Report by E.M. Villalobos, UH Honeybee Project
Project title: *"Beekeeper organization and cooperation: Our "best shot" against Africanized Honeybees"*

In this project we proposed to provide tangible services to the beekeepers to generate interest and appeal to the public's good nature to reduce the risks of Africanized bee introduction. A big part of this project aimed to connect with stakeholders to address local needs with respect to bee health.

Our approach was designed to emphasize the productivity and health of our local colonies, and assist beekeepers reach a higher level of economic success with the current bee stock. Promoting and supporting the health of local bees is expected to result on a satisfied community that will be less likely to engage in risky behaviors such as illegal introduction of used equipment, honeybee colonies, foreign queen bees and/or semen. These goals are being achieved via 2 projects that are still ongoing and have generated great interest and participation among the beekeepers:

1-Awareness of the high quality of local bee stock.

Hawaii is unique in that it hosts a population of European Honeybees in a subtropical climate. In the rest of the United States and Latin America, the tropical and subtropical areas now have Africanized honeybees and the producers must work hard at controlling the impact of this hybrid bee in their bee yards.

However, in 2008 a bee pest, the Varroa mite, and associated viruses began decimating the feral bee population of Oahu and Big Island. Managed colonies were also affected, and despite mite treatments, beekeepers lost approximately 50% of their colonies in the first few years after the invasion.

The UH Honeybee Project provided support in the testing and selection of organic treatments against the mite, and bee losses began to subside. Over time, due to the cost and difficulty of transport of treatments, the beekeepers began reducing the frequency of treatments. This was especially common during the pandemic, and now we find that a lot of stakeholders are not treating against the mite. This would have been a very worrisome situation, expect that in recent years, scientists and beekeepers have confirmed that when honeybees are given the opportunity, they can develop varroa-resistance naturally i.e., without human interference. The key to this resistance is changes in the hygienic behavior of worker bees allowing them to detect and remove bee pupae infested with Varroa, thus reducing the pest population in the colony. There are studies and records, in multiple countries, of managed and feral colonies that have not received treatment for 5 to 10 years and continue to thrive.

When we began to chat with beekeepers to discuss their perception of the mite situation on Oahu (as part of the effort to examine local bee quality, with support from this grant and additional funding from WSARE, and in collaboration with Dr. Stephen Martin from the UK) and we discovered that many colonies in Hawaii were exhibiting the hygienic behaviors that result in natural resistance against this important bee pest.

We held several in-person meetings, and a few online, (see list below) and we were able to get stakeholder collaboration and conduct apiary visits to collect samples that confirmed the development of the recapping behavior here in Hawaii. Detection of bees infested brood, removal of diseased brood, and to recapping the cells containing healthy brood are all behaviors linked to the evolution of natural mite resistance. The response to the news about the bees' behaviors has been great and everyone seems proud of the local stock and reassured that they are heading in the right direction, which is precisely the kind of sentiment that is needed to promote biosecurity. We are currently working on an extension handout that will credit both HISC and WSARE for their support.

2-Testing the impact on bee health of synthetic sheets for small hive beetle control.

To support bee health and the quality of local honey we decided to explore, in collaboration with an Argentinian researcher, Dr. Micaela Buteler, the potential contamination derived from using microfiber sheets inside the hive to trap an invasive pest, the small hive beetle, *Aethina tumida*.

Management of the beetle often includes the use of in-hive traps of different kinds, and one of those traps is as non-woven microfiber wipes. As the bees attempt to remove the foreign object by chewing it the wipes become fuzzy and fray to the point where beetles become entangled in their fibers. The study we conducted aimed to examine the composition of these microfiber sheets and to evaluate whether their use resulted in unintended MP contamination of bees and honey.

This study illustrates how in our hopes to control invasive species, the industry may sometimes select strategies that also have unintended consequences. Much like

pesticides, micro-plastics have sublethal effects on many organisms. Micro and nano plastics are found in air and in water, however, we hope that our study will promote a greater understanding of how they may contribute to contamination in a valuable hive product, honey. Microplastics are also involved in microbiome alterations, and the immune system of bees may be affected by these residues. Given that there are other ways to control the small hive beetle that do not involved pesticides or microfibers we hope our work will result in a decrease in their use.

The study has been submitted and accepted with minor revisions in the journal of Environmental Pollution. Manuscript titled: Management practice for small hive beetle as a source of microplastic contamination in honey and honeybee colonies. Authors: Micaela Buteler, Ethel Villalobos, Marina Alma, Leonel Silva, and Juan Pablo Tomba. HISC's funding is acknowledged in the manuscript.

Abstract
Microplastics (MP) have emerged as a widespread environmental contaminant affecting bee health. In this study we report on the impact of one of the cultural practices used to control the small hive beetle (SBH, Aethina tumida). Management of the beetle often includes the use of in-hive traps of different kinds, such as non-woven microfiber wipes. When placed inside the hive, bees chew on these wipes, which then become fuzzy and fray to the point where beetles become entangled in their fibers. The current study aimed to examine the composition of these microfiber sheets and to evaluate whether their use resulted in unintended MP contamination of bees and honey. We treated hives with one blue microfiber sheet placed on top of the frames for at least three months. After that time, we collected adult bees and honey samples from treated hives, control hives in the same apiary (control near), and control hives in an apiary 7.5km away (control far). Honey from treated hives had a significantly greater number of blue MF than honey from the control hives (mean ± SD, treatment 11.83 ± 3.76, control near 2.25 ± 0.92 and control far 0.25 ± 0.5 MF/20 gr honey). Also, hives treated with the microfiber sheets had a significantly greater number of blue microfibers in the gut and cuticle of bees, than the control hives located in a different apiary. However, the control and treated bees located in the same apiary had a similar number of blue microfibers (mean ± SD, treatment 4.7 ± 2.28, control near 3 ± 1.63 and control far 0.5 ± 0.58 MF in 20 bees). Thus, the current study raises concerns of the use of microfibers sheets to trap the SBH as it results in the incorporation of microfibers into the ecosystem and the food chain.

We have yet to make these results widely known to beekeepers, although a few already know, because we wanted to have the paper already published before we do. We feel this requires an in-person presentation with a big extension component.

Biosecurity and Africanized bee screening:

In addition to working on these 2 goals aimed at providing more knowledge and improving bee health in Hawaii, we continue to provide molecular screening services of swarms captured at ports. So far, as you would expect, all negative.

The swarms caught recently have had the perfect mix of a fair number of bees and brand-new comb, only eggs and young larvae, with no drones. This is a big improvement from before.

In addition, for the most part all had pheromone containers that were capped, as opposed to before when the snap-cap was open, and the chemical had degraded.

We have also continued to test trap temperatures under different sun or shade conditions. More data is needed but we have found some interesting trends, traps in the sun can obviously get hotter inside than those in the shade, which would make them less attractive to bees because they would have to invest more energy to keep the nest at a suitable temperature. Traps in full sun can reach temperature peaks that are over 10 ^{0}F greater than those in natural shade in the same ambient temperatures.

The use of plastic corrugated sheets as shading did not give good results as the “roof” did not provide enough insulation and the traps were hotter, possibly because the plastic was a bit translucent under strong light and had a greenhouse effect.

As we continue to gather readings of temperature and humidity, we get closer to understanding how to make swarm traps more appealing to bees from a thermal perspective.

Finally, we are preparing educational materials that will be posted in the already existing landing page for Africanized bees in the UH Honeybee Project. The materials are being developed based on our research, current literature, and our experiences during face-to-face meetings, groups and solo visits, with the stakeholders.
Once we have finalized what we consider appropriate we will run it past members of HISC for approval before posting.

We had group meetings and apiary visits in Oct, 2022, Nov, 2022, Dec 2022 (at UH with presentation by Dr. Stephen Martin from the UK), in Jan 2023, Mar 2023, and Apr 2023.