Multiscale approach to pest insect monitoring: Random walks, pattern formation, synchronization, and networks

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Abstract

Pest insects pose a significant threat to food production worldwide resulting in annual losses worth hundreds of billions of dollars. Pest control attempts to prevent pest outbreaks that could otherwise destroy a sward. It is good practice of the integrated pest management to recommend control actions (usually pesticides application) only when the pest density exceeds a certain threshold. Accurate estimation of pest population density in ecosystems, especially in agro-ecosystems, is therefore very important, and this is the overall goal of the pest insect monitoring. However, this is a complex and challenging task: providing accurate information about pest abundance is hardly possible without taking into account the complexity of ecosystems' dynamics, in particular, the existence of multiple scales. In the case of pest insects, monitoring has three different spatial scales, each of them having their own scale-specific goal and their own approaches to data collection and interpretation. In this paper, we review recent progress in mathematical models and methods applied at each of these scales and show how it helps to improve the accuracy and robustness of the pest population density estimation.