



Alberta West Nile Virus

wild bird surveillance 2003

SUMMARY:

Approximately 2300 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 2003. Nestlings were not examined and approximately 450 (20%) of the birds received were unsuitable for analysis (dry, rotten, too young, or unsuitable species). Thus testing was limited to 1843 corvids (899 American crows, 835 black-billed magpies, 60 common ravens, 49 blue jays). All usable corvids were tested with the VecTest, an antigen-based screening assay that was initially validated in crows and, based on data collected during this program in 2003, was later validated in magpies. In addition, 5 greater sage-grouse, 3 northern goshawks, 1 Swainson's hawk, 1 loggerhead shrike, and 1 great horned owl were assessed for WNV using a polymerase chain reaction (PCR) molecular test.

We confirmed WNV in 439 corvids, including 203 crows, 231 magpies, and 5 blue jays from the Grassland (n=210) and Parkland (n=190) as well as southern Boreal Forest (n=34), and eastern Foothills regions (n=1) [plus 4 positive birds from unknown locations]. Five sage-grouse, 2 goshawks, 1 Swainson's hawk, 1 shrike, and 1 great horned owl were also confirmed positive. Birds were collected over a wide geographic range throughout the province, although most birds (87%) came from the Grassland (n=779) and Parkland (n=816) areas of southern and central Alberta. No evidence of the virus was found in either the Rocky Mountain or Canadian Shield natural regions.

A similar proportion of VecTest-positive crows (23%) and magpies (28%) were found in affected areas. However, adjusting for the reduced sensitivity of the test in magpies, the actual proportion of positive magpies tested in Alberta in 2003 may be as high as 46%. Based on VecTest results, crows were the predominant infected corvid in the Boreal Forest region, while in the Parkland region, the proportion of positive magpies (33%) was 2X greater than the proportion of positive crows (17%). In the Grassland region, the proportion of positive crows and magpies were similar (29% and 26%, respectively).

The first positive bird was a magpie found dead on June 17. The average time between collection and testing of individual corvids in Alberta in 2003 was 5.51 ± 4.01 days (n=1548). The number of positive birds increased steadily from mid-July to a peak in late August. In August, the proportion of positive crows and magpies was consistently more than 60% of the birds tested each week.



Post mortem examinations were conducted on 196 crows (all negative for WNV), as well as 217 magpies (80 negative, 137 positive for WNV) to assess the cause of death. The majority (70%) of crows died as a result of blunt trauma. Similarly, blunt trauma was the most common cause of death of the PCR-negative magpies (40%) but only 18% of the PCR-positive magpies.

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 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 immuno-compromised humans (people whose immune systems do not work as well as they should).

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 replicates (reproduces) and thus increases its population 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 waterbodies 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. A few large, hardy females overwinter and emerge in April and May to lay the first generation of eggs. Adults produced in the summer are relatively short-lived and two, three, or 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. West Nile virus can also overwinter in a few dormant individual mosquitoes. The virus is still extending its continental range and the first cases of infected birds in Mexico as well as Central and South America were detected in 2003. 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/healthier/diseases/west_nile.html

Alberta Agriculture, Food and Rural Development

http://www.agric.gov.ab.ca/surveillance/west_nile_virus.html

Fish and Wildlife Division of Alberta Sustainable Resource Development

<http://www3.gov.ab.ca/srd/fw/diseases>

Alberta's West Nile virus Program:

Building on the successful West Nile surveillance program of 2002, representatives from four provincial departments (Alberta Health and Wellness, Alberta Agriculture, Food and Rural Development, Alberta Environment, and Alberta Sustainable Resource Development) prepared a provincial response plan for 2003 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 2003, 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.





Fresh or frozen birds were transported or sent to the Fish and Wildlife Division's Wildlife Disease Laboratory in Edmonton. Birds were thawed and then tested with a VecTest strip. Initial positive birds were sent to the diagnostic laboratory of B.C. Agriculture in Abbotsford, B.C. for confirmatory testing with a DNA-based polymerase chain reaction test (PCR).

Bird Surveillance Data:

Species composition

Over 2300 birds were received for West Nile testing between May and October 2003. Information from 1843 corvids from 5 of 6 natural regions within the province was logged into the surveillance data file. The remaining birds (20%) 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%), primarily crows and magpies (94%). A few ravens and blue jays were received as well as one or two individuals of various other species. Specifically, 5 sage-grouse, 3 goshawks, 1 Swainson's hawk, 1 shrike, and 1 great horned owl 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 439 of 1843 (24%) corvids tested (Table 1). Crows and magpies accounted for 99% of the infected corvids, with similar numbers of positive crows and magpies and similar incidence of infection (23% of 899 crows tested, 28% of 835 magpies). However, given the 74% specificity of the VecTest in magpies (see *Diagnoses* below), approximately 25% of the 604 VecTest negative magpies likely were infected, thus adding another 151 positive magpies and changing the adjusted positivity rate in magpies to 46% of 835 tested. In addition, 10% of 49 blue jays were infected (using the VecTest sensitivity as for crows). The virus was not found in any of the 60 ravens tested.

The positive corvids were collected throughout the Grassland (48%) and Parkland (43%) natural regions of central and southern Alberta and stretching northwards into the southern Boreal Forest fringe (8%) from Athabasca to Cold Lake (Figure 1). Only one positive crow was found in the Foothills natural region. Viral activity was not found in the northern forests and Peace River country nor in the Rocky Mountain Natural Region.

Non-corvids

Five sage-grouse, 2 goshawks, 1 Swainson's hawk, 1 shrike, and 1 great horned owl were confirmed positive for WNV. West Nile virus was found throughout various tissues of these birds and was considered the direct cause of death.





Other Species (Non-birds)

Note that in other components of the provincial surveillance program, Alberta Environment detected West Nile virus in 31 separate pooled samples of mosquitoes collected throughout central and southern Alberta. Thirty of these samples contained infected *Culex tarsalis*. Alberta Agriculture, Food and Rural Development identified WNV as a provincially-reportable disease and received reports of 172 positive horses throughout the Parkland, Grassland, and Boreal natural regions. The number of human cases began to rise in late August and Alberta Health and Wellness documented 275 confirmed cases as of 2 January 2004. Cases generally were concentrated in southeastern and central Alberta, reflecting the distributional pattern seen in birds, mosquitoes, and horses.

Geographic Distribution

Most of the tested birds were found sick or dead in the Grassland (42%) and Parkland (44%) natural regions (Table 1) and largely reflected the presence of urban centers (Table 2). The number of crows and magpies collected were similar in these two natural regions (Table 1). The 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). Banff and Jasper 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

The WNV bird surveillance program in 2003 ran from May 1 to September 30, although a few birds collected in April were tested (Figure 2). The average time between collection and testing was 5.51 ± 4.01 days ($n=1548$). Bird submissions were tracked on a weekly basis, using the standardized week designations as adopted by health agencies (Table 3). Overall, there was a slow rise in the number of birds submitted in April, May, and June, followed by a steep peak in early July, and a subsequent slow decline through August and September. The first positive bird was collected near Medicine Hat on June 17 (week 25) (Figure 3). The number of positive birds rose steadily from mid-July, peaked in late August and steadily declined through September. There was a decline in the actual number of positives in the third week of August (week 34), but this reflected the decreased number of birds submitted in that week. However, the proportion of positive birds per week was consistently high throughout August (over 60% of the birds tested each week) (Figure 4). The timing of dead birds and positive birds was similar in Grassland, Parkland, and the southern Boreal regions and reflected the overall pattern described above (Figure 5, 6). Using VectTest results, there were consistently more positive crows than magpies in the Boreal region and fewer positive crows than magpies in the Parkland region. Similar numbers of positive birds of both species were seen in the Grasslands region.





Diagnoses

In conjunction with the Canadian Cooperative Wildlife Health Centre in Saskatoon and Health Canada in Winnipeg, the VecTest was validated for magpies. A total of 226 magpies (113 VecTest-positive, 113 VecTest-negative) from Alberta were assessed using PCR analysis of tissue samples of brain, heart, and kidney. Test specificity was 100% (113 of 113 positive), whereas test sensitivity was 74% (29 of 113 were false negatives). Thus the VecTest failed to detect 25% of the actual number of positive magpies.

Post mortem examinations were completed on 196 WNV-negative crows selected to represent the overall spatial and temporal distribution of corvids submitted for virus testing. Trauma was the primary cause of death in 86% of the crows examined (70% blunt trauma, 12% gunshot wounds, 4% predation) (Table 4). Less than 10% had no visible lesions (NVL) or, in other words, no visible cause of death. Post mortem assessment of WNV-positive crows was not conducted.

Post mortem exams were completed on negative and positive magpies sent to Saskatoon. Trauma was the primary cause of death in the 80 magpies confirmed negative by PCR (40% blunt trauma, 9% internal congestion, 8% cranial congestion, and 6% gunshot wounds) (Table 5). An additional 26% showed no visible lesions. Of the 137 PCR-positive magpies, most of the birds had no visible lesions (48%), whereas 28% had cranial congestion, and only 18% had signs of blunt trauma (Table 6).

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, and the Central Flyway in 2002 and 2003. This movement resulted in a steady geographic expansion of infections in birds, horses, and humans from the northeastern US 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.

Thus, there was reason to believe that spring migration in 2003 would bring the virus back to northern states and provinces including for the first time, Alberta. As a result, West Nile virus surveillance of wild birds in Alberta in 2003 was designed to detect the presence of the virus and thus the potential for health risks to humans and horses in the province. Indeed this appears to be exactly what happened. The efficiency of natural systems apparently provided suitable conditions for the virus to transfer from the spring migrating birds and establish local viral populations in *Culex tarsalis* and summer birds which then amplified (built up) over time. Bird surveillance data indicate that the virus was established in Alberta as early as mid-June in the southern grasslands. Magpies are year-round residents and the dead magpie found in Medicine Hat in June was either bitten by an infected mosquito or perhaps ate a number of infected small birds. The viral population subsequently increased temporally and spatially in birds throughout the





summer. By the end of the summer, there was evidence of extensive viral activity widespread in the area bounded by the Highway 16 corridor on the north and the Highway 2 corridor on the west. Within this area of central and southeastern Alberta, crows and magpies were equally useful as sentinel indicators of presence of the virus and preceded the occurrences of WNV in horses, humans, and mosquitoes.

Based on the biological features of WNV transmission and the limitations of weather and climate on the development of *Culex tarsalis*, the concentration of viral activity in the grasslands and parklands of Alberta is fully predictable. Within these regions there is a coming together of all the components necessary to sustain the virus and to provide a suitable sentinel system for detecting its presence: an abundance of early migrant birds and then a subsequent addition of naïve birds that had fledged from the nest, an ever increasing population of suitable mosquito vectors throughout the summer, hot dry weather conditions that promote rapid *Culex* development, an abundant population of susceptible crows and magpies, and random clusters of people who could find the dead birds. Throughout the entire month of August, these factors were all at peak levels in southern and central Alberta and as a result over 60% of the crows and magpies turned in each week in August were infected. The pattern in human infections, as reported by Alberta Health and Wellness, indicated the majority of infected people were exposed from late July through August, when viral populations are at their peak throughout the grasslands and parklands.

The provincial West Nile virus Response Plan was based on passive surveillance of birds found dead by the public. In particular, people were encouraged to submit fresh-dead crows and magpies to any office of the Fish and Wildlife Division. Information was provided regarding appropriate precautions when handling any wild animal found dead of unknown causes. These were general precautions and did not reflect a specific concern from handling birds dead 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 provided appropriate means to detect the presence and activity of the virus. Transmission of WNV was later confirmed in horses, mosquitoes, and humans throughout the same area where dead corvids were found, an area consistent with the general distribution of *Culex tarsalis* and environmental conditions suitable for the virus to maintain a summer population.

It is of interest that 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 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.





The finding of WNV in predatory raptors (birds of prey) was not unexpected. Although we will never know for sure exactly how these birds were infected, it is likely that they ate a number of small birds that themselves were infected with WNV. Immature goshawks, for example learn to hunt by catching small, less agile birds. Small birds infected with WNV may be easier to catch and thus the young goshawks are exposed to greater amounts of live virus, sufficient to establish infection in some individuals. There was no evidence that significant numbers of raptors died as a result of WNV infection in Alberta last year.

On the contrary, the WNV infections in sage-grouse are more disconcerting. Sage-grouse are listed as endangered in Alberta and the current provincial population estimate ranges from 300-400 birds. The mortality in local sage-grouse populations from late July to mid-August 2003 was significantly higher than in previous years (Cam Aldridge, University of Alberta, pers. comm.). Similar alarming results were seen in Wyoming and Montana in 2003. It may be that sage-grouse are exposed to greater amounts of virus as they move to specific water bodies on the hot dry prairie just as the population of *C. tarsalis* and the number of infected mosquitoes reach a peak in mid- to late summer. Discussions are underway to determine whether management intervention is appropriate to reduce the risks to sage-grouse.

Future Outlook

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 2004 and will follow the same general pattern of increase through the summer. However, the potential effects of changing resistance and immunity in wild birds are more difficult to predict. As such, the overall extent to which the viral population will build in Alberta in July and August 2004 is difficult to predict.

The WNV bird surveillance program will again be used in 2004 to identify when the virus returns. Once 6 positive corvids have been detected in the Grassland and Parkland natural regions, further bird surveillance will be discontinued so that the program can focus on northern and western areas where the virus was not found in 2003 and it is not yet known whether the virus can establish a population.

The actual impact on wild populations of birds remains largely unknown. The local and perhaps overall populations of crows in eastern provinces and states appears to have declined in some areas. However, 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 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 countless calls by the public and took direct action as appropriate and as possible. In addition, laboratory technicians Chris Onderka and Laura MacPherson spent tireless long hours in the lab documenting and testing the mountains of dead birds that appeared throughout the summer. Judy Vance put the final touches on this report. 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 bird surveillance programs could not have happened. Their efforts, and often their patience and understanding, are gratefully acknowledged.

Cooperative efforts with the diagnostic laboratories of British Columbia Agriculture in Abbotsford, Canadian Cooperative Wildlife Health Centre in Saskatoon, and Health Canada in Winnipeg also are acknowledged.





Table 1: Incidence (%), species composition, and geographic distribution of West Nile virus in corvids tested by VecTest in Alberta in 2003.

	Boreal (north)	Foothills (west)	Grassland (south)	Mountain (far west)	Parkland (central)	Unk- nown	Species TOTAL
Blue Jay	1 of 4	0 (1)*	11 (19)	0	8 (25)	0	10 (49)
Crow	26 (107)	8 (12)	29 (376)	0 (13)	17 (386)	2 of 5	23 (899)
Magpie	10 (50)	0 (2)	26 (379)	0 (22)	33 (380)	2 of 2	28 (835)**
Raven	0 (22)	0 (3)	0 (5)	0 (5)	0 (25)	0	0 (60)
Geographi c Total	19 (183)	6 (18)	27 (779)	0 (40)	23 (816)	4 of 7	24 (1843)

* % infected (number tested) ** adjusted positive rate is 46% of 835. See details in text.

Table 2: Primary source of birds positive for West Nile virus in Alberta in 2003.

	WNV Positives	%	Natural Region
Edmonton	95 of 326	29	Parkland
Greater Edm*	128 of 488	26	Parkland
Lethbridge	34 of 92	37	Grassland
Medicine Hat	27 of 67	27	Grassland
Calgary	35 of 293	12	Grassland
Overall	439 of 1843	24	5 of 6 regions

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



**Table 3:** Standardized 2003 Table of Weeks

Week	Month	Days	Week	Month	Days
15	April	7-13	28	July	07-13
16		14-20	29		14-20
17		21-27	30		21-27
18	Ap/May	28-04	31	July/Aug	28-03
19	May	05-11	32	Aug	04-10
20		12-18	33		11-17
21		19-25	34		18-24
22	May/June	26-01	35		25-31
23	June	02-08	36	Sept	01-07
24		09-15	37		08-14
25		16-22	38		15-21
26		23-29	39		22-28
27	June/July	30-06	40	Sept/Oct	29-05

Table 4: Post mortem results of sampled West Nile virus-negative crows in 2003.

Diagnosis	Number examined	% of those examined
Aspergillus [respiratory fungus]	1	<1
Blunt Trauma	136	70
Emaciation	4	2
Gall Bladder Inflammation	1	<1
Gunshot	24	12
Miscellaneous Bacterial infections	6	3
Myiasis [infestation by fly larvae]	1	<1
No Visible Lesions	15	8
Predation	8	4
TOTAL:	196	100



**Table 5:** Post mortem results of confirmed PCR-negative magpies from Alberta in 2003.

Diagnosis	Number examined	% of those examined
Autolyzed (unsuitable)	8	10
Blunt trauma	32	40
Cranial congestion	6	8
Electrocution	1	1
Gunshot	5	6
Internal congestion	7	9
No Visible Lesions	21	26
TOTAL:	80	100

Table 6: Post mortem results of confirmed PCR-positive magpies in 2003.

Diagnosis	Number examine	% of those examined
Autolyzed (unsuitable)	8	6
Blunt trauma	25	18
Cranial congestion	38	28
Internal congestion	1	<1
No Visible Lesions	65	48
TOTAL:	137	100



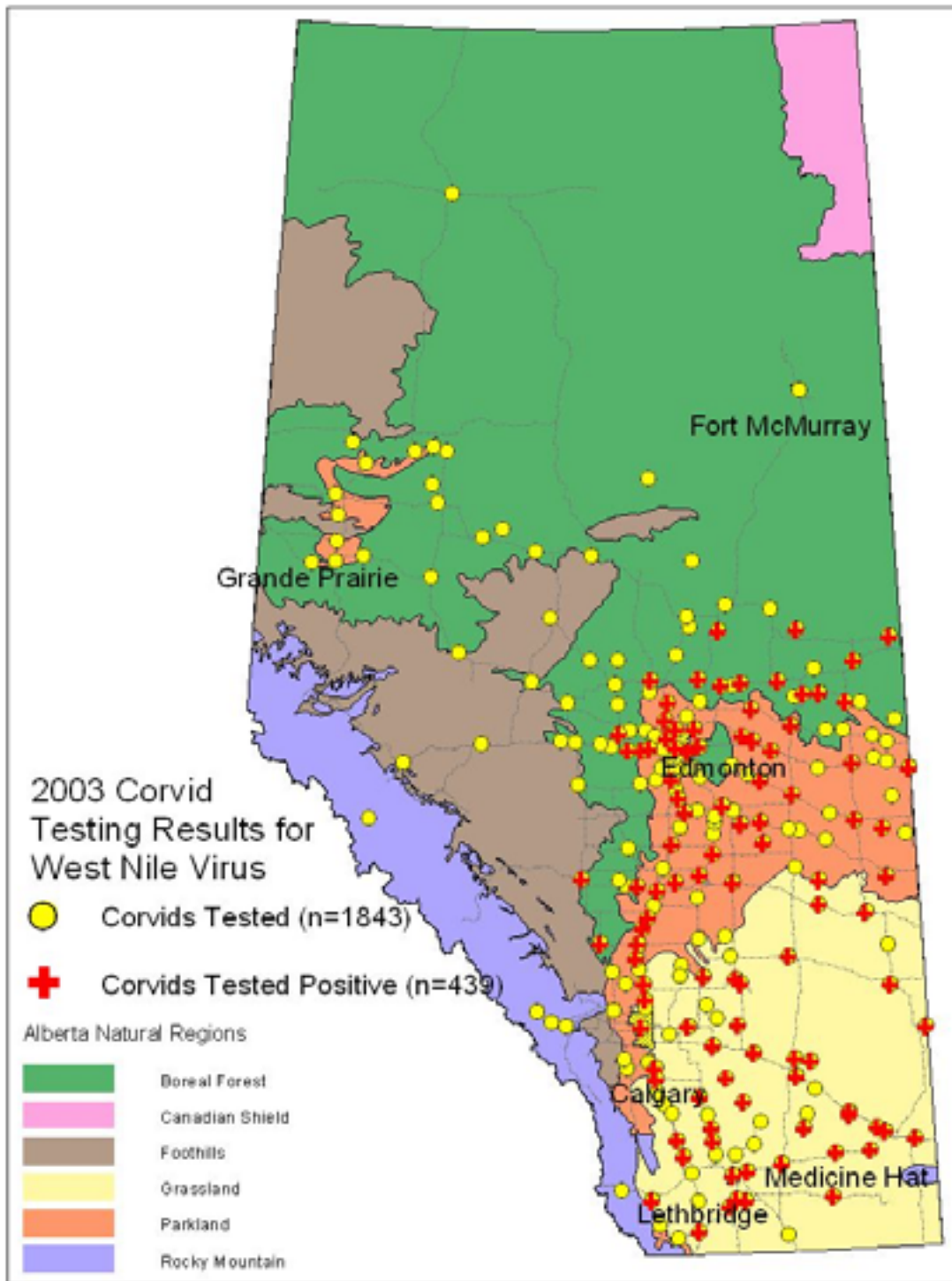


Figure 1. Distribution of corvids tested for West Nile virus in natural regions of Alberta in 2003.



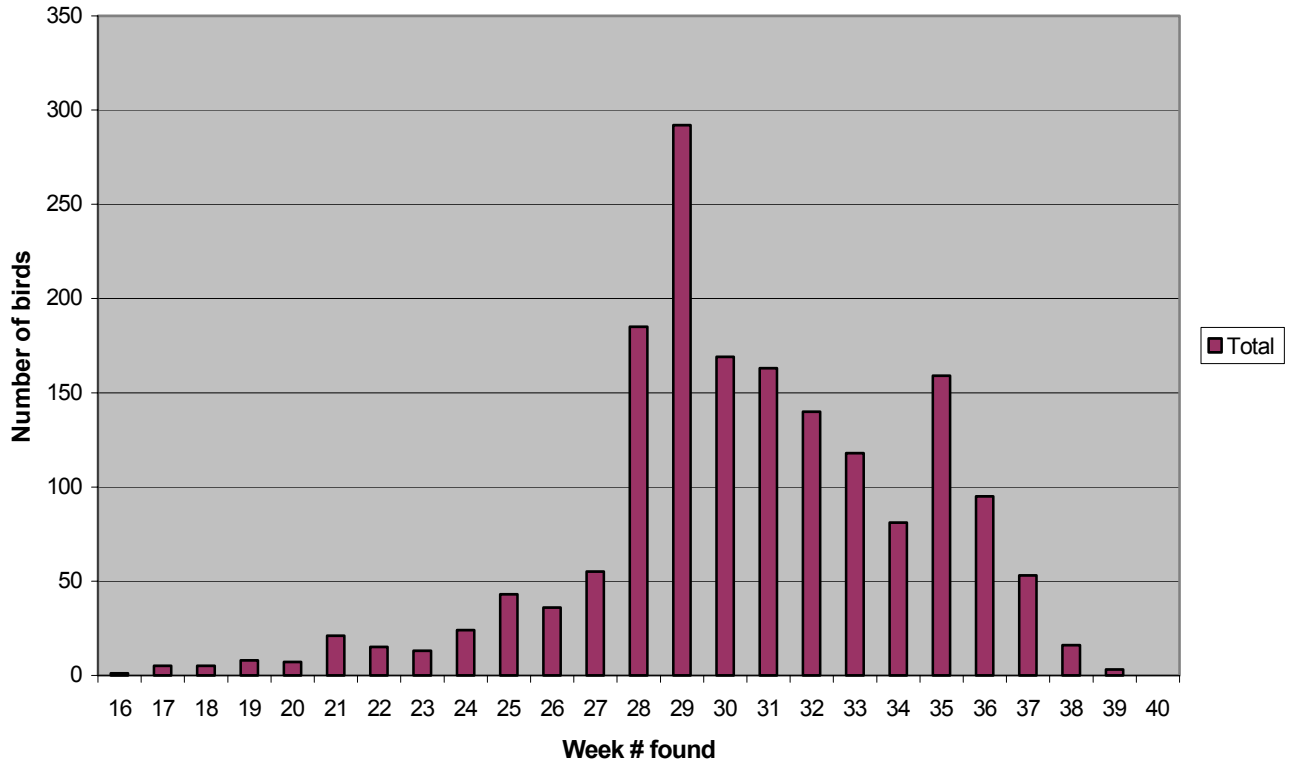


Figure 2: Weekly collection of corvids tested for West Nile virus in Alberta in 2003.

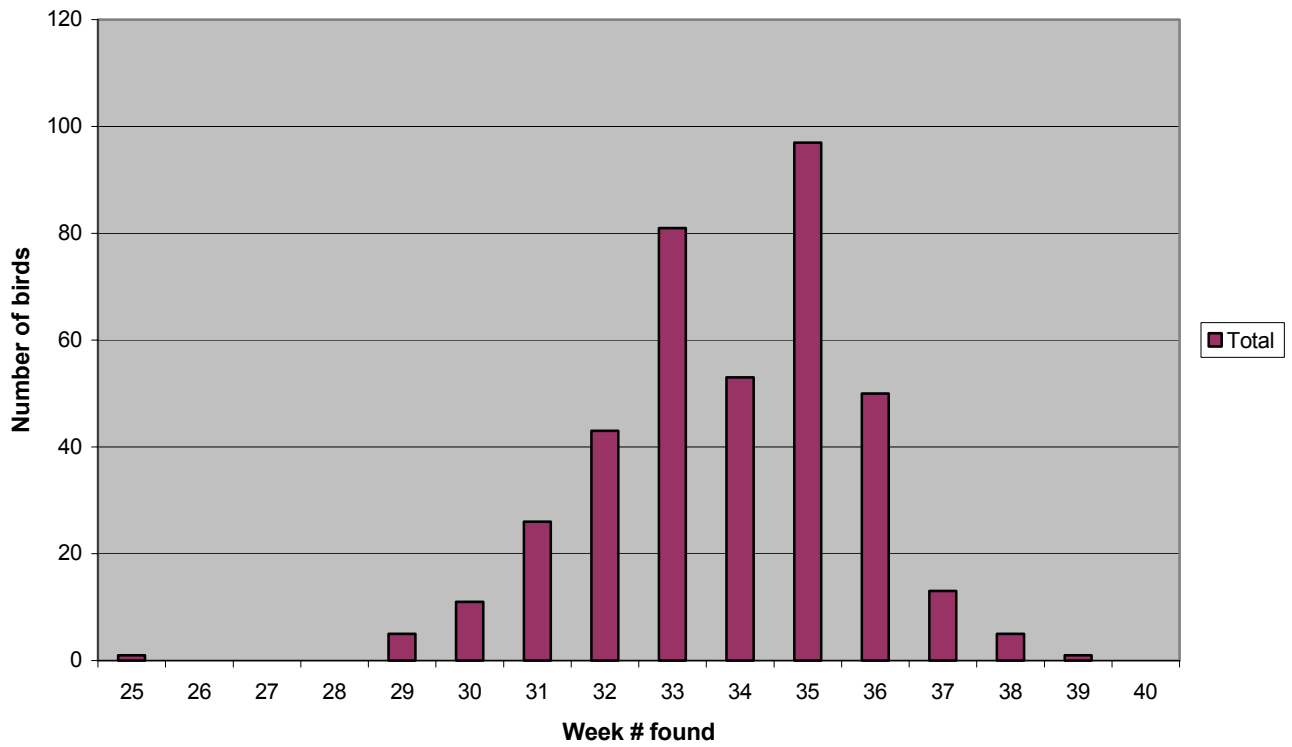


Figure 3: Weekly collection of corvids positive for West Nile virus in Alberta in 2003.



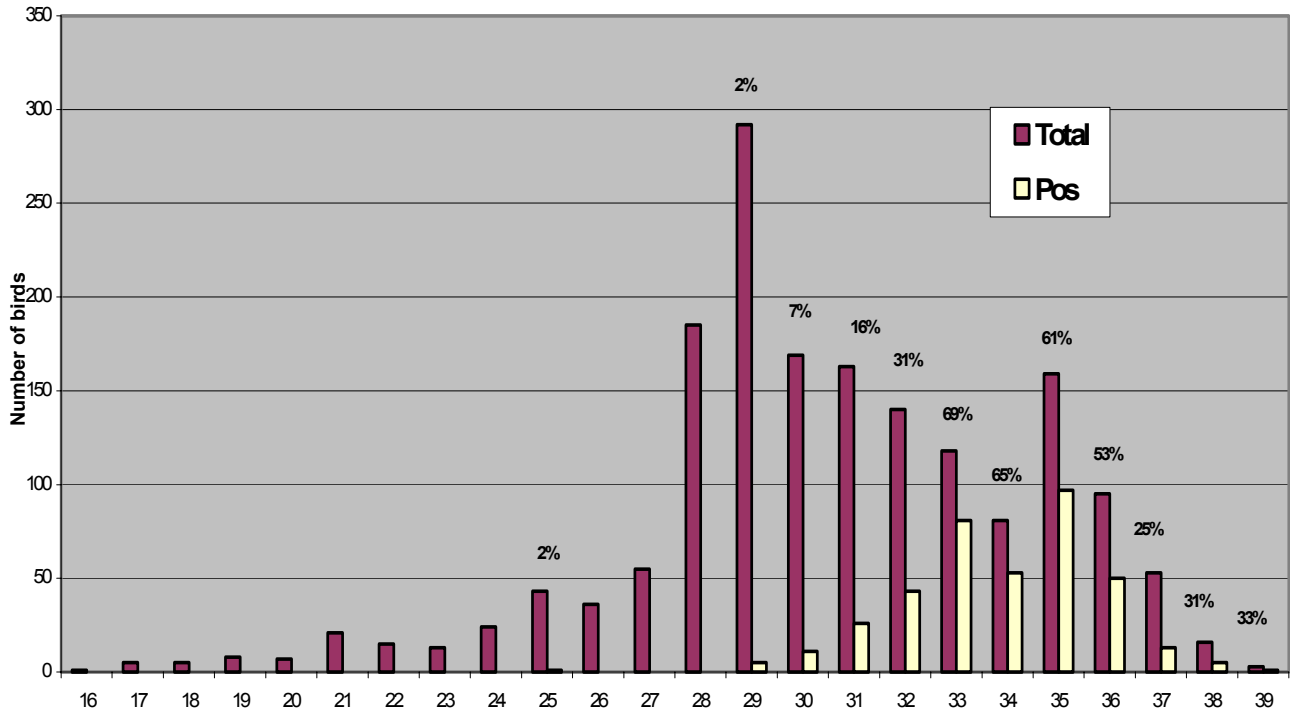
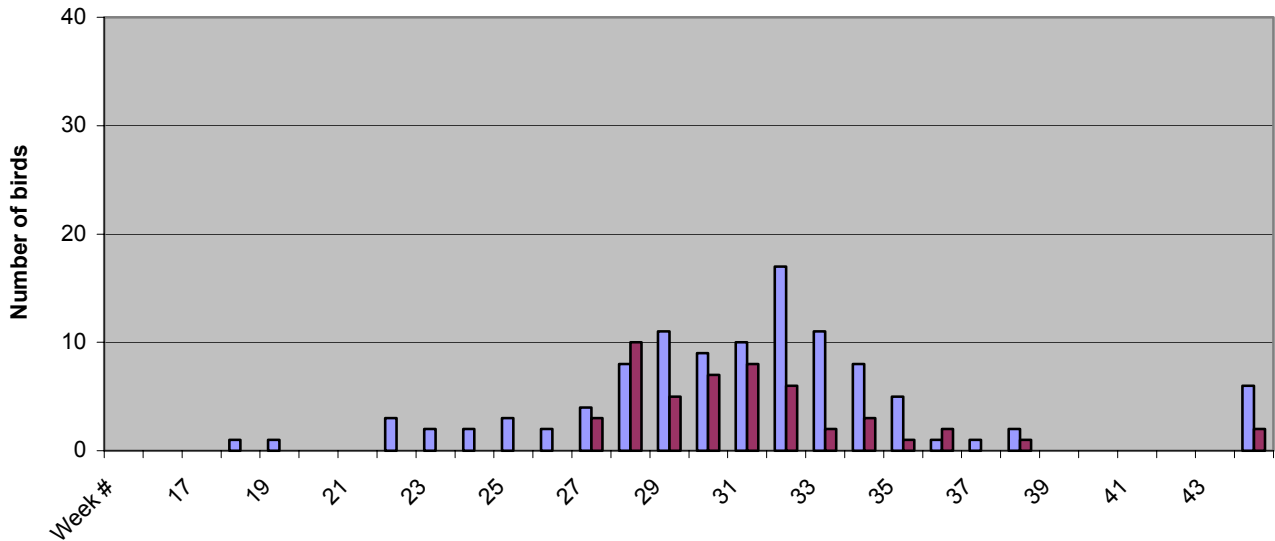


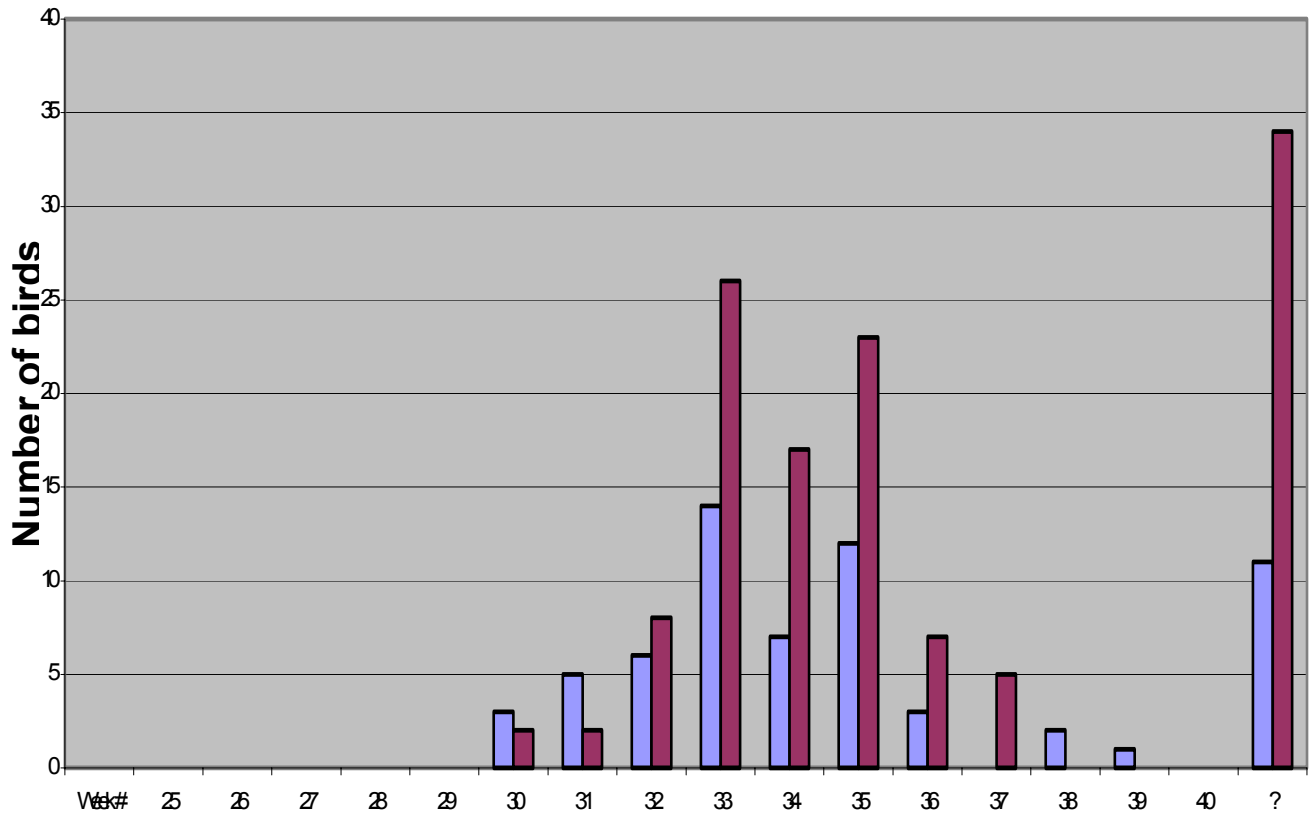
Figure 4. Weekly proportion of corvids positive for WNV in Alberta in 2003.

5a) Boreal Forest





5b) Parkland



5c) Grassland

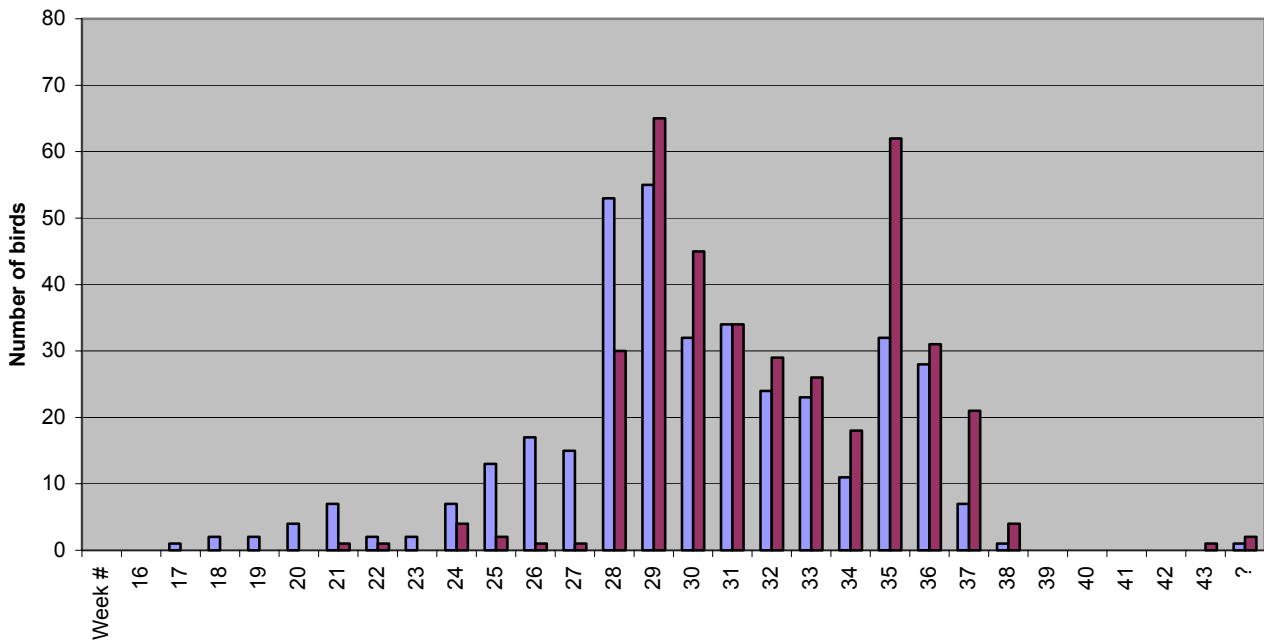
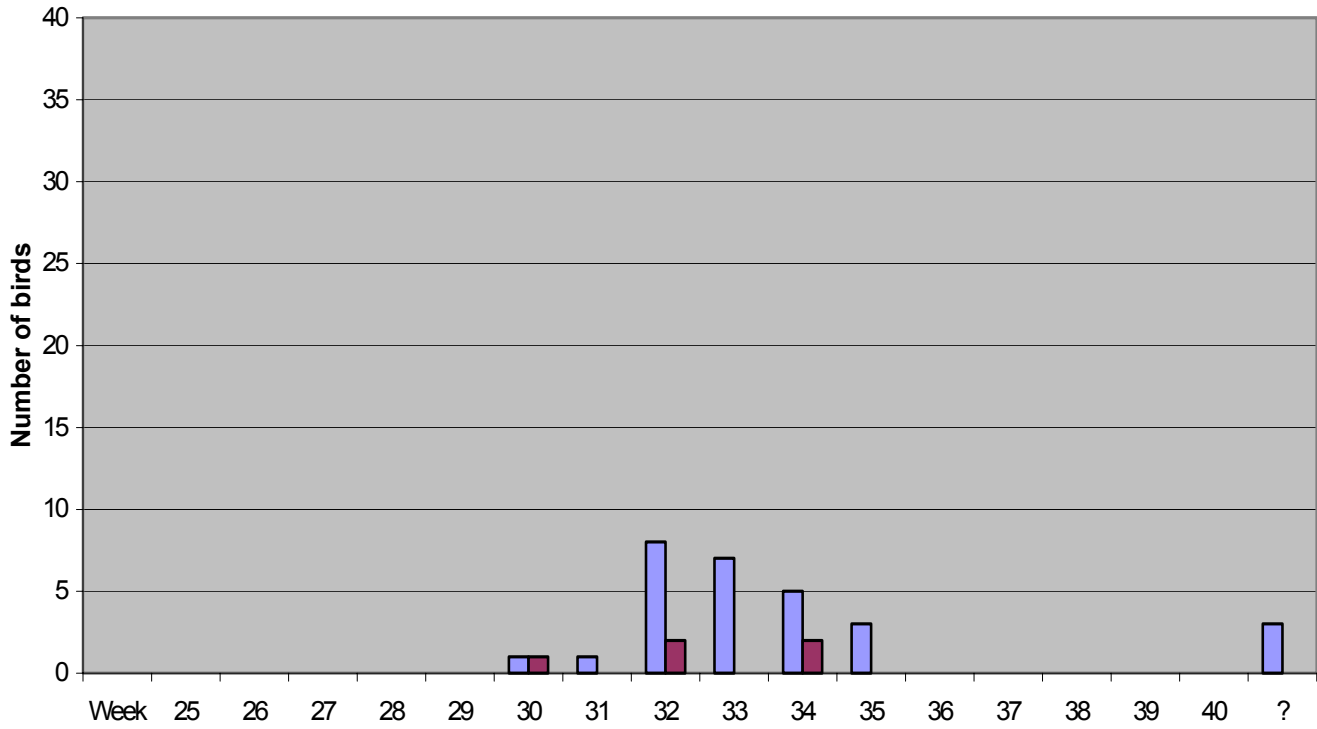


Figure 5. Weekly collection of crows ● and magpies ● in three natural regions of Alberta in 2003: a) Boreal Forest, b) Parkland, c) Grassland natural regions.

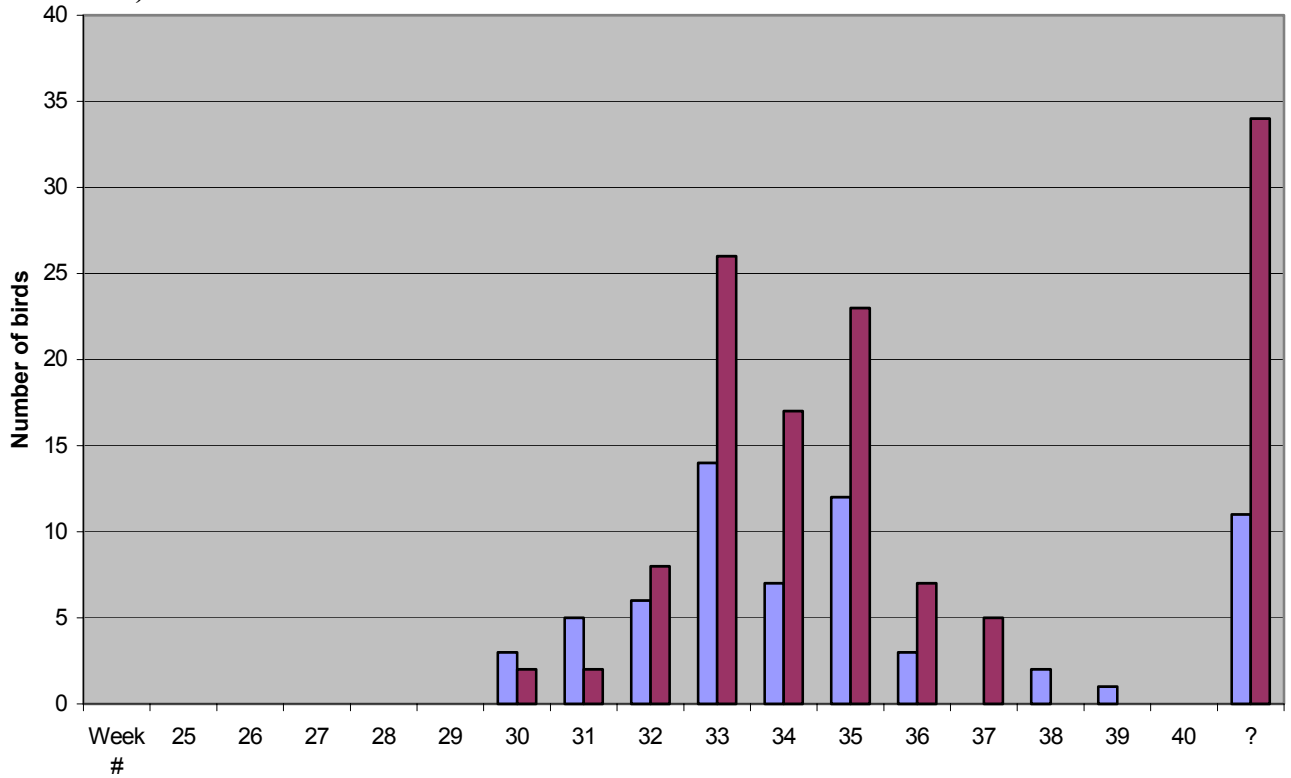




6 a) Boreal



6b) Parkland





6c) Grassland

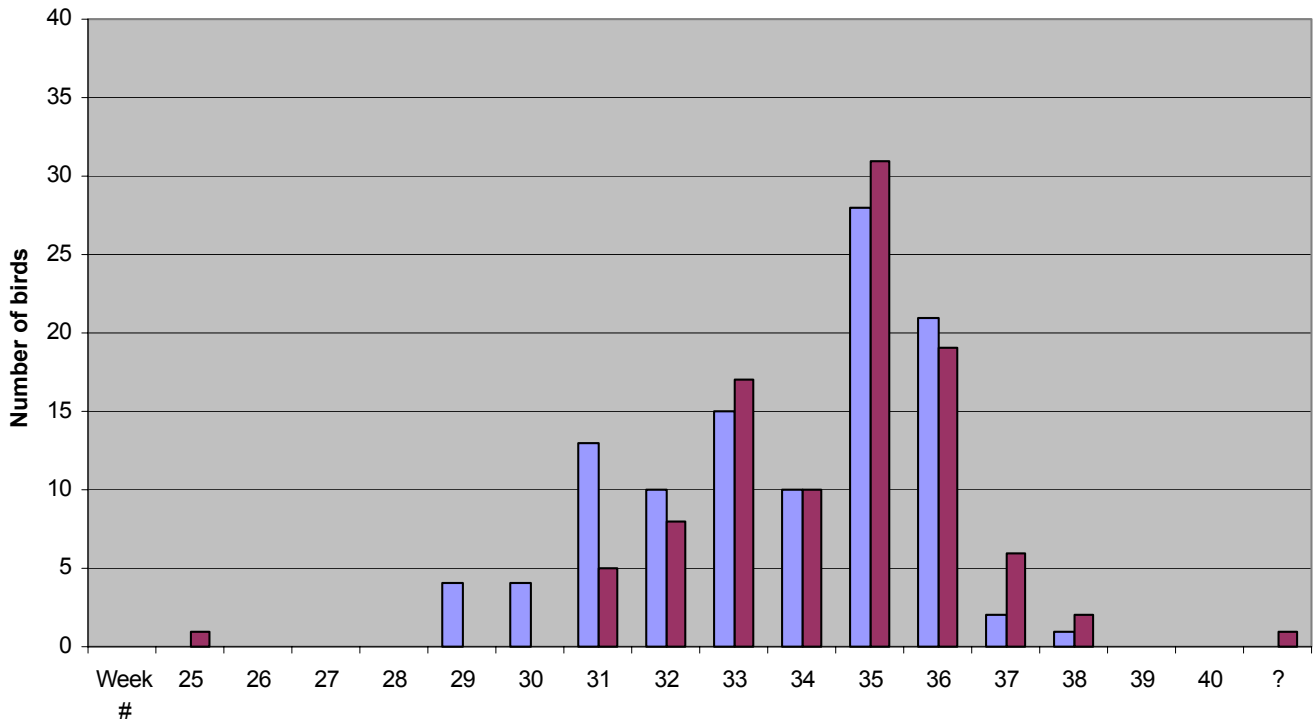


Figure 6. Weekly collection of WNv-positive crows ● and magpies ● in three natural regions of Alberta in 2003: a) Boreal, b) Parkland, c) Grassland Natural Regions.

