

**Focal Species:** Hawaiian Duck or Koloa Maoli (*Anas wyvilliana*)

**Synopsis:** The Koloa is part of the Mallard species complex, and hybridization with feral Mallards and genetic introgression is the greatest threat to this endemic species. Difficulty in distinguishing Koloa from hybrids has hindered estimation of their population size and trend. Koloa use a variety of wetland types, but habitat loss and degradation has decreased their range and abundance. They nest on the ground in dense vegetation near wetlands, where they are vulnerable to non-native mammalian predators. The most important conservation actions for Koloa are removal of feral Mallards and hybrids, habitat protection and management, and predator control to increase reproduction.



Koloa pair (male on left), Hanalei, Kaua'i. Photo E. VanderWerf



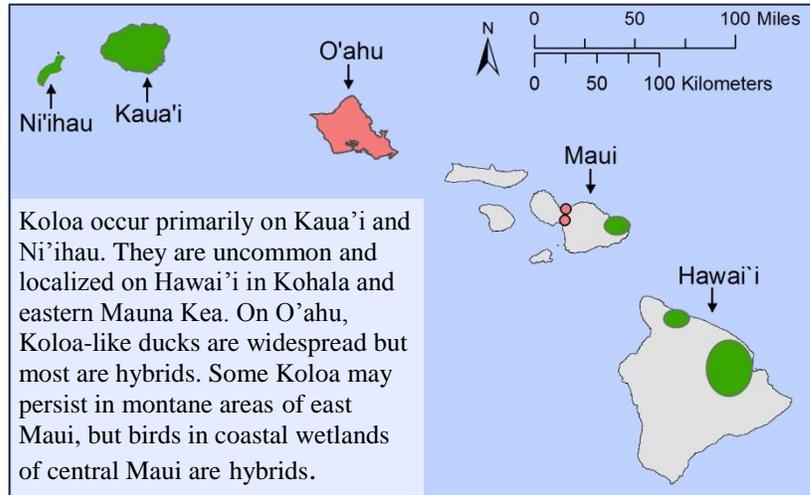
Hanalei National Wildlife Refuge, Kaua'i, showing natural and agricultural wetlands used by Koloa. Photo E. VanderWerf

<b>Geographic region:</b> Hawaiian Islands
<b>Group:</b> Water birds
<b>Federal Status:</b> Endangered
<b>State status:</b> Endangered
<b>IUCN status:</b> Endangered
<b>Conservation score, rank:</b> 17/20, At-risk
<b>Watch List 2007 Score:</b> Red
<b>Climate Change Vulnerability:</b> Moderate

**Population Size and Trend:** The Koloa population has been estimated at 2,200 birds, including 2,000 on Kaua'i and 200 on Hawai'i (Engilis and Pratt 1993), but the actual population size is poorly known and may be lower. Biannual state-wide waterbird counts yielded an average of only 360 birds from 2000-2007 (USFWS 2011), because they do not cover montane streams on Kaua'i that are thought to support much of the population. Koloa-like ducks also occur on O'ahu and Maui, but genetic research has shown that most or all of them are hybrids between Koloa and feral Mallards (*Anas platyrhynchos*; Fowler et al. 2009). The population size is thought to have increased since the 1950s on Kaua'i, but more recent trends are unknown because of incomplete survey coverage and difficulty in distinguishing Koloa from hybrids.

**Range:** Historically, the Koloa occurred on all the larger Hawaiian Islands except Lāna'i and Kaho'olawe, but they were extirpated from all islands except Kaua'i by the 1960s. Populations that occur on other islands today are the result of captive breeding and reintroduction (Engilis et al. 2002). The Koloa currently is found primarily on Kaua'i, Ni'ihau, and Hawai'i. Koloa also

may occur on Maui and O'ahu but most birds on those islands are hybrids, and difficulty in distinguishing Koloa from Koloa-Mallard hybrids has hindered determination of their range. Koloa occur in a variety of wetland habitats from sea level to 2,100 meters (6,900 feet) elevation. On Kaua'i, the largest concentration is at Hanalei National Wildlife Refuge, including the upper reaches of Hanalei Stream, but they are



widespread and also are found at Hūlei'a National Wildlife Refuge, montane streams on the Alaka'i Plateau, river valleys, reservoirs, taro fields, and a variety of managed wetlands. On Ni'ihau, surveys in the 1990s indicated the playa lakes in the southern part of the island, particularly Halali'i Lake, and Apana Reservoir were the most important locations, but recent radio telemetry and satellite tracking research has shown that Koloa also use wetlands in the northern and western parts of the island (C. Malachowski unpubl. data). On O'ahu, Koloa-like ducks are widespread in wetlands scattered around the island, including Kawainui, Hāmākua, and He'eia marshes, James Campbell National Wildlife Refuge, Kāne'ohe Marine Corps Base, and in wetlands at Punaho'olapa, Halei'wa, Pearl Harbor, and Lualualei Valley, but most or all of them are hybrids. On Maui, Koloa may persist in montane streams on the northeastern slope of Haleakalā, and Koloa-like ducks are sometimes found at Keālia Pond NWR and Kanahā Pond Wildlife Sanctuary. On the island of Hawai'i, Koloa occur in the Kohala Mountains, in Pololū, Waimanu, and Waipi'o valleys, and in stock ponds and montane streams on Mauna Kea.

**Essential Biology:** The Koloa is a small brownish duck (604 g in males and 460 g in females) in which both sexes are similar in appearance to a female Mallard (USFWS 2011). Males are darker brown and have a greenish bill, while females are lighter brown, especially on the head, and have an orangish bill (Engilis et al. 2002).

Koloa occur in a variety of wetland types, including natural wetlands such as freshwater marshes, coastal ponds, streams, montane pools, and flooded fields, and wetlands created or maintained by humans, including taro fields and other agricultural wetlands, aquaculture ponds, irrigation ditches, reservoirs, and sewage treatment ponds (Engilis et al. 2002, Uyehara et al. 2008). Koloa may use different habitats for nesting, feeding, and resting, and may move seasonally among areas (Engilis and Pratt 1993, Gee 2007). Recent radio telemetry and satellite tracking research has shown that some Koloa move seasonally between islands, especially Kaua'i and Ni'ihau, and between lowland wetlands near the coast and montane streams (C. Malachowski unpubl. data). Montane areas are thought to be important nesting and possibly molting sites. Koloa are opportunistic feeders and consume a variety of aquatic invertebrates, small fish, green algae, and leaves and seeds of aquatic plants (Swedberg 1967, Engilis et al. 2002). They most often feed in water less than 24 centimeters (9 inches) deep (Engilis et al. 2002).

Hawaiian Ducks may nest year-round, but the majority of nesting occurs from March-June (Giffin 1983). Nests are built on the ground in dense vegetation, where they are vulnerable

to non-native predators and fluctuating water levels (Engilis et al. 2002). Nests may be built away from water, and parents may lead ducklings to wetlands after hatching. Clutch size ranges from 2-10 eggs, with a mean of 8.3 (Swedberg 1967). Incubation lasts approximately 30 days, with most chicks hatching in April-June.

**Primary Threats:** The most serious threat to the Hawaiian Duck is hybridization with non-native feral Mallards and genetic introgression into the Hawaiian Duck population. Hybrids are most prevalent on O'ahu, where all Koloa-like ducks may actually be hybrids, but hybridization and genetic introgression has occurred on all islands, including Kaua'i, which supports the core of the population. Hawaiian Ducks also share a number of threats with the endangered Hawaiian Coot, Hawaiian Gallinule, and Hawaiian Stilt and are included in the same recovery plan with those species (USFWS 2011).

- Hybridization. Mallards were raised for food in the Hawaiian Islands historically and have escaped and established feral populations on all islands that support Koloa. Hybridization between Koloa and feral Mallards compromised Koloa reintroductions conducted from the 1950s to the 1990s, especially on O'ahu (USFWS 2011). Hybridization with feral Mallards and domestic Mallard varieties continues to be a problem today (Uyehara et al. 2007, Fowler et al. 2009). Feral Mallards have been removed in a few areas, but hybrids are difficult to distinguish from Koloa and their management has been problematic (Fowler et al. 2009). Until the hybridization threat is dealt with, other management actions aimed at Koloa on O'ahu and Maui will also benefit hybrids and possibly exacerbate the problem.
- Habitat loss and degradation. Filling, dredging, and draining of wetlands in Hawai'i has greatly reduced the amount of habitat available for Hawai'i's waterbirds and thus limited their distribution and abundance. In the last 110 years, approximately 31 percent of coastal plain wetlands have been lost (USFWS 2011). A shift from wetland agriculture to other crops also has reduced the amount of wetland habitat. Feral pigs (*Sus scrofa*) and goats (*Capra hircus*) can degrade nesting habitat along montane streams.
- Introduced predators. Koloa and other Hawaiian waterbirds are threatened by a variety of non-native predators. Feral dogs (*Canis familiaris*), feral cats (*Felis silvestris*), and small Indian mongooses (*Herpestes auropunctatus*) prey on adults and young. Predation by rats (*Rattus* spp.), Cattle Egrets (*Bulbulcus ibis*), Barn Owls (*Tyto alba*), and non-native fish has been documented on eggs or chicks (USFWS 2011). These predators are pervasive in wetland habitats throughout Hawai'i. Mongooses have been captured recently on Kaua'i but may not be established yet; preventing them from becoming established is of the highest priority. Native predators include the Black-crowned Night Heron (*Nycticorax nycticorax*) and Short-eared Owl or Pueo (*Asio flammeus*), which prey on chicks.
- Altered hydrology. Modifications of wetland habitats for flood control, agriculture, or to make them suitable as municipal water sources may compromise their value as habitat for Hawaiian Ducks.
- Non-native invasive plants. Several species of invasive alien plants can reduce value of wetland habitat for Hawaiian Ducks and other waterbirds, including water hyacinth (*Eichornia crassipes*), mangrove (*Rhizophora mangle*), Indian fleabane (*Pluchea indica*), and California grass (*Urochloa mutica*).
- Avian diseases. Avian botulism is a paralytic disease caused by ingestion of a toxin produced by the bacteria *Clostridium botulinum*. Botulism outbreaks occur regularly in

Hawaiian wetlands, and often are triggered by anaerobic conditions in warm water with decomposing vegetation and invertebrates. Birds can be treated if detected early, but outbreaks sometimes cause substantial mortality (Work et al. 2010).

- Environmental contaminants. Fuel and oil spills are the most important contaminant threat to all Hawaiian waterbirds.
- Human disturbance and hunting. The Hawaiian Duck was a popular game bird until hunting was prohibited in 1939, and hunting contributed to population declines.
- Climate change. Hawaiian Ducks and other waterbirds are vulnerable to climate change, particularly rising sea level, because they occur primarily in low-lying coastal wetlands. Rising water levels and storm surge could flood nests and inundate nesting areas. Incursions of salt water into freshwater wetlands appear to diminish habitat suitability.

**Conservation Actions to Date:** The Hawaiian Territorial Fish and Game Commission closed the Hawaiian Duck hunting season in 1925, but because of its similarity to female Mallards this may have provided little actual protection (USFWS 2011). A complete ban on all waterfowl hunting was imposed in 1939 and is still in effect today. The Hawaiian Duck was declared an endangered species by the Federal government in 1967, and it is also considered endangered by the State of Hawai'i.

The State Division of Forestry and Wildlife (then called the Division of Fish and Game) initiated Koloa restoration efforts in 1956 when they brought birds from Kaua'i into captivity at Pōhakuloa, Hawai'i to create a captive breeding population for use in reestablishing the species on other islands. The first release of 26 captive-bred Koloa occurred in 1958 at Kahua Ranch, Hawai'i (Engilis et al. 2002). Releases of captive-bred birds continued on Hawai'i from 1968 to 1979, with 361 birds released at Kahua Ranch and 58 released in the Hilo Forest Reserve. On O'ahu, 350 Koloa were released from 1968 through 1982 (Engilis and Pratt 1993). Feral Mallards were not removed from reintroduction sites on O'ahu prior to the releases, however, resulting in extensive hybridization and genetic introgression into the Koloa population. Koloa also were released on Maui in 1989 and 1990, resulting in the establishment of a small population, although hybridization with feral mallards has proven problematic there as well.

State and Federal biologists published an assessment of wetland habitats for endangered waterbirds (USFWS and HDLNR 1970), and that was followed by a summary of the status of Hawai'i's wetlands followed by Shallenberger (1977), both of which helped lead to establishment of numerous wetland refuges and reserves for the protection of waterbirds including the Koloa. Habitat restoration is currently underway at several sites, notably Kawainui Marsh on Oahu and the Mānā Plain on Kaua'i. Predator control is conducted at Hanalei National Wildlife Refuge to protect Koloa and other endangered waterbirds.

Various conservation-oriented research has been conducted to examine population trends (Engilis and Pratt 1993, Reed et al. 2011), habitat use (Gee 2007, Uyehara et al. 2008), hybridization and methods of distinguishing Koloa from Mallards and hybrids (Rhymer 2001, Fowler et al. 2009). Researchers from Oregon State University began a comprehensive Koloa research program in 2011 that includes habitat use, movements, survival, foraging ecology, and reproductive ecology. This research already has provided important information and funding is needed for its continuation through 2013.

#### **Planning/Research Needs:**

- Complete research to determine methods of distinguishing Koloa from feral Mallards and hybrids. This research has been ongoing and has shown that feral Mallards and Koloa can

be distinguished reliably by field marks, but that some hybrids, especially second-generation back-crosses with Koloa, are difficult to identify visually and can only be revealed by genetic screening. Final recommendations are needed on the best field marks to allow removal of birds from the wild and how to best deal with hybrid back-crosses.

- Continue research on habitat use, seasonal movement patterns, and importance of different wetland types (C. Malachowski, Oregon State University).
- Continue research on demography to determine home range size, sex ratio, age structure, sex-specific survival rates, breeding ecology (C. Malachowski, Oregon State University).
- Investigate foraging ecology of Koloa in different wetland types.
- Investigate the value to Koloa of different wetland types, including carrying capacity of natural wetlands and taro fields and other managed agricultural wetlands.
- Develop survey methods to more fully estimate the population size on Kaua’i, and obtain permission from private landowners to resume surveys on Ni’ihau, possibly using aerial methods.

**5-Year Conservation Goals:**

- Manage hybridization on all islands by removing feral Mallards and hybrids to the maximum extent practicable.
- Obtain public acceptance of feral duck control.
- Continue protection and restoration of important wetland habitats.
- Develop alternative predator control methods and explore the use of predator fences.

**Conservation Actions:**

- Hybridization
  - Remove feral Mallards and Koloa-Mallard hybrids to the maximum extent practicable on all islands, using the best available identification methods.
  - Conduct a public outreach campaign on the threat posed by hybridization and the need to control feral Mallards and hybrids in order to protect Koloa.
- Habitat restoration and management.
  - Continue management of important wetland areas, including Hanalei and Hūlei‘a National Wildlife Refuges.
  - Restore former wetland habitat on the Mānā Plain on Kaua’i (DOFAW).
- Predator control.
  - Investigate feasibility of predator fences at various wetlands on Kaua’i, including Hanalei and Hūlei‘a National Wildlife Refuges.
  - Continue predator control at Hanalei and Hūlei‘a National Wildlife Refuges.
  - Prevent establishment of mongooses on Kaua’i and Lāna‘i using all available methods. Improve biosecurity at airports and seaports.

**Summary of 5-year Actions, 2013-2017:**

Conservation Action	Year(s)	Annual cost	Total Cost
Complete research to determine methods of distinguishing Koloa from Mallards and hybrids	1-2	\$50,000	\$100,000
Continue research on habitat use and demography	1-2	\$75,000	\$150,000
Public outreach on the threat of hybridization and the need to control feral Mallards and hybrids	1-3	\$50,000	\$150,000
Remove feral Mallards and hybrids on all islands,	2-5	\$150,000	\$750,000

following public outreach			
Investigate feasibility of predator fences at various wetlands	1-2	\$10,000	\$20,000
Habitat management at Mānā Plain, Kauaʻi	1-5	\$300,000	1,500,000
Prevent establishment of mongooses on Kauaʻi	1-5	\$150,000	\$750,000
Predator control at Hanalei and Hūleiʻa NWRs	1-5	\$50,000	\$250,000

**Potential Partners:** U.S. Fish and Wildlife Service-Refuges, Hawaiʻi Division of Forestry and Wildlife, Ducks Unlimited, Pacific Coast Joint Venture, Natural Resource Conservation Service, Oregon State University.

**Ancillary Species:** Three other endemic Hawaiian waterbirds occur in the same areas as Koloa, the Hawaiian Coot (*Fulica alai*), Hawaiian Gallinule or ʻAlae ʻUla (*Gallinula galeata sandvicensis*), and Hawaiian Stilt or Aeʻo (*Himantopus mexicanus knudseni*), all of which are listed as endangered. Numerous species of migratory waterfowl and migratory shorebirds use the same habitats that are important to the endemic Hawaiian waterbirds. Some of the more common migrants are Northern Pintail (*Anas acuta*), Northern Shoveler (*Anas clypeata*), American Wigeon (*Anas americana*), Lesser Scaup (*Aythya affinis*), Pacific Golden Plover (*Pluvialis fulva*), Wandering Tattler (*Tringa incanus*), Bristle-thighed Curlew (*Numenius tahitiensis*), Ruddy Turnstone (*Arenaria interpres*), and Sanderling (*Calidris alba*).

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