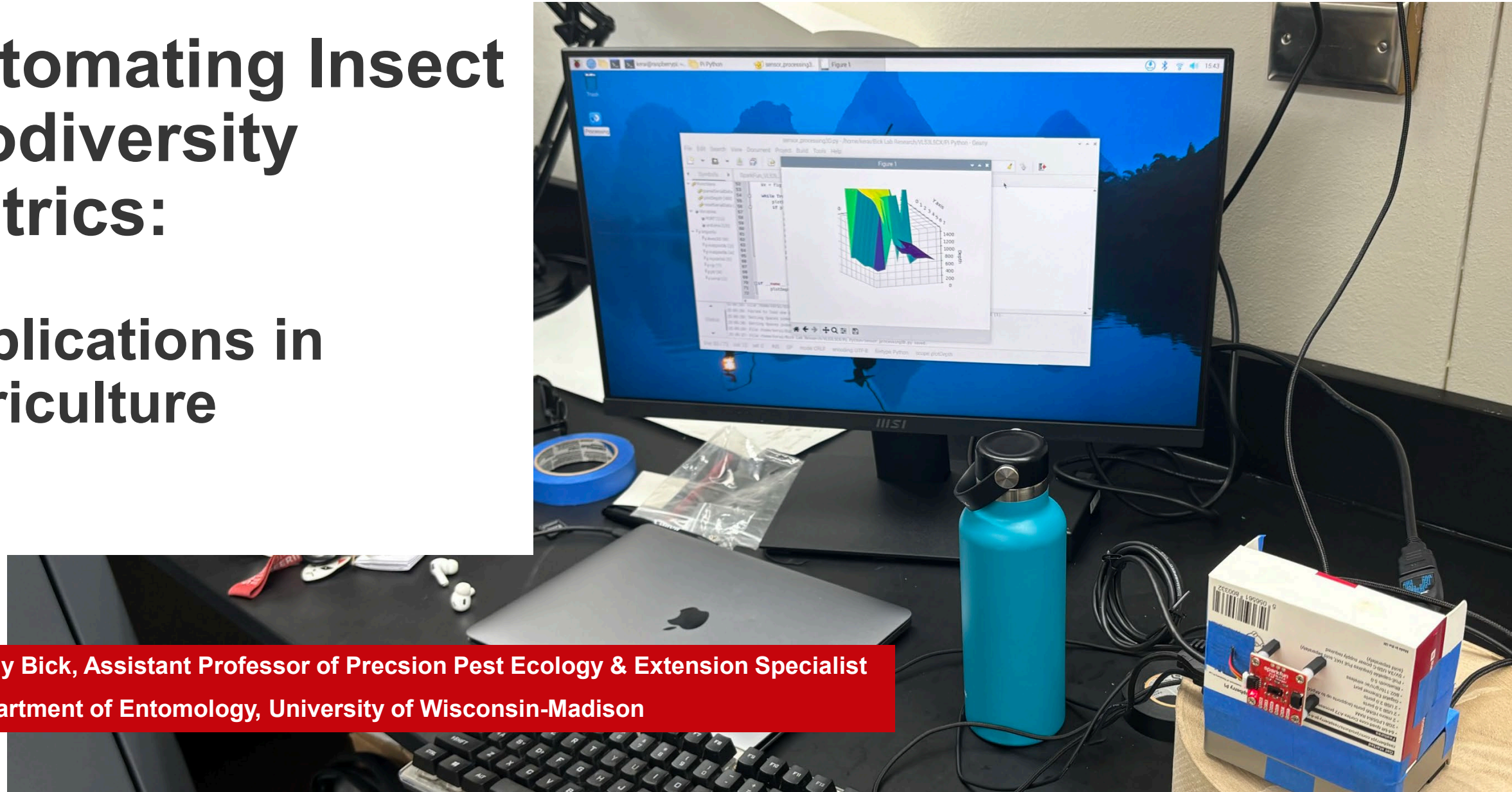
Automating Insect Biodiversity Metrics:

Applications in Agriculture



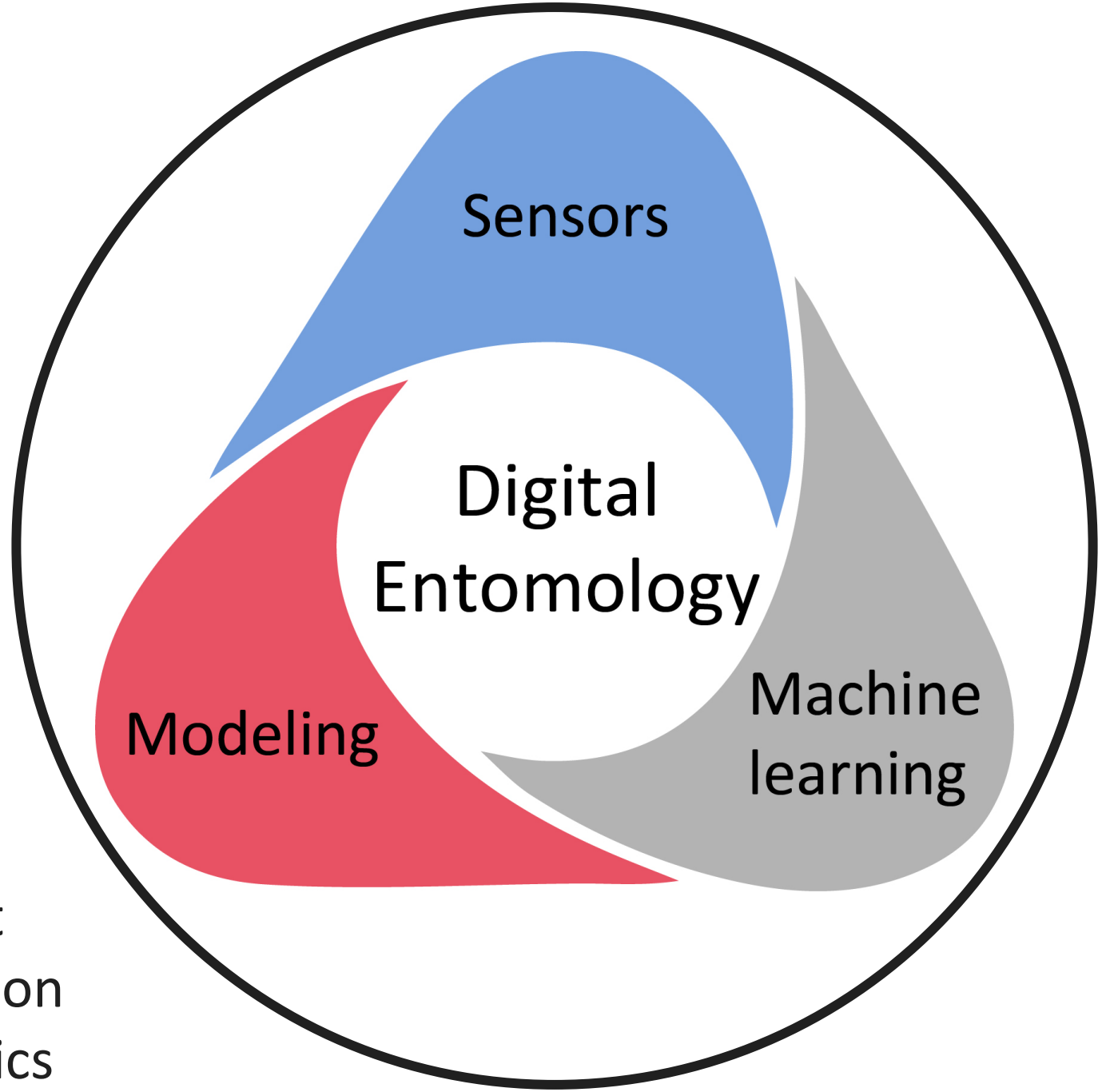
Emily Bick, Assistant Professor of Precsion Pest Ecology & Extension Specialist

Department of Entomology, University of Wisconsin-Madison

Research goal

Develop a fundamental understanding of insect population dynamics,
translate this understanding into novel tools and strategies,
that enable data-driven agricultural decisions

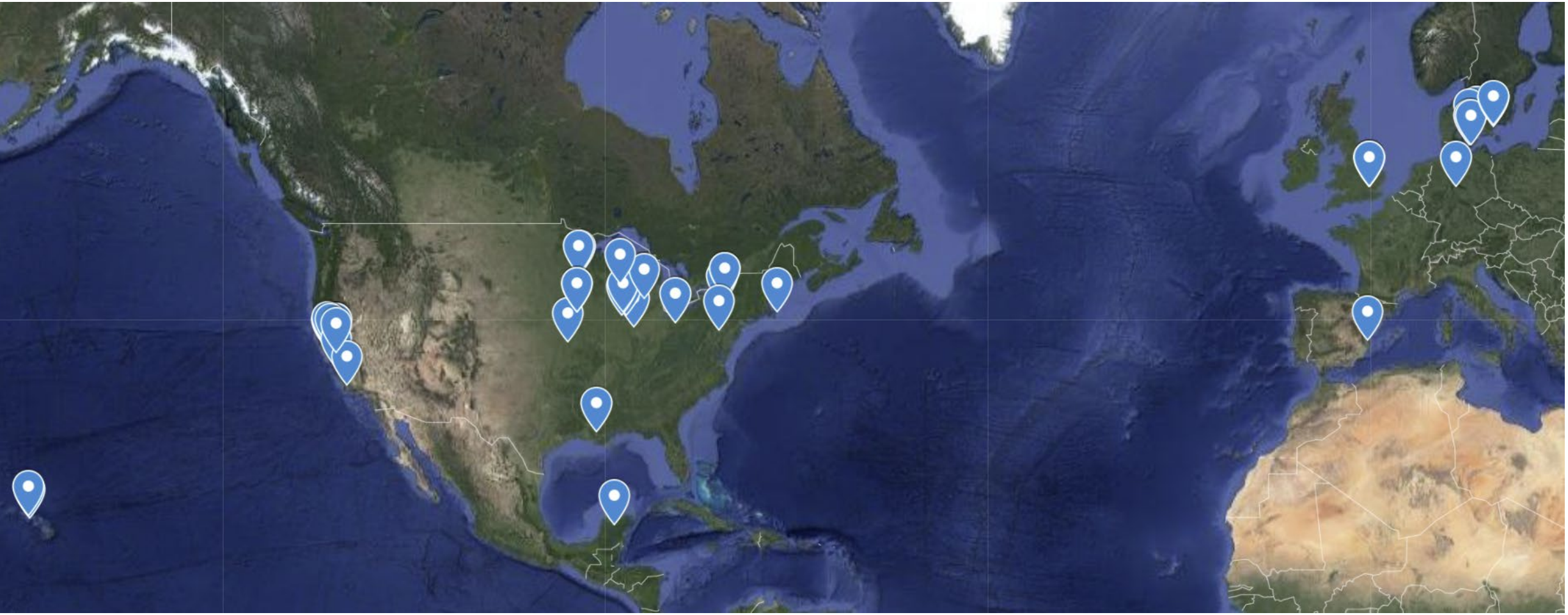
Approach: Digital Entomology



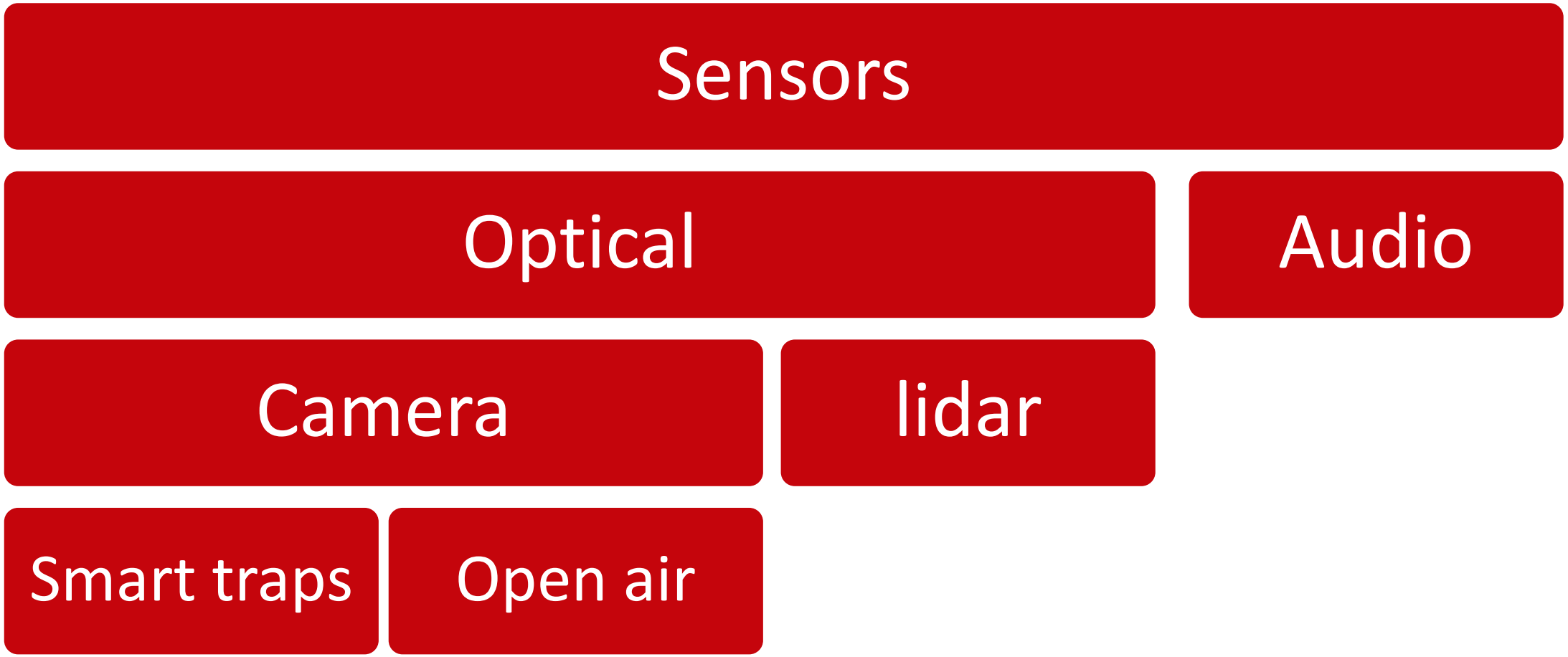
insect
population
dynamics

The Saga Begins…

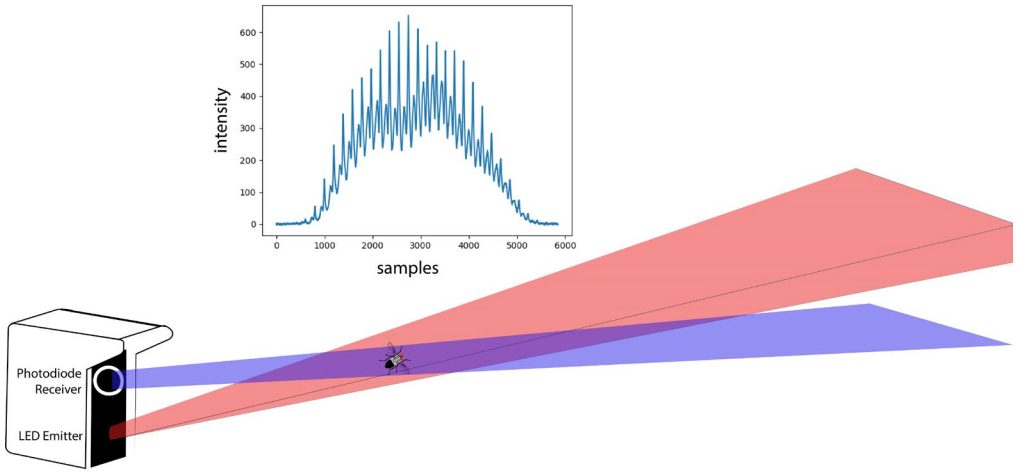
Map of field sites



Automating insect pest monitoring

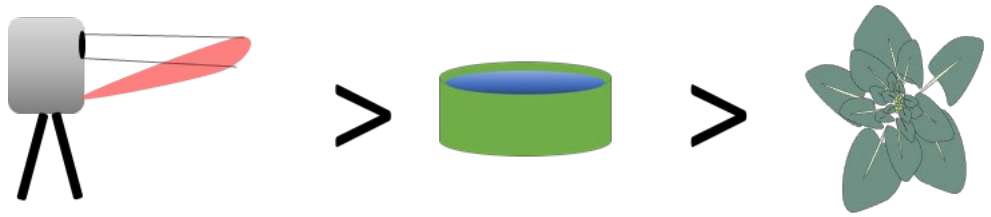


Autonomous Insect Sensor



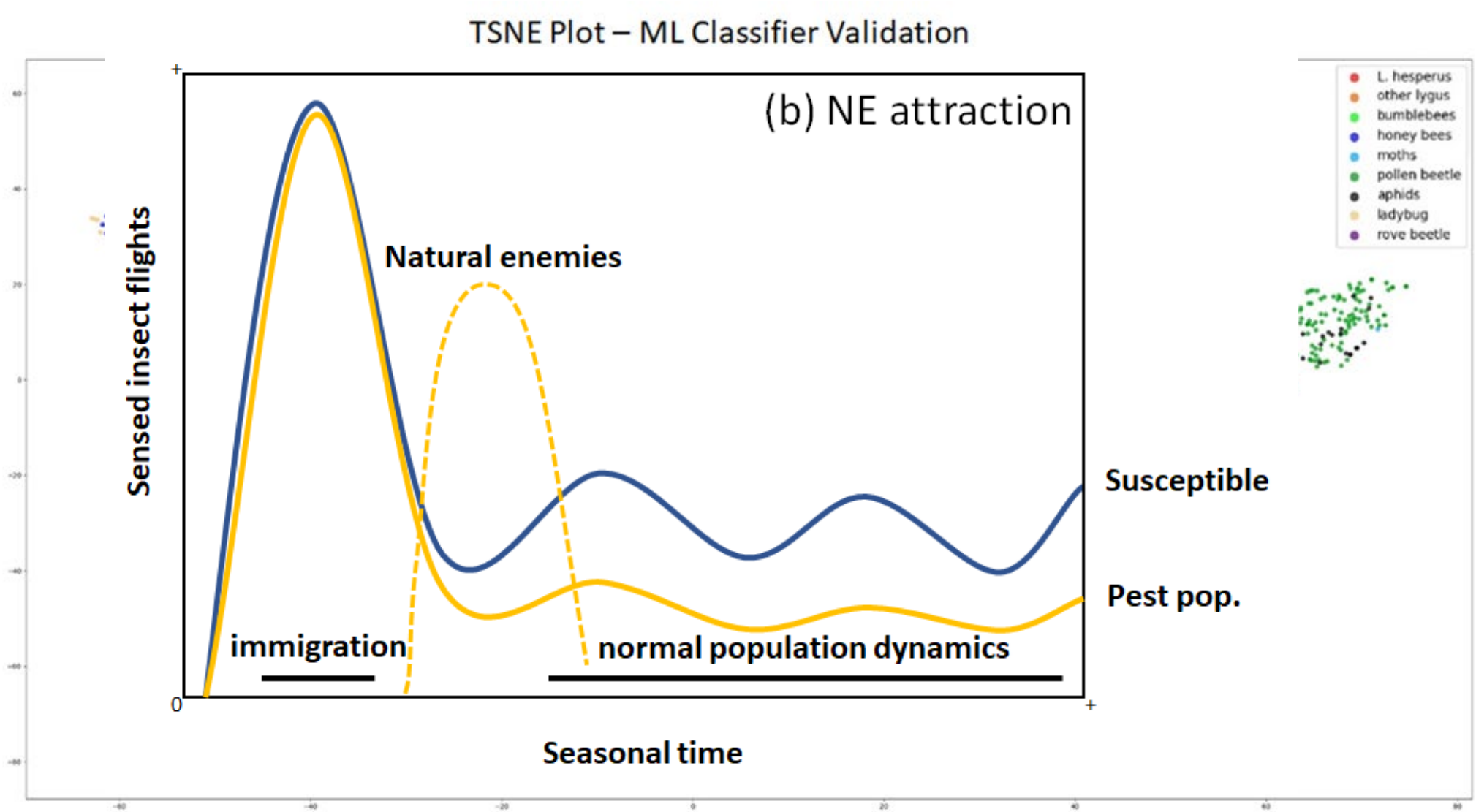
Rydhmer, K., **Bick, E.**, et al. "Automating insect monitoring using unsupervised near-infrared sensors.“ Scientific Reports (2022).

Monitoring efficiency



Bick, E., et al. “Dynamics of pollen beetle immigration and colonisation of oilseed rape (Brassica napus) in Europe.“ Pest Management Science (2023).

Insect Species Identification



Gibson, K., Bick, E., Gepts, P. BIC/NAPIA 2022.

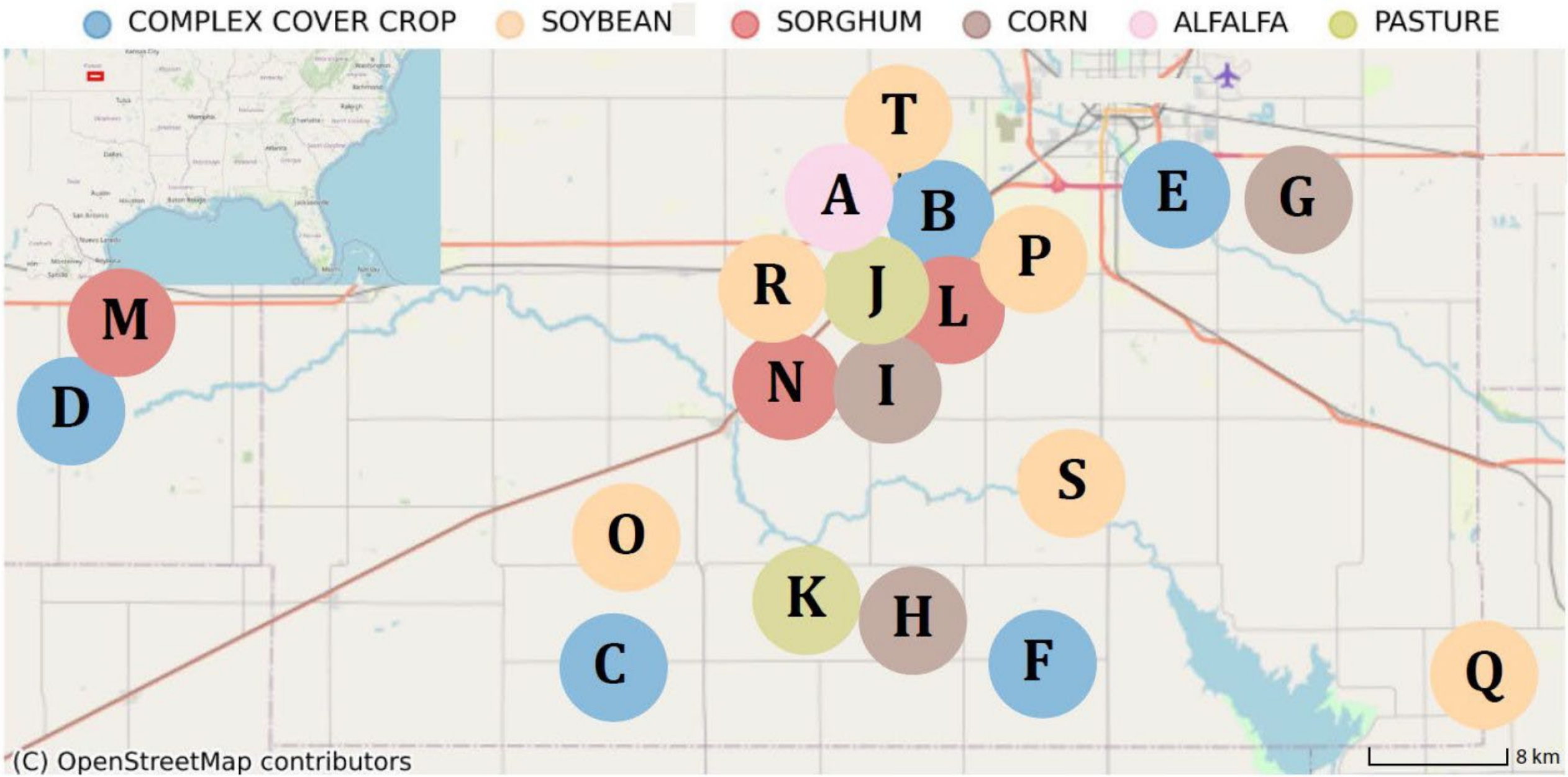
Throw out the ‘Species’

eLife Home Magazine Community About Sea

Ecology

Automating an insect biodiversity metric using distributed optical sensors: an evaluation across Kansas, USA cropping systems

Klas Rydhmer, James O. Eckberg, Jonathan G. Lundgren, Samuel Jansson, Laurence Still, John E. Quinn, Ralph Washington Jr., Jesper Lemmich, Thomas Nikolajsen ... Emily N. Bick ... show 4 more


COMPLEX COVER CROP
SOYBEAN
SORGHUM
CORN
ALFALFA
PASTURE
T
A
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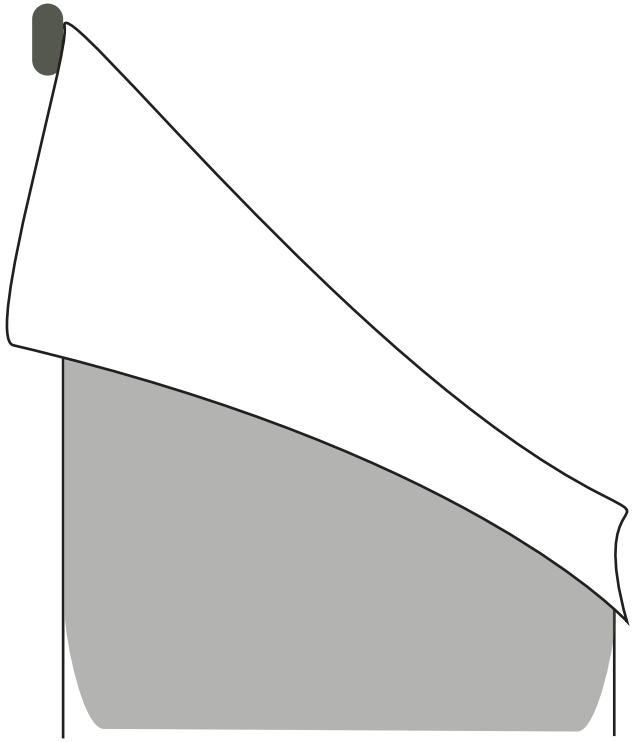
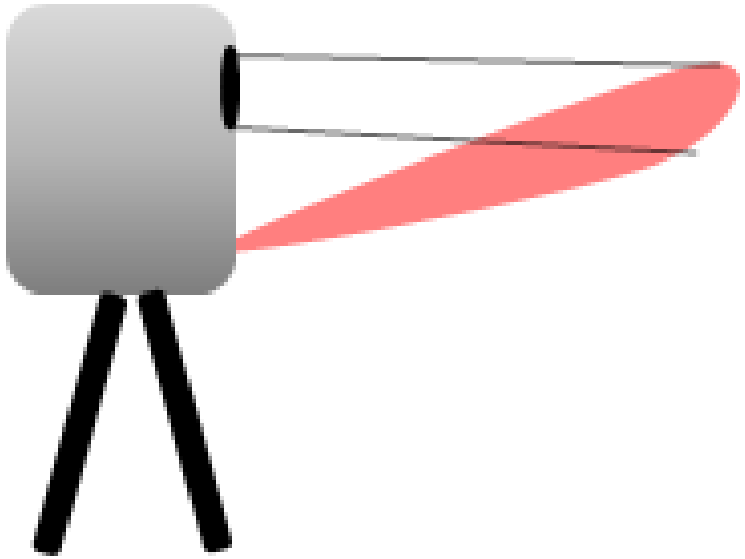
Q
(C) OpenStreetMap contributors
8 km



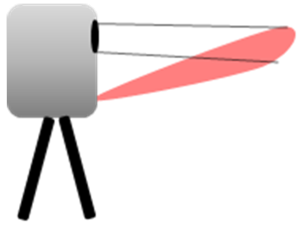
Malaise Trap

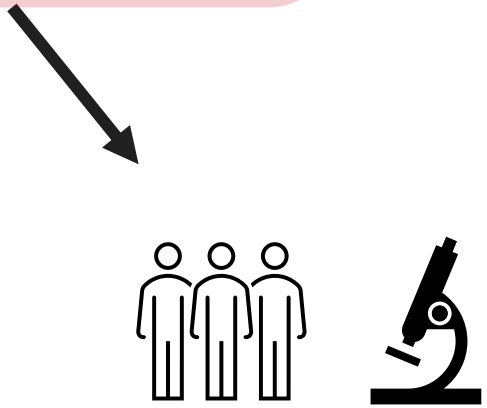
Sweepnet



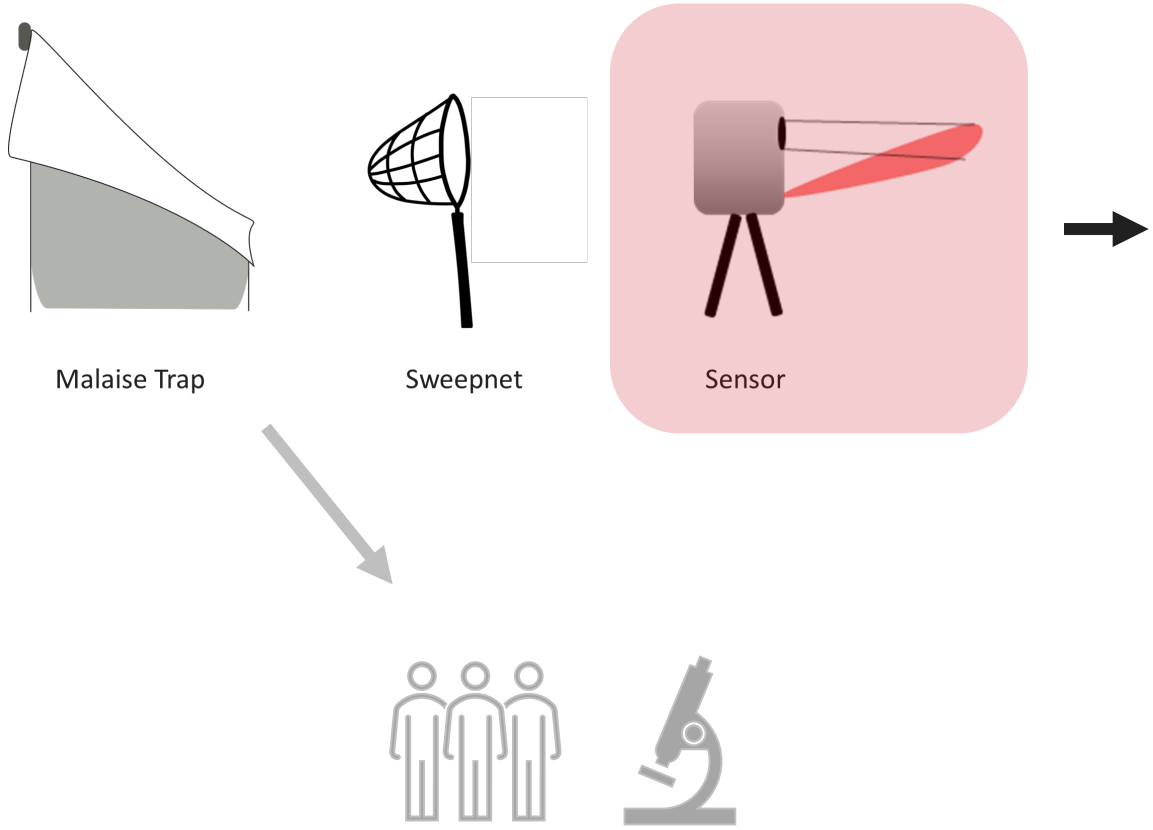
Sensor

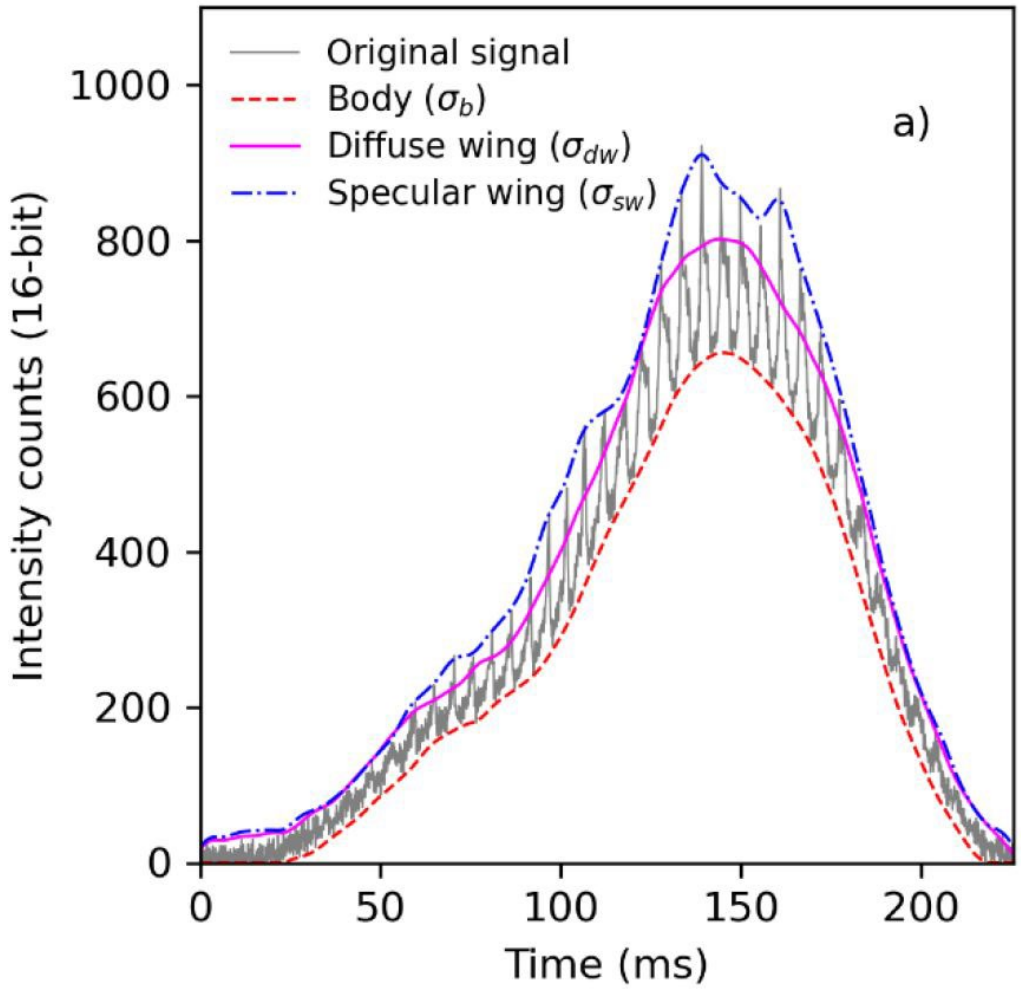
Richness: number of species



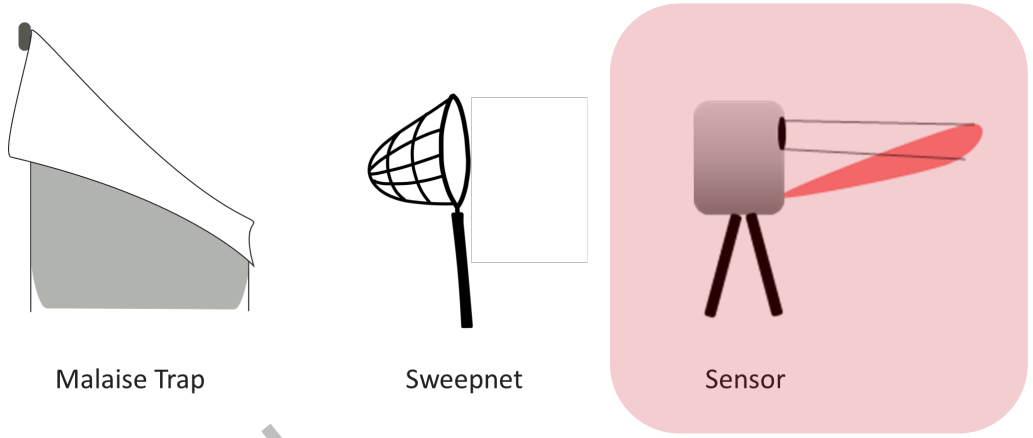


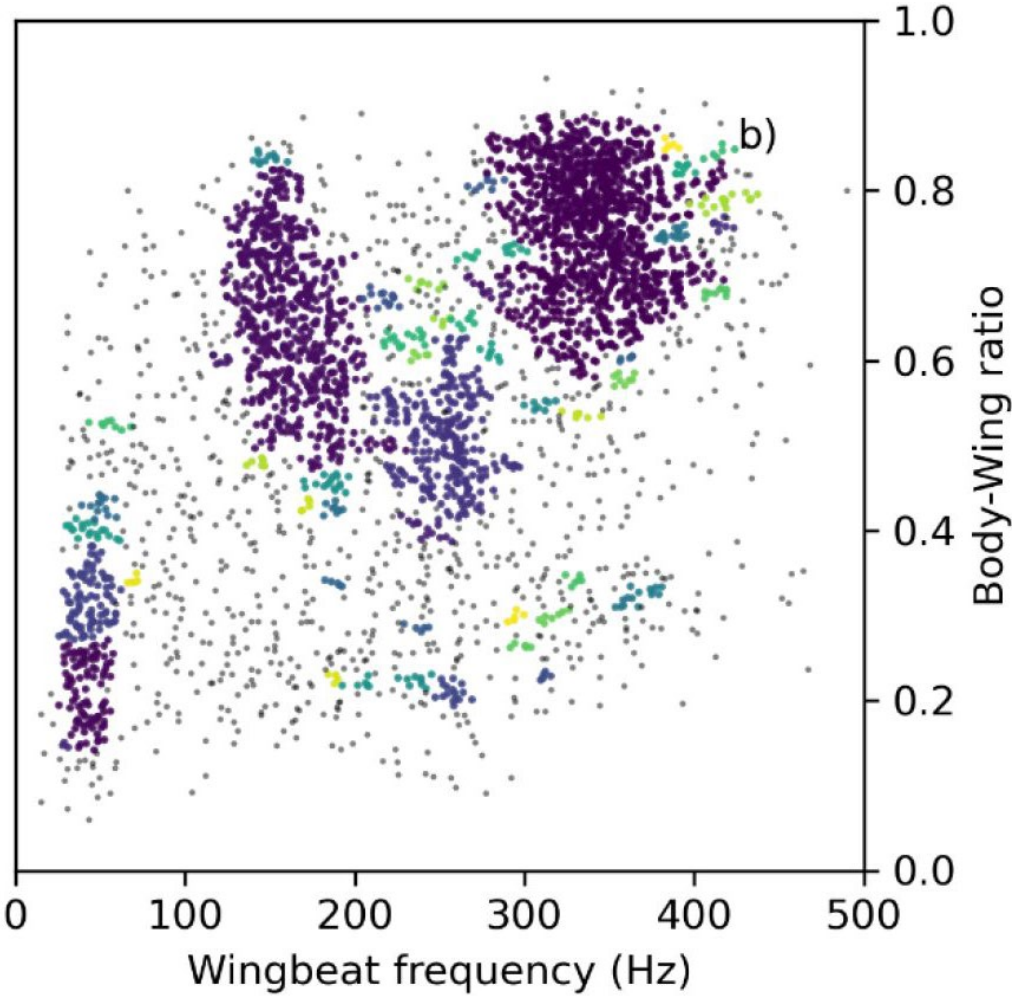
Richness: number of species

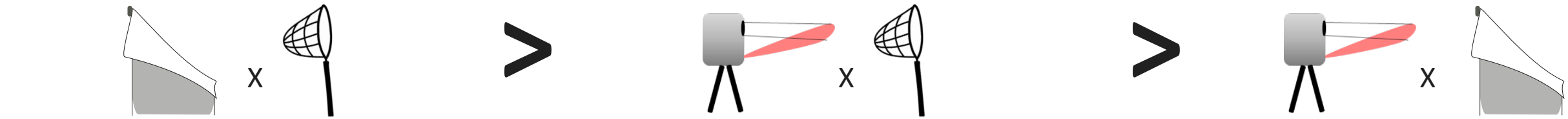




Richness: number of species



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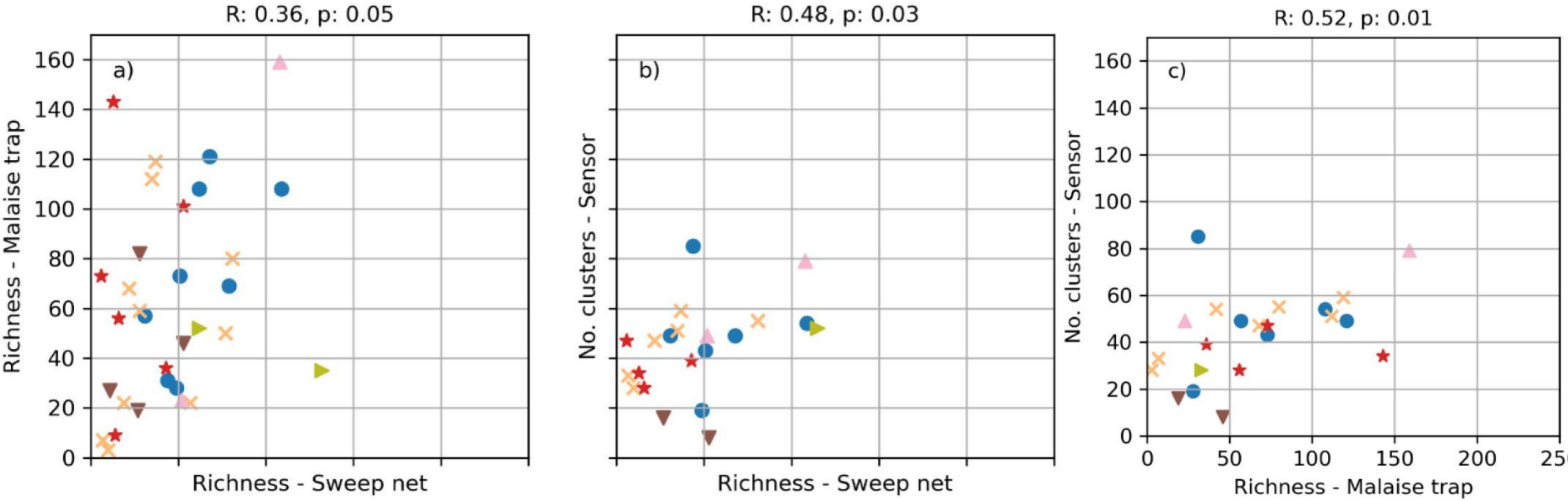
R: 0.36, p: 0.05
a)
Richness - Malaise trap
Richness - Sweep net
R: 0.48, p: 0.03
b)
No. clusters - Sensor
Richness - Sweep net
R: 0.52, p: 0.01
c)
No. clusters - Sensor
Richness - Malaise trap
COMPLEX COVER CROP
SOYBEANS
SORGHUM
CORN
ALFALFA
PASTURE

Limitations

- Cost
- Validation
- Sensor limits

Future:

- Throwing out species
  - Taxonomic limitations
- Focus on functional group
  - Pest / Predator / Parasitoid

PERSPECTIVE | BIOLOGICAL SCIENCES |

Deep learning and computer vision will transform entomology

Toke T. Høye, Johanna Ärje, Kim Bjerge, +6, and Jenni Raitoharju Authors Info & Affiliations

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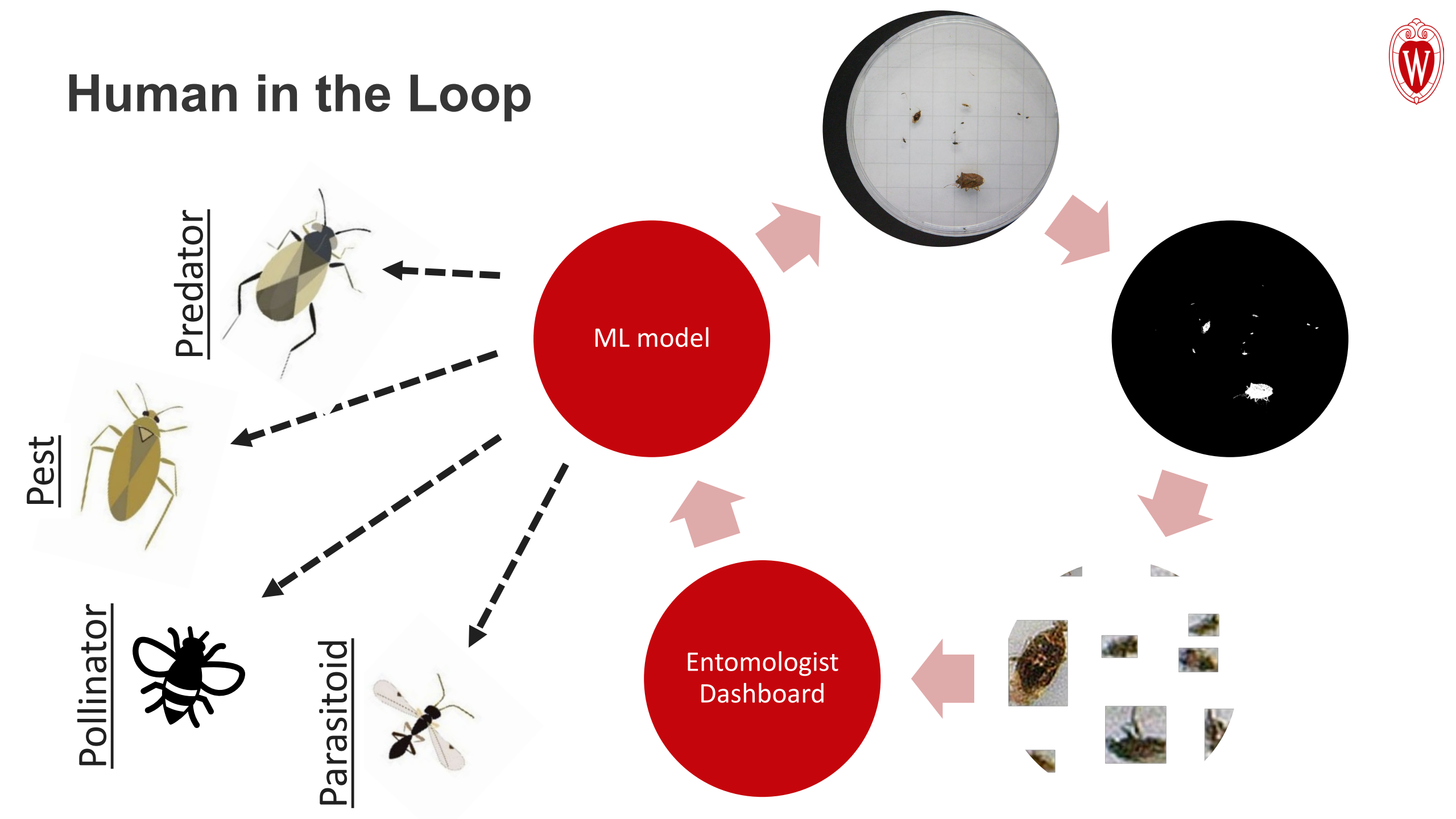
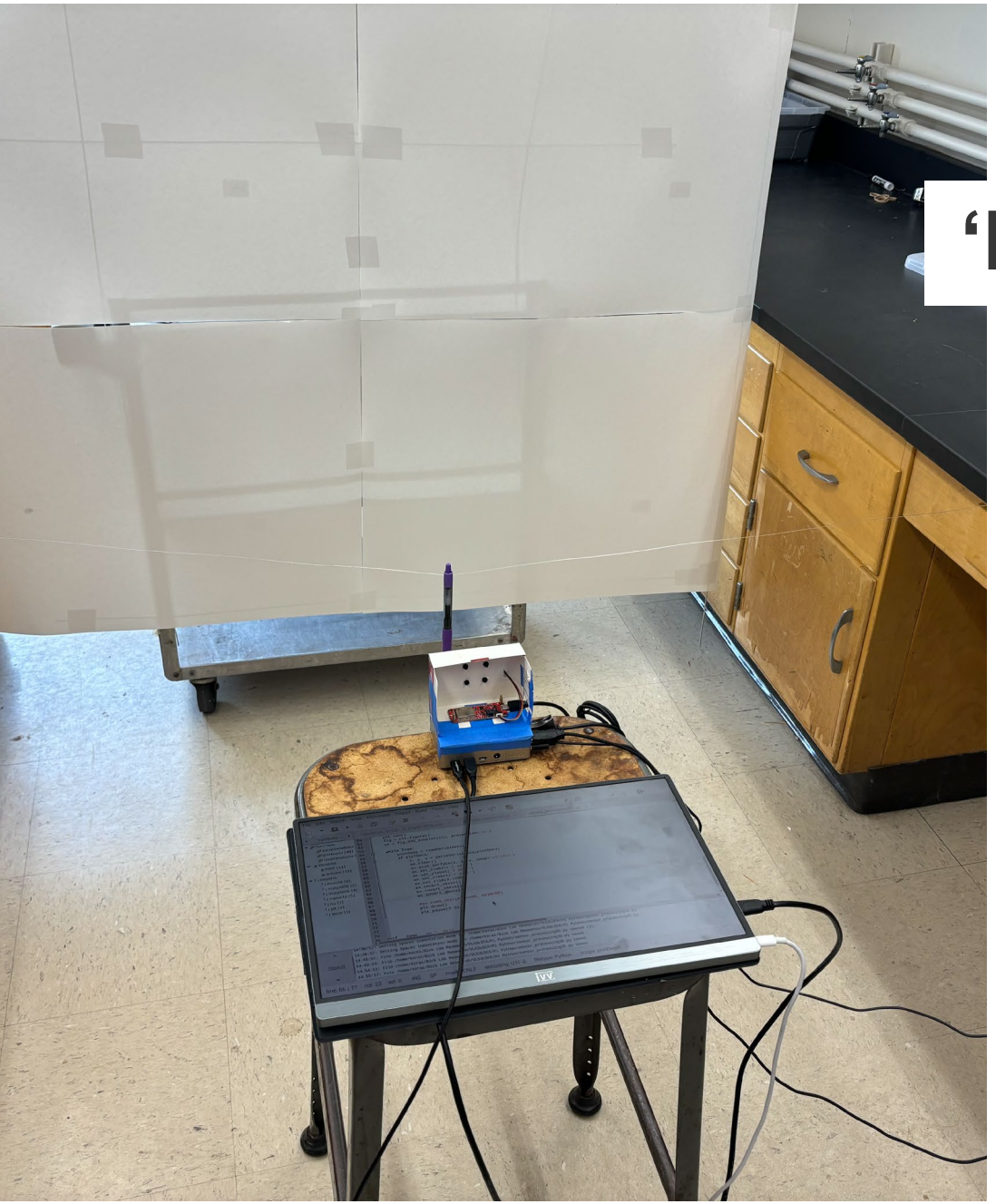
January 11, 2021 | 118 (2) e2002545117 | https://doi.org/10.1073/pnas.2002545117

Human in the Loop



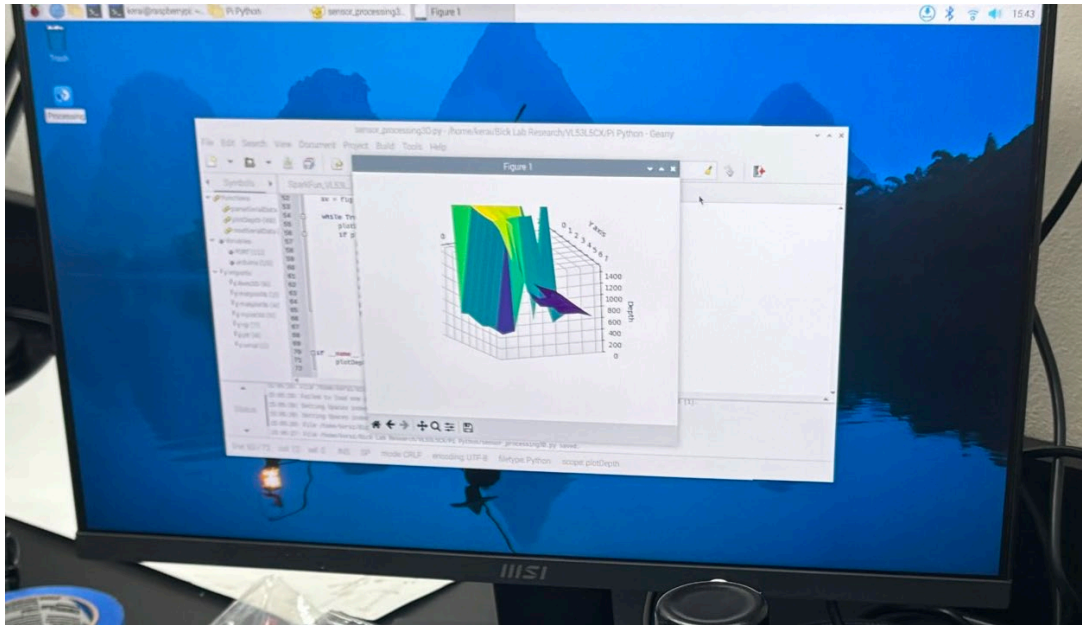
Built in Cross Validation



‘BugPulse’

Lidar-on-a-chip

- 3D reconstruction of insects in flight



Discussion

- Sensors + ML models hold great potential
  - Cost → adaption
- Conventional methods extremely valuable
- Moving away from ‘species’
- Better data = Better decisions
- Future: Automating phenotyping?

Thank you!

Bick Lab

- Lauren Glynn, MS Student
- Vidit Agrawal, BS student
- Laura Flandermeyer, lab manager
- Dhruv Kerai, BS student

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Cantor Lab, Penn State University

Silva Lab, University of Wisconsin-Madison

Gepts Lab (Dr. Paul Gepts & Kimberly Gibson)

Jim Eckberg, General Mills Foundation


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