

Secret Sounds of Bees: Analysis of Honey Bee Vibroacoustics Using Hidden Markov Models

# ANIM040

## Animal Sciences

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Honey bees are an essential part of global food production and revenue. However, pollinators around the world are declining at a rate faster than ever recorded due to pesticides, diseases and pests, and habitat loss. Unfortunately, honey bee colony loss is difficult to prevent because early warning systems for colony health are lacking. I developed an early warning honey bee health detecting system that uses a machine learning model and vibroacoustic signals to provide information about the health of a colony before it is lost. Vibroacoustics are sounds and vibrations that are emitted by bees in response to stimuli and improve our understanding about honey bee behavior and health. In this study, I developed a Hidden Markov Model within MATLAB using a Hidden Markov Model Toolkit for MATLAB (MATLABHTK). Nine health states were included in the model, and 5-minute vibroacoustic signals were recorded at least weekly from 25 hives on my family's farm in Iowa from August-November, 2021. The signals were analyzed using this Hidden Markov Model to predict their colony health. The model was 100% accurate in identifying the signals from the training repository and 92% accurate when the entire collection of 258 audio files from 25 hives was assessed. This model is the first reported model that provides beekeepers with a non-invasive analysis of their colonies' health that identifies vital situations like exposure to volatile chemicals, robbing of a dwindling hive, active honey flows, etc. This model can be used to reduce colony loss rates when combined with mitigation strategies from beekeepers.

1. In this research project, the student directly handled, manipulated, or interacted with (check ALL that apply):

- |   |  |
|---|--|
| <input type="checkbox"/> human participants | <input type="checkbox"/> potentially hazardous biological agents |
| <input type="checkbox"/> vertebrate animals | <input type="checkbox"/> microorganisms                          |
|   | <input type="checkbox"/> rDNA                                    |
|   | <input type="checkbox"/> tissue                                  |

2. I/we worked or used equipment in a regulated research institution or industrial setting (Form 1C): YES  NO

3. This project is a continuation of previous research (Form 7):  YES NO

4. My display board includes non-published photographs/visual depictions of humans (other than myself): YES  NO

5. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only:  YES NO

6. I/we hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.  YES NO

The stamp or embossed seal attests that this project is in compliance with all federal and state laws and regulations and that all appropriate reviews and approvals have been obtained including the final clearance by the Scientific Review Committee.

