

WEST NILE VIRUS INFECTION AND OTHER CAUSES OF BIRD MORTALITY IN NEW YORK CITY

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Abstract—At the time when West Nile (WN) virus was first detected in New York City and other parts of the United States, many jurisdictions, including the New York City Health Department, began collecting dead birds to analyze them for cause of death in order to determine the species of birds that were infected and/or dying due to WN virus infections. Across all species, blunt impact trauma was the leading cause of death between 2001 and 2007 in New York City (49%), and WN disease was implicated in 25% of deaths overall. In contrast, among the four species of birds that were most affected by WN disease (American Crow, Blue Jay, House Finch and House Sparrow), no less than 18% of dead specimens harbored WN virus. In New York City, House Sparrows show a high correlation to human WN cases and are a likely reservoir for WN virus, perhaps in part due to lower mortality rates compared to other species.

West Nile virus was first detected in the United States in New York City in 1999. Since that time, this mosquito-borne virus has spread quickly to every state in the continental US, infecting thousands and causing hundreds of deaths (Lindsey et al. 2010). Although mosquitoes are the vectors that transmit WN virus disease to humans, birds play an integral role as the primary host of the virus. In 1999, the NYC Health Department began surveillance of mosquitoes and dead birds as a potential early warning system for WN disease transmission to humans in the city. Dead birds that were reported to the health department were classified by species and cause of death was determined for each bird at the New York State Department of Environmental Conservation's Wildlife Pathology Unit, Albany, and the New York State Public Health Laboratory, Wadsworth. Collected birds underwent pathology and laboratory testing to determine cause of death. Avian tissue samples were tested for WN virus by real-time reverse transcription-polymerase chain reaction (RT-PCR). Confirmatory tests were performed using RT-PCR, virus isolation in cell culture and immunofluorescence assays. Bird samples were confirmed positive when they tested positive on at least two tests (Kulasekera et al. 2001). Dead bird collection and testing concluded in New York City in 2007 due to the fact that it was not an effective surveillance system as it was time consuming and costly compared to mosquito surveillance and testing. Between 2001 and 2007, 119 human cases of WN virus occurred within the five boroughs of New York City.

RESULTS

The birds analyzed in this paper are American Crow, American Robin, Blue Jay, Common Grackle, House Finch, House Sparrow and Mourning Dove. The largest cause of death among all birds between the years of 2001 and 2007 was blunt impact trauma among 49% of dead birds tested (Fig. 1, p. 216). The second largest cause of death was WN virus infection (25%) followed by undetermined causes of death (11%), poisoning (5.3%), pneumonia (3.4%), infections other than WN and pneumonia (3.8%), and lastly, starvation (1.7%) (Fig. 1). All other causes of death remained relatively steady across the time period in which dead birds were being collected. After 2004, deaths due to WN virus dropped off under twenty percent; at the same time, blunt impact trauma rose to a high of 71% of dead birds as primary cause of death in 2005 (Fig. 1). Blunt impact trauma was the primary cause of death for many species including: American Robin (66%), Mourning Dove (65%), Common Grackle (63%), House Sparrow (50%), House Finch (47%) and Blue Jay (33%). (Fig. 2). American Crow (74%), Blue Jay (45%), House Finch (36%), and House Sparrow (22%) were the species whose deaths were most influenced by WN virus infection (Fig. 3).

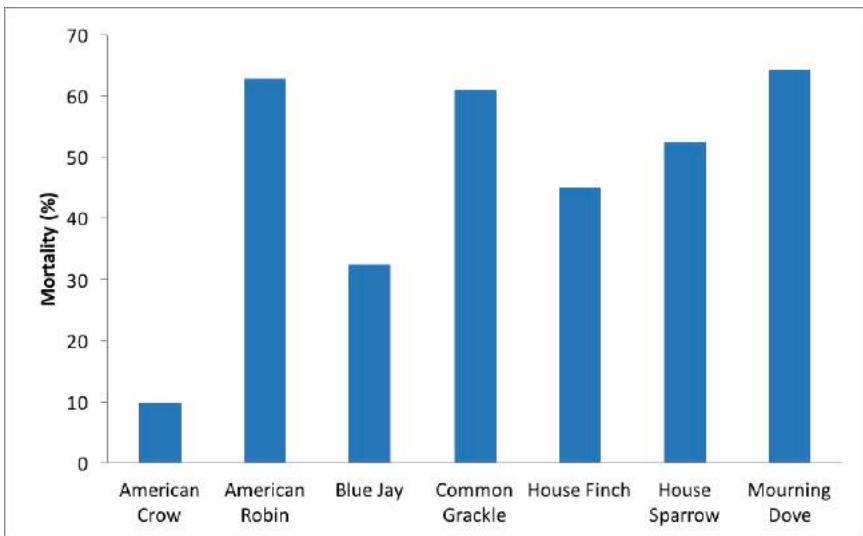


Figure 2. Percent cause of death for each species due to blunt impact trauma.

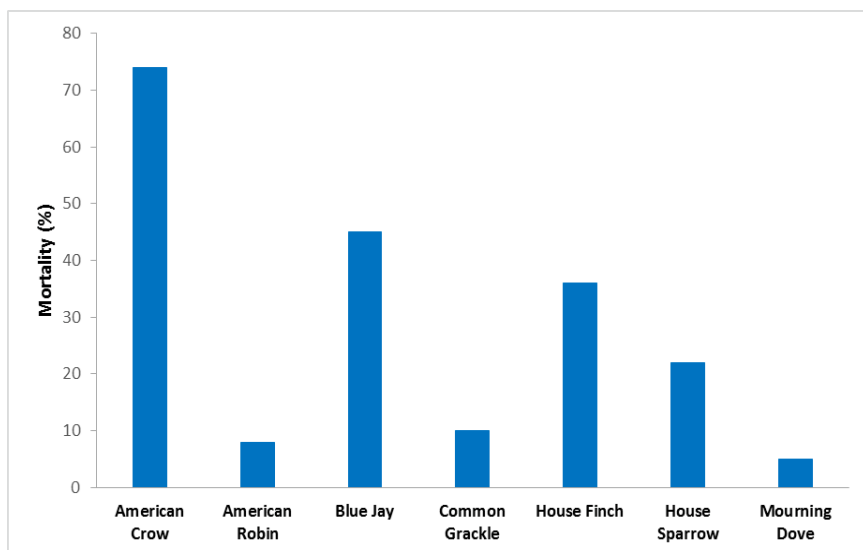


Figure 3. Percent cause of death for each species due to WN virus.

Common chemicals for poisoning found in dead birds include: organochlorine, diazinon, chlordane and lead. Poisoning only contributed to 5.3% of the deaths of the birds that were collected. Additionally, infections not including WN virus and pneumonia accounted for only 3.8% of deaths. Common reasons for infection in deceased birds include: aspergillosis (27%), trichomoniasis (23%), avian pox (9.9%), parasites (6.6%), ceolomitis (6.6%), salmonellosis (3.3%), pericarditis (1.1%), and septicemia (1.1%).

The average percentage of dead birds infected with WN virus, regardless of cause of death determination, was calculated for the following species: Blue Jay, American Crow, House Finch, and House Sparrow. American Crow (74%) and Blue Jay (42%) specimens had the highest infection rate, followed by House Finch (33%) and House Sparrow (18%) (Fig. 4). Additionally, the correlation between bird deaths attributed to WN and number of human cases for each year of data was analyzed. House Sparrows had the highest correlation with human cases ($R^2 = 0.73$), followed by Mourning Doves, American Robins, and House Finches ($R^2 = 0.38, 0.29$ and 0.28 , respectively; Table 1).

DISCUSSION AND CONCLUSIONS

Molaei et al. (2006) demonstrated that *Culex pipiens* and *Cx. restuans* most commonly fed on American Robins in Connecticut, and that this species was a competent reservoir there, when considering results of blood meal analysis, seroprevalence of WN virus, and species abundance.

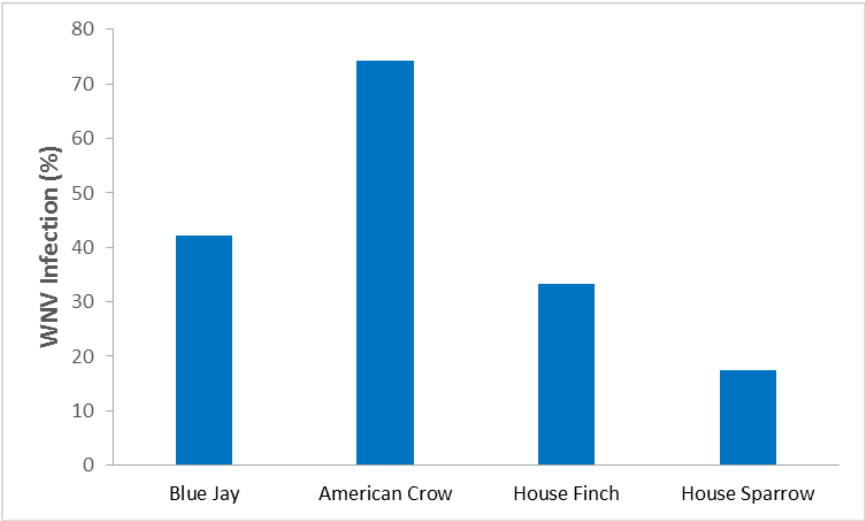


Figure 4. Average percentage of birds testing positive for WN virus through PCR (reverse transcription polymerase chain reaction) testing.

Species	R ^{2*}
House Sparrow	0.73
Mourning Dove	0.38
American Robin	0.29
House Finch	0.28
Common Grackle	0.13
Blue Jay	0.023
American Crow	0.016

Table 1. R² values for the relationship between the annual totals of bird deaths attributed to WN virus and human cases, 2001-2007.

While infections other than WN virus and poisons had a very small impact on overall bird mortality in our sample, we were also able to identify key chemicals and other diseases that played a role in bird deaths within New York City. More importantly, we determined that the main cause of death for all bird species collected was blunt impact trauma even while the percentage of death due to WN virus infection was relatively high in NYC. Death due to WN virus infection was most frequent among American Crow, Blue Jay, House Finch, and House Sparrow. Because American Crows and Blue Jays have such a high susceptibility and mortality rate due to WN virus infection, they are not an optimal reservoir for WN virus transmission in New York City. In contrast, House Sparrows experienced relatively lower levels of mortality due to WN

virus (22% vs. 74% in American Crows), even though other studies have identified House Sparrow as the most WN virus infected bird species in NYC (Komar et al. 2001b, Nasci et al. 2002). Together, these observations suggest that this species could be an important reservoir for WN virus. This inference is consistent with Komar et al.'s (2001a) conclusions from a serological study of WN virus in birds in New York. Finally, our observation that House Sparrow deaths due to WN virus showed a high correlation ($R^2 = 0.73$) with human cases from 2001-2007 provides further evidence that this species is an important reservoir for WN virus in New York City.

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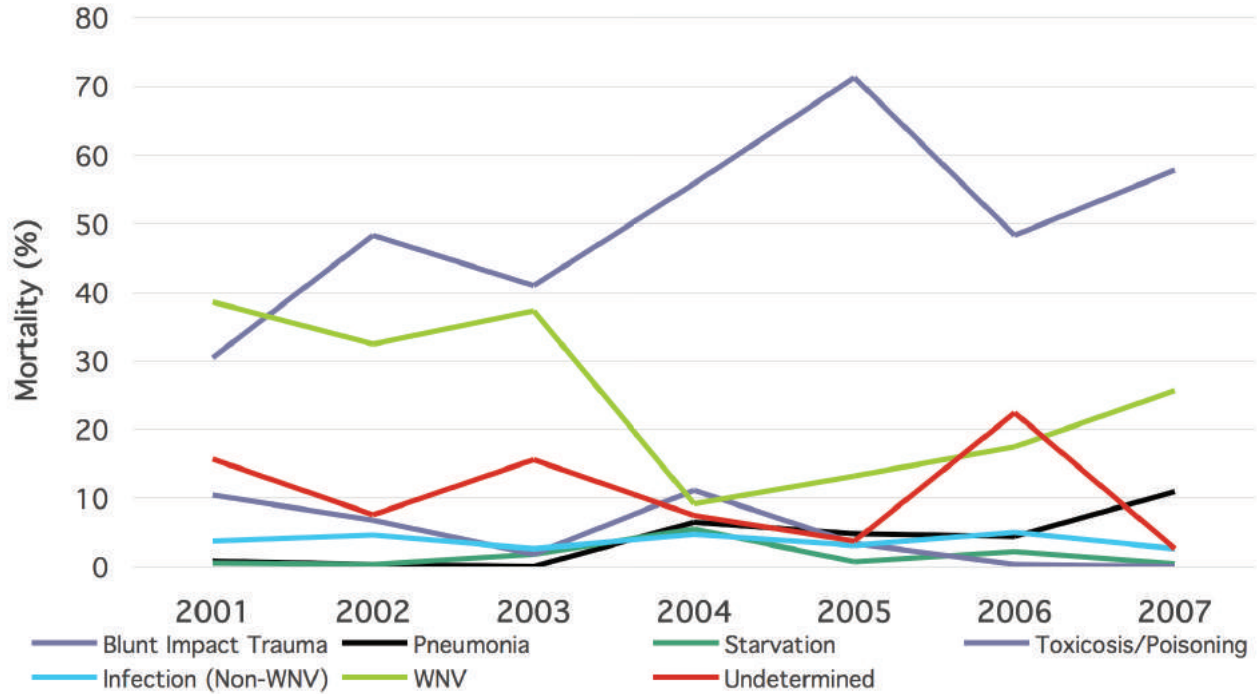


Figure 1. Cause of death trends among birds collected in New York City between 2001 and 2007. See article, pp. 174-178.