Chapter 4. Refuge Biology and Habitat

4.1 Biological Integrity Analysis

Kakahaiʻa NWR is located within the Kawela watershed. The drainage basin has changed considerably due to agricultural activities. Cattle, deer, and goats have denuded much of Kawela and accelerated soil erosion along the lower elevations. Old Pond was once an inland freshwater fish pond and New Pond was created in 1983 to provide shallow water habitat for aeʻo. Adjacent lands include both agricultural and residential properties.

Little is known about the historic pristine coastal wetland vegetation due to its conversion by early Hawaiians into fishponds and irrigated farmlands. A small number of native plants still occur at the Refuge, but their distribution before introduction of nonnative species is difficult to reconstruct. Recent vegetation changes followed the creation of New Pond. Although wetland plant species initially thrived in the 1980s and 1990s, these plants died out as the pond lost water. Due to its dewatered condition since the early 2000s, the New Pond acreage is now dominated by dry upland pest species. The remaining vegetated wetlands of Old Pond are dominated by California bulrush with small stands of kaluha (alkali bulrush) and patches of ʻākulikuli (sea purslane). The latter two species and kīpūkai (seaside heliotrope) are the only common native plants on the Refuge.

4.2 Conservation Target Selection and Analysis

Endangered Hawaiian waterbirds, migratory birds, and their associated wetland habitat are the conservation targets of this plan (Table 4.1). They are consistent with the purpose of the Refuge, the Hawaiian waterbird recovery plan and the shorebird conservation plan. The objectives as described in Chapter 2 were developed based on desired outcomes, biological and abiotic factors as well as feasibility to meet those objectives (USFWS 2005, Engilis and Naughton 2004).

Table 4.1. Conservation targets for the CCP.

System targets	Benefiting Resources
Wetland habitat	All wetland habitat species
Grassland habitat	Native plants and birds that graze on grasses
Dry forest habitat	Native plants
Coastal strand habitat	Migratory shorebirds and native plants
Species Group Targets	**Benefiting Resources**
Endangered Hawaiian Waterbirds	All listed waterbird species
Migratory birds	All migratory waterfowl and shorebirds

4.3 Wetland Habitat

Palustrine wetlands (non-tidal and dominated by trees, shrubs, and emergent vegetation) cover 20.5 acres at Kakahaiʻa NWR as delineated by the National Wetlands Inventory program (Cowardin et al. 1979). A spring provides water for Old Pond, which is dominated by California bulrush with small stands of great bulrush. When the Refuge was acquired in 1976, Old Pond had 15 acres of open water. By 1991, open water was reduced to 4 acres and by 2010 it had diminished to less than an acre.

Kiawe has spread across dried-out New Pond USFWS

Water pumped from Old Pond was the primary water source for New Pond, created in 1983 to provide shallow water habitat. The wetland was heavily impacted by residential development and overgrazing higher in the watershed. Associated water withdrawals from the aquifer and soil erosion amplified sediment buildup in Old Pond which reduced our ability to pump water. Old Pond vegetation could not be controlled without heavy equipment. By 1997, New Pond was overgrown with vegetation. In 1999, an attempt was made to clear the dikes and margins, but vegetation quickly returned. In 2000, the intake area began to dry out after just a few hours of pumping. By 2002, the intake area dried out completely except after periods of heavy rainfall.

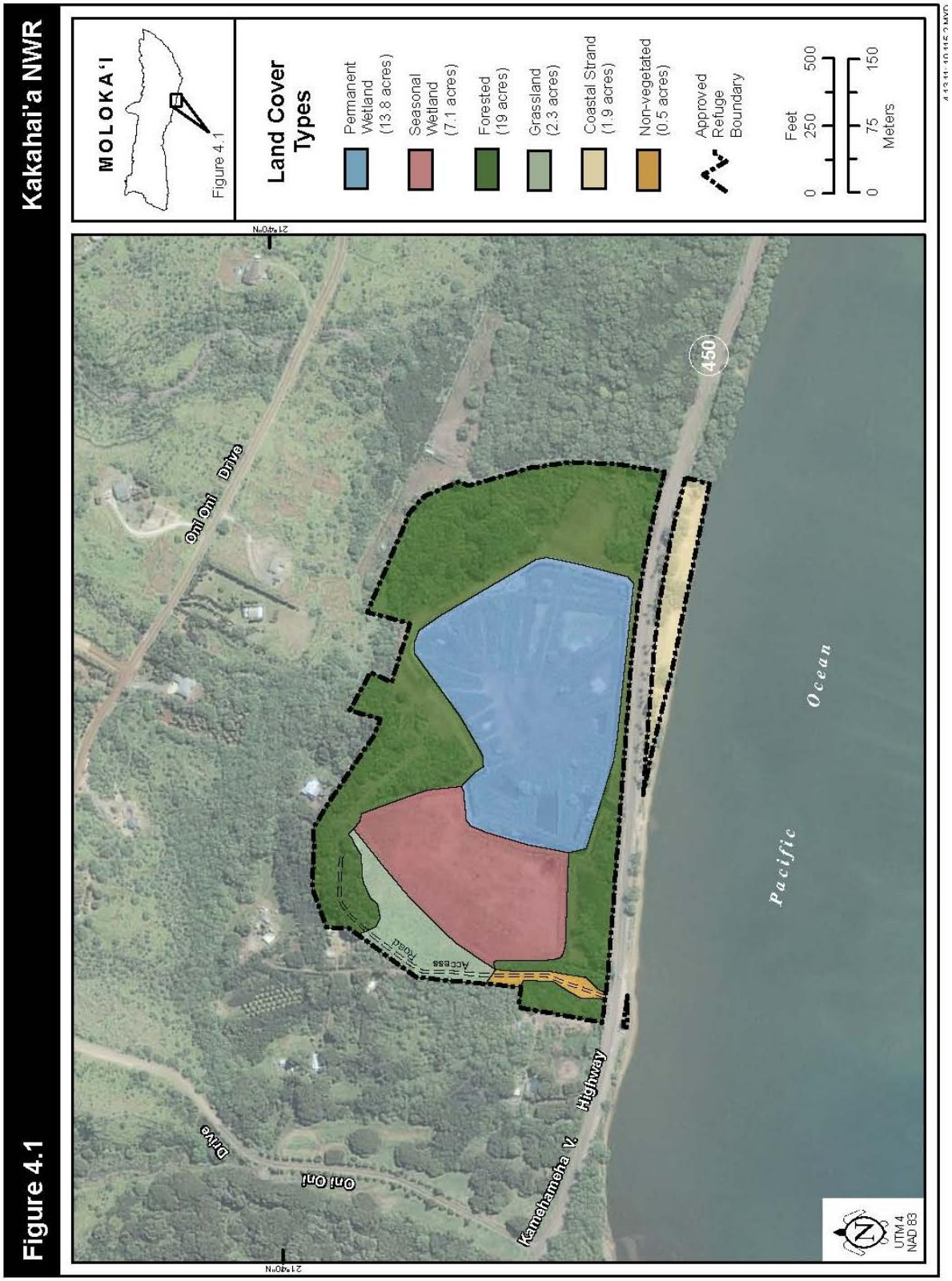
As a result, New Pond remains dry for most of the year. Nearly all of the vegetation is comprised of pest species (Indian marsh fleabane, kiawe, swollen finger grass, and Australian saltbush). Kīpūkai is the only native species currently present. In the past, the Refuge provided year-round habitat for the endangered ʻalae keʻokeʻo and aeʻo. A few migratory waterfowl and shorebirds also used the wetland. Currently, waterbirds occur only when heavy rainstorms replenish New Pond. ʻAmaʻama (mullet), *Oreochromis*, *Poecilia*, and mosquitofish are found in Old Pond.

4.4 Grassland Habitat

Over 90 percent of this ecoregion in Hawaiʻi has been lost due to human development and pest vegetation. The dominant grass in Hawaiʻi prior to nonnative grasses was probably pili. ʻAkiʻaki is another native grass that is salt-tolerant and can be grown adjacent to the coastline. Restoration of native grassland plants such as these within the fenced area of the Refuge will benefit native birds that graze on grass.

Grassland adjacent to entry road Mike Nishimoto/USFWS

Figure 4.1. Land Cover Types.



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4.5 Coastal Dry Forest

Kiawe dominates the forest USFWS

Dry forest covers 22.1 acres along the upland areas of the Refuge, mostly occurring to the north and east of the wetlands. Trees are 30-40 feet tall. The forest is species poor with most plants introduced since the 19th century. This habitat is dominated by nonnative kiawe and monkey pod with an understory of Indian marsh fleabane. The inland kiawe subtype occurs especially in dry areas on all of the main Hawaiian Islands usually below the 1,000 foot elevation.

Much of this habitat had been cleared in 1999, but 70 percent has since grown back. A portion of the area north of New Pond is relatively open and typically with scattered trees about 10-15 feet tall. Floods that result in pools of standing water may kill upland vegetation that reduces water velocity allowing sediments and vegetative debris to settle out.

A variety of nonnative birds inhabit the dry coastal forest. Gray francolins commonly occur at the forest edge while passerines such as the white-rumped shama, northern cardinal, red-crested cardinal, and house finch are found in amongst the kiawe trees. Terrestrial pest mammals commonly observed include house mouse, Norway rat, black rat, dog, mongoose, cat, and axis deer.

4.6 Coastal Beach Strand

Coastal beach strand covers 2.0 acres of the Refuge on the south side of Kamehameha V Highway. This habitat is dominated by nonnative grasses, coconut trees, and kiawe. Indian fleabane and milo also occur in this habitat. The entire shoreline has been affected by beach erosion with the west side more severely impacted. Few migratory birds inhabit the coastal strand. The beach does provide some foraging habitat for hunakai (sanderling), while the grassy area is used by kōlea (Pacific golden-plovers) and ‘akekeke (ruddy turnstone).

Kakahai‘a coastal beach strand USFWS

Pest mammals present in this habitat include house mice, Norway rats, black rats, dogs, small Indian mongooses, and cats. Shoreline erosion that converts uplands to submerged lands with the associated sedimentation of adjacent reefs is a recognized threat to the coastal beach strand.

4.7 Endangered Hawaiian Waterbirds

Kakahaiʻa NWR was established to provide protected habitat for two of Hawaiʻi's endangered waterbirds, the aeʻo and ʻalae keʻokeʻo. Statewide, the primary causes of their population decline include loss of wetland habitat, predation by introduced animals, altered hydrology, habitat alteration by pest plants, and disease. In addition, environmental contaminants may also potentially threaten populations in certain areas. No critical habitat has been designated for any of Hawaiʻi's endangered waterbirds.

Aeʻo pair © Brian Barker

4.7.1 Aeʻo (*Himantopus mexicanus knudseni*) or Hawaiian Stilt

The aeʻo is an endangered subspecies endemic to the Hawaiian Islands, which is part of a superspecies complex of stilts found in various parts of the world. The State population of this non-migratory shorebird fluctuates between 1,200-1,500 birds with a 5-year average of 1,350 birds. Refuge counts of up to 40 birds were observed in the early 1990s at New Pond. These counts were down to 20 in the late 1990s and now a few aeʻo are seen around the Refuge only after heavy rains (FWS 2005, Robinson et al. 1999).

Aeʻo favor open wetland habitats with minimal vegetative cover and water depths less than 9.4 inches, as well as tidal mudflats. Due to the deeper water, they did not use Old Pond. Aeʻo nest April-August with nesting sites consisting of simple scrapes on low relief islands within or adjacent to ponds. They tend to be opportunistic users of ephemeral wetlands to exploit seasonal abundance of food, feeding on small fish, crabs, polychaete worms, and insects. Ongoing threats to foraging and breeding birds on Refuge lands include predation by owls, mongooses, cats, rats, dogs, ʻaukuʻu (black-crowned night-heron), cattle egrets, common mynas, ʻakekeke, and laughing gulls (Robinson et al. 1999, Rauzon and Drigot 2002).

4.7.2 ʻAlae keʻokeʻo (*Fulica alai*) or Hawaiian Coot

The ʻalae keʻokeʻo is an endangered species endemic to all the main Hawaiian Islands except Kahoʻolawe. The State population has fluctuated between 2,000-4,000 birds. Nesting occurred around Old Pond in the late-1970s through the 1980s when there was open-water habitat. New Pond provided nesting and feeding habitat for a small number in the late 1990s with counts up to 50 birds. Only 2 ʻalae keʻokeʻo are currently occasionally present at the Refuge (Brisbin et al 2002, USFWS 2005).

ʻAlae keʻokeʻo Laura Beauregard/USFWS

ʻAlae keʻokeʻo are usually found on island coastal plains and prefer freshwater ponds or wetlands, brackish wetlands, and manmade impoundments. They prefer open water that is less than 12 inches deep for foraging and nesting habitat that has open water with emergent aquatic vegetation or heavy stands of grass. ʻAlae keʻokeʻo feed on seeds and leaves of aquatic and terrestrial plants, freshwater snails, crustaceans, tadpoles of marine toads, small fish, and aquatic and terrestrial insects (Schwartz and Schwartz 1949, Brisbin et al. 2002).

Nesting occurred November-April during the late 1990s, with opportunistic nesting occurring year-round depending on rainfall. ʻAlae keʻokeʻo will construct floating nests of aquatic vegetation, semi-floating nests attached to emergent vegetation, or in clumps of wetland vegetation. Cats, dogs, and mongooses are the main predators of ʻalae keʻokeʻo. Other predators include ʻaukuʻu, cattle egrets, and large fish. ʻAlae keʻokeʻo are also susceptible to avian botulism outbreaks (Brisbin et al. 2002).

4.8 Migratory Waterfowl

Koloa māpu © Tom Dove

Migratory waterfowl winter over in the Hawaiian Islands from September-May. They used the open waters of New Pond until it began to dry out in the late 1990s. Species recorded at the Refuge included koloa māpu (northern pintail), koloa mohā (Northern shoveler), green-winged teal, and koloa-mallard hybrids. Our observations through the 1990s noted migratory waterfowl were more prevalent during the winter months, with numbers exceeding 15 birds comprised of a few different species.

4.9 Migratory Shorebirds

Shorebirds use mudflats and dikes in the wetlands and along the coastal strand area of Refuge during the winter months. Although their numbers have declined significantly due to lack of water, they are still seen after heavy rains at New Pond. Occasional sightings include the kōlea, ʻakekeke, hunakai, and ʻūlili (wandering tattler). The only resident shorebird is the aeʻo.

ʻŪlili © Michael Walther

4.10 Pest Species

A pest species is defined as a species whose migration and growth within a new range is causing detrimental effects on the native biota in that range. These species become pests because their population and growth are no longer balanced by natural predators or biological processes that kept them in balance in their native ecosystems. In the absence of these restraints, they have the potential to compete with native species for limited resources, alter or destroy habitats, shift ecological relationships, and transmit diseases. Native species as well as nonnative species can become pests when their natural ecosystem is out of balance.

Pest species are one of the most serious problems in conserving and managing natural resources. In particular, the ecological integrity of Pacific Island environments is greatly threatened by pest species. Hawaiʻi, which existed in isolation for millions of years, is an exceptionally ideal environment for these species. Most native species lost their natural defense mechanisms and are more vulnerable to introduced species (Pattison et al. 1998, Ikuma et al. 2002, Middleton 2006).

4.10.1 Mammals

Rat (*Rattus* spp.)
Three pest rat species are found throughout the Hawaiian Islands. Polynesian rats arrived from the central Pacific 1,500 years ago with the Polynesians; Norway rats reached the Hawaiian Islands after the arrival of Captain Cook in the 1770s; and black rats most likely arrived in the 1870s.

Black rat © Jack Jeffrey

All three species in Hawaiʻi are known predators of eggs, nestlings, young, and occasionally adults of endangered waterbirds, seabirds, migratory shorebirds, and forest birds. Ground- and burrow-nesting seabirds are particularly vulnerable to rat predation, even by the arboreal black rat. Rats also consume plants, insects, mollusks, and other invertebrates. Because these species are also eaten by birds, a reduction in these populations may indirectly affect avian populations (Olson and James 1982, Harrison et al. 1984, Brisbin et al. 2002, Engilis et al. 2002, Mitchell et al. 2005).

The use of snap traps and ground-based application of diphacinone rodenticide to control rats in the main Hawaiian Islands has shown a positive effect in native bird survival. After wetland restoration, rat control will be conducted at the Refuge with various methods including the use of rodenticide placed in tamper-resistant bait stations, live traps, and snap traps.

Small Indian mongoose
(*Herpestes javanicus*)
The small Indian mongoose was introduced to the main Hawaiian Islands in 1883 as a bio-control agent against rats in sugarcane fields. The mongoose inhabits all habitat types from 0-10,000 feet on the islands of Hawaiʻi, Maui, Oʻahu, and Molokaʻi. In other areas of the world, mongooses appear to avoid wet areas; however, in Hawaiʻi, dense populations of mongooses are concentrated in wet habitats.

Small Indian mongoose USFWS

The home range of a female in Hawaiʻi is about 3.5 acres, and the main reproductive period occurs February-August. The high density of mongooses is due to abundant food and the lack of natural predators. They are voracious omnivores, consuming insects, reptiles, mammals, amphibians, crabs, plants, and birds. They are a major threat to any ground dwelling and nesting species in Hawaiʻi, known to eat eggs, young, and adults of endangered waterbirds, seabirds, and shorebirds. After wetland restoration, the mongoose population will be managed using traps and diphacinone rodenticide (Staples and Cowie 2001, Mitchell et al. 2005, Hays and Conant 2007).

Cat (*Felis catus*)
Cats arrived in Hawaiʻi in the early 1800s on European ships and are now found on all the main Hawaiian Islands from 0-10,000 feet. Cats are natural hunters with their sharp teeth; the upper teeth overlap the lower, giving them a firm grasp to shake or tear prey to death. Food habits of cats in Hawaiʻi include insects, centipedes, crustaceans, lizards, mice, rats, bird eggs, and birds (Scott and Thomas 2000, Mitchell et al. 2005).

Neutered and released cat with waterbird
© Michael Walther

Dog (*Canis lupus familiaris*)
The dog is a domesticated form of the gray wolf, a member of the Canidae family of the order Carnivora. Abandoned, escaped, or pet dogs allowed to run loose can cause great harm to native species and ecosystems. Dogs have caused terrible damage to native ground-nesting birds. Dogs can attack a large number of birds in a single incident by grabbing and shaking the birds around with their mouths and leaving them for dead before heading to another nest or burrow.

Axis Deer (*Axis axis*)
Eight axis deer were brought to the Hawaiian Islands in December 1867 and released on Molokaʻi in January 1868. That number has risen to over 8,000 today. Axis deer originate from India and are also known as cheetal deer. They stand about 3 feet tall at the shoulder and weigh about 185 lb. with a lifespan of 20-30 years. Axis deer have a protracted breeding season in our tropical climate, and births can occur throughout the year. Males do not have their antler cycles in synchrony and there are some fertile females at all times of the year. The growing population of axis deer has created a number of concerns ranging from vehicle accidents and poaching to crop and ecosystem damage (Waring 1996, Maui Axis Deer Group 2002, Stephenson 2010).

4.10.2 Birds

There are a number of nonnative species that have been introduced through human activity. Molokaʻi's native birds coevolved in isolation and developed specialized life history requirements in order to minimize competition. Most of the nonnative birds have been introduced just within the last 100 years and use the same habitats, eat the same foods, and use similar foraging strategies as our native birds. Direct competition for limited food and habitat may be a serious issue. These species are resistant to avian pox and malaria and may serve as carriers for transmitting these devastating diseases. Nonnative bird species are fairly common to abundant, and also play a role in spreading the seeds of pest plants into native habitats.

Cattle egret Laura Beauregard/USFWS

Cattle egret (*Bubulcus ibis*)
The cattle egret was introduced to Hawaiʻi in 1959 from Florida for insect control on cattle and has become widespread. Rookeries were documented on Niʻihau, Kauaʻi, Oʻahu, Hawaiʻi Island, Molokaʻi, Lanaʻi, and Maui by the mid-1980s.

Its diet primarily consists of grasshoppers, crickets, spiders, flies, frogs, and nocturnal moths, but the bird will also consume prawns, mice, crayfish, and the young of native waterbirds. Cattle egrets have been documented taking chicks of all endangered waterbird species occurring on the Refuge. After wetland restoration and if predation on endangered waterbirds exceeds our target limit, population control measures as identified in the IPM would be implemented (Engilis et al. 2002, Hawaii Audubon Society 2005).

4.10.3 Amphibians

Cane toad *(Bufo marinus)*
Cane toads or Pacific giant toads are native to Latin America and were brought to the Hawaiian Islands in 1932 to control insect pests. The adults only require water for breeding, an event which results in thousands of eggs per mating occurrence. Cane toads are active at night and primarily feed on cockroaches, crickets, grasshoppers, grubs, earthworms, slugs, spiders, centipedes, and snails. In addition, these highly invasive amphibians are potential predators of endangered waterbird eggs and young (Yamamoto & Tagawa 2000, Staples & Cowie 2001).

Cane toad Laura Beauregard/USFWS

4.10.4 Invertebrates

Ants

Hawaiʻi is one of the few places on Earth believed to harbor no native ant species. Today, at least 47 ant species in 7 subfamilies and 24 genera have become established. Ants are a growing concern since they can have negative effects on native and endangered plants and animals. Ants are known to attack, injure, or kill young birds. Ants are also implicated in having negative effects on native and endangered plants. Control of ants has potential on the Refuge to protect trust resources. The Service is currently studying the efficacy of various baits and approved toxins on pest ants on Oʻahu and Johnston Atoll. After wetland restoration, it is anticipated that the Refuge will adopt IPM methods to control ants based on the results of these studies.

4.10.5 Plants

At the ecosystem level, pest plants have been shown to be capable of changing fire regimes, altering nutrient cycling patterns, and modifying the surface runoff of water. Nonnative plants can physically displace native species, and/or supersede them in competition for water, nutrients, or other limited resources. They can also be vectors and hosts for introduced pests and diseases to which the native species lack natural defenses (Jui Min et al. 2007).

Almost half the flora of the Hawaiian Islands is comprised of naturalized nonnative plants, approximately 1,100 species. According to Staples et al. (2000), pest plants in Hawaiʻi share the following biological and reproductive characteristics:

- Adaptable to and capable of thriving in different habitats;
- Tolerant of variable conditions (such as light, temperature, moisture);
- Fast growing;
- Tolerant of disturbance;
- Easily dispersible to new localities by seeds, fruits, spores, or vegetative parts;
- Produce small seeds/spores early in life;
- Long reproductive periods; and
- Dispersed by animals and with no special germination requirements.

The control and eradication of pest plants has been the top priority of natural resource managers in Hawaiʻi. Pest species out-compete more desirable plant species here, as well as invade open water and mudflat habitats. In addition, the high biomass characteristic of pest grasses produces a high amount of fuel for fire. Pest plants on the Refuge include California grass, California bulrush, Indian marsh fleabane, kiawe, and long thorn kiawe.

California grass (*Brachiaria mutica*)

California grass Mike Silbernagle/USFWS

California grass is a sprawling perennial with culms up to 19 feet long. Stolons and leaf sheaths are densely hairy. It is suspected to have originated in Africa and occurs pantropically as a pasture grass, well adapted to a wide range of soil conditions (sandy to clay). It tolerates moderate shade but prefers full sun (Cook et al. 2005).

It grows prolifically in wetland habitats, but it can also withstand severe drought. In addition to displacing native plants, California grass alters and destroys wetlands, causing a reduction in bird habitat. The Hawaiʻi-Pacific Weed Risk Assessment, conducted by the University of Hawaiʻi and the U.S. Forest Service, identifies California grass as "documented to cause significant ecological or economic harm in Hawaiʻi" (Stone et al. 1999, Motooka et al. 2003).

Indian marsh fleabane (*Pluchea indica*)

Indian marsh fleabane Mike Silbernagle/USFWS

Indian fleabane is an erect shrub that grows up to 6.6 feet tall. It is native to temperate and tropical Asia, northern Australia, and is naturalized elsewhere. In Hawaiʻi, it occurs in lowland, coastal habitats such as wetlands and fishponds (GRIN Online Database).

Indian fleabane out-competes native sedges on the Refuge, reducing forage and nesting habitats for native birds. The understory and open areas of the coastal dry forest habitat are dominated by this pest species. It tends to harbor huge nests of paper wasps, which are a hazard to Refuge staff. The Refuge uses mechanical, chemical, and prescribed burning IPM techniques to control this pest species.

California bulrush (*Schoenoplectus californicus*)

California bulrush Mike Silbernagle/USFWS

California bulrush is a perennial sedge native to marshes of the tropical and subtropical Americas. It was first found on Molokaʻi in 1912. It has tall, thin, dark green stems which are usually triangular in cross-section and woolly, bristly tan or brown flowers in panicle inflorescences. It has characteristics common in the sedge family, such as creeping. It is intolerant of shade, but can spread rapidly by vegetative means (Wagner et al. 1999, Erickson and Puttock 2006).

Kiawe thorns & seed pods
© F & K Starr

Kiawe *(Prosopis pallida)*
Kiawe is native to Peru, Colombia, and Ecuador. More than 150,000 acres of kiawe forests in Hawaiʻi are descended from a single tree planted in 1828 by Father Bachelot, the first Catholic priest in the Hawaiian Islands. By 1840, progeny of the tree were already spreading to dry, leeward plains on all of the islands (Nelson and Wheeler 1963).

Most kiawe have thorns with strong, 1 inch-long spines. It usually flowers January-March, but in years with wet summers it also flowers September-October. Kiawe overshadows native plants and deep taproots use all available water. Dense kiawe thickets have replaced native plants in the coastal dry forest at the Refuge.

Long thorn kiawe (*Prosopis juliflora*)
Related to the common kiawe, long thorn kiawe differs in that it is sprawling in nature (rather than an upright tree), has a larger leaf structure and, most notably, thorns up to several inches long which are sharp enough to pierce vehicle tires. Long thorn kiawe has been known to hybridize with common kiawe. It has many seeds and grows rapidly, impeding access in New Pond with its sprawling branches and long sharp thorns. The Molokaʻi/Maui Invasive Species Committee has identified long thorn kiawe as a target pest species for removal. Our control options include hand pulling new shoots as soon as they have emerged and are large enough to grip. Cutting the plant at the base and treating with herbicide will effectively stop it from re-sprouting. Constant monitoring is needed to watch for new growth (MoMISC 2010).

Long thorn kiawe © F & K Starr

4.11 Wildlife and Habitat Research and Monitoring Efforts

A research project on wetland ecology has been conducted at Kakahaiʻa NWR for the past several years. It included a study on nitrogen source tracking through wetland plants. It showed low values from wetlands on Molokaʻi and higher values at wetlands on Oʻahu and Maui. The higher values were attributed to more developed and densely populated watersheds (Bruland and MacKenzie 2010).