Automating Insect Biodiversity Metrics: Applications in Agriculture

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Global ecosystems and food supply depend on insect biodiversity for key functions such as pollination and decomposition. High-resolution, accurate data on invertebrate populations and communities across scales are critical for informing conservation efforts. However, conventional data collection methodologies for invertebrates are expensive, labor intensive, and require substantial taxonomic expertise, limiting researchers, practitioners, and policymakers. Novel optical techniques show promise for automating such data collection across scales as they operate unsupervised in remote areas. In this work, optical insect sensors were deployed in 20 agricultural fields in Kansas, USA. Measurements were compared to conventional assessments of insect diversity from sweep nets and Malaise traps. Species richness was estimated on optical insect data by applying a clustering algorithm to the optical insect sensor's signal features of wing-beat frequency and body-to-wing ratio. Species richness correlated more strongly between the optical richness estimate and each of the conventional methods than between the two conventional methods, suggesting sensors can be a reliable indicator of invertebrate richness. Shannon- and Simpson indices were calculated for all three methods but were largely uncorrelated including between conventional methods. Although the technology is relatively new, optical sensors may provide next-generation insight into the spatiotemporal dynamics of invertebrate biodiversity and their conservation.

The implications of this research extend from the field level to the regional level. Much of what scientists understand about the decline of invertebrates comes from a small number of long-term studies that can be coarse and correlational in nature. High-resolution biodiversity data sets on fields to landscapes may provide the insight needed for the successful management and accounting of biodiversity by practitioners and policymakers. Such high-resolution data has the potential to support global efforts and coordination of biodiversity conservation.