Final Report

FY2019 HISC Project: "Building Research and Technology Capacity in Invasive Plant Management" (PO #C91197)

PI: James K. Leary; transitioned to Daniel M. Jenkins April 2019 following James K. Leary accepting a position at the University of Florida

Objectives

Initially our primary objective was to enhance the capacity for managing incipient populations of *Miconia calvescens* (miconia), through new standardization of new tools including aerial delivery of herbicide ballistic technology (HBT) from unmanned aerial systems (UAS), and operational methodologies for evaluating biological and economic outcomes of containment strategies.

Over the course of the project we encountered several challenges including departure of the original project PI (James Leary) and the key team member (Roberto Rodriguez) responsible for development of UAS related capacity, and identified current limitations on UAS operation (i.e. line of sight) as a major constraint on the potential impact of UAS-HBT for the foreseeable future. In parallel other opportunities for managing invasive organisms through UAS have been identified (i.e. little fire ant and other invertebrates). As a consequence our objective has been to develop versatile capacity for applying a suite of formulations including sprays, granular materials, and atomized "fogs" for example to control adult mosquitoes in the event of a new species invasion.

Outcomes

To establish capacity for continuing UAS operations including dispensing chemicals from UAS, the new PI has acquired remote pilot license through CFR part 107, and we have extended our FAA exemption (within CTAHR) for operation of UAS for agricultural services, including aerial applications of materials / chemicals.

We are also leveraging funding from USDA-APHIS to purchase a commercial UAS system (PrecisionVision22 from Leading Edge Aerial Technologies) with interchangeable payloads including liquid spray tank / boom / nozzles (up to 10 liter), granular applicator, and an "adulticiding" system designed for atomizing a very well defined fog of droplets (near 50 micron) for applications such as controlling adult mosquitoes, i.e. to try to contain any introduction of Aedes aegypti. The system includes flight software and avionics package that enable precision programmable flight paths and delivery rates, as well as manual operation for spot treatments. While the COVID-19 disruption has delayed progress in completing this transaction, related training, and permitting through FAA and local pesticide brance, we are in the course of executing these activities.

We also used some funds from this project to support costs to convert space in AEI 124 formerly assigned to a faculty member who retired in 2019, into a storage / hangar / system development and maintenance facility for UAS and related specialized electronic systems and accessories. Work included the assembly of several custom workbenches, repair of AC ducting and pneumatic delivery system for compressed air, and assembly of new shelving (after demolishing old waterlogged cabinets, repainting and installing new flooring paid for from indirect cost accounts of the PI). This facility is climate controlled and suitable for storage of agricultural chemicals as part of establishing capacity for delivery of payloads by UAS- for example it may significantly extend the functional life of stored projectiles for HBT.

As the project was initially related to HBT, during the course of the project the HBT also designed a new iteration of the HBT-telemetry system to be integrated in person-operated HBT markers to record origin and trajectory of every projectile discharged in HBT operations. The key improvements of this design were to incorporate much more efficient power regulation so that the system and required battery are significantly more compact, and to incorporate additional layout techniques for noise suppression (to enhance the quality of data). These designs including a prototype are available for use when manned HBT operations resume pending transfer of permitting to new personnel. The PI is committed to ensuring smooth transfer and support of this technology to HISC.

For evaluating outcomes (biological and economic) of different miconia (and other invasives) containment strategies, a spatiotemporal invasion model was developed in R Studio that simulates the growth and diffusion of a miconia population from a single mature tree over a 20-year time horizon. A 25-yr management data set that identifies the location and time of each M. calvescens individual eliminated was used to develop the invasion model, and use information on treatment costs and potential avoided damages to assess the relative benefit-cost ratio of a management strategies such as inaction, containment, and asset protection, under a number of East Maui Watershed-informed biological and economic parameters. The model is able to successfully reproduce miconia invasions in an illustrative environment and incorporates life history traits and stochastic elements such as long-di stance dispersal events.

Publications

Lewis, D, Wada, C., Burnett, K., Leary, J., and B. Mahnken. Containment versus Asset Protection Strategies for an Invasive Plant Species: Miconia calvescens in East Maui, Hawaii. In Pullaiah, T. and M. Ielmini (eds.) Invasive Alien Species, Wiley International (in press)

Rodriguez, R., D. M. Jenkins, J. K. Leary, and R. Perroy. 2020. Direct geolocation of features in unmanned aerial system acquired imagery. Journal of Applied Remote Sensing (under review)