

HAWAIIAN FISHPONDS AND ENDANGERED WATERBIRDS ON THE KONA COAST

MARIE P. MORIN¹, Research Associate, Kaloko-Honokohau National Historical Park, 73-4786 Kanalani St. #14, Kailua-Kona, HI 96740

ABSTRACT: Prior to Western contact, Hawaiians built fishponds for aquaculture on at least six of the eight main Hawaiian Islands. Few of the fishponds are actively "worked", but many of them are suitable for and utilized by waterbirds and shorebirds, including endangered species. At the new Kaloko-Honokohau National Historical Park in Kona on Hawaii Island, endangered Hawaiian Stilts and Hawaiian Coots utilize the fishponds and other coastal wetlands, both natural and man-made. Management concerns for waterbirds and wetlands throughout the Hawaiian Islands include heavy predation, human disturbance, tidal fluctuations, loss of habitat, groundwater modifications, and conflicting political and cultural considerations. Some of the solutions that have begun include predator control, the creation of nesting sites, vegetation manipulation, and baseline hydrological studies. Modifications to Park development and management have been recommended.

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GENERAL BACKGROUND

Prior to Western contact in the late 1700's, the Hawaiians built fishponds for aquaculture on at least six of the eight main Hawaiian Islands: Kauai, Oahu, Molokai, Maui, Lanai, and Hawaii. Kikuchi (1976) compiled a list of 360 known fishponds for all the islands, although other estimates range from 158 to over 370 (Cobb 1903, Anon. 1989). The handmade rock walls can still be seen for most of these fishponds, which were modifications of natural ponds, bays, estuaries, anchialine pools, and tidal areas (Wyban 1992). Few of these fishponds are still actively managed for aquaculture. Many of the old fishponds provide important habitat for Hawaii's non-migratory endangered waterbirds, as well as seasonal migratory waterbirds and shorebirds. Some of the fishponds best known for their waterbird habitat include: Kanaha Pond on Maui; Loko-Waka (Loko-aka) Pond, Makalawena Fishpond (Opaepala), and 'Aimakapa Fishpond on Hawaii Island; Nuupia Ponds, Kawai nui Marsh, and (prior to development) Ka'elepulu Pond on Oahu. Many other fishponds or fishpond remnants provide important habitat. Generally, fishponds that are shallow or silted in and have at least some freshwater inflow are the most likely to receive significant waterbird use.

The Hawaiian Islands have four endangered, endemic waterbird species that inhabit wetlands such as fishponds: the Hawaiian Coot or 'Alae ke'oke'o (*Fulica alai*; Monroe et al. 1993), the Hawaiian Stilt or Ae'o (*Himantopus mexicanus knudseni*), the Hawaiian race of the Common Moorhen or 'Alae 'ula (*Gallinula chloropus sandvicensis*), and the Hawaiian Duck or

Koloa maoli (*Anas wyvilliana*). Also resident in the Islands is a non-migratory race of the Black-crowned Night-Heron or 'Auku'u (*Nycticorax nycticorax hoactli*). Common migratory waterfowl and shorebirds include Northern Shovelers or Koloa Moha (*Anas clypeata*), Northern Pintails or Koloa Mapu (*Anas acuta*), Pacific Golden-Plovers or Kolea (*Pluvialis fulva*), Ruddy Turnstones or 'Akekeke (*Arenaria interpres*), Sanderlings or Hunakai (*Calidris alba*), Wandering Tattlers or 'Ulili (*Heteroscelus incanus*), and less usual migrants like Bristle-thighed Curlews or Kioea (*Numenius tahitiensis*) and Ring-billed Gulls (*Larus delawarensis*).

Of the endangered species, only Hawaiian Coots and Hawaiian Stilts reside at Kaloko-Honokohau National Historical Park (KAHO) in Kona on Hawaii Island, although native Black-crowned Night-Herons and all the typical migrants also utilize the area. Non-native resident Cattle Egrets (*Bubulcus ibis*) periodically occur at KAHO, as well as a feral Mallard (*Anas platyrhynchos*). A pair of Pied-billed Grebes (*Podilymbus podiceps*) apparently self-introduced during the 1980's (Anonymous 1993).

Although waterbird populations are small (a mean of 56 Hawaiian Coots and 12 Hawaiian Stilts for 1992 through July 1993 for 104 censuses; unpubl. data), KAHO contains the best waterbird habitat on the Kona Coast, and is one of the most important wetlands on Hawaii Island (Engilis and Reid in prep.). The earliest Hawaiian Waterbirds Recovery Plan listed KAHO's Aimakapa Fishpond as one of 17 "essential" waterbird habitats in the Hawaiian Islands (Walker et al. 1977).

¹ Present address: P. O. Box 3543, Kailua-Kona, HI 96745.

The other major wetland on the west side of Hawaii Island is Makalawena, frequently referred to as Opaëula Pond. Data suggests that at least Stilts move between these two primary wetlands (Paton, Scott, and Burr 1985) and probably most of the waterbirds and shorebirds also do. This wetland contains stonework suggestive of ancient fishpond use and was used by Hawaiians for aquaculture (Paton, Scott, and Burr 1985). Makalawena was the only other pond on Hawaii Island to be listed as "essential" waterbird habitat (Walker et al. 1977). In addition, many anchialine pools are scattered along the Kona Coast, providing important diffuse habitat.

Kaloko-Honokohau National Historical Park was created primarily as an important Hawaiian cultural park. There was a large Hawaiian settlement in the area and there are many archaeological sites, including graves, throughout the Park. These cultural considerations have great significance to many members of the community and must be incorporated into any wetland and waterbird management.

THE FISHPONDS OF KALOKO-HONOKOHAU

At KAHO, prominent archaeological features include a fishtrap and two fishponds. These features are protected as archaeological sites, but are also man-modified wetlands and embayments that provide waterbird and shorebird habitat.

The fishtrap, 'Ai'opio, is about two acres. Fishtraps differ from fishponds in that fishtrap walls were meant to be submerged during high tides, thus passively trapping fish as the tide fell (Wyban 1992).

The smaller of the two true fishponds, Kaloko Fishpond, is about 11 acres. In Hawaiian, this type of fishpond is called "Loko kuapa": "loko" meaning pond and "kuapa" meaning that it was a natural bay separated from the sea by a man-made seawall. This fishpond has significant freshwater intrusion or springs on its eastern side. Currently waterbirds and shorebirds use this fishpond very little, probably for several reasons. The fishpond was partially dredged prior to National Park Service (NPS) acquisition, making some of it too deep for optimal shorebird and waterbird use. Storm-generated waves have damaged the original seawall, resulting in a significant flow of saltwater into the fishpond. Alien red mangrove (*Rhizophora mangle*) covered much of the fishpond from about the late 1960's until 1993. Although the NPS recently removed this, another aggressive alien plant, pickleweed (*Batis maritima*), has rapidly expanded into the newly cleared

habitat, thus modifying the suitability of these areas for foraging.

The bigger of the two fishponds is 'Aimakapa. It is the single most important waterbird wetland on the Kona coast. 'Aimakapa is a Loko pu'uone type of fishpond, indicating it is believed to be a large natural pond behind a barrier beach. About 15 acres of open water are bordered by additional areas of wetland vegetation on the northern and southern shores. This fishpond is also fed by underground freshwater flowing in from its inland, eastern side. Honokohau Harbor closely borders 'Aimakapa to the south, and a "light" industrial area is upslope of both Kaloko and 'Aimakapa Fishponds.

Historically, 'Aimakapa Fishpond was much larger than at present, probably as much as 30 acres. Aerial photos and ground reconnaissance confirm that much of the wetland adjacent to the fishpond is sections of the fishpond that have become silted in and overgrown with vegetation. Old rock walls are obvious in aerial photos, frequently associated with Polynesian-introduced milo trees (*Thespesia populnea*) that preferentially grow on these rocky substrates under moist conditions (pers. obs.). In addition, during low tides, the rubble of apparent fishpond-type rock walls extend beyond the sandy barrier beach on the ocean side. It is unknown whether the narrow barrier beach formed over an ancient rock wall, but this possibility will be investigated (L. Schuster, pers. comm.).

Other wetlands in KAHO include anchialine pools and rocky tidal areas that provide dispersed but important peripheral waterbird habitat.

MANAGEMENT CONCERNS

Management concerns associated with waterbird use in fishponds are characteristic of waterbird and wetland concerns throughout the Hawaiian Islands, except that special consideration must be given to the cultural, historical, and legal situation for each specific fishpond. In fishponds with endangered waterbirds, especially those being used for modern aquaculture, management activity must comply with provisions of the Endangered Species Act. Salinity modifications, siltation removal, alteration of water depth, the introduction of nutrients, human activity, and other practices that may optimize aquaculture are potential sources of disturbance or habitat degradation for waterbirds. Section 7 consultation with U.S. Fish and Wildlife Service is required if an activity is proposed, permitted, or funded by a federal agency.

At fishponds, predators pose a problem for waterbirds and are detrimental to successful waterbird breeding. As is true for most lowland sites in the state, cats (*Felis catus*), dogs (*Canis familiaris*), and especially the non-native mongooses (*Herpestes auropunctatus*) present the biggest threats. Rats (*Rattus* spp.) and mice (*Mus domesticus*) have not been shown to be numerous in spite of KAHO's proximity to Honokohau Harbor (Stone, Aeder and Hao, pers. comm.). A single feral pig (*Sus scrofa*) was recently removed after residing for at least two years in the wooded area next to 'Aimakapa (pers. obs.). I have also suggested removal of the many large fish in both KAHO fishponds, because they may be ingesting endangered Hawaiian Coot chicks. Although potential avian predators such as Cattle Egrets and Black-crowned Night-herons occur in low numbers at KAHO, the Cattle Egrets are only periodic visitors. Neither species appears to be a major cause of waterbird predation (pers. obs.).

'Ai'opio Fishtrap and the beach immediately behind it are currently occupied by a Hawaiian family under permit from the NPS, although they also claim sovereign rights to the site. There are dogs and sometimes other animals (such as domestic geese) maintained there by the permittees.

The harbor represents a steady source of food for scavenging animals, and free-ranging pets from there frequently enter the Park. Dogs are often brought into the Park by visitors. Direct predation on waterbirds is a problem (pers. obs.), but the harassment of waterbirds by predators presents an equally important negative impact.

Although most of the management concerns are indirectly caused by humans, there are impacts that are obviously and directly due to humans. Neither fishpond is fenced and both are accessible to humans on foot; Kaloko Fishpond can also be accessed by motor vehicle. The barrier beach that separates 'Aimakapa Fishpond from the ocean is a popular beach, a use that was established prior to KAHO's purchase by NPS. Current visitor use next to the fishponds is not considered by NPS to be heavy, and is mostly composed of local residents, many of whom visit regularly and even daily. Visitor numbers will likely increase after KAHO signs are erected along the adjacent public highway which is the only direct route between the airport and Kona village.

Although toilet facilities exist along the access trail to 'Aimakapa, none are convenient to the fishpond.

Also, the "light" industrial area upslope of KAHO does not have a sewage treatment system. Untreated sewage and sewer water, including business by-products such as petrochemicals, are discharged into cesspools. The entire area is at the base of Mount Hualalai, a dormant volcano. Much of the substrate is geologically recent lava flows, which tend to be porous rock. Because the flow patterns of water, nutrients, and pollutants is largely unknown, water quality is a major concern. Baseline values are not available for comparative purposes. Fresh water from upslope Hualalai flows underground close to the surface and enters the ocean at various sites along the Kona Coast, including 'Aimakapa and Kaloko Fishponds and Honokohau Harbor. This water maintains the brackish status of the fishponds, as well as coastal anchialine pools. In addition to water wells that are in place, more upslope wells are proposed, with possible depletion effects on the coastal freshwater system.

Hawaii Island is the youngest of the main islands, all of which were formed by volcanoes. Because of its young age, natural wetlands have not had long to develop, and few large wetlands are available to waterbirds (Paton and Scott 1985). Appropriate habitat, particularly breeding sites, are limited. The paucity of appropriate sites was highlighted during 1993 when at least two pairs of Hawaiian Stilts attempted to breed on a bare lava flow next to artificial pools at a Kona algae aquaculture enterprise. Eggs from these nests hatched but the chicks drowned in the swift current of the pools (pers. obs.).

The Common (Hawaiian) Moorhen no longer occurs on Hawaii Island (Henshaw 1902) and populations of the other endangered Hawaiian waterbirds on Hawaii Island are small. Although waterbirds are known to move among the other main islands (Engilis and Pratt 1993), Hawaiian Stilts have not yet been documented to move between Hawaii Island and the other main islands (Reed pers. comm.) and neither have Hawaiian Coots. This raises concerns about minimum viable populations sizes.

Although floating Hawaiian Coot nests are found in 'Aimakapa Fishpond, the more typical nest found there for both Hawaiian Coots and Hawaiian Stilts are located on the shoreline, small islets, or floating grass mats within the pond. Many of the natural islets are not high enough to keep nests from becoming inundated during the highest high tides. Both 'Aimakapa and Kaloko Fishponds experience tidal fluctuation, as do all of the anchialine pools (pers. obs.). Nests and eggs are

lost due to tide damage and other water fluctuations, such as during storms (pers. obs.).

Alien species are a major problem in all the low elevation wetlands in Hawaii. Alien plants often outcompete native plants, covering open water and anchialine pools, stabilizing mudflats that would otherwise be more open, and altering the structure and composition of the vegetative community. For example, the introduced Christmasberry tree (*Schinus terebinthifolius*) grows under moist conditions and is often found in or next to anchialine pools and other wetlands. Anchialine pools should be considered endangered ecosystems, being altered to an unknown degree by leaf debris and other side effects from Christmasberry and other alien species.

One positive story for KAHO is the successful red mangrove removal accomplished most noticeably at Kaloko Fishpond but more importantly at 'Aimakapa Fishpond. The latter was in the initial stage of mangrove invasion when the colonizers were removed in 1993. Larger mangroves were manually removed by cutting them low in the water, and seedlings were either scorched with a propane torch or pulled. Mangrove seeds float and are saltwater tolerant; treatment for several years will deplete the on-site seed bank. But, a seed source on private property north of KAHO will require continual control until that source is removed. Unfortunately, after mangrove removal at Kaloko Fishpond, the aggressive alien pickleweed or salt wort (also called 'Akulikuli-kai) invaded the cleared mudflats. Pockets of native wetland and shoreline plants remain, including plants such as water hyssop (*Bacopa monnieri*), the native 'Akulikuli (*Sesuvium portulacastrum*), 'Ohelo-kai (*Lycium sandwicense*), and sedge Makaloa (*Cyperus laevigatus*). The alien pickleweed grows over and shades out the native plants, creating a dense, tall thicket very unlike the vegetative structure of a plant community composed of extant native wetland species.

The alien waterbirds at KAHO are Cattle Egrets and a single feral Mallard. Cattle Egret are few (4 to 6), they do not have a rookery at KAHO, and they generally leave the Park during the Stilt breeding season. But, because they are a predatory threat to young waterbirds, they deserve to be monitored and removed if necessary. The feral Mallard does not seem to pose a major threat as long as she remains unpaired, although her removal could be justified. Mallards generally do not migrate to Hawaii, and the feral female that lives at 'Aimakapa is thought to be an escapee from one of the resort hotels

north of Kona. The recent periodic sightings of "Koloa" at KAHO are attributable to this duck.

The Pied-billed Grebes are the only resident grebes in the state. A pair became established during the mid 1980's and stayed to breed. They or their progeny have been breeding at 'Aimakapa since. Their numbers appear to be somewhat stable or declining (less than ten), perhaps due to inbreedness. Whether the Grebes compete with the endangered native waterbirds for food and space is unclear.

SOME SOLUTIONS

Beginning in early 1993, two types of floating nest platforms were tried at both 'Aimakapa and Kaloko Fishponds (unpubl. data). The platforms were an attempt to avoid not only nest/egg loss due to flooding, but also to reduce mammalian predation and harassment. Cryptic stilt nests built on the shoreline are especially vulnerable to damage (e.g. being stepped on) because the nesting area is not closed during the breeding season. One type of platform was untreated wood and the other type was hardware cloth, with floats attached below and dried grass above woven into the wire. Both types were anchored in the mud using wooden dowels. Of the five wooden platforms used in 'Aimakapa Fishpond in 1993, Stilts nested on three (a total of four nests) and a Coot nested on one. The wooden platforms were paired with wire platforms; no wire platforms were used for nesting in 1993. The wire platforms were modified in 1994. In Kaloko Fishpond, none of the five wooden or five wire platforms were used in 1993 for nesting.

Trapping for mongooses and cats began in earnest in 1993. Only the area immediately around 'Aimakapa Fishpond is controlled. Live-trapped mongooses are euthenized and cats are taken to the local Humane Society. Trapping grids conducted nearby in 1992 and 1993 suggested that control can only be achieved in a localized area of heavy trapping because the mongoose population is so high in the lowlands. I no longer see mongooses and cats "patrolling" the 'Aimakapa Fishpond's perimeter.

Prior to the Stilt breeding season in 1993, some of the natural islets and some rock walls were manually cleared of heavy vegetation in order to promote Stilt nesting. Stilts and other shorebirds immediately fed in cleared areas in 'Aimakapa (pers. obs.). A stilt successfully nested on one of the higher islets that had previously been unavailable due to dense tree, shrub, and grass cover. Manual clearing mimics the results

commonly achieved in managed refuges where flooding is used to control vegetation.

SOME PRELIMINARY RECOMMENDATIONS

Preliminary recommendations for future KAHO Park development and management include:

1. Enlarge the wetland area suitable for waterbirds by removing vegetation in some areas that are overgrown or seriously invaded by aggressive alien plants. However, great care must be made to maintain an optimal mix of shallow, open mudflats for Hawaiian Stilts and dense cover for Hawaiian Coots. Careful removal of alien vegetation will also help to maintain the native wetland plants and could help to reseed cleared areas if given the opportunity before more degradation occurs. Vegetation management will be very labor intensive.
2. The feasibility of rebuilding the rock seawall at Kaloko Fishpond, and rebuilding the original makaha (sluice gate) at 'Aimakapa Fishpond should be further researched. In the former case, this would allow less exchange of brackish fishpond water with the ocean, and in the latter case it would allow more exchange. Although some water flow into the ocean from 'Aimakapa might be advantageous, too much flow could remove too much silt and would degrade the fishpond for Stilt use by making the fishpond too deep.
3. Manage human activities planned for this small park. These include fishing, aquaculture, bird-watching, swimming, sunbathing, hiking, and cultural uses. At specific times or sites, area closures should be enforced to protect endangered waterbird breeding and feeding and to protect the wetland vegetation itself from overuse.
4. Monitor water quality and quantity both within the Park and also upslope in the Mount Hualalai watershed. Minimum freshwater underground flows need to be established before more water wells are installed upslope.
5. A coordinated multi-agency approach should be taken with resorts in west Hawaii to educate them about problems that can be caused by non-native waterfowl and other species that escape from resort collections, and to work with them to prevent introductions.
6. Manage the waterbird resource, including the migrants, more intensively. At a minimum, predator control, alien vegetation management, minimization of disturbance, and enhancement of nest sites should

continue at KAHO. Management should be initiated at Makalawena. The waterbirds and wetlands along the Kona coast should be viewed as a single entity and management should be multi-agency and coastal in scope; the waterbirds do not recognize boundaries. The existing site-by-site management will not ensure long-maintenance of these waterbirds on the west coast of Hawaii Island.

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