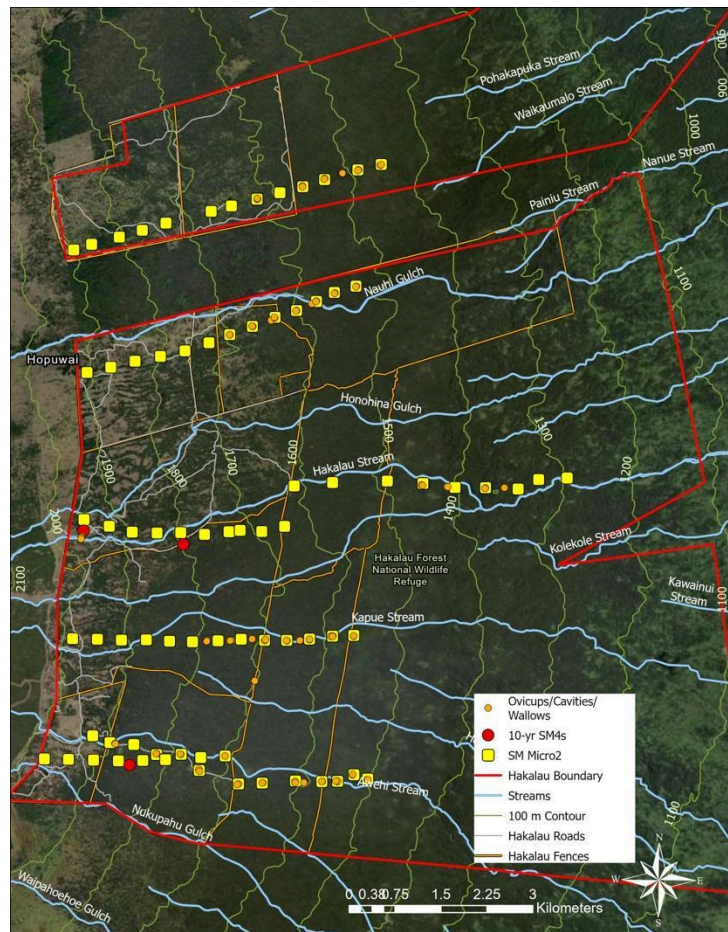


Waiwai grant/UluManu Hakalau Project Final report

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The upper elevations of Hakalau are generally considered to be a refuge from mosquito-transmitted avian disease, but as the climate warms, mosquitoes are predicted to become established in these areas in the future. The UluManu Hakalau project was initiated by the UH Hilo LOHE lab in the summer of 2025 to help provide bird and mosquito monitoring data as an early warning system for the decline of birds or the increase of mosquitoes across the refuge. On October 1, 2025, the County of Hawai'i awarded the Friends of Hakalau Forest National Wildlife Refuge a grant in the amount of \$50,000 to establish an early warning monitoring program for the presence of avian disease-carrying mosquitoes at the refuge. The Friends group then voted to have Dr. Patrick Hart from the Department of Biology at UH Hilo carry out the monitoring program through the UluManu Hakalau Project.

UluManu has established approximately 80 long-term acoustic recording stations along 5 transects across the refuge (Fig. 1). These transects are each approximately 4-miles long and run from high (approx. 6,000 feet) to middle elevations (approx. 4800 feet) across the refuge, with one going all the way down to 4200 feet. Acoustic recorders are programmed to record in intervals throughout the day, with the data saved on sound cards that are collected every seven weeks by UluManu crew members. The approximately 10 TB of soundscape data collected each cycle are uploaded and stored locally in the LOHE lab NAS system as well as on the cloud. The LOHE lab (Amanda Navine in particular) continues a collaboration with Tom Denton from Google DeepMind to develop AI and statistical analysis tools that allow for the processing of these large volumes of data to achieve estimates of the current distribution and abundance of all native bird species of interest on the refuge.



This will allow us to monitor changes in bird species abundance at much finer temporal scales (weekly, monthly, seasonally) than are currently possible and hopefully to respond quickly to bird declines where they occur.

The funding support from the Waiwai grant made it possible to add a trained mosquito technician (Kili Kawaiaea) to our field crew to prepare and deploy oviposition cups along the same five bird recording transects as a way to monitor for increases in mosquito abundance. These cups are filled with a brewed concoction we call “stinky water” that is designed to attract egg-laying female mosquitoes. The cups are placed at all stations along the bottom half of each transect monthly, and monitored for a period of two-three days. Any mosquito “eggs rafts” may then be counted and identified to mosquito species. There are two species that are known to inhabit Halakau- *Culex quinquefasciatus* and *Aedes japonicus*. Of these, the *Aedes* species has become somewhat common at the lower to middle elevation portions of the refuge but thankfully does not transmit avian disease to our native birds. Fortunately, the crew, led by LOHE Technician Kili Kawaiaea, **has not detected any egg rafts from disease carrying *Culex* mosquitoes since sampling began** in mid-spring of 2026. Starting in September 2026 the crew will also establish and monitor CO2 mosquito traps at selected stations along the lower fence of the refuge. These traps attract mosquitoes looking for a blood meal (as opposed to stinky-water traps that attract mosquitoes looking for a place to lay their eggs following the blood meal). Because CO2 traps are bulky and expensive to maintain, they will only be deployed during the months of September – January when mosquito incursion onto the refuge is most likely.



Fig. 2 LOHE Field Technician Kili Kawaiaea checking ovicup at Hakalau

Summer 2026 marks the one-year point for most of the recorders that have been placed along transects as part of this project. We have recently begun analyzing these data to detect seasonal changes in abundance of birds each time data is retrieved from the forest. For example, we can compare how the call density (number of species detections over a given period of time) has changed at each of 80 recording stations

from a given season in 2025 to the same season in 2026 (Please see Fig. 3 as an example of call density change from a single recorder at Hakalau during breeding season over an 11 year period).

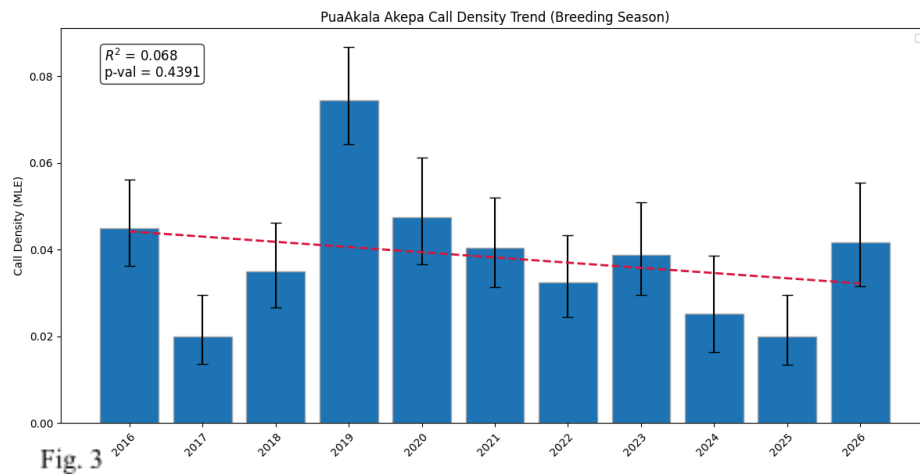


Fig. 3

In this example, there is an apparent downward trend in abundance of Hawai'i 'ākepa at a single recorder, but this trend is not statistically significant.

What do we do if we detect a decrease in bird species abundance or an increase in mosquitoes? Landscape-scale mosquito control is currently our best hope for preventing the incursion of mosquitoes into the higher elevations of the refuge and preventing the further decline of our birds. Recent discussions among biologists and managers have identified aerial application of BTi (*Bacillus thuringiensis israelensis*) by helicopter or drone as a promising tool to accomplish this. BTi is a naturally occurring soil bacterium that has been shown to primarily target mosquito larvae, but its application across large tracts of the refuge will be expensive. We believe that better, more targeted information on where and when birds are declining and/or mosquitoes are increasing across the refuge will facilitate more cost effective application of Bti to areas that need it, with improved outcomes for our forest birds! While this is considered a “final report”, the County of Hawai'i Waiwai grant made it possible for the LOHE/Ulumanu project to initiate and maintain this ongoing effort that will be supported in the long-term by leveraging additional sources of financial support.