Towards a Holistic Assessment of the Food-safety Risks Imposed by Wild Birds (Abstract)

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ABSTRACT: Wild birds pose unique food-safety risks to agriculture as they may carry multiple zoonotic pathogens, are difficult to exclude, and most are federally protected. As a result, the fresh produce industry regularly expresses concerns about these risks, and growers are sometimes instructed to not harvest crops around wild bird feces, potentially causing yield reductions and food waste. Farmers thus have financial incentives to reduce bird fecal contamination on their crops. However, existing bird deterrent methods can be expensive, have significant deleterious conservation implications, and/or are often ineffective. Thus, it is imperative to develop a holistic understanding of the true food-safety risks associated with wild bird communities and to inform growers and industry professionals about which birds, if any, represent substantive food safety concerns. Here, we evaluate the food-safety risks of wild birds, from the point of entering farms through harvest of the crop via three complementary approaches.

First, we investigated which species are more likely to shed *Salmonella enterica*, Shiga toxin-producing *E. coli* (STEC), and *Campylobacter spp*. While foodborne pathogen prevalence in avian fecal samples has been studied in some species of wild birds, research often stops at this stage, preventing a holistic evaluation of the food-safety risks imposed by avian communities. We expanded a previous database of >11,000 pathogen tests across 94 species by adding an additional 1,662 tests (554 tests per pathogen) from fresh fecal samples collected from 54 bird species. Pathogen prevalence rates in the new samples were low, with STEC, *Salmonella*, and *Campylobacter* prevalences of 0.18%, 0.18%, and 2.2%, respectively.

Second, for crop contamination to occur, infected birds must be present on or over agricultural fields and defecate on the crops. We conducted bird surveys and collected avian fecal samples for molecular species identification on 29 leafy-green farms across the Central Coast of California during the winter (i.e., at the seedling stages) as well as two separate harvest seasons (summer and fall). During our surveys on leafy-green farms, we observed ~10,000 individuals of 114 species within the farm areas. Bird communities exhibited significant seasonal differences, with twice as many individuals and nearly quadruple the number of bird flocks observed in the fall harvest season compared to spring and summer. Additionally, we surveyed fecal densities along transects within leafy-green fields and found that feces were more likely to be near the farm edge and on soil as opposed to on the produce itself.

Finally, for successful transmission to occur, pathogens must survive in fecal samples until harvest and consumption. We conducted laboratory and field experiments examining *E. coli* survival in feces from 10 common farm bird species selected to span diverse taxonomic orders, body sizes, and feeding guilds. To do so, we placed freshly collected samples on lettuce, soil, and plastic mulch, collected them after varying time points, and calculated the amount of *E. coli* remaining. We found that fecal mass – not species identity – was the strongest predictor for how long *E. coli* survived. Specifically, *E. coli* exhibited increased survival in larger fecal samples, especially on lettuce plants. Thus, not all bird feces are of equal concern: larger birds – associated with larger feces – may carry greater food-safety risks.

Our results suggest that the food-safety risks associated with most wild bird species are quite low as pathogens were generally rare and *E. coli* rapidly died off in most bird feces. That said, we also found risks were dynamic, varying among species and growing seasons. By investigating which birds are more likely to harbor pathogens, which birds occupy agricultural fields and cropland, and how long pathogens survive in bird feces after defecation, our work contributes to a more holistic understanding of the risk wild birds pose to food safety. These results will better inform farmers and policy makers on how to co-manage agricultural lands for both conservation and human health.

KEY WORDS: agriculture, agroecology, *Campylobacter spp.*, disease, *E. coli*, free-living birds, pathogen transmission, public health, *Salmonella enterica*, STEC

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