The Struggle to Save the Laysan Duck

MANAGING DISEASES THAT THREATEN A RARE BIRD IN THE HAWAIIAN ISLANDS

By Thierry M. Work, D.V.M.

In August 2008, researchers discovered sick and dead endangered Laysan ducks (*Anas laysanensis*) on two islands in Hawaii's remote Midway Atoll National Wildlife Refuge. The die-off was a setback for biologists, who had been working for more than a decade to reduce the risk of extinction for this rare species. Yet the episode also launched new strategies to manage disease in a small geographic area, and showed how collaboration can bolster endangered species conservation.

Historically, the Laysan duck ranged throughout the Hawaiian Islands. Habitat loss, introduced predators, and other factors eventually reduced its range exclusively to Laysan Island, a four-square-kilometer speck in the remote northwestern Hawaiian Islands. In the 19th century feather collectors and guano miners decimated much of the island's native seabird population, prompting Teddy Roosevelt to create the Hawaiian Islands National Wildlife Refuge in 1909.

Further protections within the archipelago have occurred since then, and today Laysan and Midway lie within the Papahanaumokuakea Marine National Monument, a broad sweep of coral atolls lying to the northwest of the main Hawaiian Islands and jointly managed by the U.S. Fish and Wildlife Service (FWS), the National Oceanic and Atmospheric Administration, and the State of Hawaii. On Laysan Island, biologists live at a field camp and monitor wildlife, control invasive vegetation, and conduct other refuge management and research activities.

A Near-Fatal Collapse

Laysan Island, a low coral sand atoll, is unique among the northwestern island chain in that it has a large, shallow hypersaline lake in the center. Laysan ducks on the island forage on brine flies, shrimp, moth larvae, and seeds. During breeding season the ducks use the few freshwater seeps around the lake to raise their ducklings. Due to the island's small size, however, duck populations seldom exceed 500 to 600 individuals, making them highly vulnerable to a disease outbreak.

In 1993 and 1994 an outbreak did occur and Laysan ducks experienced a catastrophic mortality, with an estimated loss of up to 70 percent of the population (Reynolds 2002). I joined colleagues on Laysan to investigate the cause of death. We took blood samples from live ducks to establish general health status, and conducted necropsies of dead ducks to search for clues. Affected ducks were weak, emaciated, and had numerous large intestinal nodules that contained large numbers of worms.

We sent tissue samples to the National Wildlife Health Center in Madison, Wisconsin, for further laboratory analyses. There, Carol Meteyer, a pathologist, and Rebecca Cole, a parasitologist, discovered that the nodules were caused by a proventricular worm called *Echinuria uncinata*. The worm occurs in migratory waterfowl, and is known to cause mortality in captive waterfowl in a crowded setting. The worm depends on a water flea for its life cycle; crowded conditions lead to high rates of infective worm larvae in ponds and therefore to high levels of infected birds.

Such crowding likely created the outbreak on Laysan Island in 1993 and 1994, which were particularly low rainfall years. Researchers concluded that the drought

Credit: Carlos Orrego

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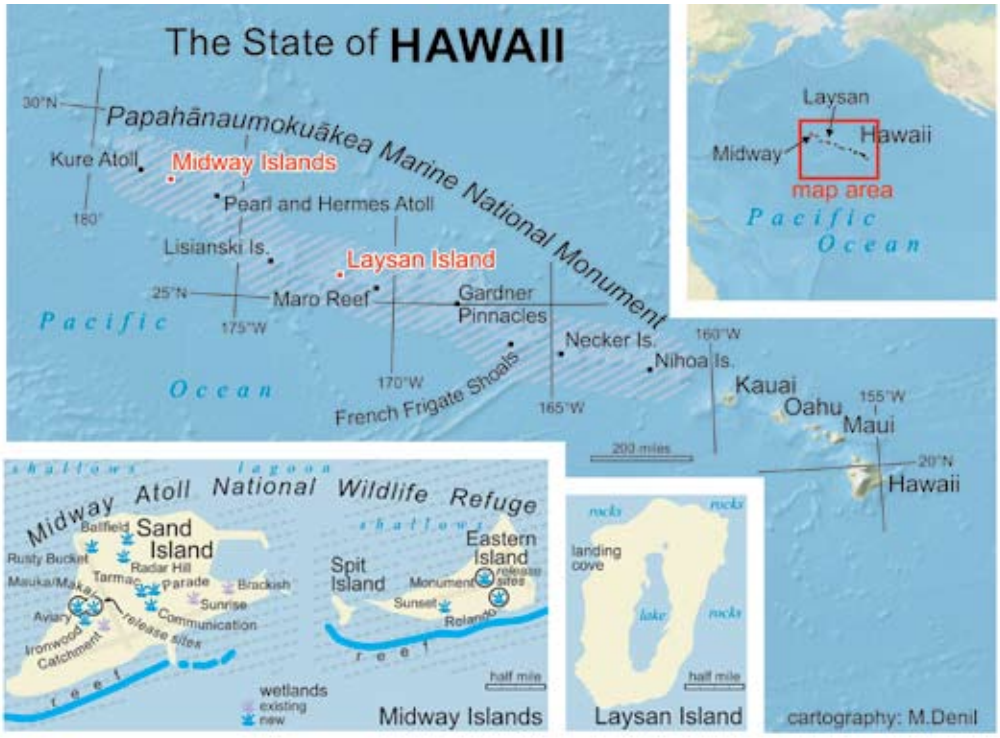
Highly endangered Laysan ducks (*Anas laysanensis*) enjoy relative peace in the wetlands of Hawaii's Midway Islands, which are actively managed to control disease outbreaks. Studies of banded Laysan ducks on Laysan Island have shown multi-year pair bonds lasting as long as nine breeding seasons.



A drought and deadly parasitic-worm outbreak on Laysan Island helped prompt relocation of some native Laysan ducks to Sand and Eastern Islands, 750 miles away in the Midway Atoll National Wildlife Refuge. There researchers created 12 new wetlands, such as Tarmac, Sunset, and Rusty Bucket, and enhanced the catchment and two existing wetlands on Sand Island. Laysan ducks are successfully breeding on Midway and routinely fly between Sand and Eastern Islands.

created low food resources and crowding around freshwater seeps near Laysan's lake, which led to the epidemic—a clarion call that the Laysan duck's survival was precarious (Work *et al.* 2004). The limited range of the bird, along with the risk of stochastic events such as disease or storms, had the potential to cause extinction of the species. Clearly it was time to attempt to re-establish populations. But where?

Michelle Reynolds, a research biologist with the U.S. Geological Survey (USGS) Pacific Island Ecosystems Research Center, conducted extensive analyses of potential locations in Hawaii's northwest islands. Her work led to the consensus that the Midway Atoll—specifically Sand and Eastern Islands—was the most suitable site for re-establishing a second population of Laysan ducks. Midway had fresh water and vegetative cover, its introduced predators had been removed, and it could be staffed by biologists who could help monitor the birds post-release.

The Trials of Translocation

Before Laysan ducks could be moved to Midway, the atoll had to be prepared to receive them. John Klavitter, the FWS refuge biologist for Midway, led an effort to restore native bunch grasses and create or enhance small freshwater wetlands on Midway's Sand and Eastern Islands. Excavations exposed fresh water from the atoll's groundwater aquifer. Because of logistic and financial constraints, the remote location of these islands, and the hydrology of the wetlands, managers could not include technology to manipulate water levels.

Midway's wetlands ranged in size from 18 square meters to a 408-square-meter catchment. Depths ran from about 0.1 to 1.5 meters, and the edges ranged from shallow feathered mud flats to steeper slopes of up to 40 degrees. Crews planted native sedges (*Cyperus laevigatus* and *C. polystachyos*) and grasses (*Eragrostis variabilis*) around the wetlands to serve as cover and promote invertebrate production for ducks and ducklings.

After population studies on Laysan, Reynolds spearheaded the translocation, a joint effort between USGS and FWS. In 2004 the team transported 20 ducks from Laysan to Midway, a two-day boat ride. In 2005, 22 more ducks made the trek. Birds selected for translocation had to be juveniles or sub-adults from different broods and in fair to good body condition with a near-even male-female ratio. The chosen ducks then received complete physical exams and subcutaneous injections of antihelminth-

ics to reduce burdens or kill *Echinuria* worms and decrease the chances of translocating the parasite to Midway—a precaution that highlights the importance of understanding a population's exposure to pathogens before moving animals to a new location.

Prior to their release on Midway, all the birds were placed in aviaries on Eastern or Sand Island and fitted with radio transmitters so researchers could monitor post-release success (Reynolds and Klavitter 2006). The ducks adapted exceedingly well to their new habitat, with birds laying successful nests with clutch sizes larger than those reported for Laysan Island (Reynolds *et al.* 2008). Given the extensive use of the freshwater wetlands, particularly as habitat for raising ducklings, researchers estimated that the population reached about 200 juveniles and adults in 2007 (Reynolds *et al.* 2007), and projected that duck populations on Midway could swell to 380 birds by 2008, making the translocation an unqualified success (Reynolds *et al.* 2008).

A New Threat on Midway

Unfortunately, in late July of 2008, large numbers of ducks on Midway were found sick and dead near wetlands on Sand Island. Yet, this time, worms (which caused the die-off on Laysan) were not to blame. The dying ducks showed clinical symptoms such as general weakness and limberneck, which were highly suggestive of avian botulism. Necropsy findings by the National Wildlife Health Center Honolulu Field Station (NWHC-HFS) and NWHC-Madison confirmed the diagnosis (Work *et al.* in press).

Botulism is caused by a toxin produced by the bacterium *Clostridium botulinum*, which is ubiquitous in soil. Under certain environmental conditions, it produces botulinum toxin, which accumulates in invertebrates. The specific conditions conducive to production of the toxin in wetlands are unknown, although temperature, pH, and protein sources appear to play an important role (Rocke and Samuel 1999). Invertebrates such as midge larve and fly maggots can bioaccumulate the toxin, and waterfowl consuming these invertebrates become poisoned. When new fly maggots feed on the dead birds, those maggots accumulate the toxin and poison more waterfowl (the "maggot cycle").

Wildlife managers can halt or greatly reduce botulism outbreaks by altering environmental conditions sufficiently to halt production of the toxin (Rocke and Friend 1999). Draining can reduce risk to migrant waterfowl at high risk wetlands, and flooding may also reduce the biotoxin production. In many managed and floodplain wetlands, infrastructure such as sluice gates, pumps, and ducts allow managers to alter water levels to flush out toxins and control vegetation, waterfowl movements, and disease.

On Midway, however, only two of its surface flow wetlands could be managed. One was a depression on the tarmac that could be both drained and flooded. The other, the largest wetland on Midway, was the water catchment area established when Midway was an active military base. It contained approximately 80 percent of the standing fresh water on the island. Because the catchment received runoff

Credit: Thierry M. Work, USGS

Preparing habitat for Laysan ducks near a seep on Midway's Sand Island, biologists Michelle Reynolds, John Klavitter, and Jimmy Breeden (left to right) pull out weeds to prepare for planting native sedges. An aviary near a newly-planted seep (below) can hold ducks until they're ready for release.

Credit: Thierry M. Work, USGS

from the airstrip and served as a source of water for the island, it was designed to be drained and cleaned regularly. In the 2008 die-off, researchers found most of the carcasses at the catchment, suggesting that the disease outbreak originated there.

FWS refuge staff flooded the catchment and later drained it, then removed approximately 180,000 liters of sludge and decomposing seabird carcasses. Shortly thereafter, mortalities began to abate there. However, the atoll is small, and birds use all the wetlands on both islands. Biologists therefore searched the smaller wetlands, removed dead birds to prevent perpetuation of the maggot cycle, and took sick birds to aviaries, where ducks received treatment with botulism antitoxin and supportive care such as fluid therapy and nutrition. Through these efforts, researchers saved 33 of 47 captured birds, or 70 percent. In the wild, however, ducks continued to die for about a month.

The lessons of Laysan will inform future work on conservation of endangered species.

The botulism outbreak lasted over two months and reduced Midway's Laysan duck population by at least 181 birds. Despite the scope of the loss, some biologists believe that the population is rebounding successfully.

Vigilance is still essential, however. In 2008 and 2009 on Midway, some Laysan duck and migratory pintail carcasses were found to be infected with proventricular worms that had a morphology similar to that of *Echinuria*, which had caused the catastrophic mortality on Laysan. Unfortunately, insufficient specimens were available to confirm the worm's identity. Whether proventricular worms were brought to Midway from Laysan in the founder stock (despite worm treatment), or whether they came in via migratory waterfowl, remains unknown. To date the few ducks infected have not manifested severe pathology in the gastrointestinal tract, as is more commonly seen on Laysan. This may indicate a different species of worm, or that worm burdens on Midway aren't severe enough to cause significant pathology. More necropsies are needed to confirm the worm's identity and its effects on Laysan ducks.

What Laysan Has Taught Us

The lessons of Laysan will inform future work on conservation of endangered species. Those of us involved in the project learned that when translocating endangered wildlife, biologists must be prepared to intensively monitor the population long term so that catastrophic declines can be detected and managed quickly. Biologists must also anticipate and monitor potential disease events and be prepared to adequately manage the new habitat to mitigate effects of disease. On Midway, botulism management will likely be an annual activity.

Prior to the Laysan translocation, Midway Atoll had been managed as a refuge for native biodiversity including seabirds, shore birds, sea turtles, monk seals, and native plants. The recent botulism outbreak prompted refuge managers to also intensify their management of wetlands to limit the effects of botulism on Laysan ducks. The refuge is taking significant steps in that direction, including:

- Using heavy equipment and portable pumps to annually remove sediments from wetlands, which may improve water quality.
- Monitoring wetlands daily during warm summer and fall months (June to October) and weekly through the rest of the year, which includes searching for sick and dead Laysan ducks.
- During the hot summer months, flooding or drying the concrete-lined catchment and searching for carcasses daily.
- Draining and cleaning the catchment in the cool fall or winter months to remove accumulated debris and seabird remains.
- Removing vegetation in and around wetlands to facilitate carcass detection and to increase natural air flow, which should keep water cooler and more oxygenated.

These methods appear to be helping. From June to October 2009, only 58 Laysan duck mortalities were attributed to botulism, a significant decrease from 2008. Close monitoring on Midway needs to continue, as well as necropsies on all dead ducks to track botulism outbreaks and the occurrence of parasites and new diseases. These tasks involve an enormous amount of time and effort, but if we can keep mortalities to a minimum on Midway, the future of the Laysan duck looks bright. ■

This article has been reviewed by subject-matter experts.

For a complete bibliography go to *www.wildlife.org*.