Towards a holistic assessment of the food-safety risks imposed by wild birds

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Summary

Birds introduce complex food-safety risks, as they carry multiple pathogens, are difficult to exclude from farms, and regularly defecate on crops. Yet very few wild bird species have been studied, and existing studies only examine pathogen prevalence. For a species to pose a significant risk, it must not only carry pathogens but also visit fields, defecate on crops, and produce feces that support pathogen survival. Our project couples existing data on pathogen prevalences in wild birds with assays of field-collected feces, bird surveys across 20 California farms, and experiments assessing how long pathogens survive in feces from multiple bird species. These analyses will then be combined to produce holistic food-safety risk assessments for wild birds on produce farms in California.

Objectives

Our objectives are four-fold (**Figure 1**):

1. Combine existing pathogen databases with *Campylobacter, Salmonella*, and STEC assays of field-collected feces, focusing on under-sampled species that frequent produce farms.
2. Quantify how proximity to rangeland affects bird community composition and fecal densities across 20 farms by censusing birds, collecting feces, and using DNA barcoding to identify species defecating on crops.
3. Compare *E. coli* survival in bird feces placed on lettuce plants, soils, and plastic mulch, including farmland species that defecate large (e.g., Wild Turkey) and small (e.g., Western Bluebird) feces.
4. Combine data on pathogen prevalence, fecal densities, and pathogen survival to develop holistic risk assessments for farmland birds as well as associated photo guides to aid on-farm management.

Methods

The following approaches are being used to address our objectives:

- We use mist nets to capture birds in farmlands and agriculturally adjacent natural areas. We collect fecal samples from sterile bags and then assay feces for *Campylobacter, Salmonella*, and STEC.
- We use point counts to survey birds on 20 farms near and far from rangeland. We also collect feces from fresh produce and use DNA analysis to determine which bird species defecate on fresh produce (**Figure 2**).
- We inoculate Wild Turkey and Western Bluebird feces with *E. coli* and then place them on lettuce, soil, or plastic mulch on an experimental farm. We later collect these samples to quantify bacterial survival in relation to species identity, fecal size, and time spent outside.

Results to Date

Objective 1: We have expanded our pathogen prevalence database, adding 75 individual birds of six under-sampled species (as well as increasing sample sizes for more common birds).
Objective 2: Avian point counts and fecal sampling across 20 farms began in mid-May.
Objective 3: We placed 98 samples from Wild Turkey and Western Bluebird on experimental plots (**Figure 3**). Initial results show fecal mass and substrate type have strong effects on *E. coli* survival (**Figure 4**). Larger feces retained bacteria longer ($p < 0.001$), with no bacteria surviving in smaller feces (i.e., songbird size) for 6 days or more. Bacterial survival was also lower on soil and plastic mulch compared to lettuce ($p < 0.05$).

Benefits to the Industry

This project evolved from conversations with growers who often encounter bird feces in their fields but are unsure about the associated risk. Indeed, our prior data suggest that implementing 1-meter no-harvest buffers around feces would result in some farmers discing >50% of their fields. This is not feasible, making it essential to define the contexts when risks are unacceptable. Our project will provide the first holistic food-safety risk assessment for farmland birds. Combining laboratory and field studies across farm types will allow us to contextualize findings and help farmers implement practices according to their farming context. Understanding risks could point towards practices that ensure food safety, while, in some cases, conserving birds and the benefits they provide (e.g., pest control).

Figure 1.
Conceptual diagram depicting how our research objectives build upon each other to provide the first holistic assessment of the food-safety risks imposed by wild birds.

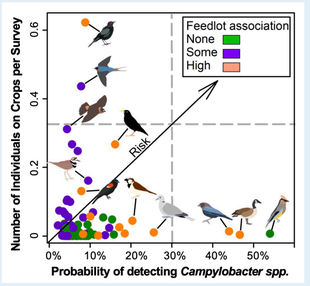

Figure 2.
Combined risk that ~100 bird species carry *Campylobacter* spp. and come in contact with crops, using our existing pathogen prevalence data (reprinted from Smith et al. 2022, *Ecological Applications*). Species (dots) are colored according to their association with livestock, with highly associated species representing the gravest food-safety risks.

Figure 3.
Photos depicting Wild Turkeys (left) and Western Bluebirds (center), the two focal species used in our pathogen survival experiments (right).

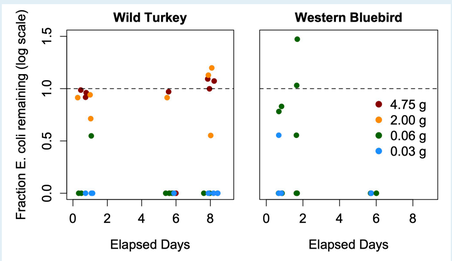

Figure 4.
Percent *E. coli* remaining in feces of Wild Turkey (left) and Western Bluebird (right) as a function of number of days in the experimental plots. Warmer colors depict larger feces (red: 4.75 g, typical turkey feces size; orange: 2.00 g, half typical turkey feces size; green: 0.06 g, typical bluebird feces size; blue: 0.03 g, typical sparrow feces size).