

## West Nile Virus –

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### Our Challenge for 2004 and Beyond

General Information - West Nile virus (WNV) belongs to a family of viruses, the flaviviridae, many of which can cause encephalitis, a potentially fatal inflammation of the brain and spinal cord. WNV is known to affect birds, horses, and humans - and occasionally other mammals - and, in an odd case, alligators in Florida that had been fed WNV-infected horsemeat.

History - The virus was discovered in Africa in 1937, and was first detected in North America in 1999 during an outbreak in New York. The "genotype" of the WNV detected in North America is most similar to the virus found in an outbreak in Israel in 1998, and distinct from other strains of WNV found around the world, which do not kill birds. Since the summer of 1999, West Nile infections have been confirmed across all of the United States. The 2002 season was particularly virulent, racing across many states which had no previous presence of the virus, and sickening and killing many thousands of birds, including a much higher proportion of raptors than in earlier years - as well as many more people and horses than before. It is not yet known if this huge expansion in impact was caused by a variant strain, or simply by environmental conditions.

For example, the drought in much of the mid-west earlier in that year was followed by rain, which may have caused a huge bloom in mosquitoes with fewer birds (who had, perhaps, gone elsewhere because of the drought) to keep them in check. The assault on raptors may have been caused by the lack of other bird hosts or by raptors eating other infected prey. However, this is all theory. In 2003, Colorado was particularly hard hit and it struck unusually early in the season - late spring, rather than the more normal late summer/early fall - possibly due to heavy spring rains and then very hot weather, perfect for hatching mosquitoes. So far in 2004, WNV continues its march west, with Arizona and California sharing the dubious distinction of the highest number of cases. It has also been identified in horses in Mexico and some birds in the Caribbean and further south.

Oddly enough, in early October 2002, it was announced that a raven in northeastern Washington was confirmed to have WNV; in late October, a case of a crow in Washington was also confirmed. But Washington then had no cases at all during 2003. Now, in late summer 2004, the virus has reached Oregon (previously the only state in the lower 48 with no cases) and is rapidly approaching Lane County, both from the east and from the south.

Transmission - Birds serve as the host for the virus, which is spread by mosquitoes to other birds and animals. So far, it has been shown that only in birds can the virus reach the level of viremia to reinfect mosquitoes. As of September 2003, West Nile Virus has been identified in 11

species of native owls, 4 species of falcons, and 15 native species of diurnal raptors, including osprey, vultures, and bald and golden eagles. Altogether, between captive and wild birds, WNV has been identified in 218 species of birds in North America, with the crow family (jays, crows, ravens, and magpies) and, in the last two years, some raptors, seeming to be especially susceptible. It has also been found in 28 species of mammals, besides horses and humans, and two species of reptiles. This is clearly only the tip of the iceberg, however, as in most areas, once the virus is confirmed present, testing at public expense ceases - and few rehabilitators or individuals can afford to take on that cost themselves. Even the list of affected species has not been updated by the US Geological Service since September of 2003. Though still considered 'newly emerging,' this disease is clearly now a permanent fixture in the Western Hemisphere.

There are no verified cases of transmission from birds or mammals to humans, or person to person (except through blood transfusions and organ donations, though an infant drinking breast milk from an infected mother whose milk showed viral particles, so far is positive for antibodies but has shown no sign of the disease). There is, however, strong concern and some indication that contact of WNV-contaminated blood or tissue with an open cut could lead to transmission to people, and thus extra precautions handling dead or sick birds are warranted.

In a laboratory environment with infected and uninfected crows housed together, the virus has been shown to travel bird to bird through, it is believed, direct contact. The virus was not transmitted from infected birds to uninfected birds when they were caged separately but in the same room. These results would suggest that, though the virus is shed in large numbers in both saliva and feces, aerosol transmission is less likely to occur and has not apparently been demonstrated to occur between birds so far. However, if an aerosol were created during washing (spraying with water) of cages that contained a bird who shed large amounts of the virus in its feces, then the risk of aerosol transmission to adjacent birds would be increased.

Some blood-sucking ectoparasites (specifically hippoboscid flies) taken from infected birds have tested positive for the virus but it is not yet known if (a) it is because they were still blood engorged (with virus in the blood meal taken from the infected bird), (b) if they would test positive after having processed the blood meal, or (c) if they can, in fact, transmit the disease through biting. Tests continue on those aspects. However, bird mites have been documented in experiments to transmit Eastern Equine Encephalitis virus (another flavivirus) to birds.

More critically for raptors in general, studies by the CDC during 2002 have shown that (1) WNV can also be transmitted through eating infected prey; (2) the virus thrives at B70C, so is not killed by freezing; and (3) there are some birds, e.g., house sparrows, that can act as asymptomatic carriers of the disease. The disease has been found in several mammal species this past year (e.g., squirrels in the mid-west), more so than in previous years, and two species of reptiles.

Human Impact - Regarding human risk, the mosquito is necessary for transmission of West Nile Virus between birds and people.

Although thousands of humans have been infected, the vast majority tested who showed antibodies to the disease never knew they were infected. For a few, flu-like symptoms arise. However, for less than 1% of those infected, WNV can cause a dangerous and even fatal encephalitis - mostly in older (over 50) or immune suppressed people. Different species of mosquitoes have different predilections to bite birds or mammals or people. Only female mosquitoes bite, only about 1% of those carry the disease in any given area, and very few people bitten will even know they were infected and mosquito bites can be prevented. The risk of serious disease or death from WNV is nowhere near as high as it is from flu.

To avoid mosquito bites, wear long pants, long sleeves, use a DEET-containing repellent on skin and clothes when working outside, and avoid being outdoors at high mosquito-activity times of the day like dawn, dusk and early evening. Remove breeding opportunities for mosquitoes where water collects. A bigger danger than the virus itself is over-reaction on the part of the authorities or the public and the resulting decision to do widespread spraying of insecticides - as happened in NY in 1999 and Louisiana and Illinois in 2002. This has the potential to cause far more harm than the virus itself, especially to birds but also to humans. The risk to wetlands organisms and other insects (and the birds, plants, and economies that depend upon them) is very high, depending on the type of pesticide used.

Although there are no proven cases where it has been passed from bird to person via blood-to-blood contact or aerosol transmissions, the Oregon Health Service and CDC web sites have suggested hunters wear gloves when handling the meat from dead game. Furthermore, Dr Ward Stone, NY DEQ veterinary pathologist, whose laboratory has been handling thousands of suspected cases in the last four years, requires his staff to wear two layers of latex gloves, a chain-mail glove (to prevent puncture by bone fragments), and two more layers of latex gloves over that when dealing with potentially WNV-infected blood and tissue. He feels that at least one case of infection among his staff was caused by direct contact.

Although there is evidence to show it can be transmitted between birds (via direct contact, fecal/oral, possible aerosol transmission, or ingesting infected prey), the risk of bird to human transmission is probably minor. There are more and more people working with sick birds each year, in a variety of circumstances, with few reported cases - any of which could have easily been from a mosquito bite. Precautions for hygiene and sanitation are always in order when handling sick animals and should be satisfactory with WNV.

West Nile Virus in Raptors - Although the crow family by far remains the most susceptible, West Nile Virus has caused sickness and death in huge numbers of raptors in many parts of the United States -- the vast majority, for some as yet unknown reason, since mid-July 2002. Great horned owls and red-tailed hawks have been infected by the thousands, especially in the mid-west. There is now laboratory proof that birds can get the virus by eating infected prey - and house sparrows are a species of often asymptomatic carriers. Kay McKeever, who runs the Owl Foundation in Ontario, Canada, has lost over 100 of her breeding owls. Other raptors deemed most susceptible are goshawks, as falconers have found; and several zoos have lost eagles. So

far falcons have seemed to be the least susceptible of the raptors, but there have been cases in the four main species of North American falcons. Some species may be as yet unlisted or under-represented, as there are also some gaps in reporting cases from rehabilitation centers to the national data banks, especially if the confirmation did not go through state public health testing labs but was done independently or were not tested at all. Smaller birds, or birds with the largest or more remote territories, are also less likely to be found - all of which means that we do not yet truly know the full impact this disease is having on raptor or other bird populations.

Clinical Signs of WNV in raptors seem to occur in three phases, specifically -

Phase 1: Depression, anorexia, weight loss (in proportion to duration of starvation), sleeping, pinched off blood feathers, elevated white blood cell count.

Phase 2: In addition to the above, head tremors, green urates (indicating liver necrosis), mental dullness/central blindness and general lack of awareness of surroundings, ataxia (clumsiness or poor equilibrium), weakness in legs, exaggerated aggression, very high fever, polio-like flaccid paralysis, excessive sleeping, detached retinas.

Phase 3: More severe tremors, seizures, and death

Obviously not all birds show all symptoms - they vary enormously but these are some of the clinical signs that have been listed by rehabilitators seeing large numbers of cases the last couple of summers. Equally obviously, there are other conditions such as head trauma that can produce similar neurological signs or many diseases that can produce elevated white counts, fever, or loss of appetite.

As with people, some birds can get the disease and show no outward signs - blood tests alone reveal exposure (through the presence of antibodies) or current infection (levels of the virus in the blood). Birds are likely to be infective for only a few days and CDC tests have shown it takes 3-4 days from exposure to develop viremic levels of the virus in the blood even in asymptomatic cases. Infected birds that do not yet display clinical signs may be more prone to other accidents, such as flying into windows, cars or fences - so quarantine protocols of all birds must be enhanced.

Because this is a virus, there is no one prescribed treatment. But supportive care can be provided and it is possible for some birds to recover. In general, the likelihood of recovery depends on what phase the bird is in. Phase 1 birds respond reasonably well to supportive care. Once they reach Phase 2, some birds respond to supportive care, but others do not and proceed to phase 3. Complete recovery is uncertain. Birds suffering from the severe tremors and seizures characteristic of Phase 3 are close to death. Intervention is probably not going to alter the course. As with other facilities which have been dealing with the disease, once CRC starts receiving WNV-infected birds coming into the clinic, room and volunteer time may force triage decisions in determining the cases with the most potential for survival and the euthanasia of others.

Recovery - Recovered birds may have cleared the virus or they may have become asymptomatic carriers - there is no way of knowing. We can never say "never," but it is assumed that once a bird recovers from WNV infection there should be little chance of its being a source of virus to vectors or directly to other birds. However, we do not know much at this time about the possibility of persistent WNV infections in birds: i.e., birds that become acutely infected followed by a chronic infection until there is a relapse at some time in the future to make virus available again for mosquito transmission. As a guideline, it is recommended that "recovered" birds be held inside for two weeks after they have recovered, not so much to prevent them being a source of virus to mosquitoes, but mostly to make sure they won't relapse - we don't know the course of the disease that well yet. In general, however, it is thought by researchers that recovered birds should have very low virus counts in their blood - probably not enough to be an immediate infection source. Oddly, some recovered birds (high antibody titers) have been found to harbor live virus in their feather follicles - and researchers do not understand why or what it means. It may be that since WNV is a summer disease, when birds are molting, and blood circulates into new feathers (i.e., blood feathers), perhaps as the feathers finish growing and the blood supply pinches off, there is a detectable residue in the follicle and surrounding tissue. It is not known if that could become a source of re-infection, either to the bird itself or to a mosquito.

No one knows if there are likely to be birds that will have permanent neurological damage, even if they have survived the virus infection. Each case is, of course, different - but if, during recovery, a bird plateaus for an extended time, showing no sign of improvement, it's likely that's as much as they are going to recover. When to euthanize must be a case by case decision. In a small CDC study during 2002 that experimentally infected some non-releasable birds with the 1999 virus, none of the birds showed any clinical signs of illness, though their blood showed viremic levels within 3-4 days; on necropsy, the only internal sign was an enlarged spleen. We do not know if that might have a long-term effect or if it returns to normal.

During 2003, Dr Patrick Redig from the Raptor Center at the University of Minnesota conducted a study with non-releasable red-tailed hawks using a new DNA vaccine made from the 2002 virus isolated from a raptor. The birds were then sent to the University of Louisiana, where they were experimentally infected with the virus. This research is only beginning, as no one knows how much vaccine is needed, or how much virus is necessary to reach an LD50. Unfortunately, it has become impossible to find enough non-releasable wild raptors that have not been exposed to WNV, so the study is now continuing using domestic quail. Their susceptibility may be completely different. Even if the vaccine proves effective, getting it manufactured for the small captive bird market - or even rehabilitated birds - will be difficult. Obviously, the horse market is much larger and the equine vaccine is the one that has also been used in birds - though no one has done a challenge test in any species except crows (where it was not effective).

Treatment Protocols - Because WNV is a virus, the primary treatment is supportive care (fluids, nutrition, warmth). In addition, treatment of the associated spinal/brain inflammation with non-steroidal anti-inflammatories such as Meloxicam, Banamine or Celebrex can be indicated. In histological examination of brain tissue, what is seen most often is necrosis and vacuolization, with varying degrees of inflammation. Steroids such as Dexamethasone are not recommended because of immuno-suppressive concerns. Vitamin B1 (thiamine) may be helpful and is often routine with neurological conditions. Vitamin E is possibly helpful, but care should be taken with dosing, as the fat-soluble vitamins can be overdosed. During 2004, an experimental treatment using a human blood pressure medicine has been tried with varying results.

Prevention of the Disease in Captive Birds - The dose of the equine vaccine (made by Fort Dodge) that has been used in birds has induced no apparent negative side effects. Many zoos and education programs have vaccinated their birds and, at least in some birds tested so far (some raptors and cockatiels), antibodies have been produced. We have no idea if this confers protection on vaccinated birds - e.g., although there is some indication that it has in sandhill cranes, it definitely does not in crows. However, it does not appear to do any harm and it is thought that it may prepare the immune system to react more vigorously if the bird becomes infected. During 2003, vaccinated goshawks at a breeding facility did get sick but few died, whereas earlier goshawks had been shown to be quite susceptible.

CRC has vaccinated all of its resident raptors with the equine vaccine, starting in early 2003, with boosters in 2004. We have not been inoculating birds we release, due to the cost of the vaccine (between \$15 and \$30 per bird, depending on size and whether two or three shots are given), the extra time in captivity that would be necessitated by the vaccine protocol (2 or 3 shots given 3-4 weeks apart) after a bird has been determined to be releasable, and the unknown efficacy of the vaccine in birds.

Protective Measures -For collections of birds, the first defense is to protect them from mosquitoes by moving them indoors, covering enclosures with mosquito netting, and/or using a USDA-approved carbon dioxide mosquito trap. We have screened all the enclosures housing our permanent resident birds and now that WNV is in Oregon, we have also moved our crow and raven inside, into screened cages in our clinic building. It is also critical to isolate infected birds in mosquito-proof areas away from other birds that may be at risk, as well as removing any ectoparasites that might possibly transmit the disease, and to incinerate carcasses of dead birds. Long-term, we must be prepared to deal with an ongoing threat of West Nile virus for the foreseeable future.

Within the clinic, housing rehabilitation birds in individual cages, without direct contact, sanitizing (careful cleaning with diluted bleach or commercial antiviral solution) of cages between use by different birds, and careful handling and sanitary disposal of fecal material should greatly reduce the risk of direct bird-to-bird transmission. CRC will use its screened outside ward as a quarantine area, and will help regulate temperature in there by putting

plastic around it, if needed, though the mosquito season should coincide with warm weather. Quarantine protocols will be very important.

Control of ectoparasites on intake is part of quarantine procedures with any new patients, and particularly important with suspected WNV cases. Starting in 2002, Cascades Raptor Center has stopped accepting killed or live wild prey for food, and will not accept free range chickens/roosters. Even donations of mice from the Forest Service or other sources must be from completely enclosed or screened buildings. We have checked with all our current chick, quail, rat and mice breeders to ensure their facilities are completely screened, and we've screened our breeding facilities as well.

Although no transmission to people directly from birds has been documented, a bird with the disease can shed the virus in both saliva and feces. So once we have cases in the CRC clinic, staff should wash hands even more frequently, wear latex gloves when cleaning hospital cages and wash their gloved hands between cages, dispose of cage newspapers to an outside receptacle immediately, and wash laundry frequently, so feces do not dry and aerosolize.

For the public - In finding or handling dead birds, minimize any direct contact. Wear gloves if possible, place the bird in a sealable plastic bag such as a Ziplock, and freeze. Wash hands thoroughly after handling.

Testing of dead birds in Oregon is funded for corvids only (crows, jays, and magpies - probably ravens) that have been dead less than 24 hours and that are part of a general die-out in a particular area - i.e., that has been going on for 2-3 days. Collection information is available at [www.oregon.gov/DHS/ph/acd/diseases/wnile/birdform.pdf](http://www.oregon.gov/DHS/ph/acd/diseases/wnile/birdform.pdf).

Pre-approval must be given before the birds can be shipped for testing. When finding dead birds that meet the above criteria, contact your county health department or vector control agency. Locally, call Lane County Public Health (682-4041) or call Environmental Health (682-4480). They will take your information and contact Dr Emilio DeBess, State Public Health Veterinarian, at the Oregon Department of Health Services: 503/731-4024. If the specimen is accepted for testing, you will be given instructions on how to send it to OSU Veterinary Diagnostic Laboratory, 30th and Washington Way, Magruder Hall - Rm 134, PO Box 429 - Corvallis OR 97339-0429. They only accept birds Monday through Thursday. For more information, see [www.oregon.gov/DHS/ph/acd/diseases/wnile/wnile.shtml](http://www.oregon.gov/DHS/ph/acd/diseases/wnile/wnile.shtml).

No one in Oregon seems able or willing to do testing on live birds. IDEXX offers a WNV antibody blood test for \$50, but actually sends it to Cornell for running and their backlog is undoubtedly large. Such diagnostics, though expensive, would help us in differential diagnoses where typical treatment for CNS problems from, say, head trauma, would be contra-indicated if the signs are from WNV. For the most part, rehabilitators have simply had to get familiar with the disease and how it manifests, and treat cases primarily with supportive care.

For more information about West Nile virus, visit the following web sites:

[www.cdc.gov/ncidod/dvbid/westnile/index.htm](http://www.cdc.gov/ncidod/dvbid/westnile/index.htm)

[www.cindi.usgs.gov/hazard/event/west\\_nile/west\\_nile.html](http://www.cindi.usgs.gov/hazard/event/west_nile/west_nile.html)

and [www.westnilemaps.usgs.gov/](http://www.westnilemaps.usgs.gov/) for WNV maps

(Much of the foregoing has been taken from the FAQ sheets of The Raptor Center at the University of Minnesota, the CDC, Wildlife Health Center, and Oregon Health Department web sites cited above, as well as personal communications with people working at the CDC, Wildlife Health Center, and vets and rehabilitators who have been working with raptor cases the last three summers, or who have been in contact with experts working in the field.)

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