

REPORT FOR FY22 HISC FUNDING

Mosquito surveys and larval control on Kauai to further landscape-level mosquito control and protect endangered honeycreepers

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Introduction

Kauai's endemic forest bird species are crashing, with 2 species numbering <500 individuals. A surge of avian malaria, vectored by *Culex* mosquitoes on the Alakai Plateau (the primary refuge for Kauai's native forest birds) is strongly implicated in these declines. Climate change has altered the abundance of larval habitat, increasing *Culex* prevalence in critical forest bird habitat. *Aedes japonicus*, an important potential vector of human and avian diseases, has also invaded the Plateau. Without concerted action to control these vectors, the demise of several forest bird species is imminent.

Landscape-level mosquito suppression can efficiently halt avian declines and protect human health. Incompatible Insect Technique (IIT) uses *Wolbachia*, an endosymbiotic bacterium of arthropods, to engender infertility through cross-matings. Sustained releases of male mosquitoes infected with incompatible *Wolbachia* suppress wild populations. To gain regulatory approval for releases in Hawaii, and achieve successful deployment and suppression, key ecological parameters of wild target mosquito populations (e.g., distribution and density) must be assessed. A key finding from our HISC-funded work and work by other partners is the tremendous variation in these parameters within and among years and sites. In FY21, HISC, American Bird Conservancy (ABC), and National Fish and Wildlife Foundation (NFWF) funded a year-long survey at 3 sites across the Plateau. USFWS funded surveys of these same 3 sites through most of FY22 and we have funds to conduct comparative studies on Maui and Hawaii Island, with HISC providing supplemental funding for larval surveys and new male-focused trapping to inform IIT. Meanwhile FY21 mosquito and bird studies suggest trapping of adult mosquitoes at a fourth site and more larval surveys are warranted because a) mosquitoes appear to be breeding in core forest bird areas and b) the fourth site may be more resistant to mosquito invasion than other sites and thus provide the last refuge for these birds; this hypothesis needs to be investigated and will be largely funded by ABC/NFWF. Furthermore, akikiki numbers are plummeting so quickly that we needed to identify larval habitat in which we can hand-broadcast the mosquito larvicide Bti to immediately reduce mosquito numbers while we await landscape implementation of IIT. This activity was jointly funded in FY22 by HISC and PIFWO, while HISC provided funds to help coordinate the logistics of these diverse grants.

Aims

- 1) Examine relative abundance of mosquitoes
- 2) Investigate disease prevalence of adult mosquitoes
- 3) Locally control mosquitoes
- 4) Conduct public outreach on danger of introduced mosquitoes and potential of IIT

Methods and Results

Significantly fewer HISC funds than requested were received and much mosquito research on Kauai was funded by other sources (PIFWO and NFWF/ABC). HISC funds received were used for field work in fall 2022, and data management, project coordination, logistical support and outreach for the three mosquito-related grants we received for 2022. As the needs for data to inform mosquito control progressively ramp up and continue to pivot, it has been critical for field crews to have additional support in the planning and execution of project goals.

1) Examine relative abundance of mosquitoes

In the start of 2022, trapping of adult *Culex* continued at three previously monitored sites, funded by PIFWO. In March 2022, we began additionally trapping at Mohihi, a previously unmonitored site, with funds provided by ABC/NFWF. This remote site is often difficult for helicopter operations due to its location. Crews were able to successfully trap at this location 4 times throughout the year. The planning and successful execution of these trips were in part thanks to the logistical support that HISC provided to field crews.

With recommendations from our partners, in Fall of 2022, the study switched gears from assessing relative abundance of females to focus on male trapping in preparation for marked-release-recapture (MRR) trials, which is an important piece of the incompatible insect technique (IIT). Male capture experiments use BG-Sentinel 2 traps and a variety of lure combinations, in addition to trap placement within habitats where males would most likely be present. Lure combinations used include CO₂, octenal, sound lure, and floral lure. The sound lure broadcasts the female *Culex* wingbeat frequency in order to attract males. In December 2022, HISC funds supported seven nights of experimental trapping at the National Tropical Botanical Gardens in Kalaheo. In total, we caught, counted, and sorted 11,177 *Culex* mosquitoes, 22 of which were male (199.1 females/trap-night and 0.39 males/trap-night). These were some of the first males caught on Kauai or Maui. Of the males caught, 19 were captured using CO₂+sound lure, 1 male was caught using just CO₂, and 2 males were caught in traps deployed with no lure.

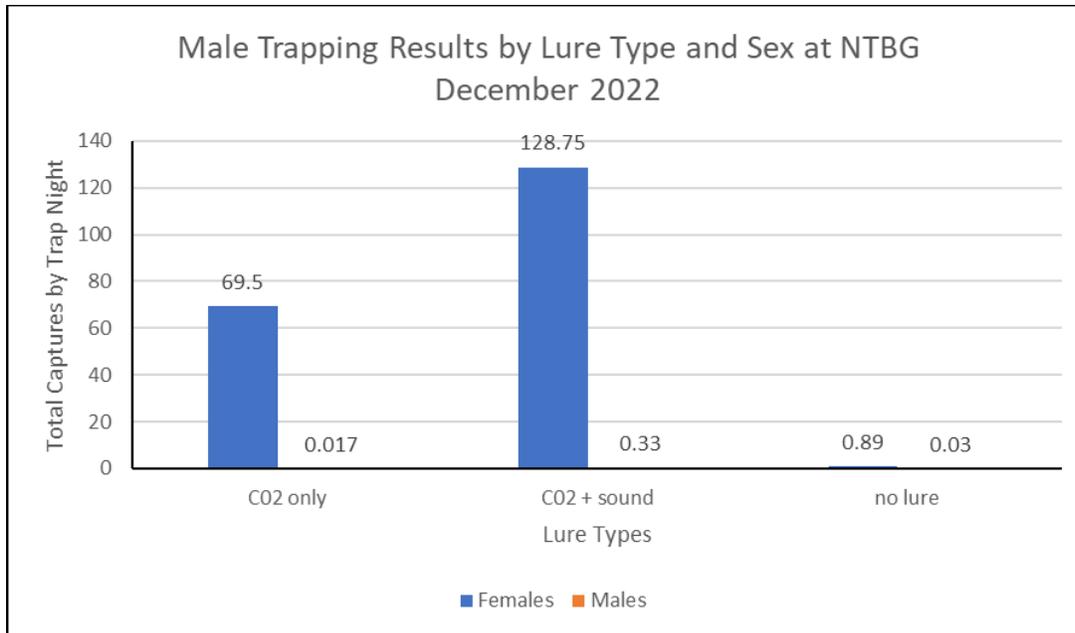


Figure 1. Male trapping results by lure type from the National Tropical Botanical Gardens (NTBG) during December 2022.

2) Investigate disease prevalence of adult mosquitoes

Throughout 2022, 649 specimens were processed and sent for analysis. The majority of samples were sent to Jeff Foster at Northern Arizona University. Specimens collected from Mohihi and Halepa’akai were sent to Renee Bellinger. Specimen collection was paid for with funds from other proposals given reduced budget, while some preparation was funded by HISC. Analysis reports have not been received for 2022 samples.

3) Locally control mosquitoes

In our efforts to locally control mosquito populations, we have been hand-applying Bti to active larval pools. Using maps to assist in scouting efforts, crews equipped with larval dippers inspect all potential larval habitat encountered. All data is recorded in Survey123, this includes both active and inactive larval habitat. Active larval habitat is then treated with Bti, using application rates recommended by the vendor. When applicable, crews will revisit treated pools within 48 hours to monitor the effectiveness of the Bti application. In November 2022, crews funded by HISC hosted a volunteer weekend in Koke’e to scout for larval sources and check in on previously monitored pools. We continued to search for larval pools through December 2022. In total, 22 new larval pools were dipped for larvae (Figure 2). Of these 22, 12 pools contained larvae of varying species. Crews positively identified 2 pools containing *Culex* larva, 2 pools with *Aedes*, and 8 pools with unknown species.

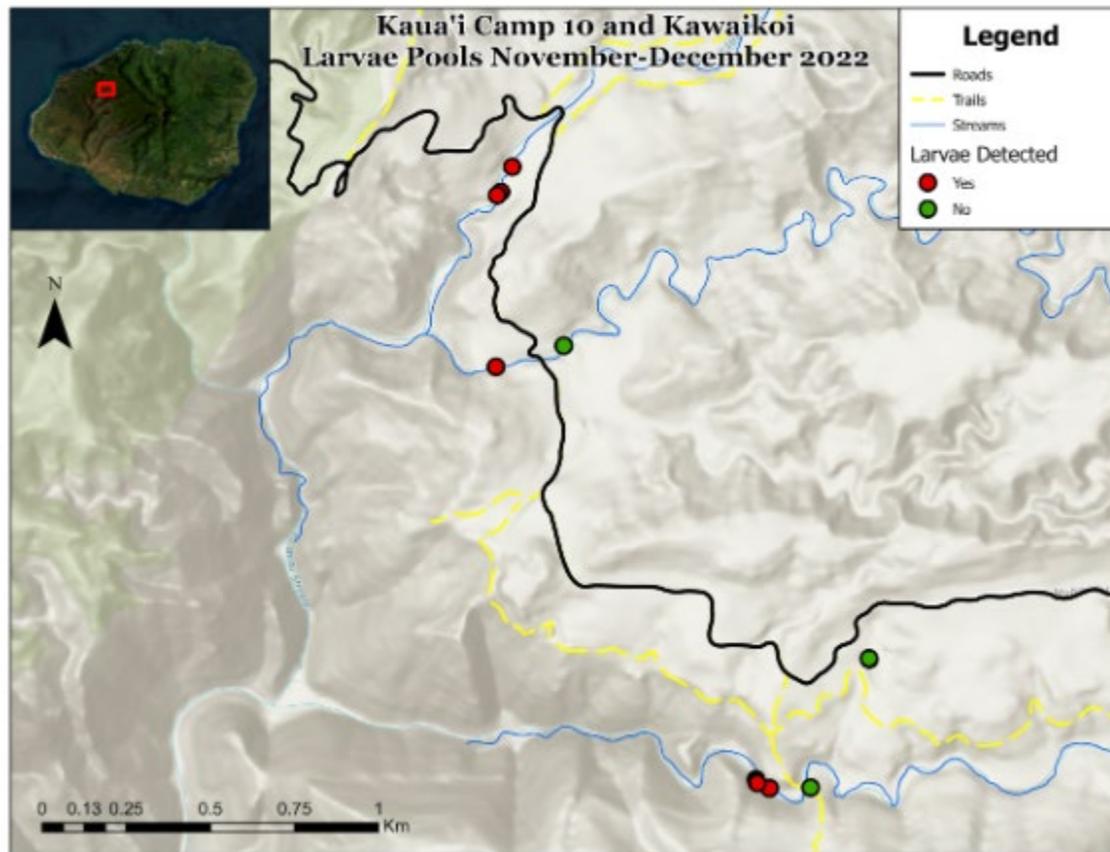


Figure 2. Mosquito larvae pools surveyed during November-December 2022 with HISC funds in the Kawaikoi/Camp 10 area, Kauai

4) Conduct public outreach on danger of introduced mosquitoes and potential of IIT

Outreach was conducted through various channels: see 7) in outcomes below.

Outcomes

1) Purchase new traps and supplies

Funds were used to purchase various trapping and camping supplies. These supplies include new BG-Sentinel 2 mosquito traps, along with the following trapping accessories: regulators, tubing, bug dorms, octenal lure sticks, and trap replacement parts. Camping supplies purchased include paracord, webbing, and propane.

2) 2000 m of larval habitat sampled at each of 2 sites, each 8 times/year, to determine relative abundance of larvae and to monitor hand broadcast of Bti

See Aim 3) above

3) Larval and adult mosquitoes collected for disease and isotope analysis (estimate we will collect a several hundred larvae and a hundred adults).

See Aim 2) above

4) Control of mosquitoes using physical removal and the biolarvicide Bti

See Aim 3) above

5) Graphs of relative mosquito abundance over time, which will be compared to other sites on Kauai, Maui and Hawaii Island.

Funded by other proposals given reduced budget

6) Analysis of factors including site, date, and LiDAR-derived forest habitat metrics that may affect mosquito abundance in time and space.

Funded by other proposals given reduced budget

7) One press release, 3 social media posts, 2 outreach events, 1 classroom presentation, 1 public speaking engagement, 1 educational material (e.g., video).

In September 2022, Dan Dennison, Senior Communications Manager with Hawaii Dept. of Land and Natural Resources, visited the Camp 10 trapping site. Following his visit, a press release was published on September 7, "KAUA'I MOSQUITO SURVEY TEAMS AT THE FOREFRONT OF AVIAN MALARIA DETECTION". In addition, two educational videos were released titled "Avian Malaria Control Begins with Surveys & Testing" and "Kaua'i mosquito trapping".

Outreach events took place in October and July 2022. Staff visited Kipu Ranch Adventures to educate and inform tour guides on the state of the forest birds and mosquitoes, what we are doing to suppress mosquitoes, and what the public can do to support this project. The goal of this outreach event was to inform tour guides so that they can accurately disseminate information to their guests.



Figure 3: KFBRP staff member Allison Cabrera poses with Sierra Club volunteers.

In partnership with KISC and the Sierra Club, staff led volunteers on a larval scouting trip on the Pihea trail (Figure 3). This outing served to both inform the public and identify potential larval pools on a heavily trafficked trail in Koke'e State Park.

One public speaking event took place in May 2022, in partnership with Birds, Not Mosquitoes. This was a virtual talk story, focused on state-wide mosquito suppression through *Wolbachia* and IIT.

In April 2022, staff participated in an outdoor education day in Koke'e State Park in coordination with Hawai'i Technical Academy. Staff led multiple groups of students through forest bird habitat. Students were introduced to the negative influence of mosquitoes on native forest bird populations and were educated on ways they can help further the goals of the project.

All social media posts were generated using funds from other grants.

8) One presentation to the Hawaii conservation community (e.g., at Hawaii Conservation Conference or Hawaii Forest Bird Symposium).

We gave a presentation at the Hawaii Conservation Conference in July 2022, which was funded by PIFWO. The 10-minute, virtual talk and PowerPoint, titled "Establishing a Foundation for Monitoring and Mitigation of *Culex quinquefasciatus* on Kaua'i" was given by Allison Cabrera.

In March 2022, Project Leader Cali Crampton provided members of the Kaua'i Conservation Alliance with a presentation, highlighting updates on the mosquito project and our collaboration with Birds, Not Mosquitoes.