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RESEARCH HIGHLIGHTS

Citizen science observations shed light on how anthropogenic food sources influence wildlife disease

Erin L. Sauer

Department of Biological Sciences, University of Arkansas, Fayetteville, Arkansas, USA

Correspondence
Erin L. Sauer
Email: erinsauer10@gmail.com

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Abstract

Research Highlight: Knutie, S., Bahouth, R., Bertone, M., Webb, C., Mehta, M., Nahom, M., Barta, R., Ghai, S., Love, A., Horan, S., Soldo, A., Cochrane, E., Bartholomew, J., Cowan, E., Bjerke, H., Balenger, S., Butler, M., Cornell, A., Kennedy, A., Rolland, V., Schultz, E., Stanback, M., Taff, C., Albery, G. (2024). Understanding spatiotemporal effects of food supplementation on host–parasite interactions using community-based science. *Journal of Animal Ecology*. https://doi.org/10.1111/1365-2656.14155. Wildlife have become increasingly dependent on anthropogenic food supplementation, resulting in altered nutritional intake and inter- and intraspecific interactions. Subsequently, supplemental feeding can affect both the immunological function of individuals and transmission dynamics among individuals and species. The magnitude of the effect supplemental feeding has on disease is likely to vary across time and space with the nutritional demands of hosts. However, the broad temporal or spatial scale effects of supplementation are poorly understood. Recently, Knutie et al. (2024) introduced their citizen science program, the Nest Parasite Community Project, a broadscale coordinated effort by scientists and the public to monitor box nesting wild birds and their ectoparasites across the eastern United States. The authors amassed an impressive 4-year data set with hundreds of nests spanning the entire US breeding range of Eastern bluebirds (*Sialia sialis*). In the first study to come from the project, the authors demonstrate that the effects of food supplementation on host–parasite interactions vary across time and space and do not consistently influence host–parasite outcomes, highlighting that host–parasite interactions are often context dependent and influenced by many environmental factors (e.g. weather and habitat quality). The authors also found that supplemental feeding increases host fitness, regardless of parasitism. The study provides strong evidence that citizen science projects can help broaden our understanding of how human food sources influence wildlife disease in various environmental contexts.

KEYWORDS
citizen science, diet, disease ecology, ectoparasites, food supplementation, host–parasite interactions, wildlife disease

With emerging infectious disease on the rise and wildlife becoming more dependent on anthropogenic food sources, researchers have become increasingly interested in understanding the effects human food sources have on wildlife diseases. The introduction of intentional (e.g. recreational feeding) or unintentional (e.g. dumpsters, agriculture) supplemental feeding sites to the landscape creates a unique resource hub that increases contact rates and subsequently transmission rates (Becker et al., 2015; Becker & Hall, 2014). Conversely, the nutritional quality and availability of supplemental food are likely to differ, and may even be an improvement, from what would naturally be available to wildlife. For example, bird feeders can be hotspots for disease transmission while simultaneously providing individuals with an easy and predictable source of nutritionally rich food that improves immune performance (Adelman et al., 2015; Strandin et al., 2018). However, the immunological benefits of anthropogenic food are likely to depend on the quality and quantity of the food and how it contrasts with what is naturally available. For instance, supplemental food may provide minimal immune benefit if food is already abundant and easy to obtain. Thus, broad spatial and temporal scale studies are needed to better understand contexts in which anthropogenic food sources affect host immune function and transmission dynamics.

Citizen science projects provide an exciting opportunity to broaden the spatial and temporal scope of research examining the effects of supplemental food on wildlife disease. Wild bird feeding is one of the most common ways humans interact with wildlife making it a useful system for understanding the effects of supplemental food on wildlife (Jones & James Reynolds, 2008). In 2022, 35% of people in the United States reported watching birds at home, spending $5.8 billion USD on supplemental food for wild birds (U.S. Department of the Interior, U.S. Fish and Wildlife Service, 2022). Citizen science efforts like Project Feederwatch in the United States and Garden BirdWatch in the United Kingdom have been used to relate bird feeder shape and frequency of cleaning to transmission risk, but none have focused on the potential effects of supplemental food host immunology (Hartup et al., 1998; Lawson et al., 2018). Knutie et al. (2024) present the first study to come from their citizen science program, Nest Parasite Community Project. Their project is a coordinated effort by scientists and the public to gather data on breeding and ectoparasites in eastern bluebird (*Sialia sialis*) nest boxes across their range in the United States. Nest box 'stewards' record breeding data and whether they provide supplemental food (mealworms or suet) and collect used nesting materials to ship to researchers for ectoparasite classification. For this study, the researchers collected a total of 674 nests from 26 states in the eastern United States collected over the course of 4 years with the main goal of determining how food supplementation affects blowfly (*Protocalliphora* sp.) prevalence in bluebird nests. The researchers found that the effects of supplementation on ectoparasite presence varied over time and space. During the study period, supplemental feeding had no effect on parasite prevalence for 2 years and opposing effects on prevalence for the other 2 years. The authors have amassed an impressive data set with the Nest Parasite Community Project and present one of the largest scale efforts towards understanding the effects of supplemental food on host–parasite interactions (Figure 1).

The effect of food supplementation on blow fly prevalence varied, suggesting that environmental conditions at each of the sites may be contributing to how useful supplemental feeding is for immune function. Previous experimental research authored by the founder of the Nest Parasite Community Project, Sarah Knutie,

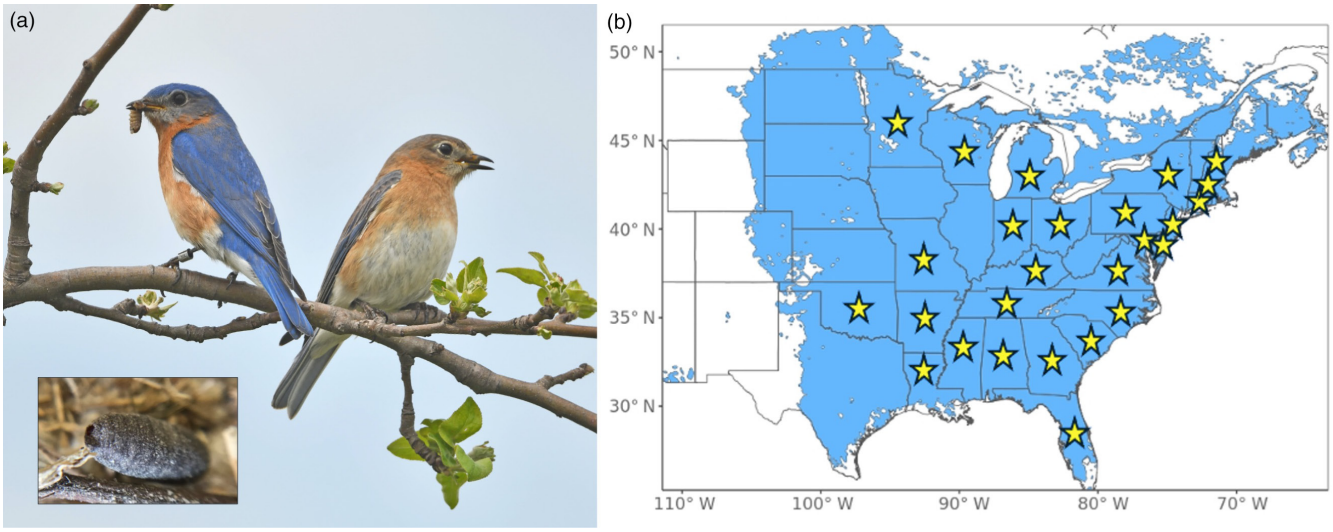

FIGURE 1 (a) Eastern bluebird (*Sialia sialis*) male and female breeding pair carrying food and a blow fly (*Protocalliphora* sp.) pupal case (inlay), the focal host–parasite pair of the first study from the Nest Parasite Community Project. The project is a citizen science initiative to collect breeding and parasite data on box-nesting wild birds. (b) Knutie et al. (2024) used nest data from 26 states, covering most of the breeding range of the Eastern bluebird (blue), to demonstrate that the effect of supplemental food on blow fly prevalence in bluebird nests varies temporally within and across breeding seasons. Eastern bluebird breeding range was mapped using eBird data (Fink et al., 2023).

found that bluebirds with access to supplemental food had reduced parasite abundance (Knutie, 2020). However, the positive effect of supplemental food decreased over time as parasite abundance in unsupplemented birds declined while abundance in supplemented birds stayed consistent. Similarly, Knutie et al. (2024) found that blow fly prevalence decreased with time during the breeding season. These intra-annual patterns may be driven by environmental effects on the host, parasite or both. Generally, insect abundance increases with warming weather during the breeding season (Winkler, 2004). Thus, unsupplemented bluebirds may be better equipped to resist blow flies later in the season when other food resources are more abundant, but it is also possible that environmental conditions are affecting blow fly fitness. Likewise, interannual variation in the effectiveness of supplemental feeding on blow fly prevalence may be driven by environmental effects on both the host and parasite. For example, multiple studies have shown that, while host fitness is typically unaffected by blow flies, infestation can result in reduced nestling survival during breeding seasons with adverse weather conditions (Musgrave et al., 2019; Pavel et al., 2008).

The first study from the Nest Parasite Community project also provided broadscale evidence that food supplementation generally increases bluebird fitness (increased nestling survival and number of fledglings) while ectoparasites generally have effect on fitness. These results are similar to previous studies, including a recent large-scale study from the NestWatch citizen science project which found that eastern bluebird nest survival was improved by supplementation (Bailey & Bonter, 2022). Interestingly, the same NestWatch study found that supplementation did not improve nest survival for the other species in the study. Thus, while food availability may limit bluebirds, other factors like predation or competition might be more important limiters of nest success in other box nesting species. Finally, Knutie et al. (2024) revealed a spatial bias in food supplementation, with nest box stewards in the south being more likely to provide supplemental food than those in the north. Survey results of Americans in 2022 revealed a similar pattern where people in the south were more likely to participate in wildlife watching activities (including bird feeding and keeping nest boxes) than people in northern regions (U.S. Department of the Interior, U.S. Fish and Wildlife Service, 2022).

The Nest Parasite Community Project is an exciting and unique addition to the ever-growing field of citizen science. In the first study to come from this project, Knutie et al. (2024) demonstrate the importance of using broadscale data, particularly over time, to understanding the effects of food supplementation on breeding and parasitism. While the results suggests that external drivers may be altering the effects of supplementation on disease, this study focuses on temporal and spatial patterns and not what environmental factors might be driving those patterns. The authors are currently working on follow-up studies to examine potential climatic drivers of the relationship between supplemental food and host–parasite relationships. The influence of habitat quality on this relationship is another promising direction that the Nest Parasite Community Project is well suited to address. Finally, a major strength of the project is its ability to explore ideas beyond the scope of food supplementation, with the potential to further the ecological and evolutionary understanding of host–parasite relationships in general at broad spatio-temporal scales.

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CONFLICT OF INTEREST STATEMENT

The author declares no conflict of interest.

DATA AVAILABILITY STATEMENT

Data have not been archived because this article does not use data.

ORCID

Erin L. Sauer https://orcid.org/0000-0002-8339-6498

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