Alberta West Nile virus

wild bird surveillance 2006

SUMMARY:

In 2006, the West Nile virus (WNv) wild bird surveillance program conducted by the Fish and Wildlife Division of Alberta Sustainable Resource Development began on June 1. Members of the public could submit dead corvids (crows, magpies, jays, and ravens) found in the Grassland Natural Region of southeastern Alberta (click here[1] for a map of the Natural Regions in Alberta); however, a significant number of birds also were accepted from adjacent areas of the Parkland Natural Region and a small number from the Boreal Natural Region.

Between June 15 and September 8, a total of 114 dead birds were received for WNv testing. Nestlings were not examined and 24 (21%) of the birds received were unsuitable for analysis (dry, rotten, too young, or unsuitable species). Thus, testing was limited to 90 corvids (47 crows, 38 magpies, 3 ravens, and 2 blue jays). All usable corvids were tested with the VecTest, an antigen-based screening assay. All but one of the birds were tested within 24 hours of receipt at the laboratory.

In total, we confirmed WNv in 12 corvids: 9 crows, 2 magpies, and 1 blue jay. Infected birds were found dead between July 28 and September 1. All positive birds were found in the Grassland region. The distribution of positive birds spanned southern Alberta from Oyen to Cardston. As recommended by the Provincial WNv Steering Committee, receipt of birds for testing was discontinued when six positive birds were identified in the Grassland Natural Region. However, an additional 6 positive birds were already en route to the laboratory and were tested when received.

Only one greater sage-grouse was received for WNv testing. It was negative.

A predictable pattern of WNv activity in Alberta is apparent. The virus appears each year in July and August, and establishes relatively weak populations in southeastern Alberta. The geographic and numerical extent of the virus each year correlates with local weather and mosquito patterns in the risk areas associated with grassland habitats in southern Alberta.

[1] URL: http://www.srd.gov.ab.ca/fishwildlife/livingwith/diseases/images/Alberta_Natural_Regions_large.gif

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Epizootiology of West Nile virus:

West Nile virus (WNv) occurs in a wide geographic area throughout the world. It was first detected on the North American continent in 1999 in the northeast U.S. To date, it has spread in migrating wild birds and local mosquitoes to encompass all of the lower 48 states of the U.S. and southern Canada east of the Rocky Mountains (see http://www.cdc.gov/ncidod/dvbid/westnile/). Virus activity in northern areas is limited to summer months when environmental and biological conditions support amplification of the virus in birds and suitable mosquitoes.

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 U.S. 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) generally are unable to effectively control the virus with their immune system. As a result, the virus can reproduce quickly in a wide range of tissues, but especially in the brain and spinal cord. Fatal infections occur, 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. Adult 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 U.S., *Culex* species do not go dormant and thus year-round transmission of WNv 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.html**
Alberta Agriculture and Food
http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex5455?opendocument
Fish and Wildlife Division of Alberta Sustainable Resource Development
http://www.srd.gov.ab.ca/fishwildlife/livingwith/diseases/

Alberta's West Nile virus Program:

Building on the successful West Nile surveillance programs since 2002, 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 2006 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, Alberta Environment monitored mosquito populations, and the Fish and Wildlife Division monitored 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 (Figure 1) and thereby support the needs of assessing the health risks 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 2006, 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 species. The surveillance program focused on the Grassland Natural Region (Figure 1) as data from previous years indicated that virus activity was most likely to occur there. Fresh dead corvids 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, and in conjunction with the University of Alberta and Alberta Environment, special attention was given to monitoring the sage-grouse population and attempting to limit mosquito populations in prime sage-grouse range in 2005 and 2006.

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, an antigen-based screening assay accepted as the national standard screening test for corvids. Testing occurred as birds arrived at the laboratory; all birds but one were tested the day they arrived at the laboratory.

Bird Surveillance Data:

Submissions

Between June 15 and September 8, a total of 114 dead birds were received for WNv testing. Nestlings were not examined and 24 (21%) of the birds received were unsuitable for analysis (dry, rotten, too young, or unsuitable species). Thus, testing was limited to 90 corvids (47 crows, 38 magpies, 3 ravens, and 2 blue jays; Figure 2). In addition, one greater sage-grouse was received for WNv testing.

The corvids were collected primarily in the Grassland (n = 68, 76%) and adjacent areas of the Parkland (n = 14, 16%) natural regions (Table 1; Figure 1), reflecting the program design of focusing on high risk areas of the province in Grassland Natural Region (Table 2). The few remaining birds came from the Boreal Forest Natural Region (n = 8, 9%), consistent with the low numbers of dead corvids reported from this region.

Most carcasses were submitted to the lab in July (33%) or August (38%), with the remainder in June (14%) and September (15%; Figure 3).

West Nile results

We confirmed WNv in 12 corvids: 9 of 47 crows (19%), 2 of 38 magpies (5%), and 1 of 2 blue jays (Tables 1, 3). All positive birds were collected from the Grassland Natural Region (Table 1, Figure 1) and spanned southern Alberta from Oyen to Cardston. Positive birds were collected in the interval July 28 – September 1. Viral activity was not found in the Parkland, Boreal, Rocky Mountain, Foothills, nor Canadian Shield natural regions, although very few birds were received from these areas.

The surveillance goal was to identify at least six positive birds in any affected natural region. Once this was achieved, and as recommended by the Provincial West Nile Virus Steering Committee, the program stopped accepting birds from that region. Despite ongoing efforts, the goal of finding six positive birds was not reached until late August. The additional six positive birds from the Grassland region were already en route to the laboratory when public submissions were discontinued.

The sage-grouse submitted for West Nile virus testing was negative.

Discussion

West Nile virus apparently arrived in North America in 1999[2]. Since then it moved systematically across the continent with subsequent summer and winter distributions reflecting the major bird migration corridors. The virus was documented on the Atlantic

[2] Centers for Disease Control and Prevention. Outbreak of West Nile-like viral encephalitis—New York, 1999. 1999. MMWR Morbidity and Mortality Weekly Report 48:845-9.

Flyway in 2000, the Mississippi Flyway in 2001, the Central Flyway in 2002 and 2003, and the southern portion of the Pacific Flyway in 2004 (patterns derived from Centers for Disease Control http://www.cdc.gov/ncidod/dvbid/westnile/). This movement resulted in a steady geographic expansion of infections in birds, horses, mosquitoes, and humans from the northeastern U.S. in 1999/2000, to the area east of the Mississippi River (including southern Ontario) in 2001, and 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. 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 in Alberta: 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. Extensive mortality was seen in crows and magpies throughout southern and central Alberta in 2003[3], and the virus also was detected in mosquitoes, horses, and humans in the same wide geographic distribution. By the end of the summer in 2003, there was evidence of extensive viral activity throughout the southern and central areas of the province.

In 2004 and 2005 the virus re-occurred in Alberta but the pattern of occurrence differed significantly from that in 2003[4]. Although the methods and approach were largely the same, there were fewer dead birds found and fewer positive corvids in 2004 and 2005 (Figures 4, 5). In addition, the proportion of found-dead birds that tested positive for WNv (as an index of viral activity) substantially declined in 2004 and 2005. Infected corvids were detected only in the late summer in 2004 (mid-August to mid-September) and 2005 (late August), whereas they occurred throughout the summer in 2003 from mid-June to late September. It was suggested that unlike 2003, the virus was unable to establish a summer population and that late summer staging movements of birds brought WNv into Alberta in 2004 and 2005. The majority of infected birds were detected in the Grassland Natural Region in all three years; however, in 2003 a significant number of positive birds also were collected in the Parkland region of central Alberta.

The pattern of WNv occurrence in corvids in 2006 was intermediate between the major outbreak in 2003 and the reduced viral activity in 2004 and 2005. In 2006 the first WNv-positive bird was found relatively early (Figure 5) and the rate or proportion of birds infected

[3]Pybus, M.J. 2003. Alberta West Nile virus wild bird surveillance, 2003; http://www.srd.gov.ab.ca/fishwildlife/livingwith/diseases/pdf/WNvSurveillance2003.pdf

[4] Pybus, M.J. 2005. Alberta West Nile virus wild bird surveillance, 2005; http://www.srd.gov.ab.ca/fishwildlife/livingwith/diseases/pdf/2005_WNV_report_final.pdf

with the virus was higher (Table 4) when compared to the previous two years. This suggests viral activity in birds was higher in 2006 than in 2004 or 2005. This was particularly apparent in crows and less so in magpies. A similar pattern of viral activity was seen in mosquitoes[5] and reflects the general environmental conditions that promoted faster development and increased abundance of *Culex tarsalis* in 2006 (Alberta Environment, published data). These data further support a generally higher population of WNv circulating in Alberta in 2006. It appears the virus was able to establish a summer population in Alberta, albeit significantly less than that seen in 2003. This is entirely consistent with basic ecological principles of disease occurrence following the introduction of a new virus to a suite of naïve hosts in a new geographic area.

Differences in methodology among years weaken other comparisons (for example, the number of found-dead corvids submitted for WNv testing in 2006 was the lowest since the epizootic began but the 2006 program focused on the Grassland Natural Region and discontinued testing once the program goal of finding 6 positive birds was achieved). However, the proportion of infected birds was highest in the Grasslands region each year since 2003 and it is readily apparent that this region is the primary risk area for WNv in Alberta. Although the overall number of birds tested was lowest in 2006, the proportion of infected birds was higher than in 2004 and 2005. This counter-intuitive result (fewer dead birds, more of them infected) could result from several overlapping hypotheses: 1) increased public familiarity with WNv could lead to less incentive to report mortalities, 2) reduced media attention on WNv relative to previous years could result in generally less public profile and concern, 3) reduced corvid populations relative to previous years could result in fewer birds to be found dead, and/or 4) reduced corvid mortality rates could result from potential increased immunity and survival of crows and magpies.

While the first two hypotheses cannot be quantified, a review of the last 10 years of Christmas Bird Count data (http://www.audubon.org/bird/cbc/) does not indicate any significant effect of WNv on the trends in abundance of crows or magpies overall in Alberta nor in Lethbridge, Medicine Hat, or Dinosaur Provincial Park, all within the Grassland region. 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. The mechanism for the selection pressure could involve death and removal of highly susceptible individual birds; thus leaving resistant individuals to produce the future generations and pass on any acquired or inherent immunity. Given the evidence of reduced viral activity and lack of significant bird mortality, it appears that local ecosystems have adapted to the seasonal presence of WNv with limited effects on wild populations of birds in Alberta. Similarly, patterns of reduced bird mortality and viral occurrence across Canada and the U.S. indicate that integration of WNv virus into North American ecosystems is well underway.

Looking at the patterns across all four years, it seems there are two primary requirements for WNv populations to build in Alberta: the virus must be present in birds by mid summer and environmental conditions in southeastern Alberta must favour increased *Culex* population growth. The absence of either component stifles transmission. Early occurrence of virus

[5] www.health.gov.ab.ca/public/wnv_evidence2006.htm

allows for uptake and amplification by the second generation of *Culex* mosquitoes. Occurrence of the third and fourth generations of *Culex* drives the relative abundance of the virus. Without sufficient populations of mosquitoes, there is not enough transmission among birds to amplify the viral population. Further, with the decline of *C. tarsalis* populations in late August, the virus population quickly declines and disappears. Thus, the WNv risk period in Alberta occurs in July and August, with maximum risk in late July to mid-August.

Future Outlook

West Nile virus was an exotic disease prior to its first appearance in Alberta. Its occurrence in 2003 resulted in a classic epizootic (=outbreak) of significant proportions among naïve corvid populations within the province. Alberta ecosystems had no previous experience with the virus and no inherent means to limit viral activity. In addition, the outbreak was supported by favourable weather conditions, particularly in spring and early summer that supported high *Culex tarsalis* populations in 2003. Now that the primary epizootic wave has passed through the Alberta ecosystems, using dead corvids as a sentinel system to detect the presence of the virus has become less effective. There appear to be significant biases associated with monitoring dead corvids, wherein mortality may be reduced and public reporting may be less sensitive to the mortality that does occur. Thus this method of detecting WNv is unreliable as an early warning system. In addition, as in other locations[6], dead bird reporting tends to be biased toward large urban centres (like Calgary), which are not the primary areas where *Culex tarsalis* populations accumulate and thus are outside the primary risk area for WNv in Alberta. Furthermore, the general patterns of WNv temporal occurrence and geographic distribution within the province were consistent across all four years from 2003 to 2006 and can now be predicted without additional dead bird data. We can assume that the virus is present in Alberta each summer, particularly in August and in the southeast, and management actions to protect human and equine health can be based on that assumption.

The recommendation from the Provincial WNv steering committee is that the WNv bird surveillance program in Alberta be modified in 2007 to focus on clusters of unusual mortality of wild birds or mammals. Routine testing of public submitted birds should be discontinued. The WNv surveillance programs from 2003-2006 significantly broadened our understanding of the epizootiology of WNv in Alberta. Based on presence of suitable biological and environmental factors that lay the foundation for WNv transmission, there is little doubt that the virus will return to southeastern Alberta each year, and if environmental conditions are sufficient, may extend into the adjacent areas of central Alberta. Routine testing of found-dead corvids will not add significantly to our understanding of the virus, nor will it change our management actions. The public and veterinary risk can be generalized across these regions and information directed accordingly.

The lack of detectable mortality in greater sage-grouse is encouraging. This species is endangered in Alberta and has low populations across its current range in northern prairie

[6] Ward, M.R. et al. 2006. Wild bird mortality and West Nile virus surveillance: biases associated with detection, reporting, and carcass persistence. Journal Wildlife Diseases 42:91-106

provinces and states. Initial concerns regarding excessive mortality as West Nile virus spread into sage-grouse range in 2003 were well founded. However, it appears the long-term effect will not be devastating to the residual populations.

Acknowledgements

This program could not have been completed without the significant efforts of 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, Stephanie Bugden documented and tested dead birds throughout the summer and she and Damien Joly analyzed the results. The Provincial 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.

Table 1: Species composition, geographic distribution, and incidence of West Nile virus in corvids tested in Alberta in 2006.

	Boreal (north)	Grassland (south)	Parkland (central)	Species TOTAL
Blue Jay	0	2 (1)*	0	2 (1)
Crow	4	35 (9)	8	47 (9)
Magpie	3	30 (2)	5	38 (2)
Raven	1	2	0	3
All Corvids	8	69 (12)	13	90 (12)

* number tested (number positive)

Table 2: Primary source of corvids tested for West Nile virus in Alberta in 2006 (n = 65).

Urban center	WNv positives and # tested	Proportion of total # tested (%)	Natural Region
Brooks	1 of 7	8%	Grassland
Calgary	1 of 30	3.3%	Grassland
Lethbridge	2 of 6	7%	Grassland
Medicine Hat	6 of 16	18%	Grassland
Olds	0 of 6	7%	Parkland

Table 3: West Nile virus positive birds in Alberta in 2006.

Species	Date Collected	Town	WMU (Wildlife Management Unit)
Crow	July 28	Brooks	108
Crow	Aug 9	Lethbridge	142
Crow	Aug 17	Calgary	212
Crow	Aug 18	Medicine Hat	148
Crow	Aug 18	Medicine Hat	148
Blue Jay	Aug 18	Medicine Hat	148
Crow	Aug 23	Oyen	162
Crow	Aug 25	Lethbridge	142
Magpie	Aug 31	Cardston	300
Magpie	Sept 1	Medicine Hat	148
Crow	Sept 1	Medicine Hat	148
Crow	Sept 1	Medicine Hat	148

Table 4: Proportion of found-dead corvids positive for West Nile virus in Alberta, 2003-2006.

Species	2003	2004	2005	2006
Crow	22.6 (899)*	2.1 (355)	5.8 (102)	19.1 (47)
Magpie	27.7 (835)	0.4 (264)	0 (95)	5.2 (38)
Blue Jay	10.2 (49)	3.8 (26)	0 (6)	1 of 2
Raven	0 (60)	0 (40)	0 (12)	0 of 3
All Corvids	23.8 (1843)	1.4 (685)	2.8 (215)	13.3 (90)

*** % positive (# tested)**

Table 5. Standardized 2006 Table of Weeks**.**

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

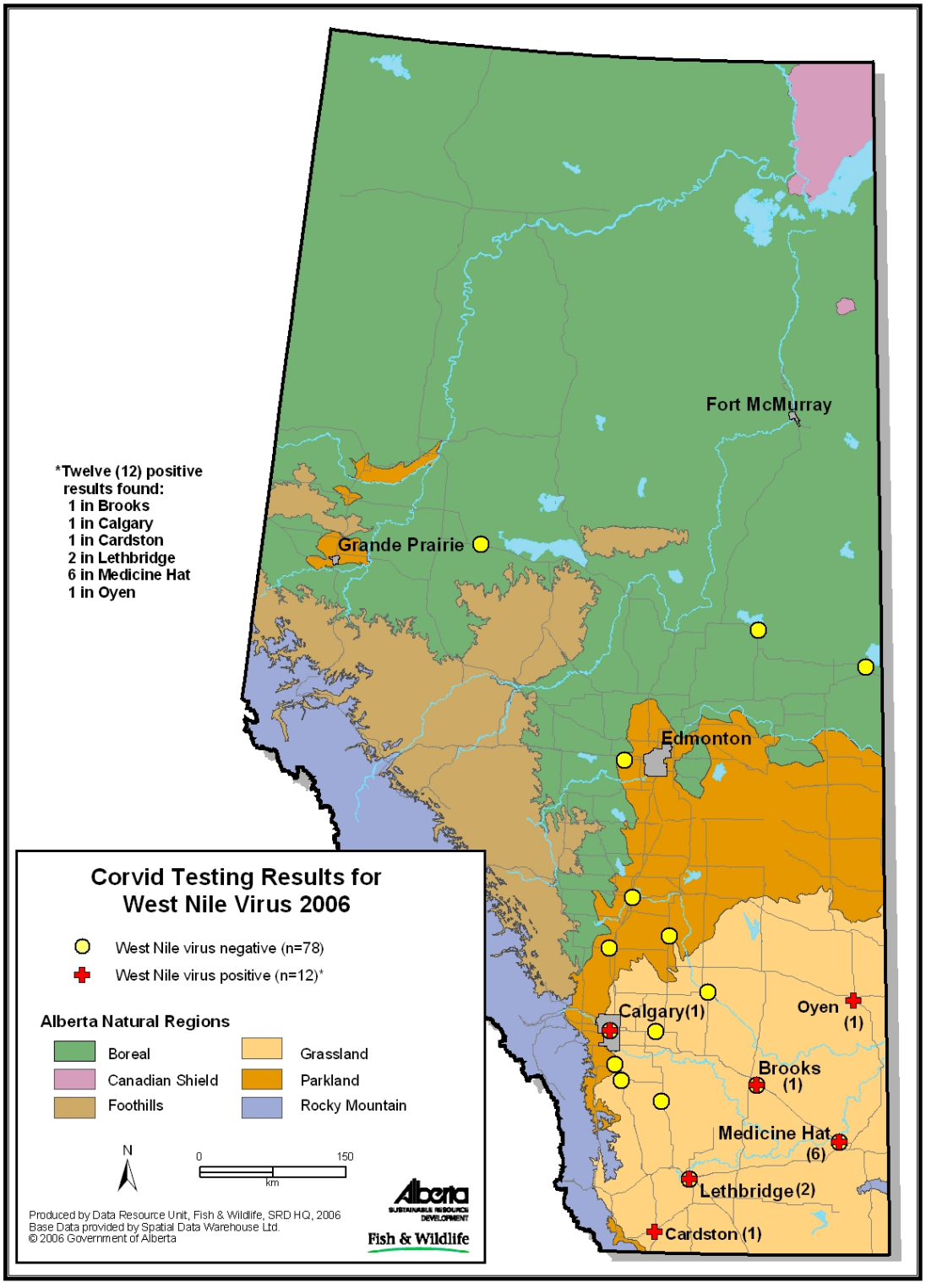

Figure 1. Corvids tested for West Nile virus in natural regions of Alberta in 2006.

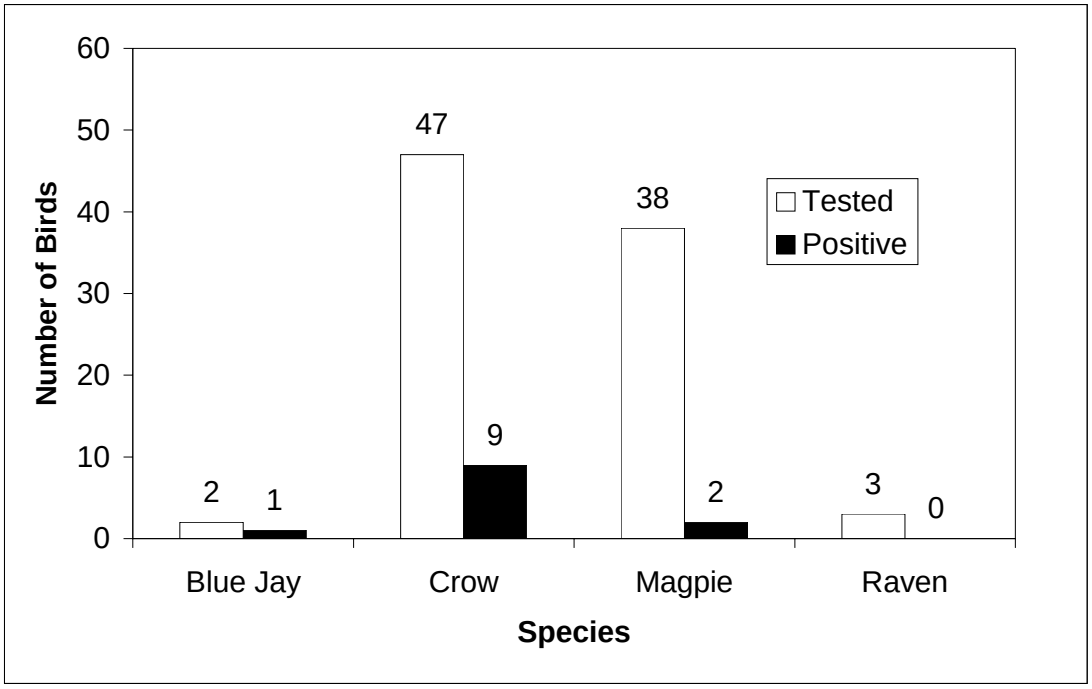

Figure 2: Species composition of corvids tested for West Nile virus in Alberta in 2006.

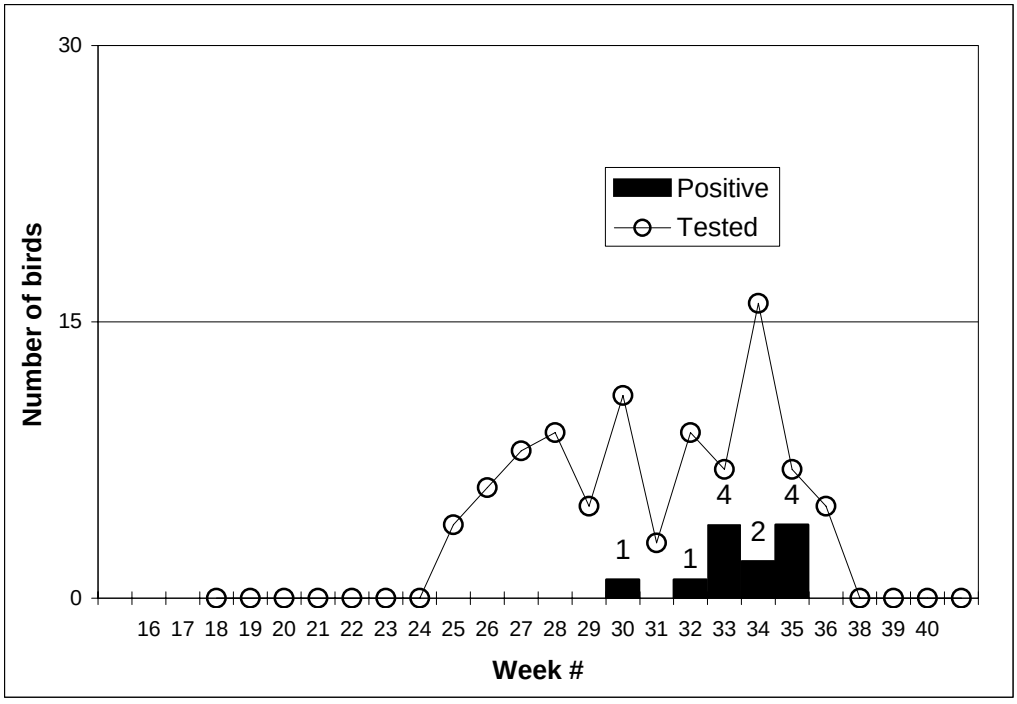

Figure 3: Corvids tested for West Nile virus in Alberta in 2006. See Table 5 for dates associated with each week. (The number above the bar indicates number of positive birds for that week.)

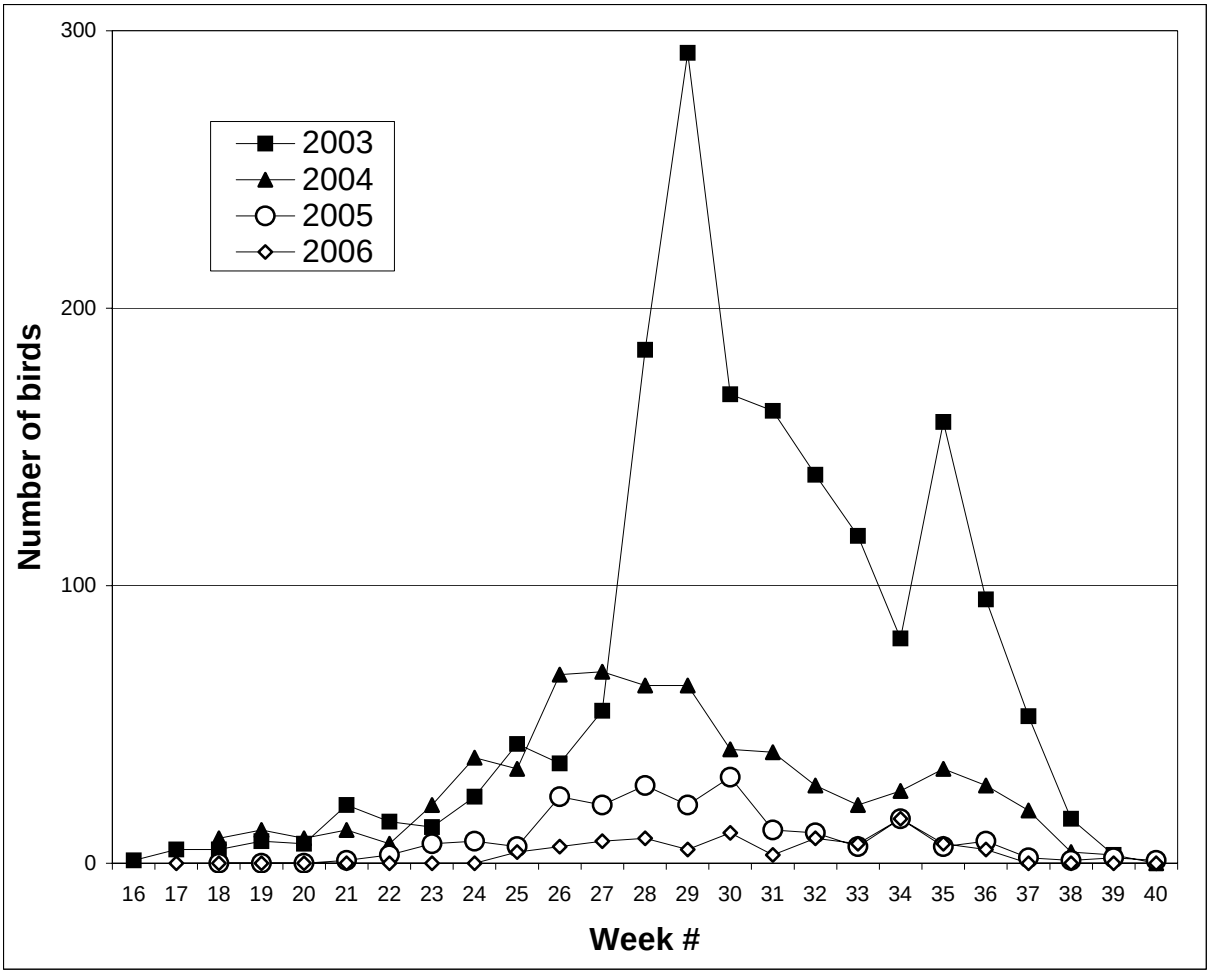

Figure 4: Weekly distribution of corvids tested for West Nile virus in Alberta, 2003-2006.

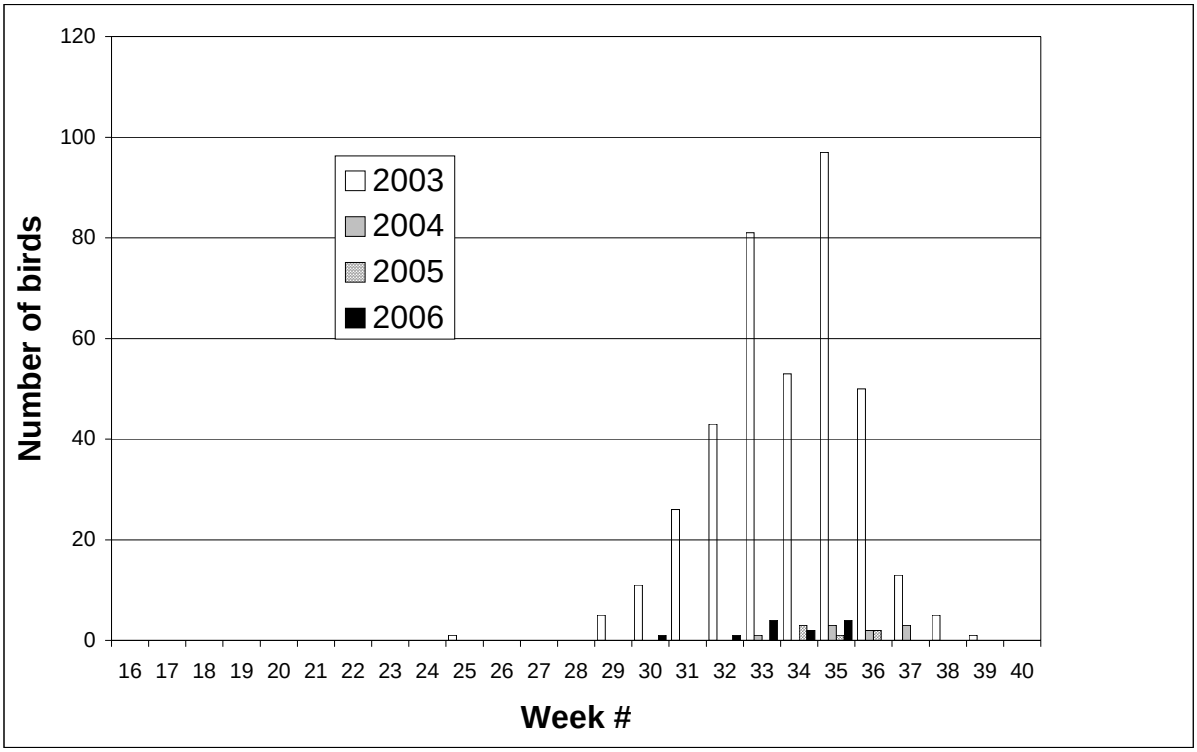

Figure 5: Weekly distribution of West Nile virus-positive corvids in Alberta, 2003-2006.