National Wildlife Research Center Scientists Examine the Roles of Wildlife in the Transmission and Spread of Emerging Pathogens

Wildlife Services' (WS) National Wildlife Research Center (NWRC) is the only Federal research organization devoted exclusively to resolving conflicts between people and wildlife through the development of effective, selective, and socially responsible methods, tools, and techniques.

Considerable concern exists around the world about emerging infectious diseases, of which 75 percent are zoonotic, meaning the pathogens causing the disease can be transmitted between animals and people. Wildlife plays a critical role in both the emergence and increased incidence of pathogens in livestock and people. For example, highly pathogenic H5 subtypes of avian influenza virus that originated in Asia, subsequently entered North America in 2014 via migratory waterfowl. In addition, wildlife has increasingly been implicated in the spread of re-emerging pathogens, such as antibiotic-resistant bacteria, that are causing significant problems to agricultural, animal, and human health.

NWRC is at the forefront of research and surveillance for many of these pathogens. Much of this effort has focused on pathogenic bacteria, including antibiotic-resistant strains, and avian influenza viruses.

Applying Science and Expertise to Wildlife Challenges

Predicting Spread of Influenza A Virus in Wild Waterfowl. Wild waterfowl and shorebirds are natural reservoirs for influenza A viruses (IAV). Some IAVs are considered highly pathogenic, causing high mortality in domestic poultry, but limited mortality in wild waterfowl. Using data from hunter-harvested and live-captured banded ducks, NWRC and U.S. Geological Survey scientists identified hotspots for waterfowl activity in the Pacific flyway of the United States. These hotspots were then used in targeted disease surveillance to predict the occurrence and movement of a novel influenza A virus (clade 2.3.4.4) introduced from Asia by waterfowl during a 2014 outbreak in North America. Scientists also tested whether the IAVs were detected more readily inside the hotspots versus other sampled areas. Results found that the hotspots were useful in predicting areas with higher virus prevalence. This approach demonstrates the value of using waterfowl ecological and behavioral data to help target disease surveillance activities and predict risk to agricultural operations.

Virulent Newcastle Disease Persistence and Spread in Wild Birds. Newcastle disease is a highly contagious and deadly respiratory and neurological virus in poultry. Virulent forms of the virus can have devastating economic effects on domestic poultry production worldwide. Low-virulent strains of Newcastle disease virus (NDV) occur throughout the world in both domestic and wild birds. To evaluate the role wild birds may have in introducing and transmitting virulent NDV in the United States, NWRC worked with the U.S. Department of Homeland Security and the U.S. Department of Energy’s Oak Ridge Institute for Science and Education to conduct a qualitative risk analysis. Findings showed that the legal and illegal movement of live birds, animal products, byproducts, and animal feed, as well as spillover from wild birds and spontaneous virus mutation, all present some level of risk to the United States. While strict U.S. import regulations for live birds and their products have helped limit NDV risks, there are still concerns about the illegal movement of birds and bird products; spillover from wild birds (i.e., double-crested cormorants, pigeons, and doves); and NDV vaccines used in domestic poultry. Researchers recommend more monitoring of wild birds to better understand their impact on NDV persistence, along with surveillance and reporting systems to detect and control disease outbreaks in at-risk populations such as backyard poultry.

Risk of Foot-and-Mouth Disease Introduction into the United States. Foot-and-mouth disease (FMD) affects domestic and wild cloven-hoofed species, such as cattle, sheep, goats and pigs. FMD is one of the most costly animal diseases in the world. Estimates indicate that FMD costs between US$6.5 and US$21 billion annually in endemic countries, with the main costs attributed to production losses and vaccination. As part of a risk analysis, NWRC researchers identified vulnerabilities that could lead to FMD introduction or persistence in the United States or other FMD-free...
regions. The legal movement of susceptible live animals, animal products, by-products, and animal feed containing animal products pose a risk of FMD virus introduction and spread. Additionally, the illegal movement of FMD-susceptible animals and their products and an act of bioterrorism present additional routes of FMD introduction. Therefore, robust surveillance and rapid diagnostics in the face of a possible introduction are essential for detecting and controlling FMD as quickly as possible. Researchers note wildlife species and feral swine complicate a FMD outbreak response since wildlife often are not closely monitored or managed, and there are logistical concerns related to disease surveillance and control in wildlife populations. This was exemplified by the recent discovery by NWRC scientists of the spillover of porcine epidemic diarrhea virus from domestic pigs to feral swine.

The Role of Wildlife in the Maintenance and Transmission of Antimicrobial-resistant Bacteria. NWRC scientists are developing methods and identifying control points to mitigate the transmission and movement of antimicrobial-resistant bacteria (AMR) by wildlife. One primary objective is to assess the impacts of wildlife in the spread and transmission of AMR bacteria to and among agricultural systems. Studies have found that some wildlife species, such as raccoons, have a high prevalence (>50%) of AMR bacteria, carry multiple strains of AMR, serve as reservoir hosts for some strains of AMR, shed large quantities of AMR in their feces, and move AMR bacteria between livestock operations and the surrounding environment. Additional research indicates that waste water treatment plants can serve as sources of AMR bacteria in wildlife. New cost-effective methods have been developed that identify AMR bacteria using mass spectrometry. Over 1,000 AMR isolates collected from wildlife have been analyzed with ≥90% prediction accuracy to detect biomarkers for antimicrobial susceptibilities in bacteria to antibiotics. To accomplish these, and future, research studies, NWRC collaborates with Colorado State University, University of Wyoming, and the USDA-Agricultural Research Service’s Meat Animal Research Center.

Rodenticide Use in Marijuana Fields Threaten Wildlife. California is the largest producer of marijuana in the United States, with a mix of illegal and legal fields grown for medical and recreational purposes. One environmental side effect of marijuana production is the extensive use of anticoagulant rodenticides (AR) to prevent rodent damage to marijuana plants. Because marijuana is classified by the Federal Government as an illegal substance, no rodenticides are currently registered for use on marijuana crops. For these reasons, regulatory compliance of rodenticide use at marijuana growing operations (MGO) is uncertain. Rodenticide use at illegal MGOs is even more concerning. NWRC and partners conducting owl surveys in California reported brodifacoum AR exposure in a northern spotted owl found dead in an area near seven active MGOs. The researchers note the exposure was likely caused by the owl feeding on AR-contaminated prey. The proliferation of MGOs and their use of ARs in forested California landscapes may serve as an added stressor to this threatened species and other wildlife.

Selected Publications:


Major Research Accomplishments:
• Using data from hunter-harvested and live-captured banded ducks, WS and U.S. Geological Survey scientists identified hotspots for waterfowl activity in the Pacific flyway of the United States. These hotspots were then used in targeted disease surveillance to predict the occurrence and movement of a novel influenza A virus (clade 2.3.4.4) introduced from Asia by waterfowl during an 2014 outbreak in North America.

• WS and partners investigated the role wild birds may have in introducing and transmitting virulent Newcastle disease virus in the United States. Findings showed that the legal and illegal movement of live birds and animal products, as well as spillover from wild birds and spontaneous virus mutation, all present some level of risk to the United States.

• As part of a risk analysis, WS researchers identified vulnerabilities that could lead to foot-and-mouth disease (FMD) introduction or persistence in the United States or other FMD-free regions.

• WS found high prevalence of antimicrobial-resistant bacteria (AMR) in wildlife near livestock feedlots and waste water treatment plants and has developed low-cost methods to detect AMR in wildlife samples.

• WS and partners compiled information about the use of anticoagulant rodenticides (AR) on marijuana growing operations in California, which affected northern spotted owls, a threatened species.