2024-2025 Florida Coordinating Council on Mosquito Control

FDACS Grant Research Abstracts

- Below are the final report abstracts for the research completed for the 2024 -2025 fiscal year. If you are interested in reading the complete report, please contact Caitlin Gill: Caitlin.Gill@fdacs.gov
- If you have specific questions regarding the research, please reach out to the researcher directly.

"Accessible 3D LiDAR for Precision Mosquito Control"

FDACS Contract# 31263

Principle Investigator: Lindsay Campbell lcampbell2@ufl.edu

Key Words: LiDAR, mapping, precision, control

Abstract:

Mosquito control is a major priority in Florida where multiple mosquito species transmit viruses important to human and animal health. However, current abatement strategies most often apply pesticides across large areas without the ability to visualize the finescale topographic and hydrological features that can affect the distribution and densities of mosquitoes. Past obstacles to identifying finescale variation have been the lack of availability of very high-resolution satellite imagery. Advances in geospatial technologies, in particular 3D LiDAR point cloud data, now provide the resolution needed to capture finescale changes in elevation, terrain, and hydrological flow across areas, and this information has been shown to be useful to identifying medically important mosquito habitats. However, 3D LiDAR data is not an "out-of-box" product for mosquito control programs. Multiple challenges can prevent acquisition and use, including cost of acquisition, specialized technical skills needed for data processing, data size, and knowledge about derivation of hydrological layers relevant to mosquito control operations. These obstacles have limited the application of these technologies in mosquito control programs. The objectives of this project are to provide freely available and easy-to-use very high-resolution digital terrain and hydrological indices to mosquito control programs in Florida. We will leverage recently available 3D LiDAR data available through the Florida Geospatial Open Data Portal and the U.S. Geological Survey to provide the greatest coverage available for the state of Florida. Resulting data layers will be made available through an interactive online dashboard hosted on the University of Florida network where mosquito control programs can visualize or download digital terrain models (DTMs) and hydrological indices. Training materials providing step-by-step instructions including screenshots will demonstrate how to view the data on the dashboard, download data, and how to process 3D LiDAR data using raw files. The result will be an accessible tool that mosquito control programs can use to target surveillance and control activities and to understand the distributional biology and ecology of medically important mosquitoes to reduce transmission risk to humans and livestock in Florida.

"Identifying the preferred plant sugar meal sources of *Aedes aegypti* in residential areas, with a focus on plants available from local nurseries and garden centers."

FDACS Contract # 31236

Principle Investigator: Dr. Edwin (Ted) Burgess edwinburgess@ufl.edu

Key Words: *Aedes aegypti*, plant feeding, mosquito control, entomology

Abstract:

Sugar feeding is an obligatory behavior of mosquitoes and plants most often provide this sugar. Like other plant feeding insects, mosquitoes most likely have preferences. The ability to describe these preferred plants on an ecological scale is of significance to operational control efforts but has eluded researchers. With better understanding of the plant sugar meal preferences, more targeted approaches could be made for control efforts and exclusion of preferred plants might also exclude targeted vectors. The proposed project will identify the plant species that Ae. aegypti uses for sugar meals in residential areas and determine how those plants impact survival through their nutritional resources. Identification of plants the mosquitoes have fed on will be done molecularly using a novel DNA extraction protocol developed in the lab of PI Burgess, and a Nanopore next-generation sequencing platform that can process samples in a high throughput manner using established plant barcoding primer sets. Identified plants will then be purchased from local nurseries and garden centers and survival experiments will be run to determine to what extent each plant can sustain Ae. aegypti longevity. This project builds on already established work in the lab of PI Burgess looking at molecular detection of plant sugar meals in Culex quinquefasciatus. This project will result in outreach resources and recommendations that mosquito control districts can use for plant recommendations to homeowners that may help reduce Ae. aegypti populations in their neighborhoods.

"Mosquito sugar feeding for vector control and arbovirus detection in Florida."

FDACS Contract # 30274

Principle Investigator: Dr. Nathan Burkett- Cadena nburkettcadena@ufl.edu

Key Words: surveillance, risk prediction, emerging pathogens, mosquito surveillance, mosquito control

Abstract:

Effective mosquito control and arbovirus surveillance remain critical challenges for public health and environmental sustainability. To address these needs, we developed and evaluated two integrated systems that leverage mosquito sugar feeding behavior: (1) a membrane-based attractive toxic sugar bait (ATSB) system, and (2) a low-cost, RNA extraction-free platform for arbovirus detection using colorimetric RT-LAMP. The membrane-based ATSB system enclosed a toxic sugar solution within a perforated membrane designed to restrict access by non-target nectar feeders while allowing consistent mosquito feeding and ingestion-based mortality. Laboratory and semi-field trials demonstrated >80% feeding success and near-complete mortality in *Culex quinquefasciatus* when exposed to propylene glycol, dinotefuran, or spinosad. Importantly, non-target species such as butterflies and honey bees showed no evidence of feeding, confirming the system's selectivity and potential for reducing ecological risk. In semi-field trials using BG-GAT traps, we observed 100% mortality in gravid *Cx.quinquefasciatus* and ≥91.7% mortality in host-seeking *Aedes aegypti*, with no loss in trap

attractiveness. For arbovirus surveillance, we evaluated a field-deployable diagnostic tool that collects infectious mosquito saliva using synthetic swabs. Diagnostic-grade flocked swabs yielded >10-fold higher West Nile virus (WNV) detection rates compared to cotton swabs, and phosphate-buffered saline (PBS) proved more stable and suitable as a transport medium than AVL buffer. Colorimetric RT-LAMP reliably detected intact WNV and Everglades virus (EVEV) without RNA extraction. The assay achieved 91.7% sensitivity relative to RT-qPCR (100%), with consistent WNV detection of infectious mosquito saliva from swabs across multiple independent trials. In a field deployment at four sites in Vero beach, Florida, we identified potential WNV positive swab samples by RT-qPCR, demonstrating the feasibility of this approach for operational surveillance. Together, these findings support an ecologically responsible mosquito control method and a field-compatible, rapid arbovirus surveillance tool. By integrating a selective toxic bait system with swab-based, RNA extraction-free colorimetric RT-LAMP, this approach offers a practical and environmentally sustainable solution for reducing vector-borne disease transmission in Florida.

"Non-target impacts of mosquito larvicides and adulticides to Florida honey bees (*Apis mellifera*)"

FDACS Contract # 30275

Principle Investigator: Dr. Cameron Jack cjack@ufl.edu

Co- Principle Investigator: Dr. Jamie Ellis jdellis@ufl.edu

Key Words: *Apis mellifera*, honey bee, mosquito control, adulticide, larvicide

Abstract:

Effective mosquito control is essential to Florida residents, as the state's environment and climate are ideally suited for mosquitos, though it is possible that some mosquito adulticides and larvicides administered by operators could have non-target impacts, including honey bees. Currently, not much is known about how simultaneous exposure to these chemicals in realistic field scenarios will impact overall honey bee colony strength. Moreover, the toxicity and impact of these products on bees in the laboratory is not well understood. The overall goals of this study are to assess the impacts of mosquito control adulticide and larvicide application practices on honey bee health in both field and laboratory settings, as well as determine the amount of these products residues that contaminate honey bee colonies matrices. First, by placing 15 colonies in areas that are treated with truck-based application of ULV mosquito adulticides and water-administered larvicides, we did not find significant differences in colony mortality or health strength parameters between colonies located in treated and control sites, as well as no direct impact of a spray event was observed in adult bee mortality. By sampling nectar, pollen, wax and honey bee larvae and subjecting the samples to residue analyses, we found some mosquito control products residues in hive matrices but at a low concentration (from 0.03 to 70.99 ng/g). Secondly, we determined the acute and chronic toxicity of mosquito control treatments (active ingredients and formulations products) on honey bee larvae reared *in vitro* and caged adult bees in laboratory assays. Toxicity endpoints were determined to estimate a risk using the U.S. EPA's Bee-REX tool. Finally, all our results were shared to beekeepers both locally and nationally through research conferences and beekeeper association. Our results provide immediate feedback to both mosquito control programs and beekeepers on how to work together to improve outcomes for all.

“Synergistic effects of exposure to thyme oil and its major component, thymol, enhance sensitivity to permethrin in resistant *Aedes aegypti* mosquitoes of Florida.”

FDACS Contract # 30352

Principle Investigator: Dr. Eric Caragata e.caragata@ufl.edu

Abstract:

The increasing detection of permethrin insecticide resistance in Florida mosquitoes has hampered efforts to control populations of nuisance biting and disease vectors around the state and increased the risk of outbreaks of arboviral disease. Accordingly, there is a clear need to improve the efficacy of current control strategies and to support those strategies by developing novel tools and programs to control mosquitoes, particularly those that are already demonstrating resistance. Increased usage of repellents for spatial or personal purposes, and the identification of novel repellents are two such strategies which could help to overcome resistance. In this project, we have investigated the synergistic effects of thyme essential oil and its major component, thymol, on susceptibility to permethrin in two populations of *Aedes aegypti* mosquitoes from Key West and Vero Beach Florida. These essential oils have both repellent and mosquitocidal activity. Via CDC bottle bioassay, we determined that the Vero Beach population was less susceptible to permethrin. Through a series of experiments, we developed and then optimized protocols for delivering thyme oil or thymol to mosquitoes either prior to permethrin exposure or simultaneously via incorporation into a standard bottle bioassay, modulating the delivery environment, delivery medium, and dosage of either essential oil. We determined that even low doses were sufficient to cause rapid mortality in our mosquito populations. After sequential exposure of essential oils and permethrin, we observed that thyme oil appeared to have an antagonistic interaction with permethrin, however thymol has a synergistic effect. Interestingly, similar effects were not observed during co-exposure experiments, suggesting that the timing and methodology of delivering thyme-derived compounds can modulate interactions with permethrin.