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NWRC Research Areas: Agricultural Food Security and Safety

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Our scientists are developing methods to evaluate and mitigate the impacts of wildlife-associated pathogens affecting agricultural health, food security and food safety.

The fastest growing threats to agricultural and human health, both from direct routes of infection of livestock, poultry, and humans, and indirect routes by entering the food chain through the wildlife-agricultural interface. These indirect routes

threaten both food security (access to sufficient food for an active, healthy life) and food safety (the scientific discipline of producing, handling, and preparing food that prevents contamination and food borne). Examples of wildlife-associated pathogens affecting food security and safety include:

Avian influenza viruses (AIV) that can spill-over into poultry operations and become highly pathogenic with large economic consequences in terms of poultry losses and embargoes on poultry products;

Pathogenic bacteria that can be carried and transmitted by wildlife to agricultural operations causing morbidity in livestock and subsequent illness in humans further along the food chain; and

Antimicrobial-resistant bacteria that have increased dramatically in both agricultural operations and human health facilities where their effects can range from morbidity-related losses of livestock production to increases in untreatable illness in humans.

In addition, emerging novel pathogens and novel strains of existing pathogens have increased substantially in the U.S. and overseas and pose an unknown threat to agricultural and human health in the U.S. Having foundational knowledge to deal with these pathogens should they enter the U.S. will provide a proactive approach to mitigate their spread and limit effects in the U.S.

Project Goal and Objectives

Goal: Develop methods and identify control points to mitigate transmission and movement of wildlife-associated pathogens affecting agricultural health, human health and food safety.

Objectives:

1. Identifying transmission risks and farm-side vectors from pathogenic viruses in wildlife. Viruses associated with negative effects to agriculture and human health continue to persist as major pathogens in the U.S. and abroad. This area of research will lead to a better understanding of the potential roles of wildlife in human and animal health and safety, identify key control points for risk reduction, inform risk assessments, and contribute to best management practices.

2. Developing models for risk assessment and optimal control strategies for viral pathogen biosecurity from wildlife. Avian influenza outbreaks, even low pathogenic outbreaks, result in significant economic losses to producers due to morbidity, mortality, and reduced output. Identifying and quantifying factors that have a significant impact on avian influenza dynamics allows for the development of quantitative models that can be used to assess risks and identify control points in order to optimize biosecurity, surveillance, and outbreak control. This area of research has important implications for agricultural health and food security in the U.S.
3. Assess impacts of wildlife in spread and transmission of pathogenic and anti-microbial resistant bacteria to and among agricultural systems. Pathogenic and antimicrobial-resistant (AMR) bacteria have become an increasing problem over the last three decades in human health. For example, the CDC estimates that at least 2 million people in the U. S. acquire serious infections with AMR bacteria each year and at least 23,000 of these cases are fatal. Often, agricultural operations, such as concentrated livestock facilities, are implicated as the source of AMR and pathogenic bacteria infections. However, the contributions of AMR bacteria to the food chain and human health are poorly understood. Other sources, such as naturally occurring wildlife and urban areas, have not been adequately investigated. In addition, wildlife may serve as transmission mechanisms to and from agricultural facilities. These same mechanisms also apply to ultimate sources and transmission of pathogenic bacteria by wildlife.
4. Assess risks of pathogen introduction and spread in the U.S. by movement of wildlife and wildlife products. There is a current lack of understanding on the potential role of wildlife in movement of pathogens that affect agricultural health and food safety. Although wildlife are surmised to play a role in movement of pathogens, there are few probabilistic statements that can be made concerning the likelihood of such introductions and spread of these pathogens. Recent development of unified databases, such as banding and recovery data from multiple continents, will allow for probabilistic inferences on waterfowl movement across continents. In addition, recent advances in statistical estimators, such as multi-state band recovery models and occupancy modeling, have direct applications to estimating transition probabilities that allow for imperfect detectability in both free-ranging wildlife and wildlife products smuggled into the U.S. A hotly debated topic associated with the ability of wildlife to introduce and spread pathogens is whether individuals are compromised by the pathogens they carry which would limit their ability as

pathogen traffickers. For example, a sick bird is unlikely to transport a pathogen long distances, while a mildly-ill or bird with no signs of disease might transport a pathogen longer distances if it shed a requisite amount or had a viremia of sufficient magnitude. Studies examining this effect will thus complement those examining empirical estimates of wildlife movement.

5. Understanding the role of wildlife as reservoirs for novel pathogens that threaten food safety and security. Understanding how wildlife contribute to pathogen persistence and transmission requires both baseline knowledge on what pathogens wildlife can reservoir and knowledge on the changing face of the conditions which impact disease dynamics. This area of research will increase our understanding on the pathogens wildlife carry, while also focusing on how species/disease introduction will affect disease dynamics. Findings will help elucidate control points and will inform on how to efficiently implement mitigation strategies.
6. Provide services and methods development to domestic and international entities on wildlife-associated pathogen issues relevant to One Health. Project staff have expertise in ecology, sampling, statistical design and analysis, and laboratory analytical capabilities that can assist in the development of research, surveillance and monitoring strategies for pathogens of concern in wildlife at different scales. For example, there are a number of statistical estimators, based on mark-recapture theory, that have potential uses in disease ecology after adaptation or re-formulation. Through overseas collaborations, this project will also support the USDA strategy to safeguard animal and plant resources against the introduction of foreign diseases. USDA-APHIS is increasing its involvement in the One Health approach with the convergence of people, animals, and the environment, which this area of research and collaboration will support.

Accomplishments

Wildlife-Associated Pathogens Affecting Agricultural Health, Food Security, and Food Safety

Goal: Understand the ecological role of wildlife in transmission and movement of emerging viral and bacterial pathogens causing livestock and human disease in order to develop diagnostic, surveillance, and management methods to minimize the impact of those diseases on agricultural production and human health

Transmission risks to agriculture from pathogenic viruses in wildlife

- WFS scientists demonstrated that mammals such as (skunks, rabbits and raccoons) are potential transmission risks for avian influenza viruses such as (H7N9). This information will be helpful for farm/wildlife biosecurity risk assessments.
- Scientists identified that low levels of wildlife incursions into produce fields (leafy greens) did not represent a high risk of produce contamination.
- H5N2, H5N8 and H5N1 were detected in healthy waterfowl which indicate general AIV models may apply to estimate movement and dispersal risks for these subtypes.

Impacts of wildlife in the spread and transmission of pathogenic and anti-microbial resistant bacteria in agricultural systems

- Prevalence of antimicrobial resistance (AMR) in raccoons and deer mice were documented at feedlots and WFS researchers determined that raccoons are a potential carrier of AMR to and from feedlots.
- AMR was documented higher downstream of water treatment plants suggesting anthropogenic sources are important.

Risks of pathogen introduction and spread in the U.S. by movement of wildlife

- Antibody persistence was quantified in mallards and will be useful in surveillance efforts.
- WFS scientists found that mallard body condition did not influence transmission and infection susceptibility for AIV.
- AIV Infection and antibody profile was examined in snow geese a highly migratory species. Other species were examined and it was found that House sparrows and rabbits could pose biosecurity risks.

- WFS scientists demonstrated that raccoons are not competent hosts for Zika Virus

Role of wildlife as reservoirs for novel pathogens that threaten food safety and security

- Commensal birds tested positive for porcine epidemic diarrhea virus (PEDV) at swine facilities prompting the need for studies to better assess risk.

Developing field and laboratory methods to improve wildlife disease research

- Methods were developed to estimate sample sizes needed to detect influenza A viruses in wild birds and these methods resulted in more streamlined and efficient influenza surveillance efforts
- A novel bead-based flow cytometric assay was developed to detect Yersinia pestis (plague) antibodies in wildlife blood sample
- A resin-based method to detect aerosolized viruses was developed.

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Publications

- Wildlife Pathogens and Food Safety

Contact Us

Agricultural Food Security and Safety

Alan Franklin, Project Leader

Email: alan.b.franklin@usda.gov

Phone: 970-266-6137

More Information

- Learn More About Dr. Alan Franklin

National Wildlife Research Center

4101 LaPorte Avenue

Fort Collins, Colorado 80521

More Information

- Learn More About Dr. Alan Franklin

Team Members

Carter Hranac, Biologist
Scott Goetz, Biologist

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