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Conference Abstract

Towards automatic assessment of pollinator biodiversity

Krista Gabriela Lielnora[‡], Ināra Melece[‡], Viesturs Melecis[‡], Tiffany Knight[§], Maximilian Sittinger[|], Jonna Heuschele[¶]

‡ University of Latvia, Institute of Biology, Riga, Latvia
§ Martin-Luther-Universität Halle-Wittenberg, Leipzig, Germany
| Helmholtz Centre for Environmental Research – UFZ, Leipzig, Germany
¶ UFZ, Leipzig, Germany

Corresponding author: Krista Gabriela Lielnora (lielnorag@gmail.com), Jonna Heuschele (jonna.heuschele@idiv.de)

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Abstract

Background

The decline in pollinating-insect abundance and diversity highlights the need for standardized and scalable monitoring methods. Pollinators include species from several insect groups, particularly *Hymenoptera*, *Diptera*, *Lepidoptera*, *and Coleoptera*. Differences in their activity patterns, habitat associations, and detectability create challenges for long-term monitoring. Conventional surveys involve observing selected plots or transects and collecting flower-visiting insects with an entomological net. Although this approach provides valuable taxonomic information and physical specimens for verification, it requires considerable field and laboratory effort. Automated imaging combined with artificial intelligence (AI) may complement conventional surveys and contribute to the development of cost-effective eLTER Standard Biodiversity Observations.

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Methods

Within the project *Standardized European Monitoring of Plant–Pollinator Interactions* (SEPPI), automated cameras developed by the Helmholtz Centre for Environmental Research (UFZ), Leipzig, were tested at Randu Meadows, a Latvian eLTER site. The project involves partners from Germany, Belgium, the Czech Republic, Finland, Hungary, Italy, Romania, and Latvia. Five cameras were initially available for the Latvian study, but one was non-functional from the beginning; consequently, four cameras were installed and provided data.

Plots representing different moisture regimes were selected, and the cameras were focused on locally common flowering plant species. Field setup began at approximately 11:00 and normally required about 30 minutes. The cameras subsequently operated for 3-4 hours, depending on suitable weather conditions and observed bee and fly activity. Cloud cover, wind conditions, and air temperature were recorded during each sampling period. The observations therefore represent standardized daytime sampling windows rather than complete daily estimates of pollinator activity and were not designed to cover the full daily activity patterns of all pollinator groups.

After field configuration, the cameras recorded automatically when movement was detected. Wind-induced movement of flowers and surrounding vegetation, however, frequently activated the system and produced false detections. Conventional pollinator surveys were conducted in parallel, and collected specimens were preserved as a taxonomic reference collection. Vegetation was assessed using the Braun-Blanquet method in 15 quadrats at each sampling plot. The time required to implement the conventional and automated monitoring methods was also recorded.

Results

During 2024-2025, conventional surveys recorded 10 non-*Bombus* bee species, 12 bumblebee species, 22 dipteran species belonging to *Syrphidae, Sarcophagidae, Muscidae, Calliphoridae, and Tachinidae,* seven butterfly species belonging to *Zygaenidae, Pieridae, Nymphalidae, Lycaenidae, and Hesperiidae*, and seven beetle species belonging *to Mordellidae, Cerambycidae, Scarabaeidae, and Cantharidae.*

The automated cameras generated more than 400,000 images. Preliminary analyses indicated associations between the number and activity of insects detected in the camera images and observations obtained through conventional surveys. During the first year, images were inspected and labelled manually using Label Studio. The current workflow uses a YOLO-based model to automate insect detection and reduce the manual processing burden (Stark et al. 2023)

Conclusions and limitations

The automated cameras provide a promising complementary method for recording standardized flower-visitation activity while reducing the need for continuous observer presence in the field. Nevertheless, further post-processing is required to remove wind-

related false detections and repeated recordings of the same visitor. Camera records should therefore be interpreted as detected visitation events rather than numbers of unique individuals. Repeated visits, for example by persistent *Eristalis* individuals, may inflate activity estimates if every detection is interpreted as a separate individual.

The preserved reference specimens support taxonomic verification, but taxa requiring genital examination, DNA-based identification, or morphological characters not visible in the images cannot reliably be identified to species level from images alone. Such observations should be assigned to the lowest taxonomic level supported by visible characteristics and expert validation.

Because the cameras were directed towards common flowering plants, the current approach may underrepresent oligolectic pollinators associated with uncommon host plants. Extending monitoring to uncommon flowering species or developing flower-independent detection represents a possible future stage rather than part of the present sampling design.

Differences among the eight participating countries in pollinator communities, vegetation, environmental conditions, and image backgrounds may cause domain shift and reduce model transferability. The multinational dataset provides an opportunity to evaluate model performance using independent countries and sites and to determine whether local calibration or model fine-tuning is required. These results demonstrate both the potential of automated pollinator monitoring and the importance of accounting for sampling periods, weather conditions, repeated visits, taxonomic resolution, image-labelling effort, and model transferability.

Keywords

pollinators, biodiversity monitoring, LTER, eLTER, artificial intelligence, computer vision, automated monitoring, SEPPI

Presenting author

Krista Gabriela Lielnora

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Conflicts of interest

The authors have declared that no competing interests exist.

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