Transforming the Future of Work for Beekeepers Using Data Science

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BACKGROUND

Pollinators around the globe are in crisis, and the problem continues to worsen (US Pollinator Report, 2015). Traditional approaches to beekeeping have been unable to stem the tide of colony collapse, which has placed stress on the beekeeping workforce. While summer losses have held steady at 20.5%, winter loss figures for 2020 were up 8.9% over the average winter loss (2006-2019). The decline of honeybees impacts both food security and national security. Given this context, the future of work for beekeeping will involve mastering research-driven practices (Kulhanek et al, 2017) that respond to bee health in different landscapes (Patel et al., 2020), and that deploy sensors (Catania & Vallone, 2020). In this planning grant, we focus on a solution related to design and deploy sensor-supported urban beekeeping (Catania & Vallone, 2020) and the K-12 education pipeline.

METHOD

This project: (a) deployed sensors in hives to generate data colony health as monitored by measurement; (b) developed cloud computing capacity to integrate the hive sensor data with field data to scientifically describe pollinator and ecosystem health; and (c) developed K-12 STEM and Data Science-related education and beekeeping career connections.

We designed, developed, and tested colony monitoring technologies. We created a scalable and deployable end-to-end system (sensors, transmitters, storage, analysis, and communications) that will acquire vast amounts of data from multiple sources and make it publicly available for analysis while safeguarding providers' privacy. Using remote monitoring, it is important to monitor three areas:

- *Internal conditions of the colony,* including acoustics, odors, vibration, hive weight, internal temperature, humidity, and video monitoring
- *Hive-adjacent conditions,* including luminosity, length of daylight, external temperature, and precipitation
- *Broader environmental conditions, e.g.,* environmental data that can identify geographical locations for many apiaries; rainfall, solar radiation, and wind velocity; and impact of weather conditions on each colony

IMPLICATIONS

This project involves a multidisciplinary approach to upskill and transform beekeeping with special attention to the education pipeline, which is necessary to prepare students for transformed careers. This project is also a product of a joint effort between the George Mason University (GMU) College of Education and Human Development (CEHD), the GMU School of Business (which houses the George Mason University Honeybee Initiative), and experts on beekeeping, data science, and education.

The future beekeeping workforce request knowledge working with data. This project provide opportunities on:

- data mining
- data modeling
- data architecture
- ETL development

Beekeeping
German Perilla (Co-PI) & Lisa Gring-Pemble (Co-PI), Frank Linton, Jeff Pettis, Andrew Garavito, Mohamed Alburaki

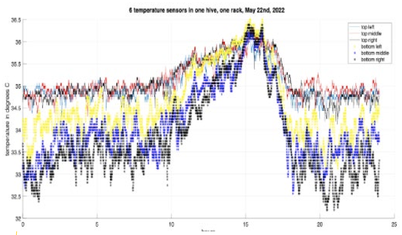
Education
Carley Fisher-Maltese (PI), Maria Bouga, MaryAnn Settlemeyer, Bradley Webster, Amy Krellwitz, Sarah Red-Laird, Regan Wilson

Increase interest in STEM occupations tied to the cultivation of bees by using the crisis of bees to learn about biology and environmental science concepts. Develop the computational thinking practices that students use to fully engage in today's data-rich and interconnected world.

Develop a cloud computing capacity to integrate the hive sensor data with field data (e.g., on phenology) to scientifically describe pollinator and ecosystem health.

Data Science
Daniel Lofaro, Nathalia Peixoto, Franklin Farrell

Dissemination
The whole team



Collate, share, and publish data, videos, and programs that can be used internationally. Information include: live data sets, infographic posters, interactive slides, Q/A page, vlogs, social media, Bee cam, and Bee sounds. We will present in various conferences (e.g., EurBee's 9th Congress on Apidology) and submit publications to peer-reviewed journals.

PLANNING ACTIVITIES

Fall 2021 Virtual panel of experts kick-off meeting

Spring 2022 Virtual panel of experts meeting on technology deployment, challenges, solutions, and education. Moreover, bee activity and hive productivity as illuminated by the data collected by the sensors were shared with the team.

Summer 2022 In-person panel of experts and field team meeting to share updates and report on writing and dissemination. The reports will focus on elements that will help transform traditional beekeeping practices and K-12 education entry points for teachers to prepare students for careers in this area.

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