

**Focal Species:** Hawaiian Goose or Nēnē (*Branta sandvicensis*)

**Synopsis:** The Hawaiian Goose, commonly known as the Nēnē, is the State bird of Hawai'i and is one of the best examples of species recovery by captive breeding. Nēnē were extirpated from all islands except Hawai'i by the 1950s, and their numbers fell to fewer than 50 birds. A captive breeding program began in 1949, and over 2,800 Nēnē have been released on four islands. Nēnē numbers have grown rapidly on Kaua'i, where mongooses are not established and high quality lowland habitat is more prevalent; populations on other islands have been periodically supplemented with captive-bred birds. Conservation actions focus on control of non-native predators and restoration of high quality habitat.

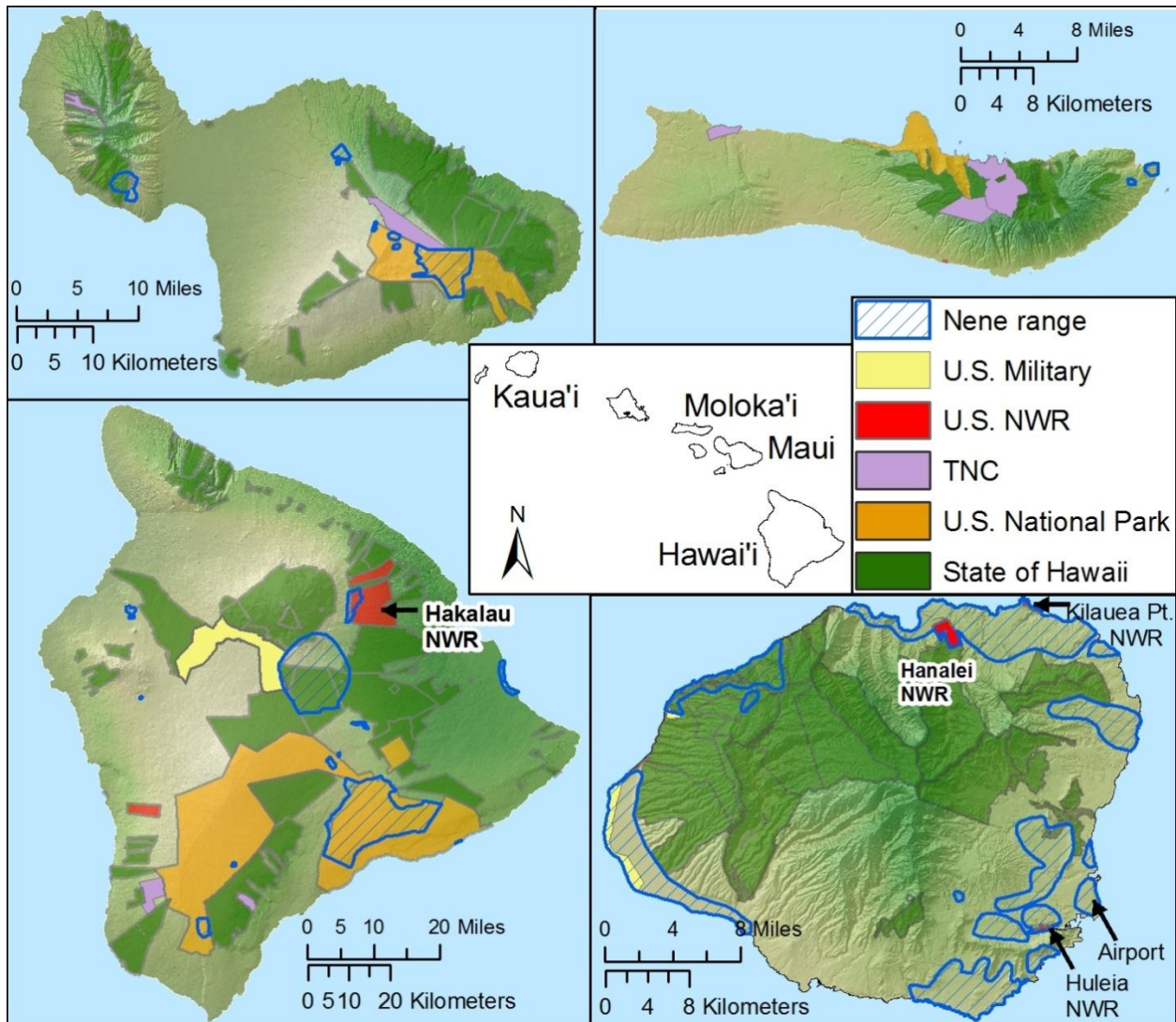
<b>Geographic region:</b> Hawaiian Islands
<b>Taxonomic Group:</b> Waterbirds
<b>Federal Status:</b> Endangered
<b>State status:</b> Endangered
<b>IUCN status:</b> Vulnerable
<b>Conservation score:</b> 17/20, At-risk
<b>Watch List 2007 Score:</b> RED
<b>Climate Change Score:</b> LOW



Nēnē at Volcanoes National Park (left) and Hanalei NWR Kaua'i. Photos E. VanderWerf.

**Population Size and Trend:** In 2011, the Nēnē population was estimated to be 2,465-2,555 birds, including 416 on Maui, 83 on Moloka'i, 1,424-1,514 on Kaua'i, and 542 on Hawai'i (Nēnē Recovery Action Group, unpubl. data). The total population has increased since 2005, when the number of birds was estimated to be 1,754. This increase was caused largely by growth of the Kaua'i population, which grew from 829 birds in 2005 (USFWS 2011). Populations on other islands have been stable or increased slightly, despite periodic releases of captive-bred birds. The Nēnē population was reduced to an estimated 30 wild and 11 captive birds in the late 1940s (Smith 1952, Kear and Berger 1980). In 2011-2012, 292 Nēnē were removed from areas near the Līhu'e Airport on Kaua'i to reduce the risk of bird-aircraft strikes, of which 239 were moved to Hawai'i and 30 were moved to Maui, where they eventually will be released (Hawai'i Division of Forestry and Wildlife [DOFAW] 2012).

**Range:** Nēnē currently occur on Hawai'i, Maui, Kaua'i, and Moloka'i, between sea level and 2,700 meters (9,000 feet) elevation. Nēnē formerly occurred on all the main Hawaiian Islands, but they were extirpated from all islands except Hawai'i by the 1950s. Current populations on other islands were re-established through release of captive-bred birds (USFWS 2004). At least five species of geese are known from the fossil record in Hawai'i; today, only the Nēnē survives (Banko et al. 1999).



**Essential Biology:** Nēnē are brown with pale edges to many feathers, have 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 (Banko et al. 1999). Vocalizations are varied and include soft mewing or mooing, loud cackling alarm calls, and high-pitched trumpeting for long-distance communication (Kear and Berger 1980).

Nēnē use a variety of habitats during different parts of the year and breeding cycle, including low and high elevation dry and mesic forest and woodland, shrubland, sparsely vegetated lava flows, grasslands, golf courses, and pastures (Banko et al. 1999, USFWS 2004). Their current distribution to some degree reflects where captive birds have been released. Historically, flocks moved between high-elevation feeding habitats to lowland nesting and molting areas (Munro 1944, Baldwin 1945), and similar movement patterns have been observed again in re-established populations (Hess et al. 2012). Water is not necessary for successful breeding, although it is readily used for bathing and drinking and appears to attract Nēnē in some areas. Nēnē graze and browse on the leaves, seeds, flowers, and fruits of at least 50 native and non-native grasses, sedges, composites, and shrubs; several species of non-native grass are

important to their contemporary diet (Baldwin 1947, Black et al. 1994). Diet composition varies with location and habitat, and the species may require a diverse suite of food plants (USFWS 2004). Nēnē disperse seeds and therefore play an important ecological role, especially in influencing the species composition of early successional plant communities (Banko et al. 1999).

Historically, Nēnē primarily nested in leeward lowlands after winter rains stimulated a flush of growth of grasses and other food plants (Henshaw 1902, Perkins 1903, Munro 1944, Baldwin 1947). Today, however, most Nēnē nest in mid- and high-elevation habitats on Hawai'i and Maui. On Kaua'i, natural high-elevation nesting habitat probably has never been available and most Nēnē nest and live year-round in areas of managed grass (e.g., golf courses) below 300 m elevation. Pairs may mate for life and engage in simple courtship displays. Nēnē have an extended breeding season and eggs can be found in all months except May-July, although the majority of birds nest between October and March (Kear and Berger 1980, Banko 1988). Nēnē nests consist of a shallow scrape lined with plant materials and down (Banko 1988). Pairs often return to previous years' nests sites, typically under trees or shrubs, though vegetation varies greatly by area. Females lay between two and five eggs that hatch after 30 days. Young are precocial and feed themselves after hatching but remain with their parents until the following breeding season.

### Primary Threats:

- **Habitat Loss and Degradation.** Degradation of lowland habitats used by Nēnē began with Polynesian colonization and agricultural practices hundreds of years ago (Cuddihy and Stone 1990). Lowland habitats have been further degraded since European arrival during the past 200 years, through agriculture, ungulate grazing and browsing, and the spread of alien plants that provide low quality foraging and nesting habitat. High elevation nesting areas are less modified than lowlands, but may be lower quality habitat for Nēnē foraging and nesting, and gosling mortality can be high in these areas (USFWS 2004). Palatable grasses and other plants in some pastures, golf courses, lawns, and roadsides allow Nēnē to forage and nest where they otherwise could not, but these areas expose Nēnē to other hazards (see below).
- **Non-native Predators.** Predation by non-native mammals is the most serious threat to the Nēnē, which nests on the ground. Predators known to take Nēnē eggs, goslings, or adults include dogs (*Canis familiaris*), feral pigs (*Sus scrofa*), feral cats (*Felis catus*), small Indian mongooses (*Herpestes auropunctatus*), and black, Norway, and Pacific rats (*R. rattus*, *norvegicus*, and *exulans*, respectively) (Hoshide et al. 1990, Baker and Baker 1996). Mongooses are responsible for the most Nēnē nest failures on Hawai'i and Maui, and feral cats may be the most serious predator on adults (Hoshide et al. 1990, Banko 1992, Black and Banko 1994, Baker and Baker 1996, Hu and Misajon unpubl. data). Kaua'i was thought to be mongoose-free, but two mongooses were captured on Kaua'i in 2012, although it is unknown if a breeding population has been established. The non-native Barn Owl (*Tyto alba*) may take goslings occasionally.
- **Collisions.** The species' low flight path when landing and taking off make Nēnē vulnerable to collisions with vehicles and man-made structures. Birds foraging along mowed roadsides are at risk from being hit by cars; between 1989 and 1999, at least 55 Nēnē were killed by cars in Hawai'i Volcanoes and Haleakalā National Parks (Banko et al. 1999). In many instances, nesting and brooding sites are separated by roads, making pairs leading small goslings vulnerable to vehicles. Birds using golf courses are vulnerable to

being struck by golf balls. Wind turbines have killed at least nine Nēnē on Maui from 2007-2011.

- **Human Conflicts.** Nēnē are attracted to feeding opportunities provided by mowed grass and human handouts and can become tame and unafraid of human activity, making them vulnerable to accidents. Human presence can also disrupt nests and brooding family groups. Crop damage by foraging Nēnē has become an issue in some areas. A large population of Nēnē has become established on the Kaua'i Lagoons golf course adjacent to the Līhu'e Airport, where they pose an aircraft strike hazard. Following a Governor's Proclamation in 2011, Nēnē are being captured near the airport and moved to other areas on Kaua'i and to Maui and Hawai'i. 292 Nēnē were removed in 2011-2012, additional birds will be relocated in the future (DOFAW 2012). Legal hunting by humans contributed to declines historically, and some poaching may occur occasionally today (Banko and Elder 1990, Banko et al. 1999).
- **Genetic Inbreeding.** Low levels of genetic diversity have been found in wild and captive Nēnē populations, and there is some evidence that fertility and gosling survival have declined in captivity as inbreeding has increased (Rave et al. 1994, Rave 1995, Rave et al. 1999). A condition known as "hairy-down" caused by a recessive gene has been observed in captive and wild Nēnē goslings (USFWS 2004), such birds do not survive in the wild (K. Misajon pers. comm.).

**Conservation Actions to Date:** Nēnē were reduced to an estimated 30 wild and 11 captive birds in the late 1940s, but the species was brought back from the brink of extinction by a successful captive propagation and release program (Smith 1952, USFWS 2004). Between 1960 and 2008, over 2,800 captive-bred Nēnē have been released on Hawai'i, Moloka'i, Maui, and Kaua'i. Early captive breeding programs were conducted by Herbert Shipman, the Territory and State of Hawai'i, and the Severn Wildlife Trust in Slimbridge, England. The National Park Service operated captive-breeding pens in the 1970s to 1990s. More recently, captive breeding programs have been conducted by the Peregrine Fund and the Zoological Society of San Diego at facilities at Olinda, Maui, and Keauhou, Hawai'i with funding from the State of Hawai'i and the U.S. Fish and Wildlife Service. Safe harbor agreements have facilitated re-establishment of Nēnē on Moloka'i at Pu'u O Hoku Ranch and several private lands on Maui.

The Nēnē was listed as endangered on 11 March 1967. An annual count is used to monitor Nēnē numbers, but methods and effort have been somewhat inconsistent (USFWS 2004). Research conducted through the 1990s demonstrated that many wild pairs did not attempt to nest, and those that did suffered high nest predation and high gosling mortality, indicating that nutrition and predation were important limiting factors (Banko 1992, Woog and Black 2001). Demographic analyses have shown that high mortality of wild young prior to fledging and among recently released captive goslings were limiting factors (Black et al. 1997, Hu 1998). Nēnē conservation efforts at Hawai'i Volcanoes National Park and Haleakalā National Park have emphasized controlling predators around nesting and rearing areas, habitat enhancement by mowing and outplanting, reducing human disturbance, and judicious supplemental feeding, and occasional augmentation with releases of captive-bred birds. Nēnē were reared in pens offering some predator protection at Hakalau Forest NWR, which now supports a sizable breeding population. At Hawai'i Volcanoes NP, various fence designs have been used successfully to exclude mongooses, cats, dogs, and pigs. Predator control programs are conducted in most areas where Nēnē nest, including Hanalei, Kilauea Point, and Hakalau Forest National Wildlife

Refuges, Haleakala and Hawai'i Volcanoes National Parks, and Pu'u O Hoku Ranch on Moloka'i. Recent satellite-tracking research on Hawai'i has revealed important information about Nēnē movements and seasonal use of different regions and habitats on Hawai'i, which will aid in habitat protection and coherent management of the Nēnē population throughout the island (Hess et al. 2012).

**Planning/Research Needs:**

- Complete reporting for previous work and continue investigating diet, nutrition, and forage quality, including the value of native versus non-native vegetation, focusing on the needs of goslings and breeding females.
- Refine predator control and exclusion methods.
- Evaluate translocation and release methods, including subsequent dispersal patterns, survival, and reproduction.
- Continue studies on movement patterns and habitat use by Nēnē.
- Investigate genetic population management to assess existing genetic variation, potential for inbreeding and inbreeding depression.
- Standardize monitoring protocols and develop a platform to more easily share data.

**5-Year Conservation Goals:**

- Ensure that mongooses do not become established on Kaua'i.
- Increase predator control effort and effectiveness, including use of predator-proof fences.
- Identify and protect habitats used by Nēnē for foraging, breeding, and flocking.
- Minimize human-Nēnē conflicts through increased public education.
- Develop a statewide, long-range management plan for all islands.

**Conservation Actions:**

- Habitat Restoration and Protection. Enhance habitat in existing protected areas for Nēnē and protect additional areas feasible based on the USFWS Nēnē Recovery Plan.
- Establish Additional Populations. Captive-breeding of Nēnē played a crucial role in saving the species from extinction, and such programs may continue to play an important role in Nēnē conservation. Nēnē removed from areas near the Līhu'e Airport on Kaua'i could be used as another source of birds for establishing new populations, but those birds may have established behaviors and habitat choices that would not be desirable in other areas and their use should be carefully considered.
  - Move family groups to Hūlei'a National Wildlife Refuge, Kaua'i from the airport.
  - Establish Nēnē at Haleakalā Ranch, Maui.
- Predator Control.
  - Increase efforts to detect and remove mongooses from Kaua'i using live traps, kill traps, and poison bait stations, where appropriate.
  - Continue predator control programs at all sites.
  - Evaluate feasibility of predator-proof fences at Hanalei NWR, Hakalau Forest NWR, and additional sites. Before fence construction, each site will require a scoping and feasibility study to determine the optimum size and placement of a fence and the estimated cost, a cost-benefit analysis comparing other forms of management, and regulatory compliance.
- Minimize Collisions.



- Where Nēnē have been hit by cars, reduce attractive habitat along roads and increase signage.
- Continue monitoring collisions with wind turbines and mitigating their effects.
- In high-risk areas on golf courses, educate and work with staff and golfers to minimize risk and if necessary haze Nēnē.
- Minimize Negative Human Interactions.
  - Continue to address the aircraft strike hazard at Līhu'e Airport on Kaua'i by removing birds and modifying attractive habitats where appropriate.
  - Collaboration between U.S. Department of Agriculture, Natural Resources Conservation Service, Hawai'i Department of Agriculture, and farmers to develop Nēnē barriers and deterrents and, if necessary, safe hazing techniques and a crop damage reimbursement program.
- Outreach. Educate the public about Nēnē, their needs, and their threats.

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

Conservation Action	Years	Annual Cost	Total Cost
Habitat management, all sites	1-5	\$500,000	\$2,500,000
Establish Nēnē population at Hūlei'a NWR, Kaua'i	1	\$125,000	\$125,000
Establish Nēnē population at Haleakalā Ranch, Maui	1	\$100,000	\$100,000
Increase efforts to capture mongoose on Kaua'i	1-5	\$150,000	\$750,000
Predator control, all sites	1-5	\$600,000	\$3,000,000
Evaluate feasibility of a predator-proof fence at Hakalau Forest NWR	1	\$10,000	\$10,000
Minimize collisions	1-5	\$100,000	\$500,000
Continue research on movements and habitat use	1-2	\$150,000	\$300,000
Minimize human conflicts	1-5	\$200,000	\$1,000,000

**Potential Partners:** U.S. Fish and Wildlife Service, Hawai'i Division of Forestry and Wildlife, National Park Service, Zoological Society of San Diego, Kaua'i Watershed Alliance, East Maui Watershed Partnership (WP), West Maui Mountains WP, Leeward Haleakalā Watershed Restoration Partnership, East Moloka'i WP, Kohala WP, Three Mountain Alliance, Mauna Kea Watershed Alliance, University of Hawai'i, U.S. Geological Survey Pacific Island Ecosystems Research Center, U.S. Department of Agriculture Wildlife Services and Natural Resources Conservation Service.

**Ancillary Species:** Because Nēnē use different habitats on different islands and at different seasons, management for Nēnē would benefit a variety of other native birds. In high elevation areas of Haleakalā NP on Maui, management for Nēnē, particularly predator control, also directly benefits the Hawaiian Petrel or 'Ua'u (*Pterodroma sandwichensis*), Pacific Golden Plover (*Pluvialis fulva*), and the Hawaiian Short-eared Owl or Pueo (*Asio flammeus sandwichensis*). Management of wetlands at Hanalei NWR would benefit several endangered waterbirds, including the Hawaiian Coot (*Fulica alai*), Hawaiian Gallinule or 'Alae 'Ula (*Gallinula galeata sandvicensis*), and Hawaiian Stilt or Ae'o (*Himantopus mexicanus knudseni*). In coastal areas on Kaua'i such as Kilauea Point NWR, management for Nēnē would benefit several seabirds, including the Laysan Albatross (*Phoebastria immutabilis*), Wedge-tailed

Shearwater (*Puffinus pacificus*), threatened Newell's Shearwater (*Puffinus auricularis newelli*), Red-tailed Tropicbird (*Phaethon rubricauda*), and White-tailed Tropicbird (*Phaethon lepturus*).

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