The Nēnē: Hawaii's Iconic Goose

A MIXED BAG OF SUCCESSES, SETBACKS, AND UNCERTAINTY

By Steven C. Hess

Courtesy of Steven C. Hess

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New research with satellite telemetry shows that the endangered Hawaiian goose, or nēnē (*Branta sandvicensis*), appears to be making a comeback—and a puzzling one at that.

In 2009, two nēnē ganders with satellite transmitters were found making regular visits to a rugged site high on the Mauna Loa volcano, where the birds had last been reported 60 years earlier. Ancient Hawaiians had named the site Kipuka Nēnē, indicating that it had been a common location for the birds. An early record of the site described it as "dotted with small, shallow, permanent pools and covered with an open ohia forest with a ground cover of lush grass and sedges" (Smith 1952). By 2009, those pools and sedges were long gone, altered by one of the largest lava flows on Earth. The habitat had changed, but the nēnē had returned. Nearly extinct by the mid-20th century, how did nēnē recover and learn to find such isolated destinations once used by their ancestors?

Credit: Jack Jeffrey

In March 2009, this nēnē became the first to receive a satellite transmitter, carefully attached with a teflon ribbon at Hawaii Volcanoes National Park. Tracked by biologists, this bird set an elevation record at the Kahuku unit of the park, flying up to 8,789 feet.

Biologists have been understandably astonished by the comeback of the nēnē, Hawaii's state bird. By 1950, there were only 20 or 30 birds known to exist in the wild, all of them on the Big Island of Hawaii. Today, there are roughly 900 on Hawaii Island and perhaps as many as 2,000 scattered across the four islands of Hawaii, Maui, Kauai, and Molokai. In addition, nēnē have appeared in ancestral places of which they could not possibly have any knowledge. For example, the birds discovered at Kipuka Nēnē came from the Hakalau Forest National Wildlife Refuge some 50 miles away, yet the Hakalau population did not exist prior to 1996. Researchers are hoping that telemetry data can shed some light on the mystery.

A Bird's Rapid Fall

Scientists believe that nēnē evolved from Canada geese (*Branta canadensis*) that made landfall in the Hawaiian Islands some 890,000 years ago (Paxinos *et al.* 2002). There they evolved in isolation from all predatory mammals. But beginning about 1,000 years ago, nēnē began a precipitous decline, sparked by the introduction of several predators such as Polynesian rats (*Rattus exulans*) and dogs (*Canis familiaris*). Norway rats (*Rattus norvegicus*) and domestic cats (*Felis catus*) appeared soon after Captain James Cook reached the Hawaiian Islands in 1778 (Tomich 1986, Steadman 1995). The small Indian mongoose (*Herpestes auropunctatus*) was then intentionally introduced in 1883 to control rodents in agricultural lands (Tomich 1986).

Perhaps the worst invader, the black rat (*Rattus rattus*) arrived on ships in the late-1800s (Atkinson 1977). Nēnē eggs, nestlings, goslings, and even adults (along with other ground-nesting birds) became subject to predation by each new species of introduced mammal, yet black rats irrupted repeatedly and uncontrollably without any predators that could effectively control them. In addition to burgeoning predator populations, unregulated hunting and lowland habitat destruction also contributed to the decline of the nēnē.

The bird's plight had become so grave by 1949 that territorial fish and game biologist J. Donald Smith promoted a captive propagation program high in the saddle of Hawaii Island at Pohakuloa. He began with two pair of nēnē contributed by Herbert Shipman, a prominent businessman who had kept a flock since 1918 (Kear and Berger 1980). The founding pool of captive breeders—not more than a handful of closely related geese—experienced several setbacks from mortality, low fertility, and poor hatching success in the cool, arid climate of Pohakuloa. The addition of three wild nēnē from Mauna Loa in 1960 enabled the program to build a flock that contributed to the restoration of nēnē throughout Hawaii's state lands and national parks. Unfortunately, many of the captive-raised nēnē were less likely to make long-distance movements than their wild counterparts, and more likely to die of starvation or dehydration during extended drought (Black *et al.* 1997). Decades of captive breeding, releases into the wild, habitat management, and predator control have restored the nēnē to four of Hawaii's largest islands.

Pattern of Puzzling Flights

Although unimpressive fliers by the standards of migratory goose species worldwide, nēnē on Hawaii Island in the late 1990s started to make regular movements between the windward side, leeward Kona, and a large natural area on Mauna Loa called Kahuku, which was acquired by Hawaii Volcanoes National Park in 2003. Yet these appearances raised more questions than they answered: Were nēnē making direct flights between these sites or stopping at places along the way? If they were stopping, what threats did they face? What kind of habitats and foods were they using? Given that geese are social animals, had a small number of survivors passed this knowledge on to contemporary descendants?

Under normal circumstances, questions like these would be well-suited for conventional radio-telemetry. However, the interior of Hawaii Island is extraordinarily rugged with lava flows, dense rainforests, and high volcanoes. A great deal of helicopter flight time was therefore required to track nēnē along their journeys. Researchers determined that satellite telemetry would provide an effective, less-costly alternative to tracking nēnē, but would require a fine-scale application of the technology, which had typically been applied to track migratory birds across much vaster distances.

Credit: Christina Cornett

With leg band and transmitter in place, a nēnē prepares to swim in a water hazard at a local golf course. Federally listed as endangered—and the only remaining goose endemic to Hawaii—nēnē often make use of human-altered landscapes such as golf courses and agricultural fields, where they face threats from predation and are sometimes considered pests.

During three years of a collaborative study conducted from 2009 to 2011 by the U.S. Geological Survey and the National Park Service, 11 nēnē ganders were fitted with backpack harnesses and 40-gram solar-powered platform transmitter terminals (PTTs) provided by the U.S. Army's Pohakuloa Training Area. These PTT devices have provided reliable GPS data on a daily basis, acquiring more than 8,500 locations to date. One of the most frequently used travel routes is along the windward slopes of Mauna Kea and Mauna Loa volcanoes, with nēnē stopping to roost once again at their historic haunt of Kipuka Nēnē. In addition, data show that east-west and north-south island crossings from leeward Kona and the high volcanoes intersect at the meeting grounds of Kipuka Ainahou in the island's high saddle, where some of the last wild nēnē were observed.

Despite the fact that nēnē are among the most terrestrial of all geese, study subjects often locate small ponds or water catchments, which are unusual features to use, given the lack of natural sources of standing water on young volcanic islands. Telemetry subjects have been located at anywhere from 199 meters (653 feet) to 2,679 meters (8,789 feet) in elevation, and from dry lowland Kona grasslands to native subalpine shrublands, exhibiting a pattern of seasonal movement—from lowland breeding grounds to high-elevation non-breeding areas—not seen since the beginning of the 20th century.

Two Steps Forward, One Back?

Although managers are encouraged by the re-establishment of these traditional movement patterns, the challenges nēnē face in the future are almost overwhelming, as they must transcend their lack of genetic diversity in a changing climate and survive in an ever-shrinking natural environment with many non-native enemies.

Hawaii is on the cusp of controlling some of its most damaging invasive predators. Rodenticides that have been used in bait stations since 1997 are now registered for aerial distribution, and mongooses are particularly susceptible to low dosages of the newly approved anticoagulant diphacinone (Hess *et al.* 2009). Hawaii Volcanoes National Park has also adapted a predator-proof fence design from New Zealand to keep feral cats, feral pigs, and mongooses out of a two-acre pen, a protected area where nēnē return each year to breed.

The island of Kauai has different challenges. Due to an absence of mongooses there, nēnē have become superabundant, reaching more than 1,000 individuals on the small island. This is posing a serious airstrike hazard at the local airport, and forcing the state to devise a plan to move the endangered birds, suspending state laws as necessary to expedite the move to other suitable locations. Some of the Kauai nēnē will likely soon be relocated to reduce airstrike hazards and bolster other island populations, but reintroduction to other islands poses its own risks. The Kauai nēnē may carry chronic avian malaria infections that must be treated prior to release. In addition, their genetic pedigree is far from optimal (Rave *et al.* 1995). Because the Kauai population was founded by a small number of individuals, it has suffered multiple bottlenecks, and like any bird species that has plummeted to fewer than 50 individuals, nēnē already experience significantly lower hatching success than more robust species (Rave *et al.* 1999, Heber and Briskie 2010).

On Hawaii Island, satellite telemetry has shown that nēnē move among multiple breeding populations. If Kauai nēnē are introduced to Hawaii Island, they would undoubtedly interbreed and thereby contribute substantially reduced genetic diversity to the entire Hawaii Island metapopulation, which is more genetically diverse than Kauai's but still not self-sustaining. This interbreeding could potentially reduce hatching success in the Hawaii Island population.

Some extent of low genetic diversity is to be expected among island populations, but a comprehensive study of population genetics would help determine the potential consequences of mixing Kauai nēnē with those of other islands.

Managers have other cause for concern. Nēnē eat valuable agricultural crops like lettuce and vegetables, but because the birds are protected, farmers have become increasingly frustrated by an inability to repel the birds from croplands. In addition, although nēnē have adapted to use human-altered landscapes such as golf courses, they face mortality from attacks by dogs and other hazards. For instance, nēnē are frequently attracted by food handouts to dangerous situations near roads where they are struck by vehicles (Banko *et al.* 1999). Toxoplasmosis, transmitted through cat feces, has also been identified as a cause of nēnē mortality (Work *et al.* 2002).

The U.S. Fish and Wildlife Service Recovery Plan for nēnē (2004) calls for restoring the birds to some of their former low-elevation locations, such as Kona and Maui. Yet this may prove difficult because there are few remaining undeveloped lowland areas without potential human-wildlife conflicts. Wildlife managers would therefore benefit from knowing if there are ways to favor wild behaviors in nēnē, providing protection in natural areas away from anthropogenic hazards.

Climate change threatens further consequences for Hawaii's nēnē and other at-risk species. The prospect of more frequent El Niño events in the Pacific may mean less precipitation for islands like Hawaii, which has areas that normally receive four to six meters or more of rainfall annually (Trenberth and Hoar 1996, Loope and Giambelluca 1998, Chu and Chen 2005). Nēnē experience substantially higher mortality from starvation in drought years (Black *et al.* 1997), and 2010 was one of the most extreme droughts on record in Hawaii. If drought is the wave of the future, the 21st century may be as perilous as the 20th century was for Hawaii's nēnē. ■

For a full bibliography and additional resources about the Hawaiian nēnē, go to *www.wildlife.org.*