

Kaua'i National Wildlife Refuge Complex

Avian Botulism and Endangered Island Waterbirds



Endangered koloa maoli C. Malachowski



Clostridium botulinum bacteria

Avian botulism type C is a paralytic disease that affects endangered waterbirds on the Hanalei National Wildlife Refuge (NWR), caused by ingestion of a toxin produced by the *Clostridium botulinum* bacteria. *Clostridium botulinum* is a naturally-occurring, benign soil bacterium that can produce a deadly toxin under warm, wet, and stagnant conditions. Following ingestion of this toxin, birds become paralyzed and eventually die due to respiratory failure or drowning from the inability to hold their head above water. Botulism is not an infectious disease, rather it is food poisoning that the birds get from ingesting invertebrates and other food that bioaccumulates the toxin.

Since December 2011, Hanalei NWR has experienced year-round avian botulism type C outbreaks resulting in approximately 931 dead or sick Hawaiian and migratory waterbirds, 90% of which are listed as federally endangered. The endangered koloa maoli (Hawaiian duck, *Anas wyvilliana*) is the species most affected by avian botulism outbreaks, accounting for 63% of the total sick or dead botulism birds found at the Hanalei NWR resulting in the average loss of approximately 130 koloa per year. The endangered 'alae 'ula (Hawaiian moorhen, *Gallinula chloropus sandvicensis*), 'alae ke'oke'o (Hawaiian coot, *Fulica alai*), ae'o (Hawaiian stilt, *Himantopus mexicanus knudseni*), nēnē (Hawaiian goose, *Branta sandvicensis*), as well as the 'auku'u (black-crowned night heron, *Nycticorax nycticorax*), and other migratory waterbirds are also affected by the disease on the Refuge.

The Hawaiian Islands provide climatic conditions that are conducive to year-round botulism outbreaks, and avian botulism outbreaks at the Hanalei NWR peak between November and March. Climate change is expected to exacerbate the risk of outbreaks. Outbreaks occur most often in the makai (northern) areas of the Refuge where kalo (taro) farming occurs; outbreaks are

rare on the mauka (southern) kalo farms, which are located closest to the main water source. Botulism outbreaks are significantly lower in the Refuge's wetland management units (where kalo is not being produced) despite the northwestern of these units being the furthest downstream on the water system, and despite the higher density of koloa that occur in these units compared to the kalo lo'i (fields).

The U. S. Fish and Wildlife Service is working with researchers and the kalo farmers in an attempt to identify the risk factors, so that we can work toward control and elimination of the disease. Many of the waterbird species that inhabit the Hanalei NWR are non-migratory species that rely on the Refuge year-round. There are few suitable wetlands on Kauai, other than those at the Refuge, where the life history requirements of these birds are supported. Because of this, and because many of these waterbird species are already federally endangered and are limited in distribution, any additional losses to botulism are potentially significant and could lead to increased risk of extinction.

Hanalei NWR staff, interns, and volunteers are working with the kalo farmers to:

- Coordinate botulism surveillance and monitoring efforts;
- Study various habitat and water manipulations to identify potential management actions to reduce risk factors;
- Install additional water delivery infrastructure to increase the water quantity to botulism hotspots
- Monitor water quality and best management practices for kalo farming and wetland management;
- Locate, stabilize, and rehabilitate sick birds;
- Collect and remove dead birds and submit for lab analysis; and
- Synthesize data from these efforts to improve management.

The general water quality and sediment parameters that have been associated with higher botulism risk in temperate wetlands include negative oxidation-reduction potential (leading to reduced oxygen content in the water column (anaerobic conditions)), slightly alkaline pH, increased water temperature, low salinity, and a high percentage of organic matter. However, the specific environmental conditions that increase risk or initiate outbreaks at the Hanalei NWR, a tropical agroecosystem, may be slightly different and the Service is working to study these risk factors.

Potential management options include:

- Continuing to improve water quality and quantity (e.g. reduction of chemical loading into system, improvement of irrigation infrastructure and methods, reducing water temperature and stagnation, etc.);
- Reducing exotic fish biomass; and
- Testing more efficient methods to locate and remove sick and dead birds (e.g., trained detector dogs).

