

Warnings of an “insect apocalypse” are premature

Our world would be unpleasant and likely uninhabitable in the absence of arthropods. Approximately 35% of global food production depends on insect pollinators, and virtually all decomposition of plant litter, animal dung, and carcasses is performed by arthropods. Troublingly, several recent long-term European studies have indicated that habitat loss and invasive species are largely responsible for steep declines observed in several important insect groups – particularly butterflies, moths, and bees. Such investigations, which are necessary to verify temporal trends in the abundance of insects and other arthropods, are rare in the western hemisphere. One paper (Lister and Garcia 2018; *P Natl Acad Sci USA* **115**: E10397–406), using open-access data from the Luquillo Experimental Forest, a Long-Term Ecological Research (LTER) site in northeastern Puerto Rico, reported that arthropod populations within the tropical forest’s food web had declined by 60% over a 30-year period as a result of increased temperatures. This study attracted widespread media attention (eg *Washington Post* 15 Oct 2018, *New York Times* 27 Nov 2018, *National Geographic* Feb 2019, *The Atlantic* Feb 2019) as evidence that arthropod abundances are declining in the western hemisphere and that global warming is to blame.

However, reports that insects as a group are declining (the so-called “insect apocalypse”) are premature. For example, if Luquillo’s arthropod populations and food web had indeed collapsed to such a degree, then several critical ecosystem services on which the island’s human inhabitants depend would have been threatened. This appears to not be the case.

The data and methodology selected by Lister and Garcia were questionable and their conclusions incorrect (Willig *et al.* 2019; *P Natl Acad Sci USA* **116**: 12143–44). When analyzed using appropriate data and statistical techniques, none of the arthropod groups that were the subject of the original study exhibited declines with increasing temperature. In fact, continued sampling through 2019 revealed that Hurricane Maria elevated walkingstick and canopy arthropod abundance to levels equivalent to those measured after Hurricane Hugo, the previous maximum in the data record. Failure to include the LTER data holders in the peer-review process resulted in a misrepresentation of long-term trends, with no consideration of the effects of major hurricanes on the system.

Several issues regarding insect decline studies need to be addressed. First, sampling methods are biased toward particular insect groups, representing only subsets of arthropod communities. For instance, light trapping attracts primarily nocturnal flying insects, interception traps passively collect flying insects, and branch bagging captures relatively immobile arthropods on the branch at the time of sampling. Few studies have combined sampling methods to represent more complete insect assemblages. No studies have measured trends in all insects.

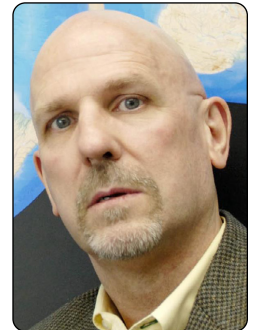
Second, literature searches that rely only on “declin*” as a search term generate non-random samples of long-term studies, thereby omitting publications that do not demonstrate population declines and leading to biased conclusions. Third, many insect populations fluctuate over time, with abundance sometimes changing by several orders of magnitude in just 2–3 years and population irruptions often recurring at 10-, 20-, or 30-year intervals. Consequently, estimating insect abundance is very sensitive to sampling frequency and duration.

Finally, we argue that protocols are needed for use of open-access data. Uncritical use of such data without proper understanding of the data structure and associated ecosystem dynamics can lead to erroneous conclusions and undue alarm, in addition to jeopardizing scientific integrity and public trust. Authors wishing to use open-access data should contact data holders to obtain necessary insight into the data. At the same time, those producing long-term data need to provide detailed, comprehensive metadata that informs potential users about the nature or limitations of the data, especially when the original data collectors are no longer available for consultation. Moreover, because journals risk embarrassment if they publish articles with incorrect information, it would seem appropriate to include data holders as reviewers to ensure appropriate use of data.

Although current concerns about the insect apocalypse may be unwarranted, trends in some major groups do threaten the continued delivery of important ecosystem services. Additional structured long-term studies of temporal trends in insect abundances are clearly needed. Given the rapid responses of insects to environmental change, these trends may serve as the “canary in the coal mine” for assessing threats to ecosystem services. Even though some groups are declining, others (such as bark beetles and termites) are maintaining their abundances or expanding their geographical ranges as climates warm. A future challenge will be to assess the independent effects of “press” disturbances such as global warming and habitat loss versus episodic “pulse” disturbances such as catastrophic storms and droughts.



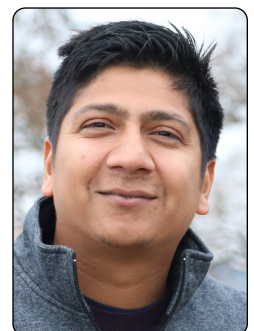
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