Alberta West Nile virus

wild bird surveillance 2005

SUMMARY:

Approximately 240 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 2005. Nestlings were not examined and approximately 25 (10.4%) of the birds received were unsuitable for analysis (dry, rotten, too young, or unsuitable species). Thus testing was limited to 215 corvids (102 crows, 95 magpies, 12 ravens, and 6 blue jays). All usable corvids were tested with the VecTest, an antigen-based screening assay. In addition, 5 greater sage-grouse were assessed for WNv using a PCR molecular test.

Starting in mid-June and continuing until the end of September, corvids were received from throughout the province for testing. Most birds (88.3%) came from the Grassland region (n=118, 54.9%) and the Parkland region (n=74, 34.4%) of central and southern Alberta. The first positive crow was found dead on August 15, 2005 in Lethbridge and the last on August 30, 2005 in Brooks. We confirmed WNv in 6 of the 102 crows (5.9%) and one sage-grouse, and all positive birds were found in the Grassland region. No evidence of the virus was found in the Parkland, Boreal, Rocky Mountain, Foothills, or Canadian Shield natural regions.

Birds were tested in batches once a week during June, whereas testing was conducted daily in July and August, and as they arrived in September. The average time between collection by the public and testing in our lab in 2005 was 18.4 ± 15.0 days (n=215). The average time between when a bird arrived at the lab and when it was tested was 3.6 ± 2.3 days (n=209).

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 most 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) 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. 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 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://www.srd.gov.ab.ca/fw/diseases/WNv/index.html

Alberta's WNv 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 2005 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 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 2005, 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. A few birds of other species were received. 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.

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. Dead bird testing occurred weekly in June, daily in July and August, and as birds arrived at the laboratory in September. 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:

Submissions

Two hundred and forty birds were received for West Nile testing from June to September 2005. Of these, 215 corvids (ravens, crows, magpies, and blue jays) were tested for WNv using VecTest (Table 1; Figure 1). The remaining 25 birds (10.4%) were unsuitable for testing (dry, rotten, too young, or non-corvid).

Most of the tested corvids were crows (n = 102, 47.4%) and magpies (n = 95, 44.2%; Figure 2). Twelve ravens and 6 blue jays also were tested. In addition, 5 greater sage-grouse were assessed for WNv using a PCR molecular test. The corvids largely were collected in the Grassland (n = 118, 54.8%) and Parkland (n = 74, 34.4%) natural regions (Table 1; Figure 1), reflecting the presence of urban centers such as Edmonton and Calgary (Table 2). The remaining birds came from the Boreal Forest (n = 20, 9.3%), Foothills (n = 2, 1%), and Mountain (n = 1, 0.5%) natural regions. No birds were received from the small portion of Canadian Shield in the far northeastern corner of the province.

Most samples were submitted in July (50.2%) or August (26.3%), with the remainder from June (8.1%) and September (15.3%) (Figure 3; see Table 5).

West Nile results

The average time between collection by the public and testing in our lab in 2005 was 18.4 ± 15.0 days (n=215 corvids). The average time between when a bird arrived at the lab and when it was tested was 3.6 ± 2.3 days (n=209). Time intervals included the extended holding period associated with weekly testing in June.

West Nile virus was found in 6 of 215 (2.8%) corvids tested (Table 1; Figure 2). The virus was found in 6 of 102 (5.9%) crows, but none of the 95 magpies, 12 ravens and 6 blue jays tested. One of the 5 sage-grouse tested positive for WNv.

The positive crows were collected from the Grassland (6 of 118, 5.1%) regions of southern Alberta (Table 1, Figure 1). Viral activity was not found in the Parkland, Boreal, Rocky Mountain, Foothills, nor Canadian Shield natural regions. All six positive crows were collected in the first two weeks of August (Table 3). The positive sage-grouse was collected in southeastern Alberta in the first week of August.

Discussion

West Nile virus apparently arrived in North America in 1999 [1]. 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 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, 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. Extensive mortality was seen in crows and magpies throughout southern and central Alberta in 2003, and the virus also was detected in mosquitoes, horses, and humans in the same wide geographic distribution[2] Mortality in birds was considerably reduced in 2004[3]

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. 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: there were fewer dead birds found and fewer positive corvids (Figures 4, 5). The prevalence of WNv in corvids was similar in 2005 to that in 2004 but significantly lower than in 2003 (Table 4). 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. 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. Similar patterns were seen in mosquitoes, horses, and humans over the three

[1] 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.

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

[3] Pybus, M.J. 2004. Alberta West Nile virus wild bird surveillance, 2004; http://www.srd.gov.ab.ca/fw/diseases/WNv/pdf/2004WNVreport.pdf

years. Although 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-dependent. Spring and early summer in 2004 and 2005 were relatively cool and evidence from mosquito surveillance conducted by Alberta Environment indicates that *Culex tarsalis* development was significantly delayed by weather conditions in 2004 and 2005 in comparison to 2003. It may be that when infected migrating birds arrived in the spring and early summer, there were inadequate numbers of *Culex tarsalis* adults available to transmit the virus and establish a new viral population in Alberta.

The late summer evidence of West Nile virus activity in 2004 and 2005 may be 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 and 2005. The occurrence of a few positive birds in late summer suggests there were sufficient *Culex tarsalis* mosquitoes to transfer the virus to other birds and establish a relatively small viral population in the Grassland natural region of southeastern Alberta.

Birds exposed to WNv can develop immunity to further infection. 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 and 2005. 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 the summer in 2004 and 2005.

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. Although 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 at low levels of viral activity. Dead corvids positive for West Nile virus were found temporally and geographically near the mosquito,

human, and equine cases, and reflected the distribution of *Culex tarsalis* mosquitoes in Alberta.

Following the WNv-related mortality in 2003, the small sage-grouse population in southern Alberta was closely monitored in 2004 and 2005. A cooperative program among the Fish and Wildlife Division, the University of Alberta, Alberta Environment, and the City of Medicine Hat was implemented in both years. The study design included a comparison of mortality in two areas treated repeatedly with a standard biological control for mosquito larvae [*Bti*] and a control area that received no treatments. Although no WNv sage-grouse mortalities were detected in 2004 and only one in 2005; the general evidence of low viral activity in southern Alberta in these years prevented any further assessment of the change in potential risk to sage-grouse. However, there was a significant decrease in the number of *C. tarsalis* in treated areas (J. Carpenter, U. of Alberta, unpublished results) and selected treatment can potentially mitigate the risk to sage-grouse in limited areas.

Future Outlook

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. However, the potential effects of changing resistance and immunity in wild birds remain 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 in any one year is difficult to predict.

The WNv bird surveillance program will be implemented in 2006 to identify when the virus returns and to track its behaviour; however, the program will be limited to the Grasslands natural region where the risk factors indicate there is potential for infections to occur. A maximum of six positive birds is considered sufficient evidence of viral activity and no further surveillance will be conducted in the region if that threshold is reached. In addition, clusters of unusual mortality of wild birds or mammals will continue to be investigated to see if WNv is involved.

It appears that local ecosystems have adapted to the seasonal presence of WNv with limited effects on wild populations of birds in Alberta. Although 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. A review of the last 10 years of Christmas Bird Count data (http://audubon2.org/birds/cbc) does not indicate any significant effect of WNv on crows or magpies overall in Alberta nor on Lethbridge, Medicine Hat, or Dinosaur Provincial Park counts, 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. Highly susceptible individual birds die and are removed from the population; resistant individuals remain to produce the future generations. Similarly, reduced patterns of bird mortality and viral

occurrence indicate integration of WNv virus into North American ecosystems is well underway.

Long-term Outlook

It is readily apparent that West Nile virus will establish populations across the continent 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 with limited direct effect on wild populations. Sporadic cases in horses and humans are likely to continue. All species will have to learn to live with West Nile virus as an integral part of the seasonal biodiversity of Alberta.

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, Junyoung Jeon 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.

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), 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 WNv positive corvids in Alberta in 2005.

	Boreal (north)	Foothills (west)	Grassland (south)	Mountain (far west)	Parkland (central)	Species TOTAL
Blue Jay	0	0	1	0	5	6
Crow	7	1	55 (6)*	1	38	102 (6)
Magpie	6	1	61	0	27	95
Raven	7	0	1	0	4	12
All Corvids	20	2	118	1	74	215 (6)

* number tested (number positive)

Table 2: Primary source of corvids tested for WNv in Alberta in 2004

Urban center	WNv positives and # tested	Proportion of total # tested (%)	Natural Region
Edmonton	0 of 50	23.3	Parkland
Lethbridge	1 of 16	7.4	Grassland
Medicine Hat	1 of 21	9.8	Grassland
Calgary	0 of 51	23.7	Grassland

Table 3: West Nile virus positive birds in Alberta in 2005 (by date found).

Species	Date Collected	Town / District	WMU (Wildlife Management Unit)
Crow	15-Aug-05	Lethbridge	108
Crow	17-Aug-05	Brooks	142
Crow	21-Aug-05	Medicine Hat	148
Crow	24-Aug-05	Brooks	142
Crow	30-Aug-05	Brooks	142
Crow	30-Aug-05	Brooks	142

Table 4: Prevalence of West Nile virus among corvids tested in Alberta, 2003-2005.

Species	2003	2004	2005
crow	22.6 (899)*	2.1 (355)	5.8 (102)
magpie	27.7 (835)	0.4 (264)	0 (95)
corvids	23.8 (1843)	1.4 (666)	2.8 (215)

*** % positive (# tested)**

Table 5. Standardized 2005 Table of Weeks**.**

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

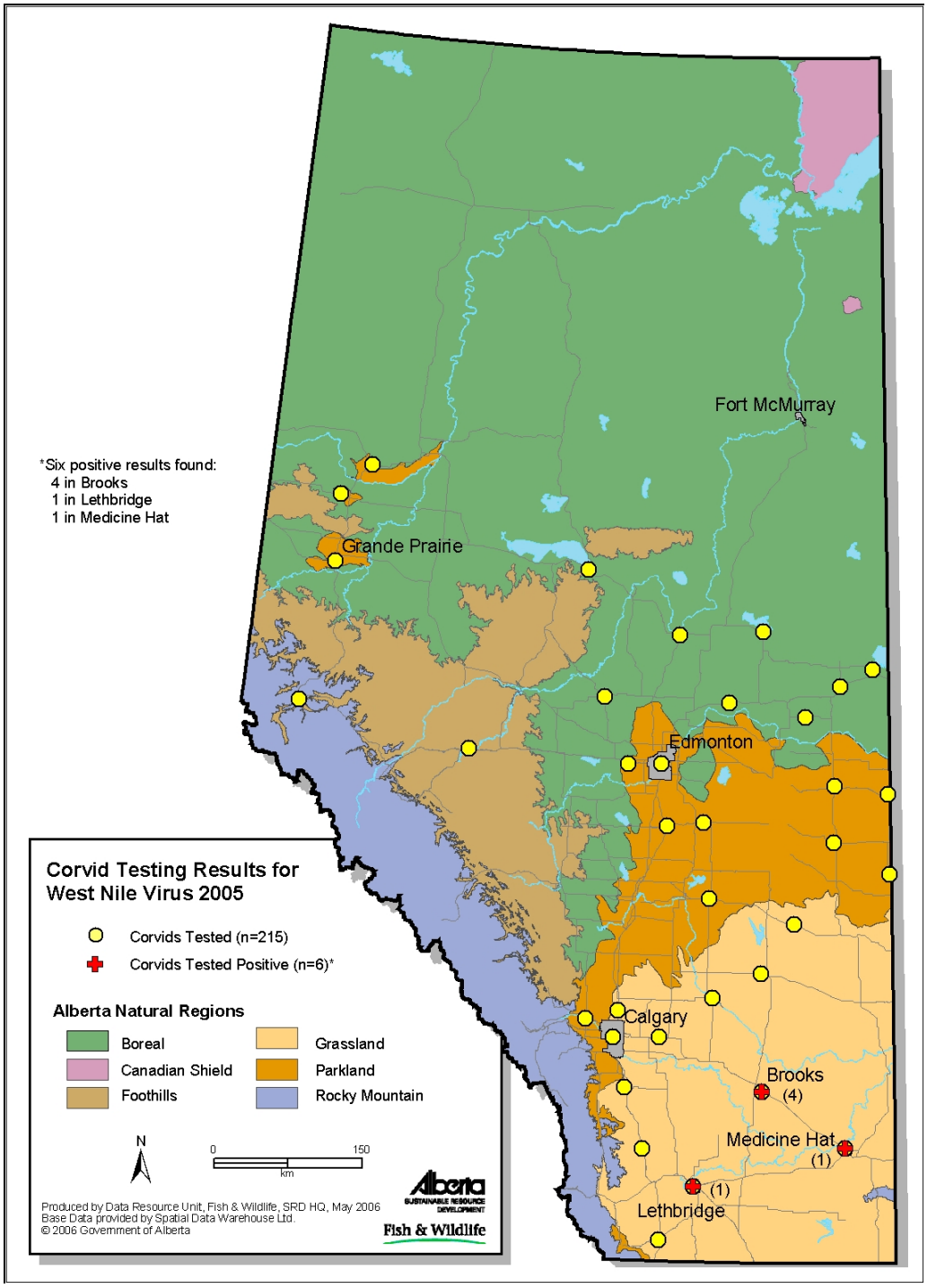

Figure 1. Distribution of corvids tested for West Nile virus in natural regions of Alberta in 2005.

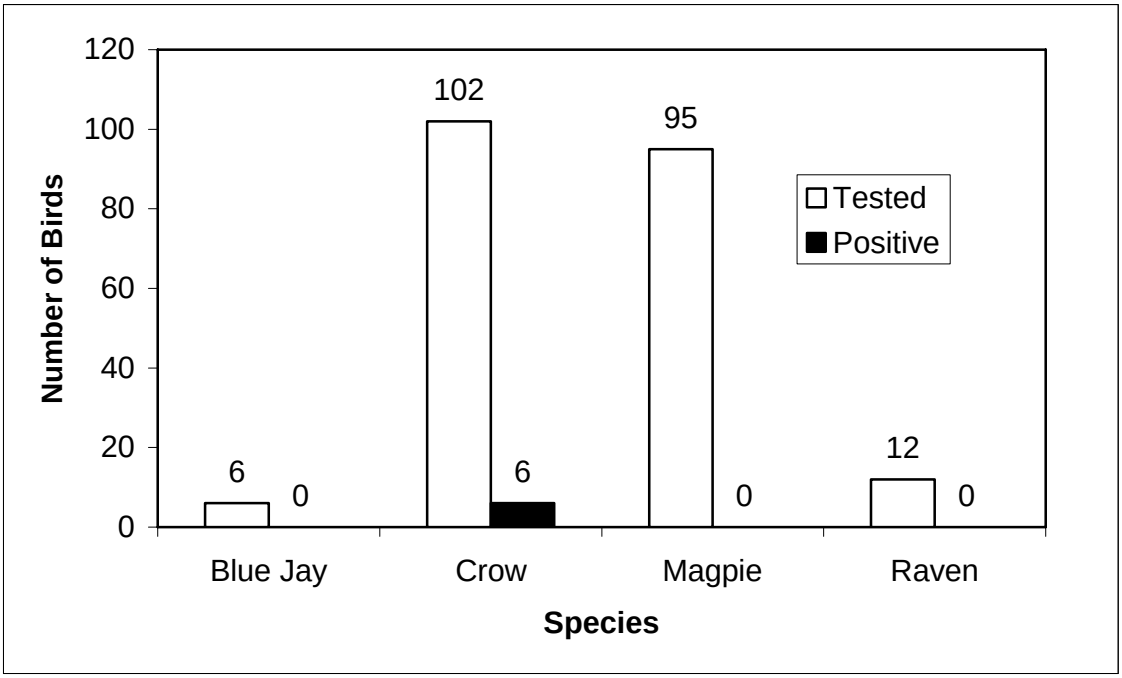

Figure 2: Corvids tested for West Nile virus in Alberta in 2005.

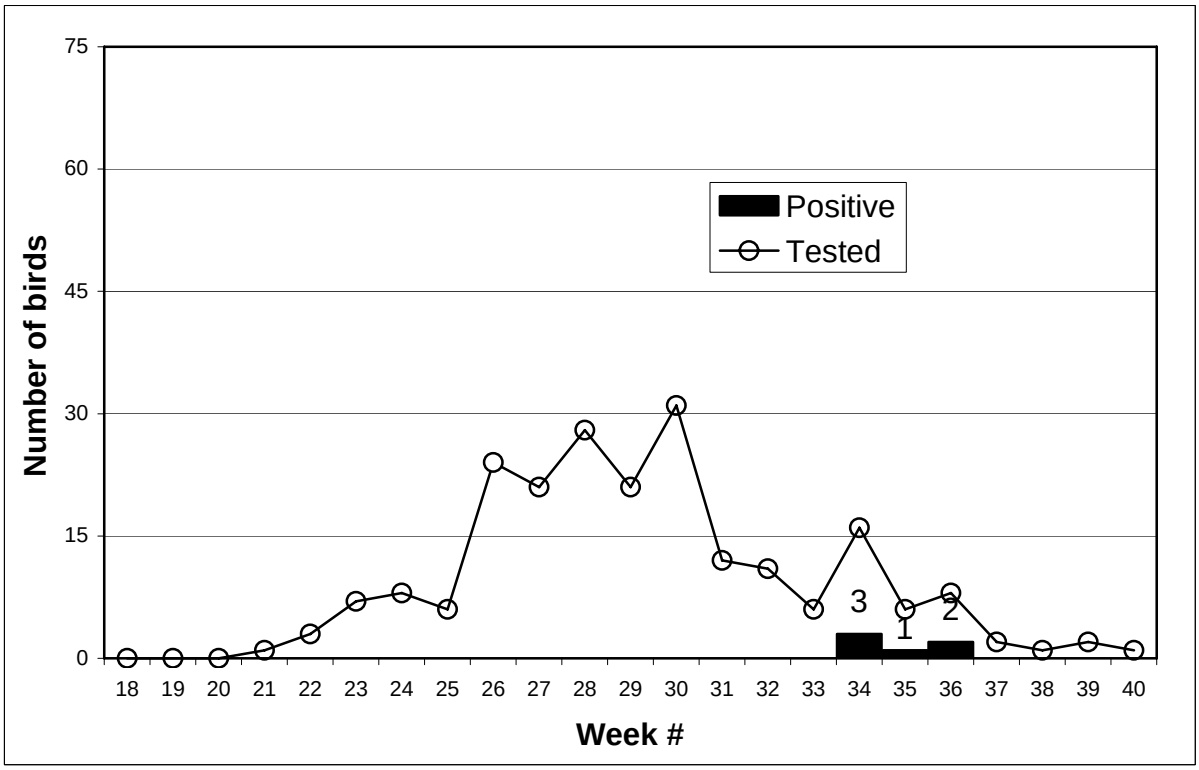

Figure 3: Weekly collection of corvids tested for West Nile virus in Alberta in 2005. See Table 5 for dates associated with each week.

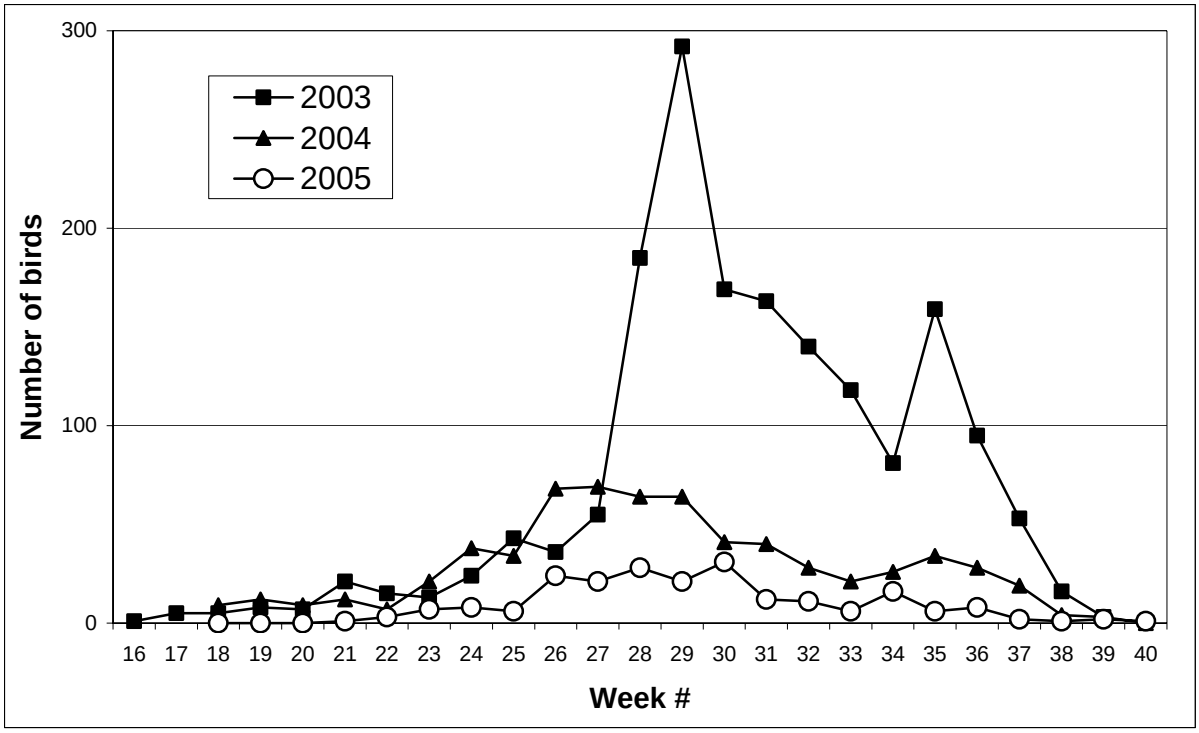

Figure 4: Weekly collection of corvids tested for West Nile virus in Alberta, 2003-2005.

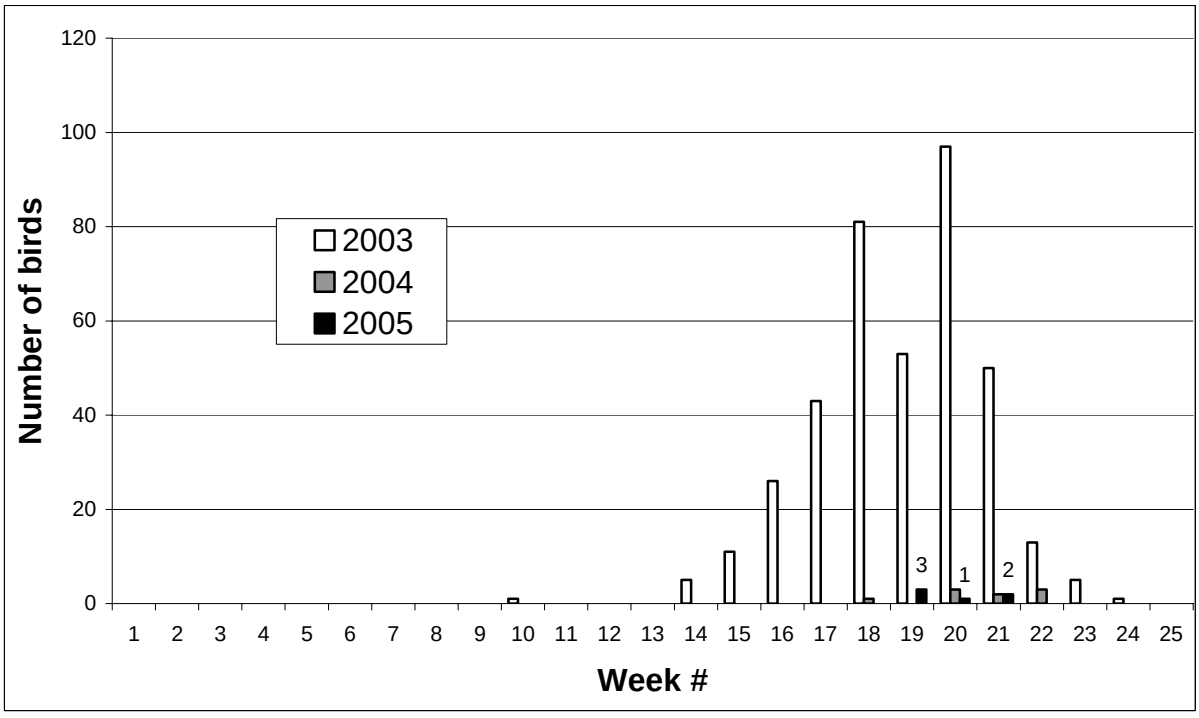

Figure 5: Number of corvids that tested positive for West Nile virus in Alberta, 2003-2005.