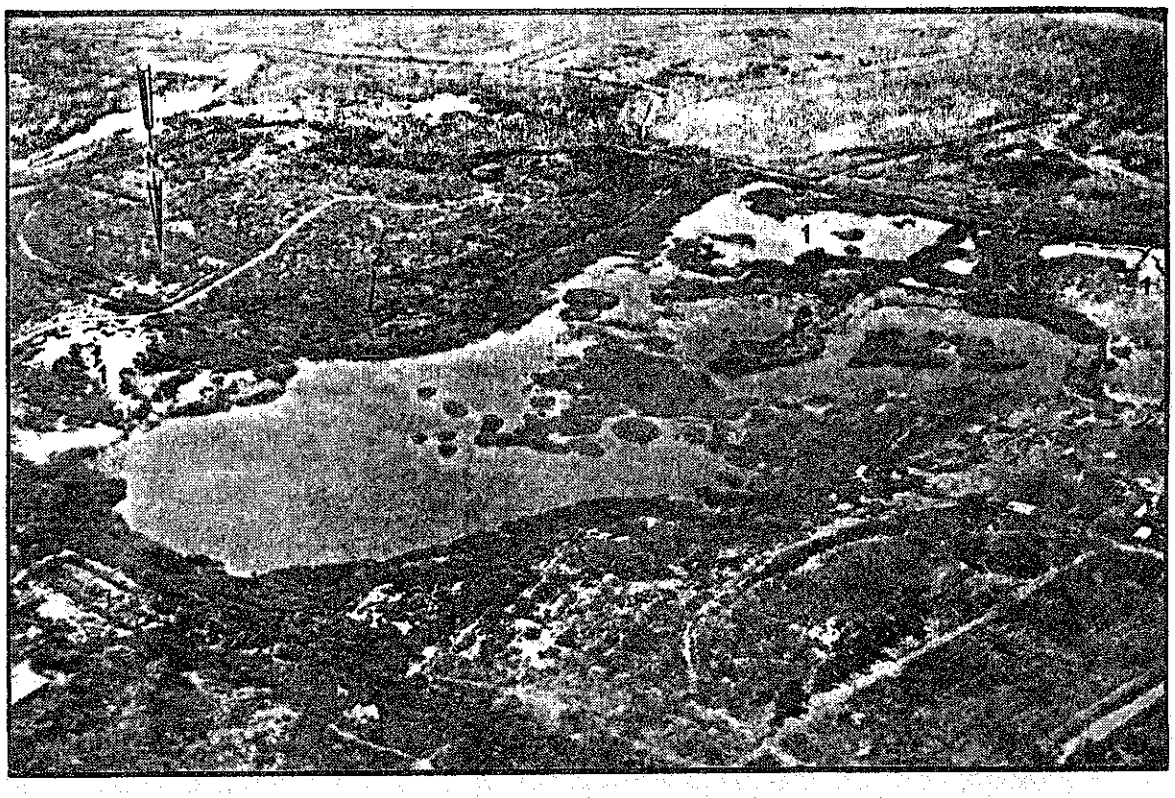
DATES OF SURVEY: 15 May, 28 May, 27 August, 1977



Ki'i Pond

1. area being flooded at time of survey; photo taken before construction of nesting islets.

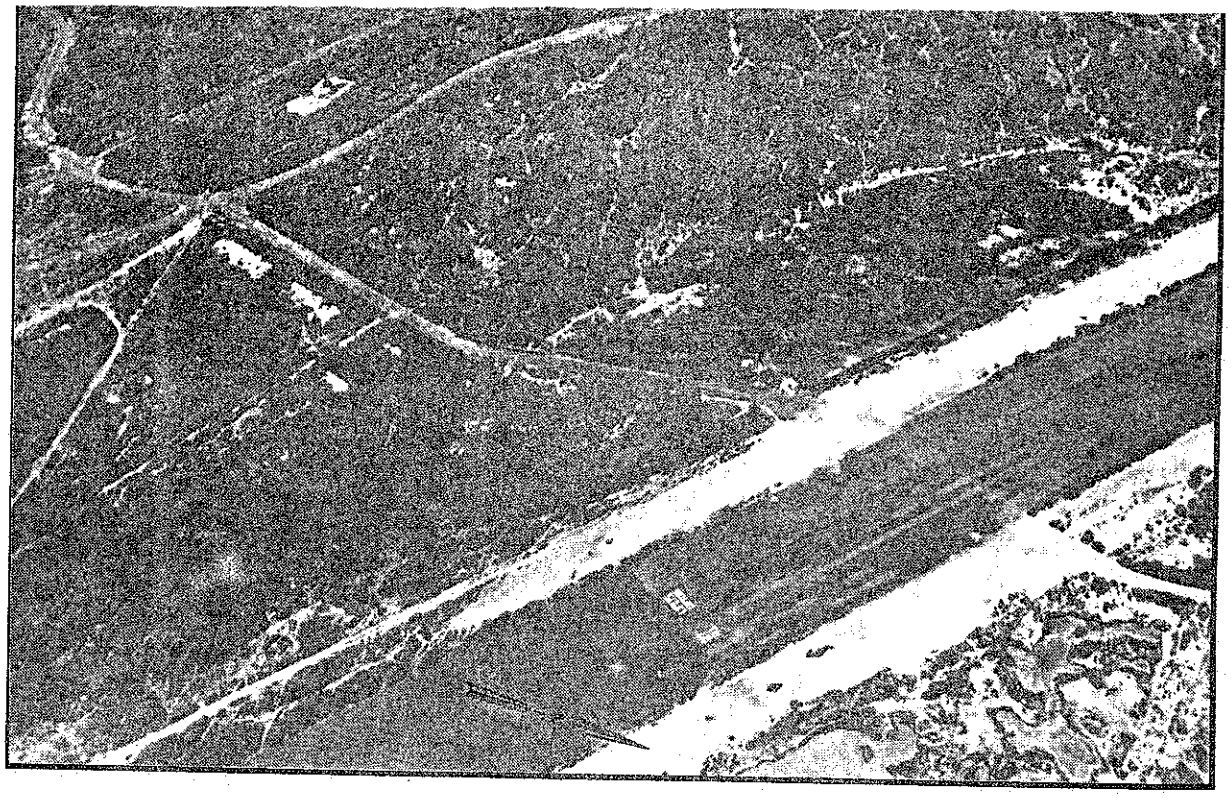
2. impoundments to be flooded in the future



Puna-manō Pond

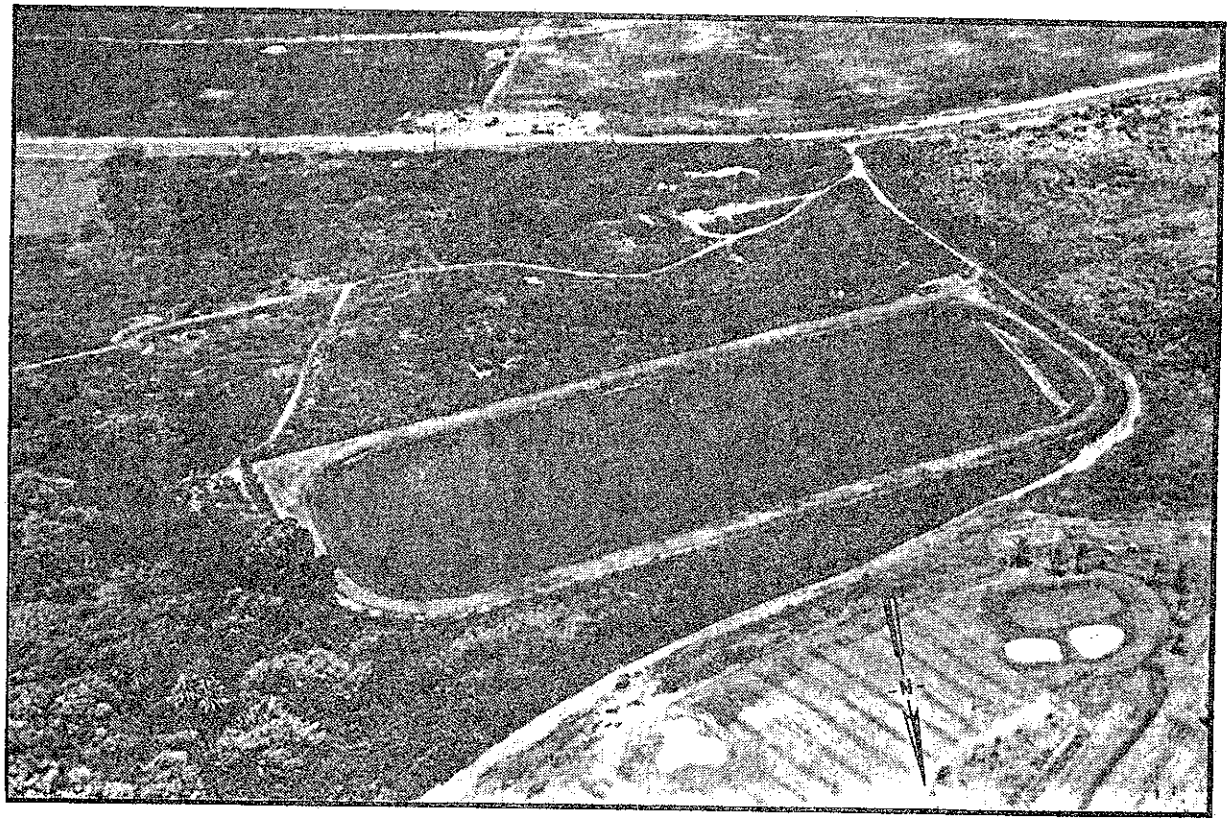
1. primary stilt feeding areas
2. extent of flooding in winter rains
3. bulrush
4. hau
5. ironwood

Puna-ho'olapa Pond



Kahuku Airstrip wetlands

Kuilima sewage pond



WETLAND DESCRIPTION: Several individual wetland sites on coastal flatlands near Kahuku were once part of an extensive marsh. The marsh was supplied with water from springs, intermittent storm runoff, and groundwater where the surface intersected with the water table. Much of the original marsh was drained and filled, and converted to sugar cane production. The principal wetlands at Kahuku since early in this century have been differentiated at Kii Pond, Punamano Pond and Punahoolapa Pond.

Kii Pond was about 460 acres in size when full with water. It was created by an extensive system of dikes and channels, designed to capture waste water from Kahuku Sugar Mill. The site was also used for some dumping of bagasse (fibrous cane waste). Over several years, accumulating silt in the pond created an expansive mudflat. Water levels in the pond varied with patterns of water use by the sugar company, so waterbird habitat conditions varied accordingly. In 1971, the sugar mill closed and pumping of water into Kii Pond ceased. Since that time, pluchea, pickleweed and California grass have encroached into the pond and drainage ditches. Water has been found within the separate impoundments of Kii Pond only temporarily after heavy rains.

Punamano Pond, north of Kii, is fed by springs and rainfall runoff. Most of the pond is less than 18 inches deep. Surrounding lands are in agricultural production. The dominant vegetation around the pond is pluchea, with localized areas of bulrush, pickleweed and California grass. Islands within the pond are densely vegetated. In periods of low rainfall, exposed mudflats provide limited feeding habitat for shorebirds and wading birds. Kridler (519) reports that he has seen this pond go dry on occasion and suggests that present ditching systems may prevent Punamano spring from supplying this pond on a permanent basis. In winter months, the area of the pond may increase as much as twenty per cent.

The draft HWRP (346) indicates that Punahoolapa Pond and adjacent marsh have "been highly altered in recent years due to drainage, conversion to agriculture and loss of water supply". Yet, the existing configuration appears to be virtually unchanged from that depicted on a topographic map prepared in the early 1940's. The pond is supplied by runoff and leakage from the groundwater basal aquifer. A large marshy area north of the open pond is choked with bulrush and California grass. The pond is actually a series of interconnected pools and channels. Dominant vegetation in the pond area is bulrush, hau, California grass, pluchea and ironwood trees. Pond depth ranges from six inches to more than eight to ten feet, and water coverage of nearby mudflats varies with rainfall patterns.

Other wetland habitat of significance to waterbirds in the Kahuku area includes marsh habitat along the abandoned Kahuku airstrip and a recently constructed sewage filtration reservoir on the south edge of the Kuilima Golf Course. Water coverage and level in the airstrip marsh varies considerably with rainfall. Water level in the sewage pond is relatively stable year around. It is fenced around the entire perimeter, and bordered by sloping grass-covered dikes that provide suitable loafing sites for waterfowl. Recent major changes in the amount and quality of wetland habitat in the Kahuku area began with closing of the Kahuku Sugar Mill in 1971. In 1972, the landowners (James Campbell Estate) proposed an extensive resort development that would have involved conversion of Kii Pond into a recreational swimming lagoon and creation of a separate "bird refuge" next to the pond. Several new buildings were planned to be constructed along the coast, and a golf course was designed for the Kii Pond area. Although the

original master plan was withdrawn, alternative development plans are still in consideration. Present plans call for construction of an injection-type sewage treatment plant 400 feet southeast of the Kii refuge boundary (514).

The USF&WS became interested in possible acquisition of wetlands at Kahuku for refuge status as early as 1969. After several years of negotiation and modification of plans, the James Campbell National Wildlife Refuge was established in early 1977, by lease of lands from the Campbell Estate. The refuge contains two units: Kii Pond (104.5 acres) and Punamano Pond (37.5 acres). Since the refuge was established, the USF&WS has begun improvements in one twenty acre impoundment of Kii Pond. Vegetation has been cleared and several islets have been constructed in this impoundment. At the time of our survey, water was being pumped into the pond to restore habitat lost when the mill shut down. It is our understanding that if the first project is successful, then additional habitat development will occur in the other impoundments. USF&WS plans call for fencing of Kii Pond in fiscal year 78. Habitat improvements under consideration for Punamano Pond include fencing to exclude cattle and dogs, rehabilitation of ditches and supply wells, clearing of encroaching vegetation and construction of nesting islets. Punahoolapa Pond was not included in the refuge although earlier plans for rehabilitation of this site included draining of the pond to allow removal of dense vegetation, followed by creation of a larger permanent pond.

NON-AVIAN WILDLIFE: We were unable to conduct more than a cursory examination of the Kii and Punamano ponds because of inability to obtain permission for independent access to the refuge. However, refuge personnel cooperated in a "guided tour" of the site. Tilapia and mosquito fish were the only fishes recorded from the Kii drainage ditches, Punamano Pond and Punahoolapa Pond. Bullfrogs were heard at all sites, while tadpoles and adults of Rana rugosa were seen only at Punahoolapa. Shallow water at Punamano Pond supports a dense concentration of aquatic insects. Small gastropod molluscs were particularly abundant in the flooded mudflats bordering Punahoolapa Pond.

Cattle grazing was occuring at all three ponds at the time of survey, although a dilapidated fence protects much of the marsh habitat surrounding Punahoolapa. Dogs and cats have unlimited access to each of the sites except the sewage pond. Gordon Black (510) indicated that feral dogs were a serious problem both at Kii and Punamano. We suspect that they pose a similar threat to waterbirds at Punahoolapa, judging from the distribution and abundance of tracks at the site. Mongoose were seen on our survey at all sites except Punahoolapa, but they are certain to occur there as well.

NON-WATERBIRD AVIFAUNA: There were few differences in non-wetland birds recorded at the three major pond sites, although the extensive koa haole forest around Punahoolapa Pond supports a greater density of several species. The list of species that were widely distributed and common at the ponds include Spotted Dove, Barred Dove, Common Myna, Spotted Munia, Red-crested Cardinal and Northern Cardinal. House Finch were seen only at Kii and Punahoolapa ponds. At the latter site they were particularly abundant within the grove of ironwood trees. House Sparrows and Rock Doves were less common in the wetlands than the other birds mentioned. In early May, Japanese Bush-warblers were quite common in the koa haole forest bordering Punahoolapa Pond and Marsh, but were recorded at no other sites. A single Pueo was observed as it flew over Kii Pond. Three other birds

that have been reported in the Kahuku area, but were not seen on our quick survey, deserve mention here. Ring-necked Pheasants are often seen on cane roads and in recently harvested fields. Mockingbirds appear on a few earlier USF&WS records for the site. Red-eared Waxbills have been seen on at least three trips to the Kuilima sewage pond during 1975-76. The only other observations of this species are from the Diamond Head area of Honolulu.

WATERBIRDS OBSERVED: Historical records of waterbirds in the Kahuku area are derived from field trips by members of the Hawaii Audubon Society (HAS) and from repetitive surveys by HDF&G and USF&WS biologists. Many early reports of visits to the site do not clearly define the areas covered, so precise information on bird distribution is sometimes difficult to find. However, HDF&G/USF&WS count records suggest considerable movement of waterbirds between ponds, so the sites should be considered as a habitat unit. Unfortunately, there has been little attempt in the past to survey Punahoolapa Pond thoroughly, so comparative data for this site is generally lacking.

Prime habitat for Hawaiian Stilt at Kahuku was provided by the mudflats and shallow water of Kii Pond until the sugar mill closed in 1971. Runoff of the mill water created extensive mudflats that provided an abundant source of food and nesting sites as well. Several HDF&G/USF&WS counts of over 50 stilt, and one as high as 87, were made at this pond in the year prior to mill shutdown. Several nests and young birds were observed at this time as well. The maximum number of stilt recorded at Kii on regular HDF&S/USF&WS surveys since the mill was closed is nine birds. Infrequent rains provide ephemeral feeding habitat on the mudflats, and some within the drainage ditches as well. We counted only two stilt at Kii during our survey.

Punamano Pond has never provided that amount and quality of stilt feeding habitat found in earlier years at Kii Pond. However, the southern shallow waters and mudflats have attracted as many as 16 birds at one time. Encroaching pluchea limits the amount of feeding area available. Heavily vegetated islands in Punamano Pond provide little, if any, suitable nesting habitat. We are unaware of any nesting records for stilt at Punamano Pond. We observed five birds on our brief survey of the site.

The draft HWRP (346) indicates that stilt have been known to visit Punahoolapa Pond in the past, but we can find only one field trip report for the site, and the species was not observed. We counted five stilt feeding in the shallow mudflats on the south side of the ponds. In its present condition, the pond has very little feeding habitat or nesting habitat that would be used by stilt. Stilt were absent on several of the earlier field trips to the airstrip ponds, but numbers as high as 50 birds have been counted. We suspect there was probably considerable movement between the airstrip ponds and Kii Pond as conditions varied.

Udvardy (412) describes Kii Pond as one of the principal areas for Hawaiian Coots on Oahu during 1958/59. He described how numbers of birds varied directly with the amount of water flowing from the sugar mill. Immediately prior to shutdown of the mill in 1971, Hawaiian Coots nested at Kii Pond in greater numbers than at any other single wetland on Oahu and possibly in the state (except possibly Niihau). As many as 30 coot nests were observed on a single visit by USF&WS biologists in 1971. Numbers of adults in the same year often exceeded 150

on several trips to the site. No more than one bird has been reported on a visit since the mill shut down. Occasionally coots are seen within the drainage canals, but it is clear that the drained mudflats are worthless as habitat in their present condition. On the other hand, Punamano Pond has provided some compensation for the loss of habitat at Kii Pond. Although the average number of birds on past counts at the pond runs less than 15, some counts have ranged as high as 24. Coots are reported to have nested in the marsh vegetation along the north shore of the pond (346). We observed 26 coots on our brief survey, including 2 juveniles. Difficulty in access to the shoreline complicates accurate counting of this species at Punamano, so earlier surveys may have under-estimated actual populations. On the single field trip report available for Punahoolapa Pond, only two coots were observed. We recorded 16 coots in the Punahoolapa Pond complex on our second visit to the site. Although no nests were seen, several birds appeared to be paired. Postural display characteristic of nest defense was observed at two different locations in the pond. The birds were widely distributed in the pond complex, and could have been present in considerably greater numbers than our count indicates.

Coots are occasionally counted in the airstrip ponds when water levels are high. As many as 20 birds have been reported here in recent years. The first surveys in the Kuilima sewage pond were made in late 1975. A fairly stable population of birds (62-94) was found on Hawaii Audubon Society trips to the reservoir during November/December, 1975. Numbers at the site during the following year were considerably lower. There is probably considerable movement between the sewage pond and the other Kahuku sites.

As far back as records are available, Hawaiian Gallinule have been less common than stilt and coots at Kahuku. The draft HWRP (346) describes the Kii settling basins as "very important nesting areas for stilt, coot and gallinule". However, I can find only one published record (possible) of gallinule nesting (504) and no field trip reports when the number of adult birds exceeded seven. No gallinule have been recorded at Kii Pond since the mill shut down. These birds are seen irregularly at Punamano Pond and in the airstrip ponds, but there are no published records of nesting at either of these sites. Kridler (519), however, informed us that he saw young gallinule on both Kii and Punamano Ponds prior to shutdown of the mill. We found gallinule only at Punahoolapa Pond during our Kahuku surveys. Four birds were feeding at the edge of bulrushes, but were widely distributed in the pond complex. It is almost certain that our count underestimated the actual population at Punahoolapa, due to the dense growth of emergent vegetation. The species has not been recorded at the Kuilima sewage pond, presumably due to the lack of cover and suitable food.

Hawaiian Ducks (Koloa) do not appear on any earlier trip reports to the Kahuku area. Until recently, the last reported nesting of Koloa on or near Oahu, was on Mokulua Island in 1941 (382). Beginning in 1969, cage-reared birds have been released by HDF&G biologists at Kawainui Marsh, Kaneohe Marine Corps Air Station and Waimea Falls Park. We observed two Koloa on our first trip to Punahoolapa and eight on our second, more thorough, survey. The birds were well distributed within the extensive pond complex, but appeared to be paired. Two pairs were reluctant to leave the pockets of water where they were seen. They flushed and circled the site, returning to the same area. This led us to believe that they may have been nesting, but a more extensive survey of the grassy areas around the open water would have been necessary to confirm this. With continuing

releases of birds at locations along the north and east shores of Oahu, it is likely that Koloa will be seen more regularly at all Kahuku sites in the future.

Black-crowned Night Herons have been reported on all the Kahuku wetlands except the Kuilima sewage pond. The maximum recorded at Kii Pond prior to mill shutdown was 33. Small numbers have continued to inhabit the area, particularly the drainage ditches, since the pond dried. An average of less than 5 herons has been recorded on Hawaii Audubon Society trips to Punamano Pond, although on several visits to this site and the airstrip ponds, no herons were counted. The first nesting record for herons in the Kahuku area was in 1960 (495), when six heron nests were found within a small Cattle Egret rookery northeast of Punamano Pond (495). We counted four birds at Kii, ten at Punamano and 14 in Punahoolapa Pond. In the latter site, herons were distributed widely along the edge of bulrush and California grass cover. The land east of Punahoolapa Pond is heavily forested, and could conceal a relatively large heron rookery unless thoroughly surveyed.

Cattle Egrets were first reported nesting at Kahuku in 1960 (the year after they were released on Oahu) (351). Count records for Kii Pond in 1968 indicated more than 200 birds at the site. Numbers have varied radically since that time, but unlike the "true" waterbirds, drying of the pond did not appreciably affect the Kahuku population. Grazing cattle are found on lands near all the Kahuku sites except near the recently constructed sewage pond, so it is no surprise that egrets appear on earlier count records for these areas. We observed more than 100 birds in the Kii Pond area, but counts at Punamano and Punahoolapa were each less than two dozen. Burr (512) reports that an egret rookery of approximately 300 birds is present about 200 feet NNE of the Kii Pond pumphouse, but we did not visit this area on our short survey.

Prior to draining, as many as 200-400 Pintails and 30-50 Shovelers could be found at Kii Pond during winter months. Some counts were much lower, suggesting movement between different Kahuku sites. This was often confirmed by repeated observations of individual rare ducks at different ponds. Kridler (519) feels that some of this movement is caused by illegal shooting of waterfowl. Records of ducks at Punamano do not go back far enough to discern a trend in population since Kii was drained, but it does appear that both Punamano and the Kuilima sewage pond together can support between 100-150 ducks through the winter. Because of the movement of birds between Kahuku sites, it is probably not significant to differentiate specific areas in listing the more uncommon species of migratory waterfowl that have been recorded at Kahuku. The list of uncommon ducks includes American Wigeon, Green-winged Teal, Lesser Scaup and Ring-necked Duck. Rarer waterfowl recorded at Kahuku include European Wigeon, Canvasback, Greater Scaup, Black Brant, Garganey Teal, Cinnamon/Blue-winged Teal and Hooded Merganser. Mallards have been recorded at Kii, Punamano and the Kuilima sewage pond in recent years. At least some of these were clearly not migratory birds since they were recorded in early August, but others seen in November may have been. Whatever their origin, our recent observations of Koloa in Punahoolapa Pond suggest some reason for concern regarding possible interbreeding.

The wet mudflats that were present at Kii Pond when the sugar mill was functioning provided expansive feeding habitat for a large number and variety of migratory shorebirds. Golden Plover counts in the past have exceeded 100 on at least a half dozen HAS or HDF&G/USF&WS counts at the site. Ruddy Turnstones

seen far more regularly than the others. Bristle-thighed Curlews appear more regularly in the Kahuku area than elsewhere on the main islands, but it is still rare. The remaining list of shorebirds, some of which have been reported only once, includes Dowitcher, Dunlin, Western Sandpiper,Baird's Sandpiper, Sharp-tailed Sandpiper, Pectoral Sandpiper, Least Sandpiper, Semi-Palmated Plover, Black-bellied Plover, Snowy Plover, Lesser Yellowlegs, Greater Yellowlegs, Black Turnstone (possible), Common Snipe, Killdeer, Hudsonian/Black-tailed Godwit, Knot and Northern Phalarope.

Kahuku wetlands have also been the location for sightings of uncommon or rare straggler seabird species, including Ring-billed Gull, Arctic Tern, Bonaparte's Bull and Glaucous Gull. One species that nests in small numbers off Oahu, but is rarely seen on Oahu, is the Gray-backed Tern. Both this species and the Great Frigatebird appear occasionally on count records for Kahuku.

HABITAT EVALUATION: Count data prior to shutdown of the Kahuku sugar mill in 1971 make it very clear that Kii Pond was one of the most important stilt and coot habitats in the State. The stilt population at Kii Pond has represented as high as 25% of the total for Oahu on earlier counts. In the 1971 summer HDF&G/ USF&WS waterbird census, the Kii Pond population of coots (186 birds) represented 64% of the island total, and 27% of the statewide total. More importantly, both species had experienced a marked increase in numbers in the few years that the Kahuku sites had been visited. Both species were nesting successfully on a relatively small proportion of the habitat before it was drained. There is every reason to believe that conditions that encouraged nesting in the past can be recreated and even improved through proper habitat management.

Refuge status for Kii and Punamano ponds does not, in itself, insure waterbird productivity that compares to earlier years. Gradual filling of the Kii impoundments with silt in runoff water has raised the bottom substrate to the point that extensive dredging may be required. Although both endemic and migratory birds have quickly taken advantage of partially restored wetland at Kii, there is no assurance that stilt or coots will find the recently constructed islets suitable for nesting. Initial problems with water supply have not yet been solved. It may be several years before the condition of the bottom fauna in the pond is such that it can support large nesting population of waterbirds. Predation and poaching are likely to continue as serious problems in the area, and encroaching vegetation will be a permanent problem that requires continual attention. A tourist-oriented railway is under consideration for the dike road that crosses through the Kii impoundments. Final decisions on potential development around the ponds have not yet been made. To the extent that all these interrelated factors have a bearing on success of a refuge management program, the future of Kii Pond is uncertain. However, the amount of management attention being directed to this site by USF&WS biologists makes it likely that initial problems will be overcome and the full potential of this once valuable habitat fully realized.

Although the relevant data are limited, it can safely be said that Punamano Pond did not fully compensate for habitat lost when Kii Pond dried up. Punamano has neither the total size nor the extensive mudflats that made Kii Pond so valuable to stilt and coots in the past. Carrying capacity for wintering birds and opportunity for nesting by resident birds could be increased at Punamano,

but it would require development of a more dependable water supply, clearing of encroaching pluchea, development of nesting islets and restriction of access to the site by cattle and dogs. Movement of birds between Punamano and other sites at Kahuku emphasizes the need to evaluate (and manage) the different wetland areas as a unit.

It is surprising to find that Punahoolapa has been largely neglected since the initial USF&WS reconnaissance efforts that led the way to refuge designation for Kii and Punamano Ponds. The draft HWRP (346) lists Punahoolapa as a wetland of secondary importance to coot, stilt and gallinule, while the other two Kahuku ponds are ranked as "primary areas". Yet, there is clearly an insufficient amount of data on waterbird populations at Punahoolapa Pond from past years to rank it in relative importance to the other ponds. Our data suggest that Punahoolapa may be of more value to waterbirds than earlier believed, particularly since cage-reared Koloa have taken up at least temporary residence. Initial USF&WS proposals for improvement of this site included draining and clearing of vegetation. Such an ambitious and costly modification of the habitat may be unwarranted, but it did appear to us that the site could be enlarged with far less effort than suggested. At the very least, a program of more repetitive and thorough surveys of the site is needed to accurately evaluate its true importance to waterbirds and to determine to what extent there is interchange of birds between the different ponds.

The primary value of the Kuilima sewage pond to coots and migratory waterfowl is that it provides a combination of feeding and loafing habitat that is comparatively protected from disturbance. It is doubtful that anything can be done to improve the condition of this habitat for waterbirds under present ownership and in view of its present function. However, State and Federal biologists should cooperate with the landowners to minimize the possibility of inadvertent adverse impact, such as herbicide spraying of shoreline vegetation.

POTENTIAL IMPACT OF DREDGE/FILL ACTIVITIES: The present value of Kii Pond for waterbirds lies more in its potential for habitat development than in its present condition. Ongoing modifications (clearing of vegetation, islet construction) involve manipulation of fill within a wetland, and hence, fall under Section 404 permit regulations. It may be necessary in the future to restore earlier habitat conditions by removal of accumulated fill. Moat construction has also been considered to assist in predator control. If carefully planned, the positive advantages of such habitat modification will far outweigh any potential adverse impacts.

If the habitat restoration at Kii Pond is successful, it may not be advisable to alter the present condition of Punamano Pond in an attempt to diversity the habitat available to waterbirds. Kii Pond has the potential to provide sufficient habitat for a large population of stilt, coot and migratory shorebirds. Punamano, on the other hand, has more potential in its present condition for management as coot, gallinule and possibly Koloa habitat. Development of means to effectively control water levels will allow the development of more abundant submergent flora, and judicious planting of suitable emergent plants may encourage coot and gallinule nesting. Removal of encroaching pluchea would increase the available mudflat feeding habitat considerably. Before adding fill to the pond to create nesting islands, it may be advisable to attempt manipulation of existing islands (i.e. vegetation control, edge sloping, etc.). This would involve far less impact on present habitat conditions. An intact fence around the pond would help

to restrict dogs, but it would do nothing to prevent access by mongoose, rats or cats. However, moat construction should be considered only if other, less significant, manipulation of the habitat proves inadequate.

Although the density of vegetation in and around Punahoolapa Pond makes survey difficult, the isolation of this habitat is a condition that should be maintained. If future survey indicates that the pond is currently of greater value to waterbirds than is generally believed, some consideration should be given to acquisition and habitat development. Dredging of formerly open marsh adjacent to existing ponds would be far more desirable than modification of existing habitat. Although it may require development of a more dependable water supply, the amount of habitat could be doubled or tripled with careful dredging and removal of vegetation. A more extensive examination of the pond's current value to waterbirds should be undertaken prior to any significant modification.

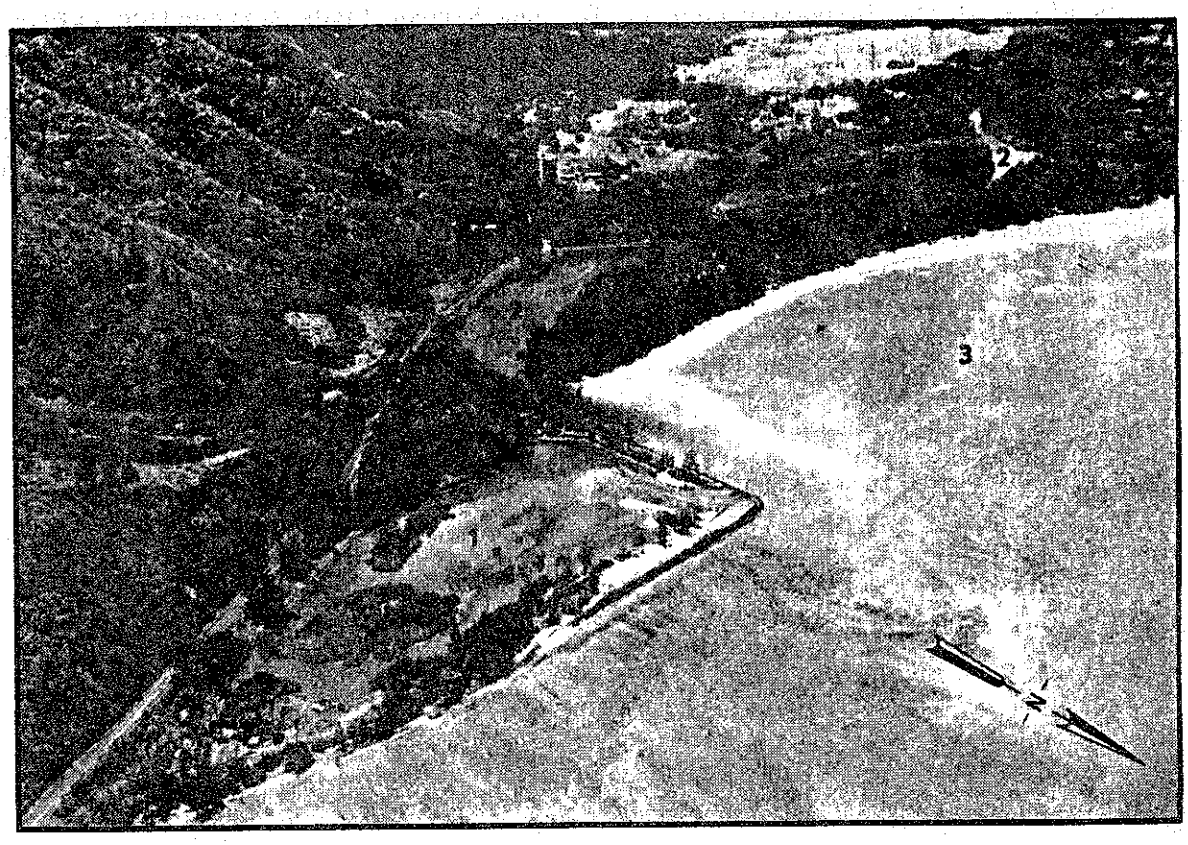
As plans of the landowner develop for the Kahuku lands surrounding refuge ponds, it is likely that projects involving considerable dredging or filling will be proposed. The integrity of existing waterbird areas will be threatened if these projects create excessive demands on groundwater supply or pollute the runoff into the wetlands. It is virtually certain that both Kii and Punamano ponds will eventually be declared "critical" habitat for endangered waterbirds. Mitigation of adverse impact on these birds or their habitat will not be allowed under present federal law.

SITE NAME: Kahana Valley Wetlands (Hui-lua Fishpond)

LOCATION: Ko'olau Loa District, O'ahu

TOPOGRAPHIC MAP: Kahana

DATES OF SURVEY: 7 May, 31 July, 1977



1. Huilua Fishpond 2. Kahana Stream estuary 3. Kahana Bay

WETLAND DESCRIPTION: Several streams and tributaries feed into the floor of Kahana Valley. The major drainage, Kahana Stream, taps a large watershed on the windward slopes of the Koolau range. The meandering stream near the outlet to the ocean has created extensive flatlands that are flooded during very high stream flow. Marsh conditions have developed where the stream meets the sea. Near the outlet, remains of a former fishpond (Huilua) are found. The "wetland" we surveyed included the pastureland above the highway, the lower marsh and the fishpond.

The upper pastureland supports an expansive growth of California grass and bulrush. Although there is no open water, drainages on the southeastern slopes of the valley create a boggy condition across much of this pasture. The stream has been narrowed over time by infiltration of mangrove. The water level in the stream varies considerably with tidal influence and rainfall in the valley.

Below the road, expansive mudflats are exposed at low tides. Mangrove is encroaching along the shores of the lower marsh and the Huilua fishpond. A narrow fringe of bulrush lines some of the islets within the fishpond. Degradation of the fishpond wall has allowed sand to deposit within the pond during storm surf, lowering the depth of the pond throughout.

The land included within our survey is owned by the State of Hawaii and much of the area is managed as a State Park. The pond is not in commercial fish production at this time, and would require major reconstruction of the wall and dredging of accumulated sand and silt if it were to be actively managed as a fishpond (112). The upper pasture land is used for cattle grazing at this time and this use is not likely to change under present management plans. The entire estuary was ranked highly on a recent survey conducted for the purpose of selecting a National Estuarine Sanctuary. Kahana Bay was regarded as one of the least disturbed natural estuaries in the State, but Waimanu Valley, on Hawaii, was chosen as the candidate for this joint Federal/State project.

NON-AVIAN WILDLIFE: Only a brief aquatic faunal survey was conducted at Kahana during this study, but it can be safely assumed that the stream and lower marsh fauna is typical of estuaries along the east coast of Oahu. Timbol (125) has conducted a thorough investigation of this estuary. We observed mullet, barracuda and tilapia in the stream drainage and lower marsh. Presumably milkfish, aholehole, bonefish, and o'opu are also present. We also found gastropod molluscs, annelid worms, tahitian prawns and various species of crabs in the lower marsh. More extensive study of the tidal mudflats in this area probably would reveal a great assortment of potential waterbird foods.

Mongoose were observed near the fishpond and in the upper pasture area. Dogs and cats run loose throughout most of the lower valley. Loose dogs at residences near the fishpond and those animals that are brought by visitors to the State Park present a continuous deterrent to nesting birds in the lower marsh or fishpond. Relatively few cattle were grazing in the upper pasture at the time of our survey, but tracks and droppings indicated that there was little of this habitat that was not accessible to these animals at one time or another.

NON-WATERBIRD AVIFAUNA: The forested lower valley at this site provides habitat for a variety of exotic birds, including Shama, Melodious Laughing-thrush, Japanese Bush-warbler, Northern Cardinal, Japanese White-eye, Spotted Dove, Barred

Dove and Common Myna. The last three of these species were especially common in the beach park area. Small groups of House Finch were also seen in the ironwood trees above the beach. Spotted Munia traveled in small flocks in the grassland and within the lower marsh during our survey.

WATERBIRDS OBSERVED: There are several published (Elepaio) reports on bird observations in the lower marsh at Kahana Bay. Unfortunately there seems to have been a loss of interest in the site among bird-watchers since the early 1960's. The lower marsh and Huilua Fishpond appear irregularly on semi-annual HDF&G/ USF&WS waterbird surveys, but even when the Kahana areas were included, it is unlikely that they were surveyed thoroughly.

Of the native waterbirds, the Hawaiian Coot appears most regularly in earlier counts. Between 1950-1960, an average of nine birds were recorded per count on Audubon field trips. The maximum observed was 20. More recent HDF&G/USF&WS surveys have noted between zero and six. At least three separate trip reports in the 1950's recorded observations of adults with chicks, but I am unaware of any recent evidence of nesting in the area. We counted a maximum of three coots in the stream above the road, and a maximum of seven birds in the lower marsh and fishpond. Again, we could find no evidence that coots were nesting in the area, perhaps because of significant changes in water level and access of predators throughout all potential nesting sites.

The average number of Hawaiian Gallinule recorded on early Audubon field trips was three, with no observations exceeding six. The species is absent from all recent HDF&G/USF&WS counts. One observation of a juvenile gallinule in the early 1950's is the only evidence that the species may have nested in the area. We observed and/or heard gallinule only in the partially flooded pastureland above the highway. A maximum of three birds was recorded.

We observed Black-crowned Night Herons feeding on mudflats in the lower marsh and fishpond, and roosting in mangrove trees in the stream above the road. A maximum of eight birds were seen on a single trip, of which six were immature. The species appears irregularly on both Audubon and HDF&G/USF&WS counts, but never in numbers as high as we observed. Although residents were unaware whether or not herons nest in the area, much of the upper valley is uninhabited and a small rookery could easily go undetected.

A report of an Audubon field trip in 1952 provides the only published record of a duck at this site. This report of a Mallard may have involved a feral bird rather than a migratory one. A resident along the upper stream reported to us that he has observed wild ducks in the lower marsh and fishpond. It is surprising that count records do not reflect this. On the other hand, migratory shorebirds do appear regularly in count records, but generally in very low numbers. Golden Plovers, Ruddy Turnstones and Wandering Tattlers have been observed at the site. Hawaiian Stilt were not observed in Kahana Bay during our survey and appear on only one recent count record for the site (464). The mudflat in the lower marsh and fishpond that are frequented by migratory shorebirds appear to provide suitable feeding habitat for stilt as well. Perhaps it is the continual human disturbance along the highway that limits the use of this site by stilt.

HABITAT EVALUATION: Wetlands in the Kahana Bay area were ranked as "secondary" in importance in the recent draft HWRP (346). The Kahana sites we surveyed do not support a large number of any resident or migratory species, and to the extent that nesting by any species has not been evident in nearly 20 years, habitat conditions may be deteriorating. All areas are subject to virtually continual disturbance by humans, dogs and other predators. The amount of vegetative cover, other than mangrove along the stream, is severely limited. Grazing cattle in the upper wet pastureland continue to disturb the habitat in which gallinule were observed on our survey. Mangrove is encroaching onto the few suitable loafing and potential nesting sites in the lower marsh and fishpond, and has shrunk the stream drainage to a fraction of its original size.

The draft HWRP (346) recommends an investigation by State biologists to determine how the habitat may be improved. In the lower marsh and fishpond area, it would maybe be advisable to initiate a repetitive program to clear mangrove. Creation of water impoundments on State-owned pastureland above the road would probably attract more waterbirds. At the very least, grazing could be restricted within the best portions of this habitat.

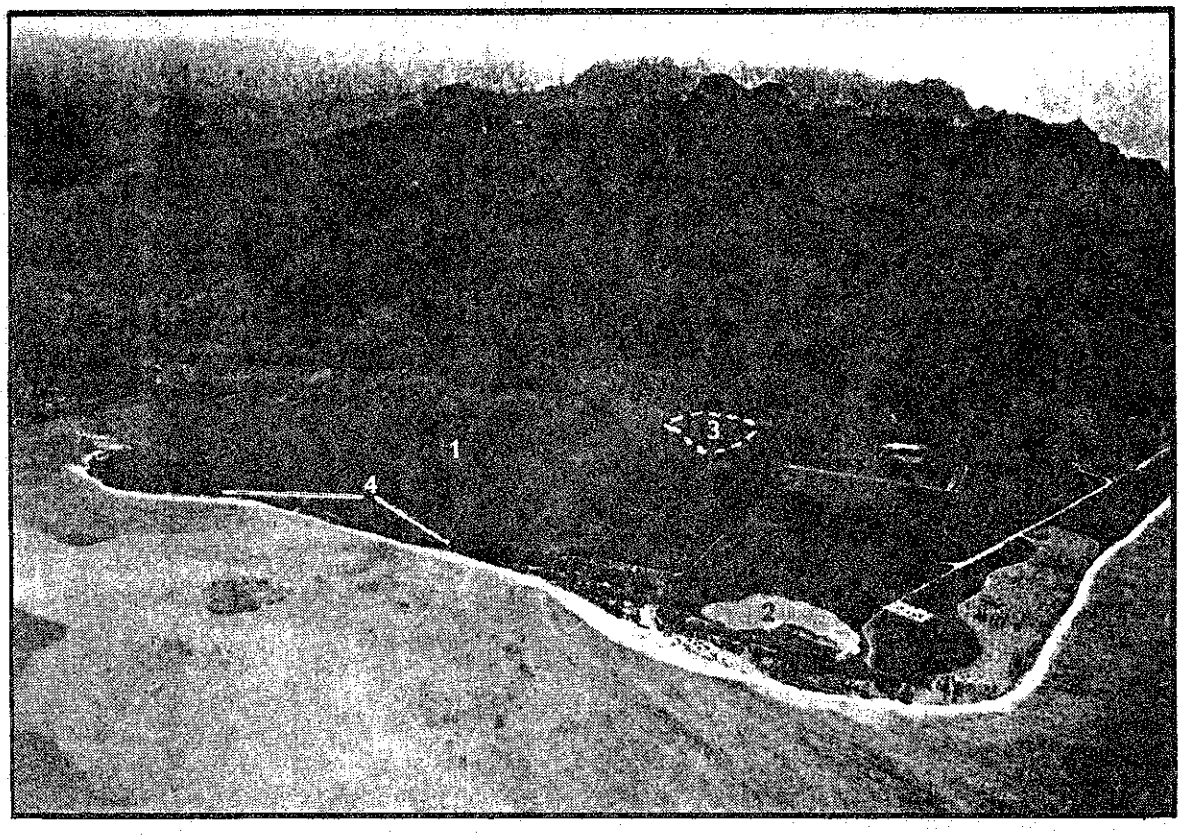
POTENTIAL IMPACT OF DREDGE/FILL ACTIVITIES: Although the Kahana wetlands are currently of limited significance to waterbirds, care should be exercised to avoid further deterioration of the habitat as a result of fill deposition. Excessive and prolonged turbidity in the stream and lower marsh would further limit the development of submergent vegetation. Siltation in the lower marsh would reduce circulation, accelerate the encroachment of mangrove and smother much of the currently available feeding habitat. Although the upper pasturelands are used only for grazing at this time, they exhibit considerable potential for improvement as waterbird habitat through diversion and impoundment of water. It may also be possible to improve the condition of Huilua Fishpond by restoration of the wall to reduce filling with sand.

SITE NAME: Mō-li'i/Kualoa Fishponds

LOCATION: Ko'olau Poko District, O'ahu

TOPOGRAPHIC MAP: Kahana

DATES OF SURVEY: 10 May, 28 May, 1977



1. Molii Pond
2. Mokolii (Kualoa) Pond
3. bulrush
4. mangrove

WETLAND DESCRIPTION: Molii Fishpond is one of few coastal fishponds in the State that are still in operation. Various sources indicate its present size at 113 (82) and 124 (112) acres. In either case, it is close to its original size. It is supplied water by springs and by rainfall runoff but its variable salinity may approach that of sea water due to several gates in the long wall. Although the present landowner is continuing to rear mullet in the pond, some biologists are concerned about the possible adverse impact of agricultural land run-off that may contain agricultural chemicals (112).

Much of the outer wall of Molii Fishpond is lined with a dense growth of mangrove. The remainder of the fishpond shores are covered with California grass and various shrubs, but a dense stand of bulrush is also found in the northeast corner of the site. Most of the bottom is sandy, although areas of suspended silt or dense mud are present as well.

A smaller fishpond at Kualoa Point has not been in fish production for many years. This pond has veen variously called Apua Pond, Mokolii Pond, Koholalee Pond and Kualoa Pond. This pond is less than five acres in size, and is much shallower than Molii Pond. Its bottom is mixed sand and mud throughout. It is surrounded by koa haole forest and scrubland with pickleweed, pluchea, milo, hau and various other shrubs and small trees. This pond is within the boundaries of Kualoa Regional Park and is managed as a waterbird sanctuary by the City and County of Honolulu.

NON-AVIAN WILDLIFE: A recent faunal survey of Molii Pond by the USF&WS provides an indication of species diversity for this site (82). The published list of fish and invertebrates included milkfish, mullet, barracuda, aholehole, bonefish, tilapia, Marquesan sardine, grapsid crabs, portunid crabs, o'pae and oysters. We found small shrimp and aquatic insects to be particularly abundant in the shallow water where stilt were seen feeding in both Molii and Kualoa ponds. It is probable that the mudflats in Kualoa Pond support other burrowing invertebrates, but no attempt was made to survey this site for these organisms.

Mongoose were observed throughout Kualoa Regional Park and along the north shore of Molii Fishpond. It appears that only the deeper water portions of this pond are inaccessible to this species. Dogs were seen near Molii Pond, and although one loose animal was seen in the Regional Park, some attempt is being made to limit their presence in the area. Two feral cats were seen in pasture land around the bulrushes at Molii Pond. Cattle were widely distributed in pasture lands between the highway and Molii Pond, but only have access to the water's edge in a few places along the north shore. Much of the shrub land on the east side of Molii Pond has been grazed in the past.

NON-WATERBIRD AVIFAUNA: We recorded several exotic birds during our survey at Molii and Kualoa fishponds, including Shama, Japanese White-eye, Red-crested Cardinal, Northern Cardinal, Spotted Dove, Barred Dove, House Finch and Common Myna. Northern Cardinals were particularly abundant in the koa haole forest within Kualoa Regional Park. The operator of the fishpond informed us that he had observed a "hawk" catching fish out of his pond during the first week of May, 1977. His description led us to believe that the bird was an Osprey (Pandion halieatus). This straggler species appears irregularly in the islands, but there are published records for this site.

WATERBIRDS OBSERVED: Hawaiian Stilt appear intermittently in recent HDF&G/USF&WS count records for both Molii and Kualoa fishponds, but invariably in small numbers (n=1-6). We recorded a maximum of three birds at Kualoa Pond and none were observed at Molii Pond. Variation in water levels at the latter site exposes some mud flat areas along the north shoreline that provide marginal habitat for this species. Kualoa Pond is limited in its potential as stilt habitat, in part, because of its small size.

Hawaiian Coots have been observed at Molii Pond even less regularly than stilt, and we found no records of the species at Kualoa Pond. The Molii fishpond operator was familiar with this species. He indicated that coots were more common in past years. Hawaiian Gallinule do not appear in count records for either fishpond. We did not observe any birds of this species until we penetrated the bulrush marsh in the northeast corner of Molii Fishpond. Three birds were seen in this area, but no evidence of nesting was found. The fishpond operator could not recall having seen gallinule away from this corner of the pond. It is not likely that birds of this species would ever be found within Kualoa Fishpond. Black-crowned Night Herons have been recorded at both ponds in past years, but are typically more common at Molii Fishpond. As many as 30 birds have been noted in one HDF&G/USF&WS count. We observed a maximum of eight birds (including six immature) during our visits to Molii. All were roosting in mangrove trees along the outer wall, or wading in shallow water in the same area.

Migratory waterfowl have not appeared on HDF&G/USF&WS count records for Molii Fishpond since 1972, when three Shovelers and one Pintail were observed. Again, the fishpond operator was familiar with the "wild ducks", but confirmed that they visited the site only occasionally. Migratory shorebirds, on the other hand, are regular winter visitors to both ponds. Golden Plovers, Ruddy Turnstones, Wandering Tattlers and Sanderlings have been recorded in small numbers at one or both ponds. The shallow water and mudflats of Kualoa Pond provide the best habitat in the area for these species.

The waterbird that appears in the Kualoa region in greatest numbers is the Cattle Egret. Yet, these birds are generally associated with large herds of cattle and horses above the highway or between the north shore of Molii Fishpond and the highway. A 1972 HDF&G/USF&WS count at Molii Fishpond reported 300 Cattle Egrets, but numbers are usually much less. We recorded less than a dozen birds in the area of the pond.

HABITAT EVALUATION: It does not appear that either Molii Pond or Kualoa Pond provide habitat that, in itself, is of major long-term significance to endangered waterbirds. Yet, together with other sites of similar value along the east coast of Oahu, these areas provide widely diverse and well-distributed feeding habitat that is important to the well-being of the Hawaiian Stilt. Our recent observations indicate value to gallinule as well. The draft HWRP (346) lists Kualoa Pond as a "secondary habitat" for endangered waterbirds. Perhaps the most important value of this pond is its current and potential use for environmental education. The City and County of Honolulu is developing an impressive program in environmental education at this regional park, and the waterbirds that use Kualoa Fishpond make up an important part of the total ecological story. There is an opportunity to insure protection of the birds with adequate fencing and predator control while not compromising the public's opportunity to enjoy and learn from the natural resource.

The bulrush marsh in the north corner of Molii Fishpond should be investigated on a repetitive basis to evaluate its significance to gallinule and other birds. It would be advisable to limit access of cattle to this immediate area and to also determine whether or not ongoing fishing operations create unnecessary disturbance that could be controlled. The aquaculture potential of the pond is said to be excellent, but whether or not the landowners will expand their operation is uncertain. The potential impact of any change in operation on this limited habitat should be considered.

POTENTIAL IMPACT OF DREDGE/FILL ACTIVITIES: Reconditioning of Molii Fishpond for expanded aquaculture projects would require construction of impoundments within the present pond (112). These impoundments would probably be located at the west end of the pond, so it is unlikely that such construction would impact on the best waterbird habitat. However, it is possible that other land development on the upland side of this pond could create significant siltation problems during periods of heavy runoff.

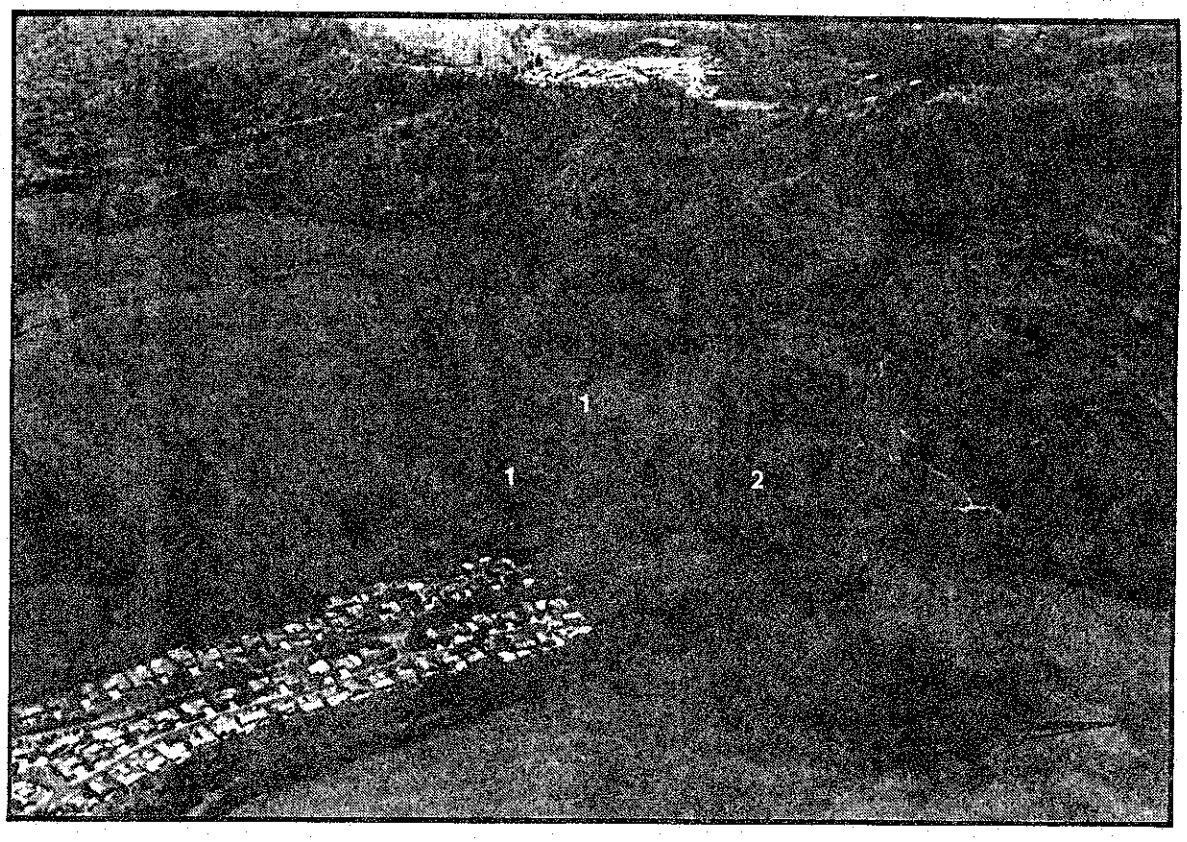
It is uncertain at this time what will be done with former grazing lands within and beyond the boundaries of Kualoa Regional Park. Clearing and development of lands surrounding Kualoa Pond should be evaluated on the basis of the potential impact on the wetland resources. It would be unwise to do anything with the surrounding land that might inadvertently lead to a reduction in water supply or deterioration in water quality in the pond.

SITE NAME: He'eia Marsh

LOCATION: Ko'olau Poko District, O'ahu

TOPOGRAPHIC MAP: Kāne-'ohe

DATES OF SURVEY: 7 May, 24 August, 28 August, 1977



1. open water
2. mangrove swamp
3. Heeia Stream
4. Heeia Fishpond
5. landfill

WETLAND DESCRIPTION: According to a recent USF&WS publication, the wetlands at Heeia include an 85 acre fishpond, a 35 acre mangrove swamp and 150 acres of grassy meadowland (82). We did not survey the shallow estuarine fishpond. The pond is said to have fair potential for aquaculture development, but would require several improvements (112).

Before relatively recent colonization of American and Oriental mangrove in this area, a large marshland and estuary existed at the ocean end of Heeia Stream. Mangrove and hau have now created a dense swamp that continues to grow with the accumulation of silt in the mangrove roots. Increasing silt loads in Heeia Stream, as a result of urban development in the Kaneohe watershed, have also reduced the open water in the upper marshland to a fraction of its original size. The existing meadowland traps and filters silt in stream flow and stores periodic flood waters. To this extent, the meadowland performs an important function to protect water quality in the bay. The reduced amount of open water in the meadowland is also due to the overall reduction in water table in the Kaneohe area and the 40 per cent reduction in Heeia Stream flow as a result of diversion (82). Various grasses, pluchea and other shrubs have invaded the meadowland as the accumulation of silt has accelerated. Although the site will continue to hold water during high runoff, the natural process of ecological succession will further reduce the amount of permanent open water.

The remaining open water in the meadowland ranged in depth from six inches to three feet on our first trip to the site, but after rains it had increased to more than five feet in the deepest areas. The lands are used for cattle grazing, and only the deepest water is free from the effects of these animals. Bulrush surrounding the open water has been partially trampled and eaten. Cattle activity has increased the turbidity of the water. A large landfill at the edge of the meadowland has further degraded the habitat through runoff into the marsh, particularly into the nearest pond.

The meadowland and swamp area are currently zoned for urban development. A major building project, involving construction of more than 5,000 homes, was proposed for the meadowland, swamp and fishpond area in 1973. The proposal was to include a large lagoon surrounded by houses within the existing meadowland, and a small boat harbor in the fishpond. There was vigorous public opposition to the proposal and attempt to appropriate State money for purchase of the wetland site to prevent its alteration. A somewhat modified proposal was made public by the landowner in October, 1977.

NON-AVIAN WILDLIFE: Recent stream surveys in the Kaneohe Bay watershed included stations at elevations above the meadowland on Heeia Stream. Investigators found 'opae, Tahitian prawns, crayfish, dojo, Chinese catfish, guppies, swordtails, mollies, and o'opu (82). Although tidal influence does not extend far upstream, it would not be surprising to also find mullet, milkfish and other anadromous fishes in the mangrove swamp and lower portions of the meadowland. We found crayfish and gastropod snails to be particularly common within the freshwater ponds. Dragonfly naiads and various aquatic insects were also widespread. Bullfrogs were heard calling near the ponds on all trips.

Only a few cattle were in the open meadowland at the time of our surveys, but tracks and sign were observed throughout the site. Dogs were observed within the mangrove swamp. A maximum of two mongoose were seen on individual trips to the

site, but mongoose droppings were seen at several locations throughout the site.

NON-WATERBIRD AVIFAUNA: Non-wetland birds that were common during our survey included Spotted Munia, Northern Cardinals, Common Mynas, Spotted Doves, Barred Doves and House Sparrows. The maximum number of Red-crested Cardinals counted on trips to the site was five. Shama were uncommon and recorded only in the mangrove forest. Both Red-vented Bulbuls and Melodious Laughing-thrush were missed on survey, but could be expected to inhabit the area.

WATERBIRDS OBSERVED: The most common native waterbird at Heeia wetlands on our survey was the Hawaiian Gallinule. A minimum of 15 gallinule were seen on the first trip, and records by sound alone suggest an even greater number were present. Less than half that number were counted during later trips of shorter duration. Nearly all gallinule in the meadowlands were within 100 feet of the open water ponds. Dense emergent bulrush and grass surrounding these sites provided cover. Several birds were feeding in among the bulrush stems at the edge of the ponds. No nests were discovered during the survey, but the soft mud bottom made it difficult for us to cover more than a third of the possible nesting habitat. Not surprisingly, this species does not appear on recent HDF&G/USF&WS count records for Heeia, because no attempt has been made to penetrate the marshland on these surveys. Most of these counts have been made from the road bridge through the mangrove swamp.

Hawaiian Coots were seen on all our trips to the ponds, with a maximum recorded number of five. In most visits, these birds were in the more open water of the ponds, rather than in the bulrush like the gallinule. Coots were diving for food, picking off floating algae or browsing off plant stems. A single coot was seen from the highway bridge on the last trip to the site. There has been only one recent HDF&G/USF&WS record of coots at the site (two birds - 1/13/72), but it is likely that they are present most of the time within the estuarine swamp or in the freshwater ponds. The mangrove and hau along the stream provides a great deal of cover that would prevent these birds from being detected.

Black-crowned Night Herons have been recorded on several previous counts in the mangrove swamp and near the fishpond. We only saw two birds at the site on our first two visits. Seven herons were counted on the last trip. All the herons on the last trip were on the perimeter of the largest pond. Richard Davis (515) has indicated that herons roosted in earlier years on the forested slopes above Heeia meadowlands, but we saw no herons in this area. Herons range widely in Kaneohe Bay, taking advantage of temporarily abundant food in fishponds, reservoirs, streams and shallow water marshlands.

Both Golden Plovers and Cattle Egrets appear on earlier count records for Heeia marsh. Tim Burr (512) reports having observed as many as 30 plovers on the landfill site, but we observed none on our summer survey. We counted as many as 15 egrets on our three trips to the site. None of the egrets was found more than fifty feet from grazing cattle. The exposed mudflats within the mangrove swamp and near the fishpond provide some additional habitat for plovers and other shorebirds.

HABITAT EVALUATION: It appears that the existing value of the freshwater ponds and associated marsh of Heeia for gallinule or coots has not been truly evidenced by earlier surveys of the site. Difficulty in access complicates accurate repetitive

censusing of these birds, but more thorough survey in the future would help to develop a clearer understanding of waterbird use throughout the year. It would be unfortunate for this habitat to degrade further through encroachment of vegetation or through urbanization. The draft HWRP (346) describes the site as of "secondary" importance to waterbirds on Oahu. However, this evaluation was based on count records that do not appear to reflect actual populations. It may also be based on the knowledge that the land is presently zoned for development. However, these recent data lend support to the widespread belief among those protesting such development that the meadowland and mangrove swamp might more appropriately be zoned for conservation use.

The continued presence of cattle in the area of the freshwater ponds will inhibit expanded use of the habitat by waterbirds, and will probably create sufficient disturbance to limit or prevent nesting. The ponds are not protected from various mammalian predators that can reach all but the deepest water. Creation of additional water impoundments and flooded potholes could be accomplished within the meadowland through diversion of stream flow. However, effective means to control water levels would be fundamental to continued successful nesting by any of the resident waterbirds.

Mangrove and hau will continue to encroach on the estuarine portion of this drainage unless controlled by a major clearing operation. California grass and honohono grass in the meadowlands will also trap silt and create more dry land. Repetitive clearing of some of this vegetation would improve waterbird habitat, but it could lead to excessive siltation within the bay and fishpond unless other artificial means were developed to filter silt from turbid runoff water. A settling basin in the upper meadowlands could solve this problem but it would require periodic clearing of accumulated silt by mechanical means. Additional water impoundments in the meadowlands would increase the habitat available to waterbirds and would also increase the capability of the site to retain flood waters when necessary.

POTENTIAL IMPACT OF DREDGE/FILL ACTIVITIES: The excessive turbidity in the pond closest to the existing landfill at Heeia provides a clear demonstration of the need to regulate neighboring land use in the protection of wetland habitat quality. In its present state, there is no effective means to control erosion in heavy rains at this landfill site. Clearing and urbanization of lands in the upstream area of the meadowland would have similar effects on turbidity, and potentially more serious long-term effects through other associated pollution. Dredging of a large lagoon, as originally proposed in the housing development plans, would destroy the functioning pond and stream ecosystem upon which birds and other species now depend.

Shallow water impoundments in the meadowland, including a settling basin for silt, could be accomplished with only temporary impact on stream flow and turbidity levels. Dredging to clear encroaching grasses and mangrove would temporarily disturb the bottom fauna and the birds that inhabit the area, but it is necessary to prevent further loss of flood capacity and eventual filling of the site. Any major habitat alteration should be preceeded by a more thorough investigation of pond ecology, so that long-term impact can be minimized.

SITE NAME: Kaneohe Marine Corps Air Station Ponds

LOCATION: Ko'olau Poko District, O'ahu

TOPOGRAPHIC MAP: Mō-kapu

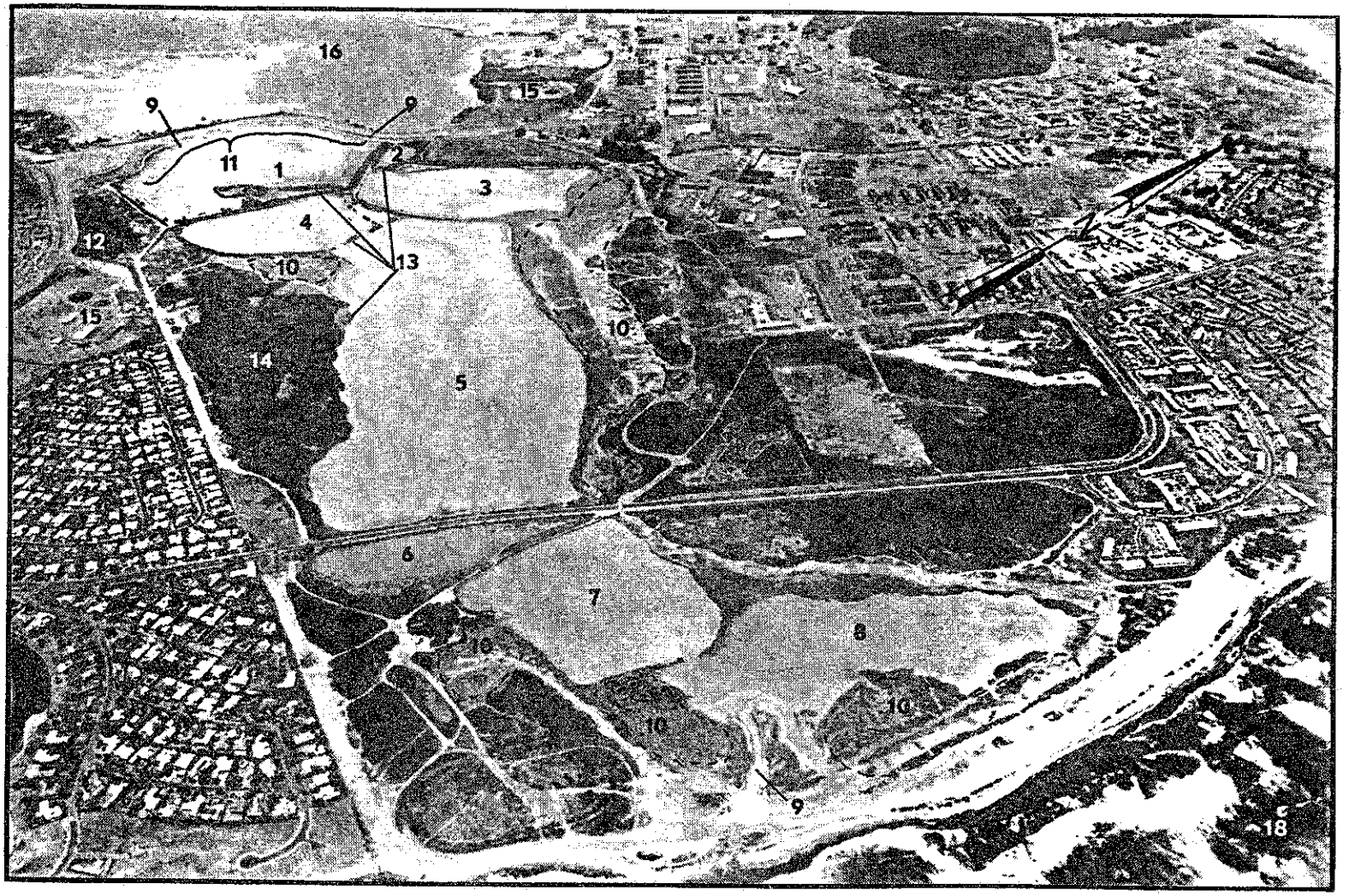
DATES OF SURVEY: 30 May, 28 June, 1977

WETLAND DESCRIPTION: Eight shallow mixohaline ponds, totalling about 180 acres of open water make up the Nuupia pond complex at Kaneohe Marine Corps Air Station (KMCAS). The ponds are named Nuupia 'Ekahi, Nuupia 'Elua, Nuupia 'Ekolu, Nuupia 'Eha, Heleloa, Halekou, Kaluapuhi and Pa'akai (see photograph). Nuupia 'Ekahi is connected to Kaneohe Bay by two culverts. Heleloa is connected to Kaneohe Bay by a canal under the recently-constructed H-3 highway. A long channel connects Pa'akai with Kailua Bay during extremely high tides or high surf. All of the ponds are joined by openings in the walls between them, or by culverts.

Salinity and water levels in the ponds fluctuate with rainfall and tidal influence. Although inlets were constructed under the H-3 highway to facilitate control of water levels, no mechanism has been installed to perform this function. Heavy rains and high tides may flood extensive pickleweed mudflats that border the ponds, creating serious problems for nesting birds. On the other hand, pond levels may drop quickly during periods of low rainfall, resulting in fish kills and exposure of formerly isolated waterbird nests to predation. Effective control over water levels would improve waterbird habitat management capability.

The ponds are surrounded by expansive mudflats where the dominant vegetation is pickleweed. Many years of military amphibious vehicle training has left much of this ground furrowed and diked. These pickleweed flats provide the most suitable nesting habitat for Hawaiian Stilt and feeding habitat for stilt and migratory shorebirds. American mangrove has encroached heavily along the edges of some ponds, particularly Nuupia Elua and Nuupia 'Ekahi. A dense kiawe forest south of the Nuupia ponds provides cover for various exotic birds as well as roosting and nesting habitat for both Cattle Egrets and Black-crowned Night Herons.

All of the ponds and additional surrounding forest and pickleweed flats have been designated as a wildlife refuge by the U.S. Marine Corps, in cooperation with the USF&WS and the HDF&G. Although the site is managed primarily for the Hawaiian Stilt, some additional use is permitted. Attempt is made to confine training activities with Marine vehicles to the least sensitive areas and to periods of the year when stilt are not nesting. Some pond areas are open to limited public fishing as well. Cooperative management activities have included: 1) construction of artificial nesting islets along the H-3 highway; 2) trapping of mongoose by



1. Nuupia 'Ekahi Pond
2. Heleloa Pond
3. Halekou Pond
4. Nuupia 'Elua Pond
5. Nuupia 'Ekolu Pond
6. Nuupia 'Eha Pond
7. Kaluapuhi Pond
8. Pu'akai Pond
9. inlet/outlet
10. stilt nesting areas
11. artificial stilt nesting islands
12. Cattle Egret colony
13. mangrove
14. kiawe and koa haole
15. sewage treatment plant
16. Kaneohe Bay
17. Aikahi Park residential area
18. Kailua Bay

members of the Rod and Gun Club; 3) dog control in nesting areas; 4) release of cage-reared Koloa into Nuupia 'Ekolu pond; 5) waterbird censusing; 6) monitoring of water levels; 7) studies of nesting habits of stilt; and 8) investigations of food availability and feeding behavior of stilt.

NON-AVIAN WILDLIFE: Recent food availability studies in the Nuupia pond complex by HDF&G and USF&WS biologists provide an overall picture of fishes and invertebrates within the ponds (82). Fishes recorded by these investigators include milkfish, mullet, sailfin molly, top minnow, mosquito fish, barracuda, aholehole and tilapia. Most of these species were widely distributed. We found tilapia redds (nest depressions in pond bottom) to be most common in Heleloa and Halekou ponds. Puddles that are left on pickleweed flats with decreasing water levels often contain dense concentrations of juvenile fishes. Biologists studying food availability also found numerous macroinvertebrates, including grapsid crabs, portunid crabs (in eastern ponds only), palaemonid shrimps, brine flies, hydrophid beetles, waterboatmen and isopods. The isopods were particularly abundant on the mudflats during our survey of the site. They were in dense concentration under the pickleweed and on the mud surrounding puddles left by evaporating rain water.

The large population of mongoose on lands surrounding the ponds has been controlled, at least in part, by the trapping efforts of the KMCAS Rod and Gun Club. More than 2,000 mongoose have been trapped at the Base and turned over to the University of Hawaii for medical research. A total of 685 mongoose were trapped in 1976 alone (80). Studies of stilt breeding biology in recent years by HDF&G continue to discover evidence of excessive predation in spite of the trapping effort. Loose dogs, often traveling in packs, have been a continuing problem in the stilt nesting colonies. Recent efforts by the Marine Corps to remove the dogs has improved conditions for nesting, but these animals are still observed on a regular basis throughout the area. We found dog tracks in virtually every area of shoreline or pickleweed mudflat.

NON-WATERBIRD AVIFAUNA: The most common non-wetland birds on the Marine Base during our survey were Barred Doves, Spotted Doves, Japanese White-eyes, House Sparrows and Common Mynas. All of these were seen in the housing areas and in the mudflats and forested lands bordering the ponds. Other less common birds observed on survey were Red-crested Cardinals, Northern Cardinals, House Finch, and Spotted Munia. The population of Red-vented Bulbuls on the Base and in surrounding urban areas has increased dramatically in recent years. We found bulbuls in greatest numbers within the kiawe forest south of Nuupia 'Ekolu. Ring-necked Pheasants have been reported from several locations on the base, but we observed them only in the grassy scrubland north of Nuupia 'Ekolu. Hawaiian Owls (Pueo) and Barn Owls have also appeared occasionally on earlier HDF&G/USF&WS count records for the site, but were not seen on our survey.

WATERBIRDS OBSERVED: Waterbirds at KMCAS have been documented over several years on HDF&G/USF&WS surveys and Audubon Christmas Counts, and more recently during breeding studies in the ponds by HDF&G biologists. Recent attention has been focused on the Hawaiian Stilt, but thirty years of records reflect population trends in several species.

One of the earliest reports of Hawaiian Stilt at the Nuupia ponds noted more than 400 birds in 1947. The first Hawaii Audubon Society (HAS) count in the same