



Waterbirds

Koloa maoli or Hawaiian duck

Anas wyvillian

SPECIES STATUS:

Federally Listed as Endangered

State Listed as Endangered

State Recognized as Endemic

NatureServe Heritage Rank G1 -

Critically Imperiled, IUCN Red List Ranking -

Endangered, Recovery Plan for Hawaiian Waterbirds – USFWS 2011

SPECIES INFORMATION: The koloa maoli, or Hawaiian duck, is one of two extant native duck species (Family: Anatidae) found in Hawai‘i and is closely related to the well-known mallard (*A. platyrhynchos*). Adult males and females are mottled brown overall. Males have darker heads and necks, olive bills and bright orange feet. The bills of females are more orange, their feet are dull orange, and they are smaller than males. Koloa maoli forage in a wide variety of freshwater habitats, including artificial wetlands. Movements between feeding and breeding habitats and between Kaua‘i and Ni‘ihau occur. The species typically forages in shallow water (less than 13 centimeters, or 5 inches, deep). Like mallards, koloa maoli are opportunistic and their diet includes snails, dragonfly larvae, earthworms, grass seeds, green algae, and seeds/leaf parts of wetland plants. They are usually found alone or in pairs and are wary, especially when nesting or molting, although during the winter they may gather in larger numbers to exploit abundant food resources. Nesting biology is poorly known. On Kauai, pairs nest in lowland habitats and upper elevation montane habitats. Nesting occurs year-round, but most activity occurs between January and May. Nests are usually on the ground near water, but few nests are found in areas frequented by humans or areas supporting populations of mammalian predators. Generally, eight to ten eggs are laid, and the precocial chicks hatch after an unknown incubation period, but likely less than 30 days. Hawaiian Ducks readily hybridize with Mallard ducks, with only the Kaua‘i Island population considered genetically pure (Fowler et al. 2008; Wells et al. 2019), and hybridization is considered the largest threat to the species (USFWS 2011).

DISTRIBUTION: Currently, pure Koloa populations are found only on the island of Kauai where hybridization with feral mallard is not a significant threat. The remaining island populations are considered hybrids with varied levels of hybridization. Wetland habitats from sea level to 3,000 meters (9,900 feet) elevation are preferred by the species. On Kaua‘i, the majority of the koloa maoli population is found in Hanalei National Wildlife Refuge but they are also distributed in other wetlands and montane streams. On O‘ahu, hybrid populations occur at Kawainui, Hāmākua, Kaneohe Marine Corp Base and James Campbell National Wildlife Refuge. On the island of Hawai‘i, hybrid populations occur in Waimea. Other island populations are a mix of hybrids or predominantly mallard populations. Historically, koloa maoli occurred on all the Main Hawaiian Islands except for Lāna‘i and Kaho‘olawe.

ABUNDANCE: Based on state-wide biannual (summer and winter) waterbird counts conducted by the Division of Forestry and Wildlife and partners between 2019-2023, the population is estimated at 673 (CI 516-854) birds where the only populations of pure Koloa are thought to exist (Gorresen, et al., 2024). The long-term population appears to be increasing, but short-term population trends on Kauai over the last 5 years appear to be declining. Historically, koloa maoli were fairly common in natural and agricultural wetland habitats. By 1949, only about 530 individuals remained, with 30 on O‘ahu and the remainder on Kaua‘i.

LOCATION AND CONDITION OF KEY HABITAT: Koloa maoli occurs in a wide variety of natural and artificial wetland habitats, including freshwater marshes, flooded grasslands, coastal ponds, streams, montane pools, forest swamplands, taro, lotus, shrimp, and fish ponds, irrigation ditches, reservoirs, and mouths of larger streams. Some important habitats are located in National Wildlife Refuges or on State lands that receive management attention, but others remain unprotected, such as wetlands facing development or those used for agriculture or aquaculture. Examples include playa lakes on Ni‘ihau; Opaeka‘a marsh; Lumaha‘i wetlands on Kaua‘i; Amorient prawn farms; Lā‘ie wetlands; Uko, Punaho‘olapa, and Waihe‘e marshes; Waiialua lotus fields; Waipi‘o Peninsula ponds on O‘ahu; Paialoa and ‘Ō‘ō‘ia playa fishponds on Moloka‘i; and Opaē‘ula and Waiākea-Loko Waka ponds on the island of Hawai‘i.

THREATS: Historically, hunting pressure likely reduced populations. Like the rest of Hawaiian native waterbirds, koloa maoli are threatened by:

- Hybridization. Currently, the most important threat to koloa maoli is hybridization with nonnative mallards, especially on islands outside of Kauai, where most individuals are hybrids.
- Habitat loss and degradation. In the last 110 years, around 44% of coastal wetlands have been lost in Hawai‘i (Burney et al., 2001; van Rees and Reed, 2014). The remainder are seriously affected by non-native species, urban and tourist development, hydrological changes, sedimentation and sea level rise (US Fish and Wildlife Service (USFWS), 2011a; Jacobi and Stock, 2017). Feral pigs and other ungulates are reducing nesting habitat suitability for koloa maoli along montane streams.
- Introduced and native predators. Eggs and ducklings are especially vulnerable to predation by dogs (*Canis familiaris*), rats (*Rattus spp.*), feral cats (*Felis silvestris*), the small Indian mongoose (*Herpestes auropunctatus*), ‘auku‘u or black-crowned night herons (*Nycticorax nycticorax hoactli*), cattle egrets (*Bulbulcus ibis*), barn owls (*Tyto alba*), bull frogs and non- native fish.
- Altered hydrology. Altering wetland habitats for flood control, agriculture or to serve as municipal water sources makes them generally unsuitable for koloa maoli. Climate change impacts are also expected to impact hydrology of wetlands.
- Nonnative invasive plants. Several species of invasive plants, including pickleweed (*Batis maritime*), water hyacinth (*Eichornia crassipes*), and mangrove (*Rhizophora mangle*), reduce open water, mudflats, and shallows.
- Avian diseases. Botulism outbreaks result in mortality. West Nile virus and avian flu may pose a risk to Hawaiian waterbirds if these diseases reach Hawai‘i.
- Environmental contaminants. Fuel and oil spills, dumping and agricultural discharge in wetlands result in toxicity and habitat degradation.
- Anthropogenic impacts: Powerline strikes, vehicle strikes and other man-made

infrastructure can cause mortality.

CONSERVATION ACTIONS: In order to establish new populations, 445 koloa maoli were released on the island of Hawai‘i from 1958 to 1979, 350 birds were released on O‘ahu from 1968 to 1982, and 12 birds were released on Maui in 1989. The State of Hawai‘i, the U.S. Fish and Wildlife Service (USFWS), and private organizations and landowners have protected 82 percent of the core wetlands for Hawaiian waterbirds and 17 percent of their supporting wetlands. Most of the populations outside of Kauai have some level of hybridization from feral ducks. Future reintroduction efforts will require management of mallard populations to protect and ensure pure koloa populations are established.

- Other actions specific to conservation of koloa maoli and other Hawaiian waterbirds should include the following:
- Continue to manage, restore, and protect core and supporting wetland habitats, including montane stream habitat.
- Eliminate or control feral mallards and mallard/koloa maoli hybrids.
- Eliminate or reduce populations of introduced predators.
- Conduct education and awareness programs regarding the mallard/koloa maoli interbreeding problem and the need for a feral and hybrid duck removal program.

MONITORING:

- Continue annual waterbird surveys of populations and habitat monitoring to detect changes in population trends.
- Monitor for the presence of hybrids in populations.
- Survey montane stream habitats to provide more accurate population estimates.

RESEARCH PRIORITIES:

- Determine the best methods to control and eliminate hybridization between mallards and koloa maoli.
- Analyze annual survey data for correlations, including use of specific wetlands, time of year, and state of wetlands, in order to improve management for koloa maoli.
- Conduct a population viability analysis to identify population numbers and time spans that can serve as predictors for the long-term recovery of koloa maoli.

References

- Engilis A Jr., Uyehara KJ, Giffin, JG. 2002. Hawaiian duck (*Anas wyvilliana*). In *The Birds of North America*, No. 694 (Poole A, Gill F, editors). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.
- IUCN Red List of Threatened Species. 2015. Version 2014.3. www.iucnredlist.org. (Accessed May 2015).
- U.S. Fish and Wildlife Service. 2010. Koloa maoli or Hawaiian duck (*Anas wyvilliana*) 5-year review: summary and evaluation. U.S. Fish and Wildlife Service, Honolulu, Hawai‘i.
- U.S. Fish and Wildlife Service. 2011. Recovery plan for Hawaiian waterbirds, Second Revision. U.S. Fish and Wildlife Service, Portland, Oregon.

Photo: NRCS



Waterbirds

'Alae 'ula or Hawaiian common gallinule *Gallinula chloropus sandvicensis*

SPECIES STATUS:

Federally Listed as Endangered

State Listed as Endangered

State Recognized as Indigenous

NatureServe Heritage Rank G5 - Secure

Recovery Plan for Hawaiian Waterbirds – USFWS 2011

SPECIES INFORMATION: The 'alae 'ula or Hawaiian moorhen is a small, striking waterbird (Family: Rallidae) and is one of 12 recognized subspecies. 'Alae 'ula is endemic to Hawai'i and is very similar to its North American relative in appearance; adults are black above and dark slate blue below, with a white stripe on their flanks and a prominent red shield over their red and yellow bill. Feet are lobed rather than webbed, and males are larger than females. In Hawaiian mythology, a moorhen brought fire to humans, which explains the red on its forehead, a symbol of the scorching from the fire. It uses a variety of freshwater and estuarine habitats and can be somewhat secretive, although it is often seen swimming across open water. 'Alae 'ula are opportunistic feeders, and their diet likely varies with habitat, but includes algae, grass seeds, plant material, insects, and snails. Nesting habitat is restricted to areas with standing water less than 61 centimeters (24 inches) deep with dense emergent vegetation. Nesting occurs year-round, but mostly occurs between March and August. Nesting phenology is apparently tied to water levels and the presence of appropriately dense vegetation. Platform nests are constructed in dense vegetation over water. The particular species of emergent plant used for nest construction is not as important as stem density and vegetation height. Five to six eggs are laid and hatch after 22 days. Although chicks are precocial and can swim shortly after hatching, they remain in the nesting area for a few days after hatching and are dependent on their parents for several weeks.

DISTRIBUTION: Historically, 'alae 'ula occurred on all the Main Hawaiian Islands except for Lāna'i and Kaho'olawe. 'Alae 'ula generally occur in wetland habitats below 125 meters (410 feet) elevation on the islands of Kaua'i and O'ahu. Although there have been reports from Ke'anae Peninsula on Maui and from the island of Hawai'i, this species is now restricted to Kauai and Oahu. Reasons for the range restriction of the species is unknown, but are likely due to a combination of hunting, sparse and deteriorating breeding habitat, and predation from non-native mammals. On Kaua'i, the largest populations occur in the Hanalei and Wailua river valleys, but they also occur in irrigation canals on the Mānā Plains of western Kaua'i and in lo'i kalo (taro fields). On O'ahu, the species is widely distributed with most birds found between Hale'iwa and Waimanalo; small numbers occur at Pearl Harbor and the leeward coast at Lualualei Valley.

ABUNDANCE: ‘Alae ‘ula are quite secretive, and current survey methods are inadequate to accurately estimate population size. Based on state-wide biannual (summer and winter) waterbird counts between 2019-2023, the population is estimated at 712 (CI 573-876) birds with Kauai supporting a majority of the species with an estimated 485 (383-611) birds. ‘Alae ‘ula long-term trends over a 38 year period appear to be increasing, but short term trends on Kauai (11-year), appear to be decreasing (Gorresen, et al., 2024). The species was common at the turn of the twentieth century, but by the 1940s, its status was considered precarious.

LOCATION AND CONDITION OF KEY HABITAT: ‘Alae ‘ula are found in freshwater marshes, wetland agricultural areas (e.g., taro patches), reedy margins of water courses (e.g., streams, irrigation ditches), reservoirs, wet pastures, and, infrequently, brackish water habitats. Important breeding areas are found on the Hanalei National Wildlife Refuge on Kaua‘i and the State and Federal managed wetlands on O‘ahu. Key habitat features include dense stands of robust emergent vegetation near open water, floating or barely emergent mats of vegetation, and water depths less than 1 meter (3.3 feet). Some important habitats are located in National Wildlife Refuges or on State lands and receive management attention, but others remain unprotected, such as wetlands facing development or those used for agriculture or aquaculture. Examples include Opaeka‘a marsh; Lumaha‘i wetlands on Kaua‘i; Amorient prawn farms; Lā‘ie wetlands; Uko, Punaho‘olapa, and Waihe‘e marshes; Waialua lotus fields; and Waipi‘o Peninsula ponds on O‘ahu.

THREATS: Like the rest of Hawaiian native waterbirds, ‘alae ‘ula are threatened by:

- Habitat loss: In the last 110 years, around 44% of coastal wetlands have been lost in Hawai‘i (Burney et al., 2001; van Rees and Reed, 2014). The remainder are seriously affected by non-native species, urban and tourist development, hydrological changes, sedimentation and sea level rise (US Fish and Wildlife Service (USFWS), 2011a; Jacobi and Stock, 2017). A shift in wetland agriculture to other agriculture crops also has reduced the amount of wetland habitats.
- Introduced and native predators: Dogs (*Canis familiaris*), rats (*Rattus spp.*), feral cats (*Felis silvestris*), the small Indian mongoose (*Herpestes auropunctatus*), cattle egrets (*Bulbulcus ibis*), ‘Auku‘u (*Black-crowned Night Herons*), barn owls (*Tyto alba*), and bullfrogs (*Rana catesbeiana*) all prey on adult or young ‘alae ‘ula. There have also been reports of predation by Red-eared Sliders and Mud Crabs.
- Altered hydrology: Altering wetland habitats for flood control, agriculture or to serve as municipal water sources makes them generally unsuitable for koloa maoli. Climate change impacts are also expected to impact hydrology of wetlands.
- Avian diseases: Botulism outbreaks result in mortality. West Nile virus and avian flu may pose a risk to Hawaiian waterbirds if these diseases reach Hawai‘i.
- Environmental contaminants. Fuel and oil spills, dumping and agricultural discharge in wetlands result in toxicity and habitat degradation.
- Climate change: Sea level rise due to climate change may result in a loss of coastal wetland habitats used by Hawaiian waterbirds. ‘Alae ‘ula depend on freshwater habitats and sea level rise is likely to make freshwater habitats saltier, reducing the suitable habitat for this species.
- Fuel and oil spills, dumping and agricultural discharge in wetlands result in toxicity and habitat degradation.

CONSERVATION ACTIONS: In order to establish a new population, the U.S. Fish and Wildlife Service (USFWS) translocated six ‘alae ‘ula to Moloka‘i in 1983; however this reintroduction was unsuccessful due to a number of reasons likely due to lack of management and potential poaching. The State of Hawai‘i, USFWS, and private organizations and landowners have protected 82 percent of the core wetlands for Hawaiian waterbirds and 17 percent of their supporting wetlands. Other actions specific to conservation of ‘alae ‘ula and other Hawaiian waterbirds should include the following:

- Continue to manage, restore, and protect core and supporting wetland habitats.
- Eliminate or reduce populations of introduced predators through predator management and predator fences.
- Reintroduce ‘alae ‘ula to at least two additional islands (Maui, Moloka‘i, Lāna‘i, and/or Hawai‘i), and monitor survival, dispersal, and reproduction.

MONITORING: Continue annual statewide surveys of populations and habitat monitoring to detect changes in population trends.

RESEARCH PRIORITIES:

- Refine survey techniques, potentially using playback calls of ‘alae ‘ula to increase detections.
- Better monitoring for nest success and fledgling success. Understand fledgling survivorship and movements.
- Analyze annual survey data for correlations, including use of specific wetlands, time of year, and state of wetlands, in order to improve management for ‘alae ‘ula.
- Use climate change models to predict sea-level rise, and assess key wetlands to protect/create in light of the analysis. Monitor current salinity levels and anticipate changes.
- Understand salinity thresholds and impacts to the ‘alae ‘ula.
- Develop removal methods for invasive amphibians, reptiles, and invertebrates that prey on chicks.

References

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- U.S. Fish and Wildlife Service. 2010. Hawaiian moorhen or ‘alae ‘ula (*Gallinula chloropus sandvicensis*) 5- year review: summary and evaluation. U.S. Fish and Wildlife Service, Honolulu, Hawai‘i.
- U.S. Fish and Wildlife Service. 2011. Recovery plan for Hawaiian waterbirds, Second Revision. U.S. Fish and Wildlife Service, Portland, Oregon.

Photo: DOFAW



Waterbirds

‘Alae ke‘oke‘o or Hawaiian coot

Fulica alai

SPECIES STATUS:

Federally Listed as Endangered

State Listed as Endangered

State Recognized as Endemic

NatureServe Heritage Rank G2 - Imperiled

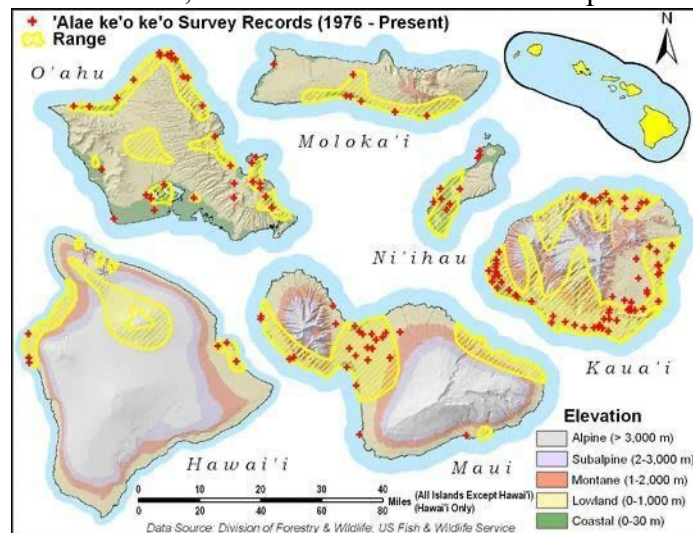
IUCN Red List Ranking - Vulnerable

Recovery Plan for Hawaiian Waterbirds - USFWS 2011

SPECIES INFORMATION: The ‘alae ke‘oke‘o or Hawaiian coot is a small waterbird (Family: Rallidae) endemic to Hawai‘i. Adult males and females have a black head, a slate gray body with white undertail feathers, and a prominent white frontal shield and bill; feet are lobed rather than webbed and are greenish gray. The Native Hawaiian considered ‘alae ke‘oke‘o to be a deity but also considered it good to eat. Life history and breeding biology are poorly known. The species is somewhat gregarious and uses freshwater and brackish wetlands, including agricultural (e.g., loi kalo or taro fields) wetlands and aquaculture ponds. ‘Alae ke‘oke‘o are generalists and feed on land, from the surface of the water, and underwater; also, they will graze on grass adjacent to wetlands. Food items include seeds and leaves, snails, crustaceans, insects, tadpoles, and small fish. The species will travel long distances, including between islands, when local food sources are depleted. Nesting habitat includes freshwater and brackish ponds, irrigation ditches, and taro fields. Floating nests are constructed of aquatic vegetation and found in open water or anchored to emergent vegetation. Open water nests are usually composed of mats of water hyssop (*Bacopa monniera*) and Hilo grass (*Paspalum conjugatum*). Nests in emergent vegetation are typically platforms constructed from buoyant stems of species such as bulrush. Nesting occurs year-round, but mostly between March and September. Nest initiation is tied to appropriate water levels from rainfall or water control systems as water levels are critical to nest success. Clutch size range from three to ten eggs, and precocial young hatch after a 25-day incubation period.

DISTRIBUTION: The ‘alaie ke‘oke‘o occurs in coastal plain wetlands usually below 400 meters (1,320 feet) elevation on all the Main Hawaiian Islands except for Kaho‘olawe; however, breeding is restricted to relatively few sites. About 80 percent of the population occurs on Kaua‘i O‘ahu and Maui. The remaining 20 percent of the population occurs in coastal ponds and playa wetlands, such as Paialoa Pond on Moloka‘i, the Lāna‘i City wastewater treatment ponds, ‘Aimakapā and ‘Ōpae‘ula ponds on the Kona Coast, and Waiākea and Loko Waka ponds on the island of Hawai‘i.

ABUNDANCE: Based on state-wide biannual (summer and winter) waterbird counts conducted by the Division of Forestry and Wildlife and partners between 2019-2023, the population is estimated at 1,564 (1,306-1,858) birds with Kauai and Oahu supporting a majority of the species with an estimated 73% of birds. Population trends of the ‘Aalae ‘keokeo over the long-term(38 year period) appear to be stable or increasing except for Hawaii Island, but short term trends (11-year), appear to be decreasing (Gorresen, et al., 2024).



LOCATION AND CONDITION OF KEY HABITAT: The ‘alaie ke‘oke‘o uses lowland wetland habitats with suitable emergent plant growth interspersed with open water, especially freshwater wetlands and loi kalo (taro fields), but also freshwater reservoirs, sewage treatment ponds, brackish wetlands, and, rarely, saltwater habitats. On Kaua‘i, some birds are reported as having occurred in plunge pools above 1,495 meters (4,900 feet) elevation, and on the island of Hawai‘i, stock ponds up to 2,000 meters (6,600 feet) elevation. They typically forage in water less than 30 centimeters (12 inches) deep but will dive in water up to 120 centimeters (48 inches) deep. Compared to ‘alaie ‘ula (Hawaiian common gallinule), ‘alaie ke‘oke‘o forages in more open water. Logs, rafts of vegetation, narrow dikes, mud bars, and artificial islands are important for resting.

Ephemeral wetlands support large numbers during nonbreeding season and may provide a key habitat. Some important habitats are located in National Wildlife Refuges and State sanctuaries and receive management attention, but others remain unprotected, such as wetlands facing development or those used for agriculture or aquaculture. Examples include playa lakes on Ni‘ihau; Opaeka‘a marsh; Lumaha‘i wetlands on Kaua‘i; Amorient prawn farms; Lā‘ie wetlands; Uko, Punaho‘olapa, and Waihe‘e marshes; Waialua lotus fields; Waipi‘o Peninsula ponds on O‘ahu; Paialoa and ‘Ō‘ō‘ia playa fishponds on Moloka‘i; and Opaie‘ula and Waiākea- Loko Waka ponds on the island of Hawai‘i.

THREATS: Similar to the rest of Hawaiian native waterbirds, ‘alaie ke‘oke‘o are threatened by:

- Habitat loss: In the last 110 years, around 44% of coastal wetlands have been lost in Hawai‘i (Burney et al., 2001; van Rees and Reed, 2014). The remainder are seriously

affected by non-native species, urban and tourist development, hydrological changes, sedimentation and sea level rise (US Fish and Wildlife Service (USFWS), 2011a; Jacobi and Stock, 2017). A shift from wetland agriculture to other types of crops has also reduced the amount of wetland habitats.

- Introduced and native predators: Dogs (*Canis familiaris*), rats (*Rattus spp.*), feral cats (*Felis silvestris*), the small Indian mongoose (*Herpestes auropunctatus*), cattle egrets (*Bulbulcus ibis*), barn owls (*Tyto alba*), and bullfrogs (*Rana catesbeiana*) all potentially prey on adults or young.
- Altered hydrology: Altering wetland habitats for flood control, agriculture or to serve as municipal water sources makes them generally unsuitable for koloa maoli. Climate change impacts are also expected to impact hydrology of wetlands.
- Nonnative invasive plants: Several species of invasive plants, including pickleweed (*Batis maritima*), water hyacinth (*Eichornia crassipes*), and mangrove (*Rhizophora mangle*) reduce open water, mudflats, or shallows.
- Avian diseases: Botulism outbreaks result in mortality. West Nile virus and avian flu may pose a risk to Hawaiian waterbirds if these diseases reach Hawai‘i.
- Environmental contaminants: Fuel and oil spills, dumping and agricultural discharge in wetlands result in toxicity and habitat degradation.
- Climate change: Sea level rise due to climate change may result in a loss of coastal wetland habitats used by Hawaiian waterbirds.
- Anthropogenic impacts: Powerline strikes, vehicle strikes and other man-made infrastructure can cause mortality.

CONSERVATION ACTIONS: The State of Hawai‘i, the U.S. Fish and Wildlife Service (USFWS), and private organizations and landowners have protected 82 percent of the core wetlands for Hawaiian waterbirds and 17 percent of their supporting wetlands. Actions specific to conservation of ‘alae ke‘oke‘o and other Hawaiian waterbirds should include the following:

- Continue to manage, restore, and protect core and supporting wetland habitats.
- Eliminate or reduce populations of introduced predators.

MONITORING: Continue annual waterbird surveys and habitat monitoring on all islands to detect changes in population trends. Improve reporting of botulism outbreaks.

RESEARCH PRIORITIES:

- Analyze annual survey data for correlations, including use of specific wetlands, time of year, and state of wetlands, in order to improve management for ‘alae ke‘oke‘o.
- Conduct a population viability analysis to identify population numbers and time spans that can serve as predictors for the long-term recovery of the ‘alae ke‘oke‘o.
- Use climate change models to predict sea-level rise, and assess key wetlands to protect/create in light of the analysis. Develop removal methods for invasive amphibians, reptiles, and invertebrates that prey on chicks.
- Better monitoring for nest success and fledgling success. Understand fledgling survivorship and movements.

References

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Hawai‘i’s State Wildlife Action Plan
October 1, 2025

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- U.S. Fish and Wildlife Service. 2011. Recovery plan for Hawaiian waterbirds, Second Revision. U.S. Fish and Wildlife Service, Portland, Oregon.

Photo: Jack Jeffery



Waterbirds

Nēnē or Hawaiian goose

Branta sandvicensis

SPECIES STATUS:

Federally Listed as Threatened

State Listed as Endangered

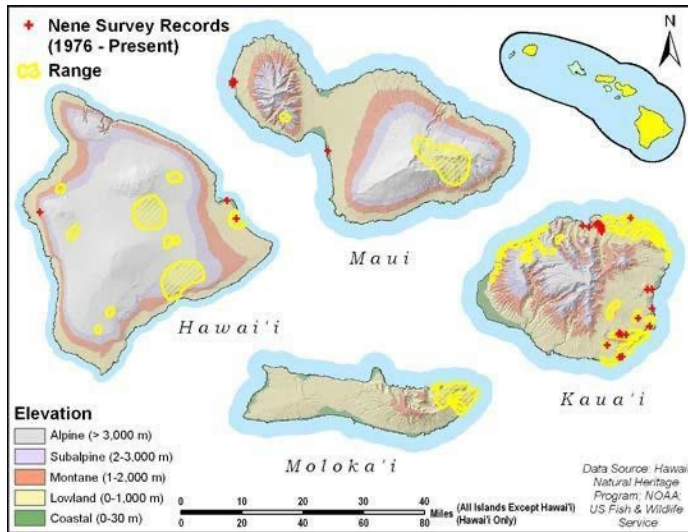
State Recognized as Endemic

NatureServe Heritage Rank G1 - Critically Imperiled

IUCN Red List Ranking - Vulnerable

Revised Recovery Plan for the Nēnē or Hawaiian Goose (*Branta sandvicensis*) – USFWS 2004

SPECIES INFORMATION: Historically, at least five species of geese (family: Anatidae) occurred in Hawai‘i; today, only the nēnē, or Hawaiian goose, survives. Adults are mostly dark brown or sepia with a black face and crown, cream-colored cheeks, and a buff neck with black streaks. Females are smaller than males. Compared to other geese, nēnē are more terrestrial and have longer legs and less webbing between their toes, which likely facilitates walking on lava flows. Nēnē graze and browse on the leaves, seeds, flowers, and fruits of at least 50 native and nonnative grasses, sedges, composites, and shrubs. Diet varies by location and habitat, and they may require a diverse suite of food plants. Currently, several species of nonnative grass are important in mid- and high-elevation habitats. Nēnē facilitate seed dispersal and play an important role in influencing the species composition of early successional plant communities. Historically, flocks moved between high-elevation feeding habitats and lowland nesting areas. Pairs mate for life and engage in relatively simple courtship displays in which the male attacks or threatens potential competitors, runs back to his mate, and calls loudly. Nēnē have an extended breeding season, and nesting may occur in all months except May, June, and July, although the majority of birds nest between October and March, and most clutches are laid between October and December. Nests consist of a shallow scrape lined with plant material and down. Breeding pairs usually return to the previous year’s nest site, typically in dense vegetation; when available, kīpuka may be preferred. Females lay two to five eggs, which hatch after 30 days. Young are precocial and not fed by their parents; however, they remain with their parents for up to a year.



DISTRIBUTION: Between sea level and 2,400 meters (7,800 feet) elevation on the island of Hawai'i, Maui, Kaua'i, and Moloka'i, and a Kaua'i translocated pair was reported and nested on O'ahu in 2014. The only remaining member of the Oahu pair was a fledgling that was translocated to Hawai'i Island therefore O'ahu no longer has any nene on the island. Historically, the species was found on all Main Hawaiian Islands and was likely widespread.

ABUNDANCE: In 1951, the wild nēnē population was estimated at 30 individuals and information on historical

abundance is limited. The 2023 population is estimated at about 3,797 birds, with 1,048 on the island of Hawai'i, 429 on Maui, 2,314 on Kaua'i and 6 on Moloka'i. During 2005-2010, about 224 nēnē were removed from near the Kaua'i Airport and released at remote relocation sites on that island to reduce the risk of bird-aircraft strikes. Between 2011 and 2016, the continued growth of the Kaua'i nēnē population prompted the removal of an additional 655 nēnē from the vicinity of the Kaua'i Airport and which were released into the wild on Hawai'i and Maui.

LOCATION AND CONDITION OF KEY HABITAT: Nēnē historically occurred in lowland dry forest, shrubland, grassland, and montane dry forest, and shrubland. Current habitat preferences are likely biased by the location of release sites of captive-bred birds. They currently use a wide variety of habitats including coastal dune vegetation and nonnative grasslands (e.g., golf courses, pastures, rural areas), sparsely vegetated low- and high-elevation lava flows, mid-elevation native and nonnative shrubland, early successional cinderfall, cinder deserts, native alpine grasslands and shrublands, and open native and nonnative alpine shrubland-woodland community interfaces. Nesting occurs in a variety of habitats, including beach strand, shrubland, grassland, and lava rock, and at a range of elevations. On the islands of Hawai'i and Maui, most nests are built under native vegetation, such as pūkiawe (*Styphelia tameiameia*), 'a'ali'i (*Dodonaea viscosa*), and 'ōhi'a (*Metrosideros polymorpha*). On Kaua'i, however, most nesting areas are dominated by nonnative species, and nēnē often nest under Christmas berry (*Schinus terebinthifolius*), shrub verbena (*Lantana camara*), and ironwood (*Casuarina* spp.). The condition of habitats occupied by nēnē varies considerably. Many of the areas managed for conservation by the State of Hawai'i and the U.S. Fish and Wildlife Service (USFWS) are also used extensively by the species.

THREATS: Historical threats included habitat loss and degradation, hunting, and predation by rats (*Rattus* spp.), cats (*Felis silvestris*), dogs (*Canis familiaris*), and the small Indian mongoose (*Herpestes auropunctatus*). Current threats include predation by nonnative mammals; exposure to diseases that can be transmitted by introduced nonnative animals such as feral and domestic cats (e.g. toxoplasmosis); nutritional deficiencies due to paucity of quality habitat, exposure stress at high-elevation habitats; a lack of contiguous lowland habitat; human-caused disturbance and mortality (e.g., road mortality, disturbance by hikers, aircraft strikes, collisions with wind

turbines and powerlines); behavioral problems related to captive propagation; and inbreeding depression.

CONSERVATION ACTIONS: Past and current actions include captive propagation and release of captive-bred individuals into the wild, predator control, habitat enhancement, research and monitoring, private conservation efforts, formation of the Nēnē Recovery Action Group, and public education. Other actions specific to conservation of nēnē should include the following:

- Enhance and protect habitats used by nēnē, including foraging habitat, breeding grounds, and summer flocking areas.
- Increase predator control effort and effectiveness, including use of predator-proof fences. Increase efforts to detect and remove mongooses from Kaua‘i.
- Significantly increase efforts to minimize negative human-nēnē interactions through public education and outreach focused on communities or areas where the number of nēnē are known to be increasing; continue to promote avoidance and minimization measures that will reduce the risk of collisions with vehicles, aircraft, powerlines and wind turbines. Identification of key areas which could host nene and attract them away from hazards, followed by restoration, fencing etc of those sites could greatly reduce these impacts.
- Develop a statewide long-range management plan for nēnē that includes all of the distinct populations and anticipates changes resulting from climate change, management actions and human interaction.
- Continue the nēnē population reintroduction efforts and establish additional populations only where risks can be minimized and habitat quality can support recovery.
- Increase outreach about the negative impacts to feeding nene and any wildlife including cats.

MONITORING: Continue surveys to monitor abundance and distribution and annual productivity.

RESEARCH PRIORITIES:

- Standardize survey and monitoring protocols and develop a platform for data sharing.
- Conduct studies on diet and nutrition, particularly as it relates to forage quality of nonnative versus native vegetation, focusing on the needs of goslings and breeding females.
- Refine predator control and exclusion methods.
- Evaluate movement patterns and habitat use by nēnē.
- Evaluate and refine translocation and release methods that incorporates monitoring subsequent dispersal and movement patterns, survival, and reproduction.
- Investigate population genetics as a management tool to monitor the potential for inbreeding.
- Understand and evaluate mortality hotspots for vehicle strike mortality areas and powerline strike areas.

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Photo: Brett Mossman



Waterbirds

Ae'o or Hawaiian stilt *Himantopus mexicanus knudseni*

SPECIES STATUS:

Federally Listed as Endangered

State Listed as Endangered State

Recognized as Indigenous

NatureServe Heritage Rank G5 – Secure

Recovery Plan for Hawaiian Waterbirds - USFWS 201

SPECIES INFORMATION: The ae'o or Hawaiian stilt is a slender, graceful waterbird (Family: Recurvirostridae) that is considered distinct from the North American subspecies, *H. m. mexicanus*. Adults are mostly black above and white below with a long, thin black bill and long, delicate pink legs. Foraging habitat consists of ephemeral freshwater, agriculture, brackish water, or saltwater habitats. They are opportunistic and prey on a variety of animals that inhabit shallow water or mudflats, including polychaete worms, small crabs, insects, and small fish. Ae'o frequently move among wetland habitats in search of food. Breeding and foraging habitats differ, and individuals move between the two daily. Nesting occurs on freshly exposed mudflats with some low-growing vegetation; individuals also will nest on islands in freshwater and brackish water ponds or artificial floating nest structures. They aggressively defend their nests, calling and diving at intruders and performing broken-wing displays to attract potential predators away from their nests. Nesting occurs between March and August and peaks in May and June. Generally, three to four eggs are laid, and the precocial chicks hatch approximately 24 days later, leaving the nest once the last egg hatches. More eggs are laid and hatched when predator pressures decline. Both parents incubate eggs and brood young, and fledglings remain with their parents for several months. Some cooperative breeding activities may occur, including “helper-at-the-nest”, extra-pair egg laying, and multi-parental care of multi-familial groups of chicks.

DISTRIBUTION: The ae'o generally is found in wetland habitats below 200 meters (660 feet) elevation on all the Main Hawaiian Islands except for Kaho'olawe.

On O'ahu, most of the population can be found on the north and windward coast at Kahuku Point on the James Campbell National Wildlife Refuge, in Kahuku Point oyster ponds, in Amorient aquaculture ponds, and in Roland and Nu'upia ponds in Kāne'ohe and Kailua wetlands.

Smaller numbers use wetland habitats associated with Pearl Harbor and the leeward coast. On Kaua'i, the ae'o is found in large river valleys, including Hanalei, Wailua, and Lumaha'i valleys; on the Mānā Plains; and at reservoirs and effluent ponds in Līhue and Waimea. Populations move annually between Kaua'i and Ni'ihau in response to water level changes in Ni'ihau's ephemeral lakes. On Maui, most ae'o use the coastal wetlands of Kanahā and Keālia; smaller numbers use reservoirs and aquaculture habitats. On Moloka'i, the southern coastal wetlands and playa lakes are important habitats. On Lāna'i, a few ae'o are permanent residents at the Lāna'i City wastewater treatment ponds. On the island of Hawai'i, the largest number of ae'o are found on the Kona coast, especially in anchialine ponds, from Kawaihae Harbor south to

Kailua. Other habitats include Makalawena and Aimakapā ponds; Cyanotech Ponds; the Kona wastewater treatment ponds; wetlands along the Hāmākua Coast; and the Kohala River valleys of Waipi‘o, Waimanu, and Pololū. Historically, ae‘o occurred on Ni‘ihau, Kaua‘i, O‘ahu, Maui, and Moloka‘i; there are no documented records of the species on the island of Hawai‘i prior to 1961. Interisland movements by ae‘o are suspected.

ABUNDANCE: Based on state-wide biannual (summer and winter) waterbird counts conducted by the Division of Forestry and Wildlife and partners between 2019-2023, the population is estimated at 1,511 (1,317-1,718) birds with Maui, Kauai and Oahu supporting a majority of the species with over 80% of the birds. Population trends of the ‘Ae ‘o over the long-term (38-year period) appear to be increasing, but short-term trends (11-year), appear to be decreasing except for the island of Maui (Gorresen, et al., 2024).

LOCATION AND CONDITION OF KEY HABITAT: Ae‘o use a variety of wetland habitats but have specific habitat requirements. Water depth and vegetation density are important determinants of foraging habitat suitability, and the species prefers sites with a water depth of less than 24 centimeters (9 inches). Preferred foraging habitats are early successional marshlands with shallow water and perennial low-growing vegetation or exposed tidal flats; other wetland habitats with similar characteristics also are used. Examples include freshwater habitats (ephemeral lakes, reservoirs, settling basins, natural or manmade ponds, brackish water habitats (coastal ponds, fish ponds, loi kalo [taro fields] and estuaries), and saltwater habitats (inshore reefs, silted beach areas, and tidal flats). Ephemeral lakes on Moloka‘i, Maui, and Ni‘ihau provide important habitats for ae‘o as do prawn farms and anchialine pools. Preferred nesting habitats are low-relief islands in bodies of fresh, brackish, or salt water and sites adjacent to these areas. Examples include reservoirs, settling basins, natural or manmade ponds, marshes, taro patches, silted fish ponds, salt evaporation pans, and other wetlands. Loafing areas are usually open mudflats or open flooded pasturelands where visibility is good and predator populations are low. Some important habitats are located in National Wildlife Refuges or on State lands and receive management attention while others lack intensive invasive predator removal. These mostly include wetlands facing development or those used for agriculture or aquaculture, such as playa lakes on Ni‘ihau; Opaeka‘a marsh; Lumaha‘i wetlands on Kaua‘i; Amorient prawn farms; Lā‘ie wetlands; Uko, Punaho‘olapa, and Waihe‘e marshes; Waialua lotus fields; Waipi‘o Peninsula ponds on O‘ahu; Paialoa and ‘Ō‘ō‘ia playa fish ponds on Moloka‘i; and Opaē‘ula and Waiākea-Loko Waka ponds on the island of Hawai‘i. Newly restored lo‘i attract Ae‘o and successful nesting has been documented in these expanding populations, particularly when predator control is implemented.

THREATS: Historically, the species was a popular game bird, and hunting contributed to population declines until its prohibition in 1939. Similar to the rest of the Hawaiian native waterbirds, ae‘o are threatened by:

- Habitat loss. In the last 110 years, approximately 31 percent of coastal plain wetlands have been lost. A shift in wetland agriculture to other agriculture crops also has reduced the amount of wetland habitats.
- Introduced and native predators. Adults and young are vulnerable to predation by dogs (*Canis familiaris*), rats (*Rattus spp.*), feral cats (*Felis silvestris*), the small Indian mongoose (*Herpestes auropunctatus*), cattle egrets (*Bulbulcus ibis*), barn owls (*Tyto*

alba), and bullfrogs (*Rana catesbeiana*). They also are vulnerable to predation by pueo or Hawaiian short-eared owl (*Asio flammeus sandwichensis*) and ‘auku‘u or black-crowned night herons (*Nycticorax nycticorax hoactli*).

- Altered hydrology. Altering wetland habitats for flood control, agriculture or to serve as municipal water sources could make them unsuitable for ae‘o. Climate change impacts are also expected to impact hydrology of wetlands.
- Nonnative invasive plants. Several species of invasive plants, including pickleweed (*Batis maritima*), water hyacinth (*Eichornia crassipes*), and mangrove (*Rhizophora mangle*) reduce open water, mudflats, or shallows.
- Avian diseases. Botulism outbreaks result in mortality. West Nile virus and avian flu may pose a risk to Hawaiian waterbirds if these diseases reach Hawai‘i.
- Environmental contaminants. Fuel and oil spills, dumping and agricultural discharge in wetlands result in toxicity and habitat degradation.
- Climate change. Sea level rise due to climate change may result in a loss of coastal wetland habitats used by Hawaiian waterbirds.
- Anthropogenic impacts: Powerline strikes, vehicle strikes and other man-made infrastructure can cause mortality.

CONSERVATION ACTIONS: The State of Hawai‘i, the U.S. Fish and Wildlife Service (USFWS), and private organizations and landowners have protected 82 percent of the core wetlands for Hawaiian waterbirds and 17 percent of their supporting wetlands. Other actions specific to conservation of ae‘o and other Hawaiian waterbirds should include the following:

- Continue to manage, restore, and protect core and supporting wetland habitats.
- Eliminate or reduce populations of introduced predators including predator proof fencing.

MONITORING: Continue annual statewide surveys of populations and habitat monitoring to detect changes in population trends.

RESEARCH PRIORITIES:

- Analyze annual survey data for correlations, including use of specific wetlands, time of year, and state of wetlands, in order to improve management for ae‘o.
- Conduct a population viability analysis to identify population numbers and time spans that can serve as predictors for the long-term recovery of the ae‘o.
- Use climate change models that predict sea-level rise, and assess key wetlands to protect/create in light of the analysis.
- Develop removal methods for invasive amphibians, reptiles, and invertebrates that prey on chicks.
- Better monitoring for nest success and fledgling success. Understand fledgling survivorship and movements.

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Photo: Richard Palmer



Waterbirds 'Auku'u or Black-crowned Night Heron

Nycticorax nycticorax hoactli

SPECIES STATUS:
State recognized as Indigenous

SPECIES INFORMATION: The 'auku'u or black-crowned night heron (Family: Ardeidae) is a stocky cosmopolitan species that breeds on every continent except for Australia and Antarctica. Four subspecies are recognized and *N. n. hoactli* occurs in Hawai'i, as well as across North America and most of South America. Adult males and females have a black crown and upper back, with a white throat, cheeks, and a narrow band above the bill that extends over the eyes, gray wings, and whitish underparts; males are larger than females. Juveniles are overall brown with light spots. The species' stout bill is black; legs and feet are yellow, and the eyes are red. 'Auku'u (black-crowned night heron) are gregarious and unlike continental birds, those in Hawai'i can be diurnal. The species uses a variety of shallow wetlands for foraging and employs various techniques to capture a diversity of prey including insects, fish, frogs, mice, and the young of other native waterbirds. Information on breeding in Hawai'i is limited, but the species is a colonial nester, and in North America breeding occurs from December to August. Eggs are laid in a bulky stick nest usually placed low in vegetation or in trees.

DISTRIBUTION: 'Auku'u (black-crowned night heron) is widely distributed throughout the main Hawaiian Islands.

ABUNDANCE: Island-wide population numbers, based on semi-annual waterbird counts conducted by DOFAW and partners, indicate that the population is variable, but appears stable. Between 2013 and 2023 the average number of 'auku'u (black-crowned night heron) counted has been just over 550 individuals. This number is certainly an under-estimate as all stream habitats are not surveyed.

LOCATION AND CONDITION OF KEY HABITAT: 'Auku'u (black-crowned night heron) occur in a wide-range of aquatic habitats including mountain streams, lowland ponds, agriculture and estuaries (wetlands and open water), aquaculture farms, and suburban/urban waterways (e.g., golf course ponds, concrete channels).

THREATS: Similar to the rest of Hawaiian native waterbirds, 'auku'u (black-crowned night heron) are threatened by:

- Habitat loss: In the last 110 years, approximately 31 percent of coastal plain wetlands have been lost. A shift in wetland agriculture to other agriculture crops also has reduced

the amount of wetland habitats.

- Introduced predators: Dogs (*Canis domesticus*), rats (*Rattus* spp.), feral cats (*Felis silvestris*), the small Indian mongoose (*Herpestes auropunctatus*), cattle egrets (*Bulbulcus ibis*), and barn owls (*Tyto alba*) all potentially prey on adult or young ‘auku‘u (black crowned night heron).
- Non-native invasive plants: Several species of invasive plants reduce open water, mudflats, or shallows.
- Avian diseases: The most important disease affecting Hawaiian waterbirds is botulism (*Clostridium botulinum*).
- Environmental contaminants: Fuel and oil spills, dumping and agricultural discharge in wetlands result in toxicity and habitat degradation. Anthropogenic impacts: Powerline strikes and other man-made infrastructure can cause mortality.

CONSERVATION ACTIONS: The goals of conservation actions are not only to protect current populations and key breeding habitats, but also to establish additional populations, thereby reducing the risk of extinction. The State of Hawai‘i and the USFWS have protected 23 percent of the State’s remaining coastal plain wetlands. Currently there are no conservation actions specifically directed at ‘auku‘u (black-crowned night heron); however, the species certainly benefits from actions taken for the protection of Hawaii’s endangered waterbirds including wetland protection and predator control efforts. In addition to common statewide and island conservation actions, specific actions directed at ‘auku‘u (black-crowned night heron) should include:

- Continue protection and management of wildlife sanctuaries and refuges. Better monitoring for abundance and distribution estimates.

MONITORING: Continue waterbird surveys and habitat monitoring on all islands. This information is needed to identify significant population declines.

RESEARCH PRIORITIES:

- Conduct studies to determine the effects on endangered waterbird populations by ‘auku‘u (black-crowned night heron) predation on the young of these species.
- Conduct life history studies to quantify the population structure, dispersal patterns, survivorship, nesting phenology and success of this poorly known species.

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Waterbirds

Koloa Pohaka Laysan duck *Anas laysanensis*

SPECIES STATUS:

Federally Listed as Endangered State Listed as
Endangered State Recognized as Endemic
NatureServe Heritage Rank G1 - Critically Imperiled IUCN Red List
Ranking - Critically Endangered

Revised Recovery Plan for the Laysan Duck (*Anas laysanensis*) - USFWS 2009

SPECIES INFORMATION: The Koloa Pohaka (Laysan duck) is a small dabbling duck (Family: Anatidae) endemic to Hawai‘i, and until recently was restricted to Kamole (Laysan Island) (370 hectares, or 911 acres) in the Northwestern Hawaiian Islands (NWHI). Even after recent successful translocation efforts to establish new populations on Kuaihelani (Midway) and Holaniku (Kure Atolls), the species still has one of the smallest geographic ranges of any duck. Adults are dark brown overall with a prominent white eye-ring and varying amounts of white feathers on the head and neck; the sexes are similar.

Unlike many other duck species, Laysan ducks have low fecundity and are nocturnal, very terrestrial, and highly secretive; the species also is relatively long-lived (about 12 years). During the day, ducks take cover under vegetation such as bunchgrass or shrub. On Kamole individuals forage mainly at night around and in a large hypersaline lake, feeding primarily on the larvae and pupae of Dipteran brine flies and adult Dipteran brine flies, the larvae and pupae of a noctuid moth, and brine shrimp. Seeds, leaves, algae, and other invertebrates also are eaten. In the most common method of foraging, the Laysan duck runs through swarms of adult brine flies while moving its head back and forth, snapping up flies. Moth larvae and pupae are taken by “filter feeding” in sand under low vegetation. The species also dabbles along the lake shore. Long-term pair bonds are not formed, and males do not participate in brood-rearing. Nesting occurs between February and November, although most eggs are laid between April and August. Nests are well concealed and typically are placed at the base of dense vegetation, especially bunch grass. Nests are shallow scrapes lined with dead grass and some down. Typically three to five eggs are laid, and they hatch after 28 days. Ducklings are precocial and are not fed by the female. Because the species evolved with avian predators, when surprised, individuals tend to walk away rather than fly and freeze rather than flush.

DISTRIBUTION: The Laysan duck currently occurs only on Laysan Island, Midway Atoll, and Kure Atoll in the NWHI; the population on Midway Atoll was a result of a successful translocation effort that occurred in 2004–2005. This success enabled 28 young adult birds to be relocated from Midway to Kure Atoll in 2014 which has greatly reduced the possibility of extinction. A second introduction of 24 individuals occurred in Feb 2023. Fossil and subfossil evidence indicates that Laysan ducks were widespread in the NWHI and Main Hawaiian Islands (MHI) prior to the arrival of Polynesians and occurred on the islands of Hawai‘i,

Moloka‘i, O‘ahu, Maui, and Kaua‘i. Laysan ducks were extant on Lisianski as late as 1844. **ABUNDANCE:** On Laysan island, the Laysan duck population is somewhat variable, but generally does not exceed 500 individuals; surveys in 2012 estimated the population at 339 individuals. On Midway Atoll, the population was estimated at 231–330 individuals in 2012 and the population at Kure Atoll in 2024 was 90 and is generally estimated to be between 70–80 birds.

LOCATION AND CONDITION OF KEY HABITAT: Two habitats are critical to the survival of Laysan duck: vegetated uplands and wetlands. Uplands supporting vegetation such as beach naupaka and bunch grass provide ducks with shelter and nesting habitat, and hypersaline lakes provide important foraging habitat. The importance of upland vegetation was demonstrated by the severe decline of ducks at the turn of the last century, when rabbits denuded Laysan, and by the species’ subsequent recovery after the rabbit population was eradicated in the 1920s and the vegetation recovered. Similarly, the number of ducks varies considerably depending on lake water levels; in 1987, there was a total breeding failure due to a drought and a lack of brine flies.

THREATS: Historical threats included the introduction of rabbits, which subsequently denuded the island’s vegetation (see above), sport hunting, and guano mining. The species’ limited population size and geographic range exacerbates the risk of extinction from demographic and environmental stochasticity and catastrophes. These threats include:

- **Nonnative species:** Introduced plants have displaced native vegetation and degraded nesting habitat, and nonnative invertebrates may be altering habitat and affecting native species. The control of big-headed ants at Hoalaniku beginning in 2014, significantly increased invertebrate and native plant populations. Potential future reintroductions of the Laysan duck to the MHI are complicated by the presence of nonnative predators, such as cats, dogs, pigs, mongooses, ants and rats.
- **Habitat degradation:** Devegetation caused by introduced rabbits has resulted in filling of Laysan’s interior lake and freshwater seeps, which are an important habitat and food source for the duck.
- **Disease:** Avian botulism has occurred annually on Midway Atoll since 2008, resulting in high mortality and population declines. The bacterium *Erysipelothrix rhusiopathiae* poses a threat to species as two deadly outbreaks occurred at Holaniku in 2023 and 2024. Other diseases such as avian flu could also pose a threat to the species.
- **Contaminants:** Oil spills, pesticides, and other types of contaminants washing ashore are potentially a serious risk to the species. Migration of PCBs reburied at Holaniku could enter fresh water seeps.
- **Climate change:** Sea level rise due to climate change may result in loss or degradation of nesting habitat, food availability and increased frequency and severity of storms could reduce survival and nesting success.
- **Catastrophes:** The Laysan duck is vulnerable to environmental catastrophes, such as severe droughts, increased temperatures, major storms, and tsunamis. For example, on Midway Atoll, some of the freshwater wetlands created for the ducks were damaged and inundated with saltwater, Japanese green beetle larvae and dead fish by the Fukushima Japan tsunami in 2011.

CONSERVATION ACTIONS: Rabbits were eradicated from Laysan in the 1920s. In 1967, the U.S. Fish and Wildlife Service (USFWS) translocated 12 ducks to Pearl and Hermes Reef; however, this attempt was unsuccessful. USFWS has successfully controlled the nonnative grass, *Cenchrus echinatus*. Twenty ducks were translocated to Midway Atoll in 2004 and 22 in 2005, establishing a second population. Other actions specific to the conservation of Laysan ducks should include the following:

- Restore habitat with native plants, and continue to maintain existing habitat (e.g., by controlling harmful weeds and stabilizing dunes and planting vegetation to prevent sand from filling the lake at Kamole and eroding dune structures at Holaniku).
- Restore native invertebrates to increase food availability, and control and monitor nonnative invertebrates.
- Prevent the establishment of additional nonnative plants and animals.
- Continue efforts to translocate Laysan ducks, and establish additional populations in the MHI and NWHI. Continue to translocate 3-5 ducks every 10 years from Kamole to Holaniku to improve Microsatellite variation and rare alleles to prevent bottlenecks.
- Conduct disease screening and prevention to prevent botulism outbreaks and the introduction of new diseases on the NWHI.
- Prepare and implement emergency contingency plans to address the potential threat of catastrophes, such as hurricanes and tsunamis.
- Redesign guzzlers and seeps to prevent Botulism outbreaks caused by invertebrates infesting these fresh water sources.
- Keep supplies of Botulism antitoxin on hand and train field crews to respond to disease outbreaks.
- Develop a Botulism vaccine
- Continue to remediate the runway hard substrate at Holaniku to increase native plants diversity and abundance that provide food (seeds and invertebrates), nesting habitat and protection from frigatebird predation on ducklings.

MONITORING:

- Monitor population status and reproduction on Laysan to determine trends, identify limiting factors that can be addressed through management, and monitor numbers and condition of juvenile ducks in years when translocations are planned.
- Monitor survival and reproduction in the Midway Atoll and Holaniku populations (and any other populations initiated through translocation), and compare that population with the Laysan population to identify limiting factors that can be addressed through management.

RESEARCH PRIORITIES:

- Study the survival, reproduction, and other aspects of Laysan duck ecology on Midway Atoll (and any other translocation sites), compare the data with data from Laysan, and assess management requirements.
- Develop new tools to prevent botulism-related mortality on Laysan, Midway Atoll, Holaniku and any future reintroduction sites.

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