

Information Sheet on Ramsar Wetlands (RIS)

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Designation date

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Site Reference Number

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2. Date this sheet was completed/updated: March 30 2005

3. Country: USA

4. Name of the Ramsar site: Kawainui and Hamakua Marsh Complex

5. Map of site included:

a) hard copy (required for inclusion of site in the Ramsar List): *yes* X -or- *no*

b) digital (electronic) format (optional): *yes* X -or- *no*

6. Geographical coordinates:

Kawainui Marsh: 21 23.5' N, 157 45.5' W

Hamakua Marsh: 21 23.5' N, 157 44.5 W

7. General location:

Kawainui Marsh is a 405 hectare (1,000 acre) wetland located near the city of Kailua on the windward, northeast coast of the island of O'ahu, State of Hawaii, USA.

Hamakua Marsh is a 9 hectare (23 acre) wetland associated with Kawainui Marsh, located adjacent to Hamakua Drive and Kawainui Stream in the city of Kailua, windward side of the island of O'ahu, State of Hawaii, USA.

Kawainui and Hamakua Marshes are located about 16 kilometers (10 miles) north of Honolulu, separated from Honolulu by the Koolau Mountains.

8. Elevation: (average and/or max. & min.)
 Kawainui – 1.5m average
 Hamakua – 0.75m average

9. Area: (in hectares)
 Kawainui – 405 hectares
 Hamakua – 9 hectares

10. Overview:

Sacred to Hawaiians, Kawainui Marsh, the largest remaining emergent wetland in Hawaii and Hawaii's largest ancient freshwater fishpond, is located in what was once the center of a caldera of the Koolau shield volcano. The marsh provides primary habitat for four of Hawaii's endemic and endangered waterbirds, and contains archaeological and cultural resources, including ancient walled taro water gardens (lo'i) where fish were also cultivated. Kawainui Marsh stores surface water, providing flood protection for adjacent Kailua town, one of the largest towns on the windward side of O'ahu. Hamakua Marsh is a smaller wetland historically connected to and immediately downstream of Kawainui Marsh, which also provides significant habitat for several of Hawaii's endemic and endangered waterbirds. The Hawaiian Islands are the most isolated high islands in the world, and constitute a distinct biogeographic region.

11. Ramsar Criteria:

1 • 2 • 3 • 4 • 5 • 6 • 7 • 8

12. Justification for the application of each Criterion listed in 11. above:

Criterion 1: Kawainui and Hamakua Marshes meet this criterion due to their hydrological functions and provision of valued services. The wetland complex is valued for its flood control of the surrounding local community, and has a major role in maintaining natural functioning and high water quality of Kailua Bay (Hawaii State Department of Land and Natural Resources, 1994; U.S. Army Corps of Engineers, 1998). The marsh acts as a flood control reservoir, storing runoff as surface water from major rainfall events, which is gradually discharged to Kailua Bay. The marsh also traps sediment and uptakes nutrients and pollutants, reducing adverse water quality impacts on the nearshore ecosystem in Kailua Bay.

Criterion 2: Both marshes meet this criterion, as the wetlands support four endangered species endemic to the Hawaiian Islands. The wetland complex provides habitat for four endemic Hawaiian waterbirds listed as endangered under the U.S. Endangered Species Act: hybrids of the Hawaiian Duck or koloa maoli (*Anas wyvilliana*), Hawaiian Coot or 'alae ke'oke'o (*Fulica alai*), Hawaiian Moorhen or 'alae 'ula (*Gallinula chloropus sandwicensis*), and Hawaiian Stilt or kukuluac'o (abbreviated as ae'o) (*Himantopus mexicanus knudseni*) (U.S. Fish and Wildlife Service, 2002). The Hawaiian Duck is listed as Endangered and the Hawaii Coot as Vulnerable on the IUCN Red List of Threatened Species (IUCN, 2004).

Criterion 3: Kawainui and Hamakua Marshes meet this criterion as the wetlands provide a significant portion of habitat requirements for the aforementioned four endangered waterbirds, which are all endemic to Hawaii, as well as for the non-endangered endemic Laysan Duck (*Anas Laysanensis*) and Hawaiian Goose or Nene (*Branta samwicensis*), thus making the wetlands critical for maintaining the biological diversity of this biogeographic region. Kawainui and Hamakua Marshes support four of these six waterbirds, making the wetland complex important for maintaining the biological diversity of this biogeographic region.

Criterion 8: Kawainui Marsh meets this criterion as the wetland provides a migration path from the ocean to mountain streams for indigenous and endemic amphidromous fish and crustaceans, including *Awaous guamensis* (indigenous goby), *Stenogobius hawaiiensis* (endemic goby), *Eleotris sandwicensis* (endemic eleotrid), and *Atyoida bisulcata* (endemic shrimp).

13. Biogeography:

a) biogeographic region:

The Hawaiian Islands are the most isolated high islands in the world, located over 3,220 kilometers (2,000 miles) from the nearest continental land mass, and are considered by some to constitute a distinct biogeographic region (Stoddart, 1992).

b) biogeographic regionalisation scheme:
Stoddart, 1992.

14. Physical features of the site:

Kawainui Marsh is located in what was once the center of a caldera of the Koolau shield volcano, which formed the Koolau mountains on the island of O'ahu. Eustatic changes in sea level have alternatively left the area submerged and emergent. During emergent periods, streams eroded the caldera and carved fluted valleys. During higher sea level, marine sediment was deposited. Until approximately 2,800 years ago Kawainui Marsh was a marine embayment. As the sea-level reached its current level, accretion across the mouth of the embayment formed barrier beach dunes that created the land where the town of Kailua now exists. It also formed Kawainui Marsh, now separated from Kailua Bay (Wheeler, 1981; U.S. Fish and Wildlife Service, 1997). Kawainui Marsh is now located between the town of Kailua and the base of the Koolau mountains on a wide barrier beach, flanked by a mountain called Pu'u-o-'ehu on its eastern boundary, and by the base of Ulumawai mountain along the marshes' southeast to western limit (Clark, 2002).

The predominant soil types of Kawainui are organic peat and silty clay. A layer of organic matter and peat exists in central portions of the marsh. A variety of other soils that have eroded from areas above and upstream of Kawainui Marsh are also present. A layer of organic silts underlays the peat to a maximum depth of ten meters. Coral sands and marine deposits lie below the silt layer (Hawaii State Department of Land and Natural Resources, 1994; U.S. Army Corps of Engineers, 1998).

The majority of water entering the marsh enters through Maunawili Stream, and Kahanaiki Stream feeds the marsh about 17% of the water that passes through Maunawili Stream. Springs and intermittent streams also contribute to the water budget of the marsh. The marshes' original drainage into Ka'elepulu Stream has been blocked by construction of a long dike along the northeast edge of the marsh, but the canal to Ka'elepulu Stream still remains. Water exits through Oneawa Canal, which drains into Kailua Bay, and some water also exits through a levee into Kawainui Stream (U.S. Army Corps of Engineers, 1998). The Oneawa Canal connects Kawainui Marsh to Kailua Bay, is 2,886 meters (9,470 feet) long, and is located at the northeast corner of Kawainui Marsh. The upper streams and surface water stored in the marsh are freshwater, while the salinity of water within Oneawa Canal is brackish and tidally influenced.

Inflow to Kawainui Marsh has been estimated from a low of 6.8 million gallons a day (mgd) to 13.1 mgd. Outflow is approximately 4.6 mgd by evapotranspiration and 8 mgd through surface outlets and groundwater seepage (U.S. Army Corps of Engineers, 1998).

Hamakua Marsh is a remnant floodplain that once connected Kawainui Marsh to Ka'elepulu Pond (also referred to as Enchanted Lake). In the early 1960s, the U.S. Army Corps of Engineers constructed a flood control levee in Kawainui Marsh, which cut off surface water flow from Kawainui Marsh into Kawainui Stream and Hamakua Marsh (Smith, 2002). Hamakua Marsh now receives its major water input from stormwater runoff from an adjacent hillside and from Coconut Grove (a suburban section of Kailua), and from seawater from Kailua Bay when Kawainui and Ka'elepulu Streams back up (Figure 1). Kawainui Stream has a small water turnover rate with concomitant anaerobic conditions and poor water quality¹ (Ducks Unlimited, 1993; Smith, 2002).

The climate of the area where Kawainui and Hamakua Marshes are located is fairly uniform, with a mean annual temperature of 24 C (75 F), humidity ranges between 70 to 80%, and solar insolation is about 375 calories/cm² in Kawainui Marsh (Hawaii State Department of Land and Natural Resources, 1994). The

¹ Water quality parameters measured in 1992 in Kawainui Stream showed that the stream significantly exceeded state water quality standards, especially for dissolved nutrients, total nitrogen, phosphorus, Chlorophyll a, turbidity, and dissolved oxygen (Ducks Unlimited, 1993).

annual rainfall is between 50 and 80 cm (20 and 30 inches), with most of it occurring between November and April.

15. Physical features of the catchment area:

Kawainui Marsh receives drainage from a watershed collection area of approximately 25 km² within the Kailua watershed. Kahanaiki and Maunawili Streams are the primary sources of water for Kawainui Marsh, although a portion of the streams' water is diverted to provide irrigation water for diversified agriculture in Waimanalo.

Urbanization in the surrounding area has led to increased runoff entering the marsh. Kapa'a Stream, a small intermittent stream, enters the marsh near the present location of a rock quarry.

16. Hydrological values:

Kawainui Marsh functions as a flood storage basin to protect the town of Kailua on the windward side of O'ahu, and protects the water quality of Kailua Bay (Hawaii State Department of Land and Natural Resources, 1994; U.S. Army Corps of Engineers, 1998). Hamakua Marsh receives surface water from a portion of suburban and commercial Kailua Town and from a vegetated hillside, and during period of high rain, conveys the surface water towards Kailua Bay.

17. Wetland Types

a) presence:

Marine/coastal: A • B • C • D • E • F • G • H • I • J • K • Zk(a)

Inland: L • M • N • O • P • Q • R • Sp • Ss • Tp • Ts • U • Va •
Vt • W • Xf • Xp • Y • Zg • Zk(b)

Human-made: 1 • 2 • 3 • 4 • 5 • 6 • 7 • 8 • 9 • Zk(c)

b) dominance:

U, Tp, Ts, O, Sp, M, N, 9, Xf, W (Non-forested peatlands: includes shrub or open bogs, swamps, fens; Permanent freshwater marsh; Seasonal/intermittent freshwater marshes/pools on inorganic soils: includes sloughs, potholes, seasonally flooded meadows, sedge marshes; Permanent fresh lake >8ha; Permanent saline/brackish/alkaline marshes/pools; Permanent streams; Intermittent springs and streams; Ditches; Freshwater, tree-dominated wetlands: includes freshwater swamp forests, seasonally flooded forests, wooded swamps on inorganic soils; Shrub-dominated wetlands; shrub swamps, shrub-dominated freshwater marshes, shrub carr, alder thicket on inorganic soils).

18. General ecological features:

Kawainui Marsh: Kawainui Marsh is a 405 ha freshwater, inland, palustrine marsh with predominantly persistent emergent herbaceous vegetation, contains about 30 ha of permanent open water ponds, two permanent streams drain into the marsh, and intermittent springs and streams also drain into the marsh.

Open water: Kawainui Marsh has 20 to 40 hectares (50 to 100 acres) of open water (this area is gradually being reduced by extension of a thick floating mat of alien vegetation) (U.S. Fish and Wildlife Service, 2002). The area of the central open-water pond varies with patterns of rainfall runoff. Other small ponds in the marsh are now covered by a dense mat of water hyacinth (*Eichornia crassipes*), water lilies (*Nymphaea* sp.), and water lettuce (*Pistia stratiotes*). Parts of the vegetation-covered portions of these ponds become open during periods of heavy rainfall or high wind.

Mudflats: A very small area of mudflat and shallow water habitat remains in Kawainui Marsh (U.S. Army Corps of Engineers, 1998).

Riparian: Approximately 850 linear meters (2,800 linear feet) of riparian habitat exists within Kawainui Marsh, as Kahanaiki (213 linear meters or 700 linear feet) and Maunawili (640 linear meters or 2,100 linear feet) Streams' lower reaches enter and drain into the marsh downstream of Kailua Road (U.S. Army

Corps of Engineers, 1998). Banks of both streams are overgrown with vegetation, including hau trees (*Hibiscus tiliaceus*) (generally believed to be a Polynesian introduction, but thought by some botanists to be indigenous to Hawaii), and have steep (1V:1H) slopes (U.S. Army Corps of Engineers, 1998).

Islands: Small islands have been created within open water areas in Kawainui Marsh to create predator-free nesting areas for waterbirds.

Vegetation communities: Kawainui Marsh has a distinct grass community. California Grass (*Brachiaria mutica*), an exotic species that was introduced to Hawaii for cattle grazing, covers more than half of Kawainui Marsh and is spreading (U.S. Army Corps of Engineers, 1998). Other plant species found in the grass community include Honohono (*Commelina diffusa*), Arrowhead (*Sagittaria latifolia*), and scattered stands of Cattail (*Typha latifolia* and *Typha angustata*). In areas of persistent emergent herbaceous vegetation dominated by California Grass, vegetation is between 2 and 3 meters tall, except for a grazed area discussed below. Other emergent vegetation species found within the grass communities of the marsh include Hilo Grass (*Paspalum conjugatum*) and *Pluchea* spp.

In Kawainui Marsh, floating mats of vegetation, estimated to be between 30 cm and 1 meter thick, cover areas that used to be open water. The vegetation mat floats over water and water-sediment slurry estimated to be between 1 and 5 meters deep. These mats are composed of a bulrush/sawgrass community, which allow upland and transitional wetland plants to grow. Typical vegetation in these floating mat communities includes Bulrush (*Schoenoplectus californicus*), Neki or Swamp Fern (*Schoenoplectus lacustris*), Sawgrass (*Cladium leptostachyum*), and Paperbark (*Melaleuca quinquenervia*) (U.S. Army Corps of Engineers, 1998). The grass and bulrush communities each occupy approximately equal areas in the marsh.

In an approximate 20 hectare area of Kawainui Marsh where heavy cattle grazing occurs, the ground is interspersed with hummock, and the majority of the plants (dominated by California Grass, Hilo Grass, Honohono, and Indian *Pluchea* (*Pluchea indica*) in this area reach no more than a meter high (U.S. Fish and Wildlife Service, 1997). In the higher elevation areas of this grazed portion of the marsh, plant species such as *Mimosa pudica* var. *unijuga*, Wedelia (*Wedelia trilobata*), and Kamole (*Ludwigia octovalvis*) increase in abundance. A large stand of Bamboo (*Phyllostachys nigra*) also occurs in this grazed area (U.S. Fish and Wildlife Service, 1997).

A tree and shrub plant community exists on the outer edges of the grass and bulrush plant communities and along the slopes above the marsh, consisting primarily of Koa Haole (*Leucaena leucocephala*), Guava (*Psidium guajava*), Chinese Banyan (*Ficus microcarpa*) and Monkeypod (*Samanea saman*). Hau trees (*Hibiscus tiliaceus*) are the dominant species growing along the banks of Kahanaiki and Maunawili Streams (U.S. Army Corps of Engineers, 1998).

Hamakua Marsh: Hamakua Marsh is a 9ha, brackish, inland, marsh with predominantly persistent emergent herbaceous vegetation. The marsh is located between a slow-moving, brackish waterway (Kawainui Stream) and dry lowland slopes. A broad band of Indian *Pluchea* (*Pluchea indica*) marked the transition from upland to wetland along the landward (southwestern) portion of the wetland (Ducks Unlimited, 1993), but was removed by the State Division of Forestry and Wildlife as part of their management of the area (Smith, 2002). Pickleweed (*Batis maritima*), forms a herbaceous zone inside of the *Pluchea*. Poned water or mudflats border the Pickleweed. Emergent vegetation is dominated by Seashore *Paspalum* (*Paspalum vaginatum*), Water Hyssop (*Bacopa monnieri*), and Ditchgrass (*Ruppia maritima*). Common indigenous plant species found throughout the marsh include Bulrush (*Bolboschoenus maritimus*), Water Hyssop, Ditchgrass, and Makai sedge (*Scirpus maritimus* var. *paludosus*) (Ducks Unlimited, 1993).

19. Noteworthy flora:

Invasive introduced species dominate the flora in Kawainui Marsh. Neither Kawainui nor Hamakua Marshes contain unique or endangered plants or plant communities (Ducks Unlimited, 1993; Hawaii State Department of Land and Natural Resources, 1994). Common indigenous plant species found throughout Hamakua Marsh include Bulrush, Water Hyssop, and Ditchgrass. Some plant species found in Kawainui Marsh were historically used by Hawaiians, such as the indigenous Great Bulrush or 'aka'akai

(*Schoenaplectus lacustris*) (used for plaiting for coarse sedge mats and for house thatch) and hau trees (bark was used to make sandals and used for cordage, and wood was used for floats, canoes, and toys).

20. Noteworthy fauna:

Apart from the six endemic Hawaiian waterbirds described in Section 12, Kawainui Marsh supports relatively low densities of endangered waterbirds compared to other less disturbed wetlands found on O'ahu due to the loss of waterbird habitat in Kawainui Marsh from introduced invasive vegetation. This suggests that the marsh has the capacity to support significantly higher numbers of waterbird and shorebird populations if an ongoing management program involving vegetation and predator control activities is implemented (U.S. Fish and Wildlife Service, 1997), and once a freshwater well and pump is installed (Smith, 2002).

Hamakua Marsh is seasonally flooded, with sources of surface water being rainfall, stormwater runoff, and hand-pumping by wetland managers. Bird populations in Hamakua fluctuate with the extent of surface water. Hawaiian Coots and Stilts are found on all of the Main Hawaiian Islands² except for Kaho'olawe. Hawaiian Ducks are found on Ni'ihau, Kaua'i, O'ahu, Maui, and Hawaii. Hawaiian Moorhens are found on Kaua'i, and O'ahu. Accurate population estimates of these four species are not available, however, the Hawaiian Duck, Stilt, and Moorhen are thought to number no more than 2,500 individuals per species, and the Hawaiian Coot is estimated to fluctuate between 2,000 and 4,000 individuals (U.S. Fish and Wildlife Service, 2002).

The Hawaiian Duck, a distinct species, was historically found on all of the Main Hawaiian Islands except Lana'i and Kaho'olawe, and while there are no population estimates available prior to 1940, the species was likely fairly common in natural and farmed wetlands. The current population is estimated to be about 2,500 birds, with 300 birds (12%) found on O'ahu. The O'ahu population frequents Kawainui Marsh, Hamakua Marsh, and He'eia Marsh on the windward coast; James Campbell National Wildlife Refuge, Punahoolapa, and Hale'iwa wetlands on the north shore; and wetlands near Pearl Harbor on the leeward coast (U.S. Fish and Wildlife Service, 2002). The Hawaiian Duck uses a wide variety of natural wetland habitats for nesting and feeding. Unfortunately, there has been extensive hybridization between Mallards (*Anas platyrhynchos*) and Hawaiian Ducks on O'ahu, with the near disappearance of Hawaiian Duck alleles (Browne *et al.*, 1993).

The Hawaiian Coot, a distinct species, historically occurred on all of the larger Hawaiian Islands with the exception of Lana'i and Kaho'olawe, was likely common in large natural marshes and ponds and used wetlands created by Hawaiians for taro cultivation and fish production (there are no population estimates prior to the 1950s), and have always been most numerous on O'ahu, Maui, and Kaua'i, (U.S. Fish and Wildlife Service, 2002). Currently, Hawaiian Coots inhabit all of the Main Hawaiian Islands except for Kaho'olawe, with a statewide population of between 2,000 and 4,000 birds, with a stable population for the past 25 years (U.S. Fish and Wildlife Service, 2002). O'ahu, Kaua'i, and Maui support 80% of the total population. Intra and inter-island movements occur when surface water storage is drawn down and food sources become concentrated (U.S. Fish and Wildlife Service, 2002). The O'ahu population is most abundant along wetlands of the windward side (including Kawainui and Hamakua Marshes), and in natural wetlands at Kahuku Point. Coots prefer wetland habitats with suitable emergent plant growth interspersed with open water, and prefer freshwater wetlands and taro patches (U.S. Fish and Wildlife Service, 2002). Coots nest in open fresh and brackish water ponds, in shallow reservoirs, irrigation ditches, and small openings of marsh vegetation.

No historical population estimates are available for the Hawaiian Moorhen, a subspecies of the common moorhen, but it was known to be common on all the Main Hawaiian Islands excluding Lana'i and Kaho'olawe. Hawaiian Moorhens currently inhabit O'ahu and Kaua'i, but precise population estimates are not available (U.S. Fish and Wildlife Service, 2002). On O'ahu, moorhens are most prevalent on the north and windward side of the island (includes the Hamakua and Kawainui wetland complex). Moorhen habitat includes freshwater marshes, taro patches, reedy margins of water courses, reservoirs, and wet pastures.

² The term "Main Hawaiian Islands" refers to the following islands of the State of Hawai'i: Ni'ihau, Kaua'i, O'ahu, Maui, Moloka'i, Lana'i, Kaho'olawe, and Hawai'i.

Moorhens nest in freshwater wetlands, placing the nests within dense emergent vegetation over shallow water.

The Hawaiian Stilt, classified as a subspecies of the black-necked stilt, was historically known from all the Main Hawaiian Islands except Lanaʻi, Kahoʻolawe, and possibly Hawaii. Historical population estimates are not available. The population may have declined to as low as 200 individuals by the early 1940s due to loss of wetlands and aquatic agricultural lands (U.S. Fish and Wildlife Service, 2002). Stilts are now found on all of the Main Hawaiian Islands except Kahoʻolawe, with a statewide population relatively stable for the past 30 years. The current population is estimated at between 1,200 and 1,600 birds (U.S. Fish and Wildlife Service, 2002). Hawaiian Stilts disperse between the islands and constitute a homogeneous meta-population. Oʻahu supports the largest number of stilts in the Hawaiian Islands, with the majority of stilts found on the north and windward coasts (includes the Kawainui and Hamakua wetland complex) (U.S. Fish and Wildlife Service, 2002). Between 1977 to 1996, Oʻahu averaged between 40 to 60 percent of the stilt population (U.S. Fish and Wildlife Service, 2002). Stilts use a variety of aquatic habitats, but require early successional marshlands with shallow water depth, perennial vegetation that is limited and low growing, or exposed tidal flats. Stilts prefer to nest on freshly exposed mudflats interspersed with low growing vegetation (U.S. Fish and Wildlife Service, 2002).

Kawainui and Hamakua Marshes also provide habitat for migratory waterfowl and wintering shorebirds (Ducks Unlimited, No Date and 1993). Migratory waterfowl, such as the Northern Pintail (*Anas acuta*), Northern Shoveler (*Anas chyeata*), Mallard (*Anas platyrhynchos*), Canada Goose (*Branta Canadensis*), Lesser Scaup (*Aythya affinis*), Green-winged Teal (*Anas crecca*), American Wigeon (*Anas americana*), and Redhead (*Aythya americana*) are found within the small ponds in the wet pasture and the larger open water areas of Kawainui Marsh during winter months (Conant, 1981; U.S. Fish and Wildlife Service, 1997). Feral mallards are regular, year-round inhabitants. Migratory shorebirds reported from Kawainui Marsh include the Pacific Golden Plover (*Pluvialis fulva*), Ruddy Turnstone (*Arenaria interpres*), Sanderling (*Calidris alba*), and Wandering Tattler (*Heteroscelus incanus*) (adapted from Conant, 1981; U.S. Fish and Wildlife Service, 1997).

The aukuʻu or Black-crowned Night Heron (*Nycticorax nycticorax boactli*) is common within the open water areas and potholes of the wet pasture (Conant, 1981; U.S. Fish and Wildlife Service, 1997). The only indigenous non-wetland dependent bird species that regularly frequents the Kawainui and Hamakua Marshes is the Iwa or Great Frigatebird (*Fregata minor palmerstoni*) (Conant, 1981; U.S. Army Corps of Engineers, 1998). The Cattle Egret (*Bulbulcus ibis*) is abundant in the marshes, and is the marshes' only alien waterbird (Conant, 1981).

Introduced species dominate the aquatic fauna in Kawainui Marsh. Common introduced fish and invertebrates found in the marsh are Tilapia (*Tilapia mossambica*), Mosquito Fish (*Gambusia affinis*), Guppies (*Poecilia* spp.), Carp (*Cyprinus carpio*), Chinese Catfish (*Clarias fuscus*), Swordtail (*Xiphophorus helleri*), Smallmouth Bass (*Microphterus dolomieu*), Tahitian Prawn (*Macrobrachium lar*), Crayfish (*Procambarus clarkia*), Damselfly (*Ischnura ramburii*), apple snails (*Pomacea* spp.) and pond snails (*Melanoidea* spp.) (U.S. Fish and Wildlife Service, 1997). Oriental Rice Eel (*Monopterus albus*) and the Bullfrog (*Rana* spp.) also inhabit the marsh. In the upper reaches of the marsh, Kahanaiki and Maunawili Streams are also dominated by introduced species of fish and crustaceans. Native species, including shrimp (*Atyoida bisculata*) and prawns (*Macrobrachium grandimanus*), are present in small numbers. Numerous native species inhabit Oneawa Canal, below the marsh, including: amphidromous gobies and eleotrids (*Awaous guamensis* (indigenous goby), *Stenogobius hawaiiensis* (endemic goby), and *Eleotris sandwicensis* (endemic eleotrid), Aholehole (*Kuhlia sandwicensis*), Mullet (*Mugil cephalus*), and Barracuda (*Sphyrnaena barracuda*). The migratory passageways through the marsh are currently partially blocked by a mat of floating alien invasive vegetation, which reduces access to the upper reaches of the streams to many of the amphidromous species (U.S. Army Corps of Engineers, 1998).

21. Social and cultural values:

Kawainui Marsh and the surrounding area was a significant prehistoric settlement as evidenced by Hawaiian legend, extensive agricultural systems, ceremonial sites, burial sites, and habitation areas. This area once supported one of the largest native Hawaiian settlements, contains some of the oldest known

Hawaiian agricultural sites, and Kawainui Marsh and surrounding environs have provided significant information about Hawaiian culture, particularly having to do with the relationship of the early Hawaiians to the environment of a windward valley (Handy *et al.*, 1972; Kelly and Clark, 1980; Kelly and Nakamura, 1981; Drigot and Seto, 1982). Kawainui Marsh was a primary food-producing area from traditional Hawaiian times to the early 20th century. Kawainui is a significant archaeological site because it is one of the few areas remaining on O'ahu where evidence of terraced agricultural pondfields and a fishpond still exist in conjunction with associated religious structures (Handy *et al.*, 1972; Kelly and Clark, 1980).

In 1979, the U.S. National Registrar for Historic Places issued a "Determination of Eligibility Notification" finding that Kawainui Marsh area is eligible for listing in the National Register for Historic Places (U.S. Heritage Conservation and Recreation Service, 1979). According to the determination, "Kawainui Marsh is important as a major component of a larger cultural district which would include...the ponding/wet agricultural area...remains of extensive terracing systems, ceremonial sites, burial sites, and habitation areas associated with this agricultural complex" (U.S. Heritage Conservation and Recreation Service, 1979).

The earliest navigators and chiefs who inhabited the area directed the water management and agricultural systems, which are unparalleled elsewhere in Polynesia. On the slopes of Ulumawao are two great stone platform temples which overlook Kawainui Marsh, Pahukini Heiau attributed to the 14th century Tahitian Chief Olopana (listed in the State and National Registers of Historic Places), and the newly re-discovered Holomakani Heiau attributed to a 10th century home-grown navigational chief, Paumakua. Surrounding the 180 hectare (450 acre) former freshwater fishpond and its tributaries are the remnants of walled water gardens (lo'i) in which the Hawaiian staple crop, taro (*Colocasia esculenta*), was grown for one of the largest native Hawaiian settlements (Kelly and Nakamura, 1981; Drigot and Seto, 1982). The agricultural site cluster associated with the Kawainui area has been described as the earliest agricultural field dated in the Hawaiian Islands. Hawaii State Department of Land and Natural Resources (1994) contains a seven page list of records of archaeological sites known in Kawainui Marsh. Hamakua Marsh was once part of this extensive system of wetlands, fishponds, and agricultural terraces of this Native Hawaiian settlement, and a historical study of the wetland found platforms, lithic scatters, and a possible habitation structure (Ducks Unlimited, 1993).

About 500 years ago, early Hawaiians maintained the freshwater fishpond in Kawainui, which was joined by a stream to nearby Ka'elepulu Pond (Enchanted Lake). The fishpond was surrounded on all sides by a system of canals ('auwai) bringing water from Maunawili Stream and springs to walled taro lo'i (Handy *et al.*, 1972). The historical walls from the lo'i still exist in Kawainui Marsh, thought to be approximately 50 cm below existing ground elevations (U.S. Army Corps of Engineers, 1998). The system of terraces east of the seaward end of Pu'u'o'ehu was fed by the stream running from Kawainui to Ka'elepulu Stream. Terraces west of Kawainui Pond at Kapa'a Valley were fed by Kapa'a Stream, while those to the north, below Mahinui, received waters diverted from Kawainui. Where the system of canals moved through what is now called the Hamakua area, excessive runoff could be directed into Kailua's other freshwater, spring-fed fishpond, Ka'elepulu (now called Enchanted Lake). Both fishponds were used to raise fish (milkfish, mullet, aholehole, and o'opu), with the residents of Waimanalo and Kailua seasonally called upon to help clear the ponds of excessive algae; all who participated in maintaining the fishponds were permitted to keep fish (Handy *et al.*, 1972; U.S. Fish and Wildlife Service, 1997).

The Kawainui Marsh area has many landforms named for sacred persons revered in over 1,500 years of Hawaiian tradition (Drigot and Seto, 1982). There is Hawaiian legendary history associated with the Kawainui Marsh area, including a legend of Hau-wahine, a guardian spirit over the Kawainui fishpond, called a mo'o, and a famous mythological tree, Makalei, which had the power of attracting fish (Kelly and Nakamura, 1981). Mo'o purportedly lived in her grove of awa by the Makalei tree near where the waters drain from Kawainui Marsh to Hamakua. Hauwahine's companion mo'o, named Kilioe, lived at the opposite end of Hamakua near where Kawainui Stream enters Ka'elepulu Stream. The length of Kawainui Stream is the area of coitus between the male, Kawainui, and the female, Ka'elepulu, explaining why those waters always teemed with the juvenile fish common to both ancient fishponds. The Hawaiian coot and Hawaiian moorhen are sacred to Hina, a Hawaiian Earth-mother category of goddess who can take the form of these birds. The eggs of these birds were traditionally used in ceremonies to consecrate chiefs and

priests. The Hawaiian Stilt is sacred to the Hawaiian god Ku, in his form as a fisherman. These birds are a culturally significant and endangered resource.

Since the 1960s, the local community around Kawainui Marsh, and a variety of local and statewide environmental, educational, and native Hawaiian groups and individuals, have consistently advocated for resource protection and against development in and around the marsh (Hawaii State Department of Land and Natural Resources, 1994; U.S. Army Corps of Engineers, 1998).

22. Land tenure/ownership:

(a) within the Ramsar site

The City and County of Honolulu owns the central portion of Kawainui Marsh and owns and manages the southern portion of Kawainui Marsh contained in the City's Maunawili Park (South of the Pali Highway). The City and County of Honolulu plans to transfer ownership of the marsh to the State of Hawaii. The Hawaii State Department of Land and Natural Resources, Division of Forestry and Wildlife manages Kawainui Marsh north of the Pali Highway. Hamakua Marsh is owned and managed by the Hawaii State Department of Land and Natural Resources, Division of Forestry and Wildlife.

Hamakua Marsh was purchased by Ducks Unlimited in the early 1990s, who subsequently transferred deed of ownership to the Hawaii State Department of Land and Natural Resources. Previous to this, the marsh had been owned by Kaneohe Ranch, which used it to graze cattle (Ducks Unlimited, 1993).

(b) in the surrounding area:

The Hawaii State Department of Land and Natural Resources owns 76 hectares (190 acres) around the periphery of Kawainui Marsh. The State of Hawaii has purchased most of the privately owned land adjacent to Kawainui Marsh (Hawaii State Department of Land and Natural Resources, 1994).

23. Current land (including water) use:

(a) within the Ramsar site: Both Kawainui and Hamakua Marshes are managed to meet primary goals of conservation and flood protection. Cattle grazing occurs within Kawainui Marsh. The State of Hawaii has leased a 32 hectare (80 acre) parcel in the southern portion of Kawainui Marsh to the Knott Ranch for the cattle grazing operation since 1971 (Hawaii Department of Land and Natural Resources, 1994). Kawainui and Hamakua Marshes are also used for research, education, and recreation, as explained in Sections 23, 25, 26 and 27.

(b) in the surroundings: Adjacent areas surrounding Kawainui Marsh, including the slopes above the marsh and the Mokulana area, are designated as urban under zoning rules. Kawainui Marsh's boundaries include Kapa'a Quarry Road to the west, VO Ranch located on the marsh side of Kapa'a Quarry Road, an industrial park borders the west side of the marsh, a quarry and rock crushing facility is located to the southwest of the industrial park, Mokapu Boulevard is to the north, the Coconut Grove subdivision is on the northeast, and Kailua Road is on the south (Figure 1). A sanitary landfill and transfer station is located just west of Kawainui Marsh. A model airplane is located on a former landfill site, which juts into the marsh on its western boundary. The level area has been used as a model airplane park since 1968, and two model airplane clubs with a combined membership of about 125 members use the park (Hawaii State Department of Land and Natural Resources, 1994). An elementary school is located at the Pali Highway junction with Quarry Road.

Hamakua Marsh parallels Kawainui Stream (also referred to as Hamakua Canal), and is adjacent to Hamakua Drive and Kailua Road, a commercial building and parking lot is located immediately adjacent to the wetland to the north, commercial buildings and parking lots are adjacent to Kawainui Stream to the east, Kailua Town is to the east of the wetland, Kawainui Marsh is across Kailua Road to the west, and vegetated flat upland and a steep hill are immediately to the southwest of the wetland (Figure 1). The flat upland to the southwest of the wetland is used for cattle grazing.

24. Factors (past, present or potential) adversely affecting the site's ecological character, including changes in land (including water) use and development projects:

(a) within the Ramsar site: Past and present land use have altered Kawainui and Hamakua Marshes. Starting about 500 years ago, early Hawaiians used the Kawainui and Hamakua wetland complex as a fishpond and to grow taro. Rice was cultivated from the 1850s to the 1920s and then ranching and grazing became the predominant uses of both Kawainui and Hamakua Marshes. In the early 1900s an Inn called the Kawainui Rifle and Hunt Club kennelled and trained hunting dogs for visiting hunters, who hunted game in Kawainui Marsh. Unregulated hunting probably played a part in the decline of the Hawaiian water bird species, but it has not been a significant limiting factor for decades, probably since the 1940's or 50's. The primary sources of decline of these species over the past 30 plus years are habitat degradation and competition with introduced mammalian predators.

Four sewage treatment plants used to discharge partially treated effluent directly into Kawainui Marsh. The discharges were terminated in 1988 (Hawaii State Department of Land and Natural Resources, 1994; U.S. Army Corps of Engineers, 1998).

In the 1960s, the U.S. Army Corps of Engineers constructed flood control structures in Kawainui Marsh, including the 2,886 meter (9,470 foot)-long Oneawa Channel, a 2,088 meter (6,850 foot)-long levee, a 15 meter (50 foot)-long groin and 15 meter (50 foot)-long revetment at the outlet of Oneawa Channel, a 113 meter (370 foot)-long and 3 meter (10 foot)-deep silt basin, and drainage outlets (U.S. Army Corps of Engineers, 1998). In 1987-8 Kawainui Marsh overflowed, with flooding of the adjacent Coconut Grove community. As a result, in 1988, an emergency ditch was excavated alongside the existing levee to increase outflow from Kawainui Marsh (U.S. Army Corps of Engineers, 1998). In 1997, additional structures were constructed and modifications made to augment flood control. The levee cuts off surface water flow from Kawainui Marsh into Kawainui Stream and Hamakua Marsh. These flood control structures have further altered the natural structure and functioning of Kawainui and Hamakua Marshes. Significant portions of Kawainui and Hamakua Marshes have been filled, such as the area adjacent to Kawainui that is now used as a model airplane field, and to create roads that cross or run along the edges of the wetlands (Figure 1).

There are approximately 700 acres of wetland in Kawainui, and probably less than 20 acres that provide habitat for native or migratory bird species, primarily due to overgrown exotic vegetation. Threats that adversely affect these species include predation and degradation of nesting habitat by introduced animals (Mongoose (*Herpestes auro-punctatus*), Rats (primarily *Rattus rattus*), Cats (*Felis catus*), Dogs (*Canis familiaris*), fish such as Tilapia, Cattle Egrets, and Barn Owls), invasion of wetlands by alien plants, altered wetland hydrology, hybridization of the Hawaiian Duck with mallards, avian botulism and other diseases, pollution, urbanization of land adjacent to wetlands (increases the numbers of cats and dogs in wetlands, reduces the quality of water entering wetlands, alters the size of wetlands' contributing watersheds), and continued loss of wetland area to development (U.S. Fish and Wildlife Service, 2002).

Cattle and horse grazing in Kawainui Marsh and upslope of Hamakua Marsh may decrease water quality in the marshes and receiving waters of Kailua Bay due to nutrient inputs. There has been no research to assess the significance of this source of nutrients, such as by quantifying the proportion of total nutrient inputs contributed by cattle and horses. The cattle and horses have altered the vegetation structure, and to some extent have changed the topography of the area in Kawainui Marsh where they graze (See Section 18). Also, the cattle in Kawainui Marsh occasionally graze in areas where waterbirds have been observed, and Conant (1981) hypothesized that the cattle may trample waterbird nests. However, cattle control invasive vegetation and improve the value of habitat for waterbirds in these areas. Invasive vegetation in non-grazed areas of the marsh reaches two meters or more in height, reducing the value of habitat for waterbirds.

Both Kawainui and Hamakua marshes are wetland types that have undergone significant decline in area and quality (pursuant to Guideline 75 of Ramsar (1999)) (U.S. Fish and Wildlife Service, 2002). In general, neither the quality of water of the streams entering Kawainui Marsh nor the quality of the estuarine water draining the marsh meet Hawaii's Water Quality Standards (AECOS, 1995). Nutrient mass loading has been reduced since the cessation of sewage discharges into the marsh in 1988 (U.S. Army Corps of Engineers, 1998). The marsh contains heavy metals, including chromium, lead, and mercury, although the source of these metals is unknown as these metals may occur naturally from weathered basalt (U.S. Army Corps of Engineers, 1998). A landfill located upslope from the marsh is a suspected source of the contaminants.

Overgrowth by nonnative vegetation has created a floating mat, reducing the potential for successful migration through the marsh (Hawai'i State Department of Land and Natural Resources, 1994; U.S. Army Corps of Engineers, 1998). Shallow water habitat is being invaded by Cattail, California Grass, Primrose Willow (*Ludwigia octovalvis*), and other nonnative species (U.S. Army Corps of Engineers, 1998). Floating species such as Water Hyacinth (*Eichornia crassipes*) and Water Lettuce (*Pistia stratiotes*) have also encroached into open water areas and cover approximately 5.5 hectares (14 acres) of Kawainui Marsh (U.S. Army Corps of Engineers, 1998).

(b) in the surrounding area: A large proportion of Hawaii's wetlands have been filled or altered. There has been an approximate 31% decrease in the area of wetlands located within Hawaii's coastal plain between circa 1780 and 1990 (U.S. Fish and Wildlife Service, 2002). As of 1990, approximately 14% (6,190 hectares or 15,474 acres) of Hawaii's 44,320 hectares (110,800 acres) of wetlands and deep water habitats existed within Hawaii's coastal plains (U.S. Fish and Wildlife Service, 2002). Numerous threats continue to reduce the area and quality of wetland habitat in Hawaii, described in detail in section 18.

In 1878 a ditch and tunnel system was constructed and later expanded in the 1920s to transport water from the upper reaches of Maunawili Stream to sugarcane fields at the Waimanalo Sugar Plantation (U.S. Fish and Wildlife Service, 1997). A sanitary land fill is located just west of Kawainui Marsh in an old quarry, and an auto wrecking business was located at the northern edge of the marsh, which was removed in 1986. The contributing watershed areas, volume of surface water input, and water quality entering the marshes has been altered due to development and alteration of adjacent land. Construction of roads through and between the wetlands (roads go across portions of Kawainui Marsh, and a road now separates Kawainui and Hamakua Marshes) has altered the hydrologic functions within and hydrologic connection between the marshes.

Prior to the early 1970's many of Hawaii's coastal wetlands were filled for agriculture or urban expansion. As has been the case with Kawainui Marsh, and despite wetland protection and endangered species legislation enacted in the early 1970's, habitat for native species continued to decline through introduced plant invasion and nonnative predators such as mongooses, cats and dogs. Furthermore, many waterbirds have become dependent on Hawaii's managed agricultural and aquaculture wetlands, and settling basins and reservoirs used for sugarcane agriculture, for their survival. The collapse of the sugarcane industry and decline of taro and aquaculture industries in Hawai'i makes the long-term maintenance of this habitat insecure (U.S. Fish and Wildlife Service, 2002). Also, waterbirds are occasionally implicated as a cause of depredation in taro and prawn farms, resulting in farmers placing exclusion devices around ponds, which eliminates some habitat previously used by waterbirds (U.S. Fish and Wildlife Service, 2002).

25. Conservation measures taken:

Most of Kawainui Marsh is in the P-1 protective subzone of the State land use conservation district. The City and County of Honolulu's land use map designates most of Kawainui Marsh and all of Hamakua Marsh as "Preservation", and all of Kawainui and Hamakua Marshes are located within its Special Management Area boundaries. The City and County of Honolulu's "Visioning Team" and the "Ameron Community Focus Group" work to enhance parks located along the periphery of Kawainui Marsh.

The Hawaiian Duck and Moorhen were listed as federally endangered species in 1967 under the U.S. Endangered Species Act. The Hawaiian Coot and Stilt were added to the federal endangered species list in 1970 (U.S. Fish and Wildlife Service, 2002). The waterfowl, shorebirds, and coastal seabirds that use Kawainui and Hamakua wetlands are also protected under the U.S. Migratory Bird Treaty Act. Hunting of Hawaii's endemic waterbirds was outlawed by 1939 (U.S. Fish and Wildlife Service, 2002).

Listing of Kawainui Marsh on the eligibility list for inclusion on the National Register of Historic Places as a "Cultural/Archaeological Historic District" requires compliance with Section 106 of the U.S. National Historic Preservation Act for any action that may impact the area.

In 1991 the City and County of Honolulu cleared approximately 8 hectares of open water channels and removed water hyacinth within Kawainui Marsh as part of the Kawainui Marsh Flood Damage Mitigation Project. The channels provided increased edge and open water habitats within areas that were previously overgrown with emergent vegetation, benefiting waterbirds and migratory waterfowl. (U.S. Fish and

Wildlife Service, 1997). Unfortunately, water hyacinth has since overtaken much of the open water habitat created by the flood damage mitigation project.

The Kawai Nui Heritage Foundation and 'Ahahui Malama I Ka Lokahi have been organizing volunteers since 1997 to remove alien vegetation to create open water areas, and to plant native vegetation, in a portion of Kawainui Marsh.

Hamakua was designated a State Wildlife Sanctuary by Hawaii State Governor Executive Order (Smith, 2002). Hamakua is a managed wetland; the Hamakua Marsh Restoration Project, funded through a combination of federal, state, and private grants, is being implemented by a number of groups: Hawaii Division of Forestry and Wildlife; Hawaii Chapter of the Wildlife Society; Kalama Land Company; the Hawaii Community Foundation; U.S. Fish and Wildlife Service; Ducks Unlimited; Lanikai, Kailua and Ke Kula o Kamakau Schools; the U.S. Natural Resources Conservation Service; the National Fish and Wildlife Foundation; the Pacific Coast Joint Venture; and Kailua Urban Design Task Force (Marine Corps Base Hawaii, 2002). The restoration project began in 1993 and is ongoing. The goal of the project is to enhance 9 hectares (23 acres) of wetlands for waterbirds, and to conduct education and outreach activities. In 2001 the Hawaii Division of Forestry and Wildlife removed nonnative invasive red mangroves (*Rhizophora mangle*) from a border between Kawainui Stream and the emergent herbaceous portion of the wetland, which had been growing there since the 1980s. Possibly as a result, the marsh's value and use by endangered waterbirds has been increasing (Marine Corps Base Hawaii, 2002).

The Hawaii Division of Forestry and Wildlife also has been hand-pumping water onto the surface of the marsh to prolong periods of ponding and mechanically removing vegetation to enhance the waterbird nesting habitat. Control of alien predators has been another component of the waterbird habitat rehabilitation effort, and has included construction of a perimeter fence to exclude large predators and grazers, and a trapping and poison (diphacinone) bait program to remove cats and mongooses (Marine Corps Base Hawaii, 2002).

26. Conservation measures proposed but not yet implemented:

The U.S. Army Corps of Engineers has proposed a restoration plan to enhance habitat for native endangered waterbirds in Kawainui Marsh that would: convert 28.3 hectares (70.7 acres) of degraded wetlands (11.8 ha) and upland (16.4 ha) into mudflats and shallow ponds, clear invasive vegetation from 6.8 hectares (17 acres) and control vegetation growth in this area, restore and create riparian habitat by removing trees and flattening banks, install fences for predator control, and implement a predator trapping program (U.S. Army Corps of Engineers, 1998). The planned waterbird habitat rehabilitation project is designed to avoid diminishing Kawainui Marsh's flood control values and avoiding impacts to archaeological and cultural sites (U.S. Army Corps of Engineers, 1998). These plans were finalized in 1992 but have not been yet implemented.

Plans for continued implementation of the habitat enhancement project at Hamakua Marsh to benefit endemic Hawaiian waterbirds and migratory shorebirds include continued control of alien vegetation using herbicides and mechanical removal, continued predator control, grading to create a moat to exclude predators from the marsh and to enhance waterbird and shorebird habitat, controlling public feeding of feral ducks, developing a water source to irrigate the marsh by drilling a freshwater well and installing a pump and delivery pipes and valves to deliver 500,000 gallons of water per day to the wetland, creating more shallow water habitat, creating islands, and restoring native riparian vegetation along the stream (Marine Corps Base Hawai'i, 2002; Smith, 2002). A central objective of the rehabilitation activities is to create a seasonal wetland by seasonally pumping water onto low elevation ground, and allowing the wetland to dry during the waterbird non-breeding season when vegetation would be controlled (Marine Corps Base Hawai'i, 2002; Smith, 2002).

The Hawai'i State Department of Land and Natural Resources (1994) prepared a master plan for Kawainui Marsh, which identifies objectives, policies, and recommended actions to protect the marsh. The majority of the Plan's recommendations, such as construction of a visitor center, cultural park, ethnobotanical garden, and commercial taro ponds, have not been implemented, but there are plans for construction of a perimeter recreational trail (section 29) and enhancement of waterbird habitat

(mentioned above) (City and County of Honolulu Department of Transportation Services, 2002; U.S. Army Corps of Engineers, 1998).

Other conservation measures proposed but not yet implemented include:

- Finally listing Kawainui in both the Hawaii and National Registers of Historic Places, declared eligible in July of 1979 but unlisted as yet. Hawaiians are eager to grow taro again in the relocated ancient lo'i aided by studies and historic photographs, to benefit cultural education.
- Finalized land "swap" between Honolulu and the Department of Land and Natural Resources (DLNR) of city-owned Kawainui, proposed in the Kawainui Management Plan in 1983 but not yet implemented.
- Environmental coalition proposals since 1983 that alien cows and horses now fertilizing excessive weeds and polluting wetland waters, to the detriment of water quality, be removed.
- Ongoing public and environmental coalition requests to government agencies for complete water quality studies which include a chemical component. We propose a need for limnological studies of not less than three years' duration, as proposed by Dr. Paul K. Bienfang's (Oceanic Foundation) pro bono study for the Lani-Lailua Outdoor Circle in 1974. (Available on request).
- Federal acquisition of Kawainui: for National Park purposes and/or Critical wildlife habitat for Hawaii endangered waterbirds and aquatic species, and as a viable migratory wildfowl haven.
- Request that DLNR not charge not-for-profit organizations (i.e., the Kailua Hawaiian Civic Club, Ahahui Malama i ka Lokahi and Conservation Council) for pro bono volunteers cleaning waters, replanting native plants and repairing ancient water-garden walls. Professionals are aided by non-violent state prisoners and other volunteers for cultural and scientific education. Programs are led by a native Hawaiian retired science teacher to the benefit of everyone.

27. Current scientific research and facilities:

In the past decade, the Hawaii Division of Forestry and Wildlife surveyed Kawainui and Hamakua Marshes two times per year during its bi-annual waterbird survey (January and August). The Kawai Nui Heritage Foundation and 'Ahahui Malama I Ka Lokahi, is conducting research and restoration work in Kawainui Marsh. The work is funded through a grant from the Kailua Bay Advisory Council for the period December 2001 through June 2003. The project will characterize the physical and chemical structure of the wetland, research sediment and water column dynamics, inventory aquatic fauna, and enhance habitat of an islet near the Oneawa Canal portion of the marsh for waterbirds (<http://www.aecos.com/aml/KBAC.html>).

28. Current conservation education:

University of Hawaii faculty use Kawainui Marsh to illustrate concepts and issues related to the objectives of their courses, ranging from Hawaiian history to limnology. Other educational groups use Kawainui Marsh for educational activities, including Sierra Club High School Hikers' Program, Lani-Kailua Outdoor Circle, Historic Hawaii Foundation, Kamehameha Schools, and Halau Mohala 'Ilima. An educational guidebook and video, produced for elementary school students, describes the legends associated with Kawainui Marsh, aspects of Hawaiian culture, and marsh ecology (McMonagle and Lembeck, 1985).

School groups visit Hamakua Marsh as part of an environmental restoration and education project. Lanikai, Kailua and Ke Kula o Kamakau School classes participate in the education program, and post information on aspects of rehabilitation needs on their Department of Education web site. The Hawaii State Division of Forestry and Wildlife's management strategy for Hamakua includes involving local community interest groups with management activities, including water quality monitoring and planting native vegetation, and integrating the wetland management and monitoring activities into local elementary school curriculum, as a strategy to augment local support for conservation activities (Smith, 2002). The State's plan also includes installing interpretive signs at Hamakua Marsh (Smith, 2002).

The Kawai Nui Heritage Foundation and 'Ahahui Malama I Ka Lokahi sponsor tours on the natural and cultural history of Kawainui Marsh and nearby sites, bringing up to as many as 200 visitors at a time.

Because of its central location, size, possession of a variety of wetland habitats, cultural resources, and history of collaborative rehabilitation efforts, Kawainui and Hamakua Marshes have the capacity to support additional significant conservation education and research activities.

29. Current recreation and tourism:

Use of a model airplane field is an active and popular recreational use on land adjacent to Kawainui Marsh (this land parcel used to be part of the wetland before it was filled) (U.S. Army Corps of Engineers, 1998). Groups such as the Sierra Club High School Hikers' Program, Lani-Kailua Outdoor Circle, History Hawaii Foundation, Kamehameha Schools, and Halau Mohala 'Ilima use Kawainui Marsh for recreational activities. People walk, jog, and ride bicycles along the flood control levee, which is the most accessible vantage point to view Kawainui Marsh.

There are plans to construct a 914 linear meter (3,000 linear foot) pathway along the perimeter of Kawainui Marsh, with educational signs (City and County of Honolulu Department of Transportation Services, 2002).

The Kailua Vision Team has proposed creating a gateway park to Kawainui Marsh on Mokapu Boulevard along with some wetland enhancement and nature trails east of the flood control levee (Marine Corps Base Hawaii, 2002).

30. Jurisdiction:

The City and County of Honolulu Department of Public Works and the Hawaii State Department of Land and Natural Resources Division of Forestry and Wildlife have jurisdiction over and each owns a portion of Kawainui Marsh. The Hawaii State Department of Land and Natural Resources, Division of Forestry and Wildlife has functional jurisdiction (management authority) over both Kawainui and Hamakua Marshes for conservation purposes.

31. Management authority:

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