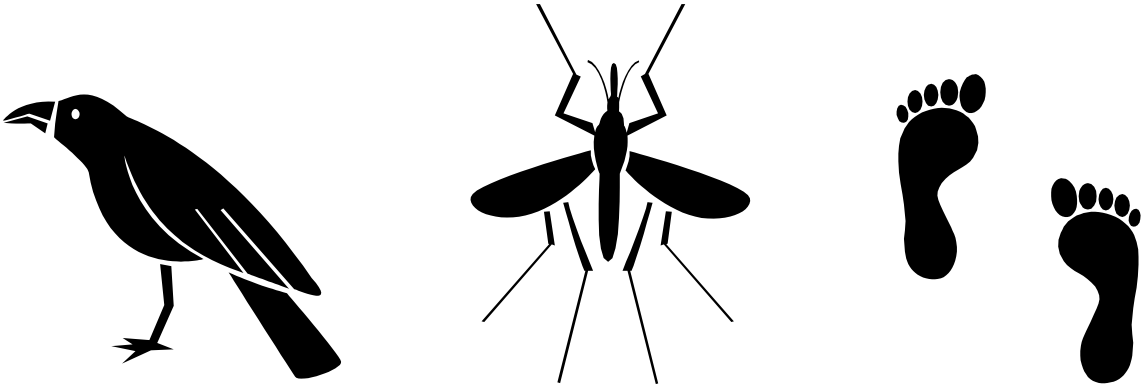
West Nile Virus Activity in British Columbia: 2006 Surveillance Program Results



Executive Summary

In 2006, endemic West Nile Virus (WNv) activity was noted in central and western Canada including Ontario, Quebec, Manitoba, Saskatchewan, and Alberta and in states bordering British Columbia (Montana, Idaho and Washington State) (Appendix 1). 2006 is the first year that viral activity levels diverged between Canada and the United States. While Canada reported fewer human cases this year compared with last, the US saw an increase of 37%. Surveillance indicators appeared earlier this year in both Oregon and Washington State, contributing to the greatest number of WNv infections detected there since the advent of WNv surveillance.

Table 1: Human WNv infections in North America, 2003-2006.

	2003	**2004**	**2005**	**2006**
Canada	1388	20	239	127
United States	9862	2344	2949	4052

Sources: Public Health Agency of Canada and US CDC as of Dec 11, 2006

South of the 60th parallel, British Columbia (BC) remains the only area of western North America without evidence of infection in avian, mosquito or human populations. ***Despite an intensive surveillance program, no evidence of West Nile Virus infection was detected in humans, birds or mosquitoes in British Columbia during 2006.*** WNv was detected in a single horse from the northeastern part of the province; investigation indicated that the infection was acquired in the United States.

Far fewer people were tested in BC for WNv in 2006 compared with 2005, both for symptomatic illness and through blood donations. CBS continues to screen all blood donors for WNv.

Annual corvid collections have steadily decreased over the last four years as have reports of dead corvid sightings collected via an on-line reporting tool. Decreases occurred in the absence of virus in the province, likely signaling a waning of public interest in the program. Corvid collections were sparse in some areas along the US border despite increased WNv activity in Washington State, northwestern Montana and the panhandle of Idaho. On average, 15/16 Health Service Delivery Areas (HSDAs) received corvid test results within one week of identifying a dead corvid (based on median lag times in collection, shipping and laboratory testing).

In contrast to the hot/dry summers of 2003 and 2004, mosquitoes have been more abundant over the last two years in response to more normal temperatures and precipitation. The geographic coverage of traps has increased steadily since 2003 and their strategic placement in mosquito rich environments has improved, reducing the number of low yield traps and providing better capture of high risk species. In 2006, 394,047 mosquitoes were trapped from 148 registered locations across the province.

Cx. tarsalis numbers more than doubled this year in most regions of the province with significant populations. Heavy localized spring rainfall contributed to increased populations of *Aedes* along major rivers and regions of the Interior; *Aedes* populations peaked earlier this year (June) compared with 2005 (August). When CO_2 was used as an attractant average trap counts for *Cx. tarsalis* were almost 5-times higher. The longer lag times for mosquito submissions that occurred in September over past few years was corrected this year, likely reflecting better coverage of seasonal staff and vacation periods. The combined median turn around time from collection of a sample in the field to receipt of mosquito test results was 6 days.

Significant contingency planning occurred during 2006 for adulticide events, should they ever be considered necessary. This included GIS analyses of the timing and effectiveness of alternate methods of pesticide application (ground Ultra Low Volume vs. aerial), a logistic review of available equipment and purchase of additional units, and a table-top exercise led by Fraser Health Authority.

Table of Contents

Tables

Figures

Appendices

Summary of Surveillance Activities

During 2006, surveillance activities for West Nile virus (WNv) focused on three target groups – humans, dead corvids and mosquitoes. The objectives for WNv surveillance were two-fold:

1. To monitor WNv activity in various species in British Columbia in order to:
   A) Predict increased risk to human health
   B) Inform public health decisions
   C) Guide communication strategies
   D) Monitor the effectiveness of control measures

2. To optimize mosquito control decision-making by identifying:
   A) The geographic and temporal distribution of potential vector species in BC
   B) Mosquito breeding sites

Human surveillance involved several stakeholders including BCCDC Epidemiology and Laboratory Services, the Canadian Blood Services (CBS) and the BC Transplant Society. Physician requests for West Nile testing received by BCCDC labs were tracked. Data sharing protocols with Canadian Blood Services were developed to ensure prompt deferral of blood collected from suspected WNv-infected persons and to allow BCCDC to monitor asymptomatic infections identified through screening of the blood supply. From May-November, all organs intended for transplant were screened by BCCDC labs prior to transplantation. In the low risk period (December through April) only organs from donors with a travel risk were screened.

Although no probable cases were identified in 2006, had they been identified, this information would have been communicated to the requesting physician as well as to public health to enable administration of a case questionnaire to collect information on symptoms, travel history, and likely mode of transmission. Cases would be classified as a case of West Nile non-Neurological Syndrome (WNnon-NS) or West Nile Neurological Syndrome (WNNS) according to self-reported symptoms as well as clinical information collected from the patient's physician. Cases would be further categorized as probable or confirmed depending on the level of specificity associated with the laboratory test performed. Case definitions can be found in Appendix 2.

The human testing algorithm used in 2006 entailed screening acute serum samples for Flavivirus EIA -IgM. Convalescent sera were requested and tested in parallel with the acute sample for both IgM and IgG. Hemagluttinin Inhibition testing was performed on both positive IgM and/or IgG samples as required. All possible and probable positive cases were referred to the National Microbiology Laboratory (Winnipeg) for the confirmatory PRNT assay. Cerebral spinal fluid, plasma and samples from organ transplant donors were tested by PCR. All submissions of cerebral spinal fluid from patients admitted for encephalitis/meningo encephalitis (regardless of test requested) were also tested for WNv by PCR.

Corvid surveillance was achieved through two mechanisms. A sample of dead corvids from across the province was collected each week for West Nile virus testing. Health Authorities collected birds in a number of different ways - some employed city Parks Department staff, others used the SPCA as a collection point and still others hired designated staff to respond to public calls and collect birds for testing. This testing was performed at the Animal Health Centre, Animal Health Branch, BCMAL in Abbotsford using a commercially available dipstick test (VEC test). In addition to birds tested, an on-line form was available at the BCCDC website (http://westnile.bccdc.org/) for the public to report sightings of dead corvids. With few exceptions, dead corvids sighted by the public and reported through the on-line form were different from those picked up for testing. The locations of birds tested and reported on-line were used to create corvid density maps for regions of the province with sufficient data. These will be used as baseline values against which to assess excess corvid mortality in future years, a potential indicator that virus has been introduced into an area.

During 2006, mosquito surveillance focused on the identification and distribution of adult mosquitoes. From June 1 to October 28, 124 traps collected mosquitoes weekly from 148 registered permanent locations. Some traps were operated in more than one location on two different days of the week. Traps were run overnight and the catches sent in coolers to BCCDC for identification and WNv testing. The BCCDC laboratory separated them into sex and taxonomic groupings: 1) *Aedes,* 2) *Anopheles,* 3) *Coquilletidia,* 4) *Culiseta* and 5) *Culex*. Mosquitoes were sorted on a chill table (to prevent denaturation of any viral RNA) and identified to genus or, in the case of *Culex*, to species. If mosquitoes were not trapped for any reason, the information (i.e. trap malfunctioned, no mosquitoes trapped or trap was not run) was faxed to the lab and recorded. Beginning in 2006, only female *Culex* mosquitoes were tested for the virus in groups of up to 50 mosquitoes/pool by PCR. The remaining mosquitoes were identified but not tested. When traps contained more than 500 mosquitoes, the entire sample was sorted to selectively pick out all the female Culex mosquitoes for PCR testing. 500 mosquitoes from large volume traps were initially identified and reported; the remainder was saved for identification at the end of the season. A fraction of the remainder (1/2, ¼, 1/8, etc.) was identified and the total number for each genus in the trap extrapolated.

In 2006, ongoing, prospective, cumulative temperature degree-day maps were developed to help forecast higher risk areas for WNv. Degree day assessments can assist in predicting the number of generations of mosquitoes expected in a given area.

Mosquito, bird, geographic and temperature data were integrated using an interactive on-line mapping tool. This was developed to assist users with geo-spatial risk assessment to help target appropriate mosquito control activities. Larval data, collected by independent mosquito control contractors was included in this mapping tool in 2006 for use by health authorities when making mosquito control decisions. Unlike adult surveillance data, larval data is not available to the public and viewing is limited to personnel in the region where the data has been collected.

Those involved in WNv surveillance and control activities included BCCDC epidemiology and Laboratories, Canadian Blood Services staff, BCMAL staff, Regional Health Authority staff, municipalities and regional government staff, mosquito experts from BCCDC, mosquito control contractors and academic centres, wildlife biologists, and communications personnel. All were included in bi-weekly teleconferences to discuss emerging surveillance issues. Surveillance results from BC, across Canada and the United States were summarized in a weekly surveillance report distributed to BC stakeholders, including members of the surveillance group, infectious disease physicians, medical microbiologists and those involved in the provision of blood products and transfusion services.

Surveillance Results

Results at a Glance

Table 2: Summary of BC surveillance statistics, 2006

	Human[1]	Corvids Submitted[2]	Corvids Sighted[2]	Mosquito Pools[3]
# Tested	239	803	605	2329
# Positive	0	0		0

1. Human suveillance started on June 1st.
2. Bird suveillance started on May 1st.
3. Mosquito suveillance started on June 1st. A pool may contain up to 50 mosquitoes that are tested at one time.

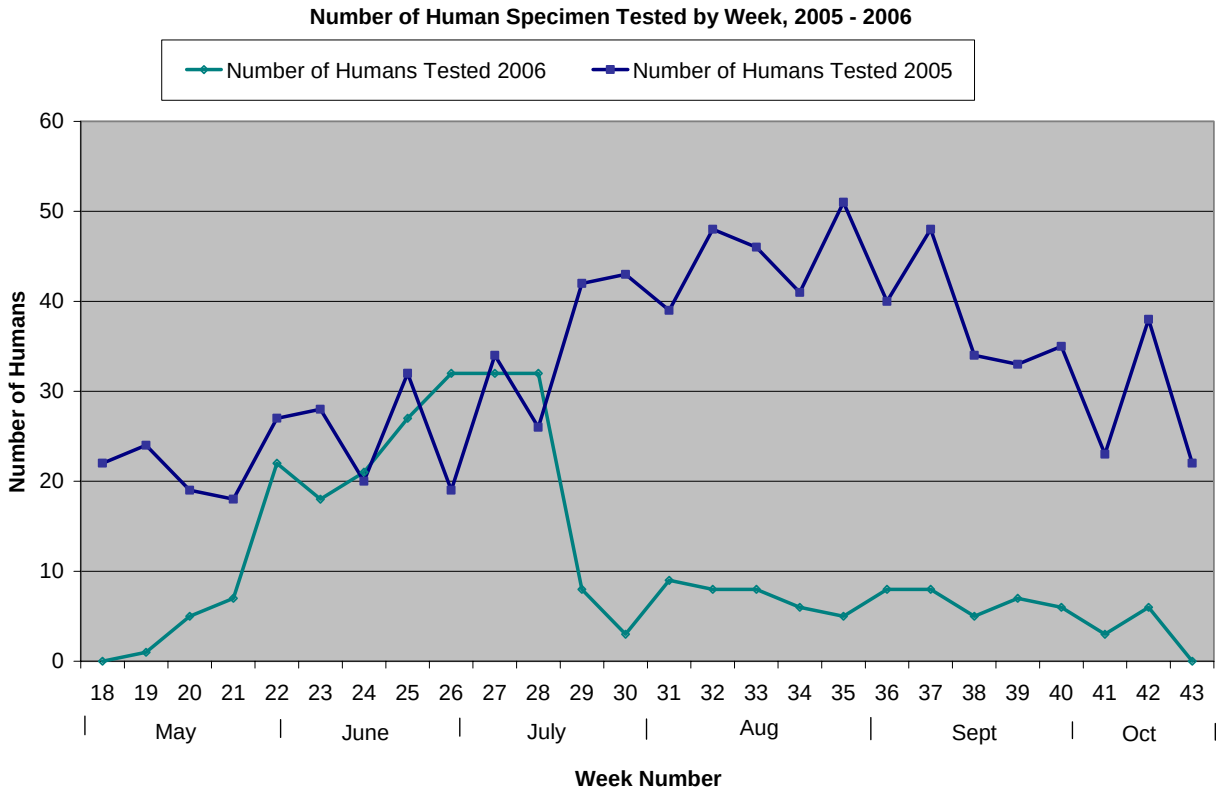
Surveillance of WNv in Humans

Laboratory Testing at BCCDC

From June 1 to October 31, IgG, IgM EIA and PCR tests were performed on 239 unique patients. This is dramatically less than 2005 when 755 individuals were tested over a similar time frame (testing was longer in 2005 by 1 month). No locally-acquired or travel-related WNv infections were identified. From June 1, 2006 to November 30, 2006, 127 cryopreservation/stem cell samples, 120 bone donor, 21 bone marrow donor, 45 living organ donor and 17 deceased organ donor samples were tested for West Nile Virus. None were positive.

The number of human specimens tested increased from mid-May to the end of July but dropped significantly during August and September, the period corresponding to the greatest risk of human infection in endemic areas (Figure 1). This is dramatically different from last year when tests were consistently high from mid-July to mid-September. This drop in testing likely reflects a decreased perceived risk of infection given that WNv was not detected in early 2006.

Figure 1: Number of Human specimens Tested for WNV by Week, 2006



Protecting the Blood Supply from West Nile Virus

During the 2006 provincial WNv surveillance season, 4 July-31 Oct, CBS tested 37,799 donations for WNv. As in previous years, there was no confirmed positive WNv donation in British Columbia.

Recapping the Year

Canadian Blood Services (CBS) continues testing every donation for West Nile virus (WNv) using an investigational WNv Nucleic Acid Test (WNv-NAT). During 2006, as in previous years, there was no confirmed positive WNv donation in British Columbia. Nationally, CBS detected WNv in 8 asymptomatic donors (at the time of collection) during 2006, representing 5.9% of the 135 cases reported in Canada (including127 cases of WNv infection reported to the Public Health Agency of Canada) this year (PHAC, 2006). This proportion of WNv-positive blood donors among reported cases is significantly biased by the fact that CBS tests all donors whereas only symptomatic, test-positive WNv cases would otherwise be reported to Public Health. All 8 WNv-infected donations were collected from the Prairies – 5 from southern Manitoba, 1 from Saskatoon and 2 from southern Alberta. Monitoring of out-of-province WNv activity is relevant to blood safety in BC because blood products from other provinces – particularly Alberta and Saskatchewan - are routinely imported into BC. Across Canada, positive donors were detected between 1 to 23 August 2006, consistent with

previous years' experience that mid-to-late summer is the period of highest WNv risk to the blood supply. As in the previous 3 years, no case of transfusion-transmitted (TT)-WNv was reported in Canada in 2006.

Minipool and Single Unit WNv Testing of Donors

CBS routinely performs WNv-NAT in minipools (MP) of 6 specimens. Single unit (SU) WNv-NAT is selectively used during WNv season since SU testing is more sensitive than MP testing in detecting early, seronegative, viremic infections that pose the highest risk of TT-WNv (Busch, 2005). For the 2006 WNv season, CBS utilized 2 criteria for implementing SU testing: either a positive donor test result or an incidence of public health-reported symptomatic WNv in a health region over a 2 week period exceeding either 1:1000 in rural areas or 1:2500 in urban settings (based on weekly CBS review of current, available human WNv surveillance data). SU testing was implemented for a minimum one week period for all donor clinics in the affected region and within geographic proximity (usually 100 km); SU testing was discontinued if neither criterion was met over the ensuing one week period.

Of the 8 positive donations detected by CBS in 2006, 4 were detected by MP testing and 4 by SU testing; all 8 units were also positive by supplementary single specimen NAT testing using an alternative commercial WNv-NAT assay. Follow-up WNv serology was available for 5 donors, who tested IgM reactive, confirming acute infection and suggesting that their donations were more likely to have been infectious (Busch, 2005). Laboratory follow-up of the 4 donations detected by SU testing will assess whether these infectious units would have been identified through MP testing.

Integrated WNv Surveillance

In BC, CBS, the BC Centre for Disease Control (BCCDC) and BC Ministry of Health (MoH) continued their close co-operation in WNv planning, preparation and surveillance. Between 31 July to 6 October 2006, BCCDC provided daily reports to CBS BC and Yukon Centre on WNv test requests; the initial BCCDC report included test records from 1 June-31 July 2006. This enabled rapid identification of donors who may have recently donated potentially WNv infectious blood, so that a product recall could be carried out as quickly as possible and, to defer donors for a 56 day period to prevent affected donors from donating while potentially infectious. A total of 625 reports were received by CBS, of which 37 (5.9%) were donors – a proportion similar to previous years. Two of the 37 donors had recently donated blood and a recall of in-date products was carried out.

Anonymized Data Linkage Project

An aim of this project, using WNv as a sentinel blood-borne pathogen, is to demonstrate that timely, accurate, secure data linkage can be performed between the BCCDC laboratory and CBS donor databases to identify potential hazards to blood safety while simultaneously protecting patient confidentiality. This year, further "tuning" of the ADL matching algorithm was carried out to optimize its sensitivity and specificity, by retrospectively matching WNv test data from BCCDC against the national CBS donor database. Interestingly, the ADL algorithm retrospectively identified 4 matches that

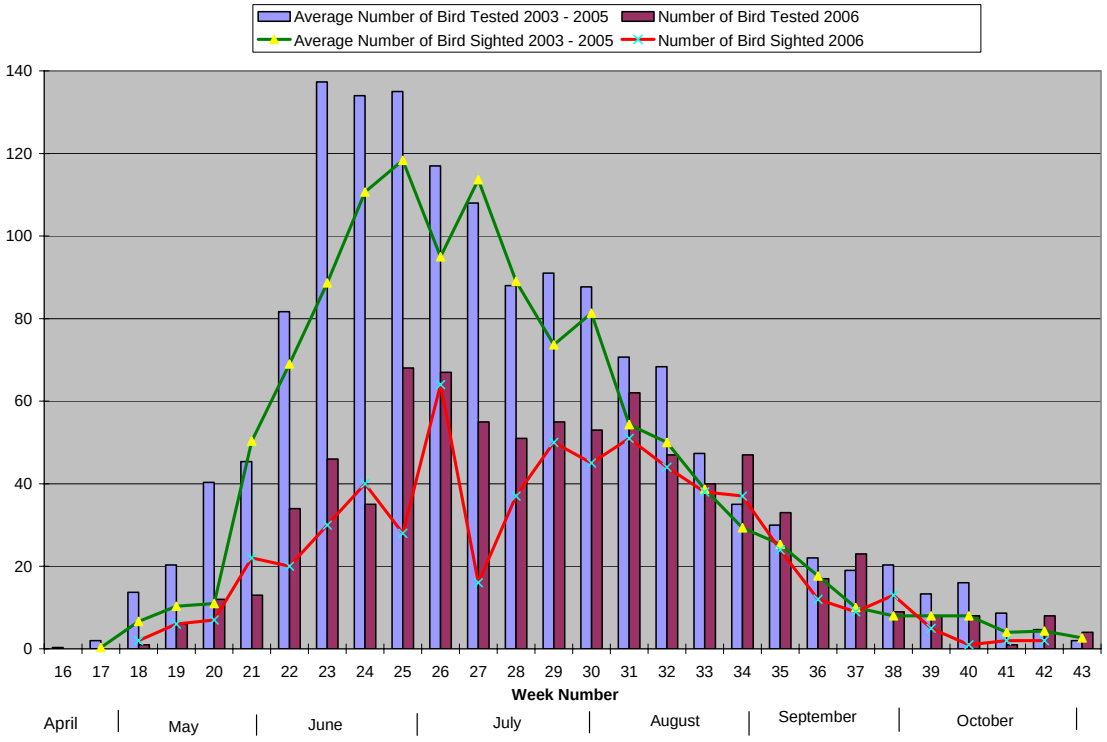
were not initially made by manual checking (due to discordant demographic data between databases), exemplifying the potential benefits of improved timeliness and accuracy of data linkage envisioned in the project. For 2007, ADL matching is planned to be performed in “real time” on a daily basis to further validate the process.

Surveillance of WNv in Corvids

Reporting of Corvid Deaths

Overall, 803 corvids were collected and tested from May 1 to October 31, 2006 (Figure 2). Annual corvid collections have steadily decreased over the last four years; collections dropped 23.6% from 2003 to 2004, 26.4% from 2004 to 2005 and 24.1% from 2005 to 2006. A similar decrease was noted in provincial dead corvid sightings collected via an on-line reporting tool (Figure 2). Decreases in corvid sightings and collections occurred in the absence of virus in the province, likely signaling a waning of public interest in the program. This decrease was most apparent in June and July, coinciding with the natural fledging die-off which begins when juveniles leave the nest in late may and peaks in mid-June. Therefore, although fewer corvids were collected during this time, deaths in this period are more likely the result of natural mortality. The provincial distribution of deaths as recorded by the public closely mirrors the weekly distribution of specimens collected for testing.

Figure 2: Comparison of Birds Sighted and Tested, 2003-2006

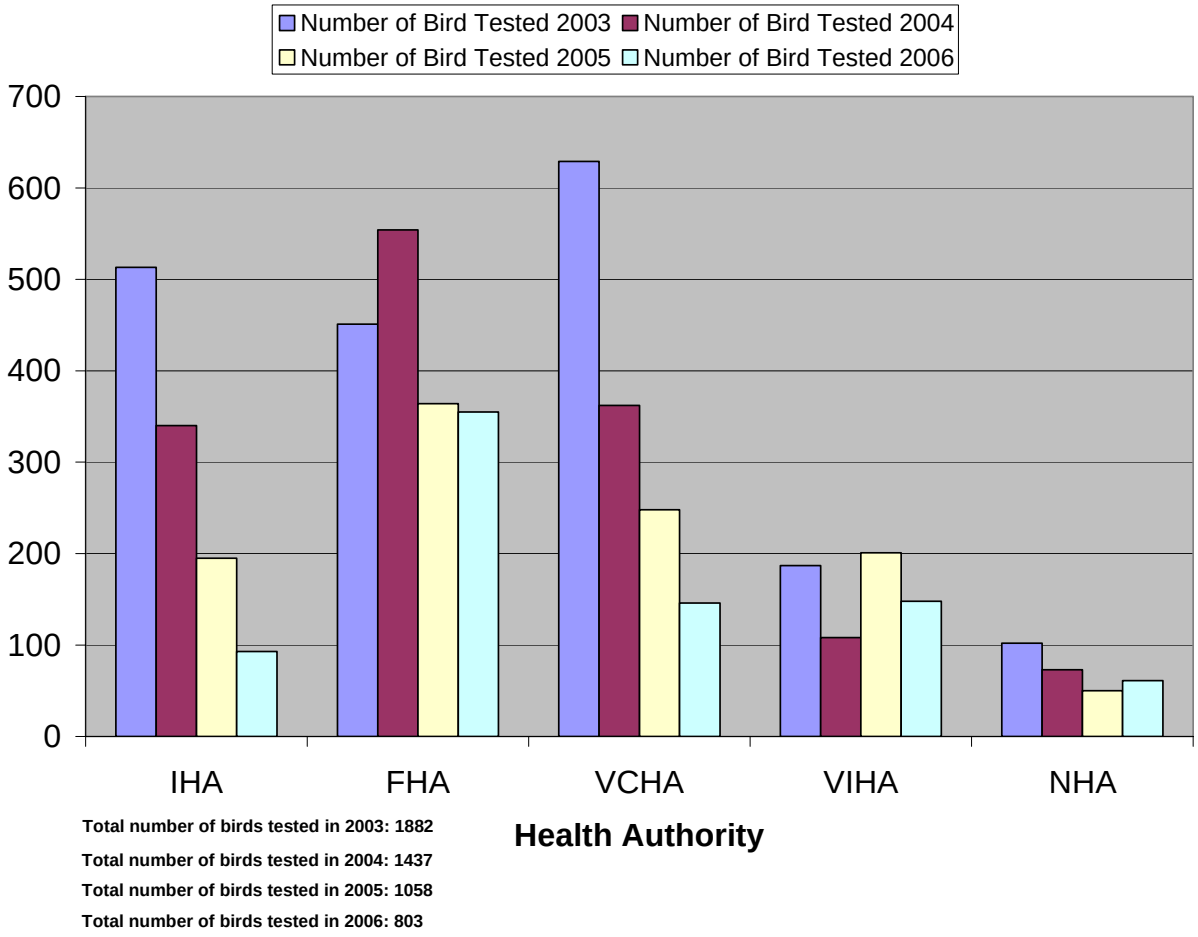


Average number of birds sighted in 2003 - 2005: 1178
Total number of birds sighted in 2006: 605

Average number of birds tested in 2003 - 2005: 1459
Total number of birds tested in 2006: 803

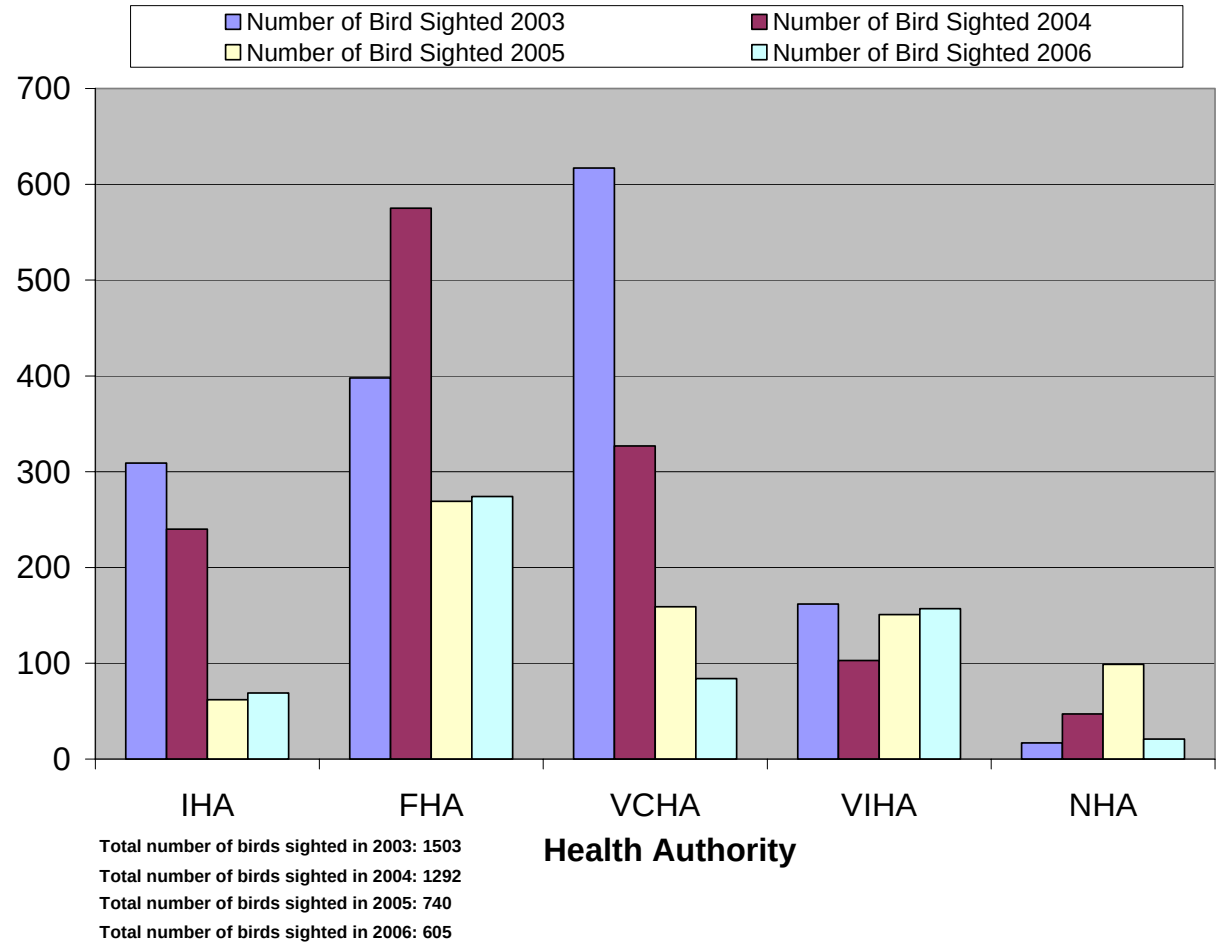
The decline in the number corvids tested from year to year is most notable in Interior Health, an area with sparse population in some areas which makes corvid collections challenging (Figure 3). At the same time, this region has been identified as the highest risk region of the province. Fraser Health has been relatively consistent in their corvid testing practices over time, while a decrease comparable to IHA has occurred in neighbouring VCH (Figure 3).

Figure 3: Comparison of Birds Tested by HA, 2003 - 2006



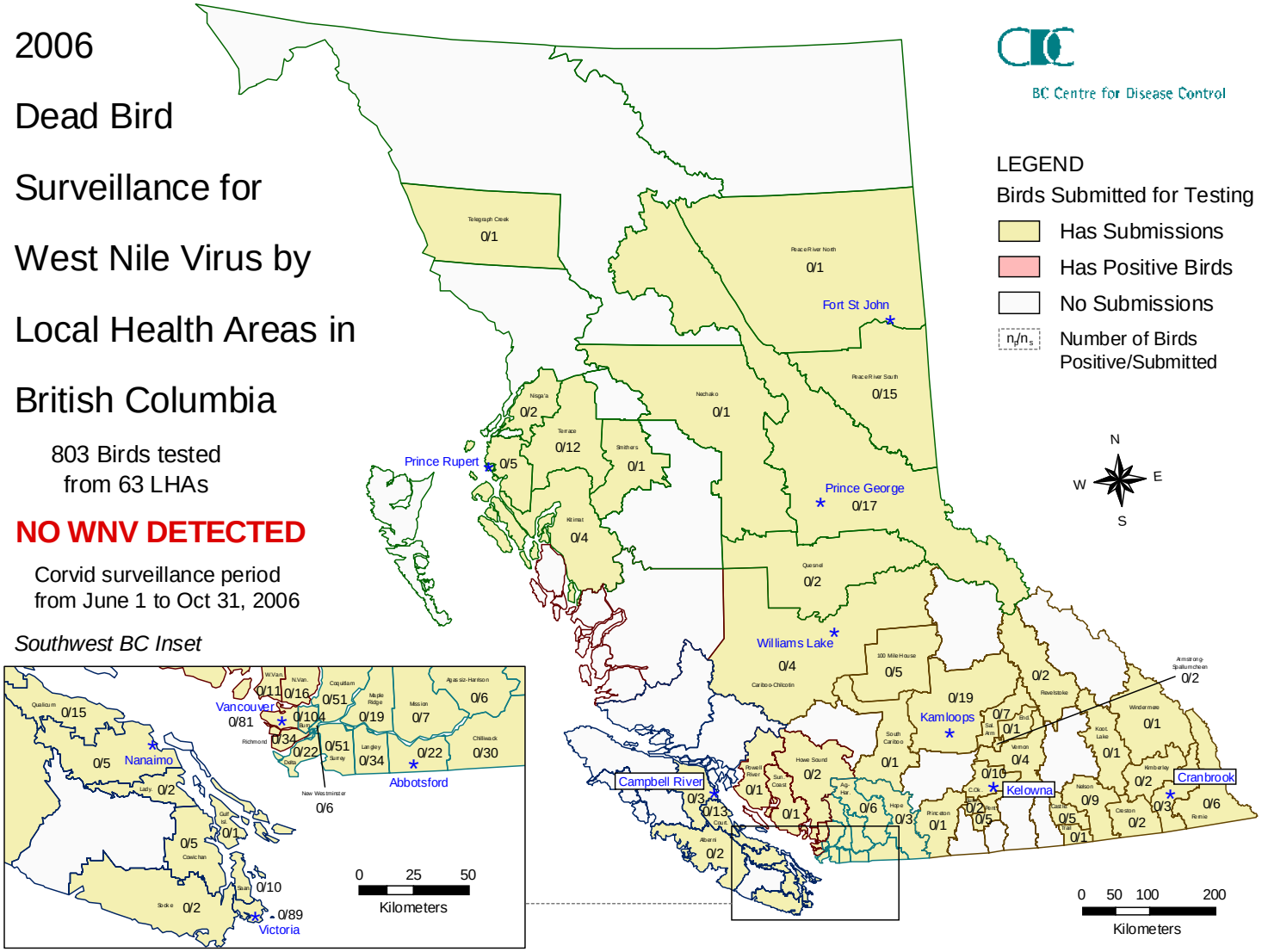
Similar decreases in use of the on-line reporting form from year to year are apparent in all HAs, except in VIHA where the public have been consistent in their use of the form (Figure 4). Differences in use likely stem from regional differences in public promotion of this tool.

Figure 4: Change in Number of Corvid Sightings Reported On-line, 2003 - 2006.



Spatial representation of dead corvid submissions was patchy in 2006 (Figure 5). The most notable gaps occurred in Southern LHAs along the US border. Given that WNv activity was detected in 2006 in Washington State, northwestern Montana and the panhandle of Idaho, a concerted effort must be made next year to increase submissions from border areas early on and throughout the WNv season, since corvids are often the first indicator of virus arrival. The frequency of submissions from individual HSDAs varied over the course of the surveillance season and from year to year (Appendix 3).

Figure 5: Geographic Distribution of Corvid Test Results, 2006



Bird Species Breakdown by Region

Over 90% of all corvid submissions in 2006 were American Crows (*Corvus brachyrhynchos*). The second most commonly submitted bird was the Common Raven (*Corvus corax*), which made up a significant proportion of dead bird submissions from eastern regions, central and north Vancouver Island – the NE (19%), the KB (24%), the CVI (17%) and NVI (38%). The species composition of dead bird submissions has remained static from 2003 to 2006.

Figure 6: Proportion of Total Corvids Tested by Species, 2006

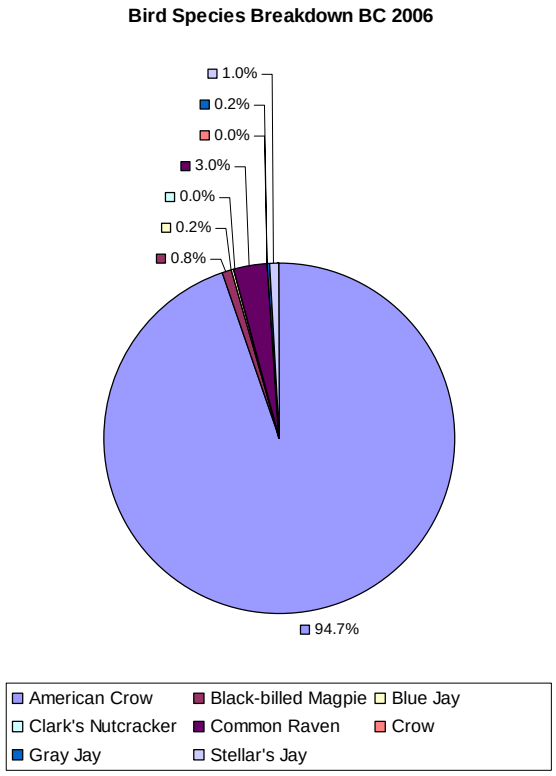
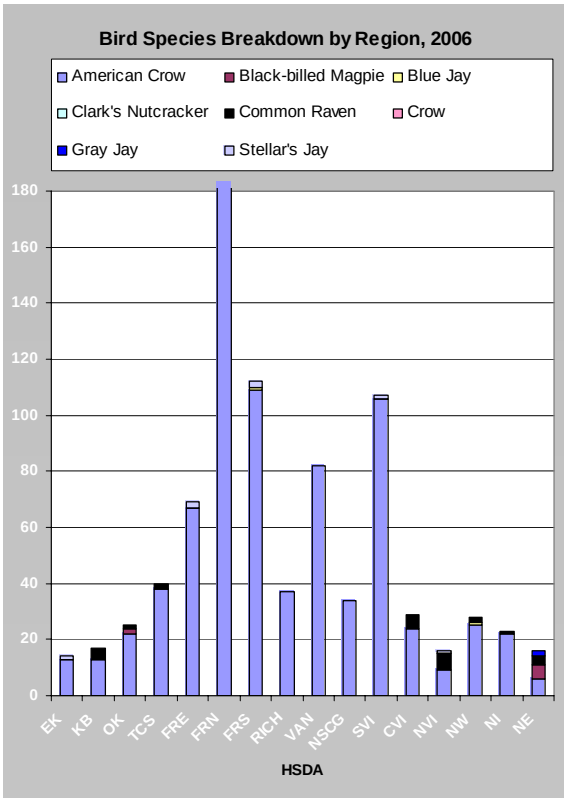


Figure 7: Corvid Species Submitted for Testing, 2006



Appropriateness of Specimens Submitted

Sometimes, corvid specimens can arrive at the laboratory in a state unsuitable for testing. This can occur for a variety of reasons including desiccation, decomposition and the submission of headless birds (which are unable to be swabbed), among others. 96% (803/835) of all corvids submitted in 2006 were suitable for testing, which does not represent a significant change from 2005 (p=0.16) (Table 3). While the absolute changes were very small, the most notable decreases in specimen suitability between 2005 and 2006 were observed in TCS, NVI and EK where 9.7%, 6.0% and 5.9% fewer specimens were acceptable for testing, respectively. This correlates well with increased

distances required for shipping from these locations. In general, program staff continues to maintain a high suitability of specimens based on feedback from the Animal Health Centre during bi-weekly teleconferences.

Table 3: Appropriateness of Bird Specimens Submitted for Testing by HSDA, 2003 - 2006

Comparison of Appropriateness of Bird Specimen Submitted by HSDA, 2003 - 2006

HSDA	2003	2004	2005	2006	Ratio Difference (2003 - 2004)	Ratio Difference (2004 - 2005)	Ratio Difference (2005 - 2006)
Overall %	98.51%	97.76%	94.80%	96.17%	-0.75%	-2.95%	1.36%

Unlike last year when decomposition was an issue, the most common reason that carcasses couldn't be tested in 2006 in BC was dehydration of the specimen (Table 4).

Table 4: Reasons for Which Corvids Were Not Able to be Tested, 2003 - 2006

Reasons Birds not Tested, 2003 - 2006

Reasons Not Tested	Number of Bird not Tested			
	2003	2004	2005	2006
Decomposed	2	7	34	5
Dehydrated	0	14	14	19
Missing Body Parts	2	10	10	7
Sighting	0	2	0	0
Non-Corvid	4	0	0	0
Other	21	0	0	1
Total	**29**	**33**	**58**	**32**

Lag Times for Corvid Submission and Testing

Improvement was made between 2003 and 2006 with respect to the timeliness of corvid submissions (Table 5). The elapsed time between when a corvid was found until it was received by the lab was reduced by a median of two days province-wide (from 6 days in 2003 to 4 days in 2005/2006). In 2006, improvements in median delays were most evident in TCS (3 days faster than 2005) and OK (2 days faster than 2005).

The median laboratory delay for processing and reporting corvid test results improved in 2006 compared with previous years. In half of all corvid samples, results were reported by the animal health centre the same day as samples were received.

When considering median delays in collection/shipping of specimens and time for laboratory processing, on average, all HSDAs except East Kootenay received corvid test results within a week of the date the bird was found.

Table 5: Lag Times for Submission of Corvid Specimens, 2003-2006

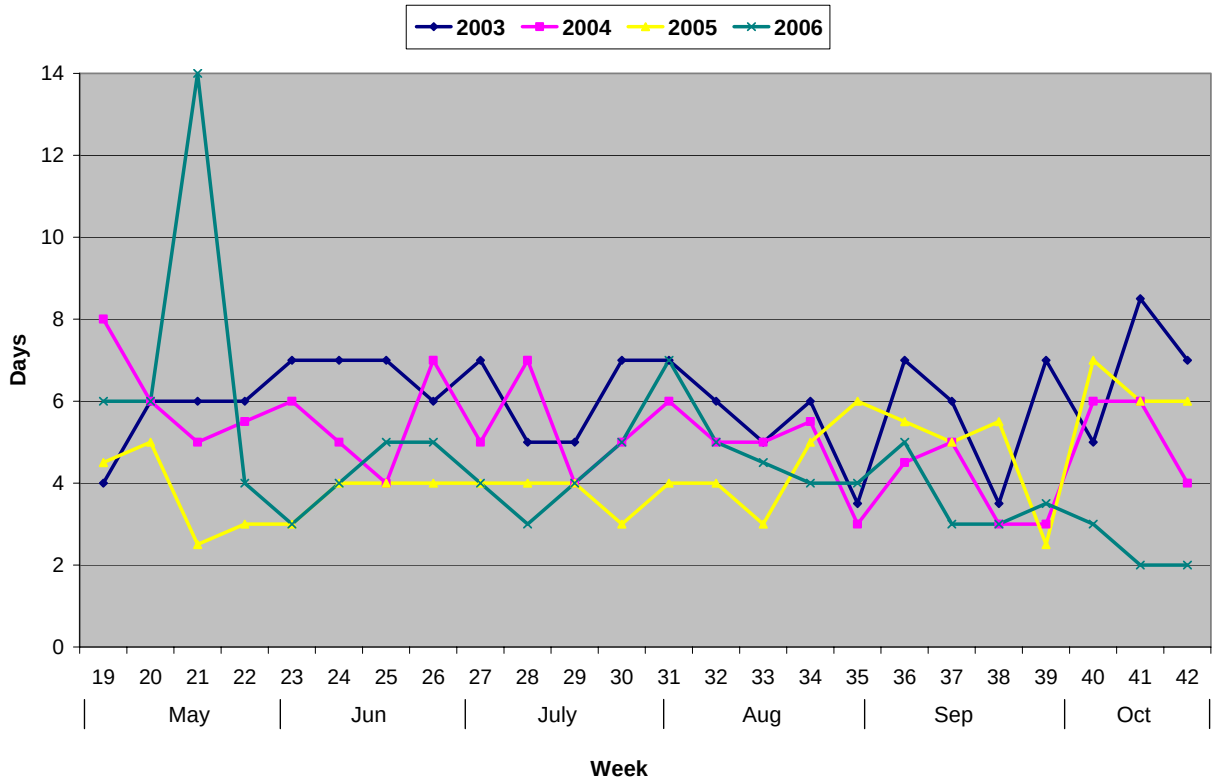
Bird Lag Time by HSDA, 2003-2006

HSDA	MedianTransit Lag Time				MaxTransitLag			
	2003	2004	2005	2006	2003	2004	2005	2006
EK	14	6	7	9	73	31	44	48
KB	6	7	5	6	35	42	14	35
OK	7	4	5	3	38	29	28	12
TCS	7	6	6	3	61	26	39	84
FRE	5	3	2	3	27	13	12	8
FRN	7	6	4	3	72	19	32	33
FRS	7	6	3	5	93	18	10	9
RICH	7	4	6	7	18	27	10	17
VAN	6	4	5	7	29	16	14	23
NSCG	5	5	4	7	32	58	46	17
SVI	4	6	3	4	18	34	32	18
CVI	5	3	4	6	39	31	14	12
NVI	7	6	5	7	22	17	12	29
NW	2	3	3	2	10	10	7	13
NI	4	4	2	5	30	13	33	20
NE	2	3	6	5	6	19	29	50
Total	**6.0**	**5.0**	**4.0**	**4.0**	**93**	**58**	**46**	**50**

Note:
- All lag times are in days.
- Transit Lag represents the number of days between when a bird is found and when it is received by Animal Health Centre (Abbotsford).

In all years, it has taken 2-3 weeks from the start of corvid collections (May 1st) for lag times to improve. However, in 2006, the median lag time for specimen submission spiked significantly for one week in mid May (Figure 8). Data suggests that this increased lag is the result of specimen batching (waiting for several birds to be collected before making a submission) from HSDAs in the lower mainland rather than long transit times from more distal HSDAs. From 2002-2005, the program suffered increased lag times for corvid submissions at the tail end of the season (October). 2006 marked significant improvements during this period. This may reflect decreased batching of samples, increased vacation/seasonal staff coverage, or a greater sense of urgency caused by late year identifications in Washington and the on-going outbreak in Idaho.

Figure 8: Median Weekly Lag Time for Submission of Corvid Specimens, 2003-2006



Density Maps of Bird Submissions and Sightings

The locations of dead birds submitted for testing and sighted by the public were mapped using a Geographic Information System (GIS). Kernel density mapping of dead corvids was performed to identify areas of concentrated bird mortality (Appendix 4). In the event of WNv activity, "hotspots" of corvid mortality may indicate localized concentration of the virus in an area. Studies from other parts of North America have shown corvid surveillance to be a reliable early warning system for WNv appearance/introduction in a region. The corvid density data collected over the last 4 years, prior to introduction of WNv, is useful for identifying areas with higher baseline bird mortality.

Recommendations for Corvid Surveillance in 2007

- In 2006, no corvids were submitted for testing from several LHAs bordering Washington State (Figure 5). Despite the fact that corvid collections from LHAs in the Okanagan and Kootenay regions of the province are meeting or exceeding expected submissions (see WNv Activity in British Columbia: 2005 Surveillance Program Results), the absolute number of specimens collected in these regions remains low, less than one corvid per week over the course of the surveillance season. **This is**

may not be sufficient for early detection of WNv's arrival in these areas. Suggestions for improving WNv dectection in these areas include:

- Increase mosquito traps in areas where corvid and human populations are sparse such as areas along the BC/US border. (note: additional traps were temporarily deployed to these locations in September 2006 due to the proximity of WNv activity in Montana and Idaho).
- Recruit sentinel communities and advocate use of the on-line form and/or active surveillance programs for dead corvids.
- Increase awareness of the corvid collection program among BC Parks personnel and wildlife conservation officers.

- Use of the on-line reporting form for dead corvids might be encouraged in areas where pick-up of birds is made more difficult by long distances.

Surveillance of WNv in Mosquitoes

Surveillance efforts in the province have focused on *Culex* species given its prevalence in BC and reports from other North American jurisdictions suggesting it as the major vector of WNv (Farnon**,** E., 2006). *Culex pipiens* was the only WNv-positive species reported in Washington State while *Culex tarsalis* was the primary infected vector reported in Idaho, Alberta and Manitoba.

In British Columbia, there were a total of 1861 submissions from mosquito traps in 2006, resulting in 2329 pools tested. A total of 394,047 mosquitoes were identified from these trap collections for a provincial average of 14.98 *Culex*/trap night.

BC surveillance data now comprises 4 years of adult mosquito surveillance. Each year we are finding new information about the distribution of species and the relative abundance of mosquitoes from year to year. This year we saw high numbers of nuisance species in the south and very little activity across the northern health authority. The central southern region of Osooyos had a record number of *Aedes* and *Culex tarsalis.*

Patterns of transmission have been difficult to predict as West Nile virus has spread westward across the North American continent since 1999 (Petersen and Hayes, 2004). California saw a dramatic extension of the virus' range in 2004 and a continued presence in 2005 and 2006 (California, 2006). Texas has seen a steady increase since 2003. The big outbreak this year was Idaho, especially Health Districts 3 and 4 in the south western portion of the state. A general spread of the virus into the Pacific Northwest included positive surveillance findings in many counties in Washington State and Oregon - the most WNv activity ever detected in these states within a single year.

New About Mosquitoes in 2006

Our planning workshop occurred in March 2006 with special presentations concerning mosquito control and WNv activity in Manitoba and Saskatchewan. Based on surveillance data from previous years, we reduced the window of mosquito surveillance from the beginning of May to the beginning of June and tested only *Culex* for the virus.

In 2005, a new biological control agent (*Bacillus sphaericus*) became available for controlling mosquito larvae in Canada. Many regions felt this offered an alternative to using chemical agents in catch basin habitat that produce *Culex pipiens*. Unfortunately this product was only given a renewable 1 year product label because the Pest Management Regulatory Agency (PMRA) could not guarantee efficacy after storage beyond this period of time (PMRA, 2006). This created a problem for municipalities trying to balance funding and viable product availability. Despite this uncertainty, in 2006, *B. sphaericus* was adopted as the larvicide of choice for catch basin use in almost all regions.

In 2006, information on larval surveillance and larviciding activities being conducted across the province by private mosquito control contractors was shared with BCCDC. This information was summarized and presented as aggregate trend analyses in this report.

Trap Coverage

Figure 9 depicts the locations of adult mosquito traps in 2006. Since adult mosquito surveillance began in 2003, the geographic coverage of traps has increased and the strategic placement of traps in mosquito rich environments has improved, reducing the number of low yield traps and providing better capture of high risk species (Table 6). Most major centers have traps located nearby providing a good baseline to assess risk in populated areas. The number of traps operated in 2006 decreased relative to 2005 since Health Canada began processing their own samples from First Nation lands. The number of pools in 2006 tested for WNv decreased due to a change in testing policy that restricted testing to *Culex* pools only. In response to positive surveillance findings in Montana counties bordering the East Kootenays, 2 additional traps were placed along the border in Elko and Grassmere, BC during September and October 2006.

Table 6: Change in Mosquito Trap Coverage, 2003-2006.

	2003	**2004**	**2005**	**2006**
# Traps operated	49	88	139	124
# Permanent locations	59	145	189	148
# Mosquitoes	6,840	52,657	198,228	394,047
# Pools tested	2,96	2,980	6,631	2,329*
Ave # C. tarsalis	0.3	0.8	1.9	4.8
Ave # C. pipiens	1.5	4.6	5.1	8.6

Geographic Distribution of Species

Figure 10 illustrates the distribution of 394,047 mosquitoes collected in 2006.

Culex pipiens

Generally *Culex pipiens* is only found north of the 39th degree N latitude (Savage and Miller, 1995). Between 36 and 39 degrees N. latitudes, *Cx. pipiens, Cx. quinquefasciatus*, and hybrids are encountered. In 2006 the largest numbers of *Cx. pipiens* were generally found in the highly urbanized areas, particularly the Fraser River Lower Mainland and south/central Vancouver Island. This species is found throughout the Interior Health Authority but the numbers were not as high in less urbanized EK, and KB (Figure 10). Only a few specimens (n=105) were collected as far north as Terrace and Vanderhoof.

Culex tarsalis

Culex tarsalis is the primary vector species of WNv in the prairie provinces of Canada and the central US, and Montana south of BC, therefore an understanding of where this species is found in BC is of major concern. ***Cx. tarsalis numbers were more than double this year in most regions of the province that have significant populations, only TCS and NSCG had slightly more of this species in 2005.*** Vancouver and South Vancouver Island collected only a few specimens and no *Cx. tarsalis* was identified in Northern Health regions.

Culex territans

Culex territans was found in small numbers across the province. This species is found more often in surveillance of larvae so baited light traps might not be effective in collecting this mosquito. The females seek a blood meal from cold blooded animals such as amphibians or reptiles, so it is not considered an important vector for West Nile virus.

Coquilletidia perturbans

Unlike other mosquitoes, *Coquilletidia perturbans* over-winter as larvae and live below the surface of the water by extracting oxygen from the stem of emergent littoral plants such as cattails. Traps placed near large stands of cattails catch the greatest number. This species emerged from the littoral zone by the middle of June, for most regions across the province (Figure 13 or Table 11). The adult population peaked slightly later this year in week 30 compared to week 28-29 in 2005 (Figure 14). They are recorded as having one generation per year (Belton, 1983) and adults were collected from the beginning of June up until the middle of August across the province. Crans (2004) noted that adult emergence appears to occur in broods over the course of the summer but this actually represents cohorts of larvae that passed the winter in different instars of larvae and so consequently take different lengths of time to emerge the following year.

Aedes species

Aedes are typically the most abundant mosquitoes in Canada and they have a reputation as nuisance pests, especially when flooding occurs. Mosquito abatement programs found in populated regions along major drainages offer the best surveillance of WNv and mosquitoes. In BC the largest abatement programs are along the Fraser River and its major tributaries (Fraser Valley Regional District, Thompson Nicola Regional District and Prince George). Similar programs exist in Idaho along the Snake River, and Washington along the Columbia River.

This year, the mid and southern Fraser basin recorded its highest river levels in 4 years. This produced large *Aedes* populations for abatement programs in 2006. Unlike 2005, when the peak was much later in the summer (August), the *Aedes* population peaked this year in the spring after the freshet[1] (Figure 13;Figure 14). Lower river levels in upper Fraser did not produce as many nuisance species for the Northern Interior HA.

Rivers are characterized by different magnitudes of discharge and flooding and these vary from year to year. Event magnitude is typically characterized by its likelihood of occurrence within a specific time span – the greater the magnitude, and thus the more rare an event, the longer time interval is expected to pass before an event of similar magnitude is seen. Snowmelt and wet weather produced high flows in 2006 (similar levels expected every 2-10 years) in small and mid-sized rivers throughout much of the southern interior (Kootenay, Columbia, Okanagan and South Thompson). Significant flooding (similar levels expected every 25-50 years) was concentrated in the Grand Forks - Slocan - Nelson area of the Boundary and West Kootenay. Mission Creek at Kelowna experienced a 30-year return period high flow on June 15, following an intense convective rain storm centered over the upper watershed (Ministry of Environment (MoE), 2006). The discharge from rivers and accumulation of precipitation was sufficient to generate a significant hatch of *Aedes* mosquitoes in 2006. We saw the greatest increase in *Aedes* in the Okanagan HA with numbers reaching over 200,000 in baited light trap collections (Figure 10). *Aedes vexans* is commonly called the floodwater mosquito because they produce large numbers during years of flooding.

Other Mosquito Species

Anopheles is the primary vector for malaria but can also act as a bridging species for WNv. The largest numbers were collected at Koocanusa, Cranbrook, Creston, Osoyoos, Vaseaux Lake and Nanaimo. Although not abundant across the province this may be important locally where these *Anopheles* species are found.

[1] a sudden rise in the level of a stream, or a flood, caused by heavy rains or the rapid melting of snow and ice

Figure 9: Geographic Distribution of Mosquito Traps in BC, 2006

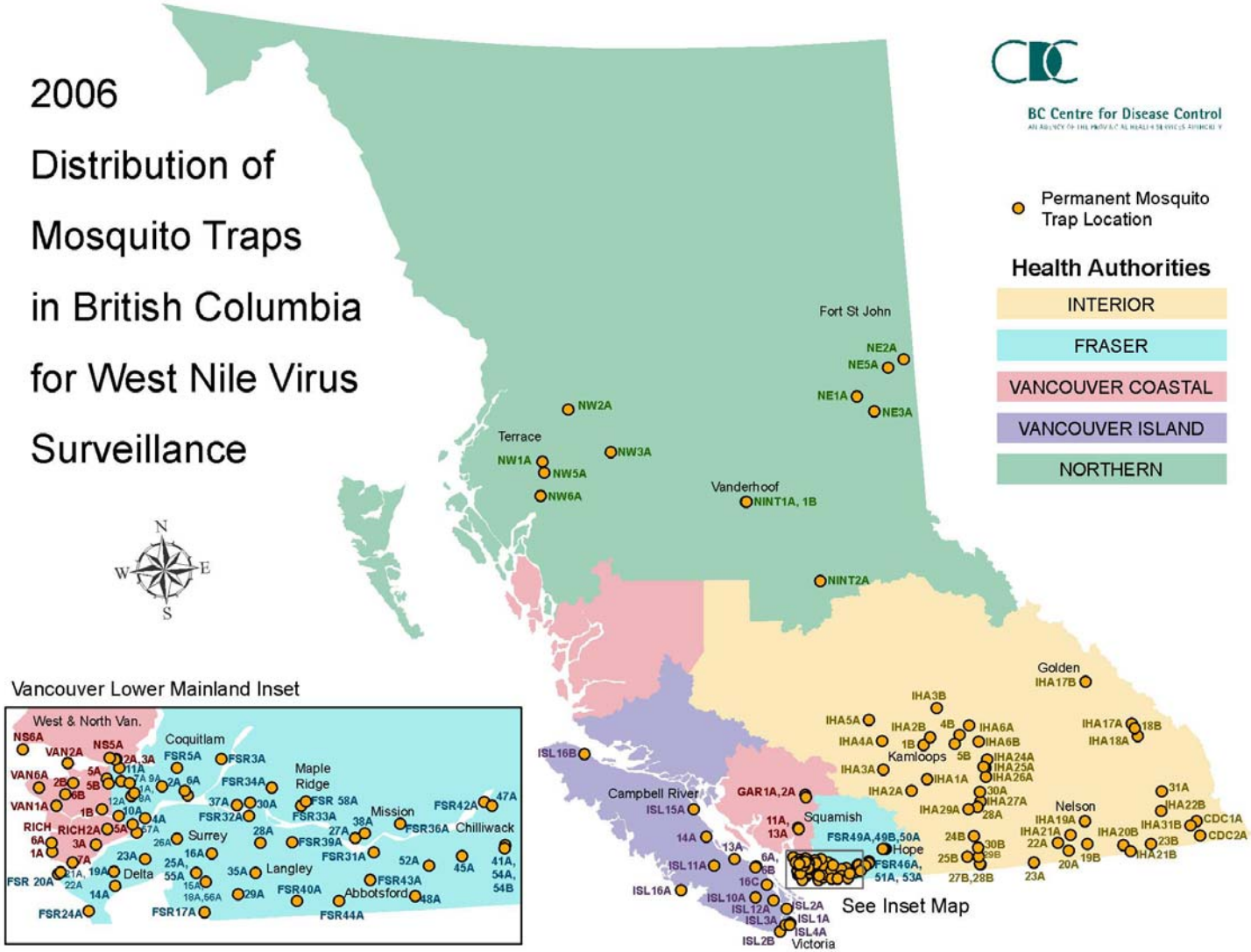
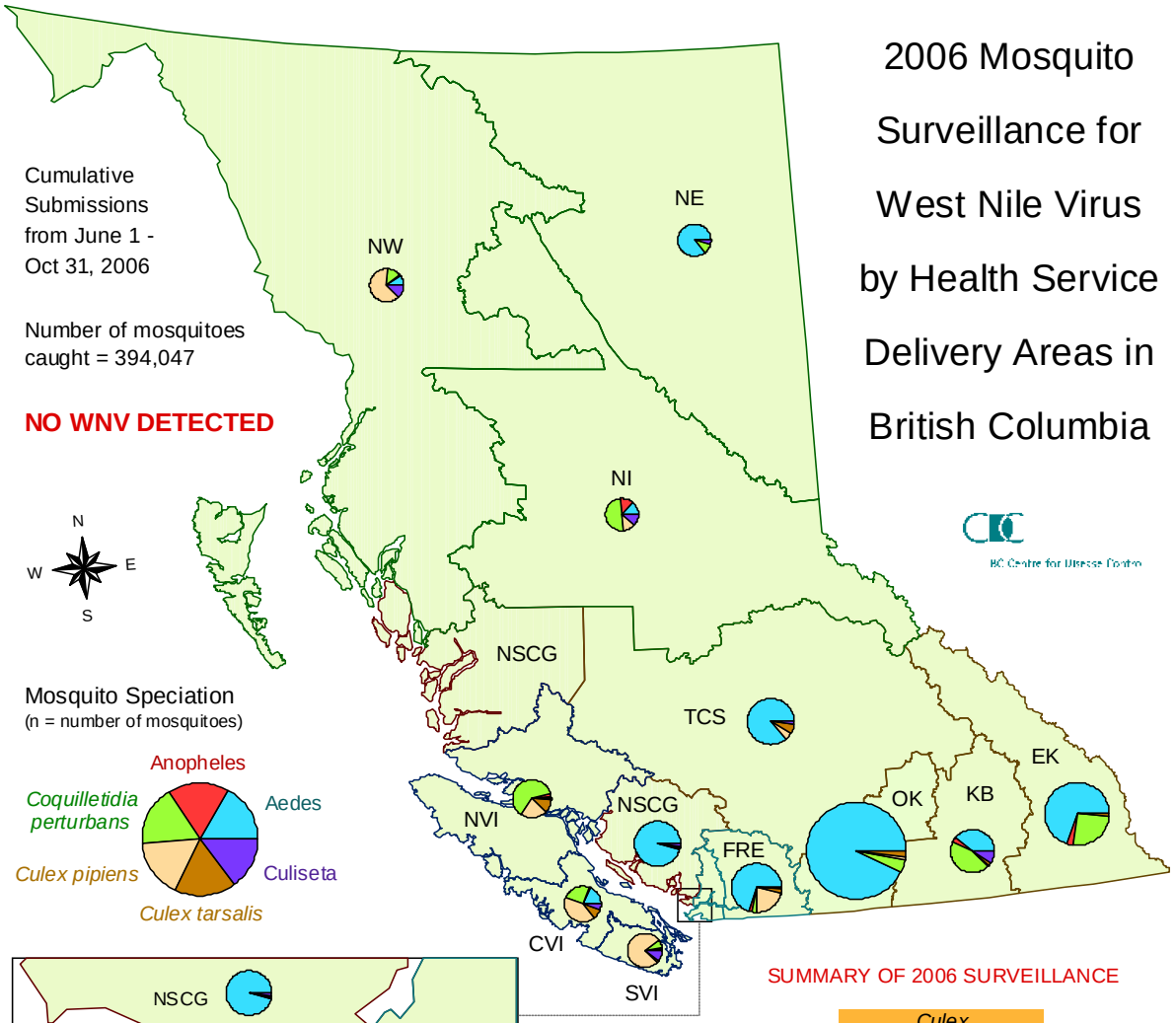


Figure 10: Geographic Distribution of Mosquito Species in BC, 2006



SUMMARY OF 2006 SURVEILLANCE

HSDA	Aedes	Anoph.	Coqui.	Culex pipi.	Culex tars.	Culex terr.	Culis.	Total
EK	44901	1653	16686	92	449	2	287	64070
KB	4146	459	4654	142	248	3	1048	10700
OK	216850	369	8833	1457	5747	1	537	233794
TCS	13914	68	35	788	1067	0	280	16152
FRE	15687	510	603	5024	468	0	256	22548
FRN	2261	85	789	3350	367	0	788	8040
FRS	2035	264	1972	7072	1903	2	408	13656
RICH	2065	1	116	2267	646	0	155	5250
VAN	5	0	1	293	4	0	24	327
NSCG	13269	34	42	206	82	1	160	13794
SVI	7	3	50	457	13	0	66	596
CVI	266	33	374	617	115	1	91	1497
NVI	77	61	2096	775	365	0	52	3426
NW	17	2	21	104	0	1	20	165
NI	1	1	4	1	0	0	1	8
NE	18	0	2	0	0	0	1	21

Effect of Rainfall and Snowmelt on Mosquito Abundance

BC is well known for yearly variation in weather patterns which will affect insect populations. We experienced very hot summers in 2003, 2004 and 2006 (Appendix 6). A hot summer this year coupled with heavy spring rainfall (at least in the Interior of province), produced large mosquito populations. Had there been a record snowpack accompanying this hot, wet spring, conditions could have been even more conducive to mosquito development. Being relatively normal years for rainfall and temperature, 2005 and 2006 are a good baseline for typical mosquito abundance.

Localized precipitation can have significant effects on mosquito abundance. At the Cranbrook weather station, significant June and July precipitation (Figure 11) created elevated water levels. Residents along Kootenay River noted significant mosquito problems this year. To the west in Creston, *Coquilletidia* populations seemed to double in 2006 and *Culex tarsalis* numbers increased. In the Oliver and Osooyos region, localized precipitation caused flooding for this region. *Aedes* populations more than doubled and *Culex tarsalis* also seemed to benefit. Successive years of optimal conditions are creating large mosquito populations in these regions.

Ada County in Idaho reported that a record snowpack resulted in high water levels for 7 to 8 weeks, causing seepage in addition to spring flooding. The existence of more habitat caused by accumulated precipitation will produce more mosquitoes, even with pond water species like *Culex tarsalis*. West Nile virus was found in mosquitoes as early as May (Bennett, 2006). In Ada County more than 5700 mosquitoes were identified in 2006, 417 pools were tested and 52 were positive; 50 were *Culex* and 2 were other species (ADA County, 2006b).

BC has a similar mosquito composition to Idaho (Ada county, 2006), both in terms of pond and floodwater mosquito species (Table 7). The Snake River runs through Ada county, this is the largest tributary of the Columbia River which drains into the Pacific Ocean at Portland Oregon.

Table 7: ADA County, Idaho: Mosquito Species

Pond species	Floodwater species
Anopheles freeborni	*Aedes vexans*
Coquillettidia perturbans	*Aedes sticticus*
Culiseta inornata	*Aedes dorsalis*
Culex pipiens	*Aedes nigromaculus*
Culex tarsalis	

Figure 11: Mean Temperature and Total Precipitation (Jan to Oct) for Cranbrook, 2003 to 2006.

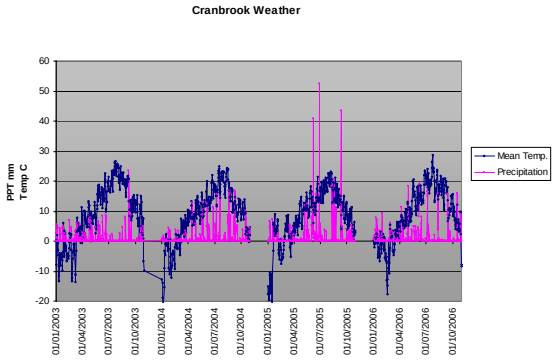
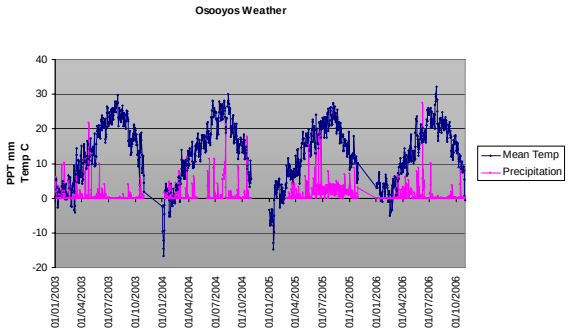


Figure 12: Mean Temperature and Total Precipitation (Jan to Oct) for Osoyoos, 2003 to 2006



Temporal Distribution of Mosquitoes

This year we reduced the window of sampling from the beginning of May to the beginning of June (Figure 13,Figure 14). Even though we started later in 2006, the major peak in *Aedes* was caught as was the start of the first generation of both *Culex* species, the primary vectors for WNv. *Coquilletidia purterbans* were the second most abundant species caught for the last 2 years, which is quite different from 2004 when *Culex* were the second most common group.

Figure 13: Average Number of Mosquitoes Species Trapped per Week, 2006

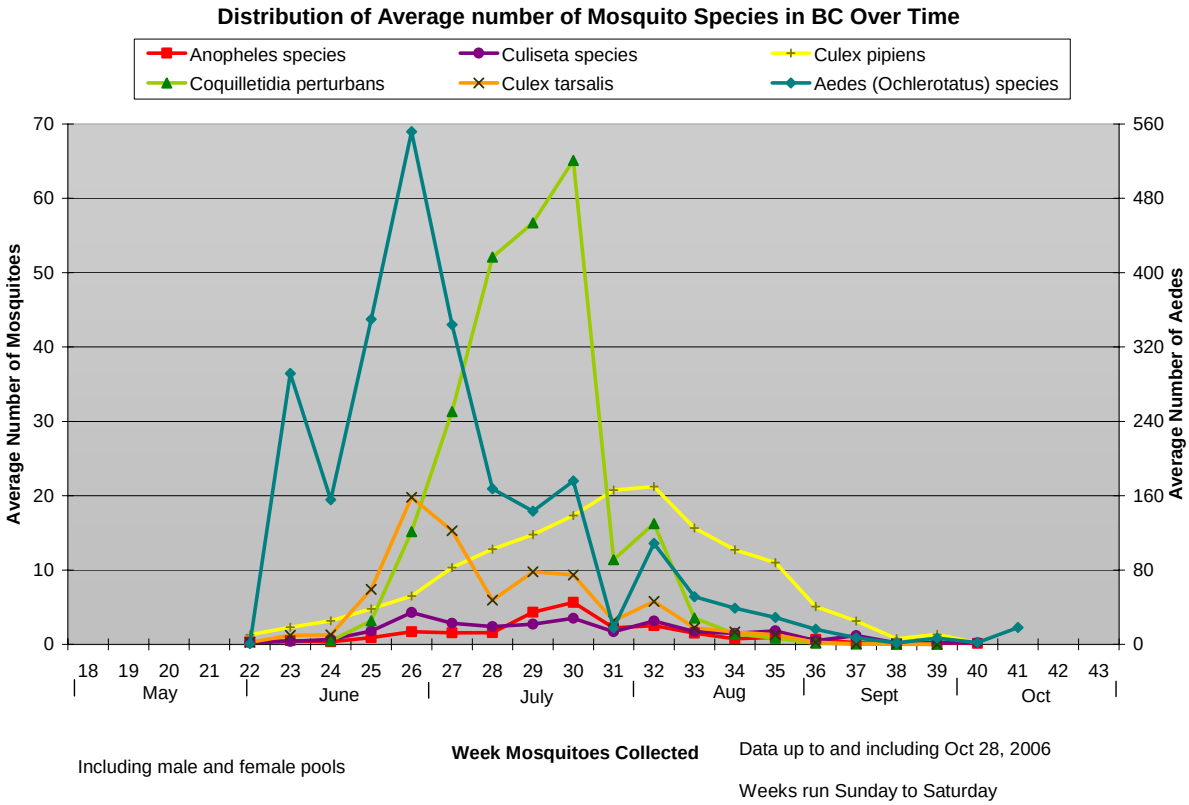
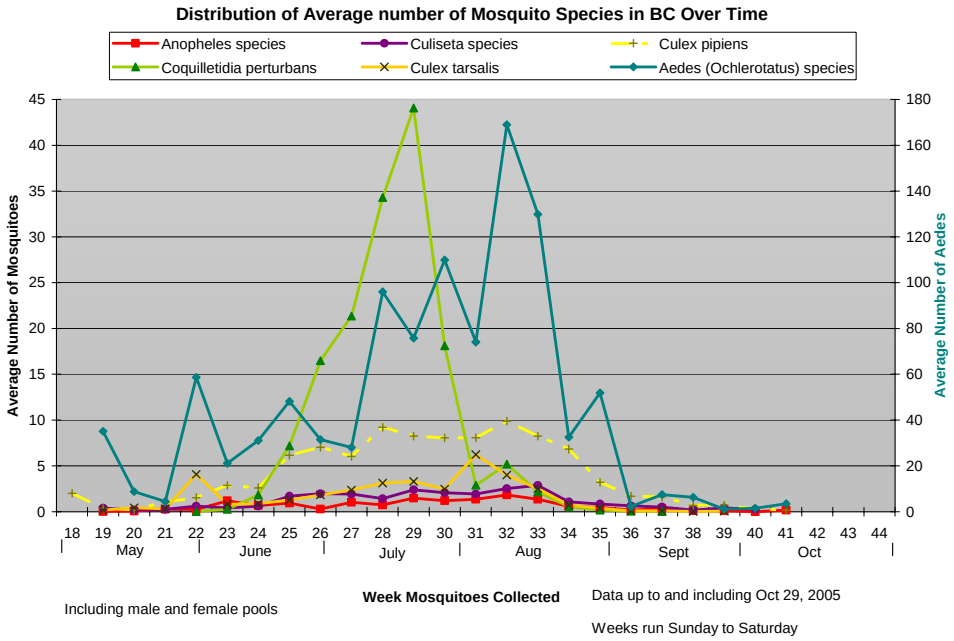


Figure 14: Average Number of Mosquitoes Species Trapped per Week, 2005



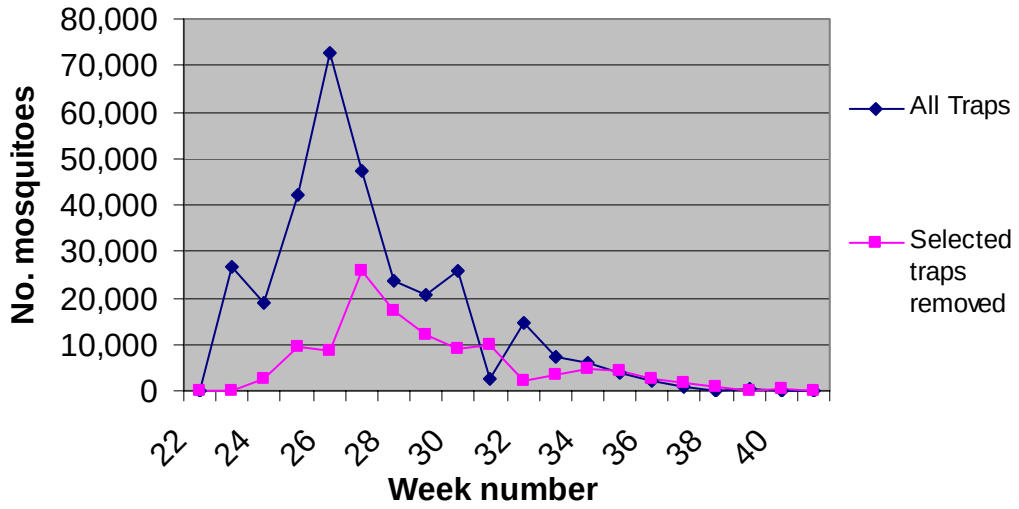
Aedes

The bulk of mosquitoes found in British Columbia are *Aedes* and they typically appear in large numbers by the beginning of June. The highest numbers of *Aedes* are collected in the Osoyoos region, with collections in 2006 greatly surpassing 2005 for traps placed in the same location. Two highly productive traps in Osooyos collected over 200,000 *Aedes* in 2006 (Table 8). When these overly productive traps are removed from the total, the provincial peak in *Aedes* shifts considerably downwards and appears one week later (
Figure 15), reflecting regional variations in *Aedes* emergence. The earlier emergence of *Aedes* in Osooyoos is due to the earlier freshet in southern BC.

Table 8: Yield from Highly Productive Osooyos Traps

Year	Trap ID	TOWN	AEDES	ANOPH	COQUI	CPIPI	CTARS	CULIS	TOTAL	NIGHTS
2006	IHA 27B	Osoyoos	38301	72	2	43	851	59	39328	19
2006	IHA 28B	Osoyoos	161939	16	1	63	1765	15	163799	18
2005	IHA 27B	Osooyos	13588	91	5	53	495	114	14346	23
2005	IHA 28B	Osooyos	45749	138	9	131	1216	306	47549	23
2004	IHA18A	Osoyoos	857	1	0	2	2	1	863	7

Figure 15: Distribution of Aedes with Selected Traps Removed (IHA27B and IHA28B)



Culex

A comparison of the temporal distribution of *Cx*. tarsalis and *Cx*. pipiens over time for each HSDA can be found in Appendix 5. In Richmond, both *Cx. tarsalis* and *Cx. pipiens* peaked later in 2006 than in previous years. In Vancouver, *Cx. pipiens* consistently peaked in late July and early August. North Shore Coast Garabaldi sees a concurrent peak of *Cx. pipiens* and *Cx. tarsalis* in August. Fraser East recorded the same early July peak in 2004 that was found in Richmond. Unlike the lower mainland, where *Cx. pipiens* peaks in July and August, South Vancouver Island seems to have more *Cx. pipiens* earlier in the year - in late June and early July. Interestingly, south and central Vancouver Island had greater numbers of *Culex pipiens* in June of 2005 much like Richmond and Fraser South that year. In general terms, across the province, *Culex tarsalis* appear in large numbers about the end of June (Week 26) and beginning of July and drop off at the middle of August (Week 33). The Thompson Cariboo Shuswap area has considerable numbers in late July and early August; the virus amplifies in the bird population throughout the breeding season, increasing the chances that *Cx. tarsalis* will bite an infected bird as the breeding season draws to an end. A prudent strategy might be to have an IPM contingency in place to deal with this species late in the season.

Timing of Mosquito emergence: Canada, BC and the Pacific Northwest

This year across Canada the earliest positive mosquito pool occurred in Manitoba (Table 9); this was first time we have seen positive mosquitoes in June (Manitoba Health, 2006). We speculated through discussions of the Provincial WNv Steering Committee that maybe an overwintering female had recently taken her 1st bloodmeal (fed on infected migratory bird), or that transovarial transmission or possibly trap contamination were responsible.

Table 9: First Recorded Dates of Positive West Nile Mosquitoes in Canada and the Pacific Northwest.

First recorded dates of positive West Nile mosquitoes in Canada.

Year	Alberta	Sask	Manitoba	Ontario	Quebec
2006	18-Jul	17-Jul	**4-Jun**	5-Jul	10-Aug
2005	7-Aug	28-Jul	15-Jul	26-Jul	3-Aug
2004	10-Aug	13-Aug	28-Jul	3-Aug	19-Aug
2003	23-Jul	12-Aug	25-Jul	23-Jul	29-Jul
2002			15-Aug	16-Jul	16-Aug

NOTE - information extracted from provincial Public Health Agency websites

WNv came earlier in 2006 to the Pacific Northwest as well resulting in more sustained transmission of WNv this year (Table 10). Washington State and Oregon saw more positive surveillance findings in 2006 compared with all previous years.

Table 10: Number of Positive Surveillance Findings in Washington and Oregon Humans, Birds, Horses or Mosquitoes.

Year	Washington		Oregon	
	# of positives	Earliest positive	# of positives	Earliest positive
2006	22	Aug 18, bird	157	July, bird/horse
2005	4	Sept 8, mosq	97	Aug, bird
2004	0	-	60	Aug, bird/horse
2003	0	-	0	-
2002	6	October, bird	0	-

NOTE - information extracted from state Public Health Agency websites

In most regions, mosquitoes were collected when trapping began at the end of May or 1st week of June. In the North and NVI, specimens did not appear until the beginning of July (Table 11). *Coquillettidia perturbans* usually appears during June for most regions but were not recorded until July in the north.

Table 11: Earliest Date and Location of Different Mosquito Species in BC, 2006

Comparision of time and location of first identificaiton of mosquito by HSDA, 2006

HSDA	Aedes and species	Anopheles species	Coquilletidia perturbans	Culex pipiens	Culex tarsalis	Culex territans	Culiseta species
EK	11-Jun-06	15-Jun-06	15-Jun-06	27-Jun-06	15-Jun-06	14-Aug-06	15-Jun-06
KB	07-Jun-06	07-Jun-06	22-Jun-06	07-Jun-06	07-Jun-06	07-Jun-06	07-Jun-06
OK	06-Jun-06	06-Jun-06	13-Jun-06	06-Jun-06	06-Jun-06	29-Jun-06	06-Jun-06
TCS	13-Jun-06	13-Jun-06	13-Jun-06	13-Jun-06	13-Jun-06		13-Jun-06
FRE	30-May-06	31-May-06	13-Jun-06	31-May-06	06-Jun-06		06-Jun-06
FRN	31-May-06	13-Jun-06	13-Jun-06	30-May-06	31-May-06		30-May-06
FRS	29-May-06	29-May-06	13-Jun-06	30-May-06	30-May-06	06-Jun-06	31-May-06
RICH	07-Jun-06	21-Sep-06	12-Jun-06	29-May-06	29-May-06		12-Jun-06
VAN	14-Jun-06		06-Jul-06	22-Jun-06	27-Jul-06		21-Jun-06
NSCG	18-Jun-06	26-Jun-06	26-Jun-06	13-Jun-06	25-Jun-06	11-Jul-06	18-Jun-06
SVI	05-Jul-06	05-Jul-06	05-Jul-06	05-Jul-06	05-Jul-06		05-Jul-06
CVI	05-Jun-06	14-Jun-06	14-Jun-06	05-Jun-06	05-Jun-06	22-Jun-06	05-Jun-06
NVI	04-Jul-06	07-Jul-06	04-Jul-06	07-Jul-06	04-Jul-06		04-Jul-06
NW	26-Jul-06	30-Aug-06	17-Jul-06	26-Jul-06		30-Aug-06	26-Jul-06
NI	26-Jul-06	26-Jul-06	13-Jul-06	13-Jul-06			13-Jul-06
NE	04-Jul-06		04-Jul-06				05-Sep-06

Note:
Blank cell means that there is no such genus-species found at this HSDA.
Yellow background means the earliest date a species was found.

Relative abundance of mosquito species over last 3 years

The graphs in Appendix 5 illustrate, for each HSDA, the average number of *Culex* mosquitoes trapped each week of surveillance over the course of the last 3 years.

While this can provide general information on trends, it does not represent an accurate comparison of mosquito abundance from year to year since the number of traps has fluctuated, as have their locations over time - both factors which will have an effect on yield. To remove the effect of trap number and location from the analysis we identified a subset of traps that were run consistently within 10 Km of one another from 2004 through 2006. In effect, most selected traps had been run in exactly the same location over the 3 year period, except in a few regions with lower trap density. Only light traps run for at least 7 trap nights were included in the analysis.

The resulting charts can be used to compare the relative abundance of different mosquito species over time within health authorities. General trends in species abundance from 2004-2006 (increase or decrease) can be compared across health authorities, however direct comparisons of average yield/trap night across HAs should be avoided since trap environments of selected traps may differ from region to region. For each species, the number of mosquitoes per trap night was plotted.

Vancouver Coastal Health Authority

This is a geographically diverse region with a large density of people. The sentinel trap locations included 3 from Richmond, 3 from Vancouver, 2 from North Shore and 1 from Squamish. *Aedes* is the dominate group of mosquitoes and has consistently increased in abundance from 2004-2006 (Figure 16). *Aedes* were collected primarily from 2 locations, one in Richmond and the other in Squamish. In Richmond, *Aedes dorsalis* is likely the dominate species while in Squamish *Aedes vexans* probably accounts for the majority of specimens; even though we do not speciate this group, personal collections support this observation. The jump in *Aedes* numbers from 2004 to successive years reflects both a true annual increase and the introduction of CO_2 to bait traps in Squamish in 2005.

A review of Appendix 5 shows that Richmond produces the most *Culex* of the 3 regions and this elevates the region to a higher potential risk from WNv. In general, *Cx. pipiens* is the most common of the primary WNv vectors in Vancouver Coastal with the greatest numbers appearing late in the summer for most years. *Cx. tarsalis* can appear throughout the mosquito breeding season with Richmond having the only significant populations. Interestingly, compared with previous years, the average yield of *Cx. pipiens* decreased in VCH in 2006 while Fraser Health and Vancouver Island experienced an increase (Figure 16;Figure 18;Figure 20). One third of the fixed-location traps used in this analysis were from Richmond where extensive pre-emptive larviciding activity was performed in 2006. Figure 17 illustrates a decrease in *Cx. pipiens* average trap yield in 2006 in Richmond; no difference in *Cx. pipiens* abundance was detected for traps placed in other regions where no larviciding was performed.

Figure 16: Species Abundance from 2004-2006 in Representative Light Traps, Vancouver Coastal Health.

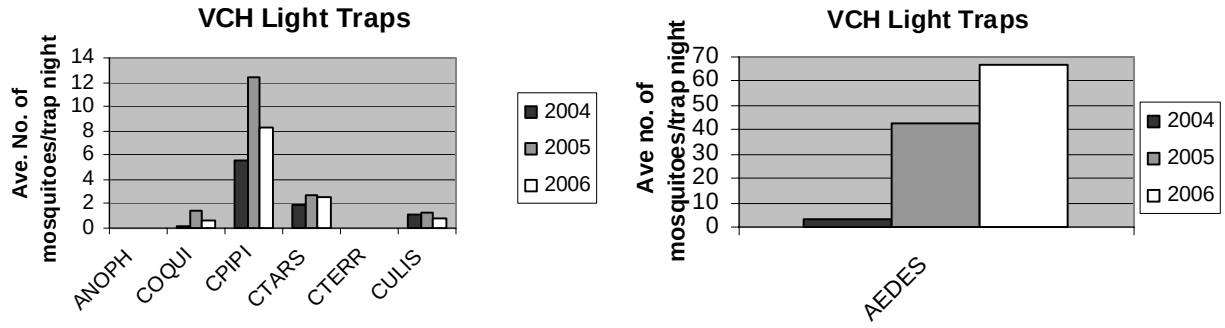
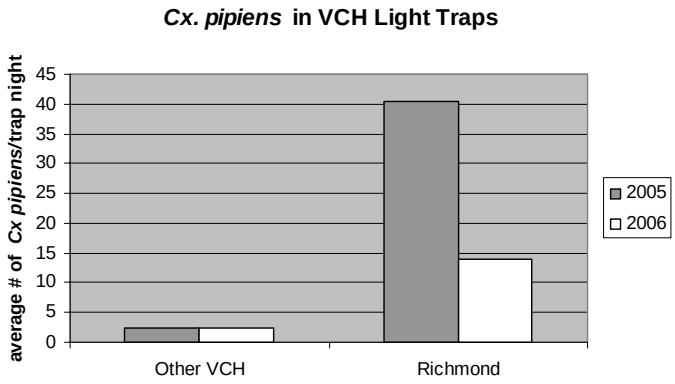


Figure 17: Culex pipiens in Representative Light Traps in VCH, Stratified by Catch Basin treatment within a 3Km Zone



Fraser Health Authority

The traps charted in Figure 18 were from 9 locations within Fraser Health Authority, ranging from urban to rural. As in Vancouver Coastal, *Aedes* is the dominate grouping and shows a large increase in 2006. The highest numbers were reported from East Fraser near an area that receives lowland spring flooding with the Fraser River freshet. Past experience suggests the dominate species to be *Ae. vexans* and *Ae. sticticus* in this region. The other sentinel trap with large *Aedes* populations was located near Burnaby Lake; this region is known to have a number of different *Aedes* species including *Aedes aboriginis*, *Ae. cinereus* and *Ae. vexans* (Belton). A review of Appendix 5 shows that all of Fraser Health produces *Culex pipiens* populations and that Fraser South produces the largest *Culex tarsalis* numbers. The greatest catch of *Cx. tarsalis* is found in Delta, which puts them at an equally high risk of potential WNv as neighbouring Richmond.

Both *Cx. pipiens* and *Cx. tarsalis* numbers were higher in 2006 compared with 2005. In Fraser Health, *Cx. pipiens* is the most common of the primary WNv vectors with greatest numbers appearing late in the summer. Although many Fraser Health municipalities treated catch basins in 2006 the average yield of *Cx. pipiens*/night increased compared with previous years. Figure 19 demonstrates that although *Cx. pipiens* increased in representative traps in 2006 compared with 2005 (reflecting variations in climatic conditions), increases were most apparent in traps operated in areas where no catch basin larviciding was conducted within a 3 Km radius.

Figure 18: Species Abundance from 2004-2006 in Representative Light Traps, Fraser Health.

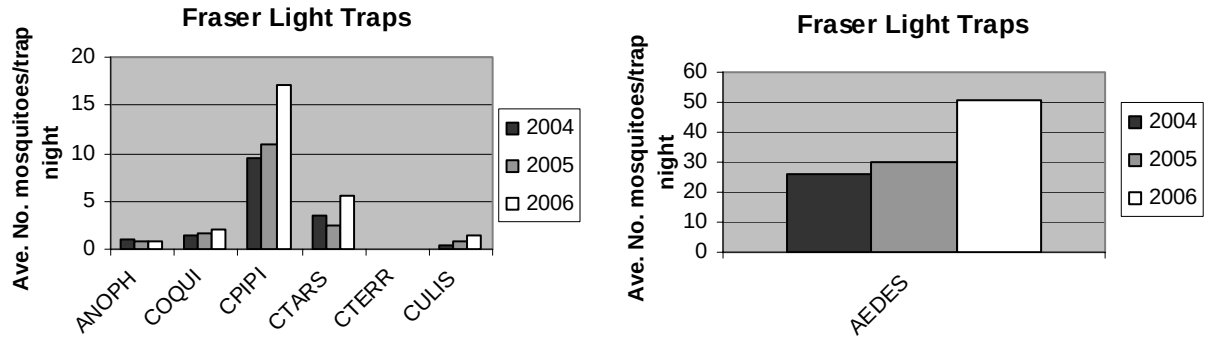
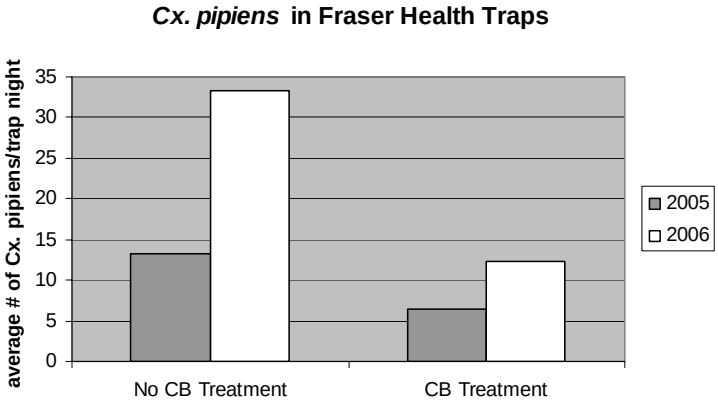


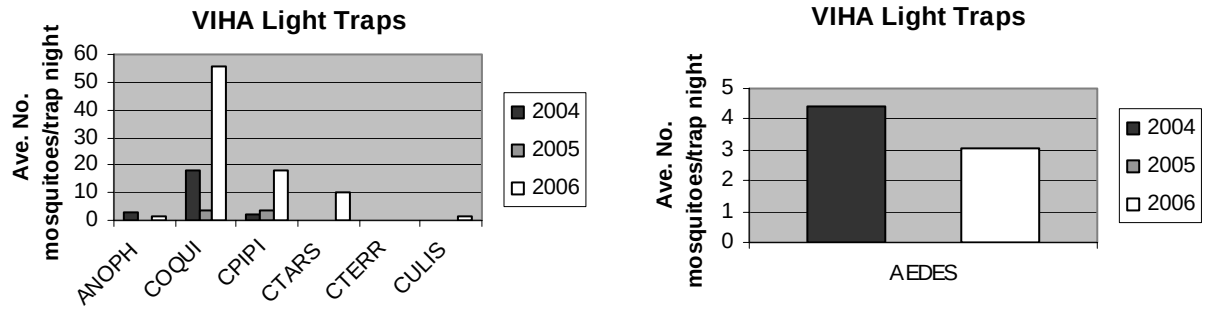
Figure 19: Culex pipiens in Representative Light Traps in Fraser Health, Stratified by Catch Basin treatment within a 3Km Zone



Vancouver Island Health Authority

WNv surveillance has developed tremendously in VIHA since 2004. Traps used in this analysis included 3 generalized community locations where yearly changes in trap locations were within 10 Km. These community based regions were Qualicum Beach, Comox/Courtenay/Cumberland area and Nanaimo. However, since trap locations were not exactly the same, yearly changes in abundance could not be completely controlled for effect of location. The jump in *Coquillettidia perturbans, Culex pipiens* and *Cx. tarsalis* for 2006 is due a new site in Cumberland that caught more mosquitoes than in previous seasons (Figure 20). *Coquillettidia perturbans* appears to be the most common species found in North and Central Vancouver Island (Stephens, 2006). A review of *Culex pipiens* and *Cx. tarslis* in Appendix 5 illustrates that more recent surveillance is capturing sufficient numbers to begin seeing trends over time. In general terms Vancouver Island does not have large mosquito populations except locally where large cattail stands seem to produce significant numbers of *Coquillettidia perturbans* and where salt marshes generate *Aedes dorsalis.*

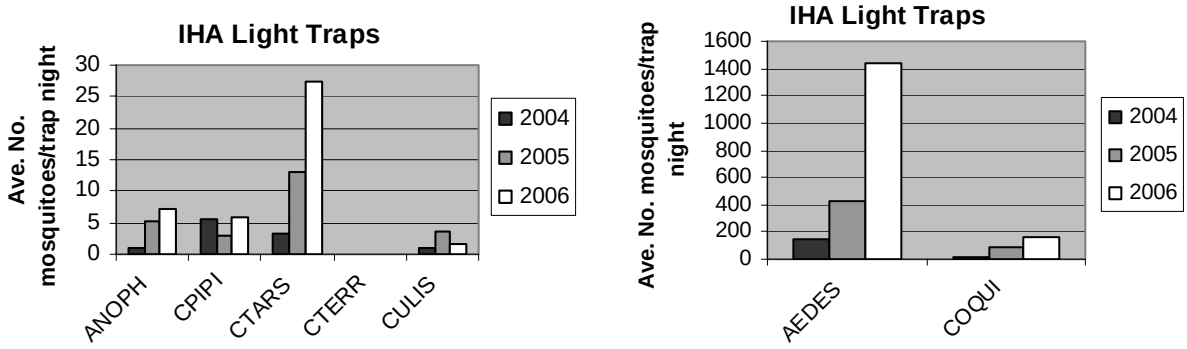
Figure 20: Species Abundance from 2004-2006 in Representative Light Traps, Vancouver Island Health Authority.



Interior Health Authority

There were 7 sentinel light traps used to develop Figure 21; they were located in Salmon Arm, Penticton, Vaseaux Lake, Osooyos, Nelson and Creston. Like VCH and FHA, *Aedes* abundance has increased in the Interior over the last 3 years, however the trap at Osooyos caught a disproportionately high number in 2006 as previously discussed. *Coquillettidia perturbans* is the second most abundant species in the Interior and this reflects the large cattail stands that are used by the larvae in the vicinity of the traps. Both Creston and Vaseaux Lake are the major contributors to these numbers. Unlike the highly urbanized Lower Mainland where *Culex pipiens* is more abundant, *Culex tarsalis* is more common in IHA. When controlling for the number of trap nights and location of the traps, the average number of *Cx. tarsalis* caught doubled in 2006, compared with 2005.

Figure 21: Species Abundance from 2004-2006 in Representative Light Traps, Interior Health.

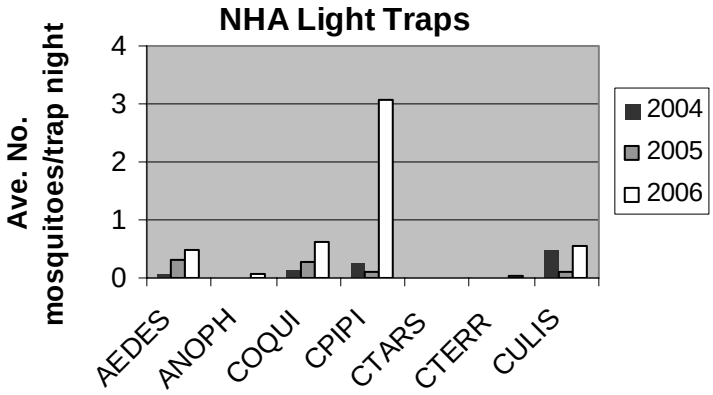


Northern Health Authority

The Northern Health Authority lies over a huge area with a small human population concentrated in urban centres. We used 4 community based locations in the northwest (Kitimat, Hazelton and Terrace) where trapping was done consistently enough, and

within a small enough geographic location, to allow the temporal comparison in Figure 22. These traps used CO_2 in 2005 and 2006 so they yielded some reliable numbers. In previous seasons *Aedes*, *Coquillettidia perturbans* and *Culiseta* had been collect in small numbers but this year they found more *Culex pipiens* than any other mosquito. These appeared in late June and lasted until the beginning of September.

Figure 22: Species Abundance from 2004-2006 in Representative Light Traps, Northern Health.



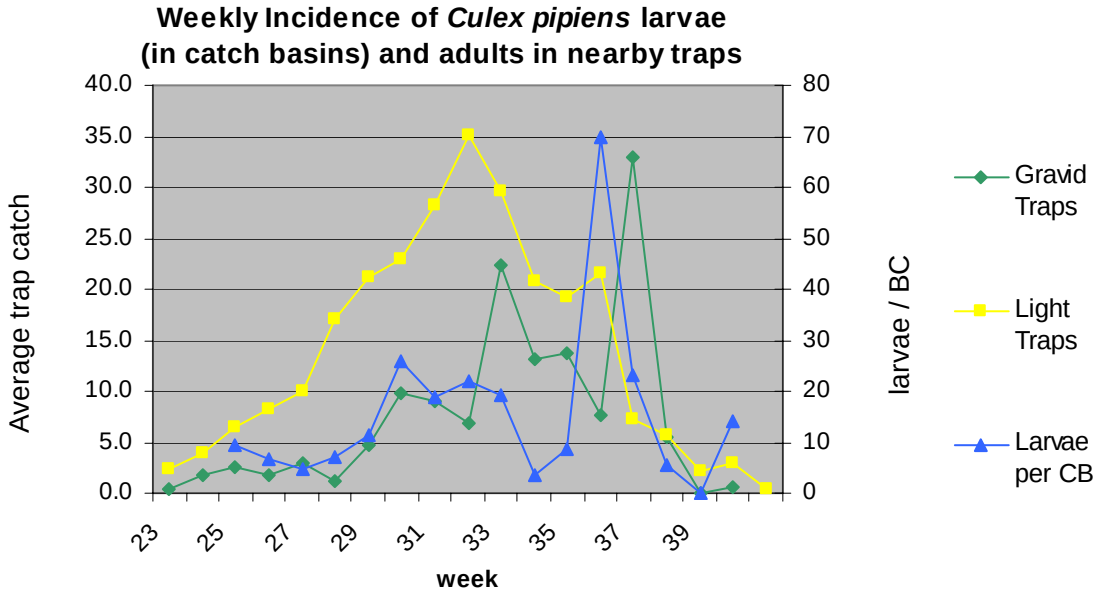
Larval Monitoring of *Culex* Species in Catch Basins

A comparison was undertaken to investigate whether trends in larval data matched trends in adult surveillance data. We took all available information on larvae from storm-water, catch basin (CB) sampling across the province and compared that to provincial adult mosquito surveillance. Since open water habitat is sampled with a dipper while a net is used for CBs, only samples that were collected with a net were included in the analysis. Samples where no *Culex* was identified were also removed. After exclusions, we had several thousand samples where *Culex* larvae were present. The number of larvae present were summed and divided by the number of samples to give the average catch per sample. This was grouped per week as with the adult surveillance. Only adult traps in the general proximity of larval surveillance were included in the analysis.

As the average number of adult *Cx pipiens/*trap increases over the season, so too does the number of larvae found in nearby catch basins (Figure 23). Collections from gravid traps mirror larval data even more closely than adult collections except for the period of week 31 to 34 (July 30 to Aug 20). Around week 33 we estimate *Cx pipiens* go into diapause to overwinter. Mosquitoes that hatch after week 33 are no longer attracted to CO_2 as they shift from bloodmeals to sucrose feeding to build up energy to survive the winter. We see this reflected as a decrease in light trap catches which use CO_2 as bait after week 33 (Figure 23). However, mosquitoes hatching before this date continue to

seek blood meals and lay eggs in catch basins and gravid traps, contributing to the twin peaks around week 36 and 37. The dip in larval populations in late July and August (week 34-35) below that seen in nearby gravid traps may be a reflection of municipal larval control efforts.

Figure 23: Culex Populations in Catch Basins Compared to Adult Trapping in 2006.



Effect of CO_2 on Mosquito Yields

Carbon dioxide is one of the chemical stimuli that a fertilized female mosquito will use to locate a host with blood. Table 12 shows that almost a 5-fold improvement in average trap counts for *Cx. tarsalis* occurred when CO_2 is used as an attractant in 2006. The average number of C. tarsalis caught across the province rose from 9 mosquitoes/trap in 2004/05 to 15 mosquitoes/trap in 2006. Vancouver Island, Fraser and Interior Health Authorities contributed most to this increase. All had at least a 2 fold increase in average *Cx. tarsalis* counts with the exception of TCS which was about the same. Richmond saw only a slight increase while NSCG, Vancouver and Northern Health Authorities maintained similar average *Cx. tarsalis* counts to previous years.

Table 12: Cx. tarsalis Counts in Light Traps With and Without CO_2, May-Aug, 2004 - 2006.

Light Trap Cx. tarsalis CO2 Vs Non CO2, May-Aug, 2004 - 2006

C. tarsalis	2006		2005		2004	
	CO2	Non CO2	CO2	Non CO2	CO2	Non CO2
Mosquito Count	11311	100	5049	80	1646	51
Trap nights	775	33	594	30	191	35
Average number/trap	**14.6**	**3.0**	**8.5**	**2.7**	**8.6**	**1.5**

In BC we captured the largest numbers of *Culex* species in June and July; baiting light traps with CO_2 produced significantly larger average trap catches between June and August (Table 13).

Table 13: Average Monthly Counts of Culex Species from Light Traps With and Without CO_2 as a Chemical Attractant

Average Light Trap Count for Traps using CO2 and Non-CO2 as Chemical Attractant

	May (n)	June (n)	July (n)	Aug (n)	Sep (n)	Oct
CO2	1.56(9)	21.58(174)	17.98(320)	6.57(272)	1.5(28)	
Non CO2		3(3)	7(4)	2.42(26)	1.5(2)	

Note:
Calculation is based on *Culex pipiens* and *Culex tarsalis* collected in Light traps
(n) represents the number of trap nights under each condition

Our trapping results indicate that CO_2 seems to have little effect on the catch after August. However, it is the type of mosquito being caught rather than the overall average number that it important at this time of year. According to the National Mosquito Control Subcommittee, after about mid-August most emerging female *Culex* enter diapause and at this time they will seek a carbohydrate meal to build up fat reserves for the winter, rather than take blood meal. Hence, baiting light traps with CO_2 will do little to attract the females entering diapause. In fact, these females will contribute little to the enzootic or epidemic amplification of the virus that year. However, there will remain in circulation females that emerged **before** diapause and these mosquitoes will continue taking a blood meal and laying eggs late into the fall, if the weather remains warm. For this reason, it is important to continue to bait light traps with CO_2 until hard frost. These females are the most responsible for WNv transmission in endemic areas, with human infections most frequent in August to mid-September when old, reproductively active *Culex pipiens* mosquitoes are highly infected with the virus (Reddy 2005). The risk of human WNv infection depends upon the age of the vector population, as well as its questing frequency.

Low Yield Traps

The yield is seasonally affected by environmental factors that affect mosquito biology and by the particular operational features in the field. For example, the number of nights the trap is run over the season will affect the total number of specimens by possibly missing their emergence from larval habitat. When we reviewed the yield of traps running for more than 4 weeks from successive years the success in getting high yields is striking. In 2004 we had 34 traps that caught less than 3 mosquitoes per night, 27 in 2005 and only 20 in 2006. The field staff has made tremendous strides in positioning traps to give significant yields.

Table 14 is a list of the low yield traps in 2006 that ran for at least 4 weeks in the field. Three of these were gravid traps that will be collecting primarily *Culex pipiens* and *Culiseta*. From the 15 light traps that gave low yields, 8 were operated without CO_2 confirming that not using this attractant leads to reduced success. Four of the low yield traps were in NHA where field staff noted they were having trouble getting any significant yields this year. The CDC labeled trap was strategically placed in the SE corner of the province late in the season to investigate the viral activity reported from Flathead County in Montana. Unfortunately very few specimens were caught at this time of year.

Table 14: Trap Locations with Low Average Catch.

Label	Location	Trap Type	# of *Culex* pools tested	# times trap operated	Average Count
ISL 4	B	CDC Light Trap	1	5	0.2
CDC 1	A	CDC Light Trap	2	5	0.4
FSR 58		CDC Light Trap	10	5	2.0
FSR 17		CDC Light Trap	12	5	2.4
NE 2	A	CDC Light Trap	1	6	0.2
NW 6	A	CDC Light Trap	3	6	0.5
FSR 25		CDC Light Trap	6	6	1.0
NW 2	A	CDC Light Trap	6	9	0.7
NINT 2	A	CDC Light Trap*	8	9	0.9
NS 5	A	CDC Light Trap*	15	10	1.5
NS 6	A	CDC Light Trap*	18	10	1.8
NW 5	A	CDC Light Trap	26	10	2.6
NS 2	A	CDC Light Trap*	24	11	2.2
VAN 1	B	CDC Light Trap*	36	14	2.3
VAN 2	B	CDC Light Trap*	20	16	1.3
VAN 1	A	CDC Light Trap*	22	17	1.3
VAN 2	A	CDC Light Trap*	24	17	1.4
FSR 22		Gravid Trap	1	5	0.2
FSR 26		Gravid Trap	10	5	2.0
NS 3	A	Gravid rap	13	12	1.1

* - traps run without use of CO_2

Lag Times for Mosquito Submissions

The time it takes for a sample to go from the field to the laboratory is important for the timely reporting of WNv results back to the RHA. The laboratory requested that samples be sent by Wednesday so that they arrived before the weekend and could be properly stored in a refrigerated environment. In some instances, samples were stored by RHAs over a long weekend so that specimens would not sit in a warm warehouse waiting for delivery.

The median submission time for mosquitoes was one day in 2006, which is the same as in 2005 (Table 15). This reflects the strong commitment by RHAs to running this program in a way that ensures that real-time results will be available when the virus arrives. The maximum submission time was 2 weeks in NSCG but this is down from 24 days in 2005 and 32 days in 2004, reflecting a continued improvement. If delays occur between collection and submission HAs are encouraged to keep specimens frozen or the quantity of virus in specimens will degrade below detection.

Table 15: Mosquito Lag Time for Sample Submission, 2003-2006

Mosquito Lag Time for Sample Submission by HSDA, 2003-2006

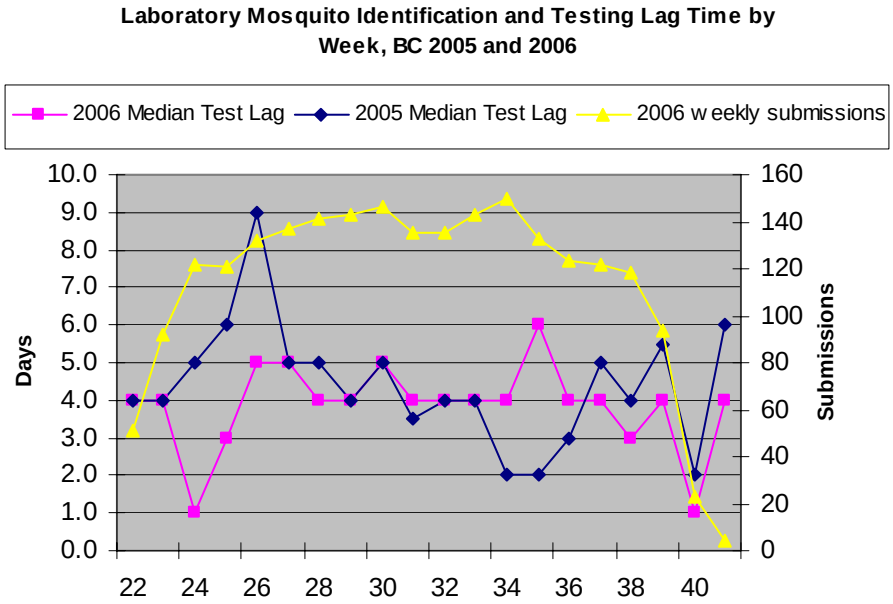
HSDA	Median of Submission				Max Of Submission			
	2003	2004	2005	2006	2003	2004	2005	2006
EK	1.0	3.0	2.0	2.0	2	7	13	5
KB	1.0	1.0	2.0	1.0	6	5	6	2
OK	1.0	2.0	1.0	1.0	8	7	9	4
TCS	1.0	1.0	1.0	2.0	8	6	5	7
FRE	2.0	3.0	2.0	1.0	5	10	8	4
FRN	2.0	1.0	1.0	1.0	3	7	6	4
FRS	1.5	3.0	1.0	1.0	7	8	16	4
RICH	2.0	1.0	1.0	2.0	17	2	6	8
VAN	0.5	0.0	0.0	0.0	6	5	1	1
NSCG	4.0	2.0	1.0	3.0	7	32	24	16
SVI	1.5	1.0	1.0	1.0	3	7	11	2
CVI	1.0	2.0	1.0	1.0	5	9	6	7
NVI	1.5	2.0	2.0	2.0	2	2	3	3
NW	1.0	2.0	2.0	1.0	1	15	7	10
NI	1.0	1.0	3.0	0.0	6	6	14	1
NE	2.0	1.0	2.0	2.0	2	5	7	12
All	**2.0**	**2.0**	**1.0**	**1.0**	**17**	**32**	**24**	**16**

Note: All numbers are in days.

BCCDC laboratories processed between 130 and 140 samples per week. Average turn around time for identification and testing was 4 to 5 days in 2006 (Figure 24). A slight jump occurred at the end of the summer since WNv field staff are often students who resumed classes at the beginning of the fall semester. Considering the large number of mosquitoes collected this year the quick turn around in processing samples reflects well

on the laboratory in training new seasonal staff. Targeting only *Culex* for testing may also account for the reduction in processing time for the lab. As previously noted, only 2 of 54 positive pools tested in ADA County in Idaho were not *Culex*, lending support for the current policy of testing *Culex* only until WNv identification occurs within BC. Once the virus is widely circulating in a region of the province the testing of other mosquito species may be considered.

Figure 24: Change in Laboratory Lag Time for Mosquito Identification and Testing

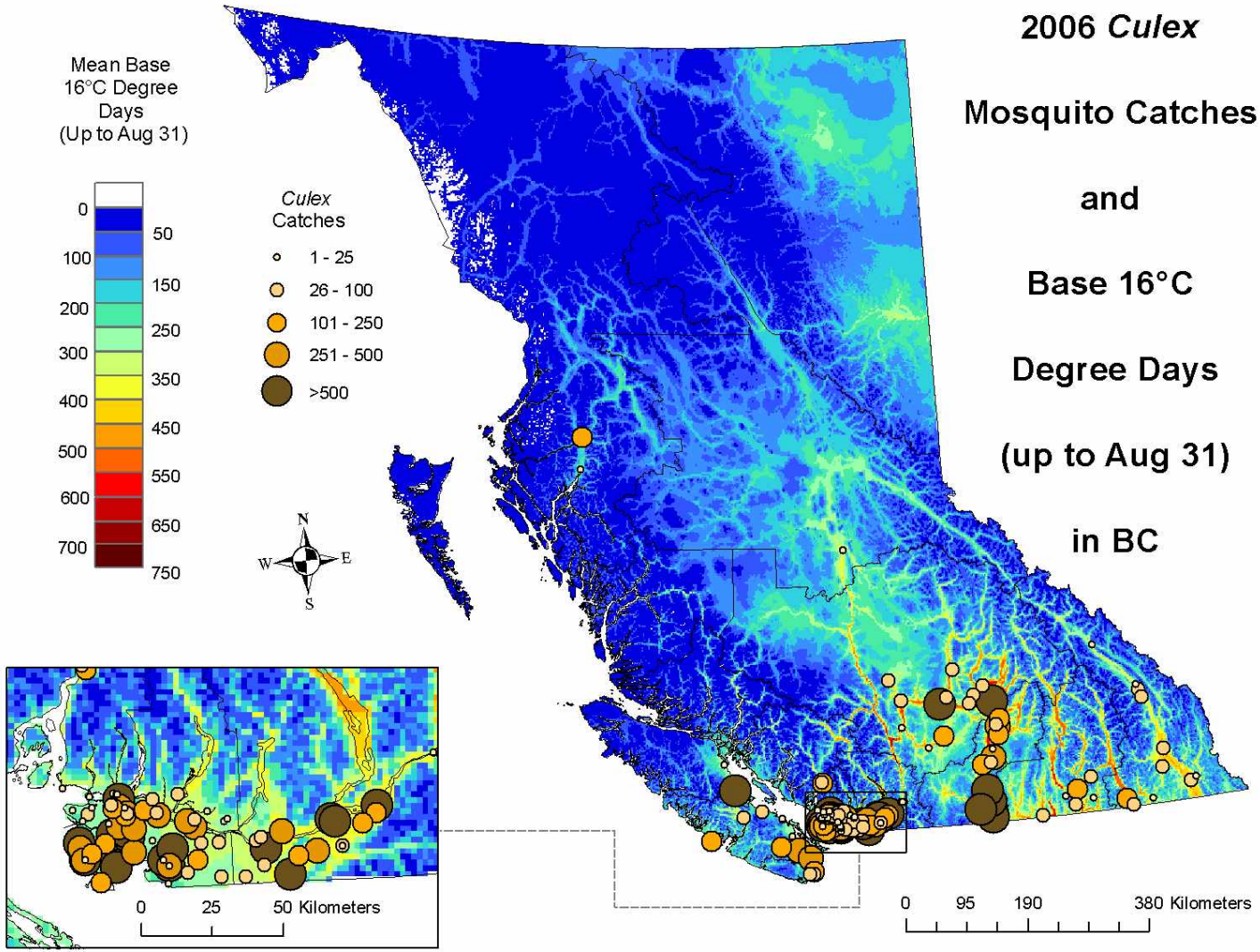


Climate Data – Growing Degree Day Mapping

A growing degree day model based on climate data was developed for *Culex tarsalis* mosquito forecasting. The concept of growing degree days involves the amount of accumulated heat required for mosquitoes to complete their growth and development (described in more detail in Appendix 6). Mosquito development occurs more rapidly with warmer temperatures, and consequently multiple generations of mosquitoes may be produced during the growing season enabling WNv to amplify and risk of transmission to humans to increase.

Growing degree days were monitored on a weekly basis for select BC communities from each HSDA. A provincial temperature map was produced and overlaid with the *Culex* mosquito catches in 2006 (Figure 25). Summer-time temperatures in 2006 were again above normal for the most of the province; and another unusually wet spring appears to have triggered an early start to the mosquito season again this year.

Figure 25: Culex Catches and Accumulated Degree Days over 16^0C, 2006



Recommendations for Mosquito Surveillance in 2007

Significant improvements continue to be made in the quality of surveillance data from the West Nile virus program. No new recommendations for mosquito surveillance need be made for 2007, however a reminder of best practices based on our current knowledge of mosquito behaviour in BC is provided.

Trap Type and Location

- Yields from adult mosquito surveillance are generally better using CO_2 baited light traps. We recommend the continuation of this method for most areas. In highly urbanized areas where *Culex pipiens* are abundant, consideration should be given to using some gravid traps; they are more likely to catch a positive, blood-fed *Culex pipiens* female than a light trap.
- Baiting light traps with CO_2, even during August and September, is important to attract those older females that do not enter diapause and are still seeking a blood meal. These are the most dangerous females because they will have taken multiple blood meals and are at the greatest risk of being infected with WNv.
- We have highlighted some of the low yield traps. If they have been strategically placed for a particular area then consider moving them to different spot in the same general area that might yield a better catch.

Timing of Surveillance

- The start of gravid trapping can be delayed until later in the season, during July and August when larger numbers of *Cx. pipiens* are found, thereby producing optimal results from this surveillance method.
- In 2006, we recommended delaying the start of mosquito surveillance until June 1st. This proved to still allow for the capture of the first generation of *Culex* mosquitoes and we recommend continuation of this timing for 2007.
- Reduced trapping should occur in the northern RHA as surveillance over last 4 years indicate there are low *Culex* numbers in the north even though there are many other mosquitoes. In addition, these *Culex* mosquitoes do not emerge until very late in the year, most likely too late to significantly amplify the virus. Surveillance in northern regions of the province can be delayed until later in the summer (July) or as soon as WNv becomes established in more southern areas of BC.

Contingency Planning

- High risk areas must have a well established surveillance program that is fully functional during August and September, especially if the virus is circulating in US states directly to the south of BC. RHAs should establish a contingency plan

for outbreaks occurring at end of August when seasonal staff may return to school.

Laboratory Activities

- *Culex* species are more often found infected with WNv than any other species of mosquitoes across the North American continent. BCCDC labs should test only pools of *Culex* mosquitoes for the presence of West Nile virus, until such time as an area is known to be infected. After this, other species should also undergo testing
- On occasion, high numbers of *Aedes* are being collected leading to difficulty testing all specimens in a timely manner. When high numbers of *Aedes vexans* are being collected, a sub-sample of mosquitoes will be tested and the remainder saved and tested later. There will be some exceptions to this general rule, for example, if species like *Ae. japonicus* or *Ae, albopictus* are found in BC then localized testing of *Aedes* will be important. These species are physically quite distinct from *Aedes vexans* because they have large rather than small contrasting bands of white scales on their black legs, giving rise to common name, Asian Tiger mosquito for *Ae. albopictus*. This allows efficient separation of the species. The lab will also consider testing *Aedes* if there are rockpools with *Ae. togoi* located within the vicinity of the trap.

Geographic Information Systems – Applications to WNv

Innovative use of Geographical Information Systems (GIS) has been used to help make decisions concerning the control of mosquitoes. The Greater Vancouver Regional District used MoH funding to generate a model that can be used to prioritize catch basin sites for treatment with larvicide. In addition, they developed a standardized sampling and data collection protocol for catch basin habitats which can then be fed into a GIS model (GDG, 2006). GIS initiatives conducted at the BCCDC involved two key activities, the maintenance of an interactive web-based mapping system for WNv surveillance and an assessment of the relative feasibility and benefits of ground compared with aerial based approaches to adult mosquito control.

Interactive Web-based Mapping for WNv Surveillance

GIS enables integration of disparate datasets from a variety of sources for visualization and analysis. An interactive web-based GIS mapping system was created to provide WNv surveillance data in a spatial format to public health officials and members of the public. Interactive web-based mapping offers GIS functionality without the need for purchasing or installing specialized software, it can be accessed at anytime from anywhere with an Internet connection (high-speed connection highly recommended), and data can be viewed and queried at a geographic location and scale that is relevant to the specific user.

Two applications were created: one for the public to view non-sensitive data such as the location and test result of dead corvids submitted for WNv testing, and another for public health officials to view sensitive information such as the location of human cases (none to date in BC), larval control events and ecologically sensitive areas for surveillance and planning purposes. This tool has been used by public health officials and members of the public for the past 3 years to keep them informed with the status of WNv risk in BC throughout the WNv season. The public application can be accessed from http://maps.bccdc.org.

GIS Assessment of Potential Ground and Aerial-based Adulticiding

Introduction

In preparation for the arrival of West Nile virus WNv, the BCCDC, MoH, and the regional health authorities have developed a comprehensive strategy to identify WNv and reduce the risk of associated human illness in BC. An integrated pest management (IPM) approach has been adopted to reduce the risk of disease due to mosquito bites. Mosquito (adult and larval) surveillance, public education (to avoid mosquitoes and eliminate mosquito breeding habitat) and pre-emptive mosquito larval control activities have been performed. The final component of the IPM strategy, the application of

pesticides to control adult mosquitoes, may be required in the event of a severe human WNv outbreak.

This study uses GIS analyses to examine the feasibility of ground and aerial-based spraying in select BC communities. The area coverage, operational time required to perform ground-based adulticiding, and land cover accessible with aerial-based adulticiding are calculated. These results will assist in determining whether a ground, aerial, or combination of ground and aerial-based adulticiding strategy will be the most feasible and effective in the event of an adult mosquito control event.

Methods

Thirty four communities from the Interior, Fraser, and Vancouver Coastal Health Authorities (HAs) were examined. These communities were selected based on their population (>15,000) and location within risk level 3 and 4 areas. Several smaller communities were also selected based on forecasted high WNv risk rating (Tachiiri et al, *IJHG* May 2006). Community population data were taken from the 2005 municipal population estimates (BC Stats), and municipal boundaries were derived from the 2001 census dissemination areas (Statistics Canada). ArcGIS was used to perform the data processing and spatial analysis.

1) Ground-based ULV Adulticiding

With the exception of environmentally sensitive areas around residential homes, ground-based spraying along roadways can provide near complete coverage of human populations since homes require road access. Road segments (CanMap Streetfiles v7.1) within community boundaries were buffered by 90 meters to represent the treatment coverage area accessible by truck mounted ultra low volume (ULV) sprayers. No spray zones around environmentally sensitive areas such as natural water courses (BC Watershed Atlas) and endangered species and habitat (Conservation Data Centre) were buffered by 100 meters, and excluded from the treatment area. The driving distance was determined by multiplying the total road network distance by two to represent one pass on each side of the road, and the driving hours were calculated based on the maximum recommended driving speed for ground-based ULV of 16 Km/hr. The number of treatment nights required to spray the entire community by road are calculated from 8.5 hours between sunrise and sunset in southern BC during mid-August (Natural Resources Canada).

2) Aerial-based ULV Adulticiding

Aerial-based spraying can potentially provide additional geographic coverage of communities over areas without road access. The aerial treatment areas were also calculated from the municipal boundaries minus a 200 meter buffer areas around no spray zones. A larger no spray buffer zone around sensitive habitat is required due to pesticide drift in the lower air column. The type of land cover accessible by aerial spraying is important since the ULV adulticide does not penetrate through heavy vegetation (i.e. forest canopy). Therefore, the type of land cover was also examined (section 4). The operational time for aerial-based spraying was not calculated since an entire community can be completed in a single night.

3) Combined Treatment Techniques

The combined treatment calculation includes areas covered by aerial and ground techniques and excludes the corresponding buffer areas. The combined treatment approach will potentially provide the maximum population and geographic coverage of ULV adulticiding.

4) Land Cover Classification

The composition of land cover within communities was examined since ULV adulticide does not penetrate through heavy vegetation (i.e. forest canopy). Land cover classification was performed on 30 meter resolution Landsat 7 imagery of the selected communities. Four classes of land cover were created based on the unsupervised classification technique: forest, low vegetation, bare ground, and water.

Results

Please refer to the following list of tables, charts and figures:

Figure 30: Ground-based Adulticiding Coverage of 80% and 90% of the City of Chilliwack's Population

Discussion

Ground-based spraying along roadways can provide near complete coverage of human populations since homes require road access. However, residential homes located near environmentally sensitive areas and within the "no spray" zone will not be covered. The geographic coverage of ground spray-able areas (median = 33%, range = 13-85%) among communities has high variability since official boundary delineations may or may not include undeveloped, rural areas. Furthermore, the provincial road, water course and endangered species datasets used in this study may not be the most up-to-date or detailed information available. Individual local governments may have more precise data for their jurisdictions.

The time required to perform ground-based spraying is also important. A number of repeat adulticiding applications may be required; however, to be effective in reducing risk of WNv, treatments within a community should be completed within 3 nights. In communities where ground-based spraying will require more than 3 nights to achieve complete geographic coverage, priority should be placed on higher population and road density areas. A preliminary examination of the City of Chilliwack found that only 9% of its land area (within the street buffer treatment area) contains approximately 80% of its population. Other communities requiring more than 3 nights to spray have also been examined.

Aerial-based ULV treatment provides greater geographic coverage (median = 62%, range = 29-84%) than ground-based spraying. The combination of ground and aerial-based treatment provides the greatest coverage (median = 68%, range = 34-90%), although only a marginal increase in coverage over ground or aerial, on average by 6%. However, the type of land cover accessible by aerial spraying should be considered since ULV adulticide will not penetrate through heavy vegetation. The "forest" land cover class is highly variable among the communities examined (median = 21%, range = 3-79% within the community; median = 35%, range = 1-90% within aerial treatment areas minus the ground treatment areas). Furthermore, most areas accessible only by aerial-based approaches are sparsely populated.

Conclusion

No single method was identified as the best strategy for ULV adulticiding in BC. In some communities the ground-based approach was superior with high population and geographic coverage, and spray-able within 3 nights, while in other communities the aerial-based approach provided higher rates of coverage. Therefore, the strategy for each community must be examined individually since the presence of no spray zones, type of land cover, network of roadways, heterogeneous distribution of human populations, and location of mosquito habitat are unique to each community.

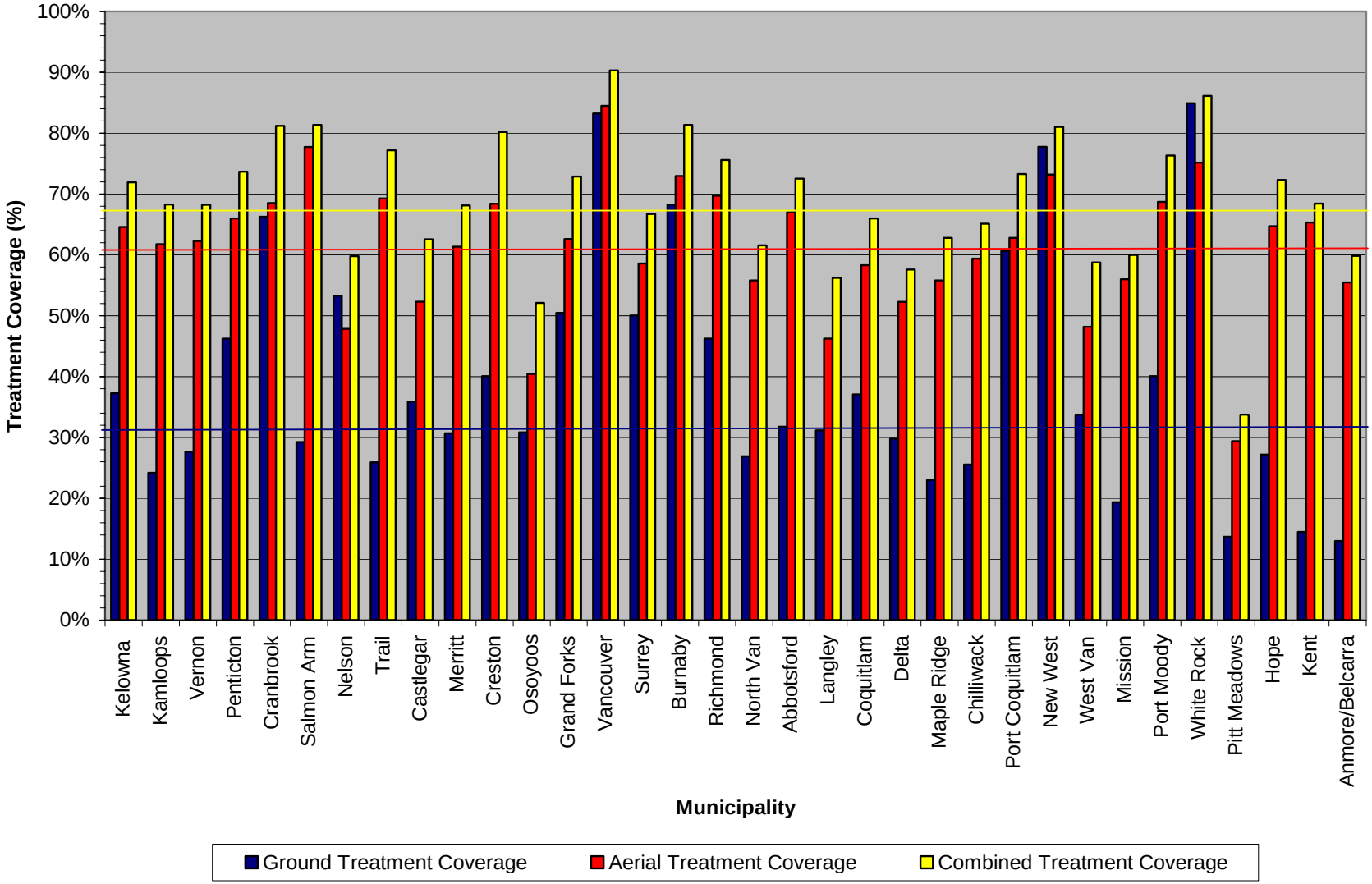
The operational logistics and experience of ground-based ULV adulticiding are much more developed in BC and Canada than aerial-based spraying. If a ground-based

approach is taken exclusively, resources should be focused on developing a strong ground-based program (i.e. purchasing sufficient equipment and training personnel) and GIS analysis should be used to optimize population and geographic coverage within the limited operation time available. Coordinating an aerial-based spray program may require much more preparation time, and complex procedural, logistical and regulatory challenges will be encountered.

Table 16: Comparison of Ground, Aerial and Combined Adulticide Treatment

Municipality	2005 Pop	Land (Km²)	Untreatable Buffer Areas %	Ground Treatment		Aerial Treatment		Combined Treatment	
				Treatable Area (Km²)	Coverage	Treatable Area (Km²)	Coverage	Treatable Area (Km²)	Coverage
Kelowna	109,000	231	28%	86	37%	150	65%	166	72%
Kamloops	83,000	308	32%	75	24%	190	62%	210	68%
Vernon	36,000	94	32%	26	28%	59	62%	64	68%
Penticton	33,000	44	26%	20	46%	29	66%	33	74%
Cranbrook	20,000	18	19%	12	66%	12	69%	15	81%
Salmon Arm	17,000	168	19%	49	29%	130	78%	136	81%
Nelson	10,000	9	40%	5	53%	4	48%	6	60%
Trail	7,900	36	23%	9	26%	25	69%	27	77%
Castlegar	7,800	20	37%	7	36%	10	52%	12	63%
Merritt	7,600	25	32%	8	31%	15	61%	17	68%
Creston	5,100	8	20%	3	40%	6	68%	7	80%
Osoyoos	4,800	9	48%	3	31%	4	40%	5	52%
Grand Forks	4,200	11	27%	5	50%	7	63%	8	73%
Vancouver	583,000	131	10%	109	83%	111	84%	119	90%
Surrey	393,000	319	33%	160	50%	187	59%	213	67%
Burnaby	204,000	90	19%	62	68%	66	73%	73	81%
Richmond	173,000	129	24%	60	46%	90	70%	98	76%
North Van	134,000	175	38%	47	27%	98	56%	108	62%
Abbotsford	127,000	364	27%	116	32%	244	67%	264	73%
Langley	123,000	320	44%	100	31%	148	46%	180	56%
Coquitlam	122,000	121	34%	45	37%	71	58%	80	66%
Delta	103,000	187	42%	56	30%	98	52%	108	58%
Maple Ridge	73,000	271	37%	62	23%	151	56%	170	63%
Chilliwack	71,000	273	35%	70	26%	162	59%	177	65%
Port Coquitlam	58,000	28	27%	17	61%	17	63%	20	73%
New West	57,000	15	19%	12	78%	11	73%	12	81%
West Van	44,000	89	41%	30	34%	43	48%	52	59%
Mission	35,000	232	40%	45	19%	130	56%	139	60%
Port Moody	28,000	26	24%	11	40%	18	69%	20	76%
White Rock	20,000	5	14%	4	85%	4	75%	4	86%
Pitt Meadows	17,000	88	66%	12	14%	26	29%	30	34%
Hope	6,600	41	28%	11	27%	26	65%	30	72%
Kent	5,700	190	32%	28	14%	124	65%	130	68%
Anmore/Belcarra	2,400	35	40%	5	13%	19	55%	21	60%

Figure 26: Treatment Coverage areas by Ground, Aerial and Combined Adulticide Treatment



The median of each treatment coverage is displayed on the chart as the corresponding coloured line.

Table 17: Ground-based ULV Adulticide Scenario

Municipality	2005 Pop	Land (Km²)	Roads (Km)	Ground-based ULV Sprayer (Truck Mounted)						
				Driving Distance (Km)	Driving Hours	Treatment Nights (1 Unit)	Units Needed for <3 Nights of Treatment	Treatable Area (Km²)	100m Buffer (Km²)	Treatment Coverage
Kelowna	109,000	231	845	1691	106	12	4	86	44	37%
Kamloops	83,000	308	846	1691	106	12	4	75	64	24%
Vernon	36,000	94	312	624	39	5	2	26	21	28%
Penticton	33,000	44	230	459	29	3	1	20	9	46%
Cranbrook	20,000	18	150	300	19	2	1	12	3	66%
Salmon Arm	17,000	168	375	749	47	6	2	49	21	29%
Nelson	10,000	9	82	165	10	1	1	5	3	53%
Trail	7,900	36	118	237	15	2	1	9	6	26%
Castlegar	7,800	20	84	167	10	1	1	7	6	36%
Merritt	7,600	25	93	185	12	1	1	8	6	31%
Creston	5,100	8	41	83	5	1	1	3	1	40%
Osoyoos	4,800	9	42	84	5	1	1	3	4	31%
Grand Forks	4,200	11	56	113	7	1	1	5	2	50%
Vancouver	583,000	131	1648	3296	206	24	8	109	11	83%
Surrey	393,000	319	1732	3464	216	25	8	160	78	50%
Burnaby	204,000	90	783	1566	98	12	4	62	14	68%
Richmond	173,000	129	728	1455	91	11	4	60	23	46%
North Vancouver	134,000	175	584	1169	73	9	3	47	41	27%
Abbotsford	127,000	364	1092	2184	136	16	5	116	64	32%
Langley	123,000	320	972	1944	122	14	5	100	97	31%
Coquitlam	122,000	121	532	1064	66	8	3	45	29	37%
Delta	103,000	187	671	1342	84	10	3	56	58	30%
Maple Ridge	73,000	271	593	1187	74	9	3	62	67	23%
Chilliwack	71,000	273	742	1484	93	11	4	70	65	26%
Port Coquitlam	58,000	28	217	433	27	3	1	17	6	61%
New West	57,000	15	192	384	24	3	1	12	3	78%
West Vancouver	44,000	89	396	791	49	6	2	30	25	34%
Mission	35,000	232	440	881	55	6	2	45	70	19%
Port Moody	28,000	26	132	263	16	2	1	11	5	40%
White Rock	20,000	5	68	135	8	1	1	4	1	85%
Pitt Meadows	17,000	88	142	285	18	2	1	12	44	14%
Hope	6,600	41	127	253	16	2	1	11	9	27%
Kent	5,700	190	260	519	32	4	1	28	44	14%
Anmore/Belcarra	2,400	35	42	84	5	1	1	5	9	13%

Figure 27: Time Requirements for Ground-based ULV Treatment

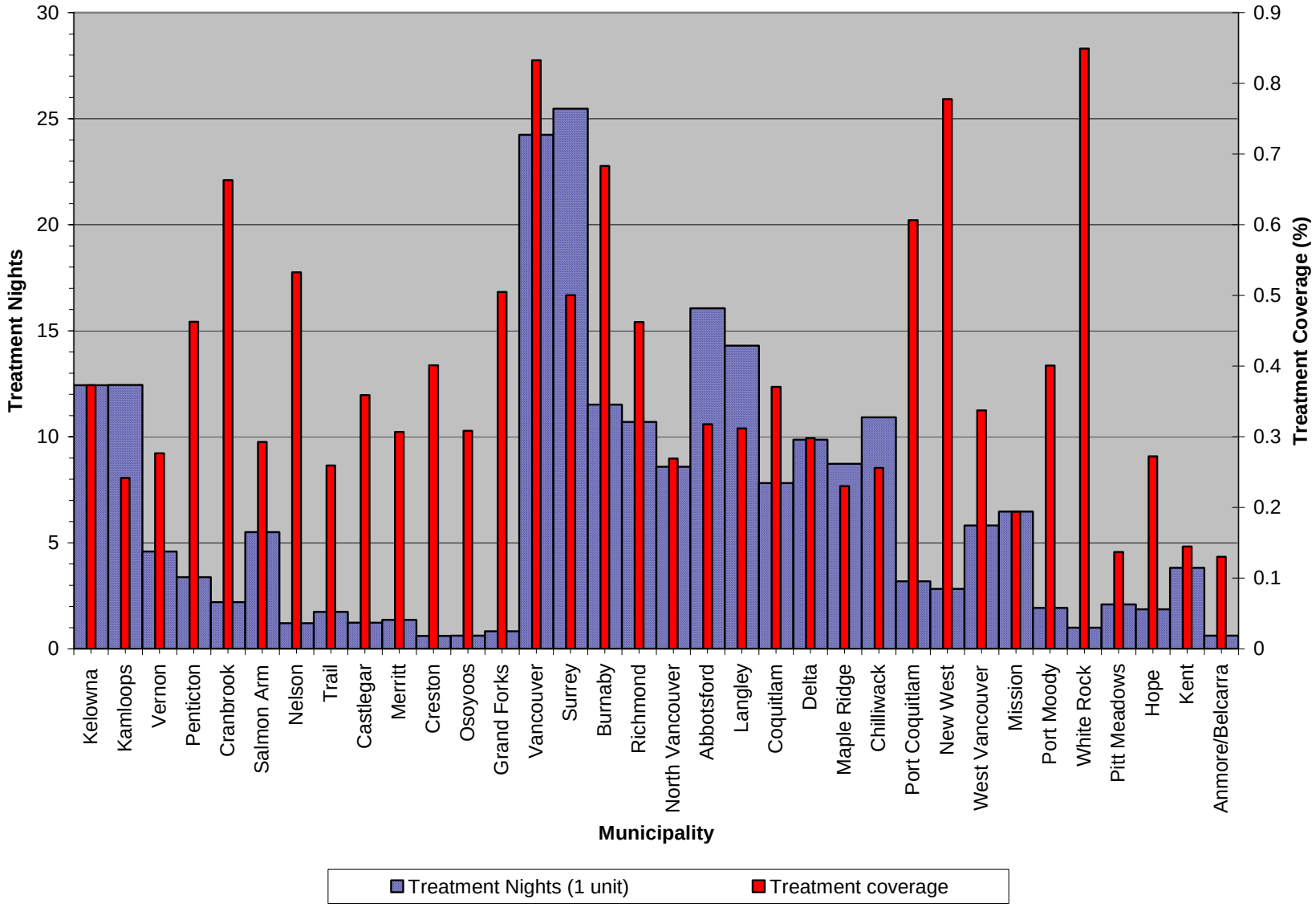


Table 18: Land Cover Classification

	Within Municipal Boundaries					Within Aerial Treatment Area*				
	Land	%				Aerial	%			
Municipality	Area Km²	Forest	Low Vegetation	Bare Ground	Water	Area Km²	Forest	Low Vegetation	Bare Ground	Water
Kelowna	231	13%	21%	64%	1%	83	17%	26%	56%	1%
Kamloops	308	6%	17%	76%	1%	136	8%	19%	72%	1%
Vernon	94	11%	19%	65%	6%	38	19%	25%	56%	1%
Penticton	44	9%	19%	66%	5%	12	13%	17%	68%	1%
Cranbrook	18	8%	5%	86%	1%	3	19%	9%	72%	1%
Salmon Arm	167	35%	30%	34%	2%	87	43%	29%	27%	1%
Nelson	9	17%	26%	33%	24%	1	22%	52%	12%	14%
Trail	36	40%	25%	28%	7%	19	48%	25%	19%	8%
Castlegar	19	21%	29%	29%	20%	5	37%	41%	14%	8%
Merritt	25	5%	18%	77%	0%	9	7%	18%	75%	0%
Creston	8	22%	38%	40%	1%	3	43%	43%	14%	1%
Osoyoos	9	3%	29%	59%	9%	2	1%	22%	75%	1%
Grand Forks	11	12%	26%	56%	5%	2	13%	13%	71%	3%
Vancouver	131	15%	9%	73%	3%	9	57%	22%	19%	2%
Surrey	319	21%	22%	55%	2%	53	31%	30%	37%	2%
Burnaby	90	21%	13%	64%	2%	12	48%	22%	28%	2%
Richmond	129	11%	19%	67%	3%	39	17%	32%	49%	3%
North Vancouver	175	65%	6%	24%	6%	61	83%	4%	7%	6%
Abbotsford	364	23%	29%	46%	2%	148	26%	32%	41%	1%
Langley	320	28%	29%	41%	2%	80	30%	34%	35%	1%
Coquitlam	121	53%	12%	34%	2%	35	79%	13%	7%	1%
Delta	187	19%	19%	56%	5%	52	16%	29%	49%	6%
Maple Ridge	271	69%	13%	16%	3%	108	82%	10%	6%	3%
Chilliwack	272	32%	32%	34%	2%	108	40%	34%	25%	1%
Port Coquitlam	28	17%	14%	66%	2%	3	14%	18%	67%	1%
New Westminster	15	6%	5%	87%	2%	1	15%	16%	66%	3%
West Vancouver	89	63%	9%	23%	5%	22	84%	7%	4%	5%
Mission	232	67%	16%	13%	4%	94	78%	14%	6%	2%
Port Moody	26	56%	8%	33%	4%	10	88%	6%	5%	1%
White Rock	5	9%	5%	84%	3%	0	50%	4%	46%	1%
Pitt Meadows	88	28%	25%	41%	6%	18	33%	28%	36%	2%
Hope	41	50%	18%	20%	12%	18	64%	14%	8%	15%
Kent	190	58%	28%	11%	3%	102	68%	25%	7%	1%
Anmore/Belcarra	35	79%	6%	6%	10%	16	90%	3%	2%	4%

* The aerial treatment area excludes areas where ground spraying is available (i.e. road network).

Water within aerial treatment area may include water courses and wetlands that were not in the available datasets.

Forest = coniferous and deciduous trees
Low vegetation = grasses, shrubs, agricultural and rangeland
Bare ground = exposed soil, pavement, rock and sand
Water = water bodies, flooded land and wetlands

Figure 28: Land Cover Classification

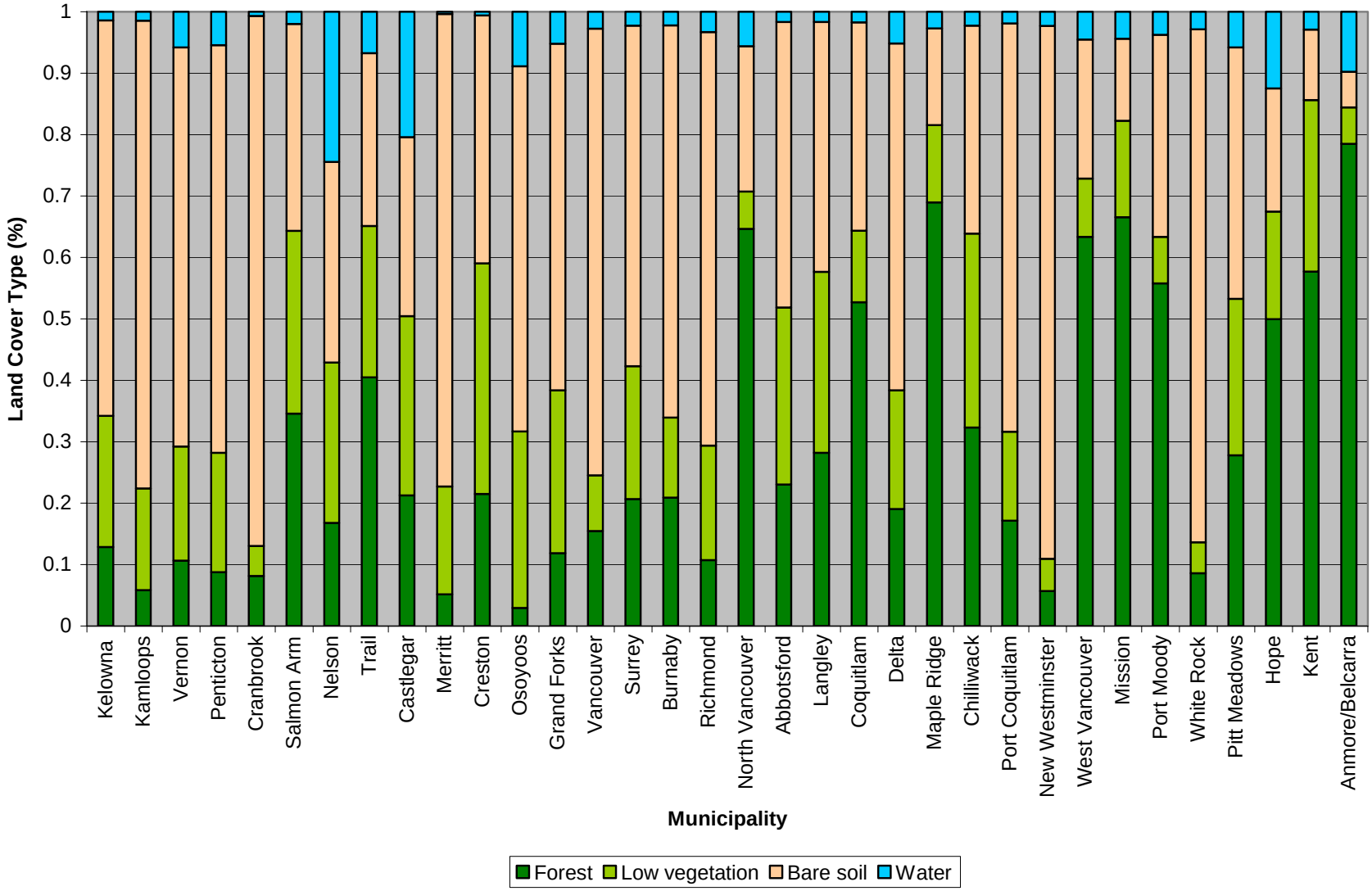
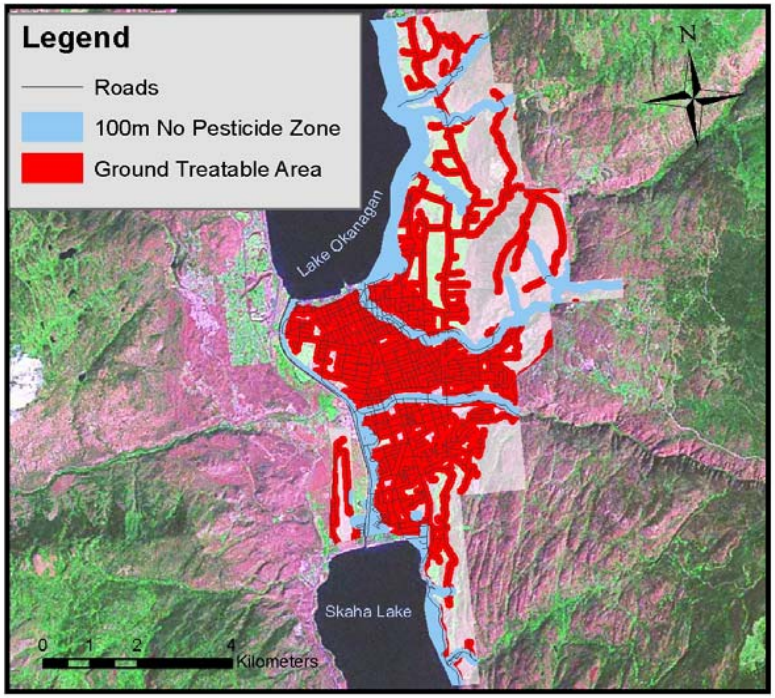
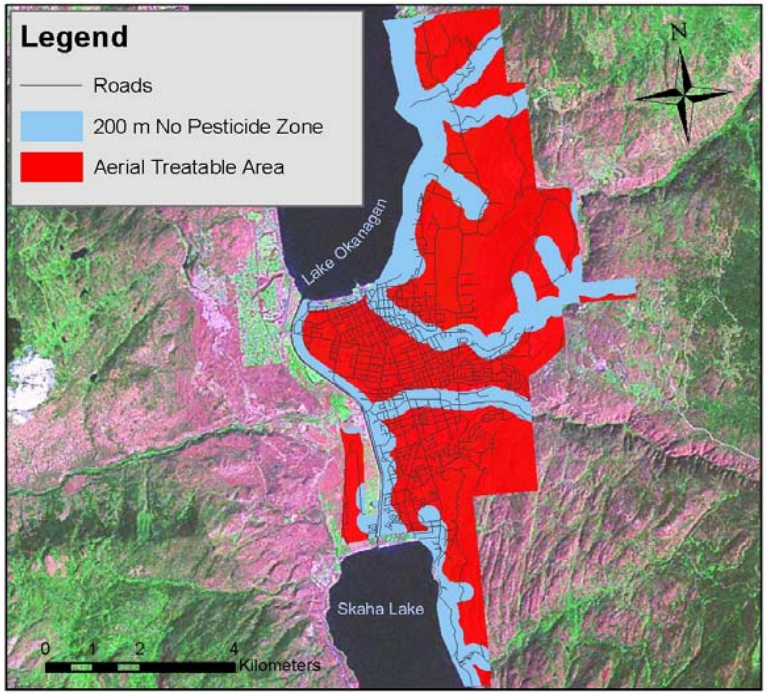


Figure 29: City of Penticton Adulticiding Scenario

City of Pentiction Adulticiding Scenario

Population (2005) 33,061 Landmass 44.1 Km² Linear Road Distance 229.6 Km





Truck Mounted ULV Spray Scenario

Truck Based ULV spraying requires a 100 metre buffer zone around sensitive areas, and water bodies. This treatment technique applies the pesticide up to 90 metres in from each side of the street.
The 100 metre buffer zone occupies 8.9 Km² of land.
Street Network is 229.6 Km long.
The truck travels 16Km/h
The distance to be covered is 459.2 Km (one pass on each side of the street) which would take one truck 29 hours to drive.

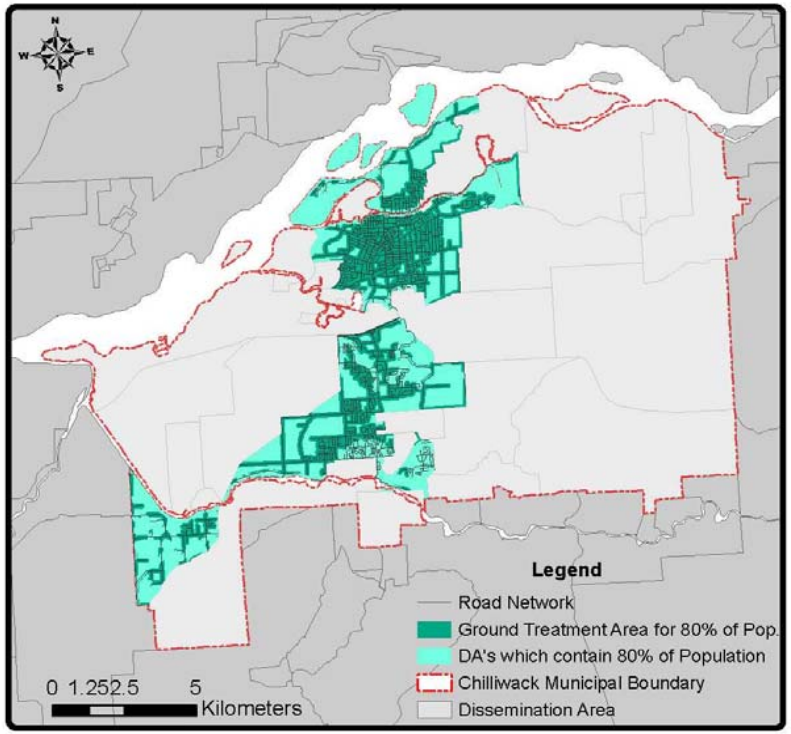
This technique would cover 20.4 Km² of land or 46.3% of the City of Penticton.

Fixed Wing Aircraft Spray Scenario

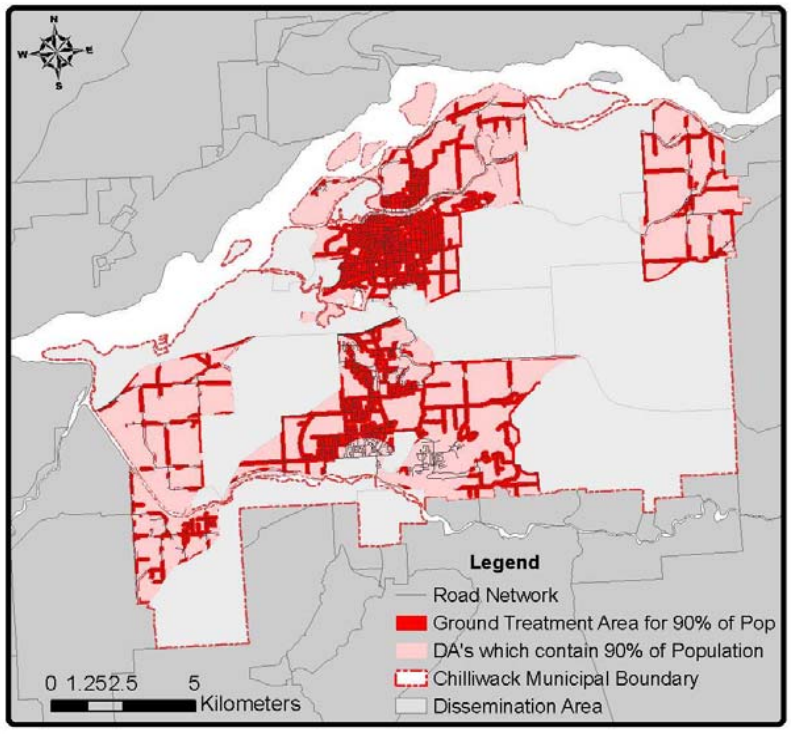
Fixed Wing Aerial spraying requires a 200 metre buffer zone around sensitive areas, and water bodies.
The 200 metre buffer zone occupies 81.8 Km² of land.

This technique would cover 29.1 Km² of land or 65.9% of the City of Penticton.

Figure 30: Ground-based Adulticiding Coverage of 80% and 90% of the City of Chilliwack's Population



80% of Population selected by highest population densities



90% of Population selected by highest population densities

Ground Based ULV Sprayer (Truck Mounted)											
Municipality	2001 Pop	Untreated Population	Land (Km²)	Roads (Km)	Driving Distance (Km)	Driving Hours	Treatment nights (1 unit)	Units needed for <3 nights treatment	Treatable Area (Km²)	100m Buffer (Km²)	Treatment Coverage
Chilliwack	65,132	0	273	742	1484	93	11	3.6	70	65	26%
Chilliwack 90%	58,831	6,301		427	854	53	6	2.1	37	65	14%
Chilliwack 80%	52,490	12,642		300	599	37	4	1.5	25	65	9%

Communications Highlights

Despite predictions that WNv might arrive in BC for a number of years, the virus had not yet done so at the beginning of the 2006 surveillance season. Therefore, in an effort to counter public and media fatigue around WNv messages, the communications strategy for the 2006 season was less proactive in garnering media attention than in previous years. Communications, in consultation with Epidemiology, decided only to send out one press release for 2006, in July, which focused on the most important aspect for the public - personal protective measures. Not surprisingly, overall media interest was was not as high in 2006 compared with previous years and centered mainly around the identification of West Nile virus cases in neighbouring Washington State and future predictions for BC. The BCCDC received 21 requests for interviews throughout the season. This compares with 43 in 2005, 29 in 2004 and over 100 in 2003. The BCCDC also circulated a general brochure about West Nile virus to BC Parks and Canadian Blood Services for distribution to the public.

In 2006, the BCCDC continued to lead a provincial communications group on West Nile virus which met every month via teleconference. The mandate of the group was to strategize on overall communications approaches, help define roles and responsibilities and share information about West Nile activity and initiatives that were underway in BC. This group was comprised of communications representatives from various agencies including provincial government ministries, health authorities and municipalities.

Adulticide Contingency Planning

Over the 2006 season considerable work was done by the Adulticiding Contingency Planning Subcommittee to review the evidence of effectiveness and potential risks of adulticiding and to further the preparedness process. The subcommittee reviewed evidence about both malathion and pyrethrin and discussed the issues of the indemnification that is required by the manufacturer of malathion. We also reviewed the evidence for aerial versus ground based ULV spraying and their effectiveness at preventing WNv disease in humans. The subcommittee determined that there was a need in BC at least for the near term to continue to investigate resources for aerial adulticiding. In the meantime the subcommittee felt it was important to ensure that adequate resources were available in the province to rapidly deploy ground-based spraying if required. To this end four more truck-mounted ULV sprayers were purchased. In order to assist in this decision making process BCCDC developed a series of multi-layered maps of the 34 communities in the highest risk areas to determine if there was added value to having aerial capacity over and above the ground-based capacity. Interestingly, when aspects such as topography, road coverage and land use were considered it became apparent there are some communities where ground based ULV spraying would be best and some where aerial spraying was the preferred option. In addition, some communities are not accessible by either method.

This helped the group to think of different ways of mitigating a potential WNv outbreak in these areas; for example by focusing on source reduction, larviciding and education.

Finally, a table-top exercise was held in Fraser Health to review in detail the logistical aspects of ground-based ULV spraying in a community. Participants included local leaders and Emergency Preparedness (EP) as well as health authority staff from Fraser, Vancouver Coastal and Interior Health, GVRD representatives, BCCDC and the local contractor. This exercise highlighted the need to involve local Emergency Planners to ensure that communication messages and support are available for the community. Efforts are underway to ensure that Provincial Emergency Preparedness are aware of the issue and have developed plans to support WNv response should it be needed.

References

Ada County, Idaho, 2006. Mosquito and health.
http://www.phd4.state.id.us/epi/WNV.htm

Ada County, Idaho, 2006b. Data survey download
http://www.adaweb.net/departments/weedpestmosquito/wnv_survey_history.htm

BC Ministry of Environment, June 15 2006. Snow survey bulletin: Snowpack and Water Supply Outlook for British Columbia.
http://www.env.gov.bc.ca/rfc/river_forecast/bulletin.htm

BC Stats, Government of British Columbia. 2006. BC municipal population estimates, 1996-2005. http://www.bcstats.gov.bc.ca/data/pop/pop/mun/Mun9605s.asp

Belton, P., 1983. Mosquitoes of British Columbia. Provincial Handbook No. 41. 189 pp.
http://wlapwww.gov.bc.ca/wld/documents/techpub/rbcm_hb41/mosquitoes.pdf

Bennett, Jack 2006. Idaho State Update. Report at 2006, North West Mosquito and Vector Control Association, Newport Oregon (Oct. 5, 2006).

Busch MP, Tobler LH, Tobler J, Sandanha S, Caglioti V et al. Analytical and clinical sensitivity of West Nile virus RNA screening and supplemental assays available in 2003. Transfusion 2005;45(4):492-9.

California, 2006. West Nile Virus maps and data. http://westnile.ca.gov/maps_data.htm

Conservation Data Centre, Government of British Columbia. 2006. Species and ecosystems at risk. http://www.env.gov.bc.ca/cdc/index.html

Crans, W. J., 2004. A Classification system for mosquito life cycles: Life cycle types for mosquitoes of the northeastern United States. J. Vector. Ecol. 29(1):1-10.
http://www.sove.org/Journal%20PDF/journal%202004%20pdfs/Crans.pdf

dmti Spatial. 2005. CanMap streetfiles v7.1 – British Columbia.
http://www.dmtispatial.com/cm_streetfiles.htm

Farnon, Eileen, 2006. Summary of West Nile Virus Activity, United States 2005. Seventh National Conference on West Nile virus in the United States. San Francisco, Feb. 23, 2006.

GDG Environmental Inc., 2006. Pre-emptive West Nile virus mosquito control in catch basins: Identification of triggers and Priority Areas for larval treatment. Final Report. GDG Environmental and Morrow BioSciences Project 4805-910. 30pp.

Idaho, 2006. Map of Idaho with rivers. http://nationalatlas.gov/natlas/Natlasstart.asp and http://en.wikipedia.org/wiki/Image:Columbia.png

Land Information BC, Government of British Columbia. 1996. Base maps watershed atlas coverages. http://www.bcfisheries.gov.bc.ca/fishinv/basemaps-watershed.html

Manitoba Health, 2006. News Release Bulletin #2, June 13, 2006. http://www.gov.mb.ca/chc/press/top/2006/06/2006-06-13-03.html

Ministry of Environment, 2006. River Forecast Centre. http://www.env.gov.bc.ca/rfc/ http://www.env.gov.bc.ca/rfc/archive/2006/20060615/bulletin.htm

National Research Canada, Government of Canada. Sunrise/sunset calculator. http://www.hia-iha.nrc-cnrc.gc.ca/sunrise_e.html

Pesticide Management Review Agency, 2006. Regulatory Note, REG2006-02: *Bacillus sphaericus* Strain http://www.pmra-arla.gc.ca/english/pdf/reg/reg2006-02-e.pdf

Petersen, L. R., and E. B. Hayes, 2004. Westward Ho? — The Spread of West Nile Virus. N. Engl. J. Med. 351,22: 2257-2259.

Public Health Agency of Canada. West Nile Virus MONITOR. 2006 Human Surveillance. Available at: http://www.phac-aspc.gc.ca/wnv-vwn/mon-hmnsurv_e.html. Accessed 4 Dec 06.

Reddy, M. 2005. Non-Correlation of the Reproductive Activity of the Vectors of West Nile Virus with Human Infection. Abstract 4th International Congress of Vector Ecology (SP-18).

Savage, H., and B. Miller. 1995. House Mosquitoes of the U.S.A., *Cules pipiens* complex. Wing Beats, Vol. 6(2):8-9.

Statistics Canada, Government of Canada. 2002. Dissemination areas cartographic boundary files. http://www.statcan.ca/bsolc/english/bsolc?catno=92F0169X

Stephen, C., N. Plamondon and P. Belton. 2006. Notes on the distribution of mosquito species that could potentially transmit West Nile virus on Vancouver Island, British Columbia. JAMCA 22(3):553-556.

Tachiiri K, Klinkenberg B, Mak S, Kazmi J. 2006. Predicting outbreaks: a spatial risk assessment of West Nile virus in British Columbia. *Int J Health Geogr*. May 16;5:21.

US Geologic Survey, 2006. Mid April to mid June Idaho in >90% streamflow discharge http://water.usgs.gov/waterwatch/?m=pamap&r=id&w=flood%2Cmap

Contributors

Epidemiology Services, BCCDC

Laura MacDougall, Surveillance Epidemiologist
Allen Furnell, Medical Entomologist
Sunny Mak, GIS Analyst
Min Li, Surveillance Analyst
Mieke Buller, GIS Consultant
Ian Roe, Communications
Bonnie Henry, Physician Epidemiologist

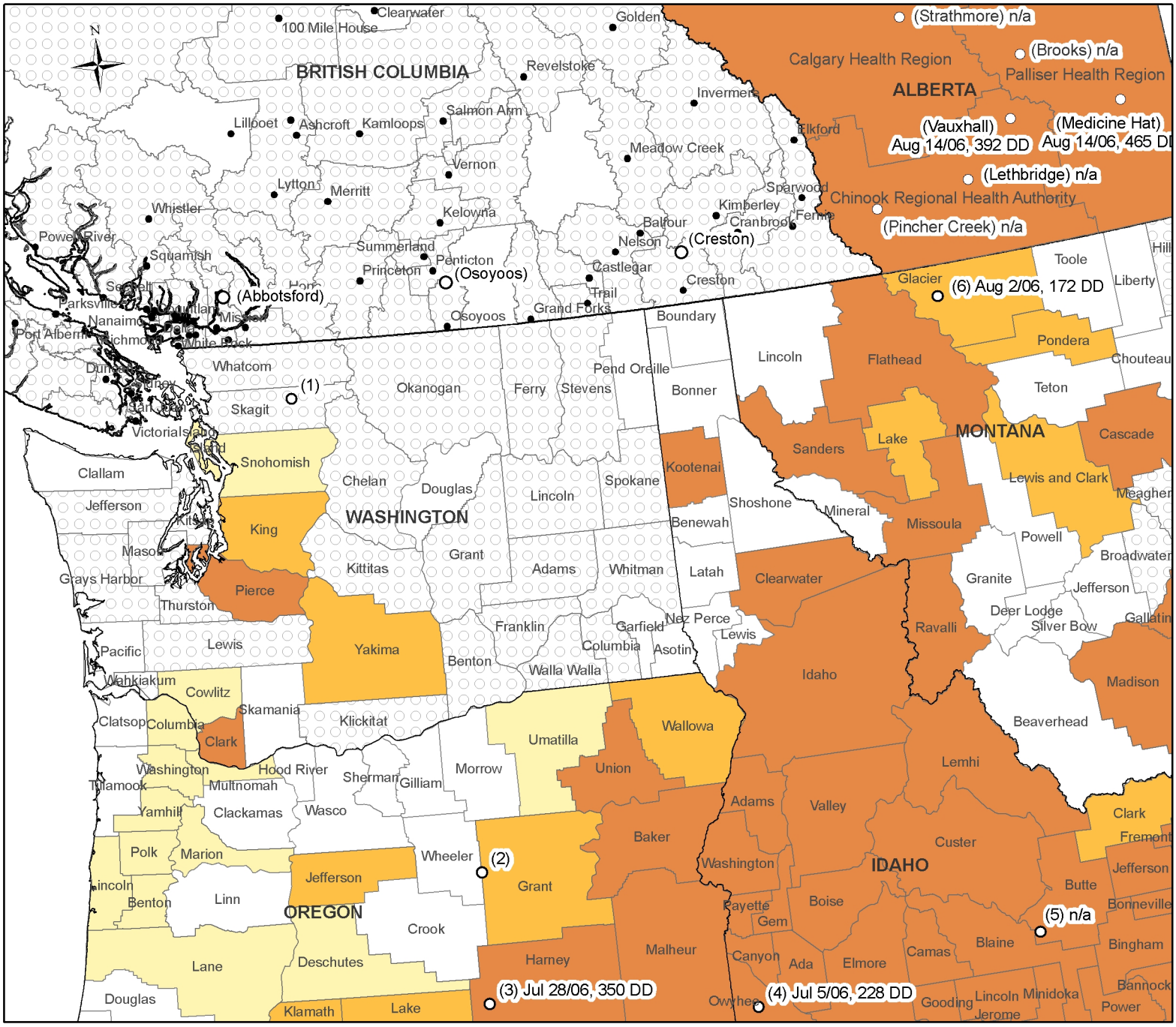
Laboratory Services, BCCDC

Muhammad Morshed, Senior Scientist, Zoonotics and Emerging Pathogens
Annie Mak, Supervisor, Virology
Yvonne Simpson, Lab Scientist, Zoonotics and Emerging Pathogens
Quantine Wong, Supervisor, Parasitology
Teresa Lo, Lab Scientist, Parasitology
Doug Ruissard, Systems Analyst
Peter Ng, Laboratory Information Management Coordinator

Canadian Blood Services, BC and Yukon Centre

Mark Bigham, Medical Consultant
Gershon Growe, Medical Director
Patrick Loftus, Medical Services Co-ordinator
Alice Cheung, Co-ordinator, Donor Records and Business Systems

Appendix 1



State	Climate Station	Degree Days Accumulated to Aug 31, 2006
Washington	1	361
Oregon	2	734
Oregon	3	494
Idaho	4	612
Idaho	5	514
Montana	6	240
British Columbia	Abbotsford	342
British Columbia	Osoyoos	687
British Columbia	Creston	554
Alberta	Strathmore	293
Alberta	Brooks	468
Alberta	Lethbridge	382
Alberta	Medicine Hat	551
Alberta	Pincher Creek	295
Alberta	Vauxhall	460

Legend

- Climate Station (date, degree day of first human positive)
- No data
- No positive submissions
- WNv positive corvid
- WNv positive mosquito
- WNv positive equine
- WNv positive human

0 50 100 200
Kilometers

National Surveillance for West Nile Virus (WNV)

Section A: Case Definitions

The current Case Definitions were drafted with available information at the time of writing. Case Definitions and Diagnostic Test Criteria are subject to change as new information becomes available.

1) West Nile Virus Neurological Syndrome (WNNS):

Clinical Criteria:

History of exposure in an area where WN virus (WNV) activity is occurring[1]
OR
history of exposure to an alternative mode of transmission[2]
AND
onset of fever
AND RECENT ONSET OF AT LEAST ONE of the following:

- encephalitis (acute signs of central or peripheral neurologic dysfunction), or
- viral meningitis (pleocytosis and signs of infection e.g., headache, nuchal rigidity),or
- acute flaccid paralysis (e.g., poliomyelitis-like syndrome or Guillain-Barré-like syndrome), [3] or
- movement disorders (e.g., tremor, myoclonus), or
- Parkinsonism or Parkinsonian-like conditions (e.g., cogwheel rigidity, bradykinesia, postural instability), or
- other neurological syndromes as defined in the *Note* below

Note: A significant feature of West Nile viral neurologic illness may be marked muscle weakness that is more frequently unilateral, but can be bilateral. WNV should be considered in the differential diagnosis of all suspected cases of acute flaccid paralysis with or without sensory deficit. WNV-associated weakness typically affects one or more limbs (sometimes affecting one limb only). Muscle weakness may be the sole presenting feature of WNV illness (in the absence of other neurologic features) or may develop in the setting of fever, altered reflexes, meningitis or encephalitis. Weakness typically develops early in the course of clinical infection. Patients should be carefully monitored for evolving weakness and in particular for acute neuromuscular respiratory failure, which is a severe manifestation associated with high morbidity and mortality. **For the purpose of WNV Neurologic Syndrome Classification, muscle weakness is characterized by severe (Polio-like), non-transient and prolonged symptoms.** Electromyography (EMG) and lumbar puncture should be performed to differentiate WNV-associated paralysis from acute demyelinating polyneuropathy (e.g., Guillain-Barré syndrome). Lymphocytic pleocytosis (an increase in WBC with a predominance of lymphocytes in the cerebrospinal fluid [CSF]) is commonly seen in acute flaccid paralysis due to WNV whereas pleocytosis is not a feature of Guillain-Barré Syndrome.

Other emerging clinical syndromes, identified during 2002 included, but were not limited to the following: myelopathy, rhabdomyolysis (acute destruction of skeletal muscle cells), peripheral neuropathy; polyradiculoneuropathy; optic neuritis; and acute demyelinating encephalomyelitis (ADEM). Ophthalmologic conditions including chorioretinitis and vitritis were also reported. Facial weakness was also reported. Myocarditis, pancreatitis and fulminant hepatitis have not been identified in North America, but were reported in outbreaks of WNV in South Africa. **"Aseptic" meningitis without encephalitis or acute flaccid paralysis** occurring in August and September when WNV is circulating may be due to non-polio enteroviruses circulating at the same time. This should be considered in the differential diagnosis.
[Sejvar J et al. JAMA (2003) Vol.290 (4) p. 511-515, Sejvar, J. et al. Emerg Infect Dis (2003) Vol 9 (7) p.788-93 and Burton, JM et al Can. J. Neurol. Sci. (2004) Vol.31 (2) p.185-193]

[1]History of exposure when and where West Nile virus transmission is present, or could be present, or history of travel to an area with confirmed WNV activity in birds, horses, other mammals, sentinel chickens, mosquitoes, or humans.

[2]Alternative modes of transmission, identified to date, include: laboratory-acquired; *in utero*; receipt of blood components; organ/tissue transplant; and, possibly via breast milk.

[3] A person with WNV-associated acute flaccid paralysis may present with or without fever or mental status changes. Altered mental status could range from confusion to coma with or without additional signs of brain dysfunction (e.g. paralysis, cranial nerve palsies, sensory deficits, abnormal reflexes, generalized convulsions and abnormal movements). Acute flaccid paralysis with respiratory failure is also a problem.

Suspect WNNS Case:

Clinical criteria IN THE ABSENCE OF OR PENDING diagnostic test criteria (see below) AND IN THE ABSENCE of any other obvious cause.

Probable WNNS Case:

Clinical criteria AND AT LEAST ONE of the probable case diagnostic test criteria (see below).

Confirmed WNNS Case:

Clinical criteria AND AT LEAST ONE of the confirmed case diagnostic test criteria (see below).

2) West Nile Virus Non-Neurological Syndrome (WN Non-NS):

Clinical Criteria:

History of exposure in an area where WN virus (WNV) activity is occurring[1]
OR
history of exposure to an alternative mode of transmission[2]
AND AT LEAST TWO of the following [4] :

- fever,
- myalgia[5],
- arthalgia,
- headache,
- fatigue,
- lymphadenopathy,
- maculopapular rash

[4] It is possible that other clinical signs and symptoms could be identified that have not been listed and may accompany probable case or confirmed case diagnostic test criteria. For example, gastrointestinal (GI) symptoms were seen in many WNV patients in Canada and the USA in 2003 and 2004.

[5] Muscle weakness may be a presenting feature of WNV illness. **For the purpose of WNV Non-NeurologicAL Syndrome classification, muscle weakness or myalgia (muscle aches and pains) is characterized by a mild, transient, unlikely prolonged symptoms that are not associated with motor neuropathy.**

Suspect WN Non-NS Case:

Clinical criteria IN THE ABSENCE OF OR PENDING diagnostic test criteria (see below) AND IN THE ABSENCE of any other obvious cause.

Probable WN Non-NS Case:

Clinical criteria AND AT LEAST ONE of the probable case diagnostic test criteria (see below)

Confirmed WN Non-NS Case:

Clinical criteria AND AT LEAST ONE of the confirmed case diagnostic test criteria (see below)

3) West Nile Virus Asymptomatic Infection (WNAI)[6]:

Probable WNAI Case:

Probable case diagnostic test criteria (see below) IN THE ABSENCE of clinical criteria

Confirmed WNAI Case:

Confirmed case diagnostic test criteria (see below) IN THE ABSENCE of clinical criteria

[6] This category could include asymptomatic blood donors whose blood is screened using a Nucleic Acid Amplification Test (NAT), by Blood Operators (i.e. Canadian Blood Services or Hema-Quebec) and is subsequently brought to the attention of public health officials. The NAT that will be used by Blood Operators in Canada is designed to detect all viruses in the Japanese encephalitis (JE) serocomplex. The JE serocomplex includes WN virus and 9 other viruses, although from this group only WN virus and St Louis encephalitis virus are currently endemic to parts of North America. Blood Operators in Canada perform a supplementary WN virus-specific NAT following any positive donor screen test result.

Section B: West Nile Virus Diagnostic Test Criteria:

Probable Case Diagnostic Test Criteria:

AT LEAST ONE of the following:

Detection of flavivirus antibodies in a single serum or CSF sample using a WN virus IgM ELISA [7] without confirmatory neutralization serology (e.g. Plaque Reduction Neutralization Test -PRNT) **OR**
A 4-fold or greater change in flavivirus HI titres in paired acute and convalescent sera or demonstration of a seroconversion using a WN virus IgG ELISA [7] **OR**
A titre of $\geq$ 1:320 in a single WN virus HI test, or an elevated titre in a WN virus IgG ELISA, with a confirmatory PRNT result **OR** [Note: A confirmatory PRNT or other kind of neutralization assay is not required in a health jurisdiction/authority where cases have already been confirmed in the current year]
Demonstration of Japanese encephalitis (JE) serocomplex-specific genomic sequences in blood by NAT screening on donor blood, by Blood Operators in Canada.

Note: WNV IgM antibody may persist for more than a year and the demonstration of IgM antibodies in a patient's serum, particularly in residents of endemic areas, may not be diagnostic of an *acute* WN viral infection. Seroconversion (by HI, IgG ELISA or PRNT assays) demonstrates a current WNV infection. Therefore, the collection of acute and convalescent sera for serologic analysis is particularly important to rule out diagnostic misinterpretation early in the WNV season (e.g. May, June) and to identify initial cases in a specific jurisdiction. However, it should be noted that seroconversions may not always be documented due to timing of acute sample collection (i.e. titres in acute sera may have already peaked). If static titres are observed in acute and convalescent paired sera, it is still possible the case may represent a recent infection. To help resolve this the use of IgG avidity testing [8] may be considered to distinguish between current and past infection. The presence of both IgM antibody and low avidity IgG in a patient's convalescent serum sample are consistent with current cases of viral associated illness. However test results that show the presence of IgM and high avidity IgG are indicative of exposures that have occurred in the previous season.

Immunocompromised individuals may not be able to mount an immune response necessary for a serological diagnosis. West Nile virus diagnostic test criteria for these individuals should be discussed with a medical microbiologist.

[7] Both CDC and commercial IgM / IgG ELISAs are now available for front line serological testing. Refer to appropriate assay procedures and kit inserts for the interpretation of test results.

[8] Early in infection the immune system generates antibodies that bind relatively weakly to viral antigen (low avidity). As the infection proceeds, an increasing percentage of newly generated IgG antibody displays higher binding affinity to virus antigen and thus avidity also rises (Note:

avidity is usually measured based upon the ability of IgG to dissociate from antigen preparations after incubation with a solution of urea). As long as high avidity IgG is not yet detected in the serum it can be assumed that the individual was exposed to the viral agent during a recent exposure. With respect to WNV infection it has not been precisely determined when (i.e. post-exposure) high avidity antibodies reach levels in serum that can be accurately detected by serological assays (there may be significant variation depending on the individual). However, it has been shown that greater than 95% of sera collected from individuals exposed to WNV 6-8 months previously will have IgG antibodies that bind strongly to viral antigen and will give high avidity scores using both IFA and ELISA testing formats. ***Note: Avidity testing will not replace confirmatory neutralization testing, non-WNV flavivirus IgG antibody (e.g. dengue, SLE, etc.) may bind to the antigen preparations used in avidity assays.*** *The Euroimmun West Nile virus IFA IgG avidity test is now licenced for use in Canada by the Medical Devices Bureau (MDB). An ELISA format is currently being evaluated and is available from the company, however, it is not yet registered by MDB.*

Confirmed Case Diagnostic Test Criteria:

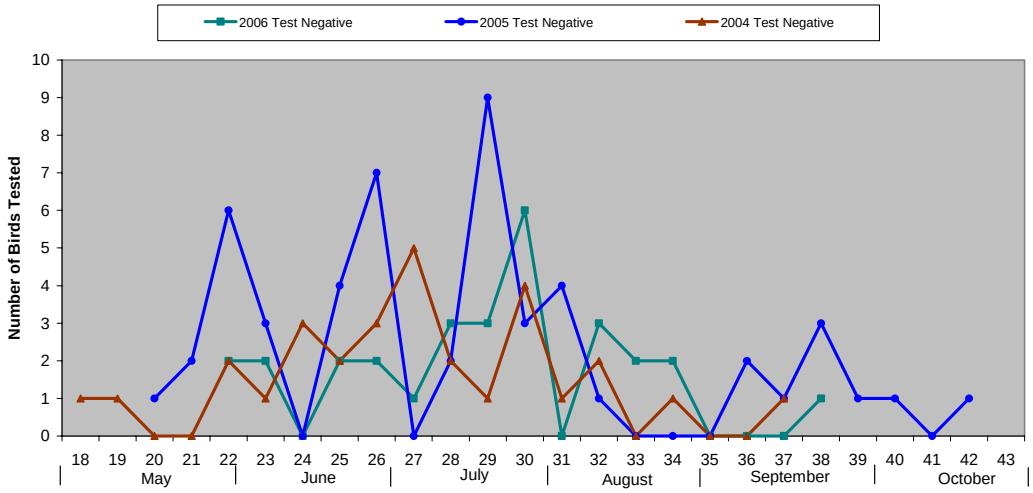
It is currently recommended that health jurisdictions/authorities use the Confirmed Case Diagnostic Test Criteria to confirm index cases (locally acquired) in their area each year; for subsequent cases, health jurisdictions/authorities could use the Probable Case Diagnostic Test Criteria to classify cases in their area as "confirmed", **for the purposes of surveillance**. Throughout the remainder of the transmission season health jurisdictions/authorities may wish to document PRNT antibody titres to West Nile virus in a proportion of cases, to be determined by that health jurisdiction/authority, in order to rule-out the possibility of concurrent activity by other flaviviruses. [For further information on diagnostic testing algorithms for West Nile virus, see the section entitled Laboratory Specimen Diagnostic Testing Algorithm in Appendix 4 of the National Guidelines for Response to West Nile virus.]

AT LEAST ONE of the following:

A 4-fold or greater change in WN virus neutralizing antibody titres (using a PRNT or other kind of neutralization assay) in paired acute and convalescent sera, or CSF. **OR**
Isolation of WN virus from, or demonstration of WN virus antigen or WN virus-specific genomic sequences in tissue, blood, CSF or other body fluids **OR**
Demonstration of flavivirus antibodies in a single serum or CSF sample using a WN virus IgM ELISA [7, 8], confirmed by the detection of WN virus specific antibodies using a PRNT (acute or convalescent specimen). **OR**
A 4-fold or greater change in flavivirus HI titres in paired acute and convalescent sera or demonstration of a seroconversion using a WN virus IgG ELISA [7, 8] **AND** the detection of WN specific antibodies using a PRNT (acute or convalescent serum sample).

APPENDIX 3

Comparison of Number of Birds Tested in Central Vancouver Island, 2004-2006



2006 Line Graph - Birds Tested n=(29)

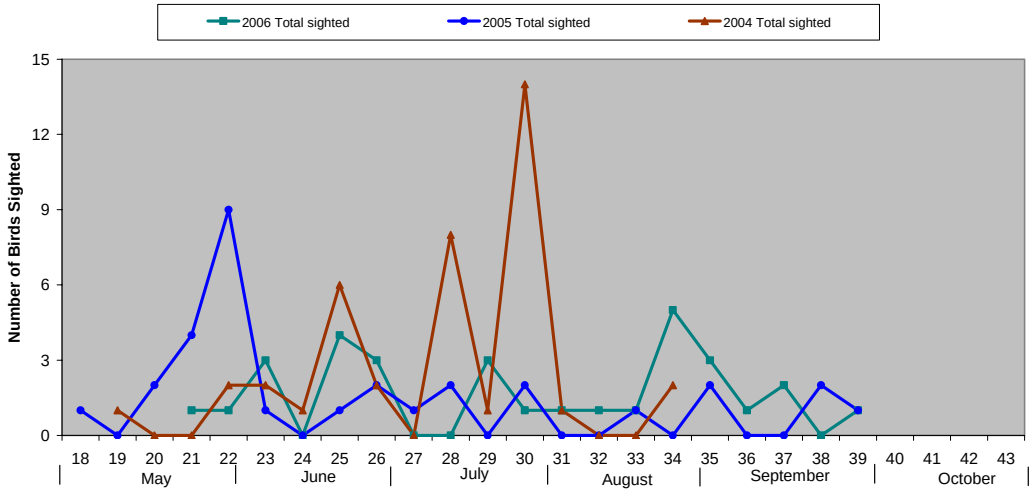
2005 Line Graph - Birds Tested n=(51)

2004 Line Graph - Birds Tested n=(30)

Data from week 18 to 43

Weeks run Sunday to Saturday

Comparison of Number of Birds Sighted in Central Vancouver Island, 2004 - 2006

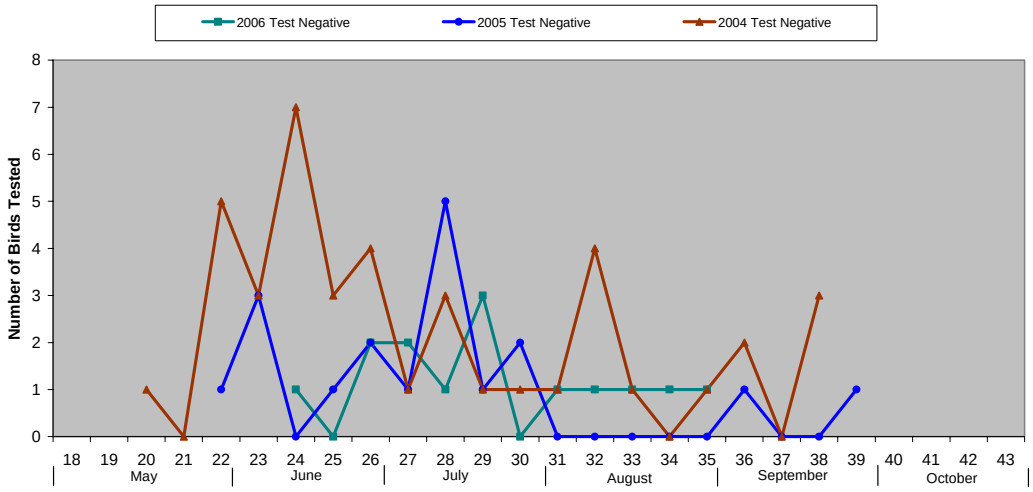


2006 Line Graph - Birds Sighted n=(31)

2005 Line Graph - Birds Sighted n=(31)

2004 Line Graph - Birds Sighted n=(40)

Comparison of Number of Birds Tested in East Kootenay, 2004-2006



2006 Line Graph - Birds Tested n=(14)

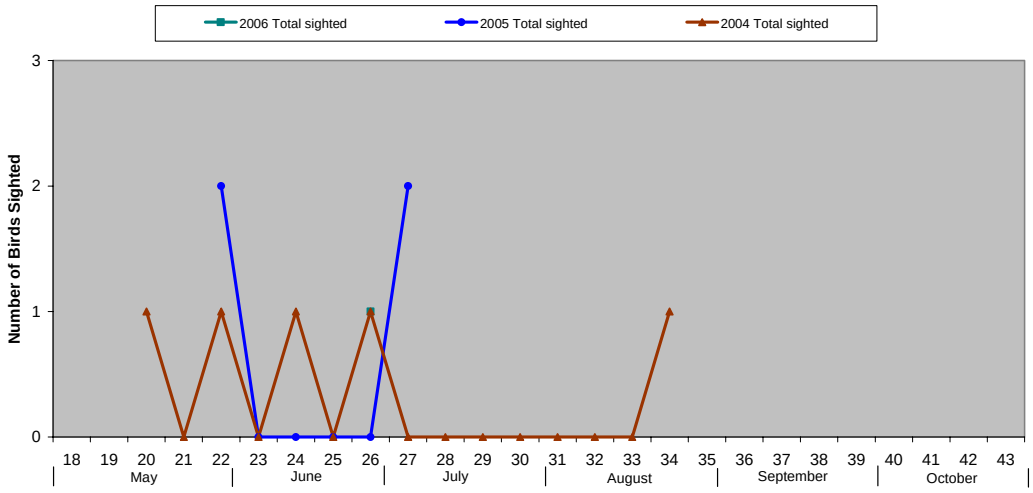
2005 Line Graph - Birds Tested n=(18)

2004 Line Graph - Birds Tested n=(41)

Data from week 18 to 43

Weeks run Sunday to Saturday

Comparison of Number of Birds Sighted in East Kootenay, 2004-2006



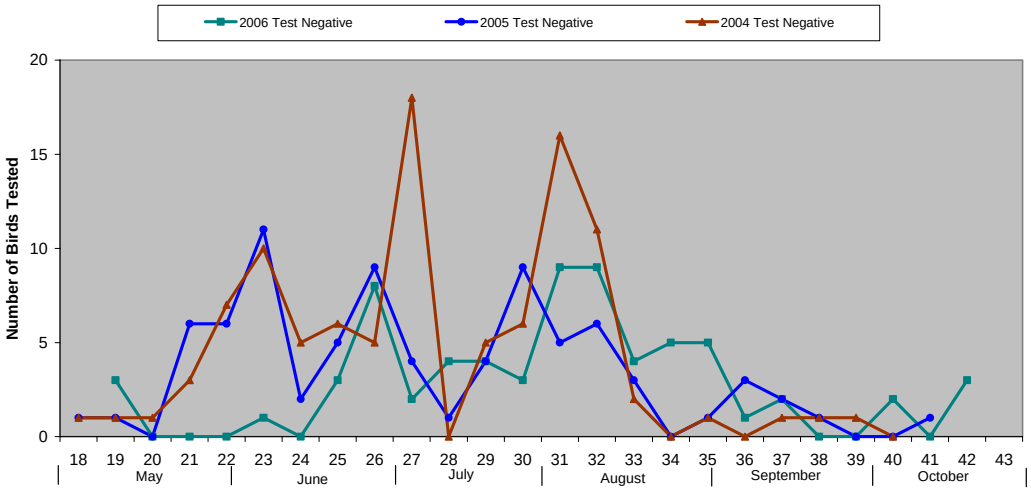
2006 Line Graph - Birds Sighted n=(1)

2005 Line Graph - Birds Sighted n=(4)

2004 Line Graph - Birds Sighted n=(5)

Weeks run Sunday to Saturday

Comparison of Number of Birds Tested in Fraser East, 2004-2006



2006 Line Graph - Birds Tested n=(68)

2005 Line Graph - Birds Tested n=(81)

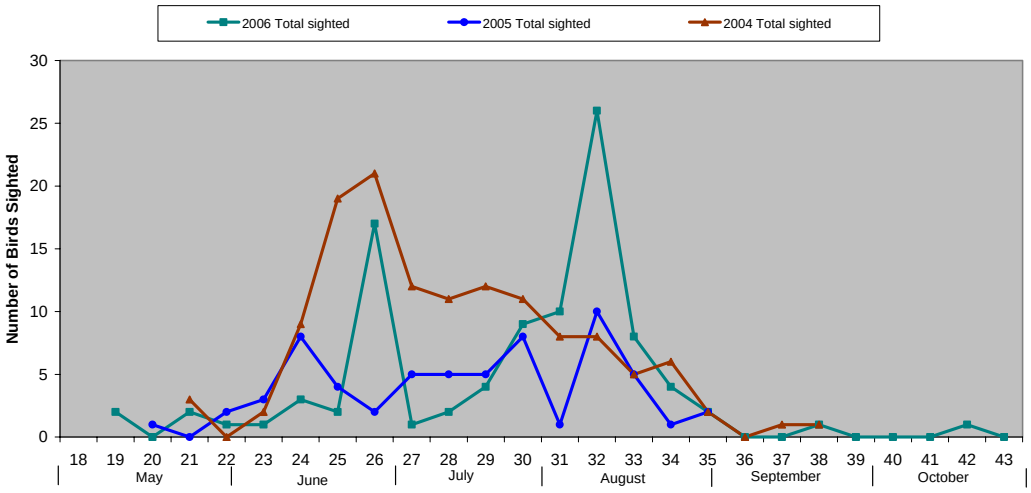
2004 Line Graph - Birds Tested n=(101)

Week Number

Data from week 18 to 43

Weeks run Sunday to Saturday

Comparison of Number of Birds Sighted in Fraser East, 2004-2006



2006 Line Graph - Birds Sighted n=(96)

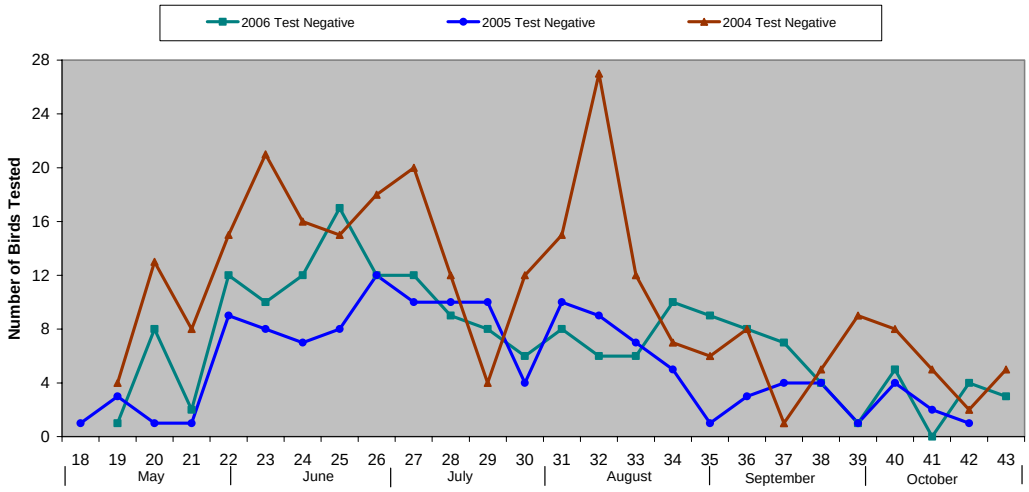
2005 Line Graph - Birds Sighted n=(62)

2004 Line Graph - Birds Sighted n=(131)

Week Number

Weeks run Sunday to Saturday

Comparison of Number of Birds Tested in Fraser North, 2004-2006



2006 Line Graph - Birds Tested n=(180)

2005 Line Graph - Birds Tested n=(135)

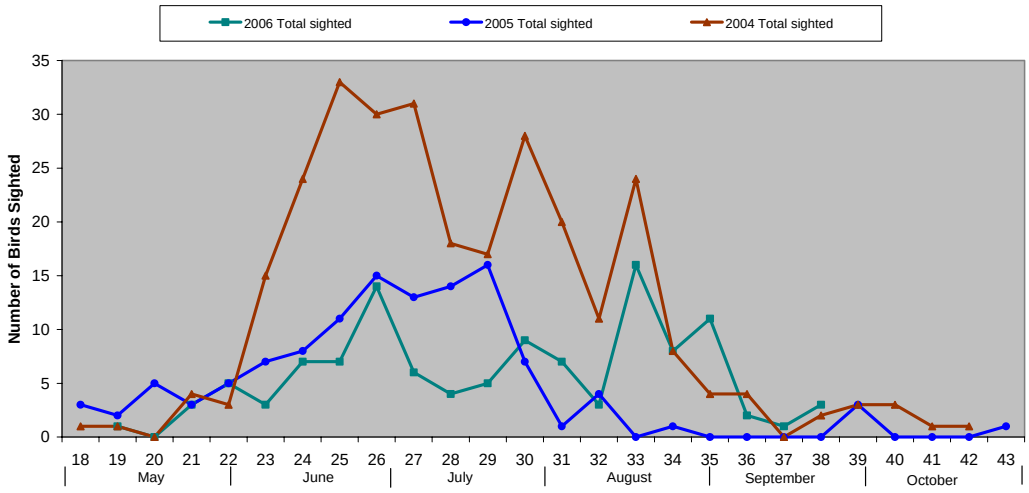
2004 Line Graph - Birds Tested n=(268)

Week Number

Data from week 18 to 43

Weeks run Sunday to Saturday

Comparison of Number of Birds Sighted in Fraser North, 2004-2006



2006 Line Graph - Birds Sighted n=(115)

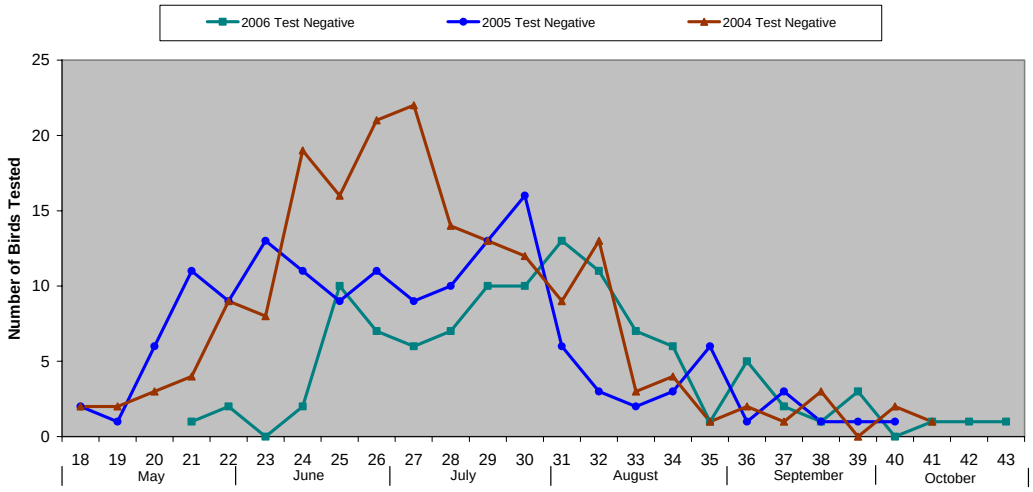
2005 Line Graph - Birds Sighted n=(119)

2004 Line Graph - Birds Sighted n=(286)

Week Number

Weeks run Sunday to Saturday

Comparison of Number of Birds Tested in Fraser South, 2004-2006



2006 Line Graph - Birds Tested n=(107)

2005 Line Graph - Birds Tested n=(148)

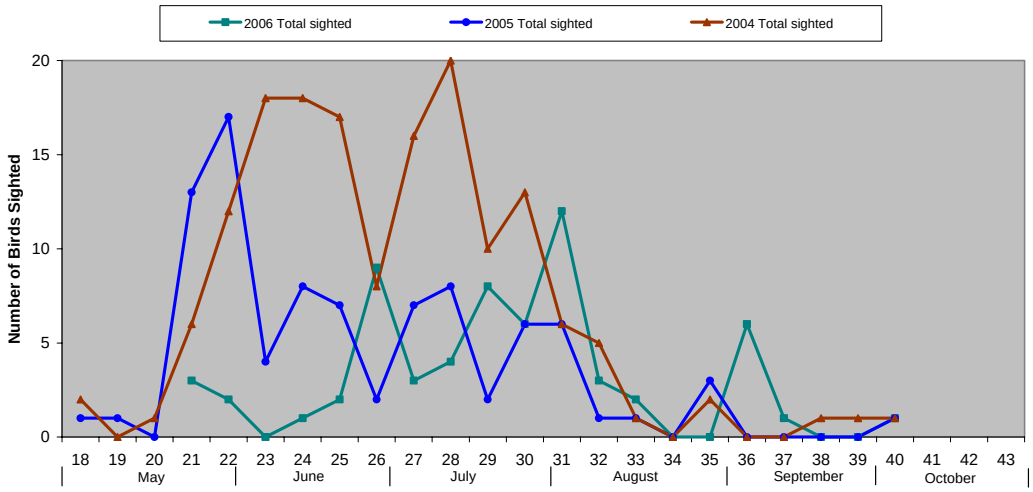
2004 Line Graph - Birds Tested n=(184)

Week Number

Data from week 18 to 43

Weeks run Sunday to Saturday

Comparison of Number of Birds Sighted in Fraser South, 2004-2006



2006 Line Graph - Birds Sighted n=(63)

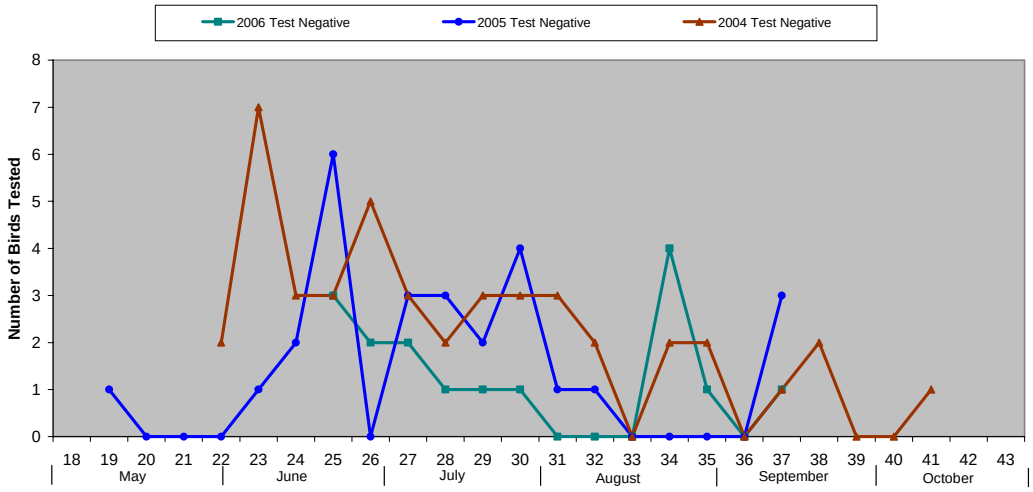
2005 Line Graph - Birds Sighted n=(88)

2004 Line Graph - Birds Sighted n=(158)

Week Number

Weeks run Sunday to Saturday

Comparison of Number of Birds Tested in Kootenay Boundary, 2004-2006



2006 Line Graph - Birds Tested n=(16)

2005 Line Graph - Birds Tested n=(27)

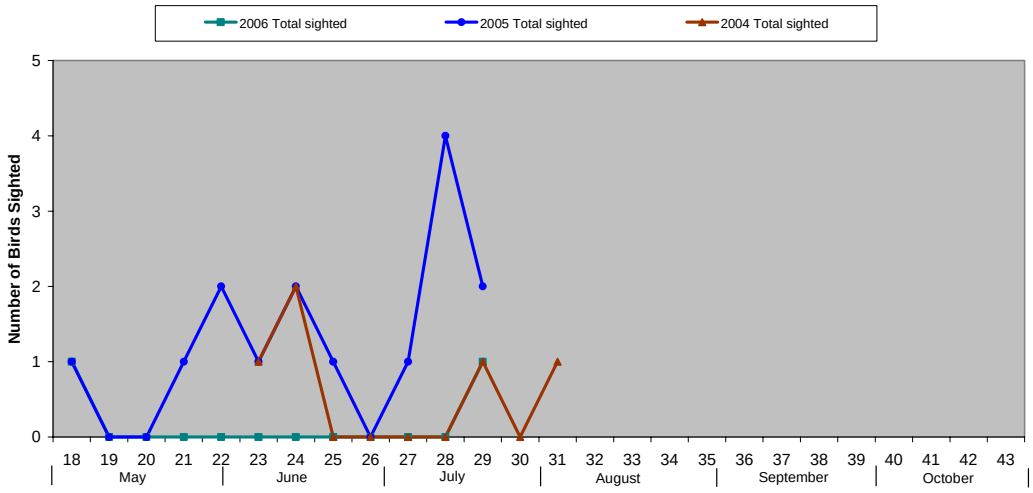
2004 Line Graph - Birds Tested n=(44)

Week Number

Data from week 18 to 43

Weeks run Sunday to Saturday

Comparison of Number of Birds Sighted in Kootenay Boundary, 2004-2006



2006 Line Graph - Birds Sighted n=(2)

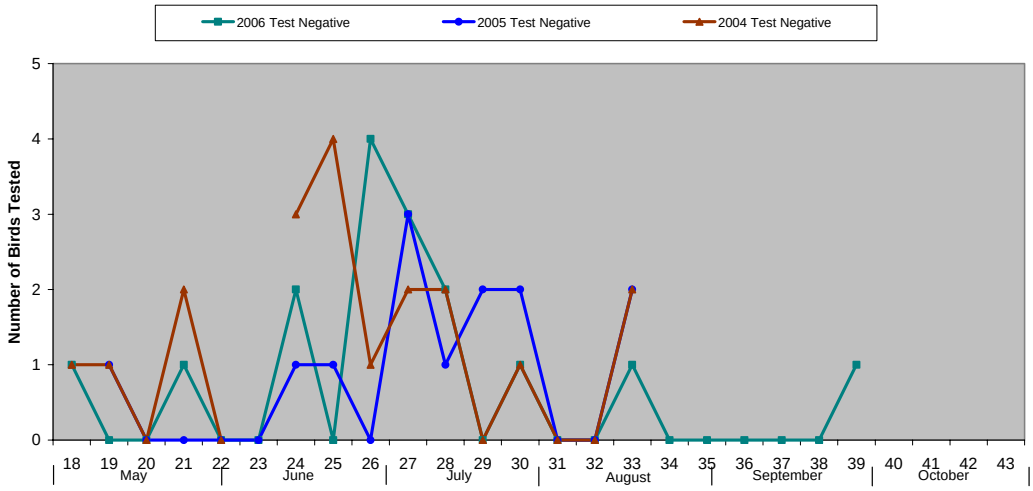
2005 Line Graph - Birds Sighted n=(15)

2004 Line Graph - Birds Sighted n=(5)

Week Number

Weeks run Sunday to Saturday

Comparison of Number of Birds Tested in Northeast, 2004-2006



2006 Line Graph - Birds Tested n=(16)

2005 Line Graph - Birds Tested n=(13)

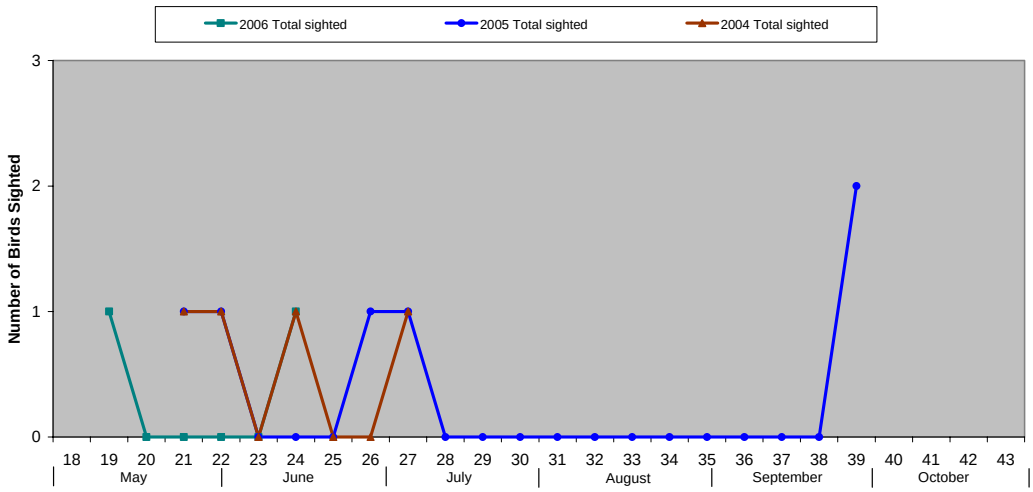
2004 Line Graph - Birds Tested n=(19)

Week Number

Data from week 18 to 43

Weeks run Sunday to Saturday

Comparison of Number of Birds Sighted in Northeast, 2004-2006



2006 Line Graph - Birds Sighted n=(2)

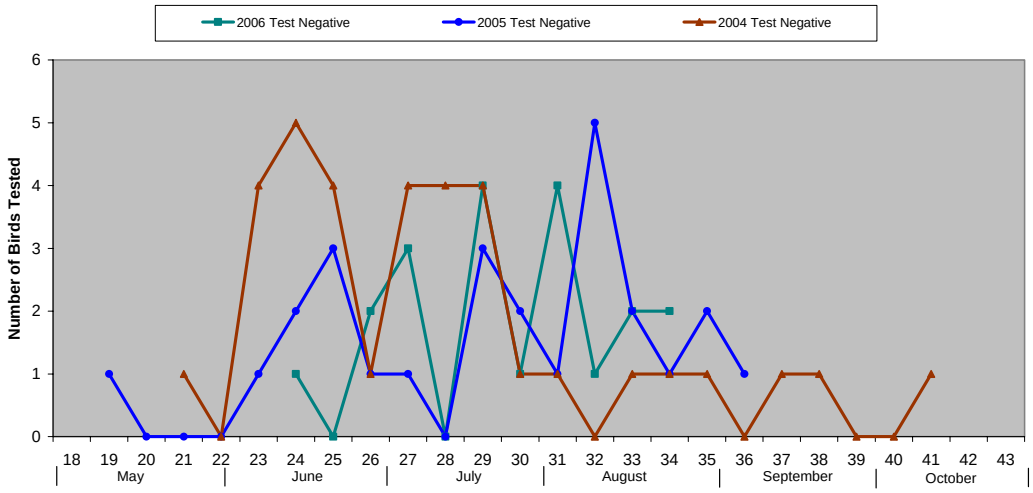
2005 Line Graph - Birds Sighted n=(6)

2004 Line Graph - Birds Sighted n=(4)

Week Number

Weeks run Sunday to Saturday

Comparison of Number of Birds Tested in Nothern Interior, 2004-2006



2006 Line Graph - Birds Tested n=(20)

2005 Line Graph - Birds Tested n=(26)

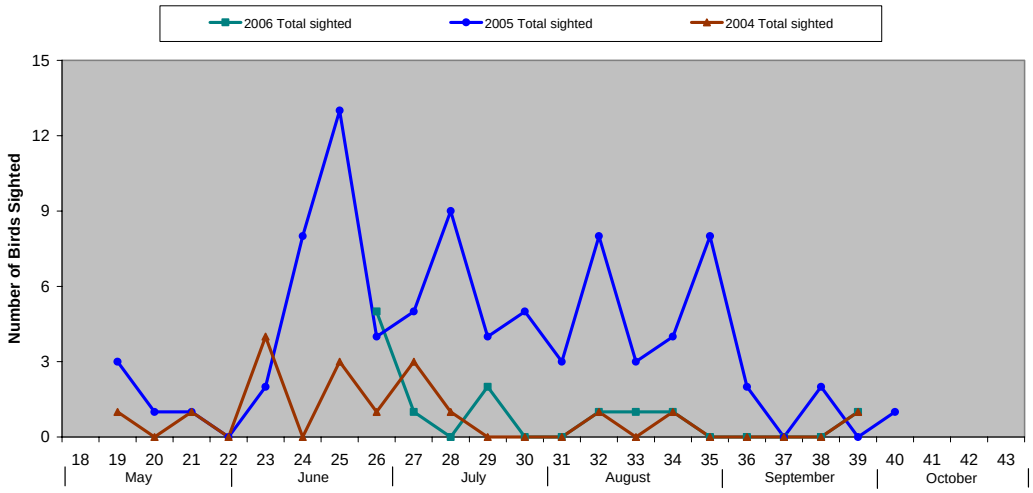
2004 Line Graph - Birds Tested n=(35)

Week Number

Data from week 18 to 43

Weeks run Sunday to Saturday

Comparison of Number of Birds Sighted in Nothern Interior, 2004-2006



2006 Line Graph - Birds Sighted n=(12)

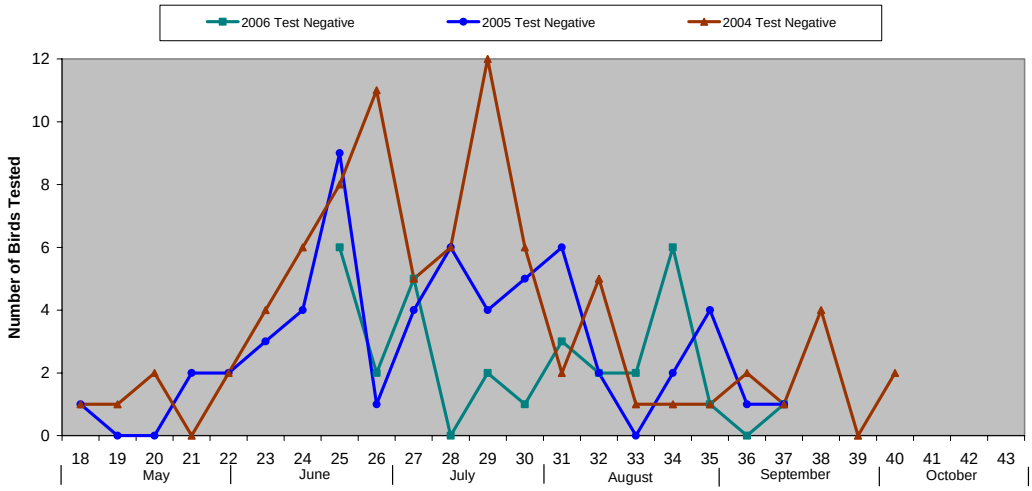
2005 Line Graph - Birds Sighted n=(86)

2004 Line Graph - Birds Sighted n=(17)

Week Number

Weeks run Sunday to Saturday

Comparison of Number of Birds Tested in North Shore/Coast Garibaldi, 2004-2006



2006 Line Graph - Birds Tested n=(31)

2005 Line Graph - Birds Tested n=(57)

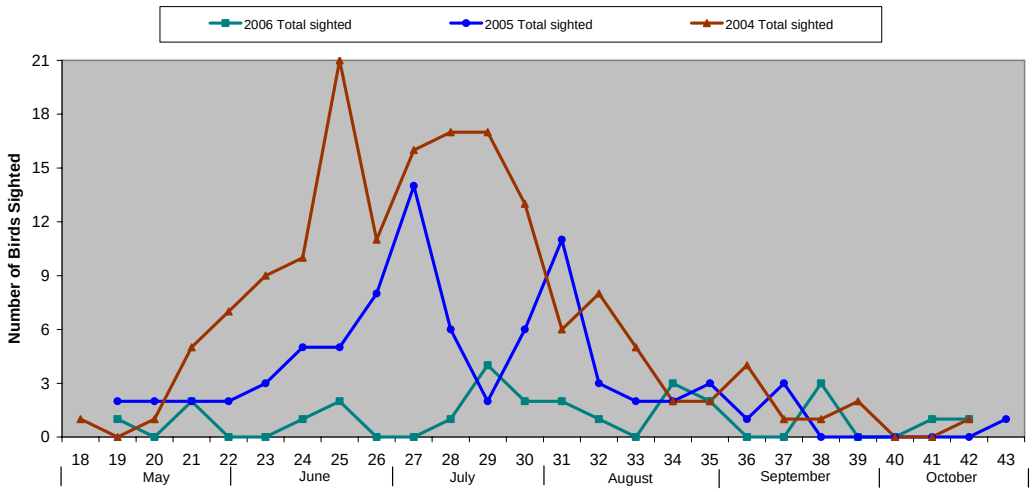
2004 Line Graph - Birds Tested n=(83)

Week Number

Data from week 18 to 43

Weeks run Sunday to Saturday

Comparison of Number of Birds Sighted in North Shore/Coast Garibaldi, 2004-2006



2006 Line Graph - Birds Sighted n=(26)

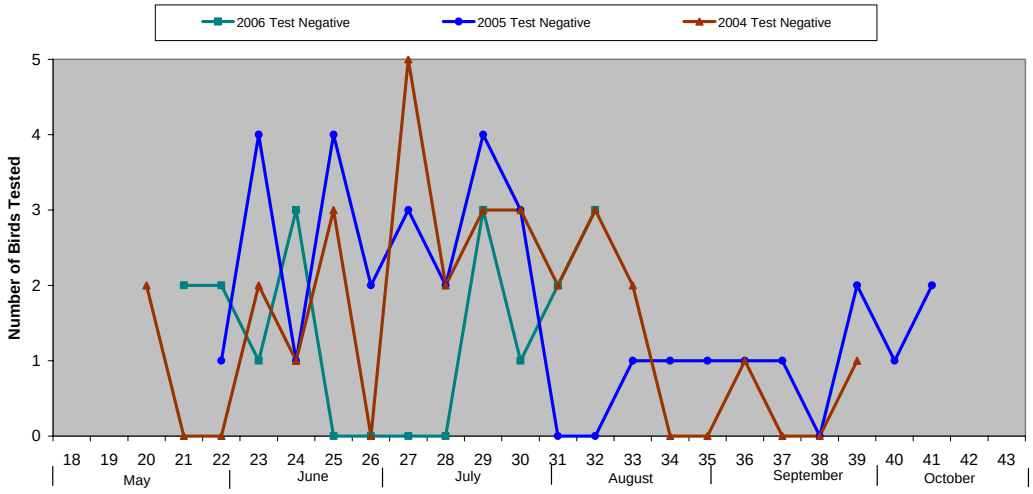
2005 Line Graph - Birds Sighted n=(83)

2004 Line Graph - Birds Sighted n=(160)

Week Number

Weeks run Sunday to Saturday

Comparison of Number of Birds Tested in North Vancouver Island, 2004-2006



2006 Line Graph - Birds Tested n=(17)

2005 Line Graph - Birds Tested n=(34)

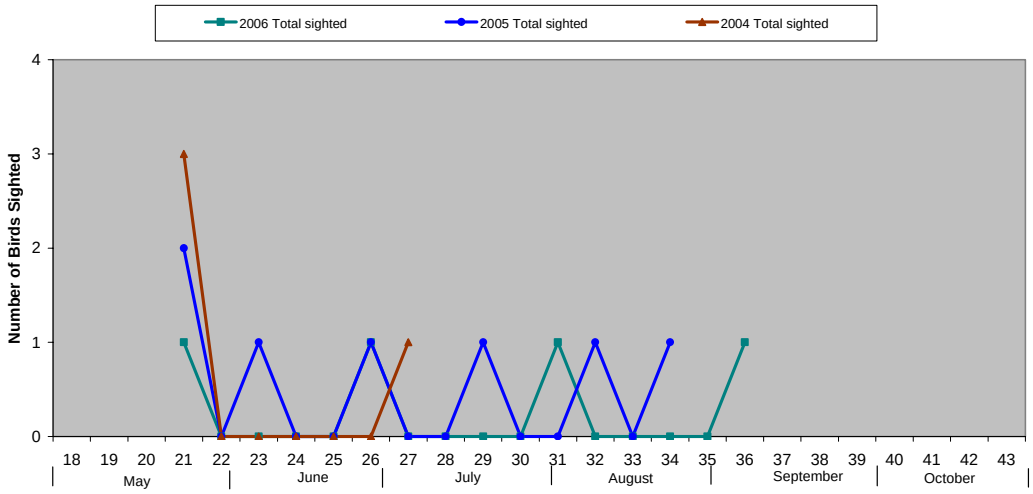
2004 Line Graph - Birds Tested n=(30)

Week Number

Data from week 18 to 43

Weeks run Sunday to Saturday

Comparison of Number of Birds Sighted in North Vancouver Island, 2004-2006



2006 Line Graph - Birds Sighted n=(4)

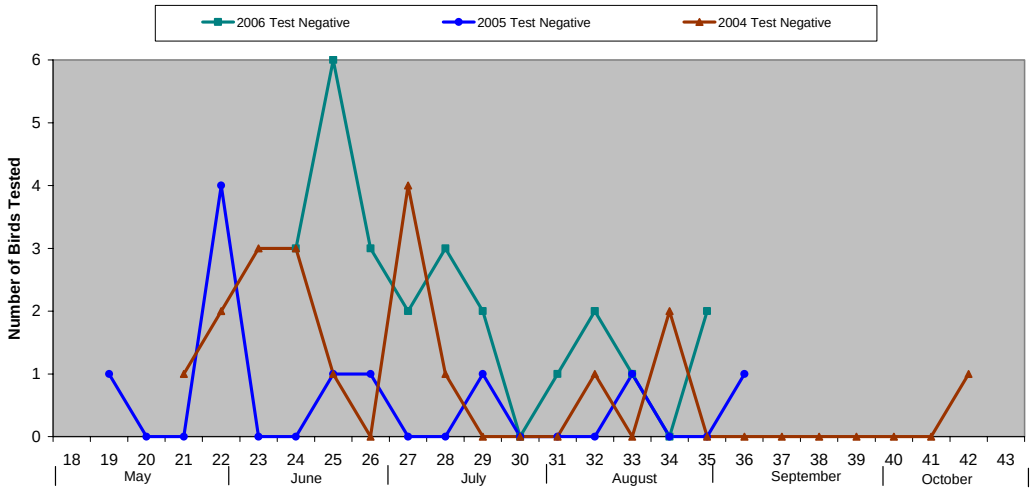
2005 Line Graph - Birds Sighted n=(7)

2004 Line Graph - Birds Sighted n=(4)

Week Number

Weeks run Sunday to Saturday

Comparison of Number of Birds Tested in Northwest, 2004-2006



2006 Line Graph - Birds Tested n=(25)

2005 Line Graph - Birds Tested n=(10)

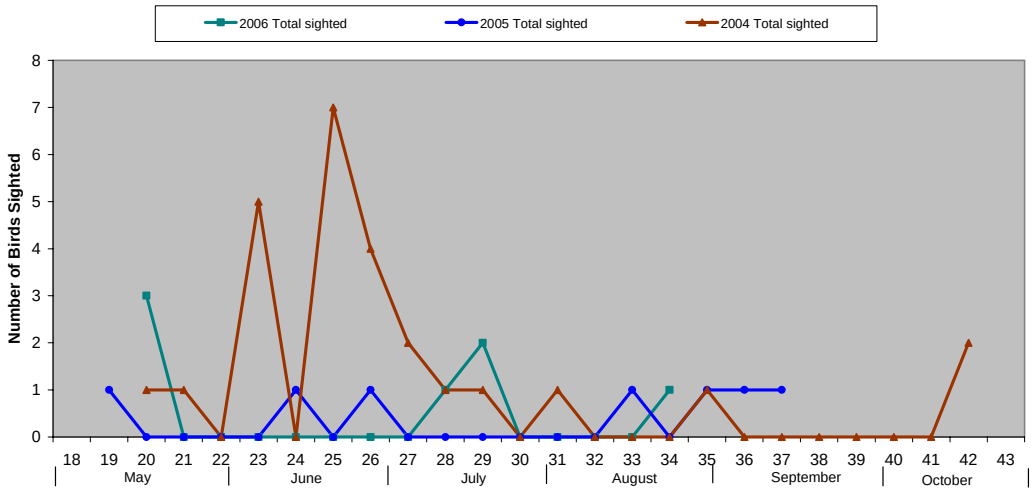
2004 Line Graph - Birds Tested n=(19)

Week Number

Data from week 18 to 43

Weeks run Sunday to Saturday

Comparison of Number of Birds Sighted in Northwest, 2004-2006



2006 Line Graph - Birds Sighted n=(7)

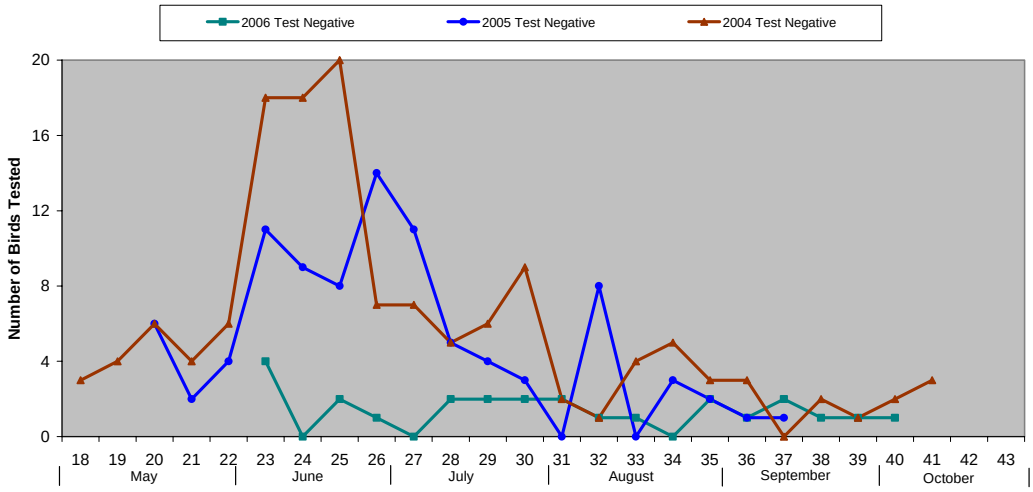
2005 Line Graph - Birds Sighted n=(7)

2004 Line Graph - Birds Sighted n=(26)

Week Number

Weeks run Sunday to Saturday

Comparison of Number of Birds Tested in Okanagan, 2004-2006



2006 Line Graph - Birds Tested n=(25)

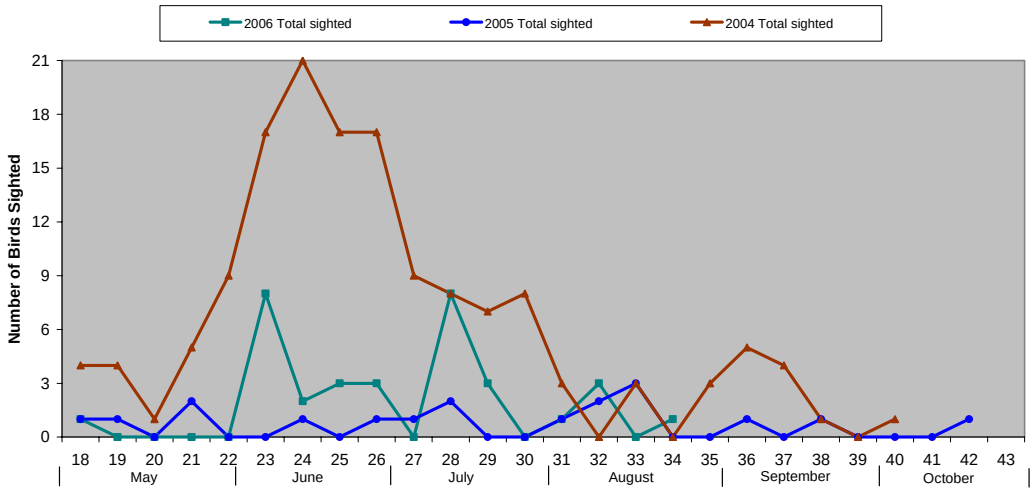
2005 Line Graph - Birds Tested n=(92)

2004 Line Graph - Birds Tested n=(139)

Data from week 18 to 43

Weeks run Sunday to Saturday

Comparison of Number of Birds Sighted in Okanagan, 2004-2006



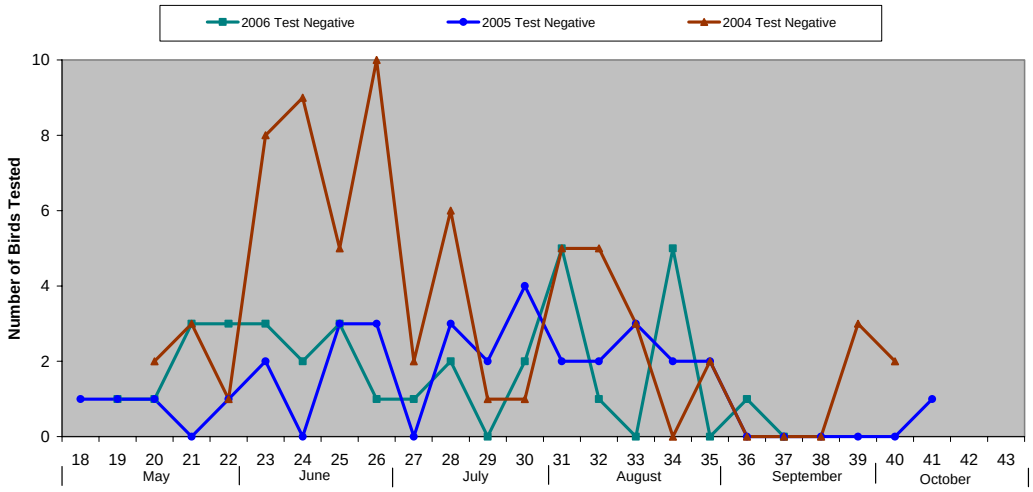
2006 Line Graph - Birds Sighted n=(33)

2005 Line Graph - Birds Sighted n=(18)

2004 Line Graph - Birds Sighted n=(147)

Weeks run Sunday to Saturday

Comparison of Number of Birds Tested in Richmond, 2004-2006



2006 Line Graph - Birds Tested n=(34)

2005 Line Graph - Birds Tested n=(33)

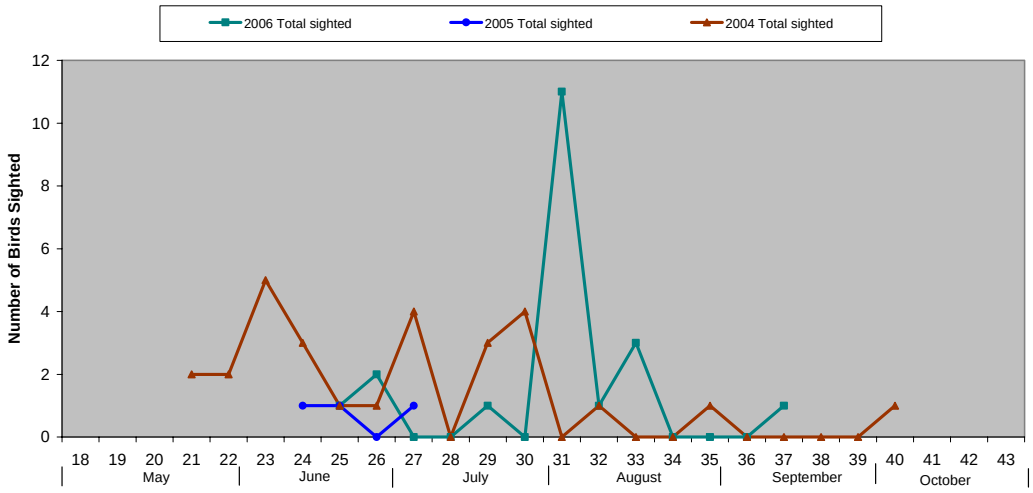
2004 Line Graph - Birds Tested n=(68)

Week Number

Data from week 18 to 43

Weeks run Sunday to Saturday

Comparison of Number of Birds Sighted in Richmond, 2004-2006



2006 Line Graph - Birds Sighted n=(20)

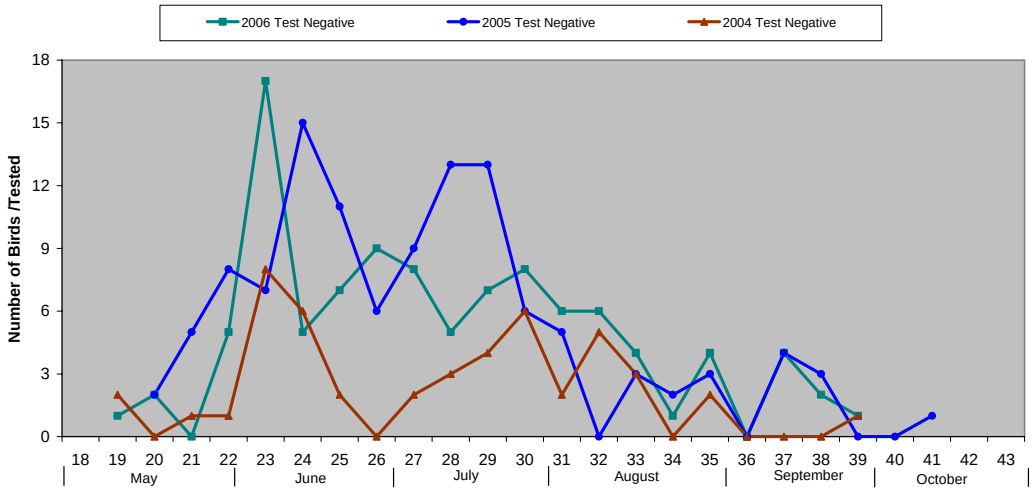
2005 Line Graph - Birds Sighted n=(3)

2004 Line Graph - Birds Sighted n=(28)

Week Number

Weeks run Sunday to Saturday

Comparison of Number of Birds Tested in South Vancouver Island, 2004-2006



2006 Line Graph - Birds Tested n=(102)

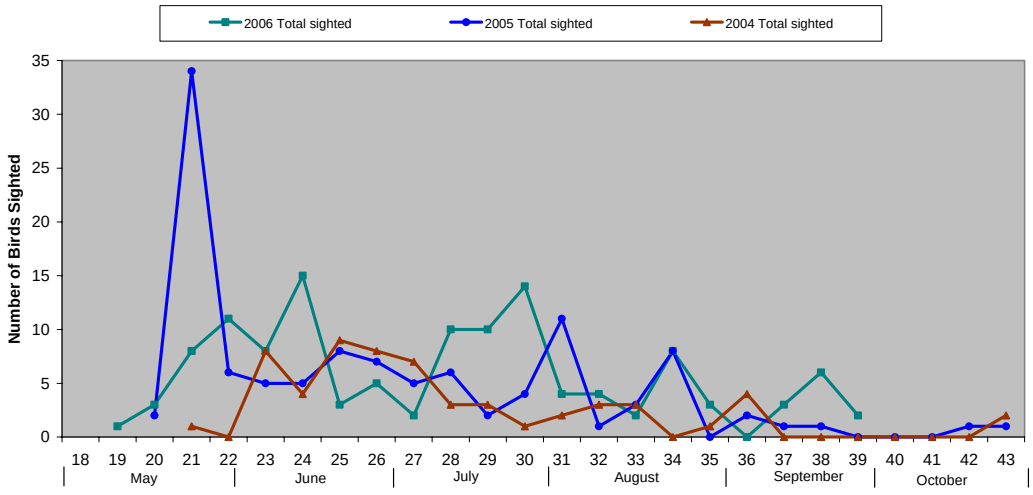
2005 Line Graph - Birds Tested n=(116)

2004 Line Graph - Birds Tested n=(48)

Data from week 18 to 43

Weeks run Sunday to Saturday

Comparison of Number of Birds Sighted in South Vancouver Island, 2004-2006



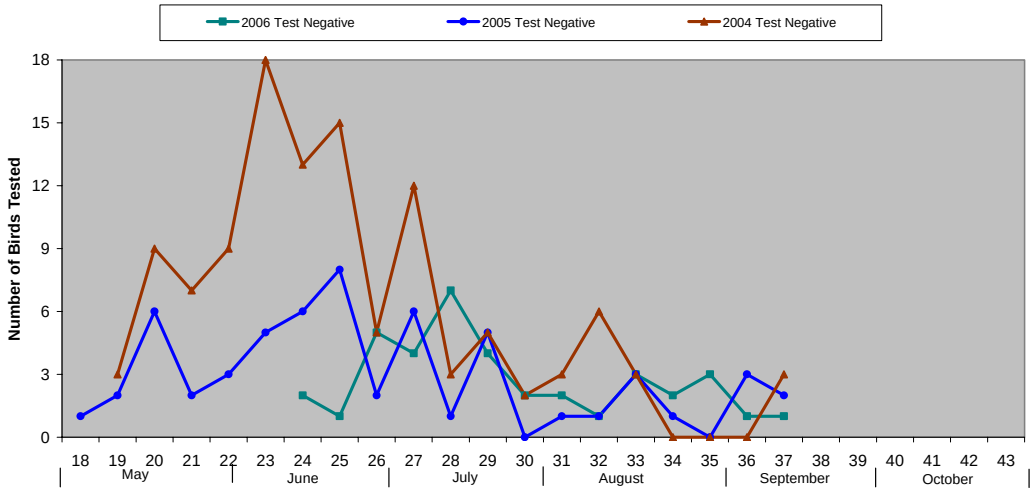
2006 Line Graph - Birds Sighted n=(122)

2005 Line Graph - Birds Sighted n=(113)

2004 Line Graph - Birds Sighted n=(59)

Weeks run Sunday to Saturday

Comparison of Number of Birds Tested in Thompson Cariboo Shuswap, 2004-2006



2006 Line Graph - Birds Tested n=(38)

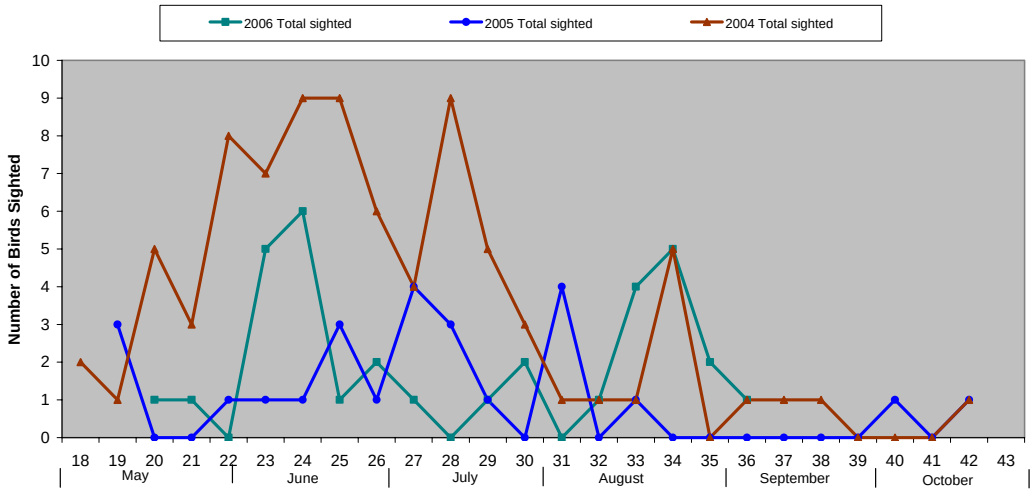
2005 Line Graph - Birds Tested n=(58)

2004 Line Graph - Birds Tested n=(116)

Data from week 18 to 43

Weeks run Sunday to Saturday

Comparison of Number of Birds Sighted in Thompson Cariboo Shuswap, 2004-2006



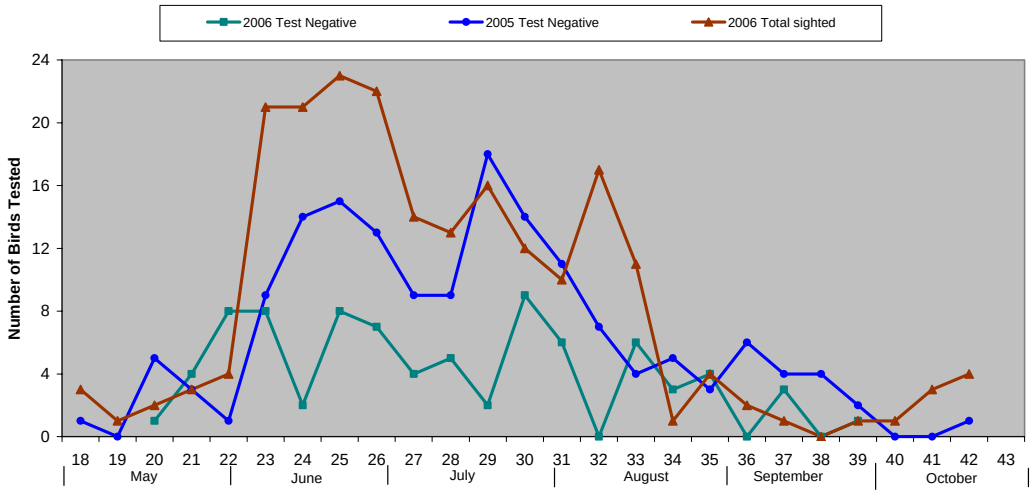
2006 Line Graph - Birds Sighted n=(33)

2005 Line Graph - Birds Sighted n=(25)

2004 Line Graph - Birds Sighted n=(83)

Weeks run Sunday to Saturday

Comparison of Number of Birds Tested in Vancouver, 2004-2006



2006 Line Graph - Birds Tested n=(81)

2005 Line Graph - Birds Tested n=(158)

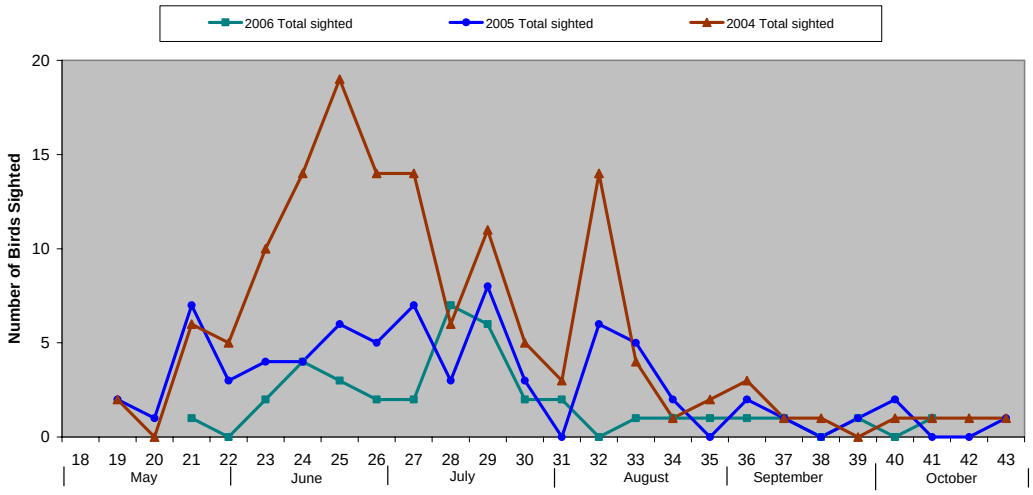
2004 Line Graph - Birds Tested n=(210)

Week Number

Data from week 18 to 43

Weeks run Sunday to Saturday

Comparison of Number of Birds Sighted in Vancouver, 2004-2006



2006 Line Graph - Birds Sighted n=(38)

2005 Line Graph - Birds Sighted n=(73)

2004 Line Graph - Birds Sighted n=(139)

Week Number

Weeks run Sunday to Saturday

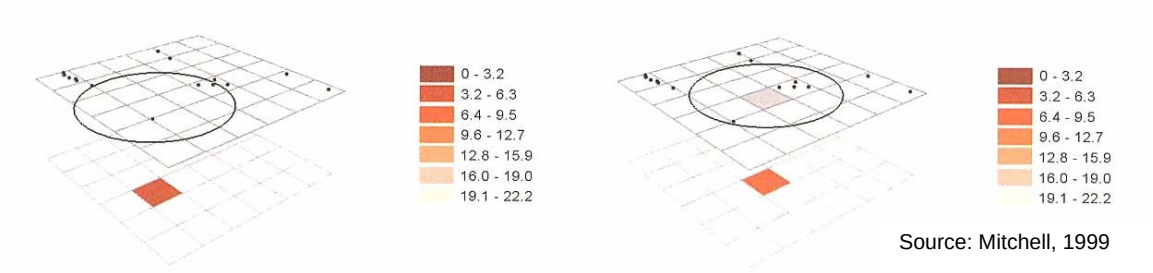
Appendix 4: Dead Bird Density Mapping

Dead corvid surveillance is valuable for early detection of West Nile virus (WNv). The first report of a WNv-positive bird can precede the onset of human cases by up to 3 months.[1] This critical time period can be used to guide public education and mosquito control efforts.

Kernel density mapping is a Geographic Information Systems (GIS) analysis technique that creates a continuous surface map based on point data. Density surfaces are effective at identifying where features are concentrated – highlighting areas of intense activity.

The procedure for creating a kernel density map surface is:
1. An invisible grid is laid over the study area
2. You specify the search radius for the GIS to define the neighborhood around each cell center
3. The number of features that fall within that neighborhood are counted and divided by that area
4. The calculated value is assigned to the cell and the process is repeated

This creates a running average of features per area to create a smoothed, continuous surface.



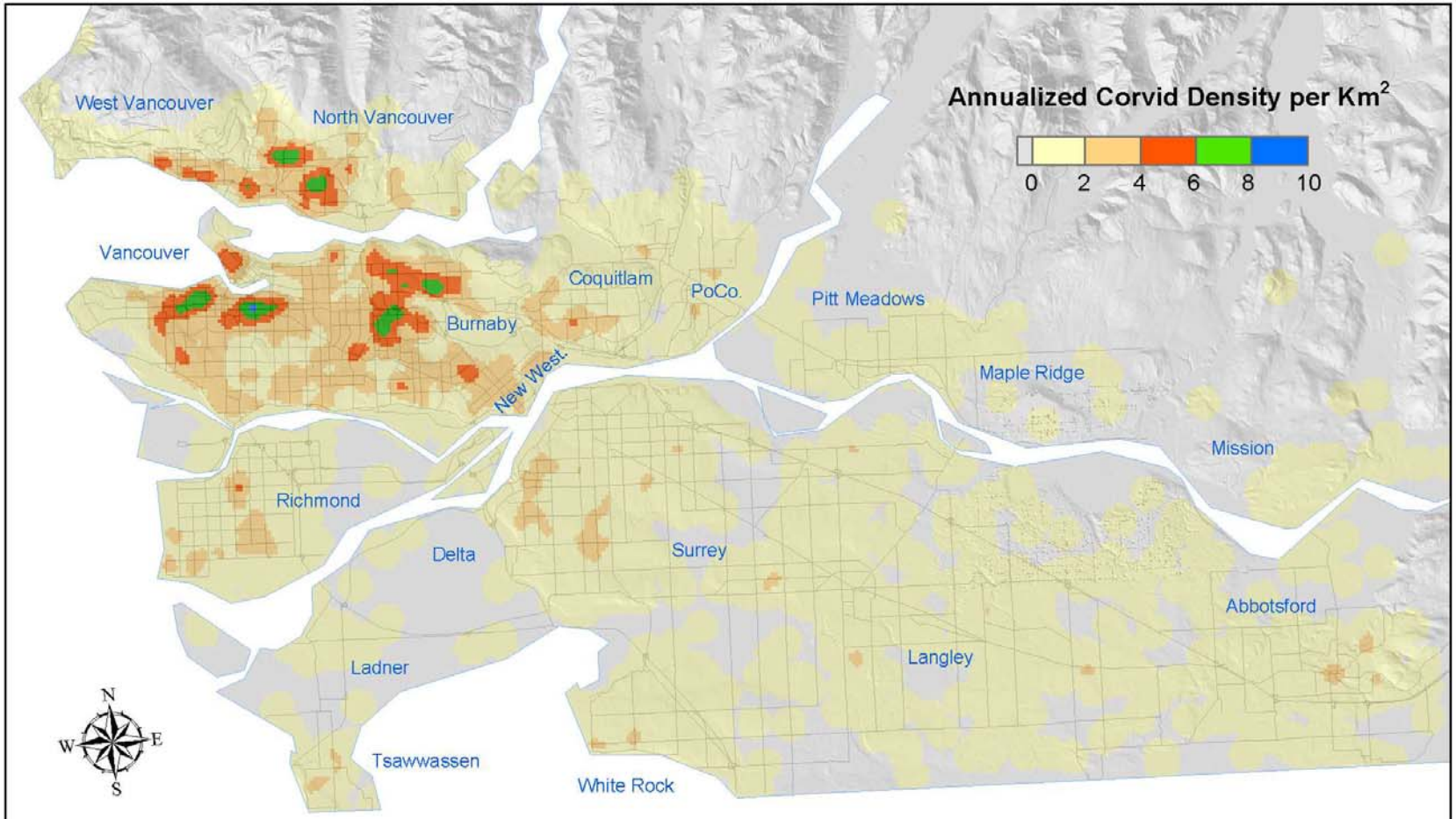
Source: Mitchell, 1999

This methodology was applied to dead corvid surveillance data reported to the BCCDC. The locations of dead corvids picked up for testing or sighted by the public were mapped by either Global Positioning System (GPS) coordinates, street address or postal code. The resulting maps identify areas of concentrated bird mortality. In the event of WNv activity, "hotspots" of corvid mortality may indicate localized concentration of the virus in an area. The corvid density data collected in 2003, 2004, 2005 and 2006, prior to introduction of WNv in BC, are useful for identifying areas with higher baseline bird mortality.

References:

1. Eidson M et al. 2001. Dead Bird Surveillance as an Early Warning System for West Nile Virus. *Emerging Infectious Diseases* Vol. 7, No. 4, pp. 631–5. Webpage accessed 14 December 2006. http://www.cdc.gov/ncidod/eid/vol7no4/eidson1.htm

2. Mitchell A. 1999. The ESRI® Guide to GIS Analysis: Geographic Patterns & Relationships. Environmental Systems Research Institute, Inc. Press. Redlands, CA.

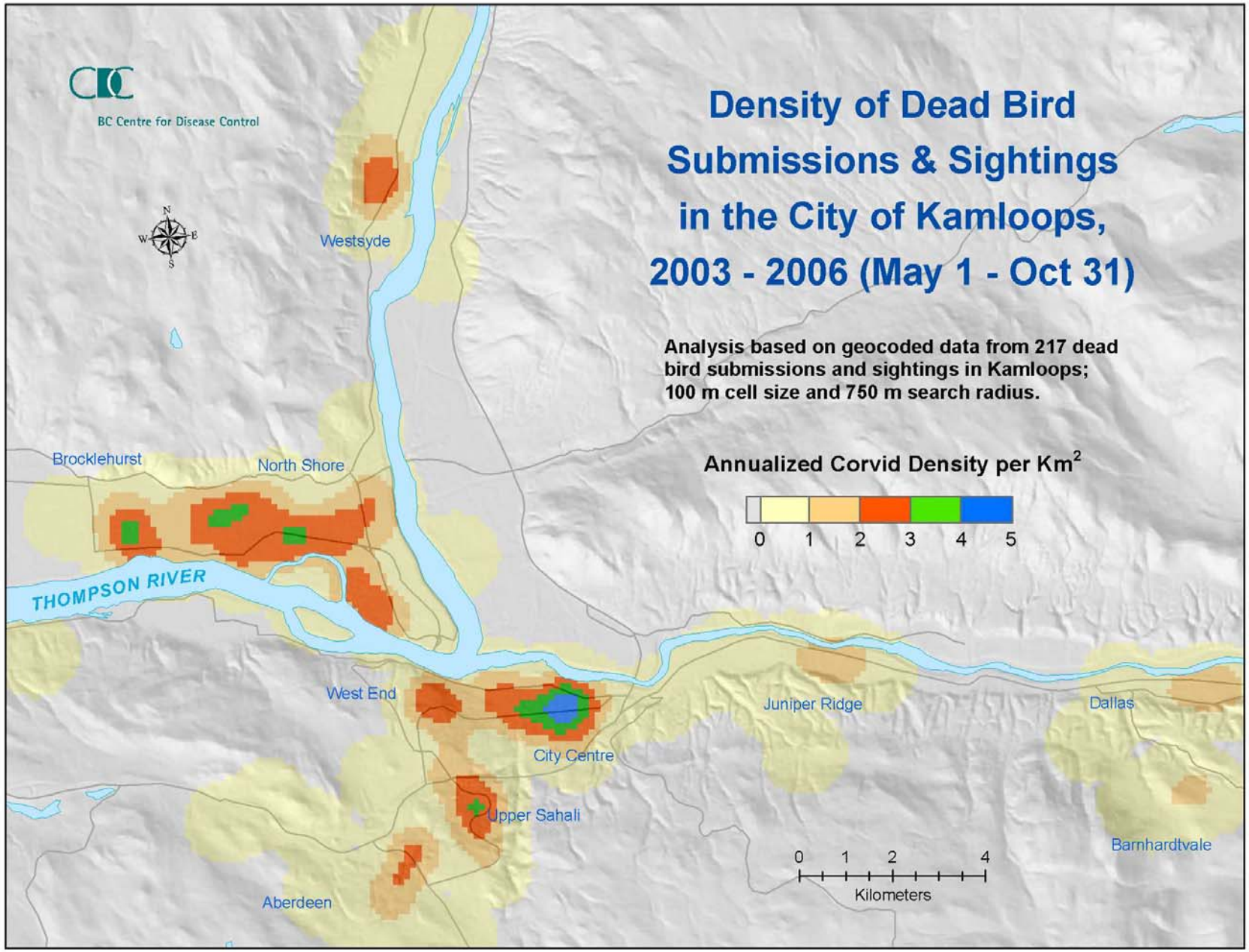


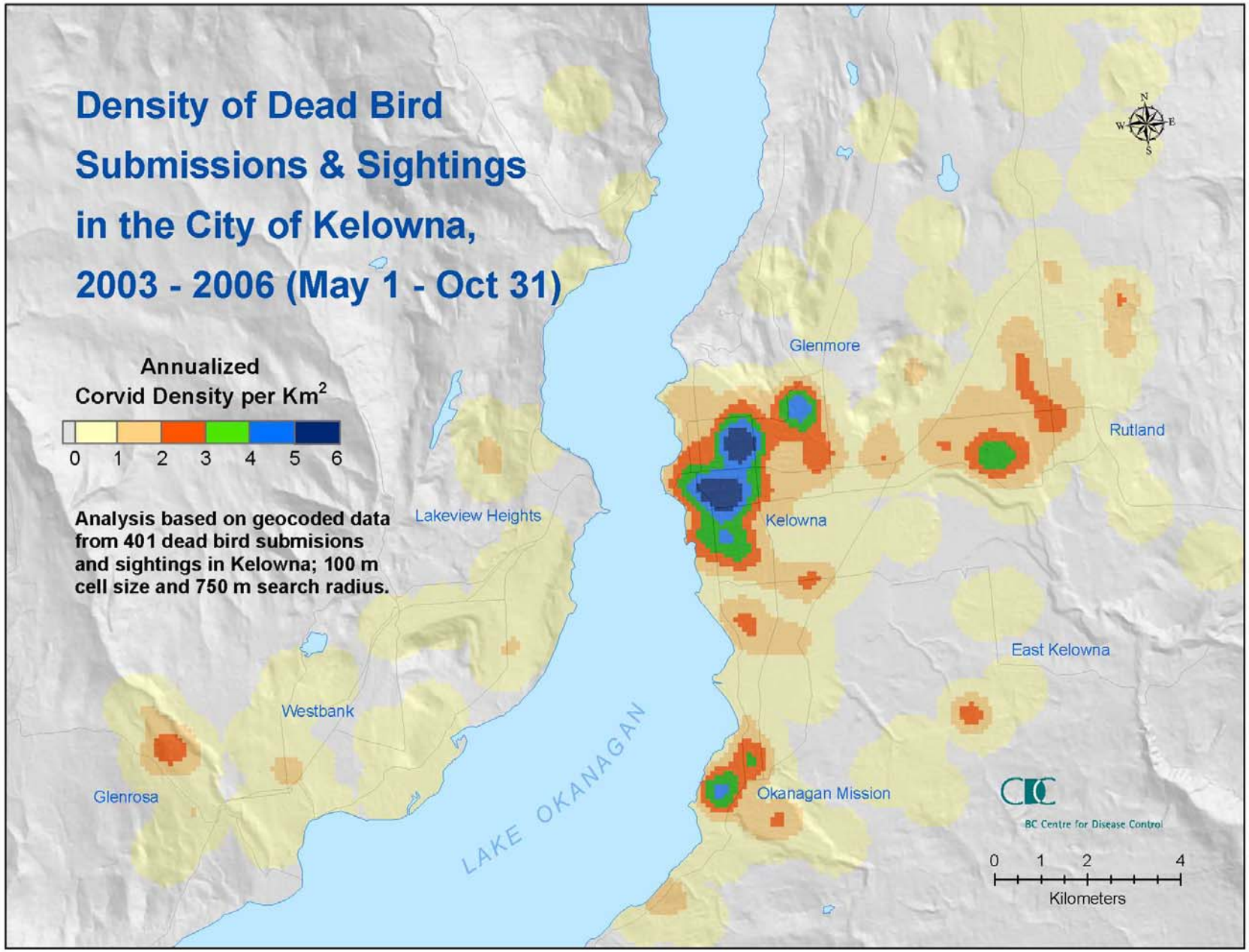
Density of Dead Bird Submissions and Sightings in the Vancouver Lower Mainland, 2003 - 2006 (May 1 - Oct 31)

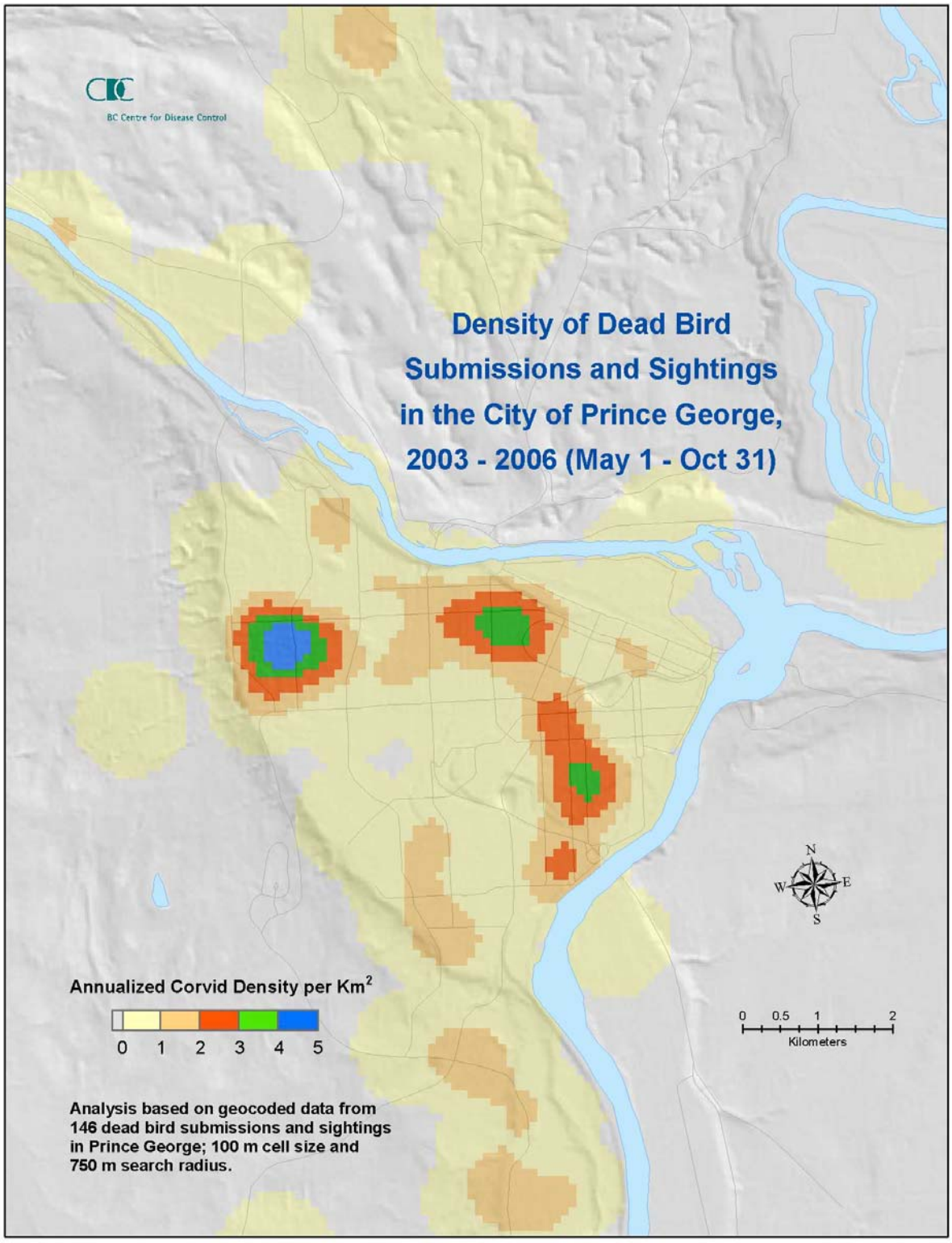
BC Centre for Disease Control

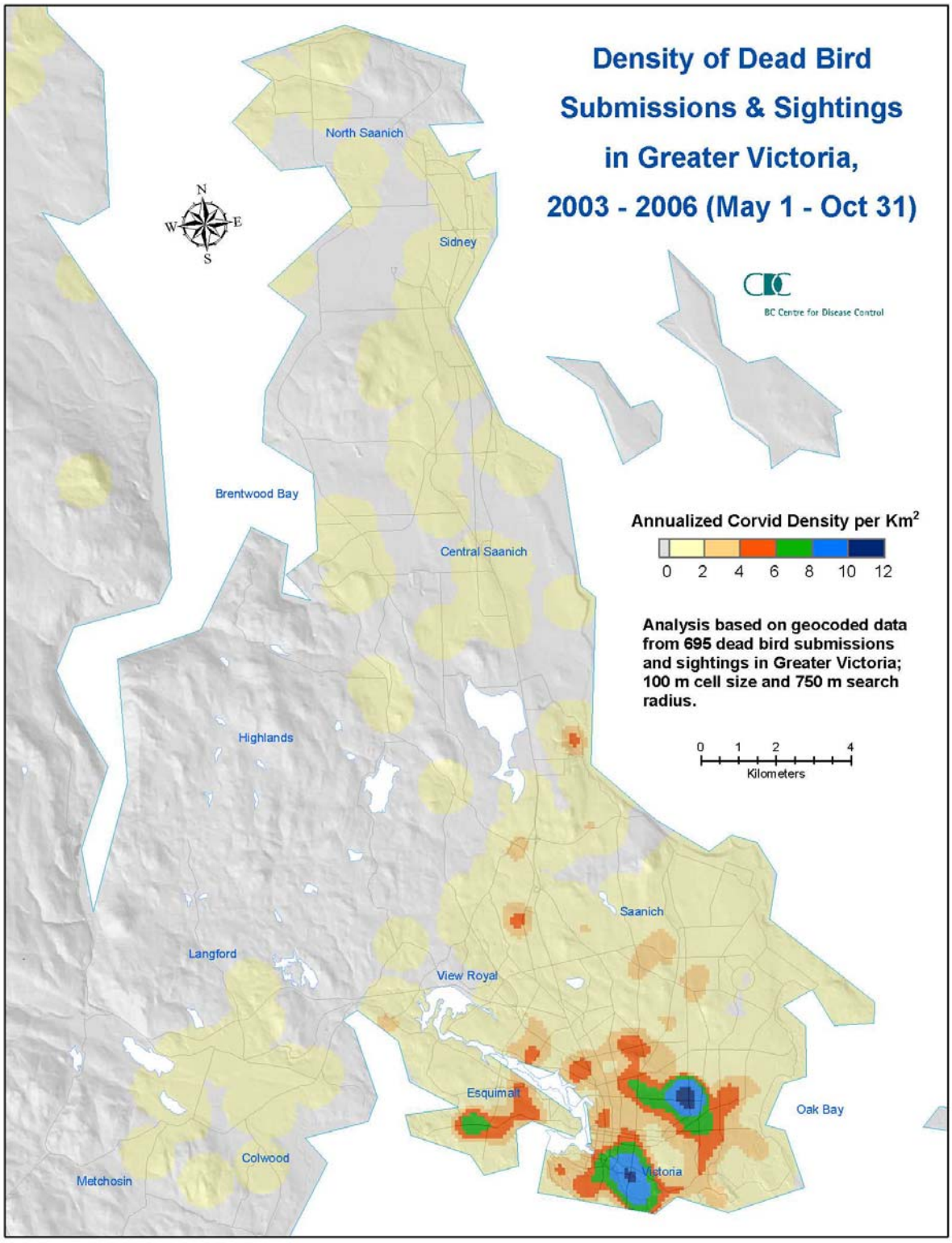
Analysis based on geocoded data from 5053 dead bird submissions and sightings in the Vancouver Lower Mainland; 200 m cell size and 1000 m search radius.

0 5 10 20
Kilometers


BC Centre for Disease Control
Density of Dead Bird Submissions & Sightings in the City of Kamloops, 2003 - 2006 (May 1 - Oct 31)
Analysis based on geocoded data from 217 dead bird submissions and sightings in Kamloops; 100 m cell size and 750 m search radius.
Annualized Corvid Density per Km2
0 1 2 3 4 5
Westsyde
Brocklehurst
North Shore
THOMPSON RIVER
West End
City Centre
Upper Sahali
Aberdeen
Juniper Ridge
Dallas
Barnhardtvale
0 1 2 4
Kilometers


Density of Dead Bird Submissions & Sightings in the City of Kelowna, 2003 - 2006 (May 1 - Oct 31)
Annualized Corvid Density per Km2
0 1 2 3 4 5 6
Analysis based on geocoded data from 401 dead bird submisions and sightings in Kelowna; 100 m cell size and 750 m search radius.
N
W
E
S
Glenmore
Rutland
Lakeview Heights
Kelowna
East Kelowna
Westbank
Glenrosa
LAKE OKANAGAN
Okanagan Mission
BC Centre for Disease Control
0 1 2 4
Kilometers

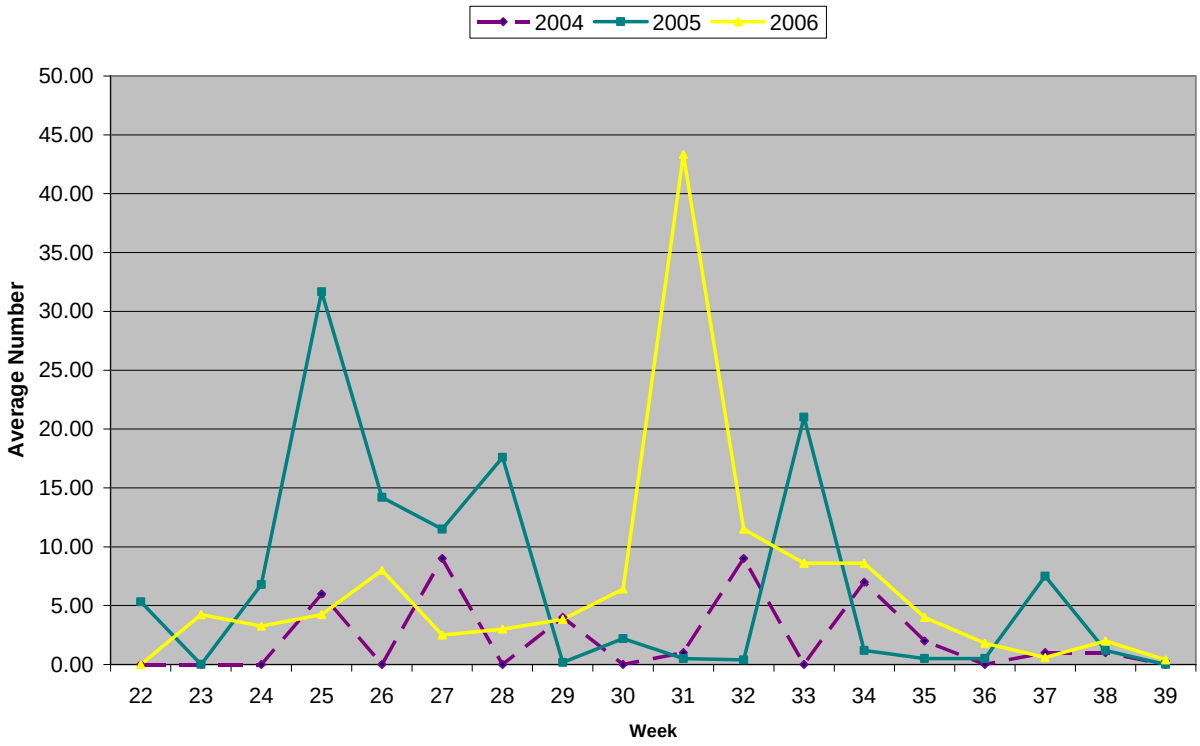

BC Centre for Disease Control
Density of Dead Bird Submissions and Sightings in the City of Prince George, 2003 - 2006 (May 1 - Oct 31)
N
W
E
S
Annualized Corvid Density per Km2
0 1 2 3 4 5
0 0.5 1 2
Kilometers
Analysis based on geocoded data from 146 dead bird submissions and sightings in Prince George; 100 m cell size and 750 m search radius.


Density of Dead Bird Submissions & Sightings in Greater Victoria, 2003 - 2006 (May 1 - Oct 31)
BC Centre for Disease Control
North Saanich
Sidney
Brentwood Bay
Central Saanich
Highlands
Saanich
Langford
View Royal
Esquimalt
Oak Bay
Colwood
Metchosin
Victoria
N
W
E
S
Annualized Corvid Density per Km2
0 2 4 6 8 10 12
Analysis based on geocoded data from 695 dead bird submissions and sightings in Greater Victoria; 100 m cell size and 750 m search radius.
0 1 2 4
Kilometers

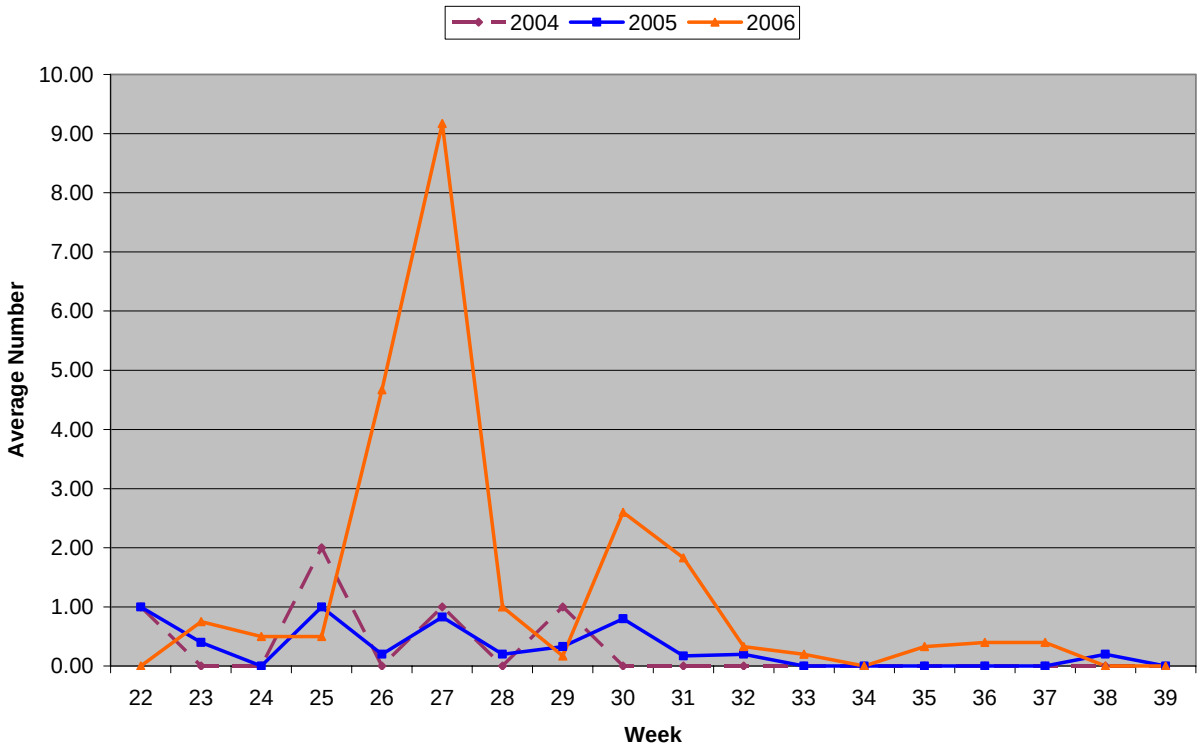
Appendix 5 – Average Culex Captured by Week by HSDA, 2004-2006

Note: total numbers of *Culex* were too low to generate meaningful trends for successive years in Northern Health Authority therefore data is not presented.

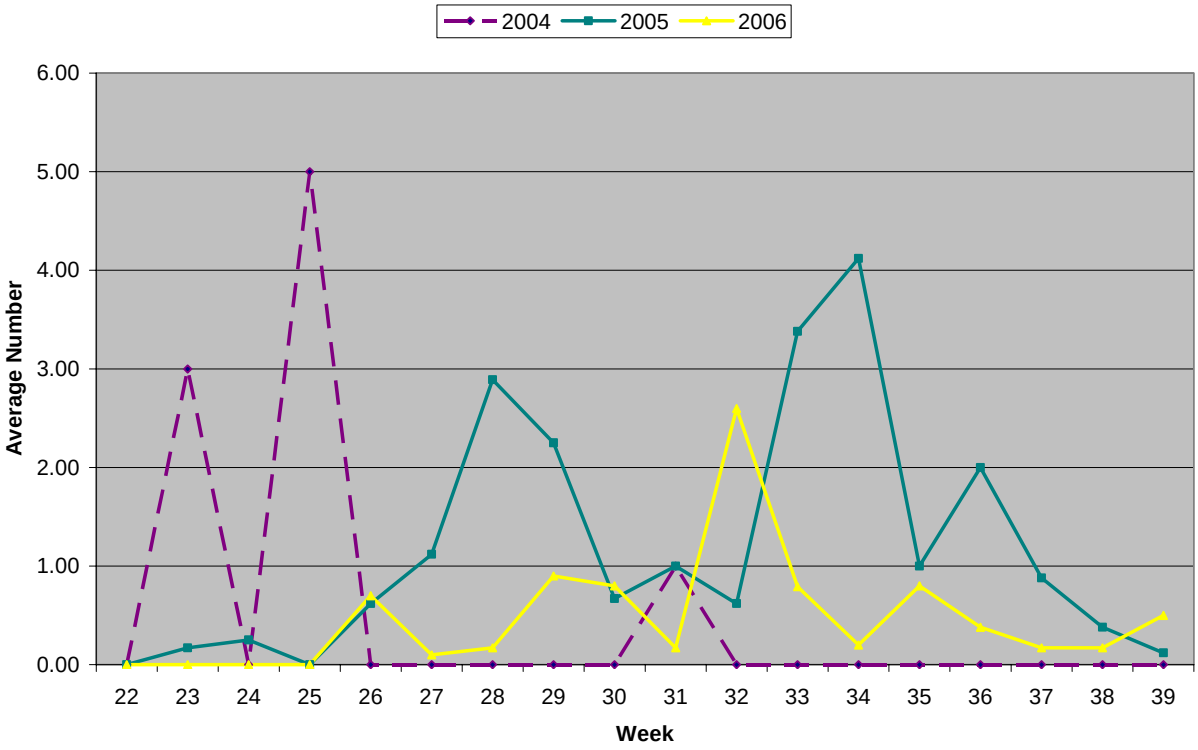
Average Number of Culex pipiens Captured, CVI 2004-2006



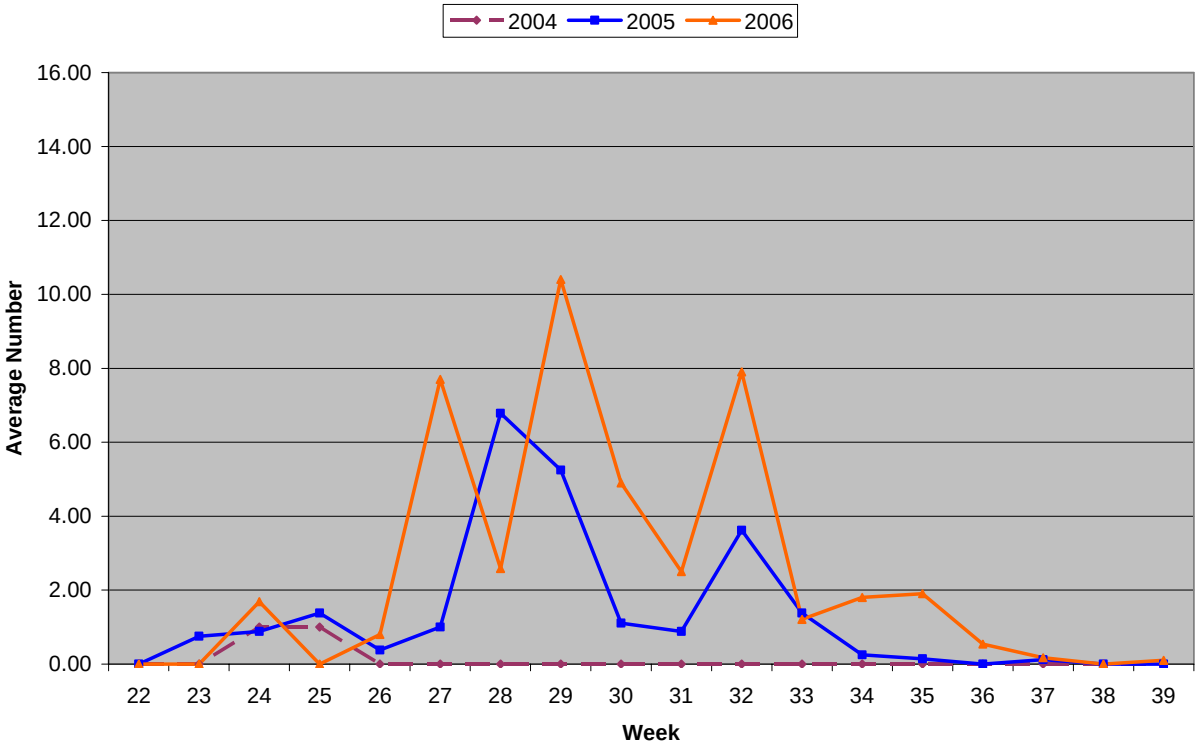
Average Number of Culex tarsalis Captured, CVI 2004-2006



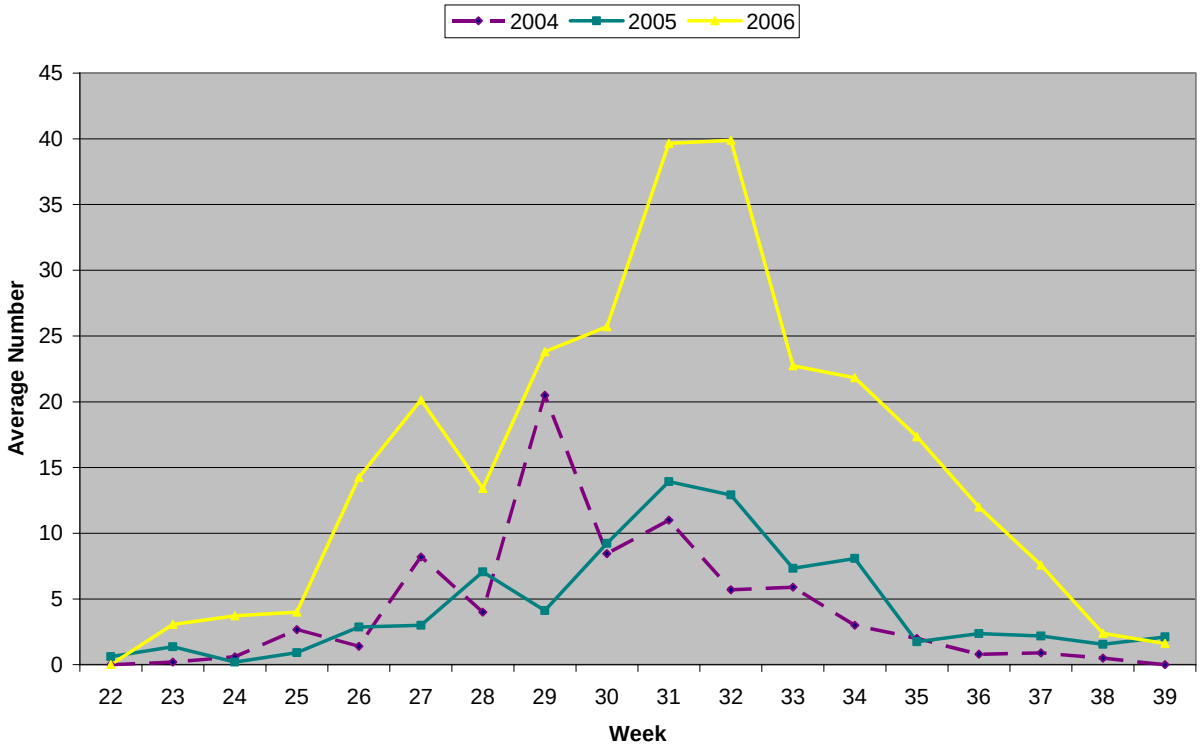
Average Number of Culex pipiens Captured, EK 2004-2006



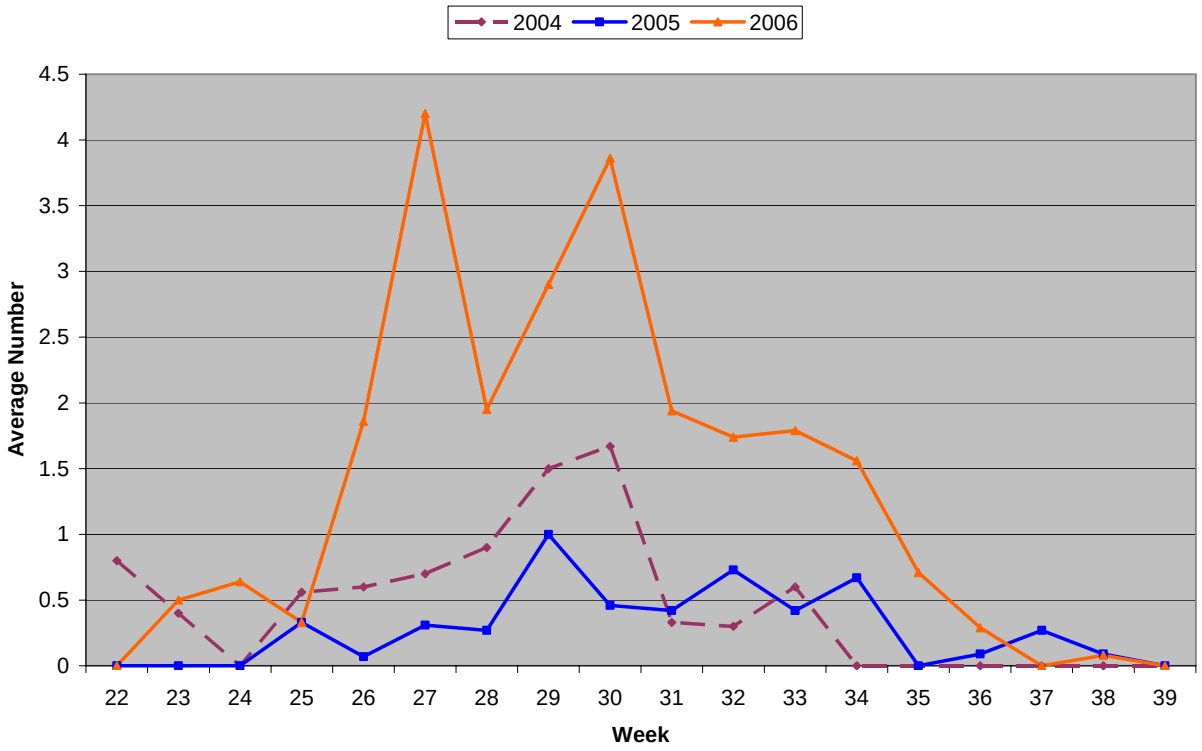
Average Number of Culex tarsalis Captured, EK 2004-2006



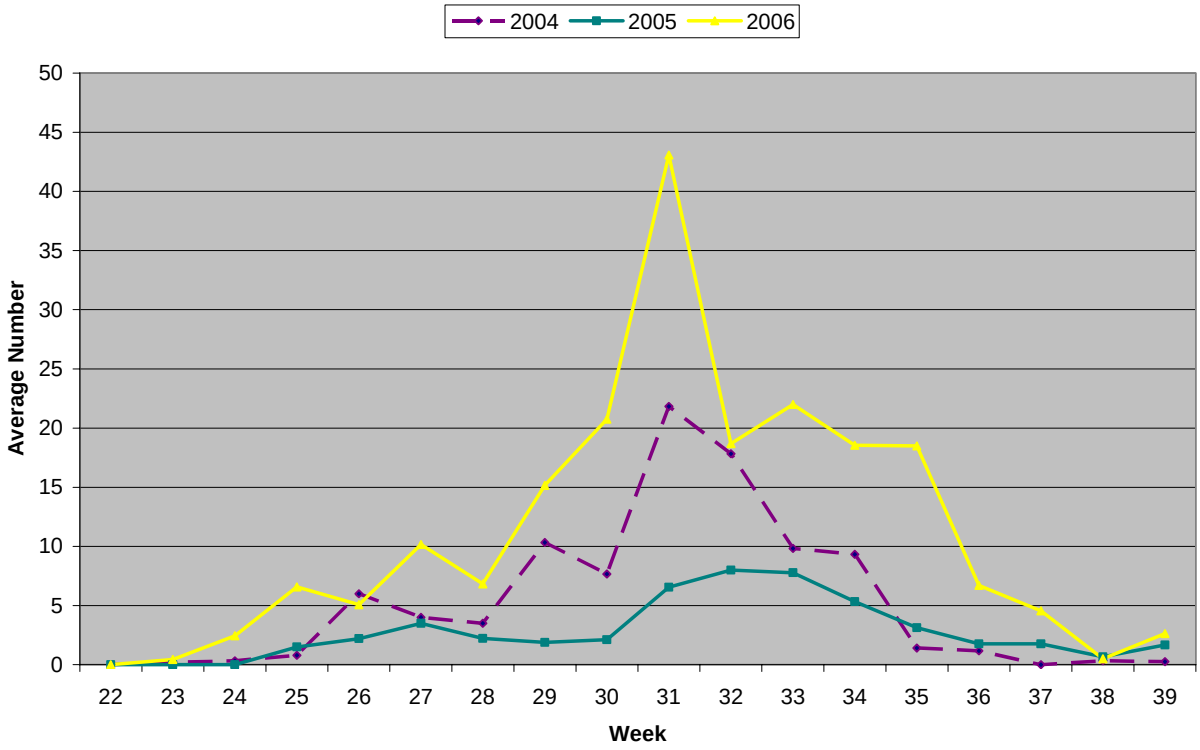
Average Number of Culex pipiens Captured, FRE 2004-2006



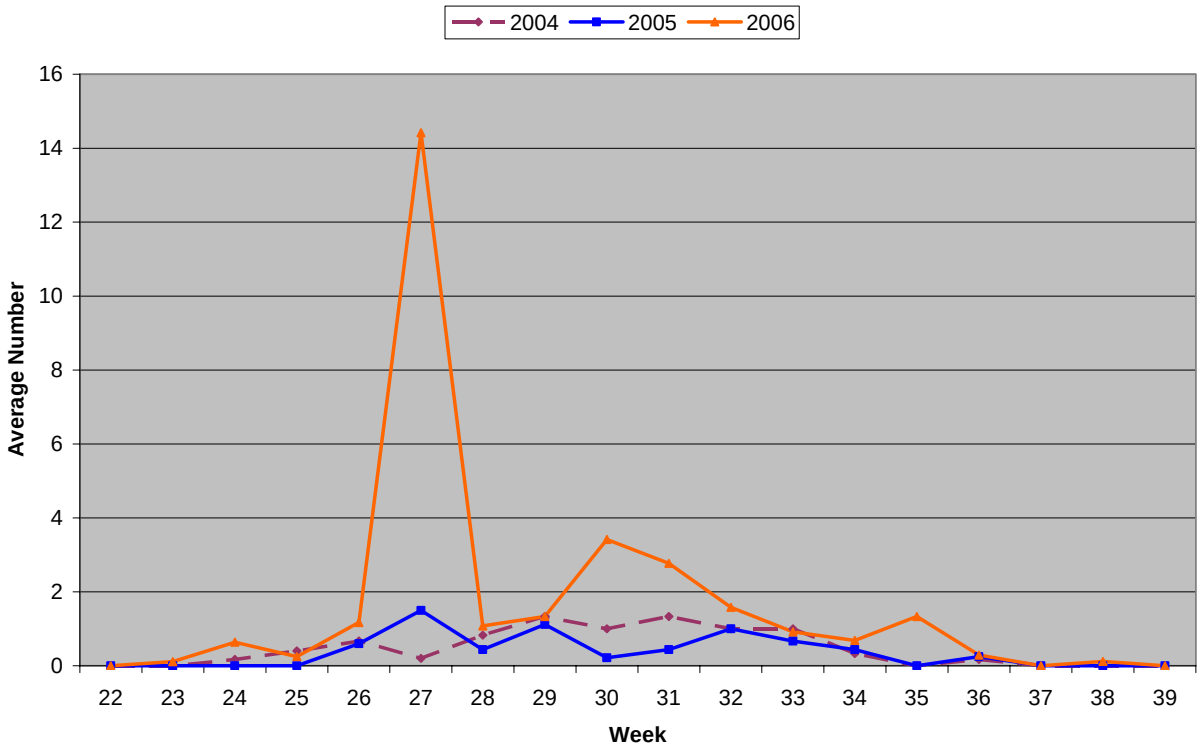
Average Number of Culex tarsalis Captured, FRE 2004-2006



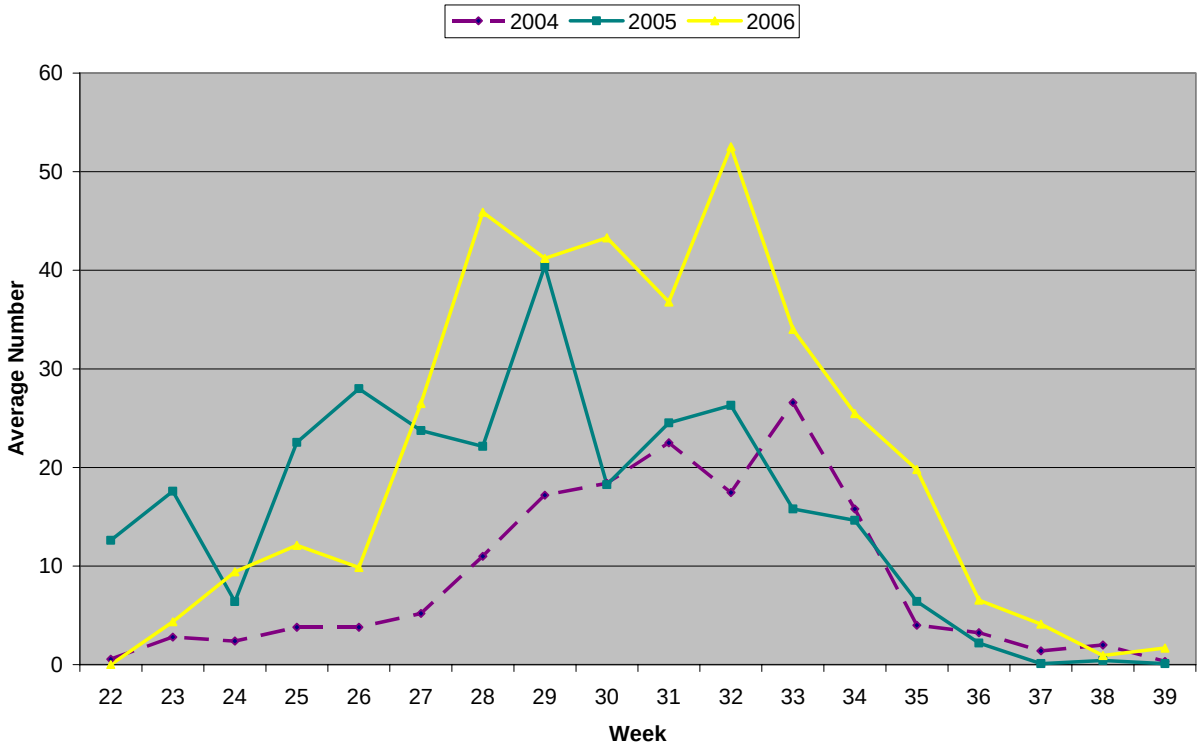
Average Number of Culex pipiens Captured, FRN 2004-2006



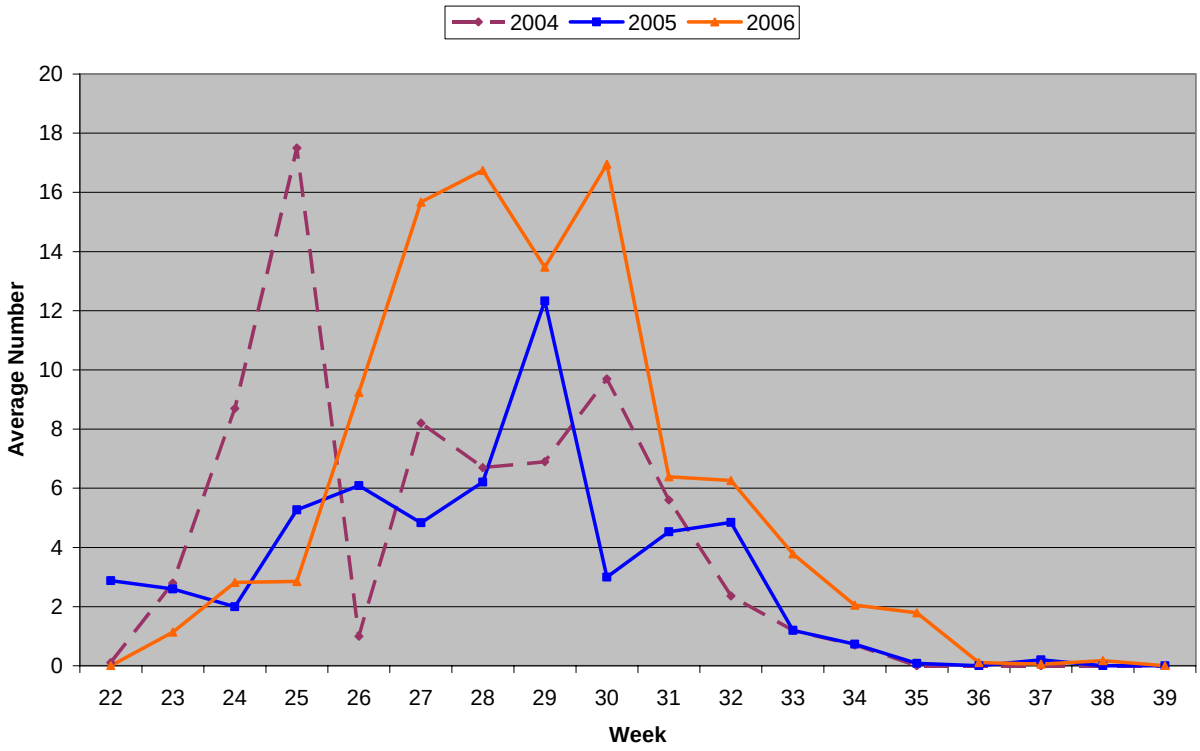
Average Number of Culex tarsalis Captured, FRN 2004-2006



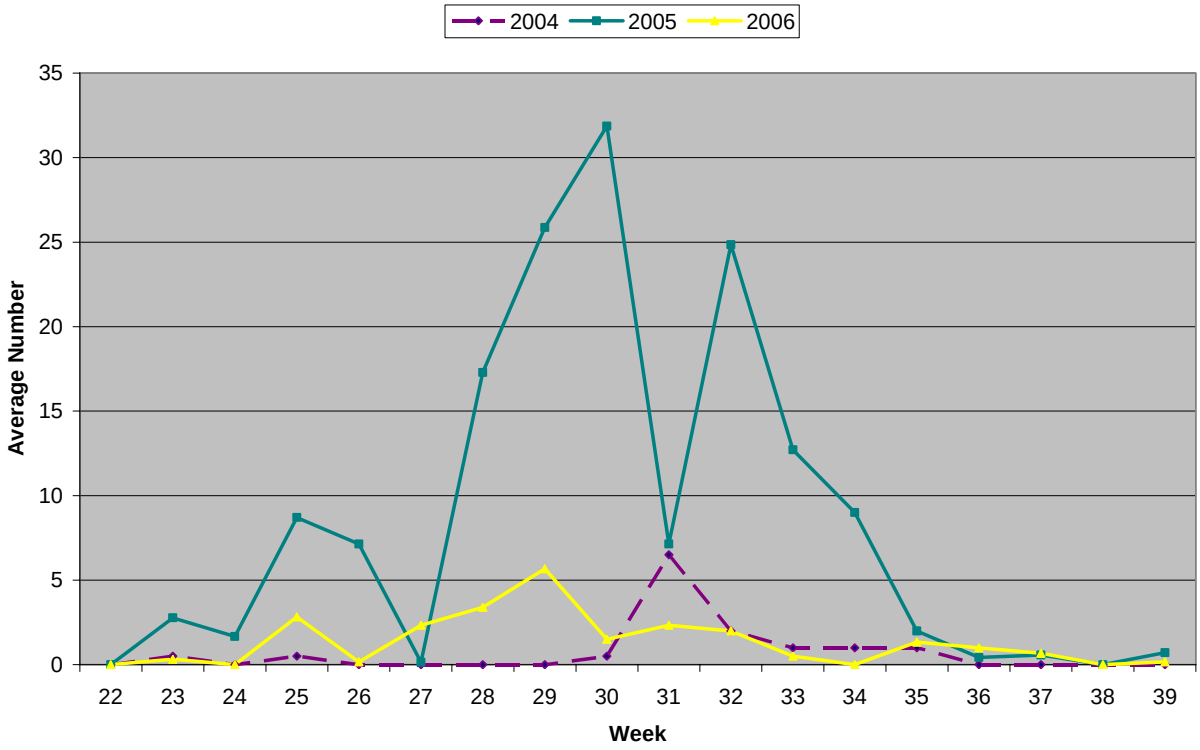
Average Number of Culex pipiens Captured, FRS 2004-2006



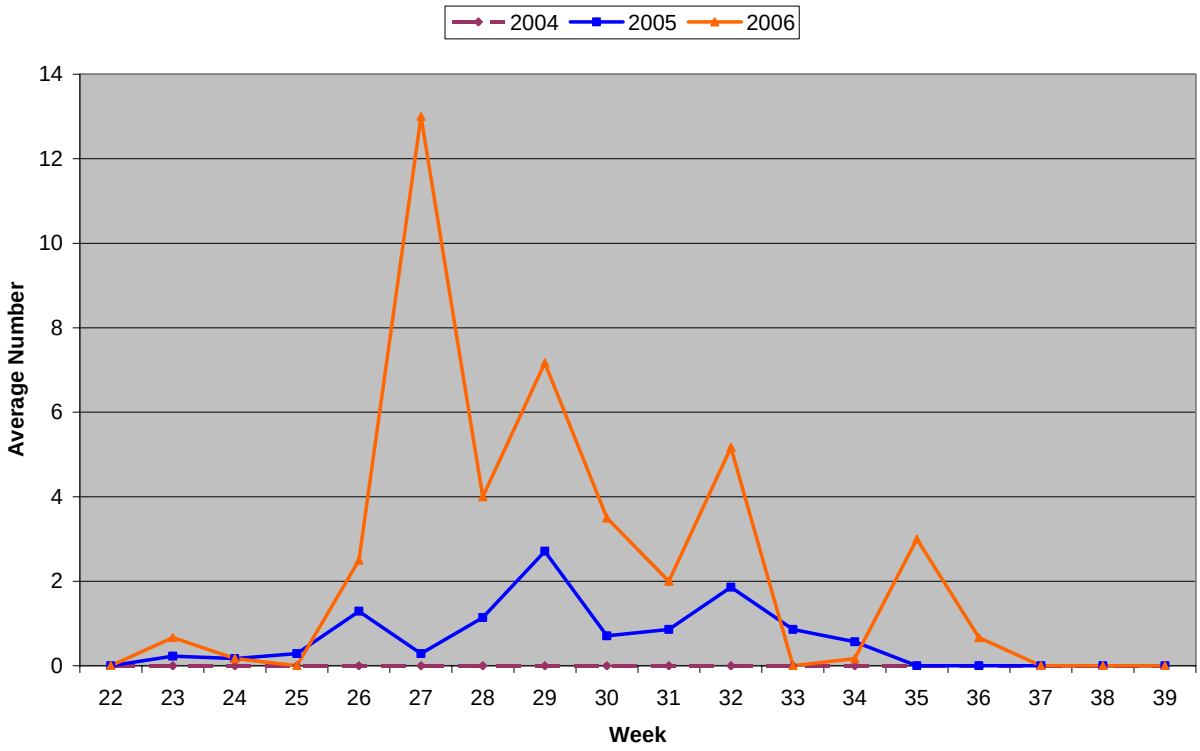
Average Number of Culex tarsalis Captured, FRS 2004-2006



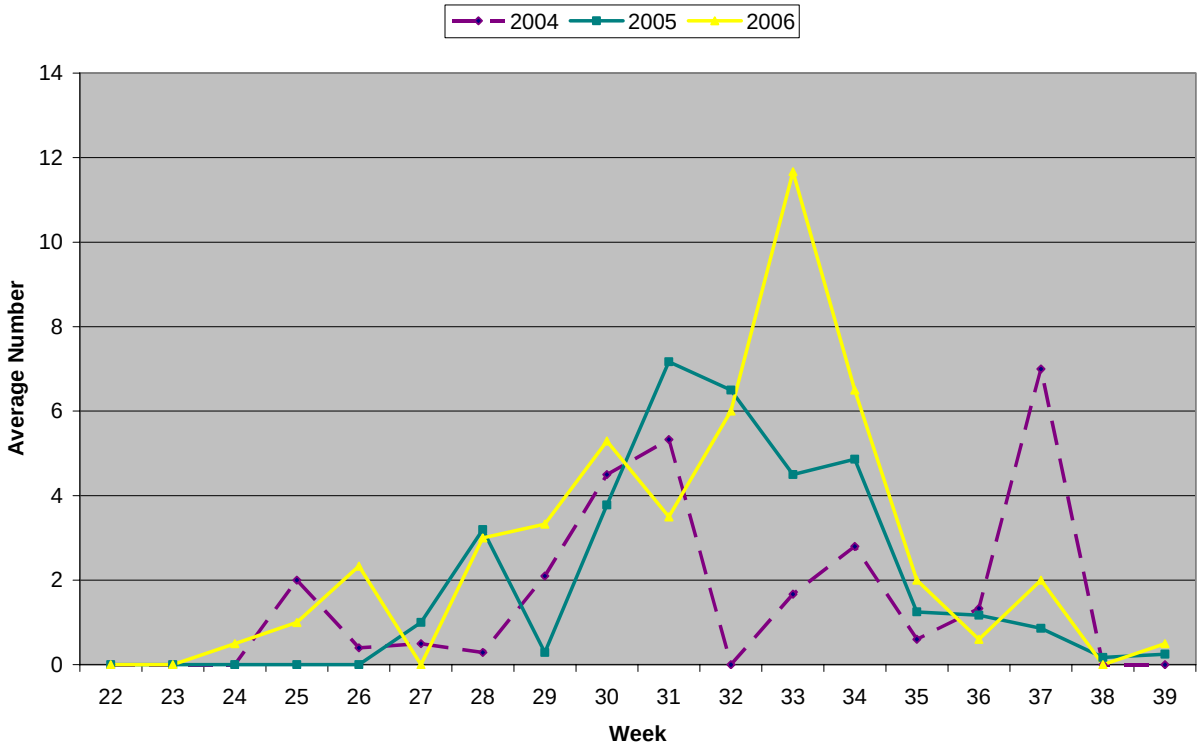
Average Number of Culex pipiens Captured, KB 2004-2006



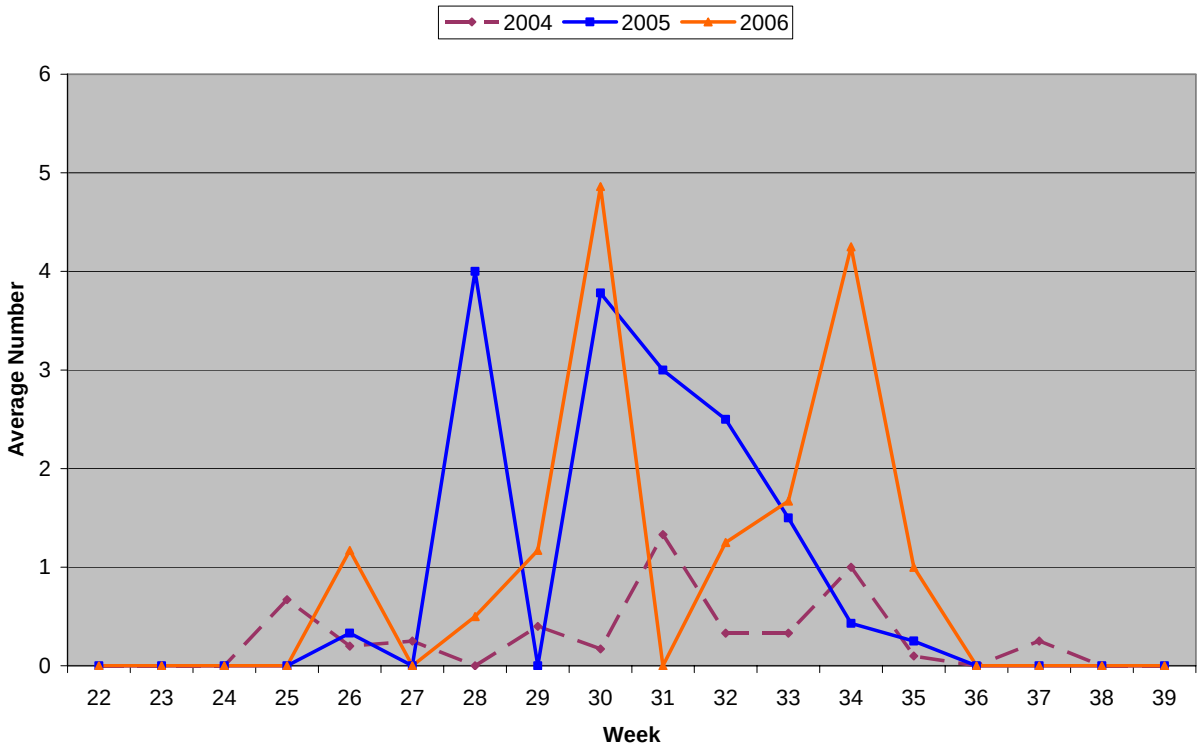
Average Number of Culex tarsalis Captured, KB 2004-2006



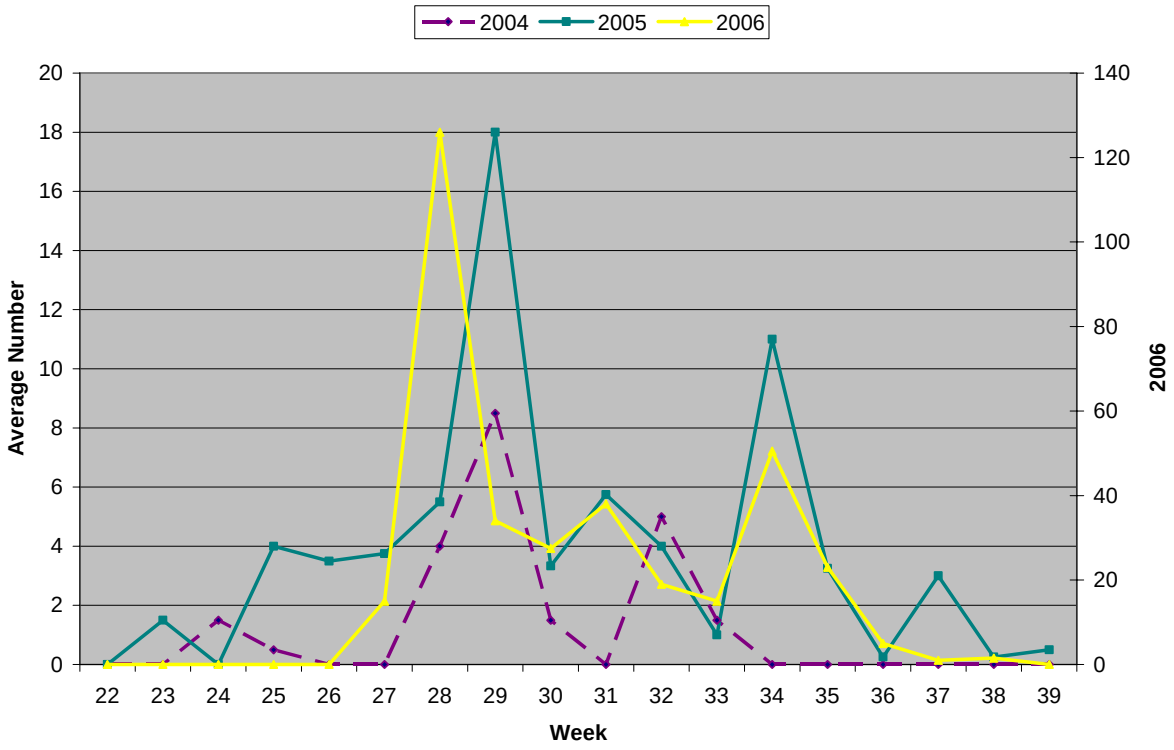
Average Number of Culex pipiens Captured, NSCG 2004-2006



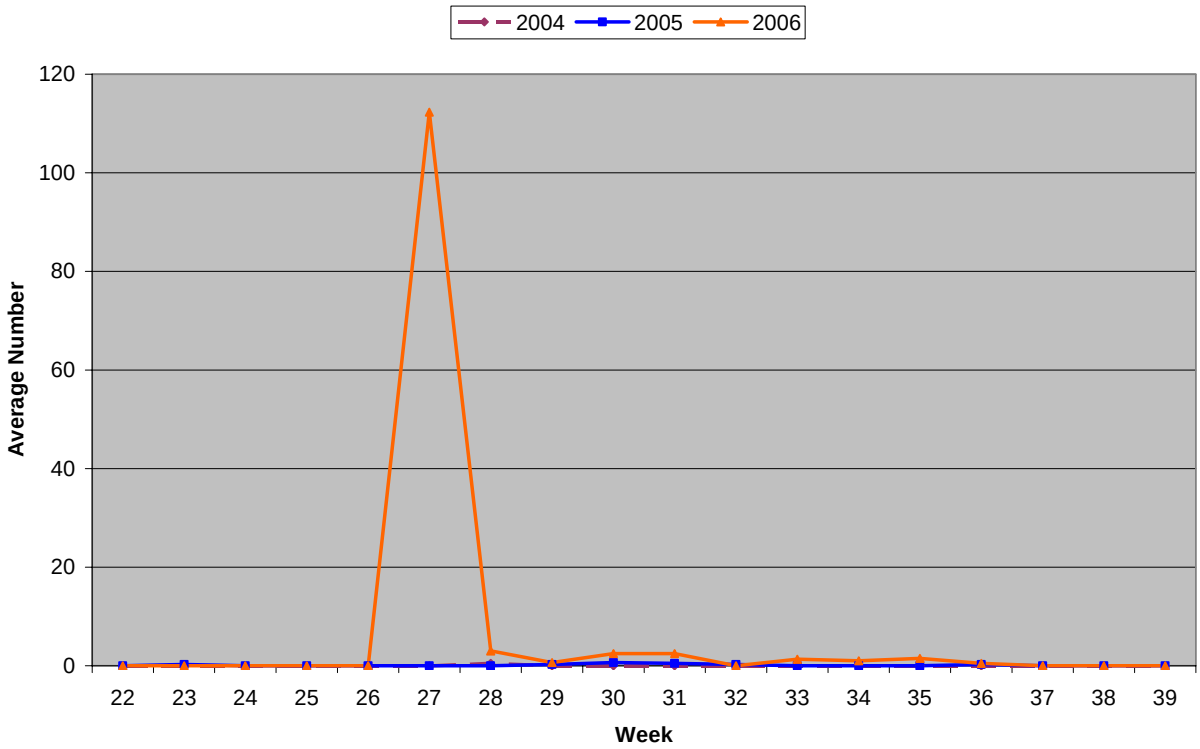
Average Number of Culex tarsalis Captured, NSCG 2004-2006



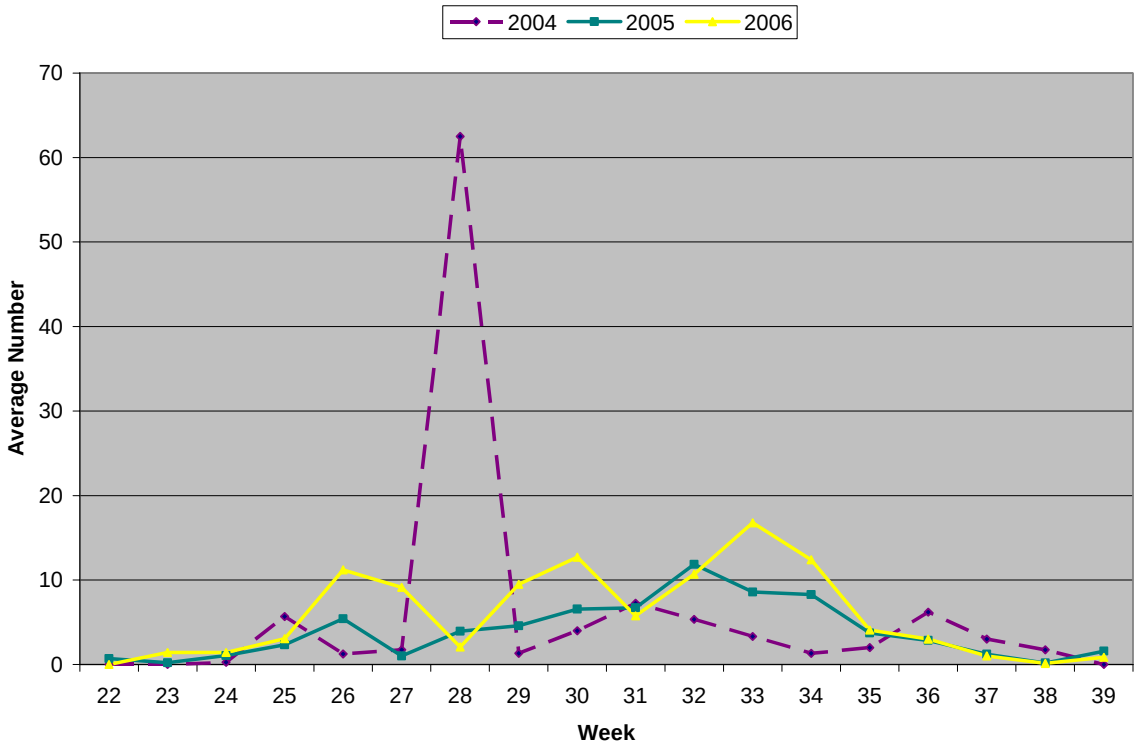
Average Number of Culex pipiens Captured, NVI 2004-2006



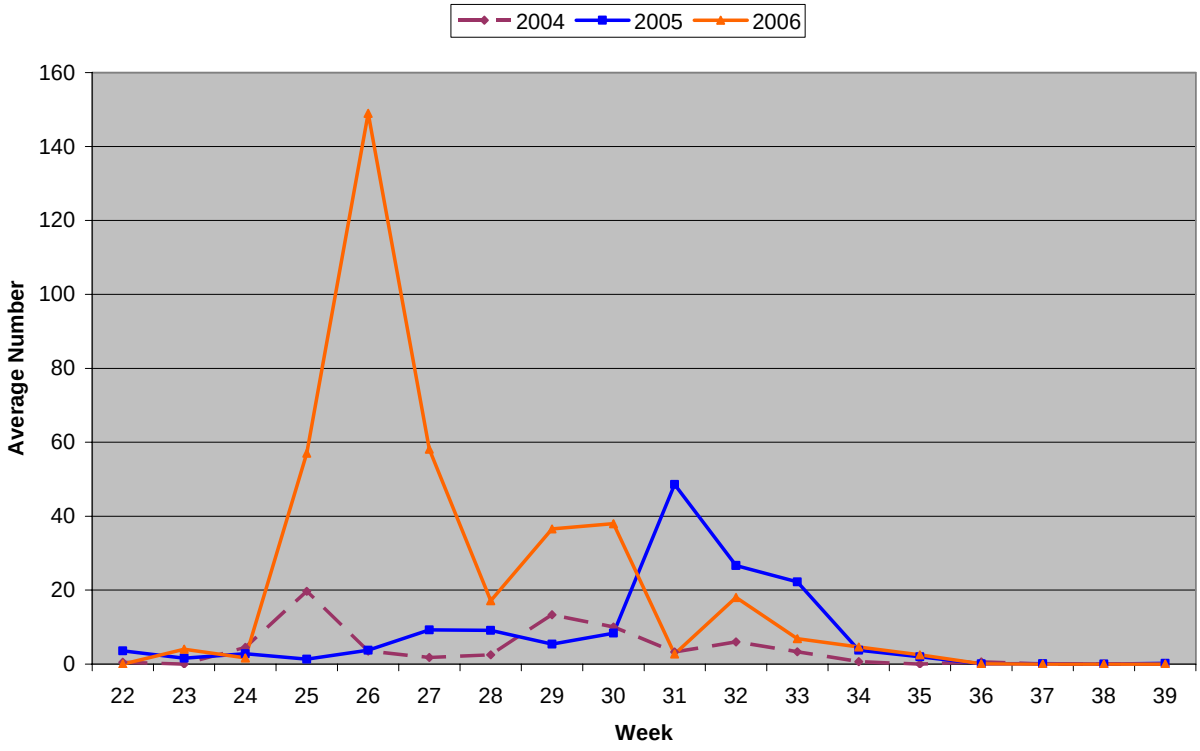
Average Number of Culex tarsalis Captured, NVI 2004-2006



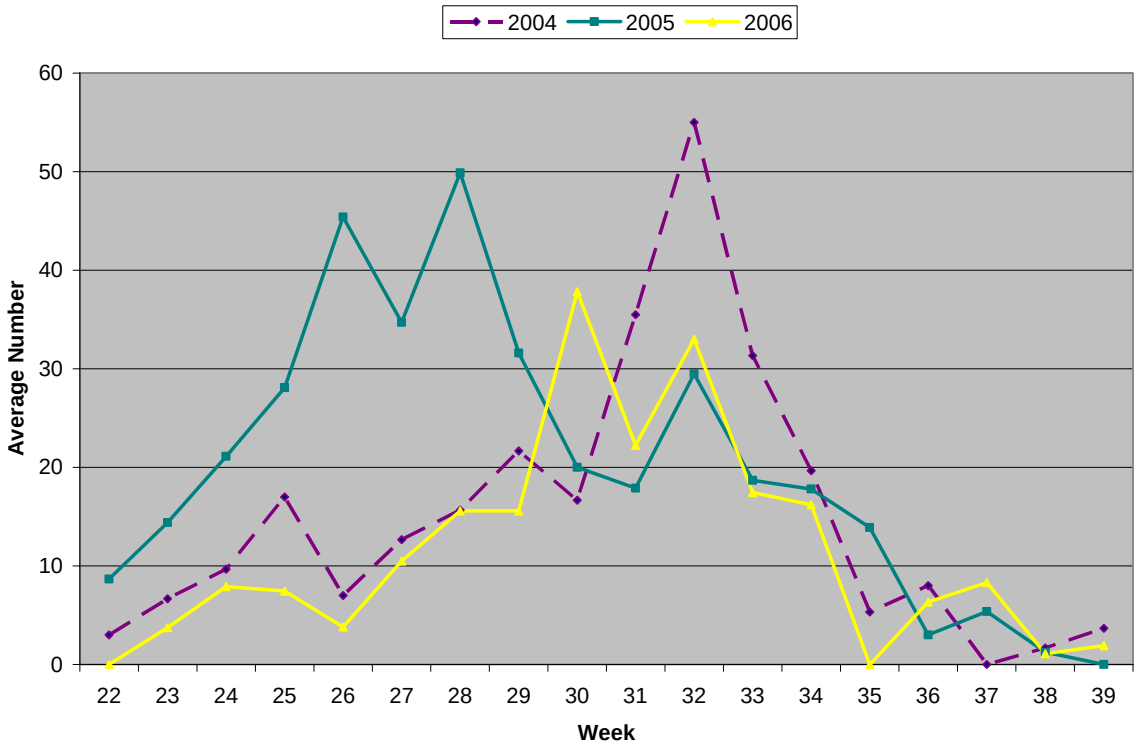
Average Number of Culex pipiens Captured, OK 2004-2006



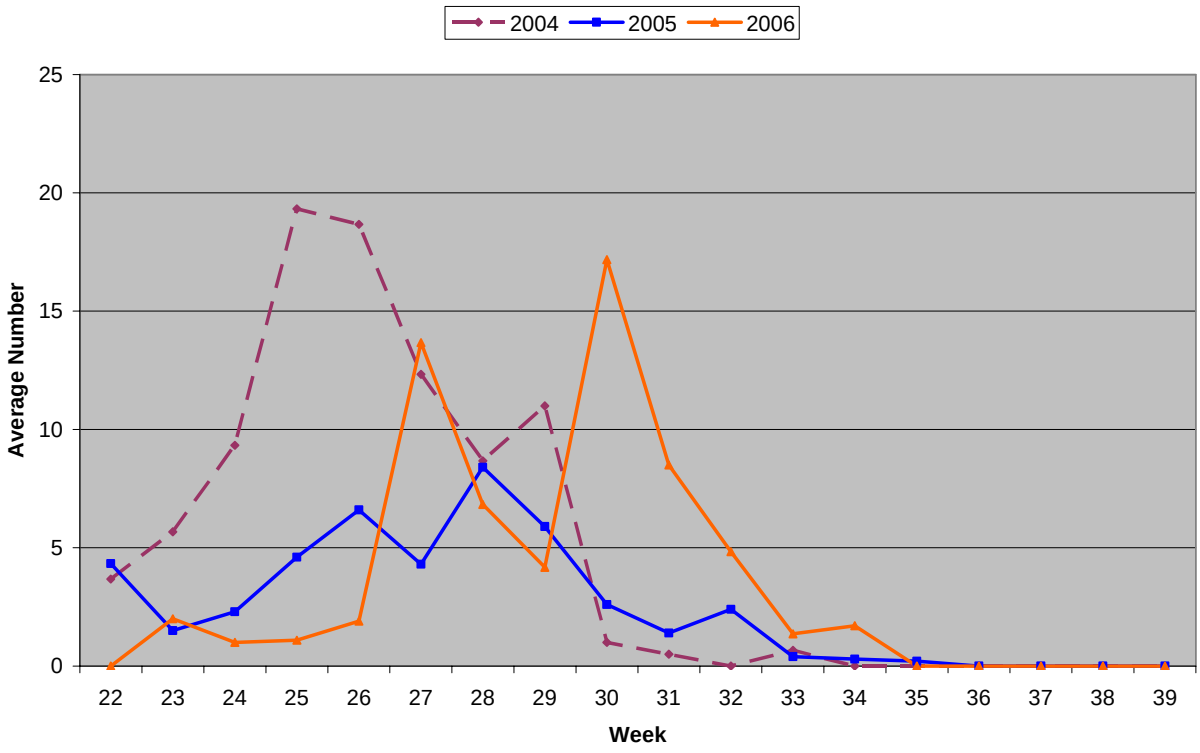
Average Number of Culex tarsalis Captured, OK 2004-2006



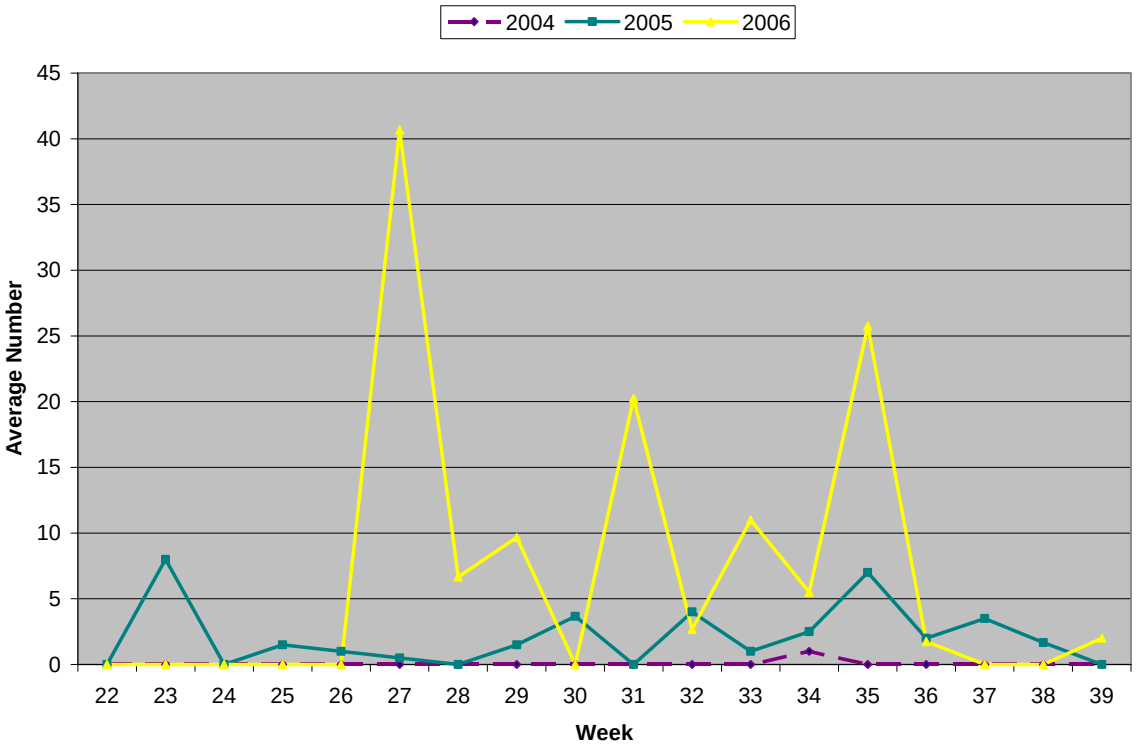
Average Number of Culex pipiens Captured, RICH 2004-2006



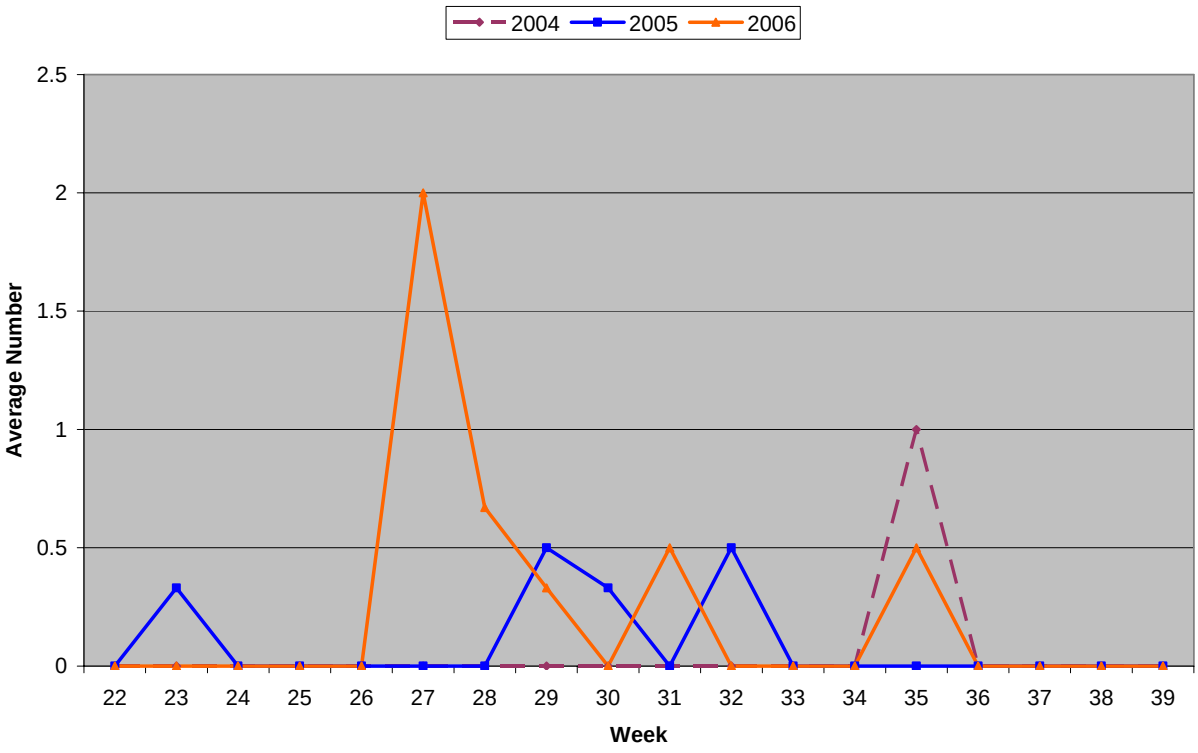
Average Number of Culex tarsalis Captured, RICH 2004-2006



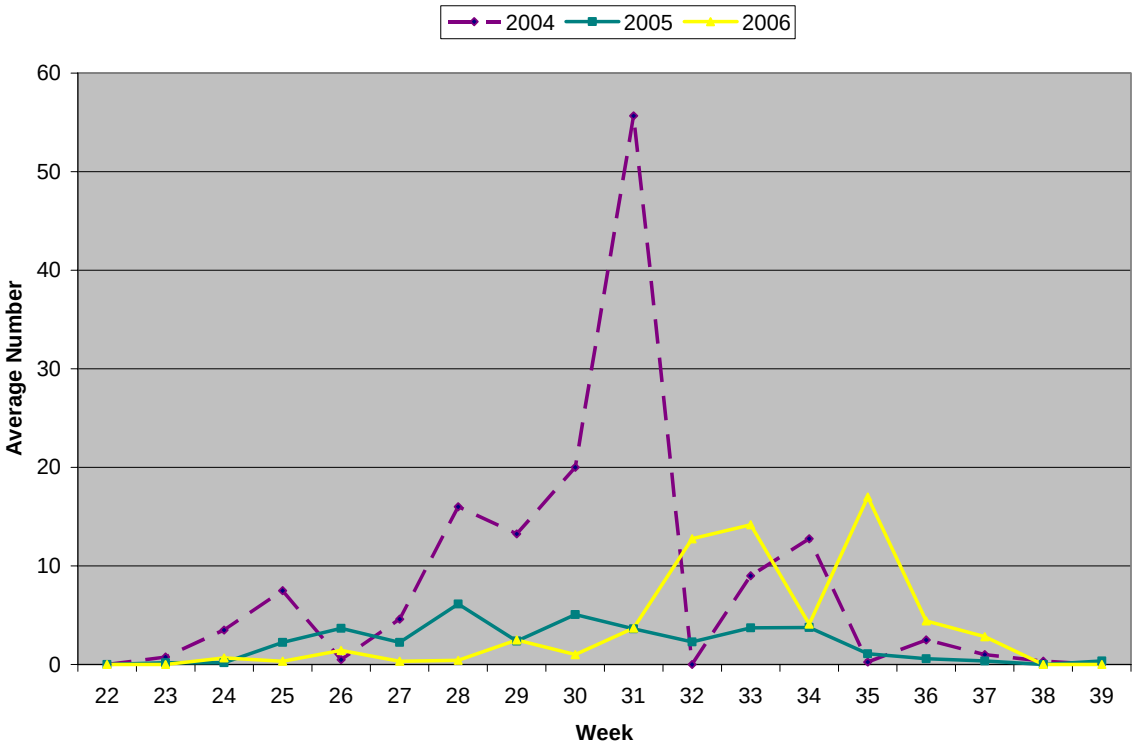
Average Number of Culex pipiens Captured, SVI 2004-2006



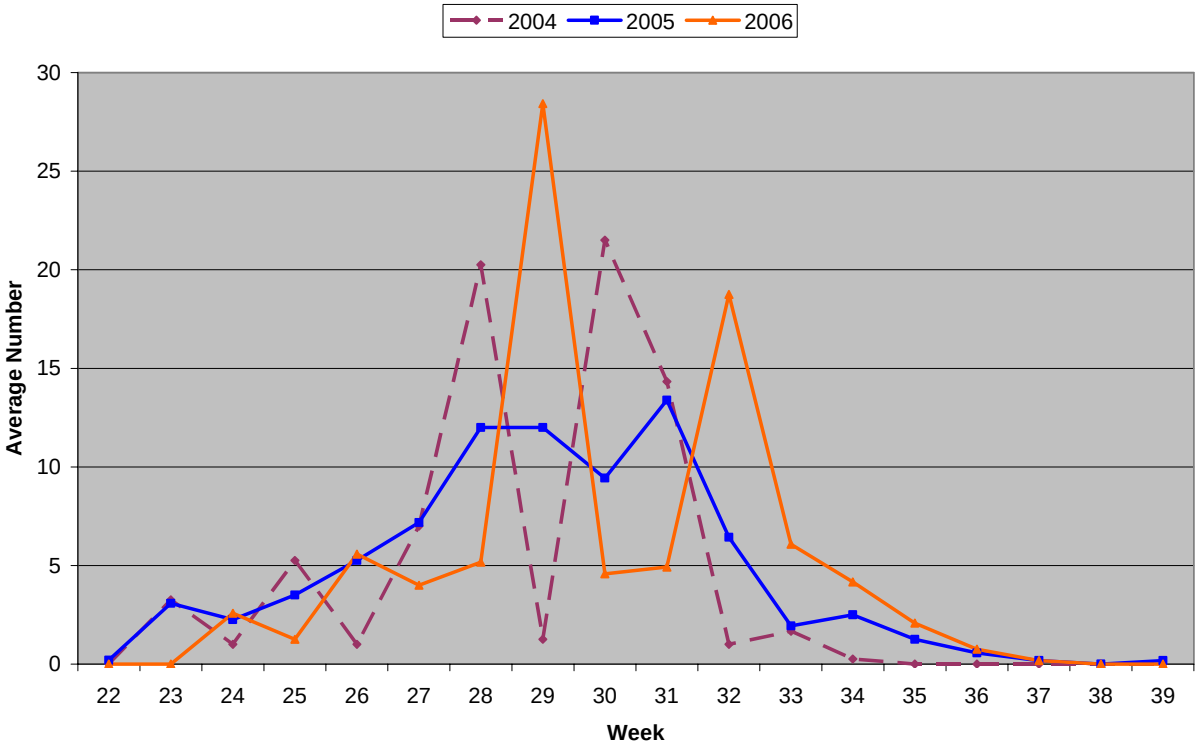
Average Number of Culex tarsalis Captured, SVI 2004-2006



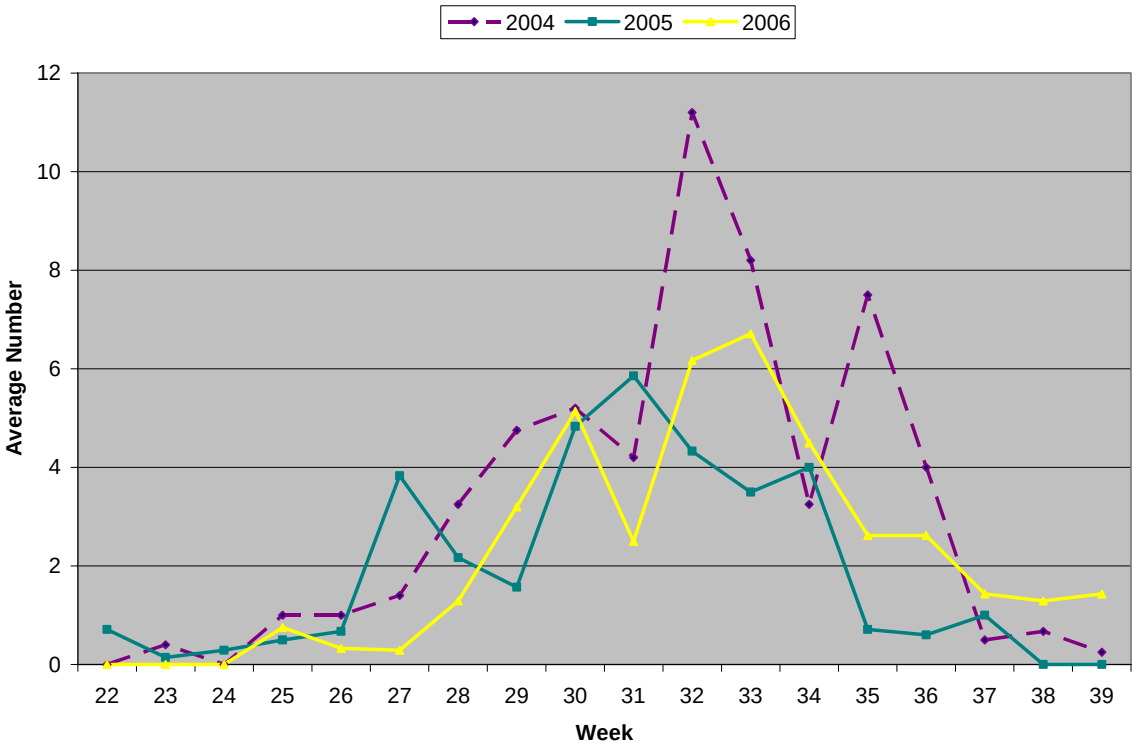
Average Number of Culex pipiens Captured, TCS 2004-2006



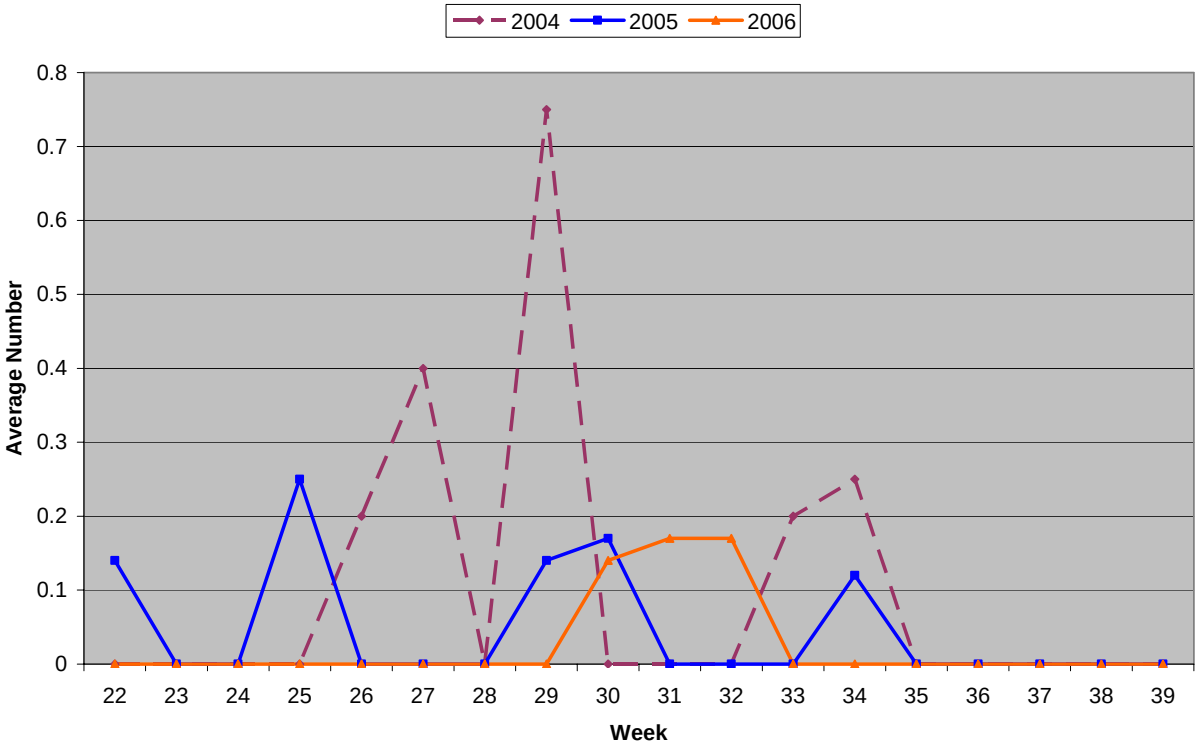
Average Number of Culex tarsalis Captured, TCS 2004-2006



Average Number of Culex pipiens Captured, VAN 2004-2006



Average Number of Culex tarsalis Captured, VAN 2004-2006



Appendix 6: Growing Degree Days Mapping

The concept of growing degree days for mosquito forecasting involves the amount of accumulated heat required for mosquitoes to complete their development from one point in their life cycle to another. This measure of accumulated heat for development is known as physiological time.[1] Mosquitoes are unable to regulate their body temperature and are dependent on the temperature of their surroundings for warmth and growth.

Researchers from Saskatchewan use a base temperature of 16 ^{o}C for *Culex tarsalis*.[2] The simplest form of degree days calculation is by the rectangle method.[3] Degree days are accumulated whenever the daily average temperature is above 16 ^{o}C. For example, if the average temperature on May 1st is 18 ^{o}C, 2 degree days are accumulated since 18-16 ^{o}C = 2 degree days. No degree days are accumulated or subtracted if the average daily temperature is less than 16 ^{o}C. This calculation is repeated for every calendar day and a running total is kept for the duration of the growing season or year. August 31st is the approximate end of the growing season for mosquitoes since the shortening of day length will trigger mosquitoes to go into diapause. The number of degree days required to produce a generation of *Culex tarsalis* varies according to ecosystem type and latitude.

This methodology was applied to BC data in collaboration with UBC Geography and Environment Canada. Climate data from approximately 1000 weather stations between 1971-2000 ("Normals"), and from the 101 active EC weather stations were used in the geostatistical spatial analysis.[4] An obvious bias inherent in most climate data is the location of weather stations in valley bottoms and absence on mountain tops. Therefore, temperature was adjusted for elevation – air temperature decreases with elevation – using the standard lapse rate of 6 ^{o}C per kilometer.

The results of this analysis are the 2006, 2005, 2004, 2003 and 30 year average accumulated degree days maps for BC. As expected, the Okanagan, Upper Columbia River and Thompson regions have the warmest climate in BC. The highly populated Vancouver Lower Mainland and Fraser Valley also have enough heat units to produce multiple generations of *Culex tarsalis*. BC has experienced very hot summers in 2003, 2004 and 2006, and virtually every region of the province accumulated higher than average degree-days. Warmer climates translate into greater West Nile virus risk since the development time between mosquito generations are shortened resulting in more generations and higher amplification of the virus. Biting activity of mosquitoes is also increased during warm temperatures.

References:

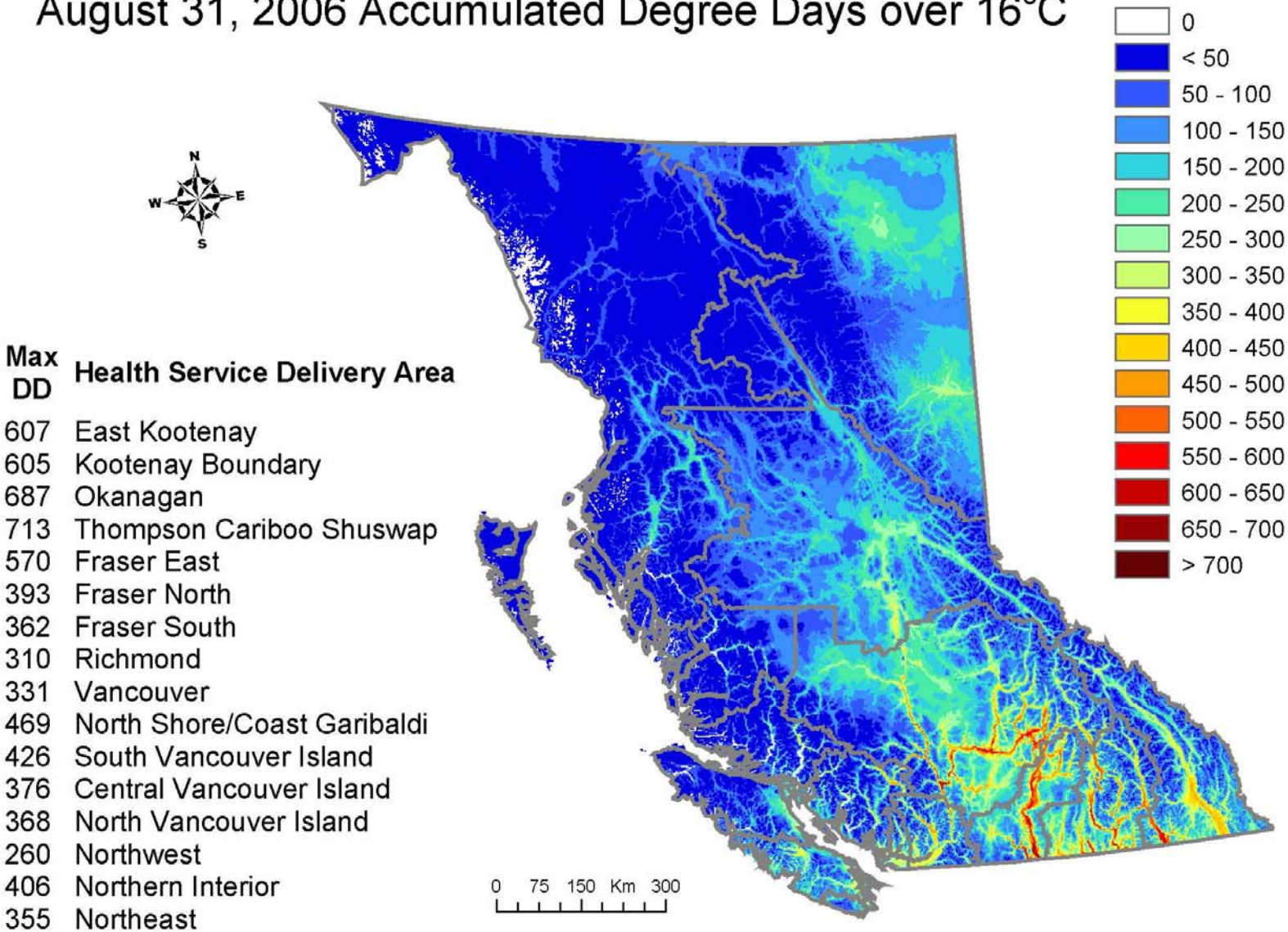
1. University of California and California State Department of Agriculture and Natural Resources Integrated Pest Management Program. "Degree-Days." Webpage accessed 21 January 2005. http://www.ipm.ucdavis.edu/WEATHER/ddconcepts.html

2. Saskatchewan Health and Agriculture Canada. Unpublished data. 2003-2005.

3. University of Illinois Integrated Pest Management. "Degree-Day Calculation". Webpage accessed 21 January 2005. http://ipm.uiuc.edu/degreedays/calculation.html

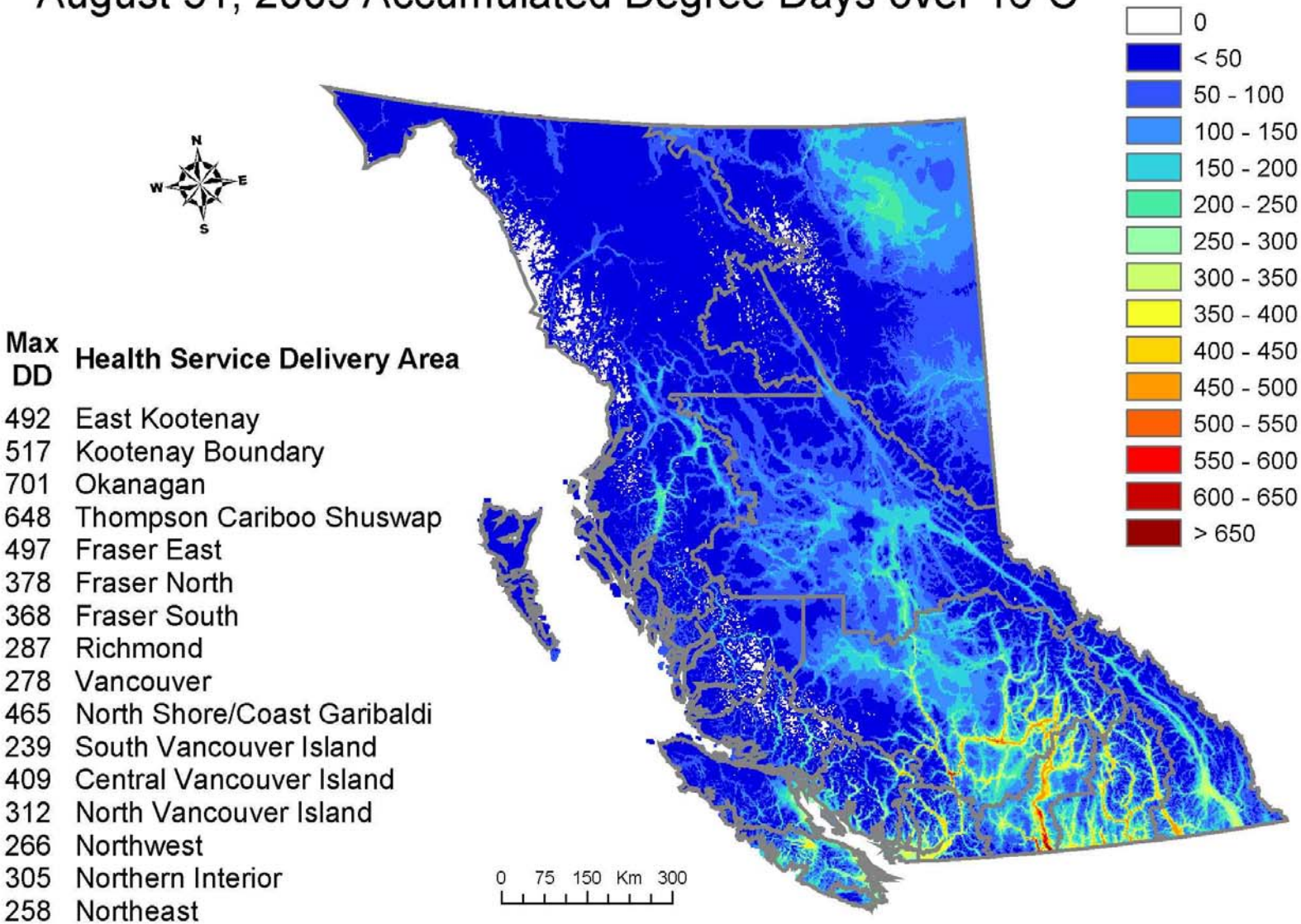
4. Environment Canada. "Canadian Climate Normals or Averages 1971-2000" and "Canadian Climate Data Online". Webpage accessed 21 January 2005. http://www.climate.weatheroffice.ec.gc.ca/climate_normals/index_e.html http://www.climate.weatheroffice.ec.gc.ca/climateData/canada_e.html

August 31, 2006 Accumulated Degree Days over 16°C



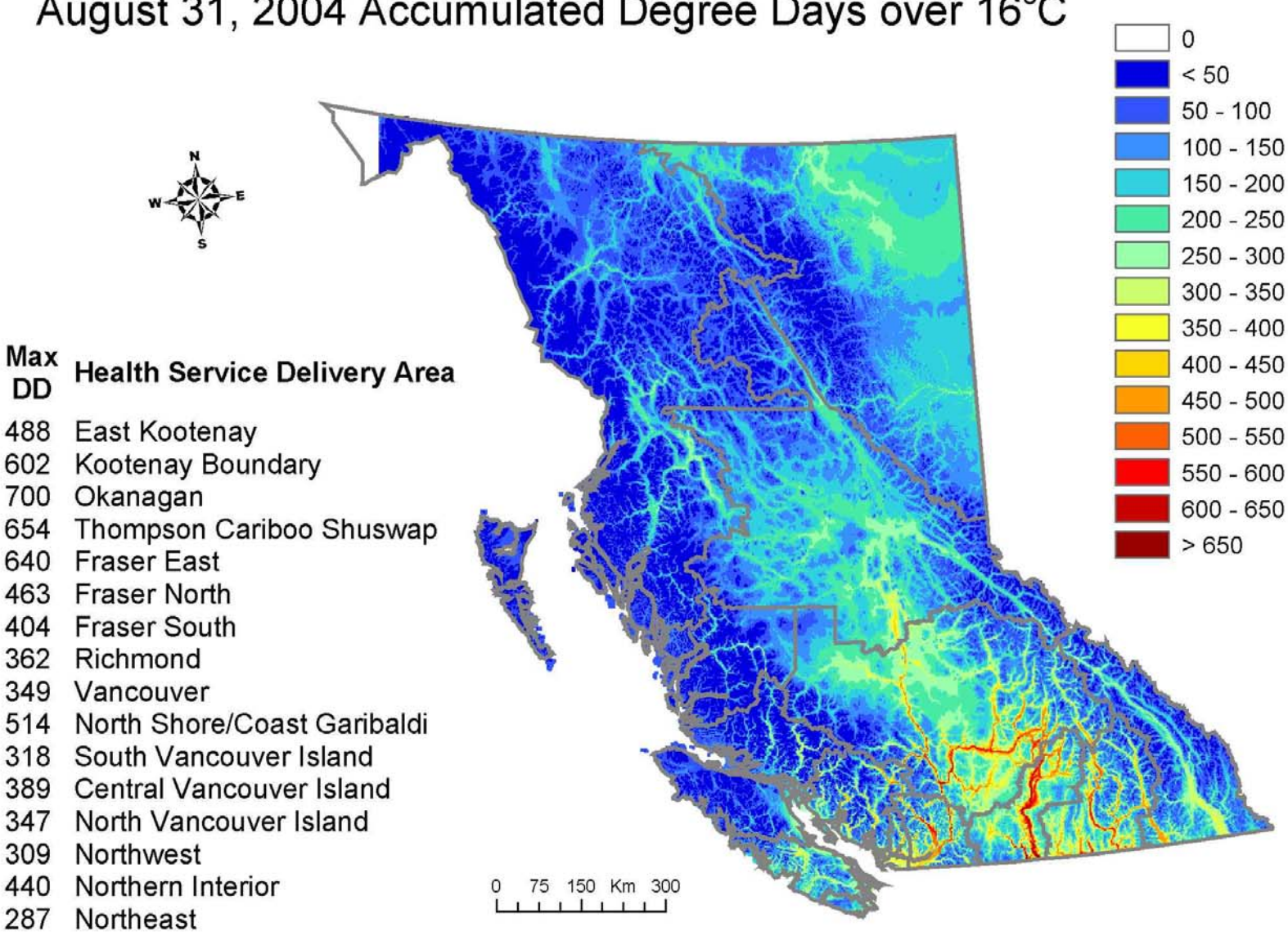
Max DD	Health Service Delivery Area
607	East Kootenay
605	Kootenay Boundary
687	Okanagan
713	Thompson Cariboo Shuswap
570	Fraser East
393	Fraser North
362	Fraser South
310	Richmond
331	Vancouver
469	North Shore/Coast Garibaldi
426	South Vancouver Island
376	Central Vancouver Island
368	North Vancouver Island
260	Northwest
406	Northern Interior
355	Northeast

August 31, 2005 Accumulated Degree Days over 16°C



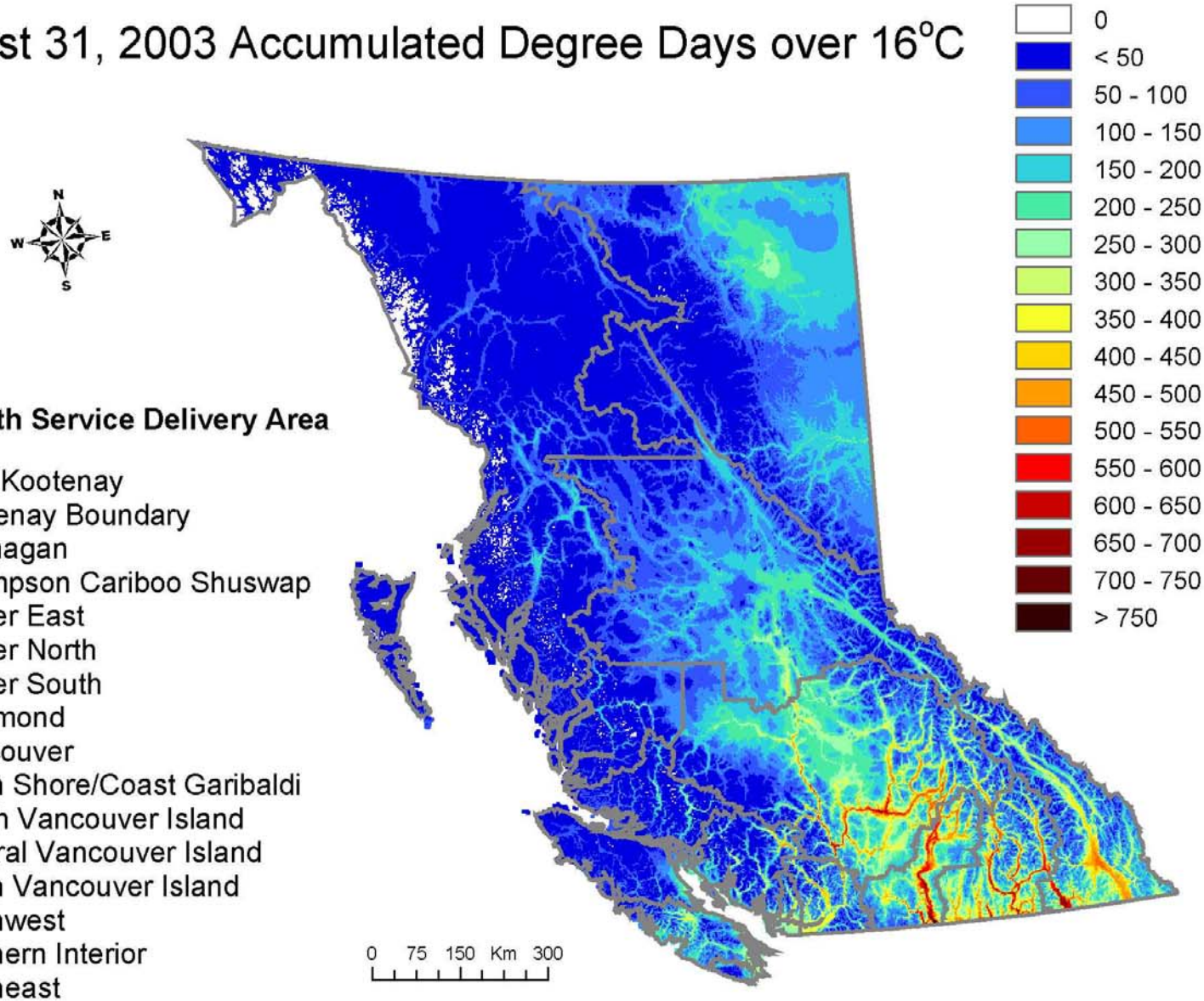
Max DD	Health Service Delivery Area
492	East Kootenay
517	Kootenay Boundary
701	Okanagan
648	Thompson Cariboo Shuswap
497	Fraser East
378	Fraser North
368	Fraser South
287	Richmond
278	Vancouver
465	North Shore/Coast Garibaldi
239	South Vancouver Island
409	Central Vancouver Island
312	North Vancouver Island
266	Northwest
305	Northern Interior
258	Northeast

August 31, 2004 Accumulated Degree Days over 16°C



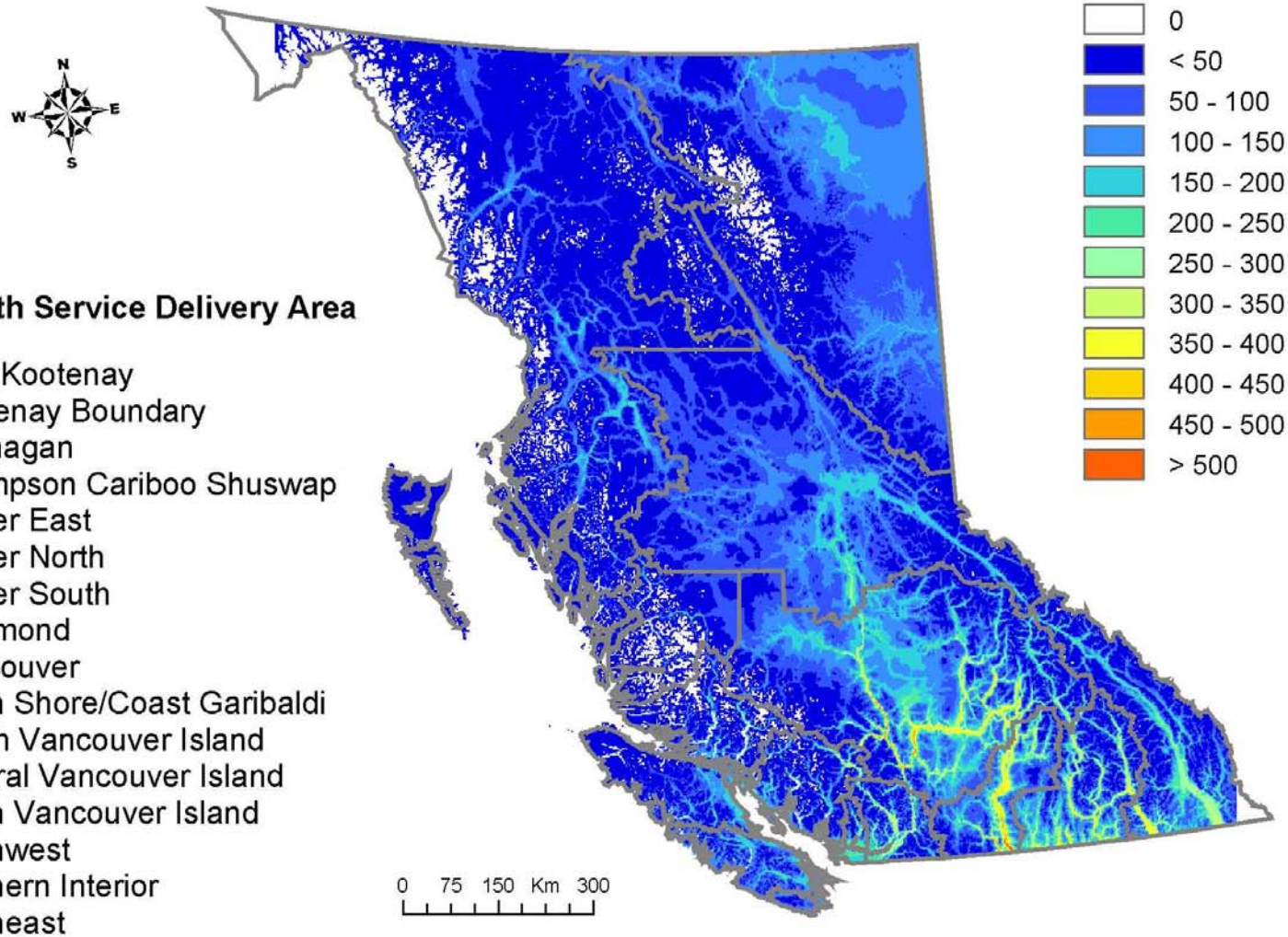
Max DD	Health Service Delivery Area
488	East Kootenay
602	Kootenay Boundary
700	Okanagan
654	Thompson Cariboo Shuswap
640	Fraser East
463	Fraser North
404	Fraser South
362	Richmond
349	Vancouver
514	North Shore/Coast Garibaldi
318	South Vancouver Island
389	Central Vancouver Island
347	North Vancouver Island
309	Northwest
440	Northern Interior
287	Northeast

August 31, 2003 Accumulated Degree Days over 16°C



Max DD	Health Service Delivery Area
674	East Kootenay
673	Kootenay Boundary
782	Okanagan
695	Thompson Cariboo Shuswap
542	Fraser East
381	Fraser North
342	Fraser South
293	Richmond
298	Vancouver
503	North Shore/Coast Garibaldi
460	South Vancouver Island
388	Central Vancouver Island
285	North Vancouver Island
214	Northwest
396	Northern Interior
297	Northeast

August 31, 1971-2000 Mean Accumulated Degree Days over 16°C



Max DD	Health Service Delivery Area
398	East Kootenay
428	Kootenay Boundary
514	Okanagan
509	Thompson Cariboo Shuswap
374	Fraser East
277	Fraser North
238	Fraser South
204	Richmond
187	Vancouver
376	North Shore/Coast Garibaldi
162	South Vancouver Island
220	Central Vancouver Island
278	North Vancouver Island
214	Northwest
293	Northern Interior
189	Northeast

APPENDIX 7
WEEK CODES - 2006

Code	Week Starting	Week Ending
1	01-Jan-06	07-Jan-06
2	08-Jan-06	14-Jan-06
3	15-Jan-06	21-Jan-06
4	22-Jan-06	28-Jan-06
5	29-Jan-06	04-Feb-06
6	05-Feb-06	11-Feb-06
7	12-Feb-06	18-Feb-06
8	19-Feb-06	25-Feb-06
9	26-Feb-06	04-Mar-06
10	05-Mar-06	11-Mar-06
11	12-Mar-06	18-Mar-06
12	19-Mar-06	25-Mar-06
13	26-Mar-06	01-Apr-06
14	02-Apr-06	08-Apr-06
15	09-Apr-06	15-Apr-06
16	16-Apr-06	22-Apr-06
17	23-Apr-06	29-Apr-06
18	30-Apr-06	06-May-06
19	07-May-06	13-May-06
20	14-May-06	20-May-06
21	21-May-06	27-May-06
22	28-May-06	03-Jun-06
23	04-Jun-06	10-Jun-06
24	11-Jun-06	17-Jun-06
25	18-Jun-06	24-Jun-06
26	25-Jun-06	01-Jul-06

Code	Week Starting	Week Ending
27	02-Jul-06	08-Jul-06
28	09-Jul-06	15-Jul-06
29	16-Jul-06	22-Jul-06
30	23-Jul-06	29-Jul-06
31	30-Jul-06	05-Aug-06
32	06-Aug-06	12-Aug-06
33	13-Aug-06	19-Aug-06
34	20-Aug-06	26-Aug-06
35	27-Aug-06	02-Sep-06
36	03-Sep-06	09-Sep-06
37	10-Sep-06	16-Sep-06
38	17-Sep-06	23-Sep-06
39	24-Sep-06	30-Sep-06
40	01-Oct-06	07-Oct-06
41	08-Oct-06	14-Oct-06
42	15-Oct-06	21-Oct-06
43	22-Oct-06	28-Oct-06
44	29-Oct-06	04-Nov-06
45	05-Nov-06	11-Nov-06
46	12-Nov-06	18-Nov-06
47	19-Nov-06	25-Nov-06
48	26-Nov-06	02-Dec-06
49	03-Dec-06	09-Dec-06
50	10-Dec-06	16-Dec-06
51	17-Dec-06	23-Dec-06
52	24-Dec-06	30-Dec-06

Weeks run Sunday to Saturday

APPENDIX 8

Health Authority and Health Service Delivery Area Reference Table

Health Authority (HA)	HA Description	Heath Delivery Service Area (HSDA)	HSDA Description
FHA	Fraser Health Authority	FRE	Fraser East
FHA	Fraser Health Authority	FRE	Fraser Valley*
FHA	Fraser Health Authority	FRN	Fraser North
FHA	Fraser Health Authority	FRN	Simon Fraser*
FHA	Fraser Health Authority	FRS	Fraser South
FHA	Fraser Health Authority	FRS	South Fraser*
IHA	Interior Health Authority	EK	East Kootenay
IHA	Interior Health Authority	KB	Kootenay Boundary
IHA	Interior Health Authority	OK	Okanagan
IHA	Interior Health Authority	TCS	Thompson Cariboo Shuswap
NHA	Northern Health Authority	NE	Northeast
NHA	Northern Health Authority	NI	Northern Interior
NHA	Northern Health Authority	NW	Northwest
VCHA	Vancouver Coastal Health Authority	NSCG	North Shore/Coast Garibaldi
VCHA	Vancouver Coastal Health Authority	RICH	Richmond
VCHA	Vancouver Coastal Health Authority	VAN	Vancouver
VIHA	Vancouver Island Health Authority	CVI	Central Vancouver Island
VIHA	Vancouver Island Health Authority	NVI	North Vancouver Island
VIHA	Vancouver Island Health Authority	SVI	South Vancouver Island

Note:
* Name used in 2003