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

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Project funding dates

January 1, 2022 – December 31, 2023

Acknowledgements

We are grateful to the undergraduate field assistants, laboratory assistants, and staff of the UC Davis Student Farm who made this work possible. We are indebted to the growers and landowners who generously provided access to their farms. Finally, we thank the Center for Produce Safety for funding our work.

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. Quantify *E. coli* survival in feces from multiple bird species and on multiple substrate types, including lettuce heads, soil, and plastic mulch.
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

1. We collect fecal samples by capturing birds with mist nets and by placing sterile tarps beneath roosting sites. We then assay feces for *Campylobacter*, *Salmonella*, and STEC.
2. We use point counts to survey birds on produce farms near and far from rangeland. We also collect feces from fields and use DNA analysis to determine which species defecate on produce. Surveys are repeated across 15-20 farms in summer, fall, and winter to assess seasonal patterns.
3. We inoculate bird feces with *E. coli*, place them on multiple substrates (lettuce, soil, or plastic), and collect samples to quantify bacterial survival. Experiments occur in fields and greenhouses to quantify variation among bird species, fecal sizes, and environmental conditions.

Results to Date

Objective 1: We expanded our pathogen database by adding 243 individuals from 26 under-sampled species.

Objective 2: Though prior work on bird intrusion only occurred during summer, we found 2 times more birds and 3.4 times more flocking events occur in fall, suggesting strong seasonal dynamics (**Figure 2**). Bird feces were detected in 12% of 1m2 quadratics across 108 transects. DNA analysis attributed 143 field-collected feces to 25 species, with a few species disproportionately responsible for contamination (**Figure 2**).

Objective 3: *E. coli* was much less likely to survive in smaller feces on soil or plastic compared to larger samples on lettuce (**Figure 3**). Indeed, differences among bird species in pathogen survival primarily arose from differences in fecal mass (**Figure 4**).

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. Our data suggest implementing 1-m no-harvest buffers around feces is not feasible and would result in farmers discing >12% of their fields. Fortunately, results from our pathogen survival experiments suggest farmers may be able to safely ignore small feces, which constitute the vast majority found in fields. More generally, low pathogen survival coupled with rare pathogen prevalence suggests food-safety risks associated with most species are low. Our holistic risk assessments will thus allow farmers to understand when birds present food-safety risks (depending on the species, season, and farming context) versus when conserving birds and the pest-control benefits they provide is possible.

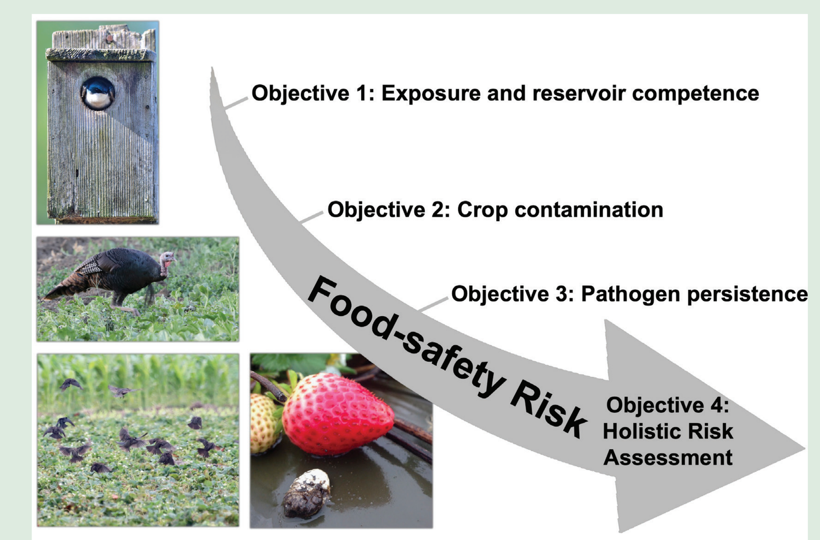

Figure 1. Conceptual diagram depicting how our research objectives build upon each other to provide the first holistic assessment of the food-safety risks imposed by wild birds.

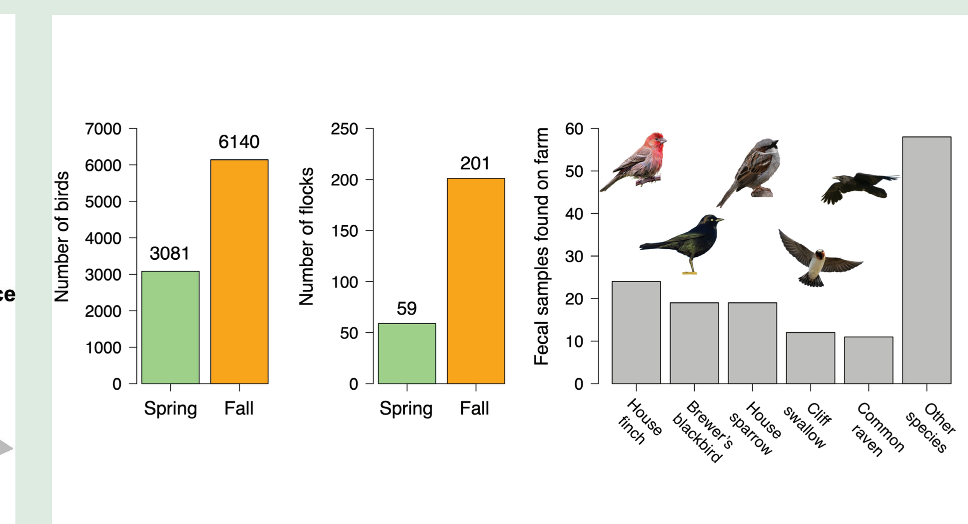

Figure 2. Total bird abundance (left) and number of flocks (seven or more birds of the same species observed together; middle) observed during point counts on leafy-green farms in the Central Coast of California in the spring (green) and fall (orange). Number of fecal samples attributed to different bird species (right), as identified through DNA analysis of feces found on the same farms.

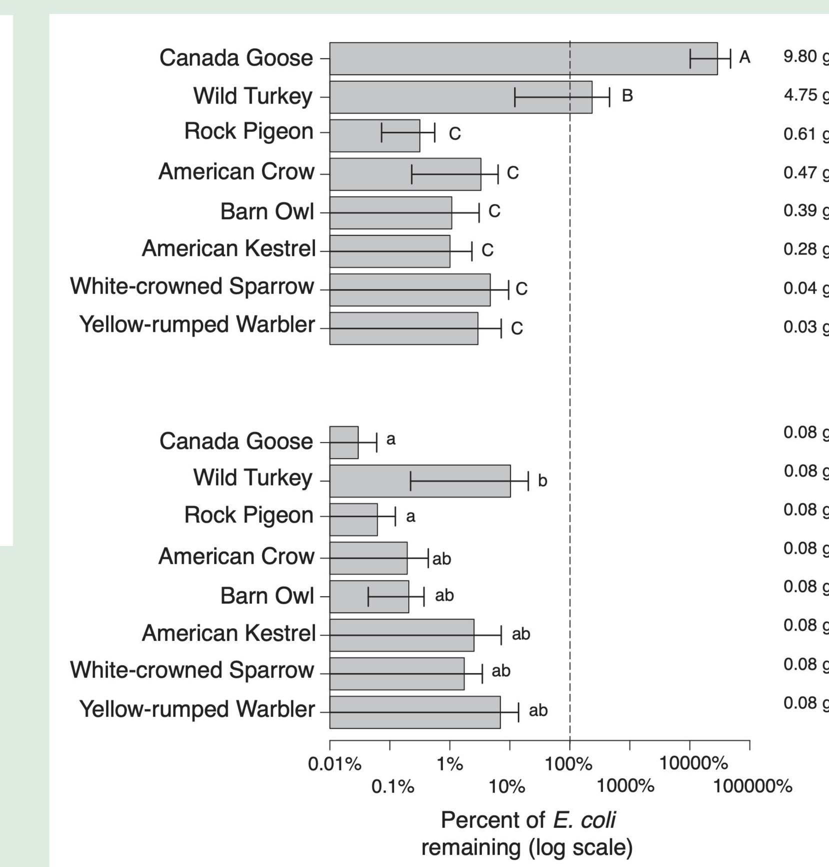

Figure 4. Percent of initial *E. coli* remaining in naturally sized (0.03–9.80 g; top) and standardized (0.08 g; bottom) fecal samples from eight bird species after 3 days in the greenhouse. Plots show that *E. coli* exhibits higher survival in the large feces defecated by Canada Goose and Wild Turkey (top); however, survival exhibits minimal variation among feces from different species when standardized to one size (bottom). Bars left of the dotted line represent *E. coli* decline versus growth. Error bars represent 95% confidence intervals, and different letters denote significant differences within plots. Fecal mass sizes are noted to the right of bars.

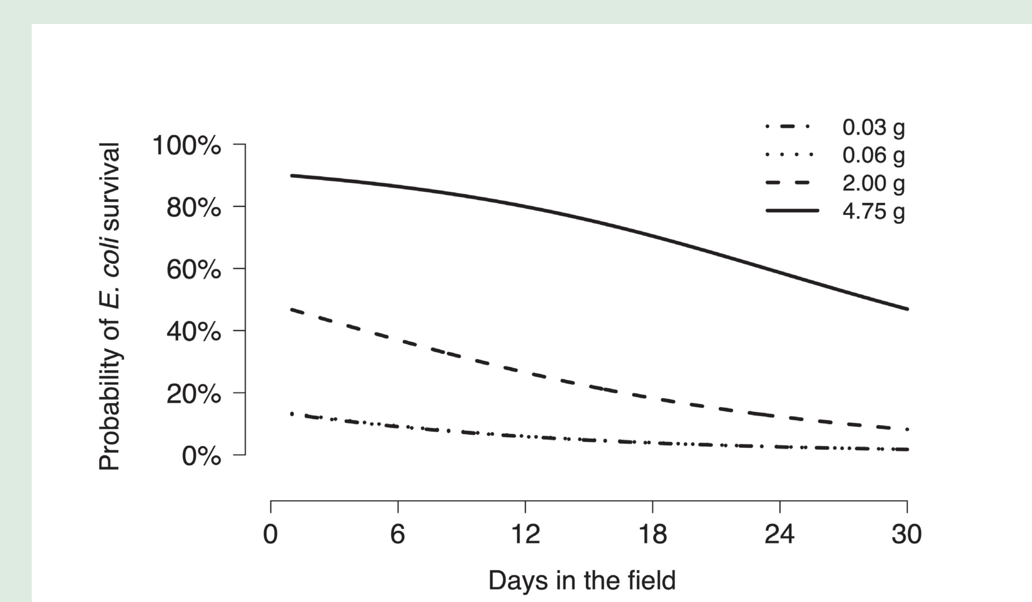

Figure 3. Probability of *E. coli* survival as a function of number of days the fecal sample was left in the field. *E. coli* survival showed a significant relationship with fecal mass, with larger fecal samples associated with higher *E. coli* survival. Fecal mass and number of days in the field had a significant interaction where larger fecal samples were less likely to have *E. coli* after being in the field for longer. Line type signifies different fecal sizes.