Alberta West Nile virus

wild bird surveillance 2004

SUMMARY:

At least 762 dead birds were received during the West Nile virus (WNv) surveillance program implemented by the Fish and Wildlife Division of Alberta Sustainable Resource Development in 2004. Nestlings were not examined and neither were 96 (12.6%) of the birds received, because they were unsuitable for analysis (dry, rotten, too young, or unsuitable species). Thus testing was limited to 666 corvids (335 crows, 264 magpies, 40 ravens, 26 blue jays, and 1 Clark's nutcracker). All usable corvids were tested with the VecTest, an antigen-based screening assay. In addition, 2 great grey owls and 1 great horned owl were assessed for WNv using a PCR molecular test.

We confirmed WNv in 9 corvids, including 7 crows, 1 magpie, and 1 blue jay. Positive birds were found primarily in the Grassland region (n=7) but also the southeastern Boreal Forest (n=1) and eastern Parkland (n=1) natural regions. West Nile was not confirmed in any other bird species. Birds were collected over a wide geographic range throughout the province, although most birds (85%) came from the Parkland region (n=400) and the Grassland region (n=166) areas of central and southern Alberta. No evidence of the virus was found in the Rocky Mountain, Foothills, or Canadian Shield natural regions.

The first positive bird was a crow found dead on August 14, 2004 in Lethbridge. The overall time between collection and testing of individual corvids in Alberta in 2004 was 7.72 ± 10.15 days (n=617). The time between arrival of the individual corvids at the lab and their testing was 0.39 ± 0.86 days (n=617). Positive birds were collected from mid-August to mid-September, with most birds found in late August and early September.

Post mortem examinations were conducted on 158 crows as well as 116 magpies negative for WNv, to assess the cause of death. Blunt trauma was the most common cause of death in both crows (51%) and magpies (55%).

MJ Pybus, PhD, Wildlife Disease Specialist

Epizootiology of West Nile virus:

West Nile virus occurs in a wide geographic area throughout the world. It was first detected on the North American continent in 1999 in the northeast US. To date, it has spread in migrating wild birds and local mosquitoes to encompass most of the US and southern Canada east of the Rocky Mountains. Virus activity in northern areas is limited to summer months when mosquitoes are active.

Birds are the primary habitat for West Nile virus and it occurs in a wide range of bird species, most of which show little or no clinical effect. Now that the virus is well established over much of North America, billions of birds in Canada and the US are potentially infected with WNv. This includes the tiniest hummingbirds; the biggest swans, cranes and eagles; and everything in between. However, members of the corvid family (crows, magpies, ravens, and jays) are unable to effectively control the virus with their immune system. As a result, the virus reproduces quickly in a wide range of tissues, but especially in the brain and spinal cord. Fatal infections often occur in corvids, particularly in crows and magpies. In contrast, **mammals generally are quite resistant to infection** but rare fatal cases can occur in horses and some humans.

A variety of mosquito species are able to draw virus from the blood of infected birds and pass the virus on to others; however, in *Culex* spp. the virus appears to replicate (reproduce) more extensively within each mosquito. Thus *Culex* mosquitoes are the most efficient transmitters of WNv and directly contribute to increasing the amount of virus circulating in the environment. In Alberta, *Culex tarsalis* is the primary vector of WNv. This species prefers shallow, non-moving water bodies and thrives in the hot dry conditions present in southern Alberta. Pools of standing water that accumulate in mid- to late summer at the edges of drying ponds, in old tires and rain gutters, or on irrigated lands are perfect for the development of this species. The females attempt to overwinter and become active in late May to lay the first generation of eggs. Two, three, and sometimes four generations occur each summer, depending on suitable environmental conditions. As day-length shortens in the fall, metabolic changes direct the last generation of females to abstain from taking blood. Instead, they seek a warm, dry place to spend the winter in a state of suspended animation.

In broad areas across the southern US, *Culex* species do not go dormant and thus year-round transmission of WNv now occurs from the Atlantic and Gulf coast states westward to southern California. The virus is still extending its continental range and establishing populations within Mexico as well as Central and South America. There is little doubt that West Nile virus will establish itself throughout the Western Hemisphere, although the full picture in a North American context is still evolving.

Additional background material about West Nile virus in Alberta can be found on the websites of

Alberta Health and Wellness http://www.health.gov.ab.ca/public/WNv/Index.html

Alberta Agriculture, Food and Rural Development
http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex5455?opendocument
Fish and Wildlife Division of Alberta Sustainable Resource Development
http://www3.gov.ab.ca/srd/fw/diseases/WNv/index.html

Alberta's West Nile virus Program:

Building on the successful West Nile surveillance programs in 2002 and 2003, representatives from five provincial departments (Alberta Health and Wellness; Alberta Agriculture, Food and Rural Development; Alberta Environment; Alberta Municipal Affairs; and Alberta Sustainable Resource Development) prepared a provincial response plan for 2004 to address the potential risks posed by West Nile virus in Alberta. The plan contained two primary components: communication and surveillance. Communication occurred largely through the ***Fight the Bite*** public awareness campaign and information provided in departmental web pages and fact sheets (see above) as well as technical information provided directly to health care, wildlife, and veterinary professionals. The surveillance programs focused on monitoring "at risk" populations: physicians monitored human illness, veterinarians monitored horse health, and the Fish and Wildlife Division monitored mortality of wild corvids found dead by the public. The surveillance programs were designed to identify the presence of the virus in natural regions of the province and thereby support the need to assess the health risk to humans and assist Alberta Health and Wellness in providing appropriate provincial information to health care professionals and to the public.

The current report provides data only from the wild bird component of the provincial West Nile virus surveillance program. In 2004, the program focused on corvids (particularly crows and magpies) as the primary bird species likely to exhibit fatal infections and thus reflect the presence or absence of the virus in Alberta populations. In addition, Fish and Wildlife staff as well as the public were encouraged to report unusual clusters of mortality in any wild bird or mammal. A few additional birds of other species also were received. Fresh dead birds collected by the public were dropped off at any Fish and Wildlife office. Following up on the WNv-related mortality detected in greater sage-grouse in southern Alberta in 2003, special attention was given to monitoring the sage-grouse population and attempting to limit mosquito populations in prime occupied sage-grouse range in 2004.

Fresh or frozen birds were transported or sent to the Fish and Wildlife Division's Wildlife Diseases Laboratory in Edmonton. Birds were thawed and then tested with a VecTest strip. Non-corvid birds to be tested for West Nile virus were sent to the diagnostic laboratory of the Canadian Cooperative Wildlife Health Center, Saskatoon, SK for testing with a DNA-based polymerase chain reaction test (PCR).

Bird Surveillance Data:

Species composition

Over 750 birds were received for West Nile testing between May and October 2004. Information from 666 corvids from 5 of 6 natural regions within the province was logged into the surveillance data file. The remaining birds (12.6%) were unsuitable for testing (dry, rotten, too young) and, for efficiency, were not included in the file. The majority of the tested birds were corvids (99.6%), primarily crows and magpies (90%). A few ravens and blue jays and one Clark's nutcracker were received. In addition, 1 great horned owl and 2 great grey owls met the appropriate criteria and were sent to the Canadian Cooperative Wildlife Health Centre in Saskatoon to be assessed for WNv using the PCR molecular test.

West Nile results

Corvids

West Nile virus was found in 9 of 666 (1.4%) corvids tested (Table 1). The virus was found in 7 of 335 (2.1%) crows, 1 of 264 (0.4%) magpies, and 1 of 26 (3.8%) blue jays, but not in the Clark's nutcracker or in any of the 40 ravens tested.

The positive corvids were collected from the Grassland (7 of 166, 4.2%), eastern Parkland (1 of 400, 0.3%) and the southeast edge of the Boreal Forest (1 of 72, 1.4%) natural regions of central and southern Alberta (Table 1, Figure 1). Viral activity was not found in the northern forests and Peace River country, nor in the Foothills or Mountain natural regions.

Non-corvids

No evidence of West Nile virus causing death in non-corvids was detected in Alberta in 2004. The great horned owl and two great grey owls were tested but were found to be negative for West Nile virus. A small number of individuals of other species was examined but did not meet the criteria for further WNv testing. Each bird either had an identifiable cause of death or was too decomposed for appropriate examination.

Other Species (Non-birds)

Note that in other components of the provincial surveillance program in 2004, Alberta Environment detected WNv in only one pooled sample of mosquitoes collected in the County of Vulcan. This sample contained infected *Culex tarsalis*. West Nile virus is a provincially-reportable disease and Alberta Agriculture, Food and Rural Development received reports of four positive horses in the Grassland (n=3) and Parkland (n=1) natural regions. Alberta Health and Wellness documented one human travel-related case as of December 1, 2004.

Geographic Distribution

Most of the tested birds were found sick or dead in the Parkland (60%) and Grassland (25%) natural regions (Table 1). The preponderance of birds largely reflects the presence of urban centers, particularly the greater Edmonton area (Table 2). Remaining birds were collected widely throughout the area from the southern fringe of the Boreal Forest south to the US border and from the edge of the Foothills east to the Saskatchewan border (Figure 1 **{{ask Stuart to map the negatives}}.** Banff and Lake Louise areas provided a few samples from the Mountain natural region. No birds were received from the small portion of Canadian Shield in the far northeastern corner of the province.

Temporal Distribution

In 2004, the WNv bird surveillance program ran from May 1 to September 30 (Table 5, Figure 2). The average time between collection and testing was 7.72 ± 10.15 days (n=617). Bird submissions were tracked on a weekly basis. Overall, there was a slow rise in the number of birds submitted in May and June, followed by a steep peak in late June and early July, and a subsequent slow decline through August and September (Figure 2). The first positive bird was collected in Lethbridge on August 14, 2004 (week 33) and subsequent positive birds were found in late August and into September (weeks 35-37) (Table 3, Figure 2).

Diagnoses

Post mortem examinations were completed on 158 WNv-negative crows and 116 WNv-negative magpies, selected to represent the overall spatial and temporal distribution of corvids submitted for virus testing. Trauma was the primary cause of death in 59% of the crows (51% blunt trauma, 8% gunshot wounds) and 70% of the magpies (55% blunt trauma, 14% gunshot wounds, 1% predation) (Table 4). Only 5% of the crows and 6% of the magpies had no visible lesions (NVL) or, in other words, no visible cause of death.

Respiratory tract infection (involving the lungs, air sacs, or both) with the fungus *Aspergillus* sp. was found in 5% of the crows and 3% of the magpies submitted during the late summer and early fall (Table 4). Although *Aspergillus* is found throughout the environment, increased rainfall during the spring and early summer likely permitted greater than normal spore development in the environment. Miscellaneous bacterial infections were diagnosed more commonly in crows (20%) than in magpies (10%) (Table 4).

Post mortem assessment of WNv-positive corvids was not conducted.

Discussion

In recent years migratory birds, primarily songbirds and waterfowl, systematically moved West Nile virus westward across North America from the Atlantic Flyway in 2000, to the Mississippi Flyway in 2001, the Central Flyway in 2002 and 2003, and now the southern portion of the Pacific Flyway in 2004. This movement resulted in a steady geographic expansion of infections in birds, horses, mosquitoes, and humans from the northeastern US in 1999/2000, to the area east of the Mississippi River (including southern Ontario) in 2001, the area east of the Rockies (including southern Saskatchewan, Manitoba, Ontario, Quebec as well as Nova Scotia) in 2002. In 2003, the greatest viral activity was up against the east side of the Rocky Mountains, including its first appearance in Alberta.

The transmission of all viruses is driven by a complex interaction of biological and non-biological factors. In the case of West Nile virus, this involves birds, mosquitoes and weather. However, the species, distribution, migration, immune response and previous exposure to the virus all affect its success in birds. Similarly, the species distribution and life stage (only adults transmit the virus) affect the success of the virus in mosquitoes. Infected birds and mosquitoes must overlap in time and space in sufficient numbers to establish and maintain a viral population. In 2003, these components all came together: the virus was introduced in late spring/early summer by migrating birds and established local viral populations in *Culex tarsalis* mosquitoes. During a relatively hot dry summer, the virus multiplied and spread in at least three generations of suitable mosquito vectors. By the end of the summer in 2003, there was evidence of extensive viral activity throughout the southern and central areas of the province. Thus, there was reason to believe that spring migration in 2004 would bring the virus back to northern states and provinces, including Alberta.

Indeed, the virus was found in Alberta in 2004, but the pattern of occurrence differed significantly from that in 2003: there were fewer dead birds found and a lower proportion that were positive in 2004 (Figure 3, 4, 5). The first positive bird was found two months later in 2004 (mid-June in 2003 versus mid-August in 2004). Similarly, there were fewer infections detected in mosquitoes, horses, and humans in 2004. While the underlying causes cannot be definitively identified, there are contributing factors that are readily apparent.

There may be two driving factors that affect the extent to which WNv can establish a significant summer population in northern regions: weather and avian immunity. Only adult mosquitoes can transmit West Nile virus, and the development of *Culex tarsalis* from larval to adult stages is temperature dependant. Spring and early summer in 2004 were relatively cool and evidence from mosquito surveillance conducted by Alberta Environment indicates that *Culex tarsalis* activity was significantly suppressed by weather conditions in 2004 in comparison to 2003. It may be that when infected migrating birds arrived, there were inadequate numbers of *Culex tarsalis* adults available to transmit the virus and thus a new viral population in Alberta was not established.

The late summer evidence of West Nile virus activity in 2004 may have been associated with movements of birds gathering at staging/moulting lakes during the period between fledging (when the young are able to fly) and migration. Previous banding results show that birds from areas such as Saskatchewan and Montana move into Alberta during August, and there was evidence of WNv activity in these regions during July and August in 2004. By late August and early September, the occurrence of a few positive birds, horses, and one human suggest there were sufficient *Culex tarsalis* mosquitoes to transmit the virus and establish a relatively small viral population in southern and east-central Alberta.

There is growing evidence of significant build up of immunity in non-corvid bird species exposed to WNv. During the summer of 2003, birds throughout the Grassland and Parkland regions of Alberta were exposed to a massive population of the virus. A significant number of birds that survived the infection may have developed immunity to Wnv. Similarly, young birds likely were exposed to the virus while they were still in Alberta or in the wintering areas in the U.S. and Central America. These factors may have affected the amount of virus that was present in migratory birds that returned to Alberta in 2004. A similar immunity may have developed in birds that are year-round residents of the southern and central areas of the province, such as magpies. Immune birds do not have virus circulating in their blood and thus cannot pass WNv to biting mosquitoes. The combined effects of the slow development of *Culex* mosquitoes and the presence of immunity in many individual birds may be reflected in the lack of viral activity in June and July of 2004.

The provincial West Nile virus Response Plan is based on passive surveillance of birds found dead by the public. In particular, people are encouraged to submit fresh-dead crows and magpies to any office of the Fish and Wildlife Division. Information is provided regarding appropriate precautions when handling any wild animal found dead of unknown causes. These are general precautions and do not reflect a specific concern from handling birds that died of West Nile virus. While no surveillance program can ever be 100% effective, the combined tools of passive public submission of found dead corvids and the unique susceptibility of crows and magpies to fatal infections of West Nile virus provide appropriate means to detect the presence and activity of the virus, even with the low levels of activity seen in 2004. Dead corvids positive for West Nile virus were found temporally and geographically near the single human and several equine cases, and reflected the distribution of *Culex tarsalis* mosquitoes in Alberta in 2004.

It is of interest that, as observed last year, the great majority of birds collected did not die of West Nile virus. Indeed, trauma is the most common cause of death even in the two bird species highly susceptible to the virus (crows and magpies). Human activities in the 21st century provide a multitude of risk factors for wild birds. Fast-moving vehicles are among the most deadly. Crows and magpies that do become infected with West Nile virus appear to die very quickly as a direct result of the viral infection. Thus road-kills and gunshot birds are less likely to have WNv than those that die without trauma.

The small sage grouse population in southern Alberta was closely monitored for WNV-related mortality in 2004. In addition, the study to compare mortality in two areas treated repeatedly with a standard biological control for mosquito larvae [*Bti*] and a control area that received no treatments was logistically successful, although not without a few hiccups. There were no sage grouse mortalities detected in 2004; however, the general evidence of low viral activity in southern Alberta this year prevented any further assessment of the potential risk to sage grouse. The cooperative program among the Division, the University of Alberta, Alberta Environment, and the City of Medicine Hat was well designed and implemented and should be considered again for 2005.

Future Outlook

The second year of West Nile virus in Alberta revealed completely different patterns of infection and transmission, making it very difficult to predict what will happen in 2005. Based on the biological factors that lay the foundation for viral transmission, there is little doubt that WNv will return to southern and central regions of Alberta in the spring of 2005. However, the potential effects of changing resistance and immunity in wild birds are unknown, and environmental conditions vary greatly from year to year. As such, the overall extent to which the viral population will build in Alberta in July and August 2005 is difficult to predict.

The WNv bird surveillance program will again be used in 2005 to identify when the virus returns and to track its behavior. The basic approach will be as in 2004, including thresholds to discontinue corvid testing on a natural region basis. A maximum of six positive birds from one region is sufficient evidence of viral activity and no further surveillance will be conducted in that region so that the program can focus on northern and western areas where the virus was not found in previous years and it is not yet known whether the virus can establish a population.

The actual impact of West Nile virus on wild populations of birds remains largely unpredictable across North America. While local and perhaps overall crow populations in eastern provinces and states appear to have declined in some areas, there are ample populations still present in Alberta and western jurisdictions. Mortality in other bird species has not been at the same level nor is there evidence that such mortality has been significant. There *may* be intense natural selection pressure to reduce the effects of the virus in conjunction with increased resistance in non-corvid birds and, perhaps, mosquitoes. Highly susceptible individual birds (and mosquitoes??) die and are removed from the population; resistant individuals remain to produce the future generations. Although we need to wait for further data, it may be that integration of WNv virus into North American ecosystems already is well underway.

Long-term Outlook

It is readily apparent that West Nile virus will establish populations across the continent and throughout Alberta wherever suitable bird and mosquito species exist. There is a high probability that West Nile virus eventually will occur in all states and provinces from the Atlantic to the Pacific, although perhaps at differing local levels. With its ability to circulate year-round in southern states and occasionally overwinter in some individual mosquitoes, in addition to continental transmission across a broad range of bird and mosquito species, West Nile virus is unlikely to be controlled or eradicated. Fortunately, it is a relatively benign virus and the evidence to date indicates limited direct impact on wildlife. Sporadic cases in horses and humans are likely to continue but with limited overall impact. All species will have to learn to live with West Nile virus as an integral part of the biodiversity of North America.

Acknowledgements

This program could not have been completed without the significant efforts of many many Fish and Wildlife staff, particularly the district officers, wildlife biologists, and administration staff who fielded phone calls by the public and took direct action as appropriate and as possible. In addition, Lisa Yadernuk spent long hours in the lab documenting and testing dead birds throughout the summer and analyzing the results. The Interdepartmental West Nile Virus Steering Committee provided ongoing input and review of the program and the Fish and Wildlife Division managers were supportive at all times.

The program also began in most cases with a member of the public providing us with a dead corvid. Without this input, the WNv bird surveillance programs could not have happened. Their efforts, and often their patience and understanding, are gratefully acknowledged.

Cam Aldredge and Jennifer Carpenter, with assistance from Maria Olsen and Mike Swystun, largely designed and carried out the sage grouse program, in consultation with Jock McIntosh (Alberta Environment), Mark Boyce (University of Alberta), Dan Johnson (University of Lethbridge), and Steve Brecthel, Joel Nicholson, Dale Eslinger, and Margo Pybus from the Fish and Wildlife Division.

Table 1: Species composition, and geographic distribution of corvids tested for West Nile virus and incidence of West Nile virus positive corvids in Alberta in 2004.

	Boreal (north)	Foothills (west)	Grassland (south)	Mountain (far west)	Parkland (central)	Species TOTAL
Blue Jay	2	0	7 (1)*	0	17	26 (1)
Crow	40 (1)	7	99 (5)	5	184 (1)	335 (7)
Magpie	18	3	58 (1)	3	182	264 (1)
Raven	12	4	2	5	17	40
Clark's Nutcracker	0	0	0	1	0	1
All Corvids	72 (1)	14	166 (7)	14	400 (1)	666 (9)

* number tested (number positive)

Table 2: Primary source of birds tested for West Nile virus in Alberta in 2004.

Urban center	WNv positives and # tested	Proportion of total # tested (%)	Natural Region
Edmonton	0 of 198	30	Parkland
Greater Edm*	0 of 266	40	Parkland
Lethbridge	3 of 20	3	Grassland
Medicine Hat	3 of 7	1	Grassland
Calgary	0 of 85	13	Grassland
All urban centers	6 of 576	87	

* Includes Edmonton, St Albert, Sherwood Park, Beaumont, Spruce Grove, Stony Plain,

Table 3: Birds positive for West Nile virus in Alberta in 2004 (by date found).

Species	Date Found	Town / District
crow	14-Aug-04	Lethbridge
crow	24-Aug-04	Brooks
crow	27-Aug-04	Medicine Hat
crow	28-Aug-04	Bonnyville
crow	31-Aug-04	Vermilion
blue jay	4-Sep-04	Lethbridge
crow	7-Sep-04	Lethbridge
crow	10-Sep-04	Medicine Hat
magpie	12-Sep-04	Medicine Hat

Table 4: Post mortem results of sampled West Nile virus-negative crows and magpies in 2004.

	Crows	**Magpies**
Number Examined	**n=158**	**n=116**
Blunt Trauma	81 (51%)	64 (55%)
Gunshot	13 (8%)	16 (14%)
Miscellaneous Bacterial Infections	32 (20%)	12 (10%)
Respiratory Infection (*Aspergillus spp.*)	5 (3%)	3 (3%)
Emaciation	8 (5%)	10 (9%)
Electrocution	2 (1%)	0
Other	9 (6%)	4 (3%)
No Visible Lesions	8 (5%)	7 (6%)

Table 5. Standardized 2004 Table of Weeks**.**

Week #	Month	Days	Week #	Month	Days
18	April/May	26-2	30		19-25
19	May	3-9	31	July/Aug	26-1
20		10-16	32	Aug	2-8
21		17-23	33		9-15
22		24-30	34		16-22
23	May/June	31-6	35		23-29
24	June	7-13	36	Aug/Sept	30-5
25		14-20	37	Sept	6-12
26		21-27	38		13-19
27	June/July	28-4	39		20-26
28	July	5-11	40	Sept/Oct	27-3
29		12-18			

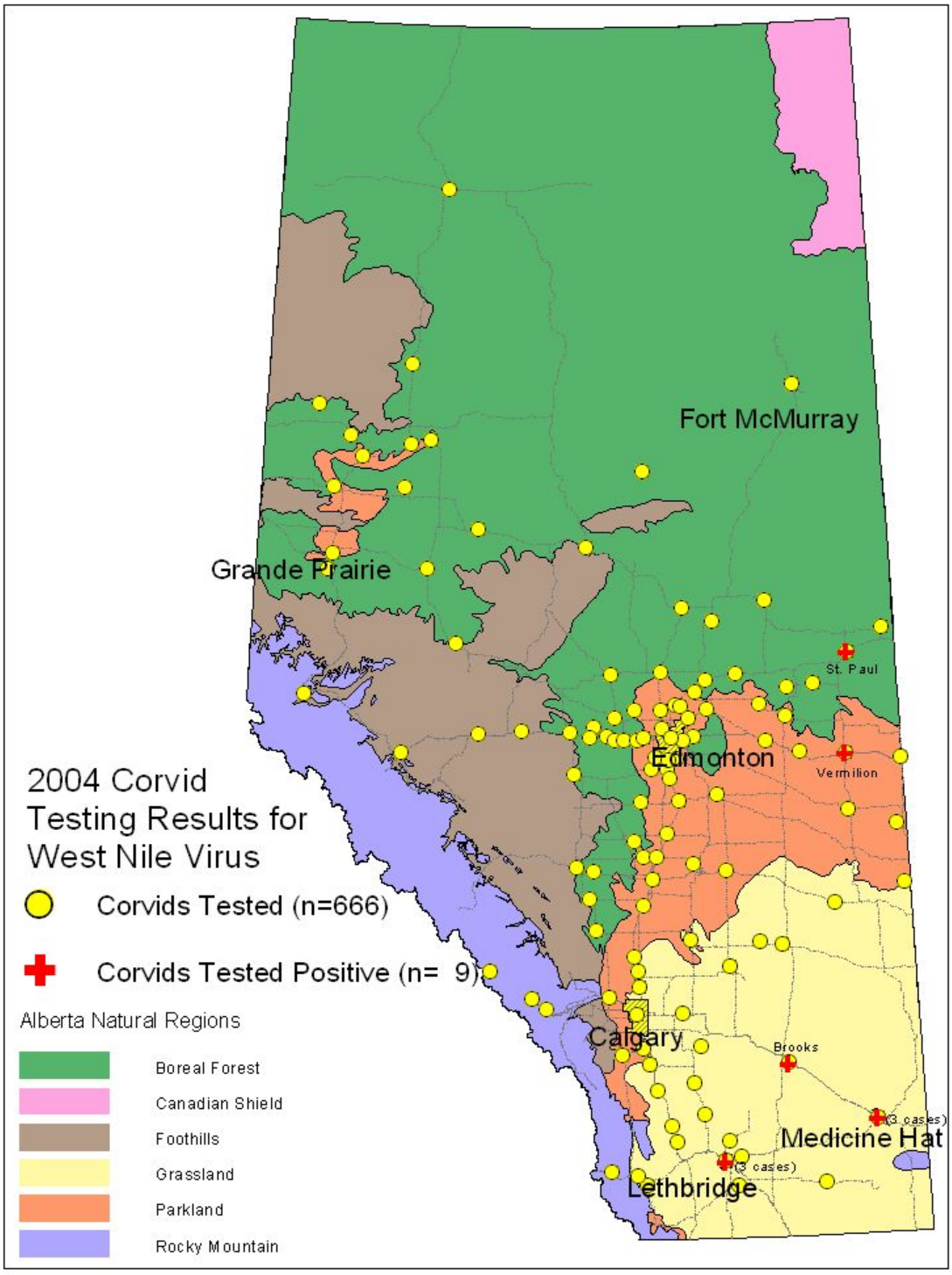


Figure 1. Distribution of corvids tested for West Nile virus in natural regions of Alberta in 2004

Figure 2: Weekly collection of corvids tested for West Nile virus in Alberta in 2004.

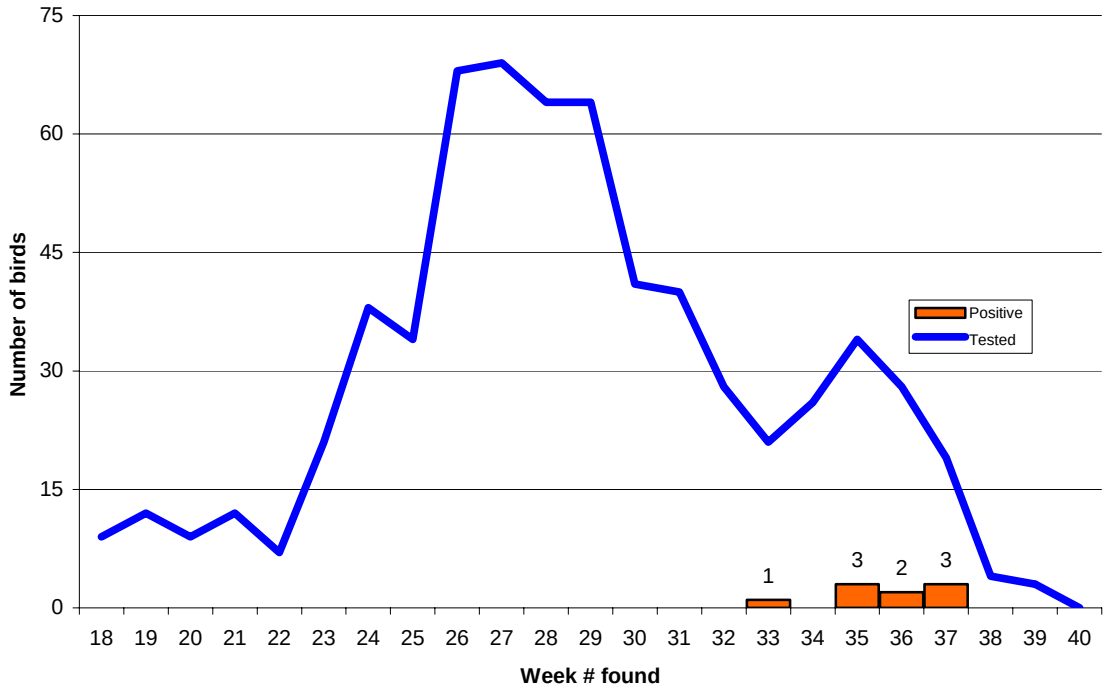


Figure 3: Weekly collection of corvids tested for West Nile virus in Alberta, 2003 and 2004.

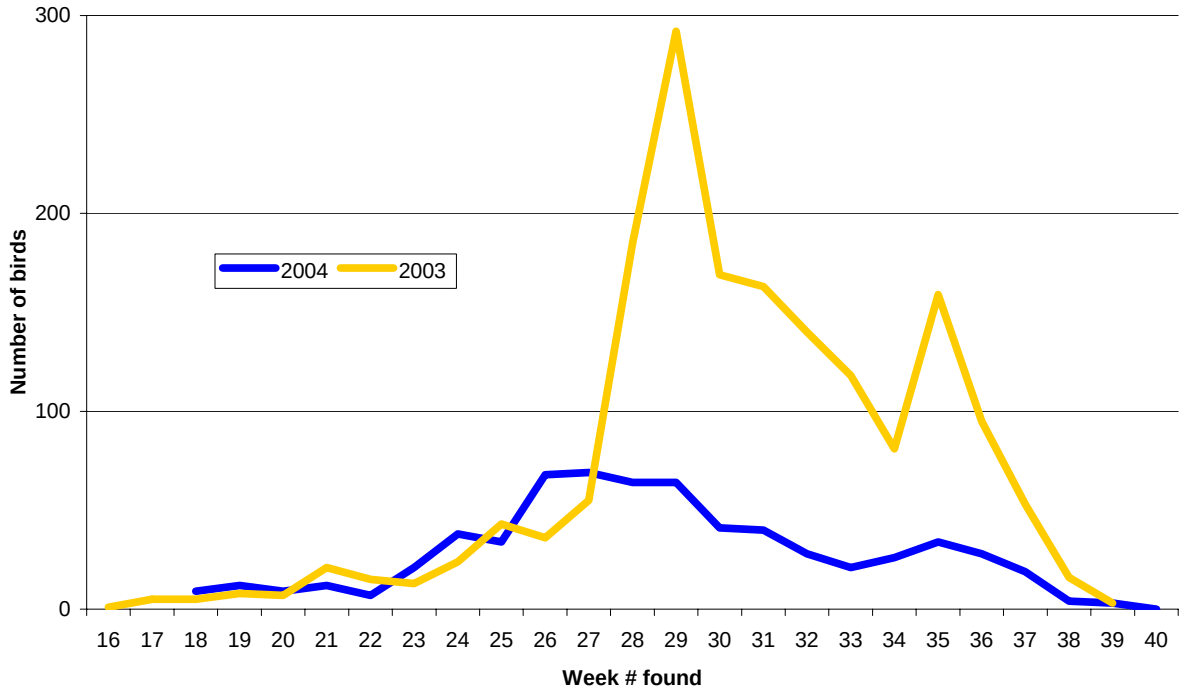


Figure 4: Weekly percentage of corvids positive for West Nile virus in Alberta, 2003 and 2004.

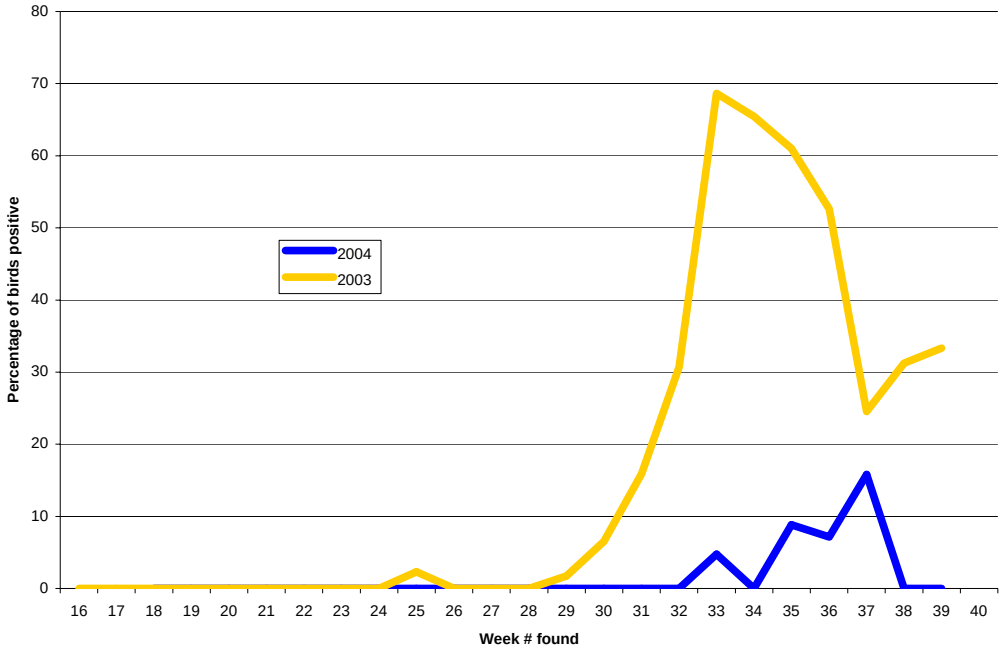


Figure 5: Weekly collection of corvids tested for West Nile virus in Alberta, 2003 and 2004.

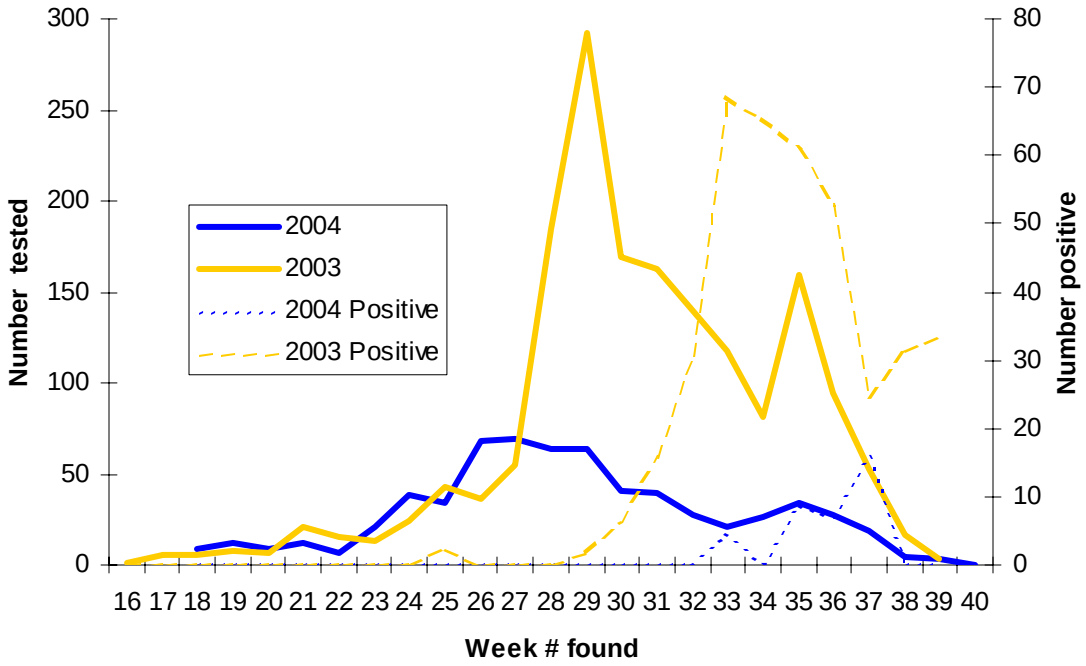
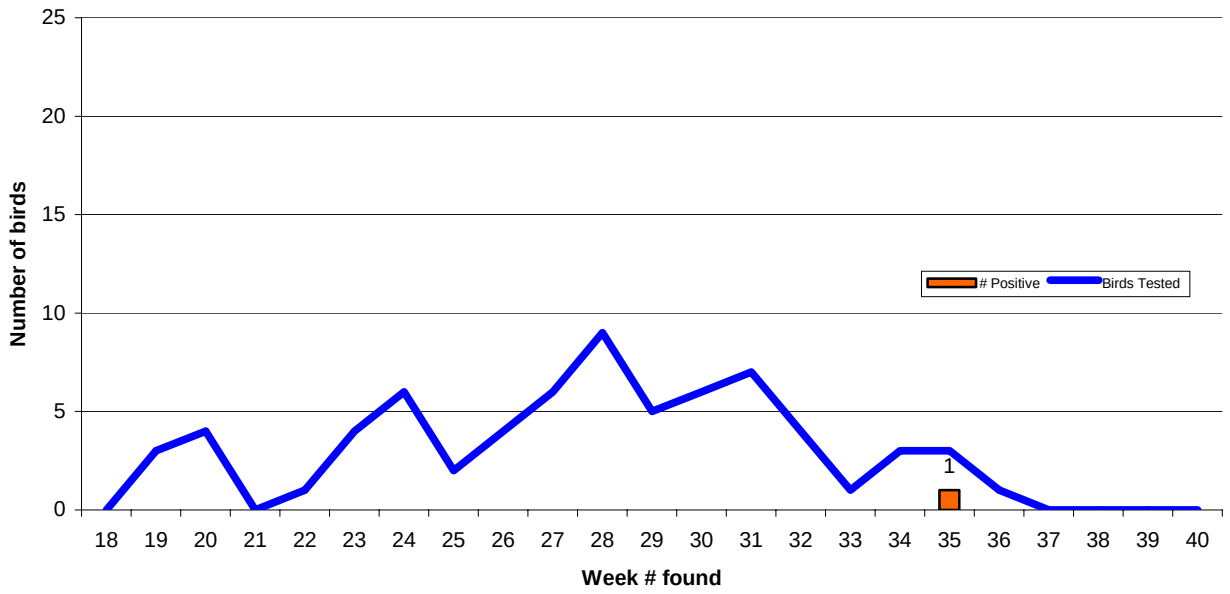
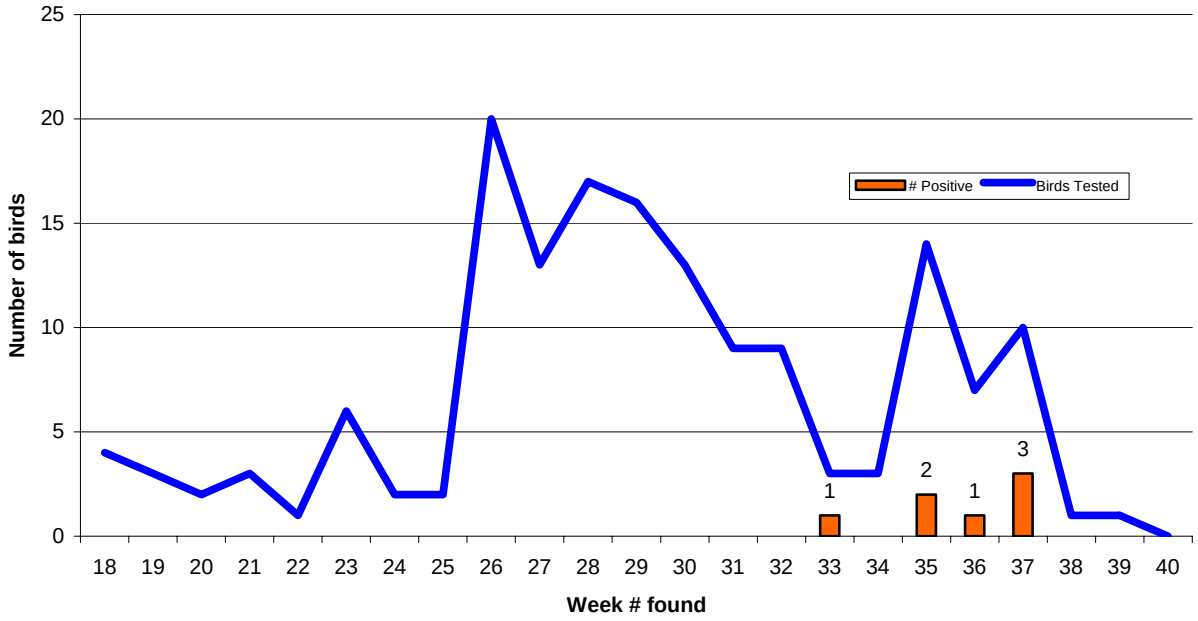


Figure 6. Weekly collection of corvids tested for West Nile virus in Alberta in 2004, by natural region.

6a) Boreal Forest Natural Region



6b) Grassland Natural Region



6c) Parkland Natural Region