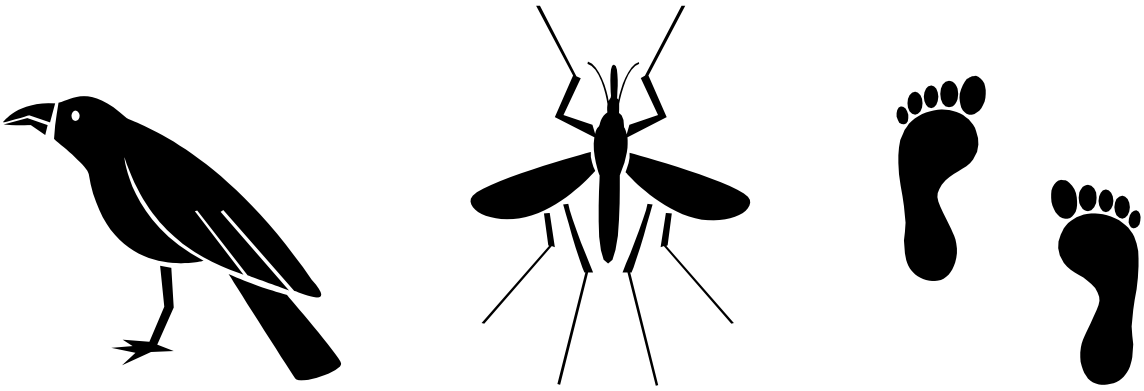
BC Centre for Disease Control
AN AGENCY OF THE PROVINCIAL HEALTH SERVICES AUTHORITY

West Nile Virus Activity in British Columbia: 2005 Surveillance Program Results



Executive Summary

In 2005, endemic West Nile Virus (WNv) activity was noted in central and western Canada including Ontario, Quebec, Manitoba, Saskatchewan, and Alberta. Viral activity levels were higher across Canada in 2005 compared with 2004 but less than that observed during the dramatic expansion of previous years. In all, 225 human cases were reported in Canada in 2005 compared with 20 in 2004 and 1388 during the 2003 outbreak year. The United States reported similar incidences in 2004 and 2005 (2344 and 2775 cases respectively), a 4-fold decrease from 9862 cases in 2003. Despite more moderate activity levels, the virus appeared earlier in Oregon this year than last and spread as far north as Washington State, a region that had been without detectable virus activity since 2002. South of the 60th parallel, British Columbia remains the only area of western N. 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 2005.

Although over 36,000 samples from potential BC blood donors were screened for the virus, and 755 symptomatic patients were tested, no evidence of infection was found. Similarly, samples from all organ donors tested negative for the virus.

While corvid deaths were monitored closely and almost 1,058 specimens were collected across the province and tested for the presence of virus, no positive birds were detected. 95% of submissions were in acceptable condition for testing. On average, 15/16 HSDAs received results within one week of identifying a dead corvid (based on median lag times in collection, shipping and laboratory testing).

An evaluation of corvid sightings and submissions based on 2004 data determined that the majority of the LHAs testing more corvids than expected were in the eastern and south-eastern parts of the province (the directions from which WNv was expected to enter the province). However, even though these areas surpassed expectations, due to low human and corvid densities, expected corvid sightings and submissions were low (0-1 corvids in an LHA sighted or tested per year). This small number of corvids may not be sufficient for WNv detection when the virus is introduced. Rural areas with low population and corvid densities will need to focus on other methods of WNv detection, such as mosquito surveillance.

In contrast to the hot/dry summers of 2003 and 2004, the abundance and species distribution of mosquitoes collected during 2005 are indicative of normal temperatures and precipitation. In 2005, 198,228 mosquitoes were trapped from 189 registered locations across the province. Mosquitoes were separated into 5 genus groupings: *Aedes, Anopheles*, *Coquilletidia (Mansonia)*, *Culex*, and *Culiseta.* Three species of *Culex* mosquito were further confirmed: *Culex pipiens*, *Culex tarsalis*, *Culex territans.* No mosquito pools tested positive for the presence of West Nile virus by PCR. The combined median turn around time from collection of a sample in the field to testing was 6 days.

All mosquito species were more abundant in 2005 compared with 2004 except *Cx. pipiens. Cx. pipiens* was less abundant in both the gravid and light traps in 2005. This year *Cx. tarsalis* and *Cx. pipiens* numbers peaked at the beginning of June, several weeks earlier than in 2004. In the northern Health Authorities (NW and NI), *Cx. pipiens* did not appear until the middle of June/early July. Increased rainfall in the East Kootenays and South Okanagan areas this year resulted in significantly higher numbers of Aedes mosquitoes including a second late summer peak that placed a burden on BCCDC laboratories involved in sorting and identification.

When CO_2 was used as an attractant average trap counts for *Cx. tarsalis* were more than 3-times higher. The average yield of mosquitoes in individual traps was higher in 2005 compared with 2004 due to increased CO_2 use and improved trap placement. Even when considering the lowest-yielding 25% of traps, the average count was 1.2 mosquitoes per trap night in 2005 compared with 0.6 mosquitoes per trap night in 2004.

We had a 1-day improvement in the median submission time for mosquitoes in 2005. This reflects the strong commitment by RHAs to ensuring that real-time results will be available when the virus arrives. The lag time for submissions was greatest after the beginning of September, coinciding with the period when seasonal staff return to school in the fall.

Summary of Surveillance Recommendations for 2006:

- Consider increased monitoring for infected mosquito populations in areas with low human and corvid densities.
- Delay the start of mosquito trapping activities until 1 June for high risk areas and 1 July for low risk areas of BC.
- Test only mosquito pools of *Culex* species until WNv activity is detected in an area.
- Review staffing needs to ensure sufficient resources for the critical surveillance period at the end of August and September are available.

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Summary of Surveillance Activities

During 2005, 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. All organs intended for transplant were screened by BCCDC labs prior to transplantation.

Although no probable cases were identified in 2005, 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 1.

The human testing algorithm used in 2005 entailed screening acute serum samples by 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 (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 (www.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. On-line reports were used to create corvid density maps for regions of the province with sufficient sightings. These will be used as baseline values against which to assess excess corvid mortality in future years, an indicator that virus has been introduced into an area.

During 2005, mosquito surveillance focused on the identification and distribution of adult mosquitoes. From May 1 to October 29, 139 traps collected mosquitoes weekly from 189 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. 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. Once identified, mosquitoes in the same group were pooled to a maximum of 50 mosquitoes/pool, ground and tested for WNv by PCR. 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.

In 2005, 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 was integrated using an interactive on-line mapping tool in 2005. This was developed to assist users with geo-spatial risk assessment to help target appropriate mosquito control activities.

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 from Canadian Wildlife Services and others, 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 1: Summary of BC surveillance statistics, 2005

	Human Cases	Corvids Submitted	Corvids Sighted	Mosquito Pools
# Tested	755	1058	740	6631
# Positive	0	0		0

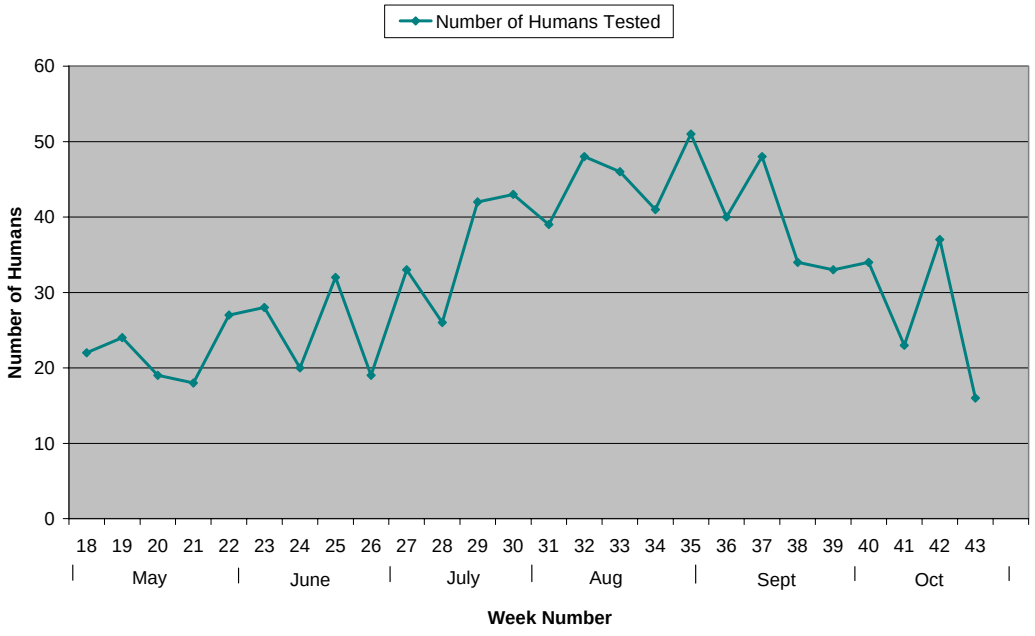
Surveillance of WNv in Humans

Laboratory Testing at BCCDC

From May 1 to October 29, IgG, IgM EIA and PCR tests were performed on 755 unique patients. No locally-acquired or travel-related WNv infections were identified.

From April 1 to October 31, 2005 twenty-eight cryopreserved/stem cell samples, 132 bone donors, 31 living and 9 deceased organ donors were tested for West Nile virus. None were positive. The number of human specimens tested increased from mid-July to mid-September corresponding to the period of greatest risk of human infection (Figure 1).

Figure 1: Number of Human specimens Tested for WNV by Week, 2005



Laboratory Testing at Canadian Blood Services

During the 2005 transmission season (July 4-Oct 31), Canadian Blood Services screened 36,240 BC and Yukon blood donations for WNv. No cases of asymptomatic infection were detected.

Recapping the year
Since July 2003, Canadian Blood Services (CBS) tested every donation for West Nile virus (WNv) using an investigational WNv Nucleic Acid Test (WNv-NAT). During 2005, as in previously years, there were no confirmed positive WNv donation in British Columbia. Nationally, CBS detected WNv in 15 donations during 2005, representing 6.3% of the 239 cases of WNv infection reported to Health Canada this year. Seven positive donors were detected in Ontario, 4 from Saskatchewan and 2 each from Manitoba and 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. Positive donors were detected between 26 July and 29 September 2005, 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 2 years, no case of transfusion-transmitted (TT)-WNv was reported in Canada in 2005.

Minipool and Single Unit WNv Testing of Donors
CBS performed WNv-NAT either in minipools (MP) of 6 specimens, or by single unit testing (SUT). SUT is more sensitive than MP testing in detecting early, seronegative, viremic infections that pose the highest risk of TT-WNv, and was deployed during WNv season when evidence of higher WNv activity was present. This year, CBS made SUT available for the 11 week period between 24 July to 9 October and employed SUT for approximately 8% of all donations over this period, although no SUT was performed on BC donations.

For the 2005 WNv season, the criteria used by CBS for implementing SUT were either a positive donor test result or an incidence of public health-reported WNv in a health region over a 2 week period exceeding an incidence 1:1000 population in rural areas or 1:2500 population in urban settings. SUT was implemented for a 2 week period for all donor clinics in the affected region; SUT was discontinued if neither criterion was met over the ensuing 2 week period. In its ongoing review of SUT deployment, CBS undertook ongoing risk assessments for each health region in each province, using the most current available human WNv surveillance data. CBS was also able to implement SUT for blood collections from clinics in an affected region within hours of a positive donor test result and no donor clinics were cancelled.

Of the 15 positive donations detected by CBS in 2005, 9 were detected by MP testing and 6 by SUT; 14 of 15 were seronegative donations and hence more likely to have been infectious. Subsequent laboratory follow-up revealed that only 1 of the 6 units detected by SUT would not have been identified through MP testing. This is consistent with other recently published data that indicate that MP testing is very effective at interdicting potentially infectious WNv donations.

Fresh Frozen Plasma Not Stockpiled
Based on previous experience, it was also determined that national requirements for fresh frozen plasma (FFP) could be met using FFP that was collected from low WNv risk areas; consequently for 2005, there was no stockpiling of FFP that had been collected prior to mosquito season.

Inter-Agency Co-operation and Communications
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. Previous years' detailed provincial WNv blood response plan was reviewed and updated (available at public Provincial Blood Co-ordinating Office website http://www.traqprogram.ca/). A WNv blood update for BC physicians was included in an early summer edition of the BC Medical Journal, providing physicians with reporting instructions concerning suspected TT-WNv and resource information for providing patient informed consent. Additional information was also provided by CBS to hospitals and physicians more directly involved in transfusion medicine throughout BC. CBS, MOH and public health officials participated in

ongoing conference calls throughout WNv season to share information and updates. Biweekly updates during the core WNv season were provided by CBS to the blood-user community across BC and to public health. In addition, CBS was able to provide regional donor WNv testing denominator to BCCDC.

Public Health Reporting of Suspect WNv Cases to CBS

With the support of the Provincial Health Officer, an Order-in-Council again authorized BCCDC this year to provide CBS with data on persons for whom WNv testing had been requested. The purposes of this reporting were to identify 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 again while they may potentially remain infectious. Between 1 June and 31 October, BCCDC provided daily reports to CBS BC and Yukon Centre on WNv test requests. Over this period, 427 reports were received by CBS of which 23 (5.4%) were also donors. Three of the 23 donors had recently donated blood and recall of in-date products was carried out. Of particular interest was one donor whose last donation was in Hamilton, but who subsequently became ill and was tested in BC. Hamilton blood centre was immediately informed and able to follow-up with hospital customers.

Anonymized Data Linkage Project

In addition, development and testing of an Anonymized Data Linkage (ADL) process between BCCDC and CBS has continued over 2005, using WNv as a sentinel blood-borne pathogen. Among the goals of this project 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 and enhancing patient confidentiality. The ADL matching algorithm is being tuned to optimize its sensitivity and specificity, using real-world WNv test data from BCCDC during the 2005 WNv season and matching this with the national CBS donor database. Interestingly, the ADL process retrospectively identified 1 match that was not initially made by manual checking (due to discordant date of birth between databases), exemplifying the potential benefits of improved timeliness and accuracy of data linkage envisioned in the project.

The Future

A number of changes to CBS' future approach to donor WNv testing are under review. Health Canada has recently approved a submission by Hema Quebec for "seasonal" WNv testing – i.e. discontinuing routine donor WNv testing during the cold winter months and over this time, only requiring testing of donors who have traveled outside Canada; CBS is examining the utility of a similar approach. Also under review is a possible reduction in the current 2 week duration of SUT in a region following a single reported positive donor. Cumulative experience indicates that there would likely be subsequent cases identified in the week following an initial positive donor if a region was indeed experiencing sustained high WNv activity.

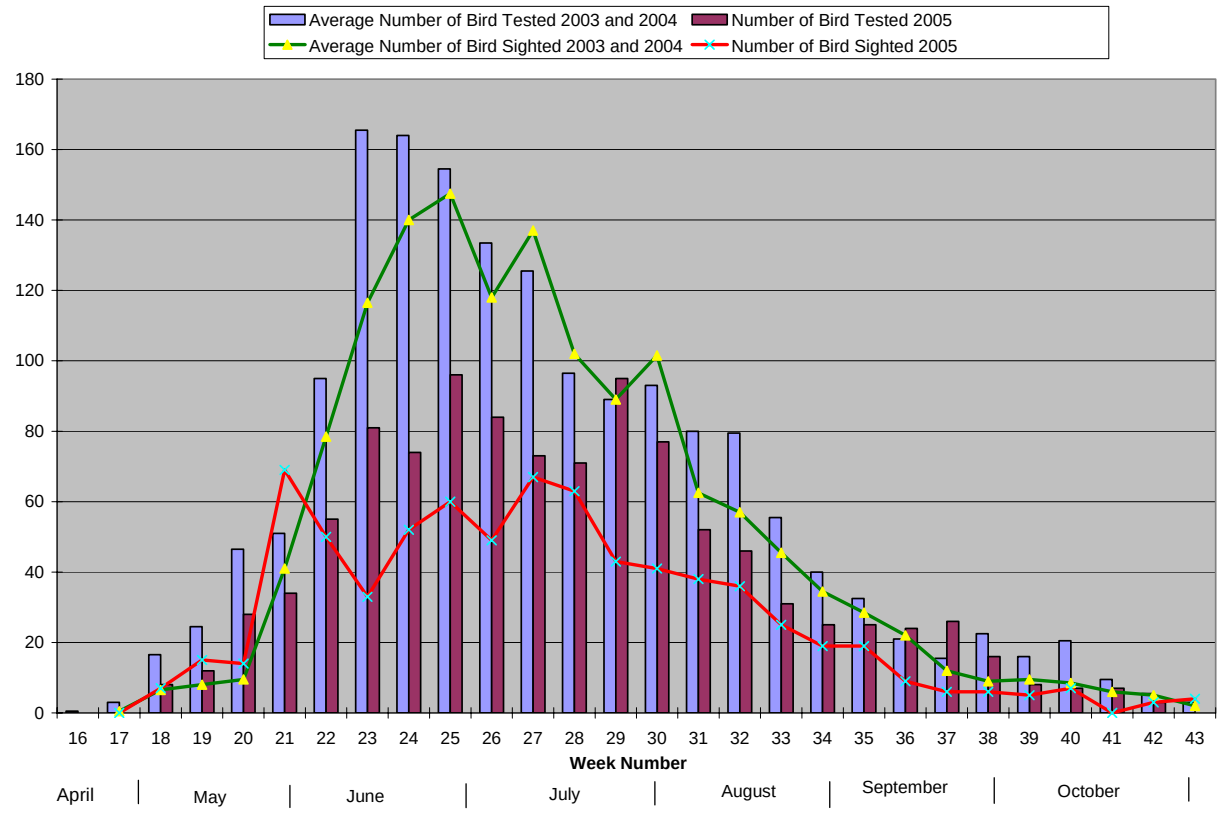
An evolving, increasingly integrated approach to this emerging blood-borne pathogen, involving blood suppliers, public health agencies at all levels, laboratories, hospitals, health care providers and Ministries of Health serves as an excellent example of how a system-wide approach can enhance blood safety.

Surveillance of WNv in Corvids

Reporting of Corvid Deaths

Overall, 1058 corvids were collected and tested in BC from May 1 to October 24, 2005. Annual corvid collections have decreased over the last three years; collections dropped 23.6% from 2003 to 2004 and 26.4% from 2004 to 2005. A similar decrease was noted in dead corvid sightings across the province. Decreases in the number of sightings and specimens tested were not time dependent, occurring throughout the surveillance season. As such, the overall distribution and shape of the curve remain similar from year to year. 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 or possibly a reflection of natural fluctuations in wild bird populations. In the absence of WNv, increases in dead corvid deaths begin in late May as fledglings begin leaving the nest, peak in mid-June and begin a steady decline through October. The provincial distribution of deaths as recorded by the public closely mirrors the weekly distribution of specimens collected for testing (Figure 2).

Figure 2: Comparison of Birds Sighted and Tested, 2005 and Average number of 2003, 2004

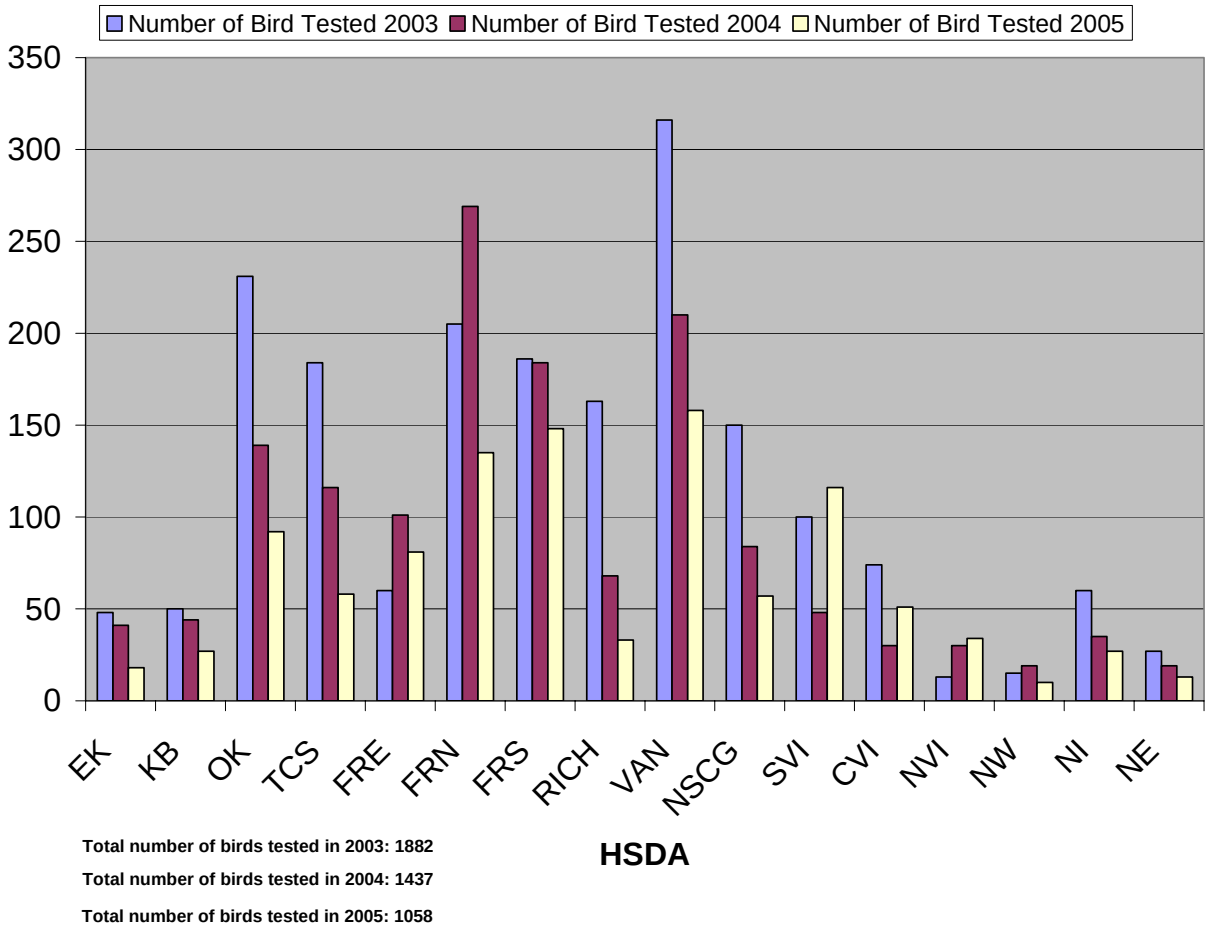


Average number of birds sighted in 2003 and 2004: 1397
Total number of birds sighted in 2005: 740

Average number of birds tested in 2003 and 2004: 1659
Total number of birds tested in 2005: 1058

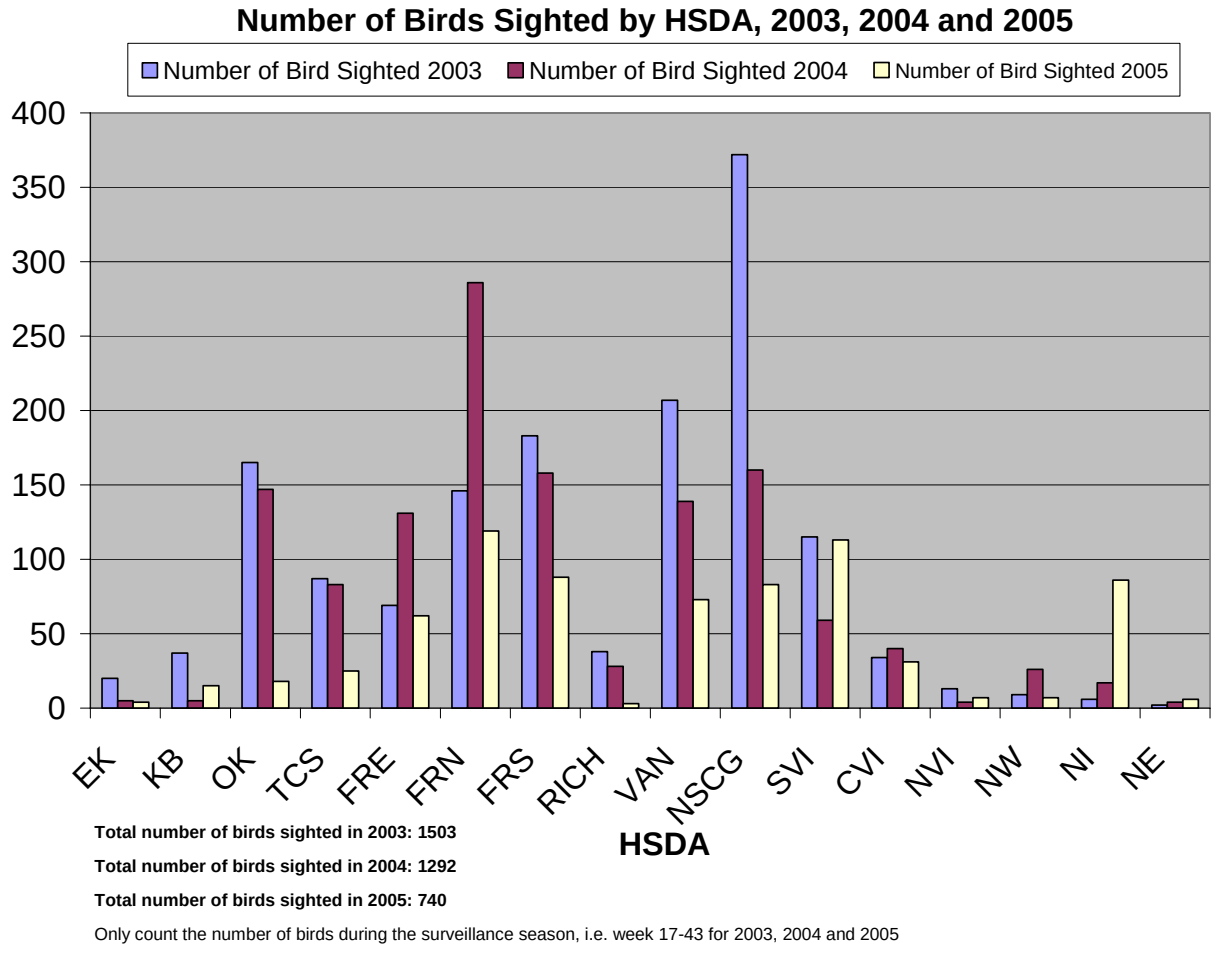
Despite overall declines in most HSDAs, notable increases in corvid submissions for 2005 occurred on Vancouver Island (South, Central and North Vancouver Island) compared with previous years (Figure 3). Good spatial representation was achieved for dead corvid submissions in 2005 when considering cumulative totals (Figure 6), however 10 fewer HSDAs submitted birds for testing in 2005 compared with 2004, most notably in Southern and Eastern locations along the US and Alberta borders. Submissions from individual HSDAs varied over time (Appendix 2).

Figure 3: Comparison of Birds Tested by HSDA, 2003, 2004 and 2005



From 2004 to 2005, public use of the on-line form increased most noticeably in Northern Interior and South Vancouver Island. The largest drop occurred in NSCG, Fraser Health, Okanagan and TCS. (**Error! Reference source not found.**).

Figure 4: *Change in number of corvid sightings reported on-line, 2003, 2004 and 2005.*



Representativeness of Corvid Reporting[1]

In 2004, it was determined that only urban areas of the province were able to submit at least one corvid per week over the course of the surveillance season. As failure to make regular submissions from more rural areas of the province may impair the timely detection of WNv, we were interested to know whether fewer submissions from these areas was a function of an unrepresentative surveillance system or accurately reflected the true mortality in these areas. Corvid submissions and on-line mortality reports depend both on the fact that dead birds are present in an area and that people are around to witness their

[1] ST David, S Mak, L. MacDougall and M. Fyfe. A Bird's Eye View: Using Geographic Information Systems to Evaluate the Representativeness of Corvid Indicators for West Nile Virus Surveillance.

deaths. Hence the number of birds that are expected to be reported from any given area is a function of the size of the area, and the human and corvid population densities therein.

An evaluation was performed to determine whether reports of dead corvid sightings and submissions of dead corvids for West Nile virus (WNv) testing were representative of true corvid mortality in British Columbia in 2004, a year with no WNv activity, in order to ensure the surveillance system was accurately describing corvid mortality rather than reflecting regional differences in surveillance methods.

The proportions of dead corvid sightings reported and corvid carcass submissions for WNv testing from each of 83 Local Health Areas (LHAs) were compared to expected proportions using the exact Poisson distribution at 0.05 significance. The expected proportions were based on the LHA size, and human and corvid population densities. Corvid densities were interpolated from the North American Breeding Bird Survey data by the Ordinary Kriging method using geographic information systems.

LHAs reported 0-159 (median=3) dead corvid sightings and 0-209 (median=5) submissions for WNv testing. The expected numbers of dead corvid sightings and submissions for testing from each LHA were 0-228 and 0-254, respectively. In the final analysis, some LHAs were over-represented and others under-represented in terms of corvid WNv surveillance indicators (*Figure 5*). Eleven LHAs reported significantly fewer sightings than expected; 28 reported significantly more. Eleven LHAs submitted significantly fewer corvids than expected; 31 submitted significantly more.

Sixty-six (80%) LHAs met or exceeded expectations for reports of dead corvid sightings and submissions of corvid carcasses for WNv testing. Only 5 (6%) LHAs were below expectations for both indicators - Surrey, Vancouver, Cowichan, Greater Victoria and Sooke. Three of these LHAs (Cowichan, Greater Victoria and Sooke) were on Vancouver Island. This lower level of surveillance activity may have been a result of lower public health emphasis or low perception of risk. Vancouver Island had been projected to be a low risk area for the initial introduction of WNv into the province. Following circulation of these results, VIHA increased both corvid submissions and sightings in 2005.

The majority of the LHAs testing more corvids than expected were in the eastern and south-eastern parts of the province (the directions from which WNv was expected to enter the province). However, even though these areas surpassed expectations, due to low human and corvid densities, expected corvid sightings and submissions were low (0-1 corvids in an LHA sighted or tested per year). This small number of corvids may not be sufficient for WNv detection when the virus is introduced. Rural areas with low population and corvid densities will need to focus on other methods of WNv detection, such as mosquito surveillance.

Figure 5: Number of dead corvid sightings reported and number of corvid carcasses tested for West Nile virus versus expected numbers, by Local Health Authority, 2004

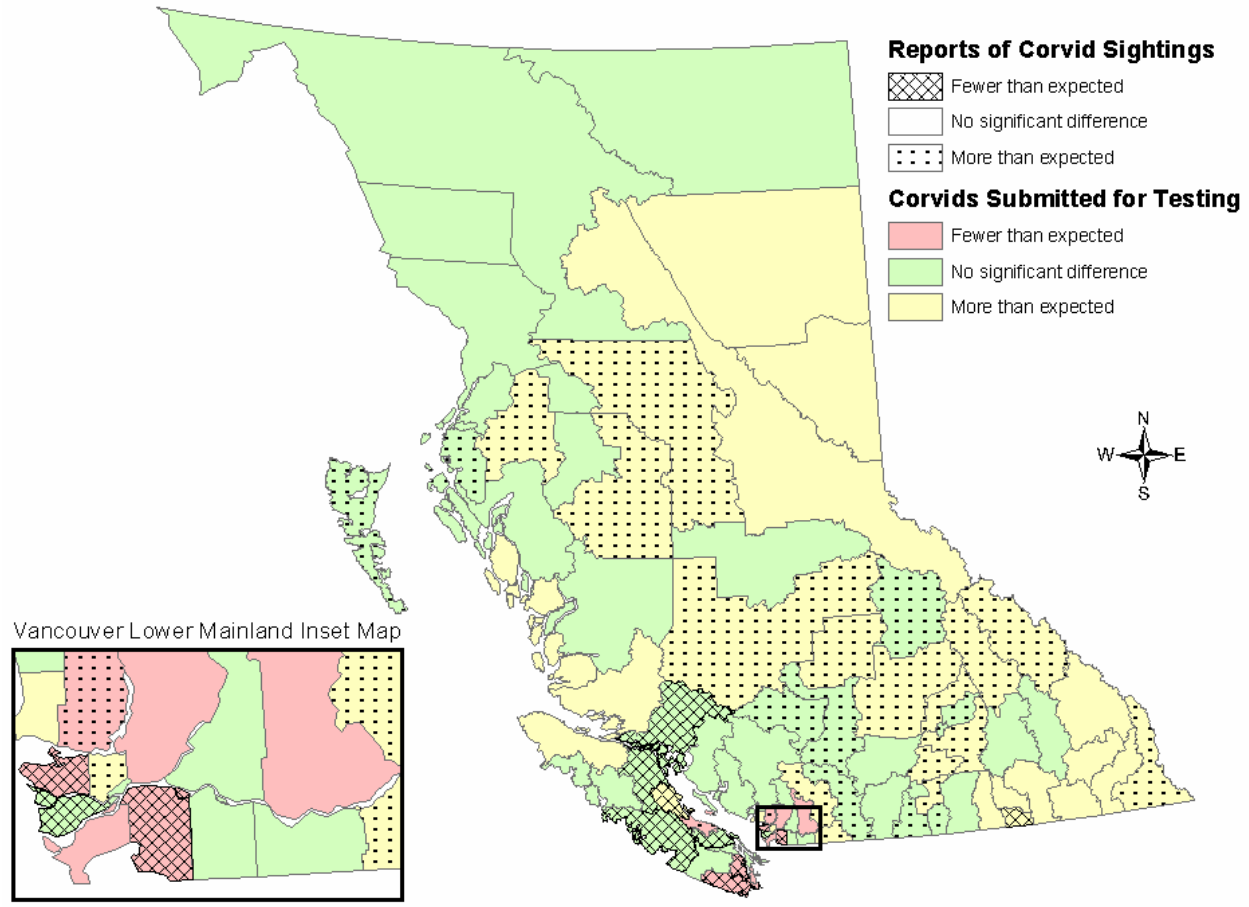
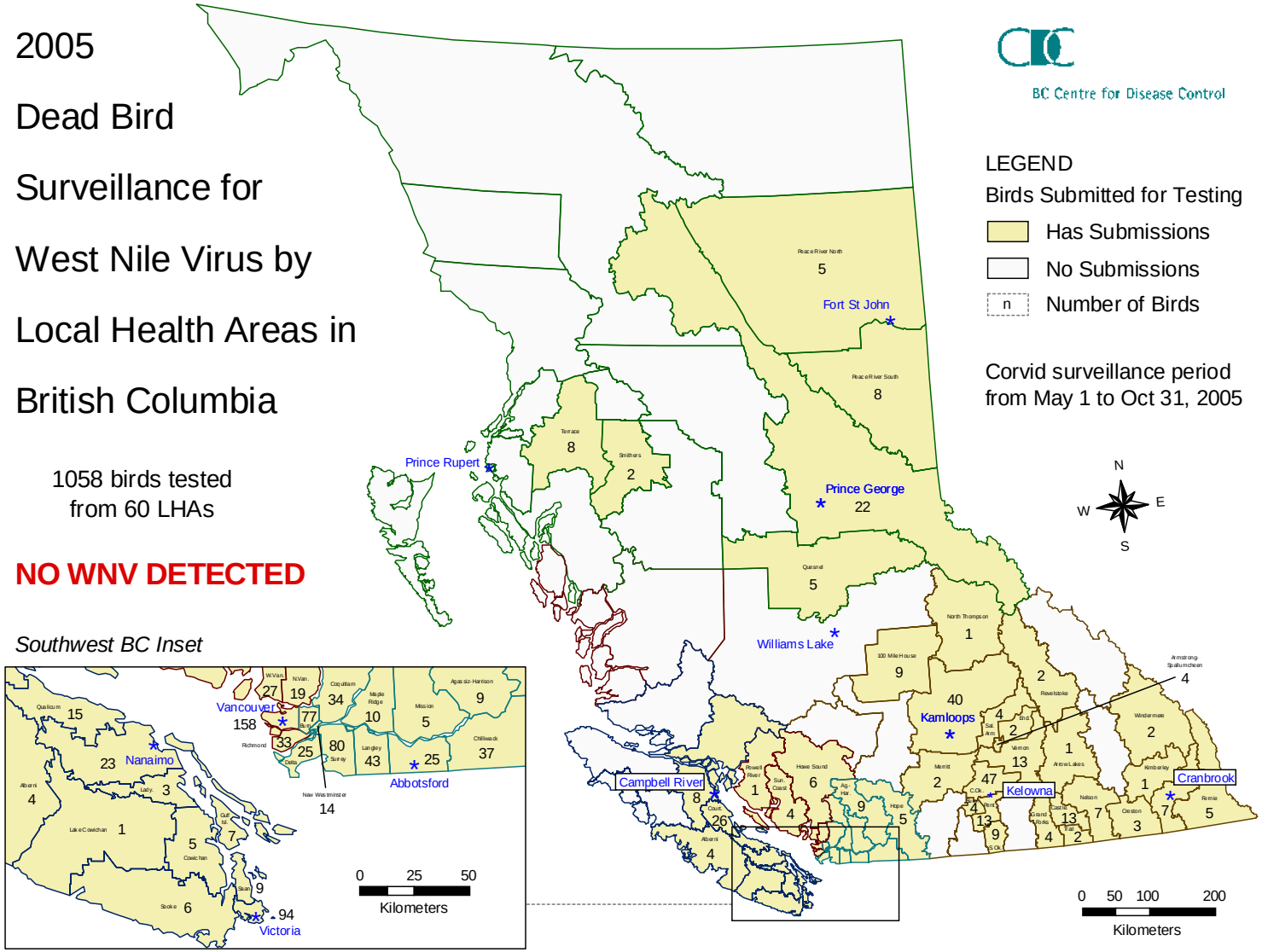


Figure 6: Geographic Distribution of Corvid Test Results, 2005



Bird Species Breakdown by Region

Over 90% of all corvid submissions in 2005 were American Crows (*Corvus brachyrhynchos*). The second most commonly submitted bird was the Black Billed Magpie (*Pica pica hudsonia*), which made up a significant proportion of dead bird submissions from eastern regions of the province – the Northeast (62%), the Okanagan (19%) and Thompson Cariboo Shuswap (17%). The Common Raven (*Corvus corax*) was most often submitted from the Okanagan, the Kootenays, and Vancouver Island. The species composition of dead bird submissions has remained static from 2003 to 2005.

Figure 7: Proportion of Total Corvids Tested by Species, 2005

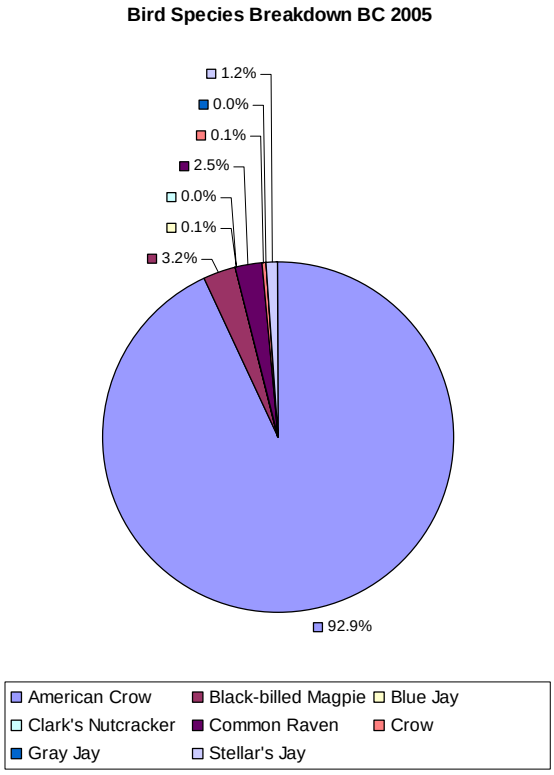
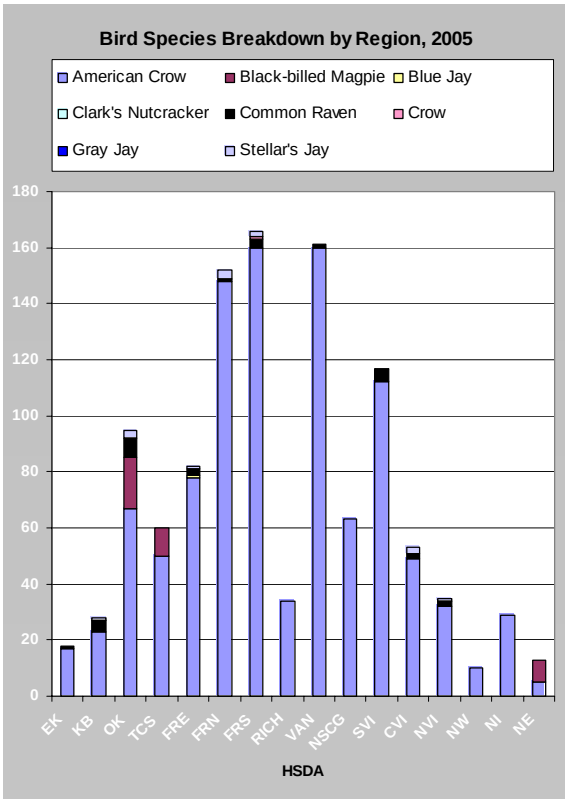


Figure 8: Corvid Species Submitted for Testing, 2005



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. Although 94.8% of all corvids submitted in 2005 were suitable for testing, this constitutes a significant drop from 2004 ($p<0.001$) (Table 2). The most notable decreases in specimen suitability were observed in Fraser North and South where 8.6% and 9.2% fewer specimens were acceptable for testing in 2005 compared with 2004. Appropriateness of specimens submitted in other provinces ranged from 86% to 100%.

Table 2: Appropriateness of Bird Specimens Submitted for Testing by HSDA, 2003 - 2005

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

The most common reason that carcasses couldn't be tested in 2005 in BC was advanced decomposition of the specimen (Table 3). This occurred significantly more often in 2005 compared with 2004 ($p<0.001$). This is unlikely to be an effect of higher ambient temperatures, since average temperatures in all regions of BC were lower in 2005 compared with 2004.[2] Over one quarter (16/58) of all of specimens unable to be tested during 2005 were collected during a single week of the surveillance season (week 30: July 24th to 30th) and 63% (10/16) of these were from Fraser North. When this single, aberrant event is excluded, specimen acceptability was very high for all regions of the province throughout the entire surveillance period.

Table 3: Reasons for which corvids were not able to be tested, 2003/4/5

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

Lag Times for Corvid Submission and Testing

Continued improvement was made between 2003 and 2005 with respect to the timeliness of corvid submissions (Table 4). 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 2004). In 2005,

[2] Source: Environment Canada. Summer regional temperature departures, ranked warmest to coolest, 1948 – 2005. http://www.msc-smc.ec.gc.ca/ccrm/bulletin/rtable_e.html?region=f&table=temperature&season=Summer&date=2005&rows=58

improvements in median delays were most evident in Fraser South (3 days faster than 2004) and South Vancouver Island (3 days faster than 2004).

As in 2003 and 2004, the median laboratory delay in 2005 for processing and reporting corvid test results was one day.

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 4: Lag times in the submission of corvid specimens, 2003-2005

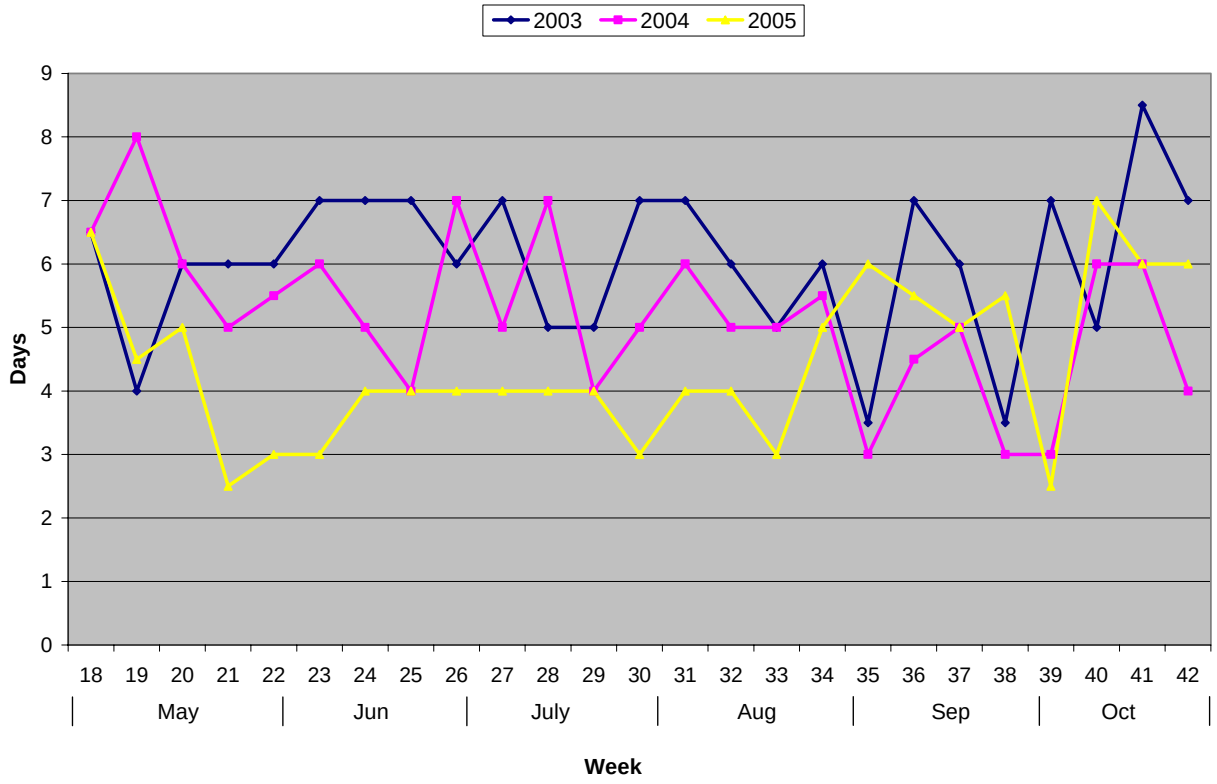
Bird Lag Time by HSDA, 2003-2005

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

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, the lag time to from collection to laboratory receipt of specimens, is highest at the tail ends of the surveillance period, at the beginning of May and again during the month of October (Figure 9). In all years, it takes 2-3 weeks from the start of corvid collections on May 1st for lag times to improve. In 2005, there was less variation in lag times than in previous years from June through August.

Figure 9: Median weekly lag time in the submission of corvid specimens, 2003-2005



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 3). 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 3 years, prior to introduction of WNv, is useful for identifying areas with higher baseline bird mortality.

Recommendations for Corvid Surveillance in 2006

- Despite the fact that corvid collections from LHAs in the Okanagan and Kootenay regions of the province are meeting or exceeding expected submissions (Figure 5), the absolute number of specimens collected in these regions is low (Figure 6), 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. Areas with low population and corvid densities may choose to focus surveillance efforts on mosquito and human surveillance, rather than corvid surveillance. Consideration should be given to increased monitoring for infected mosquito populations in these areas.

- Staff in LHAs where fewer dead corvid sightings than expected are reported should strive to increase reporting by the public. This may involve further communications, public education concerning the existence of the online reporting form, or adapting the reporting format for those without internet access.

- Staff in LHAs where fewer corvids are submitted for WNv testing than expected should consider ways to increase the number of corvids submitted for WNv testing relative to other areas of the province.

- Public health authorities should consider ways to ensure staff are available for the WNv surveillance program late in the summer and early fall as this is the most likely time we will see initiation of WNv activity.

Surveillance of WNv in mosquitoes

After receiving collections of adult mosquitoes from Regional and Local Health Authorities, the BCCDC laboratory separated them into sex and taxonomic groupings. Female specimens were pooled in groups of 50 or less and tested using Polymerase Chain Reaction (PCR) to identify the presence of any virus RNA in the sample. Five taxonomic groupings were used: 1) *Aedes,* 2) *Anopheles,* 3) *Coquilletidia,* 4) *Culiseta* and 5) *Culex*. The *Culex* genera were separated into species because at least two Cx species are known to be highly competent vectors of West Nile virus in other regions of North America. There were a total of 2778 submissions from mosquito traps in 2005 (resulting in 6631 pools tested). A total of 198,228 mosquitoes were identified from these trap collections.

In 2005 we put more CO_2 baited CDC traps in the field and fewer gravid traps. This was based on 2004 surveillance data that indicated that CO_2-baited CDC traps attract the best representation of all mosquito species, but that gravid traps were useful for catching *Culex pipiens* in specific areas where this species was abundant. Therefore, in order to control for differences in trap type and location, year-to-year comparisons presented in this report have been restricted to similar trap types operating in the same locations over time. Any remaining observed differences are likely due to seasonal and climate factors.

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). In 2001, *Culex pipiens* (Northern House mosquito) was the most common species found infected with WNv during surveillance programs across the United States. In 2003 as the virus spread up the central plateau of North America, *Culex tarsalis* became the most infected species of mosquito. In 2005 as reported at the National US WNv meeting (Smith, 2005) *Culex quinquefasciatus* (southern house mosquito) was found to be infected more often than other species of mosquitoes identified during surveillance. Fortunately this species is not found above 39 degrees N Latitude (Savage and Miller, 1995) and is therefore not present in Canada. 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. *Culex pipiens* was the only species reported positive in Washington State in 2005 while *Culex tarsalis* was the reported infected vector in Idaho, Alberta and Manitoba.

BC surveillance data now comprises 3 years of adult mosquito surveillance. Each year we are finding new information about the occurrence of species; in-part this can be attributed to roaming traps during the beginning weeks of the surveillance season in order to fix the best trapping sites for the remainder of the season. To this extent, the RHAs have made great strides in the early capture of mosquitoes as they emerge from their over-wintering hibernaculums.

New about mosquitoes in 2005

Early in 2005, BCCDC held its annual WNv planning workshop and were fortunate to hear from representatives from California about WNv amplification across their state. In April, the American Mosquito Control Association held their annual meeting in Vancouver. This presented an opportunity to hear the most recent attempts at arbovirus control from across the American continent. In 2005, a new biological control agent (*Bacillus sphaericus*) became available for controlling mosquito larvae in Canada. This product has the advantages of residual (longer-term) control by recycling in the environment and the ability to target mosquitoes in their aquatic habitat, prior to emergence.

Articles concerning taxonomy by Reinert have proposed elevating some of the subgenera in the Aedini grouping to generic status (Reinert, 2000, Reinert et al. 2004). Most authors have used this convention when writing about mosquitoes. Recently, the Journal of Medical Entomology and other associated journals in the entomological realm are taking the position that more research is needed before this change should take place (http://www.entsoc.org/Pubs/periodicals/JME/mosquito_name_policy.htm). We

will be following this convention and use *Aedes* rather than the elevated subgenera *Ochlerotatus* in our report. For people who identify mosquitoes in British Columbia, the Ministry of Environment has posted the Provincial Museum Handbook No. 41; Mosquitoes of British Columbia by Peter Belton (1983) on their website for public access (http://wlapwww.gov.bc.ca/wld/documents/techpub/rbcm_hb41/mosquitoes.pdf). This book has been out-of-print for many years.

Geographic Distribution of Species

Figure 10 illustrates the distribution of 198,228 specimens of mosquitoes collected in 2005.

Climatic conditions in British Columbia led to an average crop of mosquitoes this year after several years of hot, dry weather which resulted in low mosquito abundance. This year, snowmelt caused flooding in the mid Fraser River (North Thompson) and significant June precipitation in the eastern portion of the province created ideal conditions especially for mosquitoes in the East Kootenay region and southern portion of the Okanagan.

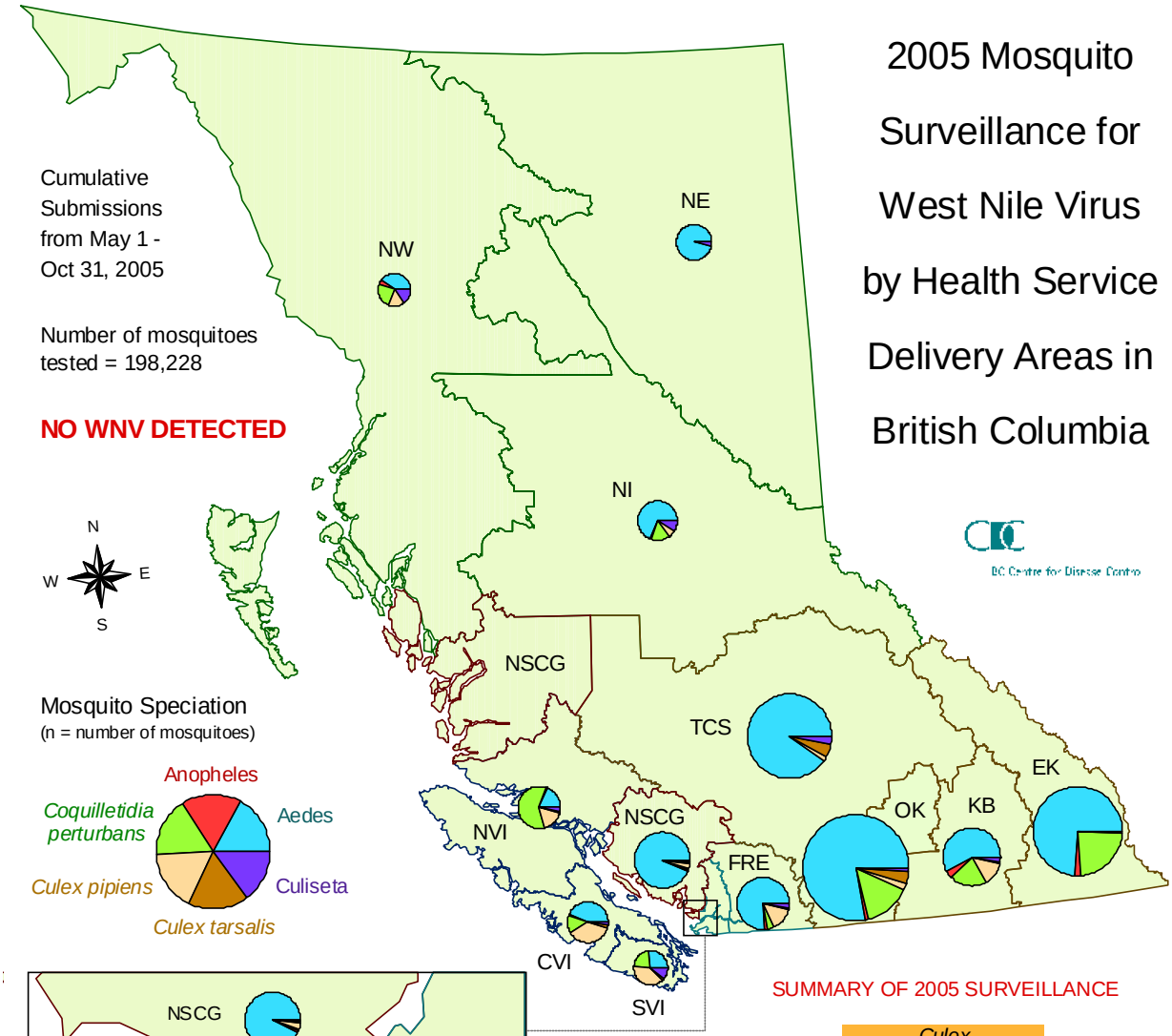
The number of traps operated in 2005 increased relative to 2004. In 2004 , 88 traps were operated in 145 locations; in 2005, 139 traps were used to collect mosquitoes from 189 registered permanent locations. The distribution of these traps is illustrated in Figure 11. Increased mosquito trapping resulted in 2778 trap night submissions in 2005 compared with 2262 in 2004. While this represents a 22% increase in overall submissions, the subset of *Culex tarsalis* submissions increased by 186%. By replacing gravid traps with light traps we achieved the goal of collecting and testing more *Cx. tarsalis* during our surveillance program.

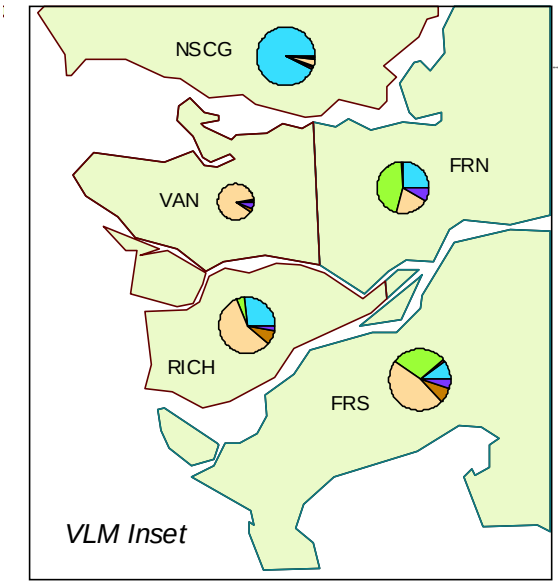
Culex pipiens
Generally *Culex pipiens* is only found north of the 39th degree N latitude (Savage and Miller, 1995). Between 36 and 39 degrees N. latitudes, *Cx. pipiens, Cx. quinquefasciatus*, and hybrids are encountered. The largest numbers of *Cx. pipiens* are generally found in the highly urbanized areas, particularly the Fraser River Lower Mainland area. We did collect *Cx. pipiens* as far north as Terrace, Prince George and Valemont this year but numbers were significantly lower than in the south. Two other locations where large numbers of *Cx. pipiens* were found were Castlegar in Kootenay Boundary region and Lake Cowichan on Vancouver Island.

Culex tarsalis
Culex tarsalis is the primary vector species of WNv in the prairie provinces of Canada and the central US, therefore an understanding of where this species is found in BC is of major concern. *Cx. tarsalis* was collected in the southern 1/3 of the province with no traps catching this species north of East Kootenay or Thompson/ Cariboo/ Shuswap Heath Authorities, except one specimen from Vanderhoof (west of Prince George). This is similar to our findings during 2003 and 2004 surveillance. This species is most active above 13 to 16 degrees, so does not develop significant populations in northern latitudes where the temperature is generally cooler. Hot summer days can produce large numbers of this species following spring flooding.

Culex territans
Culex territans was found across the province but in low numbers. 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.

Figure 10: Geographic Distribution of Mosquito Species in BC, 2005

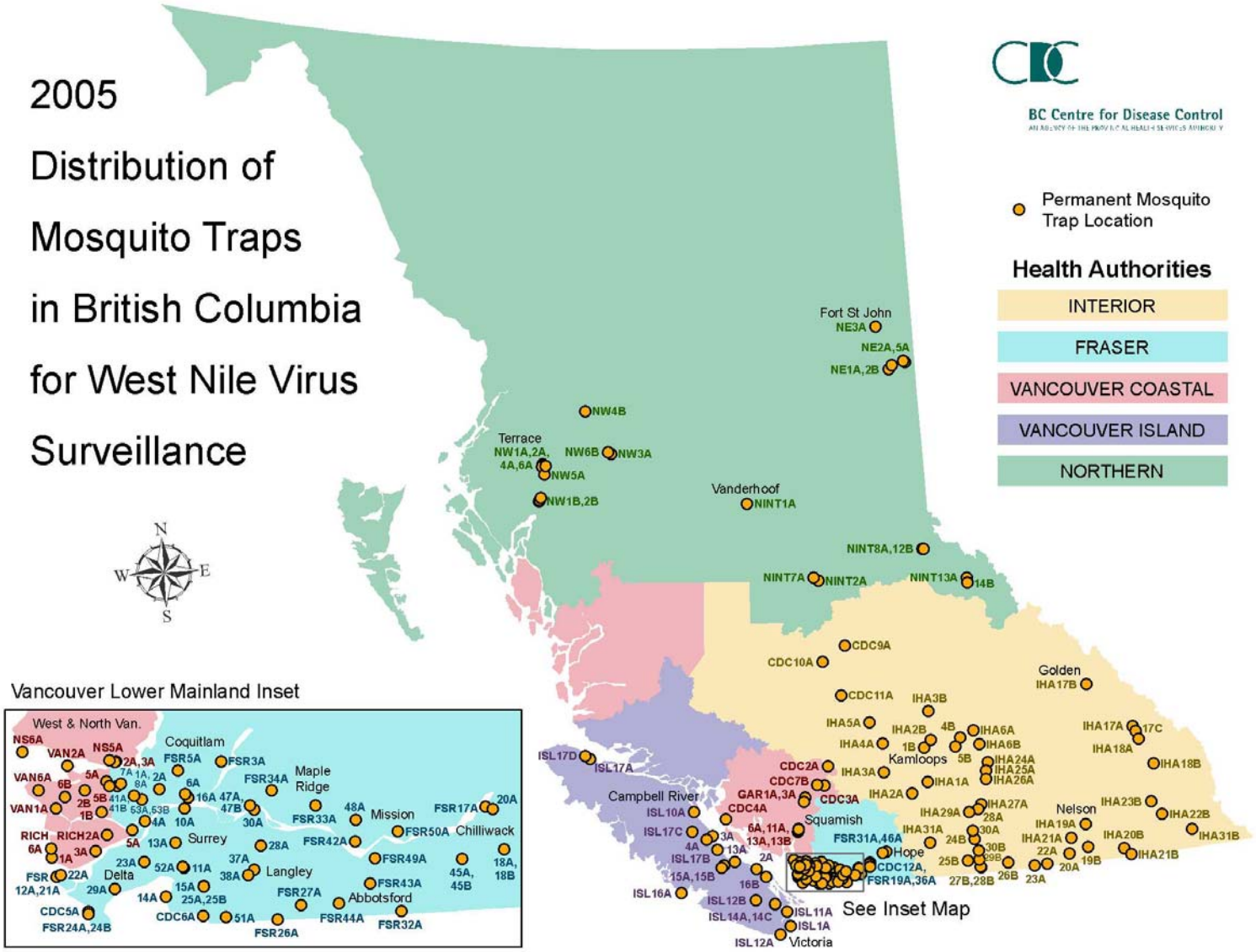




SUMMARY OF 2005 SURVEILLANCE

HSDA	Aedes	Anoph.	Coqui.	Culex pipi.	Culex tars.	Culex terr.	Culis.	Total
EK	39239	801	9624	167	202	1	316	50350
KB	4882	352	1747	1086	78	2	226	8373
OK	66064	541	6319	1018	2339	2	929	77212
TCS	20684	108	109	461	1149	0	566	23077
FRE	5238	183	340	1037	68	0	178	7044
FRN	895	21	1578	1143	55	0	340	4032
FRS	881	48	2500	4194	717	3	544	8887
RICH	1374	1	220	3376	413	0	145	5529
VAN	3	0	4	253	6	0	17	283
NSCG	7993	34	54	229	102	0	125	8537
SVI	12	0	41	103	5	3	22	186
CVI	821	18	256	697	32	1	30	1855
NVI	220	9	694	304	10	0	70	1307
NW	21	2	13	9	0	0	7	52
NI	903	14	200	83	1	3	126	1330
NE	165	0	0	0	0	0	10	175

Figure 11: Geographic Distribution of Mosquito Traps in BC, 2005



Coquilletidia perturbans

Unlike other mosquitoes, *Coquilletidia purturbans* 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. This species emerged from the littoral zone by the beginning of June and were abundant across the province. The adult numbers peaked by week 28-29 (Jul 10-23 in Figure 14), especially in traps from East Kootenay, Kootenay Boundary and Okanagan (Appendix 4). 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. Heavy rainfall in early June and again in mid-June caused rivers in southern Alberta to flood. BC also experienced considerable rainfall in eastern regions during this period, creating a significant hatch of the floodwater species, *Aedes vexans*. Figure 10 shows the concentration of these large hatches in Okanagan and East Kootenay. Mid Fraser River flooding typically produced many *Aedes* in the Thompson/Cariboo/Shuswap region. The Northern Health regions, Vancouver Island and Lower Fraser did not have these large numbers. Turnell (2005) recently noted the many *Aedes* can act as a bridge vector for WNv but *Ae. vexans* is unlikely to act as an amplifying vector for the maintenance of this virus in nature because of their mammalian feeding habits.

Effect of Rainfall on Aedes Mosquito Abundance

An unusually large number of Aedes mosquitoes were recorded in the East Kootenay Health Authority and south Okanagan. One trap from Radium Hot Springs collected over 22,000 Aedes during 9 nights of operation. The closest available monthly data at the writing of this report was the Cranbrook weather station, 110 km to the south; it reveals that more precipitation fell in May and June than in the previous 2 years (Figure 12). These mosquitoes produced large numbers even though the mean temperature was cooler in this region in 2005. In Creston (EKHA) we used a light trap within a 1 Km area for the last 2 years (See IHA2B &IHA 20B in Table 5) and this year we collected many more Aedes and Coquilletidia. In the Osoyoos region of the south Okanagan they also recorded significant June precipitation (Figure 12).

Figure 12: Mean Temperature and total precipitation for Cranbrook, 2005

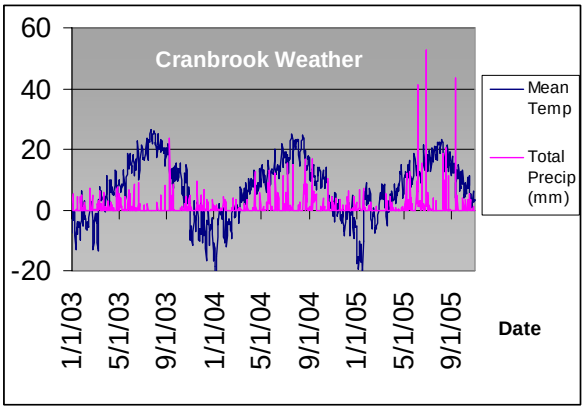
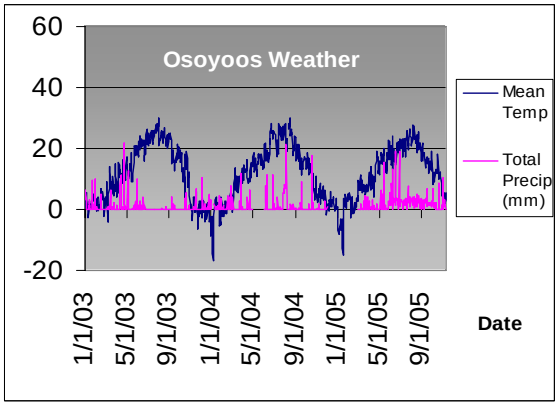


Figure 13: Mean Temperature and total precipitation for Osoyoos, 2005



The difference in mosquito numbers, especially *Aedes*, is dramatic between a dry 2004 summer and a wet 2005. Table 5 provides a comparison of traps from similar locations in 2004 and 2005. Other species also benefited from this precipitation; *Cx. tarsalis* and *Culiseta* numbers increased as well although to a lesser extent. One trap to the north of Osoyoos Lake caught over 45,000 *Aedes* this year and another trap just south caught 13,588. The effect appeared localized since the Town of Oliver just 12 km north did not have as great an increase in these mosquitoes. Localized trap placement is important to catch these biological events.

Table 5: Comparison of select IHA light trap catches from the same trap locations, 2004 and 2005

Year	Trap ID	Location	AEDES	ANOPH	COQUI	CPIPI	CTARS	CULIS	TOTAL	Weeks
2004	IHA2B	Creston	33	4	194	9	2	3	245	18
2005	IHA 21B	CRESTON	2400	366	4695	79	71	143	7754	22
2005	IHA 20B	CRESTON	1033	138	3917	11	7	16	5122	21
2004	IHA18A	Osoyoos	857	1	0	2	2	1	863	7
2004	IHA19A	Oliver	18	0	0	47	1	1	67	6
2005	IHA 27B	OSOYOOS	13588	91	5	53	495	114	14346	23
2005	IHA 28B	OSOYOOS	45749	138	9	131	1216	306	47549	23
2005	IHA 29B	OLIVER	477	15	2	147	138	110	889	23

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 Creston, Osoyoos, Salmo and Vaseaux Lake near Penticton. Although not abundant across the province this may be important locally where these *Anopheles* species are found.

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

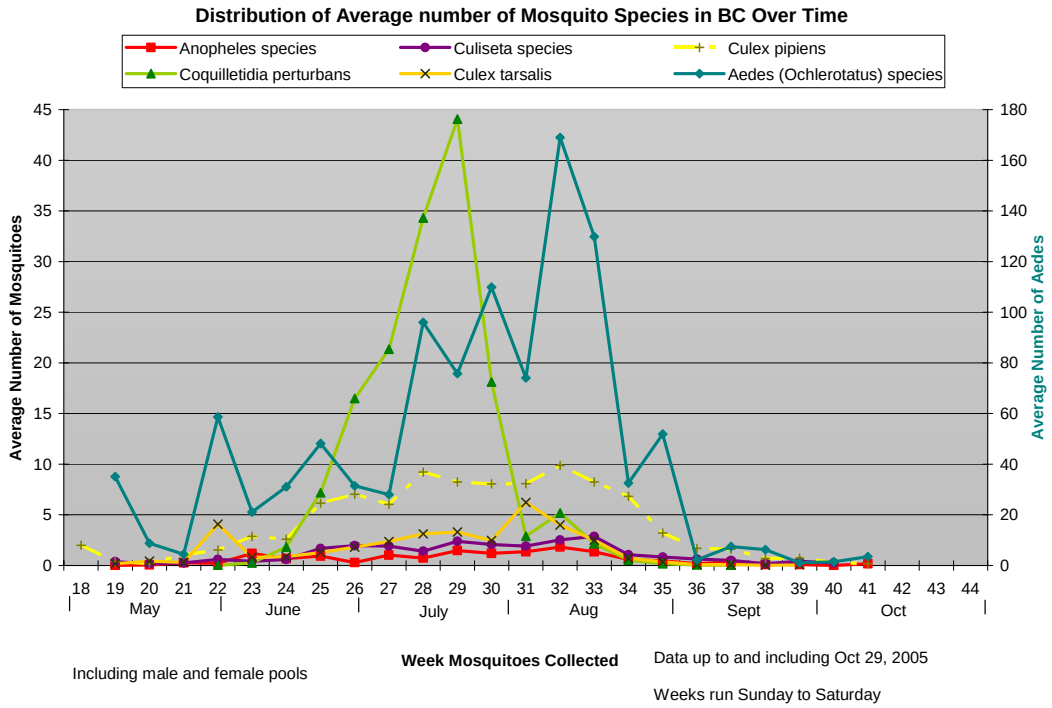
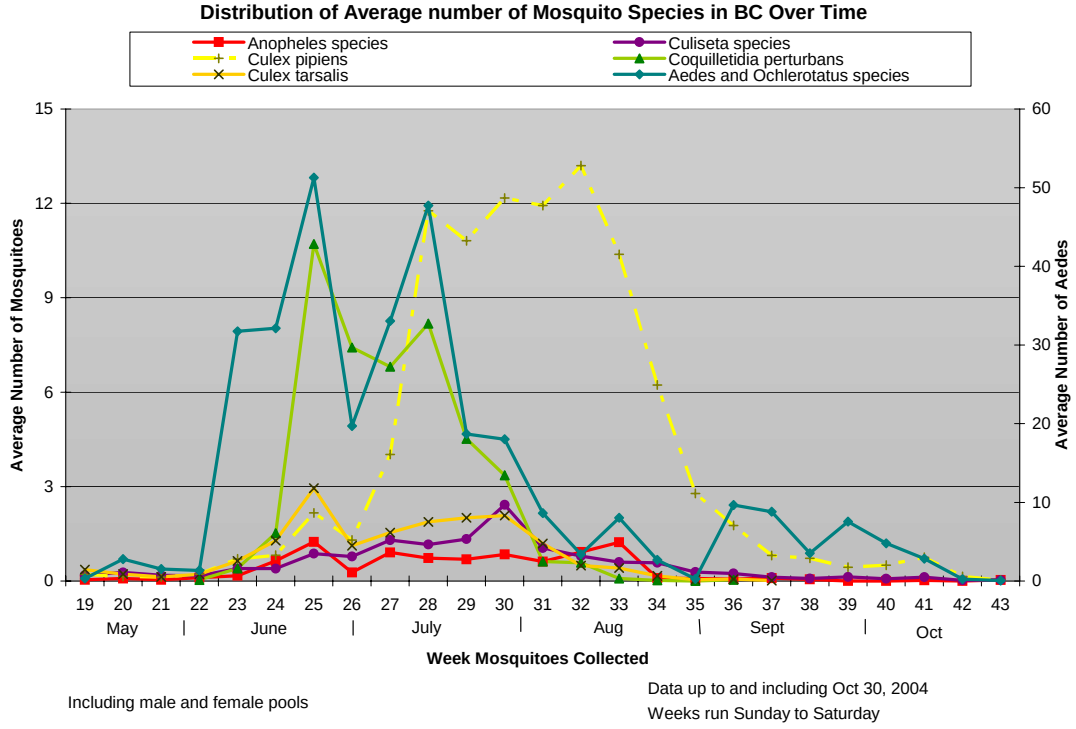


Figure 15: Average Number of Mosquitoes Species Trapped per Week, 2004

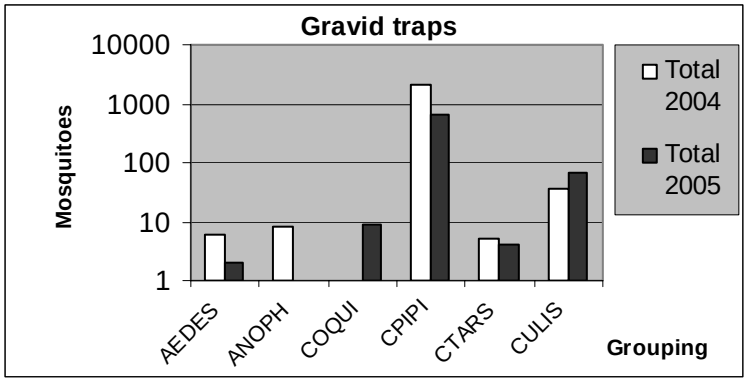


Relative abundance of mosquito species in 2005 compared with 2004

Figures 14 and 15 depict the average numbers of mosquito species trapped over time in 2004 and 2005. To control for differences introduced by changes in trap type, results from 2004 and 2005 were compared using subsets of traps where the same trap type was operated in the same location over both years for a similar period of trap nights.

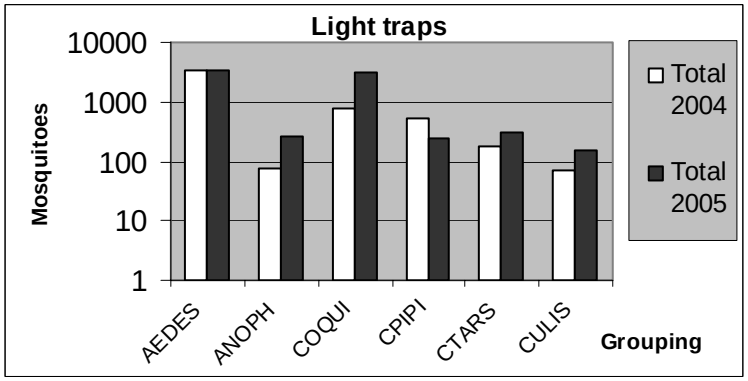
Cx. pipiens was less abundant in Lower Mainland gravid traps in 2005 with 629 specimens collected from these 4 traps compared with 2156 the year before (Figure 16). *Cx. pipiens* made up 97% (2004) and 88% (2005) of gravid trap collections, respectively. A similar comparison of light trap collections was conducted for 7 light traps across the province, including three from the Lower Mainland (Figure 17). Counts indicated that all species groupings were more abundant this year with the exception of *Cx. pipiens* which was less abundant in both the gravid and light traps in 2005.

Figure 16: Comparison of Gravid trap catch from the same location over 2 years.



Traps included in analysis (2005 nomenclature): FSR5B, FSR12A, FSR13A and NS3A

Figure 17: Comparison of Light traps from the same location over 2 years.



Traps included in analysis (2005 nomenclature): VAN1A, VAN2B, FSR20A, ISL17B, IHA19A, IHA30B and IHA24B)

Temporal distribution of mosquito species

This year across Canada the earliest positive mosquito pool occurred in Manitoba; this was slightly earlier than the first detection from Ontario in 2002 (Table *6*). In regions closer to BC the virus appeared in mosquitoes later in the summer, by the beginning of August. South of the Canadian boarder in Montana positive pools were not found until Aug 2 and even later in Washington on Aug 22. Many Canadian agencies do not begin adult mosquito surveillance until June (Alberta: June 21, Manitoba: June 6, Perth-Ontario: June 30).

Table 6: First recorded dates of positive West Nile mosquitoes in Canada.

First recorded dates of positive West Nile mosquitoes in Canada.

Year	Alberta	Sask	Manitoba	Ontario	Quebec
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 Public Health Agency of Canada website

Culex species

This year the numbers of *Cx. tarsalis* caught peaked at the beginning of June (Figure 14), several weeks earlier than in 2004 (Figure 15). The build-up of summer populations of *Cx. pipiens* also began two weeks earlier this year. Although Vancouver Island and the City of Vancouver regions collected their first *Cx. pipiens* at the end of May in 2005 (Table 7), among traps catching large numbers of *Cx. pipiens*, only one yielded greater than 100 specimens by the beginning of June (Figure 18). *Cx. pipiens* circulating in early June are less likely to be infected females because the virus has not had a chance to amplify in the avian hosts. Despite yearly fluctuations in the timing of emergence, a start date of June for adult surveillance would capture the first significant emergence of *Cx. tarsalis* in BC in both 2004 and 2005 and most of the early spring *Cx. pipiens* populations.

By week 25 to 26 (Jun-19 to Jul-2) most traps yielding high numbers of *Cx. pipiens* were exceeding 100 mosquitoes per trap night (Figure 18). This is a critical period to implement larviciding of *Cx. pipiens* breeding habitat to suppress the late summer adult populations

In the northern Health Authorities (NW and NI) *Cx. pipiens* were not found until the middle of June, this is later than most other parts of the province (see Table 7).

Figure 18: High yield Culex pipiens traps, 2005.

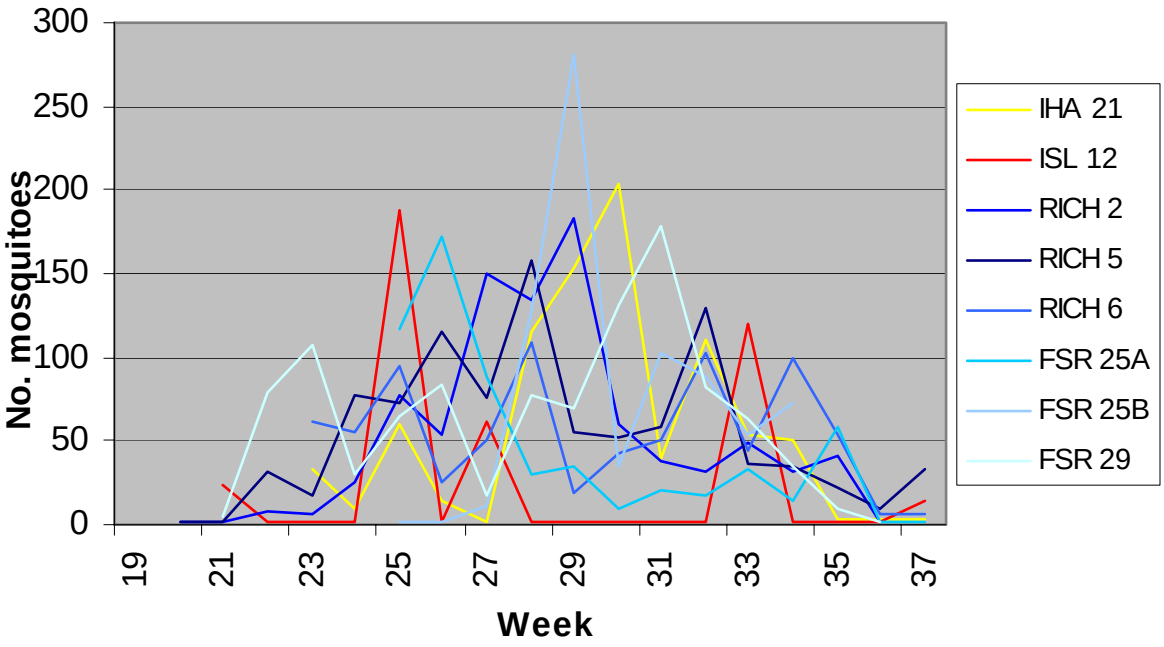


Table 7: Earliest Date and Location of Different Mosquito Species in BC, 2005

Comparision of time and location of first identificaiton of mosquito by HSDA, 2005

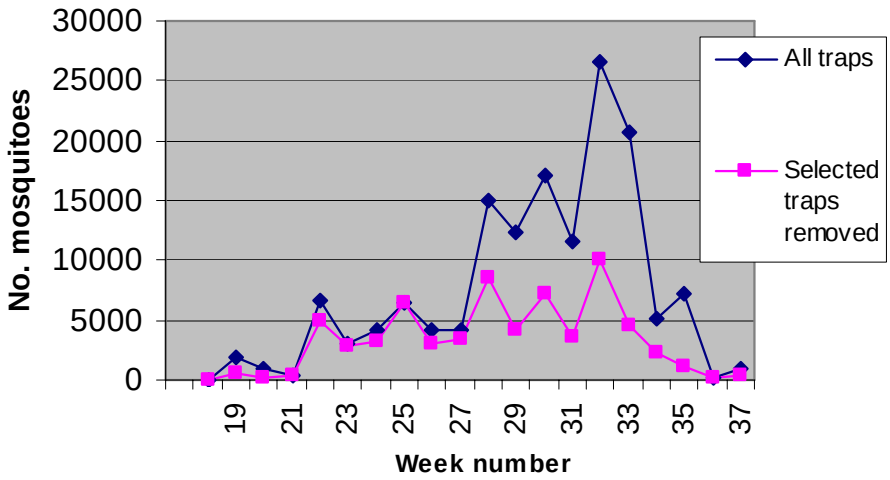
HSDA	Aedes and species	Anopheles species	Coquilletidia perturbans	Culex pipiens	Culex tarsalis	Culex territans	Culiseta species
EK	16-May-05	30-May-05	16-Jun-05	05-Jun-05	05-Jun-05	20-Jun-05	16-May-05
KB	17-May-05	05-Jun-05	21-Jun-05	05-Jun-05	05-Jun-05	03-Aug-05	05-Jun-05
OK	10-May-05	12-May-05	07-Jun-05	10-May-05	12-May-05	30-May-05	10-May-05
TCS	17-May-05	17-May-05	21-Jun-05	11-May-05	17-May-05		17-May-05
FRE	15-May-05	26-May-05	01-Jun-05	19-May-05	26-May-05		26-May-05
FRN	11-May-05	07-Jun-05	07-Jun-05	10-May-05	11-May-05		10-May-05
FRS	11-May-05	19-May-05	08-Jun-05	05-May-05	17-May-05	14-Jun-05	10-May-05
RICH	25-May-05	15-Sep-05	21-Jun-05	17-May-05	17-May-05		25-May-05
VAN	26-May-05		13-Jul-05	26-May-05	01-Jun-05		17-May-05
NSCG	24-Jun-05	07-Jul-05	21-Jun-05	05-Jul-05	29-Jun-05		14-Jun-05
SVI	18-May-05		06-Jun-05	31-May-05	06-Jun-05	06-Jun-05	31-May-05
CVI	25-May-05	25-May-05	08-Jun-05	25-May-05	25-May-05	14-Sep-05	17-May-05
NVI	17-May-05	21-Jun-05	21-Jun-05	24-May-05	31-May-05		31-May-05
NW	31-May-05	17-Aug-05	28-Jun-05	15-Jun-05			16-May-05
NI	13-May-05	09-Jun-05	27-Jun-05	04-Jul-05	14-Sep-05	04-Jul-05	26-Apr-05
NE	24-May-05						24-May-05

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.

Aedes

The bulk of mosquitoes found in British Columbia are *Aedes* and they typically appear in large numbers by the beginning of June. This year they persisted throughout the summer and an unusual peak occurred at the end of August, see Figure 14. Two highly productive traps were situated in Osoyoos and one in Radium giving the false impression that *Aedes* were overly abundant throughout the summer for the whole province. When these three outlier traps were removed, the graph did not demonstrate a large fall peak of *Aedes* species (Figure 19). August and September are critical times for the real-time surveillance of mosquitoes to catch the appearance of WNv within the vector populations. The appearance of large numbers of mosquitoes with low vector potential can create a burden on the laboratory in processing these samples.

Figure 19: Distribution of Aedes with selected traps removed (IHA17C, IHA27B and IHA28B)



Coquilletidia perturbans

Coquilletidia purterbans were the second most abundant species caught this year, which is quite different from 2004 when *Culex* were the second most common group.

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 8 shows that more than a 3-fold improvement in average trap counts for *Cx. tarsalis* is achieved when CO_2 is used as an attractant. Note that while we did catch more absolute specimens of *Cx. tarsalis* in 2005 due to an increased number of light traps, the average number per trap was about the same as last year. In BC we captured the largest numbers of *Culex* species from June to August; baiting light traps with CO_2 produced significantly larger average trap catches between May and August (Table 9). *Culex* sample submissions peaked in August with more than 400 submissions.

Table 8: Cx. tarsalis counts in light traps with and without CO_2, May-Aug, 2004 & 2005.

Light Trap Cx. tarsalis CO2 Vs Non CO2, May-Aug, 2004 & 2005

Cx. tarsalis	2005		2004	
	CO2	Non CO2	CO2	Non CO2
Mosquito Count	5049	80	1646	51
Trap Running	594	30	191	35
Average	**8.5**	**2.7**	**8.6**	**1.5**

Table 9: 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	9.8(69)	14.1(234)	19.94(296)	17.56(365)	3.74(148)	
Non CO2	3.44(9)	2.61(18)	11.51(37)	8.06(50)	2.67(18)	

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 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.

Effect of Diapause on Mosquito Sex Distributions

Male mosquitoes usually do not enter diapause like the female. At the end of summer the females will mate before entering diapause, so the males are out in numbers trying to pass their genes on to the next generation. Our trapping shows an interesting peak in male mosquitoes at about the same time emerging females would be entering diapause.

Figure 20: Sex distribution of Cx. tarsalis over time, 2005

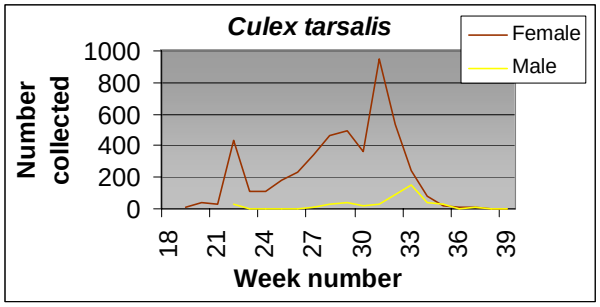
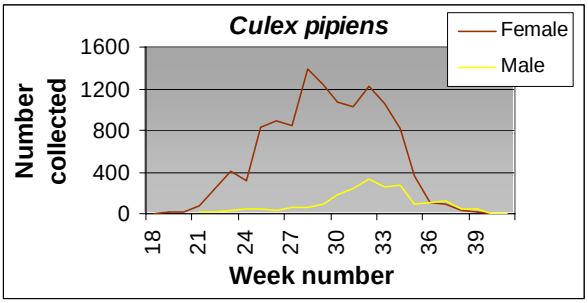


Figure 21: Sex distribution of Cx. pipiens over time, 2005



Between week 32 and 33 (Aug 8 to Aug 21) there was a noticeable increase in male Cx. tarsalis caught in the traps (Figure 20). With *Cx. pipiens,* the number of males increased in week 31 but peaked in week 32 and 33 in a similar manner as *Cx. tarsalis*. This increase in male mosquitoes may be signaling the period during August when emerging *Culex* are entering diapause. As noted by the National Mosquito Control Committee larviciding after this date will have little effect on reducing the transmission of WNv because most of the emerging females will not be questing for a host.

Low yield traps

The average yield of mosquitoes in individual traps was higher in 2005 compared with 2004. We feel this is primarily due to a concerted effort of RHAs to improve trap placement. Even when considering the lowest-yielding 25% of traps, the average count was 1.2 mosquitoes per trap night this year compared with 0.6 mosquitoes per trap night in 2004. Table 10 provides a list of traps that were operated for at least four weeks but whose average mosquito count/trap night was below the twenty-fifth percentile. The green coloured cells are from the northern regions of the province where traps do not seem to catch many mosquitoes, probably because of cool weather. The three CDC Label traps highlighted in blue are from the Inuit and First Nations group that began surveillance for the first time this year but only partway through the season. Improvements in yield will come with more experience in trap placement. All low-yield traps within Fraser Health (labeled FSR) were gravid traps, purposefully positioned to capture *Cx pipiens* in areas of high population density. For strategically placed light traps that are not providing good yields, we suggest moving the trap within the same general area. The NS and VAN traps would probably do better if CO2 was used as an attractant.

Table 10: Trap locations with average catch in the lower 25th percentile

Label	Location	Trap Type	# Nights Run	Total catch	AVG Count
FSR 10	A	Gravid Trap	28	22	0.79
FSR 33	A	Gravid Trap	12	21	1.75
FSR 36	A	Gravid Trap	14	18	1.29
FSR 37	A	Gravid Trap	9	6	0.67
FSR 38	A	Gravid Trap	7	7	1.00
IHA 31	A	CDC Light Trap	13	24	1.85
ISL 15	B	CDC Light Trap	14	28	2.00
NS 5	A	CDC Light Trap	17	21	1.24
NS 6	A	CDC Light Trap	9	11	1.22
VAN 5	B	CDC Light Trap	17	2	0.12
NE 3	A	CDC Light Trap	13	4	0.31
NE 5	A	CDC Light Trap	14	8	0.57
NINT 1	B	CDC Light Trap	7	9	1.29
NINT 14	B	CDC Light Trap	11	11	1.00
NINT 2	A	CDC Light Trap	11	5	0.45
NINT 7	A	CDC Light Trap	15	29	1.93
NW 1	A	CDC Light Trap	6	2	0.33
NW 1	B	CDC Light Trap	8	8	1.00
NW 2	B	CDC Light Trap	7	6	0.86
NW 2	A	CDC Light Trap	13	18	1.38
NW 3	A	Gravid Trap	8	4	0.50
NW 4	B	CDC Light Trap	8	12	1.50
NW 4	A	CDC Light Trap	9	18	2.00
NW 5	A	CDC Light Trap	20	30	1.50
NW 6	B	CDC Light Trap	8	6	0.75
CDC 5	A	CDC Light Trap	4	4	1.00
CDC 6	A	CDC Light Trap	5	5	1.00
CDC 7	B	CDC Light Trap	6	2	0.33

Table 11 provides a list of publicly supplied traps that are being under-utilized. These are traps with permanent registered locations that were run extremely infrequently or not at all in 2005. In the best interests of surveillance, BCCDC may ask for the return of these traps to be used in other areas if there is no view to using these traps in a consistent manner for surveillance in 2006.

Table 11: Under-utilized light traps, 2005

GISID	HSDA	Trap Type	City	Submissions
GAR 1A	NSCG	CDC Light Trap	Whistler	3
GAR 2	NSCG	CDC Light Trap	Whistler	0
GAR 3A	NSCG	CDC Light Trap	Whistler	1
GAR 14	NSCG	CDC Light Trap		0
GAR 15	NSCG	CDC Light Trap	Sechelt	0
FSR 30A	FRS	CDC Light Trap	Langley	1
NS 1	NSCG	CDC Light Trap		0

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.

A 1-day improvement in the median submission time for mosquitoes was noted in 2005 (Table 12). 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 number of days between sample collection and laboratory receipt remains high in some instances. The increase in the maximum submission time over the last couple of years is primarily attributed to the multitude of new external agencies participating in surveillance (i.e. First Nations Inuit Health Branch, City of Prince George and independent contractors), increasing the likelihood that mosquitoes are frozen and shipped at later date for testing. In 2005, this occurred in Prince George where the municipality sent their samples only after a seasonal coordinator was hired. Many of the First Nations communities who participated in surveillance this year stockpiled samples until the end of the season before sending in submissions. These delays were so lengthy that all First Nations samples have been removed from calculations of lag time. Unfortunately passive submission without proper storage of samples can affect testing results and to ensure quality testing these delays should be reduced if possible.

Table 12: Mosquito lag time for sample submission, 2003-2005

Mosquito Lag Time for Sample Submission by HSDA, 2003-2005

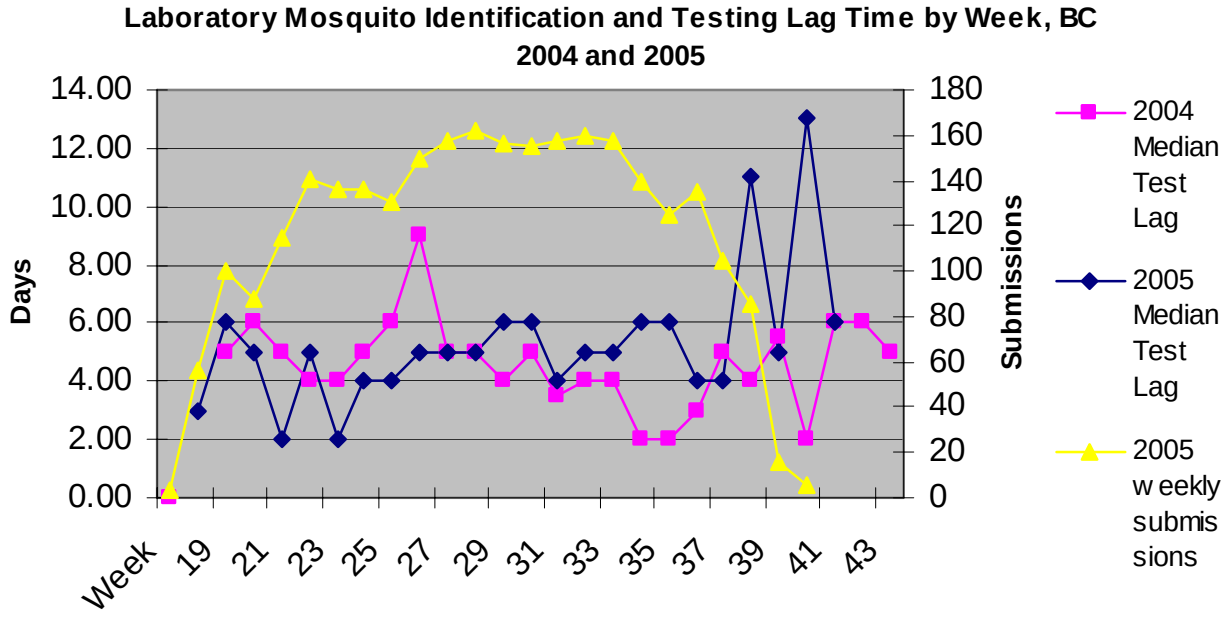
HSDA	Median of Submission			Max Of Submission		
	2003	2004	2005	2003	2004	2005
EK	1.0	3.0	2.0	2	7	13
KB	1.0	1.0	2.0	6	5	6
OK	1.0	2.0	1.0	8	7	9
TCS	1.0	1.0	1.0	8	6	5
FRE	2.0	3.0	2.0	5	10	8
FRN	2.0	1.0	1.0	3	7	6
FRS	1.5	3.0	1.0	7	8	16
RICH	2.0	1.0	1.0	17	2	6
VAN	0.5	0.0	0.0	6	5	1
NSCG	4.0	2.0	1.0	7	32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

Note: All numbers are in days.

The lag time for submissions was greatest after beginning of September (week 36), coinciding with the period when seasonal staff return to school in the fall. If there is an outbreak and positive pools begin appearing in late August and September, as seen in other Canadian provinces, RHAs will require a strategy to cover for field surveillance when the seasonal staff return to school.

As previously discussed, several traps collected large numbers of *Aedes* at the end of August. This created a delay in the processing of samples by the laboratory (Figure 22).

Figure 22: Change in Laboratory Lag Time for Mosquito Identification and Testing

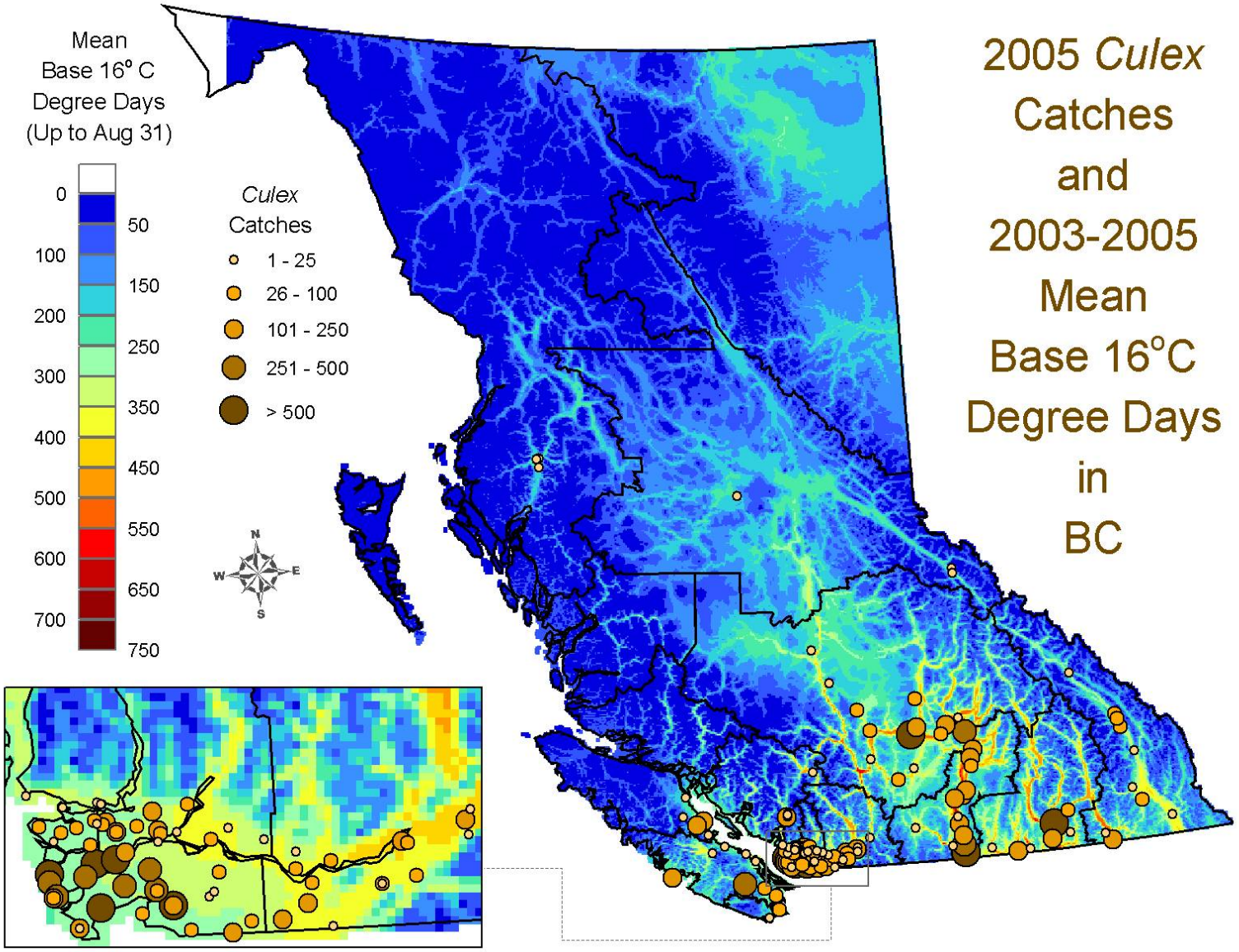


Climate Data – Growing Degree Day Mapping

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 5). 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 2005 (Figure 14). Summer-time temperatures in 2005 were again above normal for the most of the province; however, an unusually wet spring appears to have triggered an early start to the mosquito season this year.

Figure 23: Culex Catches and 3 Year Mean Accumulated Degree Days over 16^{0}C, 2005



Recommendations for mosquito surveillance in 2006

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. There are some light traps that were not run for more than a few evenings. Over the winter we will work with local health authorities to move these light traps so that they can be placed in higher risk areas.

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 the more northern latitudes typical of Canadian provinces, positive mosquito pools are not found until mid to late July (Table 6) when the *Culex* species begin to increase in numbers. We recommend delaying the start of mosquito surveillance until June for 2006. This will allow sufficient lead time to account for beginning of season delays and still allow the capture of the first generation of *Culex* mosquitoes (Figure 14).
- Reduced trapping should occur in the northern RHA as surveillance over last 3 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 (Table 7), 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. We have seen the greatest lag time for sample submissions in September and this maybe the most critical period for timely surveillance of mosquitoes.

Laboratory Activities

- *Culex* species are more often found infected with WNv than any other group 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

Interactive Web-based Mapping for WNv Surveillance

Geographic information systems (GIS) enable 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 areas and ecologically sensitive areas for surveillance and planning purposes. It is hoped that use of this tool by public health officials and members of the public will keep them informed with the status of WNv risk in BC throughout the WNv season. The public application can be access from https://maps.bccdc.org.

Use of GIS Mapping to Identify Areas to Spray and to Avoid

Spraying pesticides to reduce the number of adult mosquitoes may be necessary in the event of a severe WNv outbreak. The BCCDC has started and will continue to work with the regional health authority, local government, mosquito control contractors and the provincial emergency program to determine which areas can and should be sprayed. GIS analysis and mapping can be used to assess whether spraying is feasible by aerial or ground application based on the size of the population at risk, location and size of no-spray zones and accessibility of the community's road network. The land area of the community and time required to spray this area (by air or ground) can be calculated. 'No-spray' areas such as fish bearing streams and ecologically sensitive habitat can be identified. The most efficient driving route for vehicle mounted spraying can also be planned.

Additional information, especially local knowledge of the area to be sprayed, will be required if adulticiding is ever required in an area. Detailed, up-to-date airphoto and map data such as road networks, land use and environmental data from local governments in GIS format will be required. The BCCDC and Ministry of Health will be surveying the GIS capabilities and data inventories of local governments in the province over the winter of 2005.

Communications Highlights

Overall, media interest was quite high in 2005, with a total of 43 requests for interviews throughout the season. This compares with 29 in 2004 and over 100 in 2003, a year with unusually high WNv activity across Canada and the United States. In addition to these interviews, there were a number of stories written on the Centre's activities based on the press releases sent to the media throughout the year. The BCCDC also produced and printed a brochure on West Nile virus which was distributed to various stakeholders around the province including BC Parks and Canadian Blood Services for distribution to the public. A copy of this publication can be found at: http://www.bccdc.org/download.php?item=2099

In 2005 the BCCDC also led 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. From this, the BCCDC developed a scenarios matrix, the purpose of which was to describe the communications messages and protocols that would evolve under different scenarios for the first discovery of WNv in BC i.e. WNv infected birds vs. human case, etc.
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Contingency Planning

In addition to surveillance activities, in 2005 the BCCDC partnered with the public health field as well as the Ministry of Health to initiate contingency planning for a possible WNv outbreak in BC. A contingency response plan was developed and is being revised and finalized over the winter of 2005-06. Part of this initiative was the development of a mosquito control decision document to assist in program planning and decision making around mosquito control issues in BC.

References

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) NOTE: Ministry has changed names and the address wlapwww.gov.bc does not work, www.env.gov.bc.ca address has not fixed all of their address issues with document links.

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

Reinert J. F., 2000. New classification for the composite genus *Aedes* (Diptera: Culicidae: Aedini), elevation of subgenus *Ochlerotatus* to generic rank, reclassification of the other subgenera, and notes on certain subgenera and species. J. Am. Mosq. Control Assoc. 16: 175-188.

Reinert J. F., Harbach, R. E., Kitching I. J., 2004. Phylogeny and classification of Aedini (Diperta: Culicidae), based on morphological characteristics of all life stages. Zool. J. Linnean Soc. 142: 289-368.

Savage, H., and B. Miller. 1995. House Mosquitoes of the U.S.A., *Cules pipiens* complex. Wing Beats, Vol. 6(2):8-9.
http://www.rci.rutgers.edu/~insects/sp1.htm

Smith, T., 2005. National West Nile Virus Surveillance Summary, United States, 2004 By The ArboNET Team. 6th National Conference on West Nile Virus, San Jose, CA.

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).

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

Trunell M. J., D. J. Dohm, M. R. Sardelis, M L. O'Guinn A. G. Andreadis and J. A. Blow., 2005. An update on the potential of North American mosquitoes (Diptera:Culicidae) to transmit West Nile Virus. J. Med. Entomol. 42(1): 57-62.

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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.***

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.]

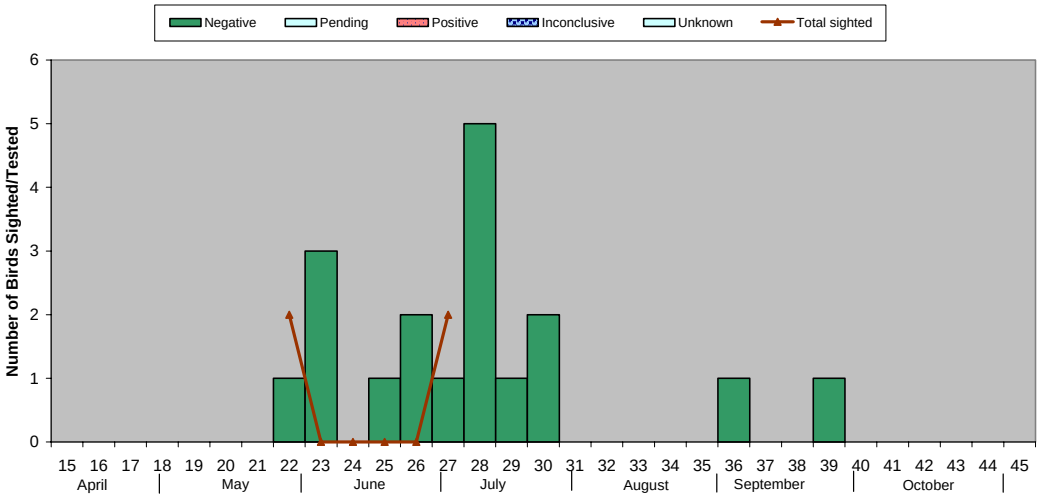
AT LEAST ONE of the following:

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).

L:\COMMON\ENTERICS\zoonoses\A_pbuck\West Nile Virus\Human case definitions\2005\National WNv Case Definition - 2005 - June 30.rtf

APPENDIX 2

Comparison of Number of Birds Sighted and Birds Tested in East Kootenay, 2005



Bar Graph - Birds Tested n=(18)

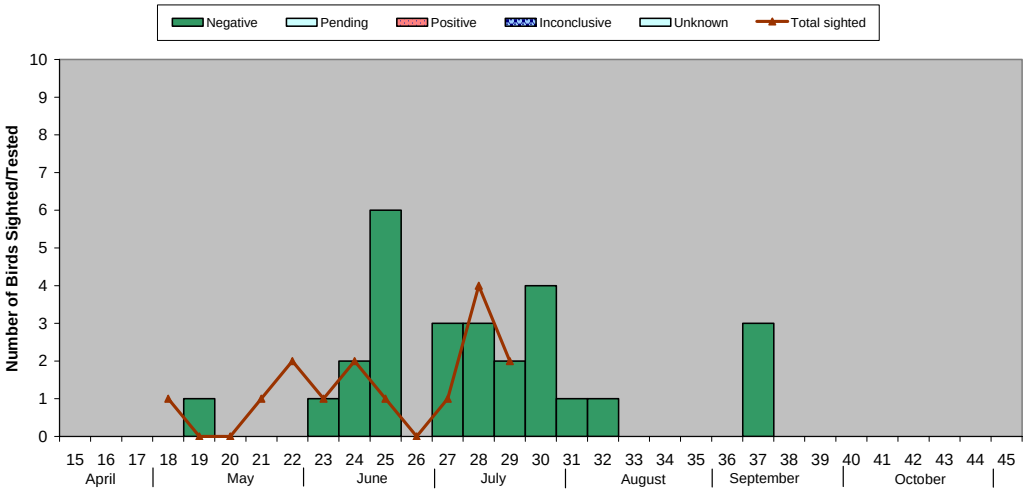
Line Graph - Birds Sighted n=(4)

*0 birds submitted without date found;

Data up to and including Oct 29, 2005

Weeks run Sunday to Saturday

Comparison of Number of Birds Sighted and Birds Tested in Kootenay Boundary, 2005



Bar Graph - Birds Tested n=(27)

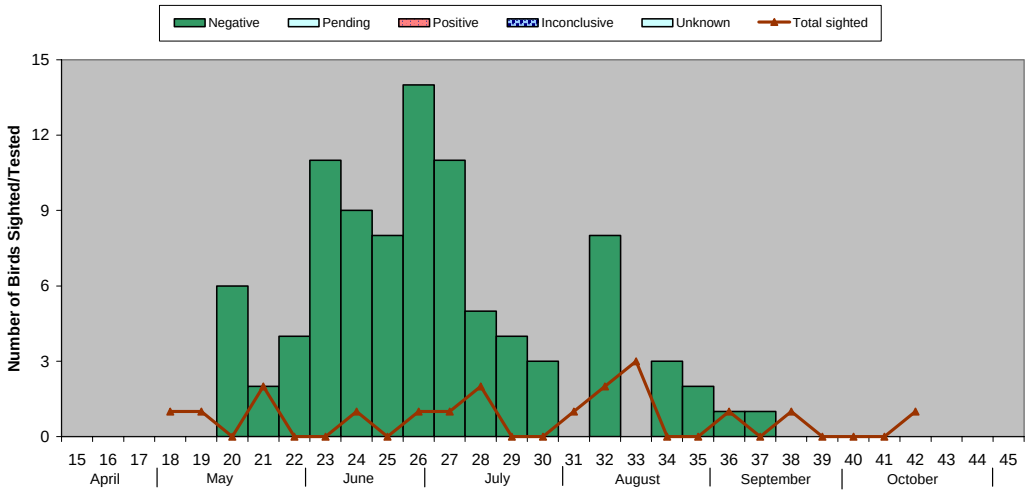
Line Graph - Birds Sighted n=(15)

*0 birds submitted without date found;

Data up to and including Oct 29, 2005

Weeks run Sunday to Saturday

Comparison of Number of Birds Sighted and Birds Tested in Okanagan 2005



Bar Graph - Birds Tested n=(92)

Line Graph - Birds Sighted n=(18)

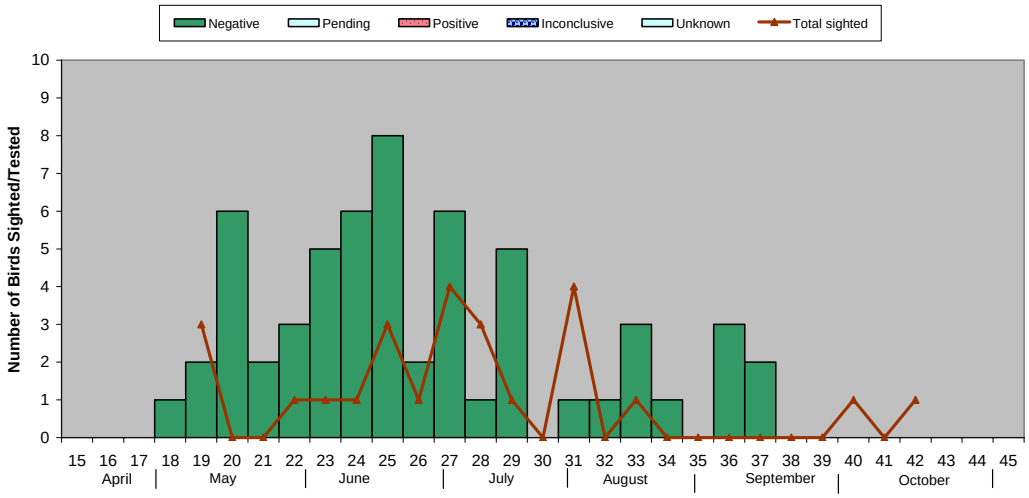
Week Number

Data up to and including Oct 29, 2005

Weeks run Sunday to Saturday

*0 birds submitted without date found;

Comparison of Number of Birds Sighted and Birds Tested in Thompson Cariboo Shuswap, 2005



Bar Graph - Birds Tested n=(58)

Line Graph - Birds Sighted n=(25)

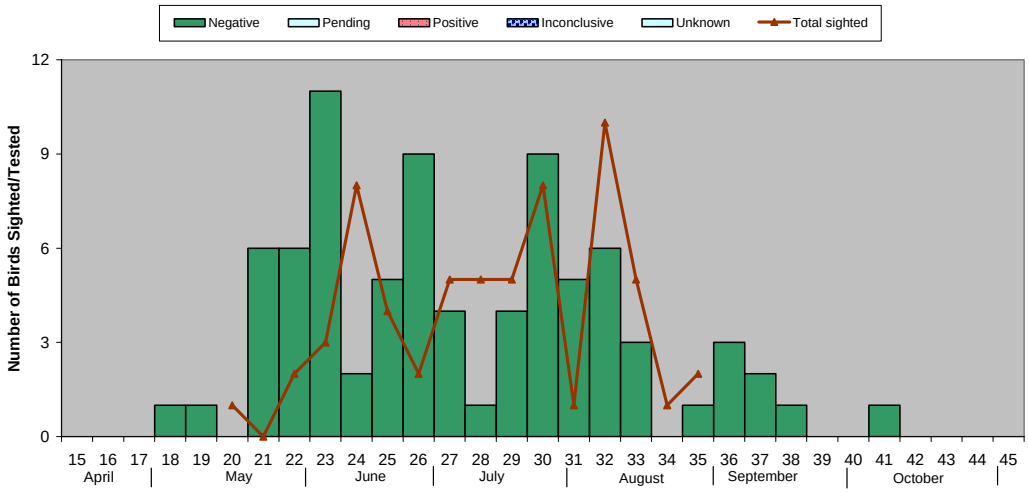
Week Number

Data up to and including Oct 29, 2005

Weeks run Sunday to Saturday

*0 birds submitted without date found;

Comparison of Number of Birds Sighted and Birds Tested in Fraser East, 2005



Bar Graph - Birds Tested n=(81)

Line Graph - Birds Sighted n=(62)

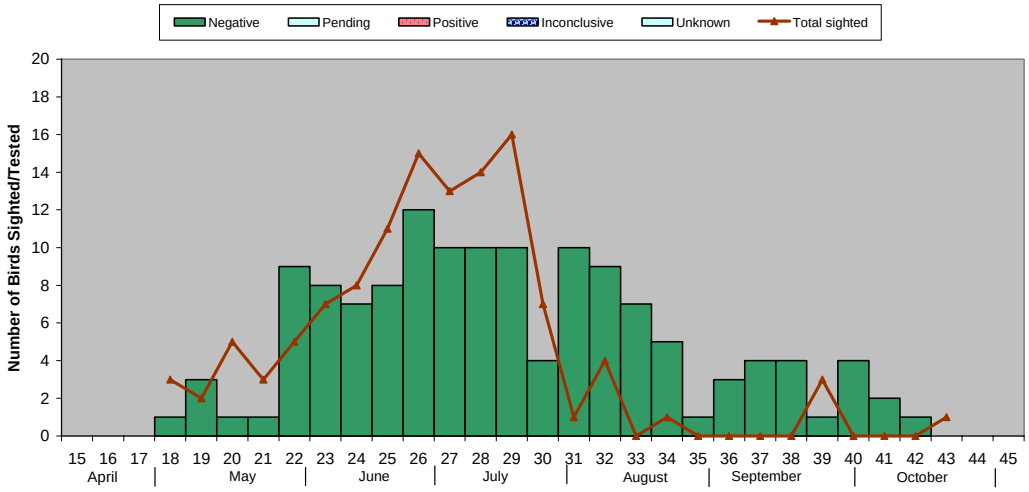
*0 birds submitted without date found;

Week Number

Data up to and including Oct 29, 2005

Weeks run Sunday to Saturday

Comparison of Number of Birds Sighted and Birds Tested in Fraser North, 2005



Bar Graph - Birds Tested n=(135)

Line Graph - Birds Sighted n=(119)

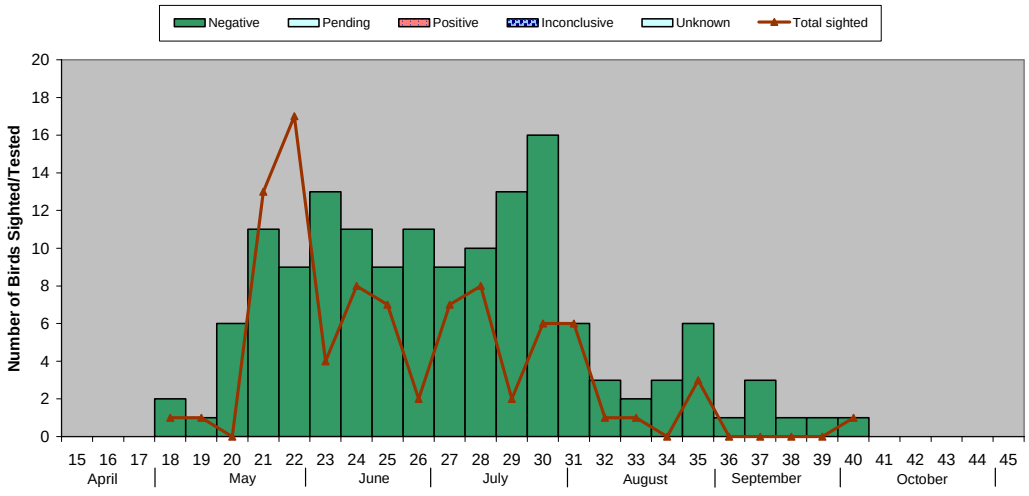
*0 birds submitted without date found;

Week Number

Data up to and including Oct 29, 2005

Weeks run Sunday to Saturday

Comparison of Number of Birds Sighted and Birds Tested in Fraser South, 2005



Bar Graph - Birds Tested n=(148)

Line Graph - Birds Sighted n=(88)

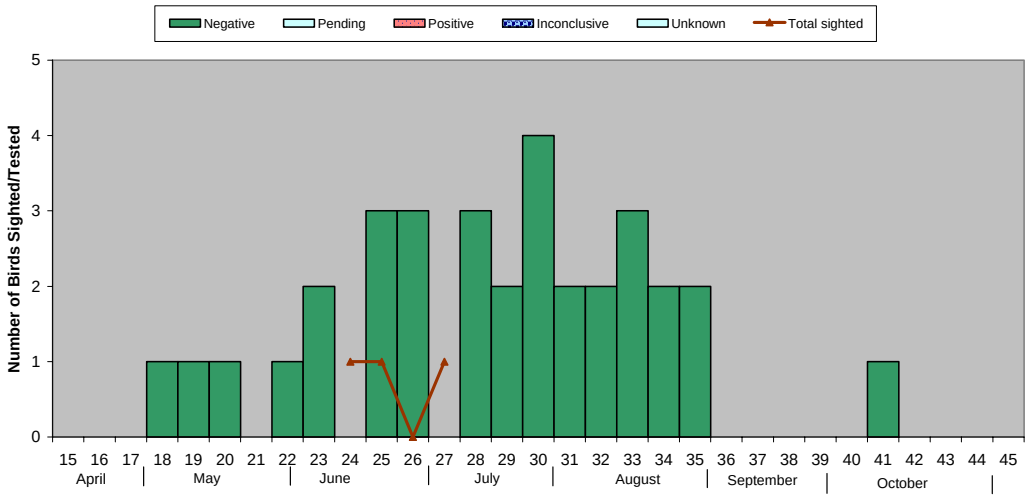
*0 birds submitted without date found;

Week Number

Data up to and including Oct 29, 2005

Weeks run Sunday to Saturday

Comparison of Number of Birds Sighted and Birds Tested in Richmond, 2005



Bar Graph - Birds Tested n=(33)

Line Graph - Birds Sighted n=(3)

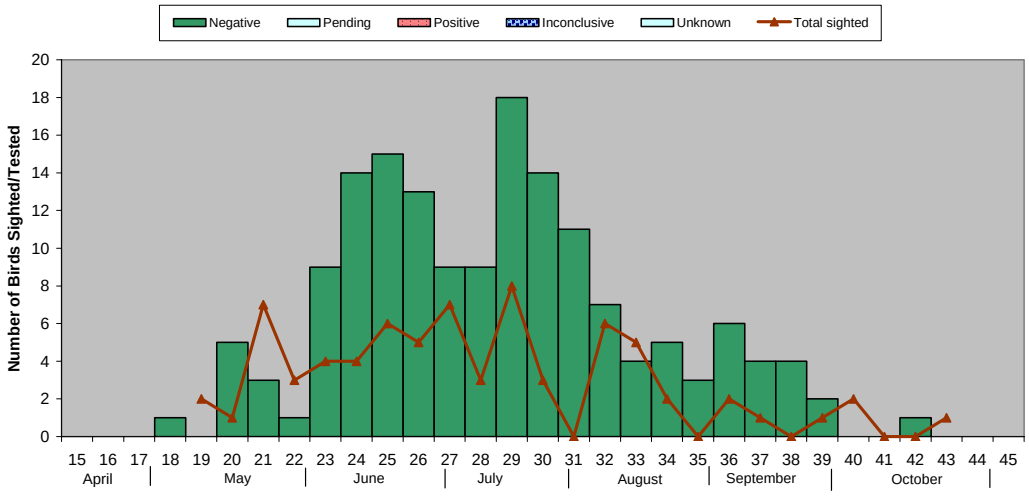
*0 birds submitted without date found;

Week Number

Data up to and including Oct 29, 2005

Weeks run Sunday to Saturday

Comparison of Number of Birds Sighted and Birds Tested in Vancouver, 2005



Bar Graph - Birds Tested n=(158)

Line Graph - Birds Sighted n=(73)

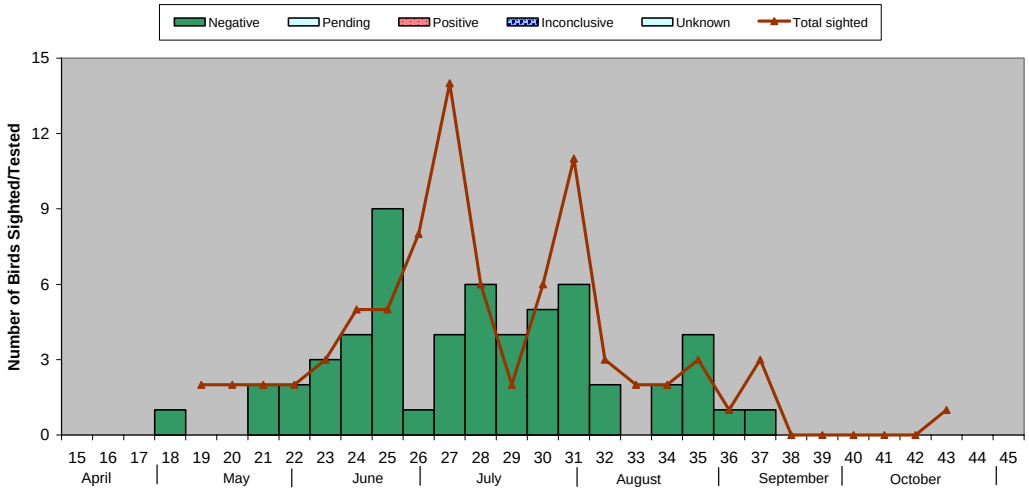
*0 birds submitted without date found;

Week Number

Data up to and including Oct 29, 2005

Weeks run Sunday to Saturday

Comparison of Number of Birds Sighted and Birds Tested in North Shore/Coast Garibaldi, 2005



Bar Graph - Birds Tested n=(57)

Line Graph - Birds Sighted n=(83)

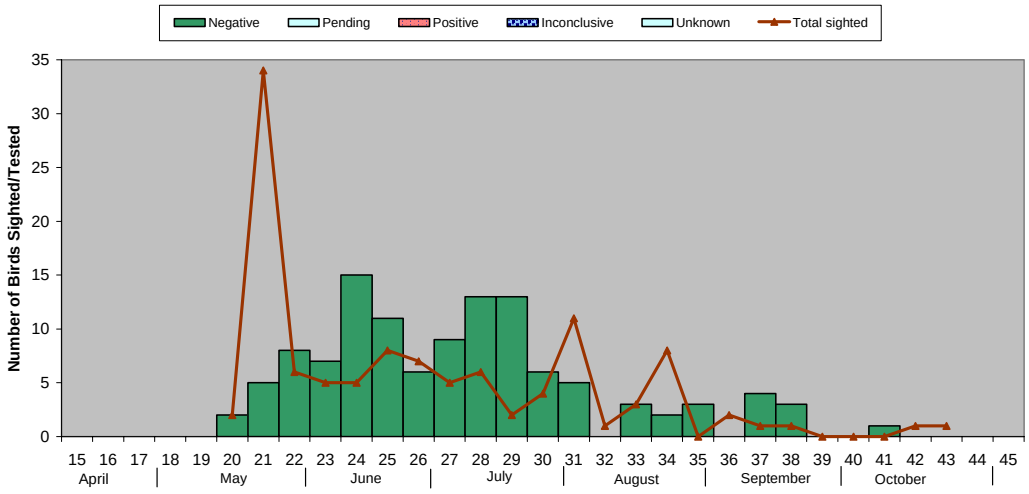
*0 birds submitted without date found;

Week Number

Data up to and including Oct 29, 2005

Weeks run Sunday to Saturday

Comparison of Number of Birds Sighted and Birds Tested in South Vancouver Island, 2005



Bar Graph - Birds Tested n=(116)

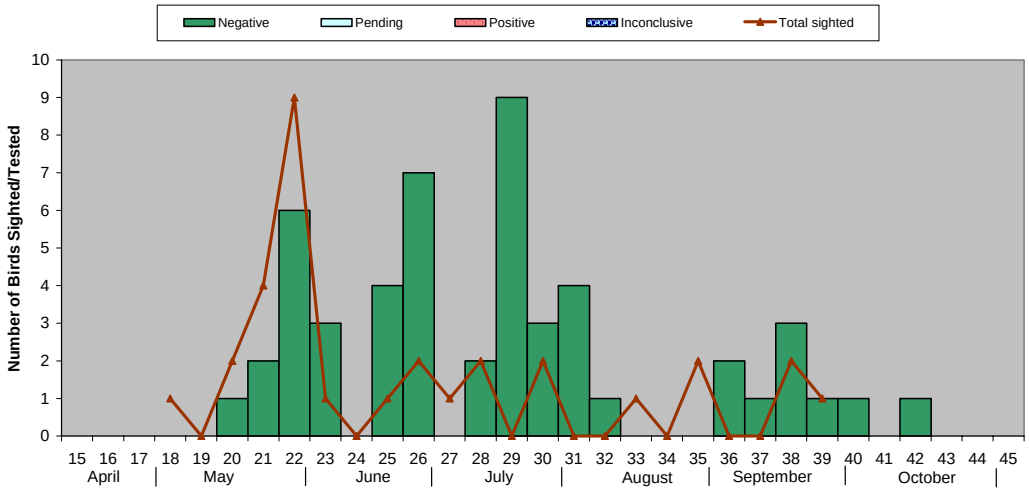
Line Graph - Birds Sighted n=(113)

*0 birds submitted without date found;

Data up to and including Oct 29, 2005

Weeks run Sunday to Saturday

Comparison of Number of Birds Sighted and Birds Tested in Central Vancouver Island, 2005



Bar Graph - Birds Tested n=(51)

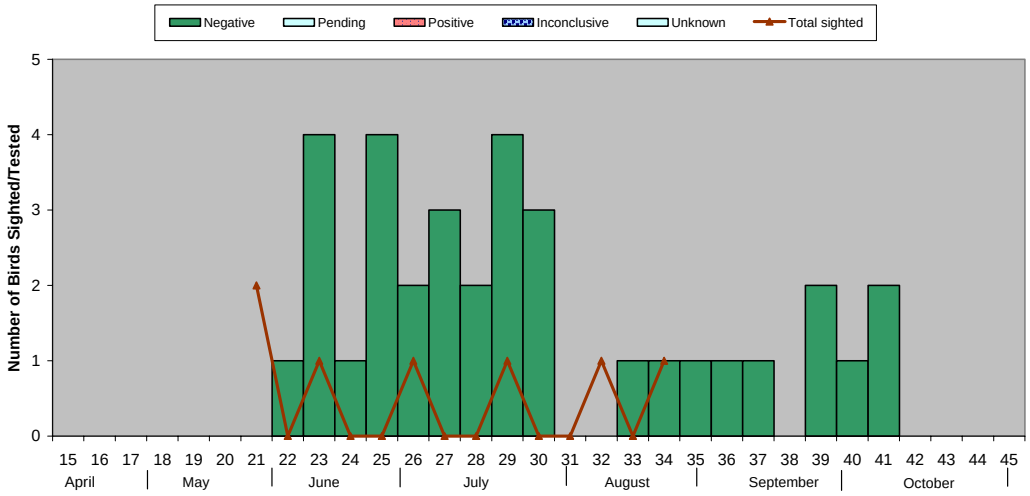
Line Graph - Birds Sighted n=(31)

*0 birds submitted without date found;

Data up to and including Oct 29, 2005

Weeks run Sunday to Saturday

Comparison of Number of Birds Sighted and Birds Tested in North Vancouver Island, 2005



Bar Graph - Birds Tested n=(34)

Line Graph - Birds Sighted n=(7)

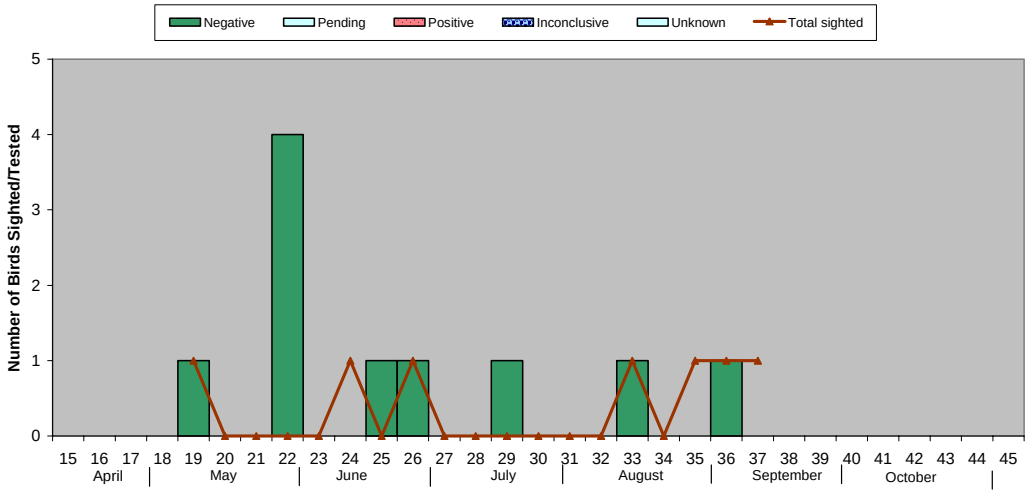
Week Number

Data up to and including Oct 29, 2005

Weeks run Sunday to Saturday

*0 birds submitted without date found;

Comparison of Number of Birds Sighted and Birds Tested in Northwest, 2005



Bar Graph - Birds Tested n=(10)

Line Graph - Birds Sighted n=(7)

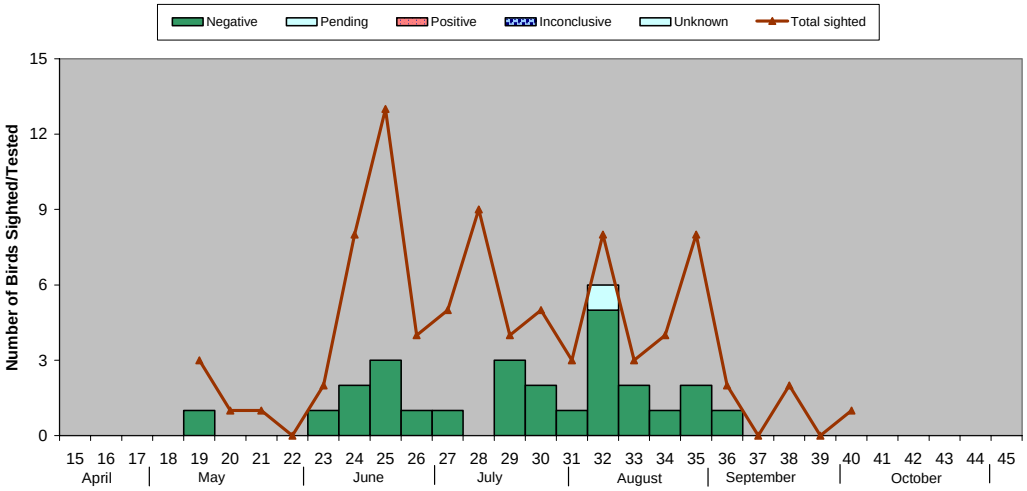
Week Number

Data up to and including Oct 29, 2005

Weeks run Sunday to Saturday

*0 birds submitted without date found;

Comparison of Number of Birds Sighted and Birds Tested in Nothern Interior, 2005



Bar Graph - Birds Tested n=(27)

Line Graph - Birds Sighted n=(86)

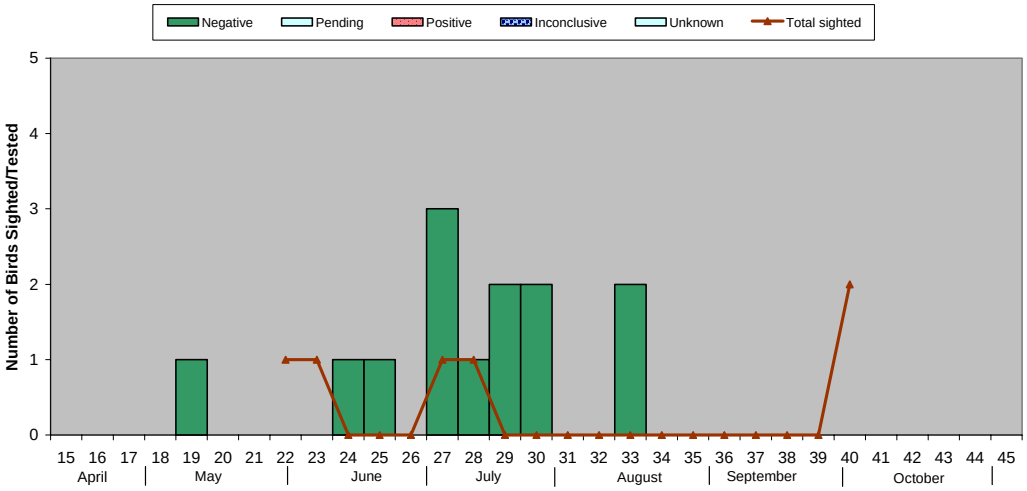
Week Number

Data up to and including Oct 29, 2005

Weeks run Sunday to Saturday

*1 birds submitted without date found;

Comparison of Number of Birds Sighted and Birds Tested in Northeast, 2005



Bar Graph - Birds Tested n=(13)

Line Graph - Birds Sighted n=(6)

Week Number

Data up to and including Oct 29, 2005

Weeks run Sunday to Saturday

*0 birds submitted without date found;

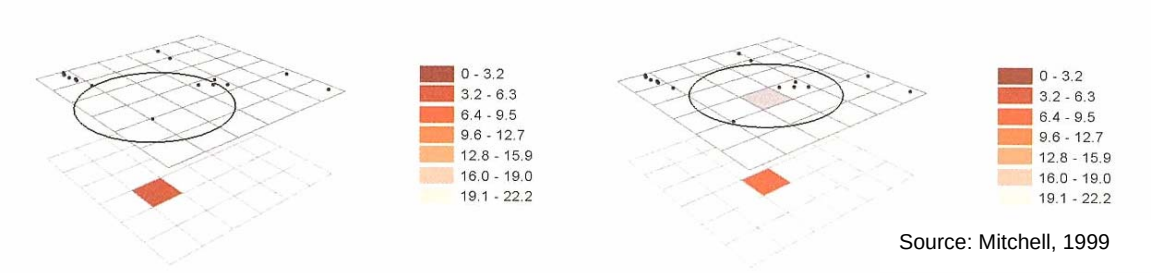
Appendix 3: Dead Bird Density Mapping

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.



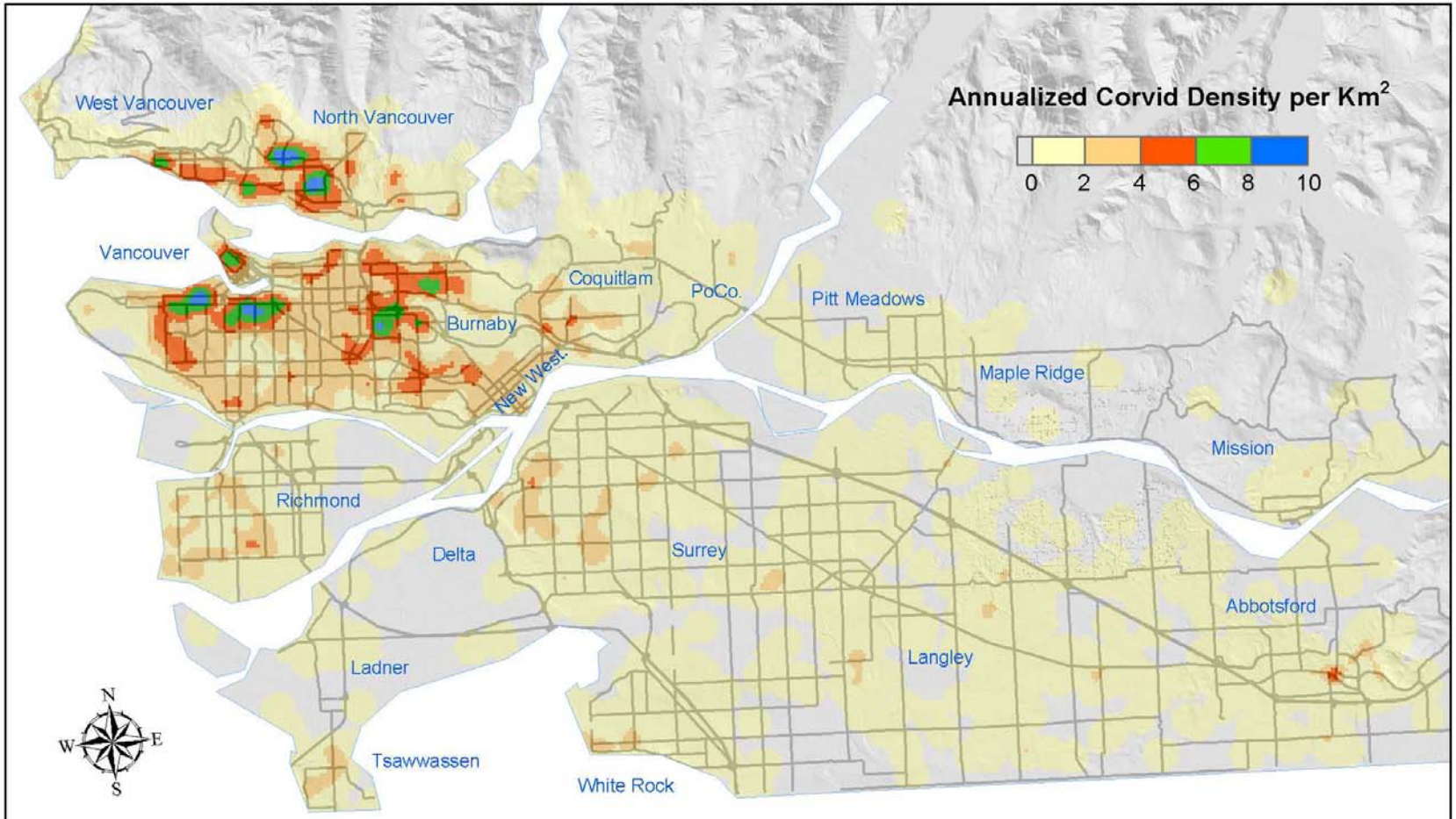
Source: Mitchell, 1999

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 and 2005, prior to introduction of WNv, is 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 21 January 2005. 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.

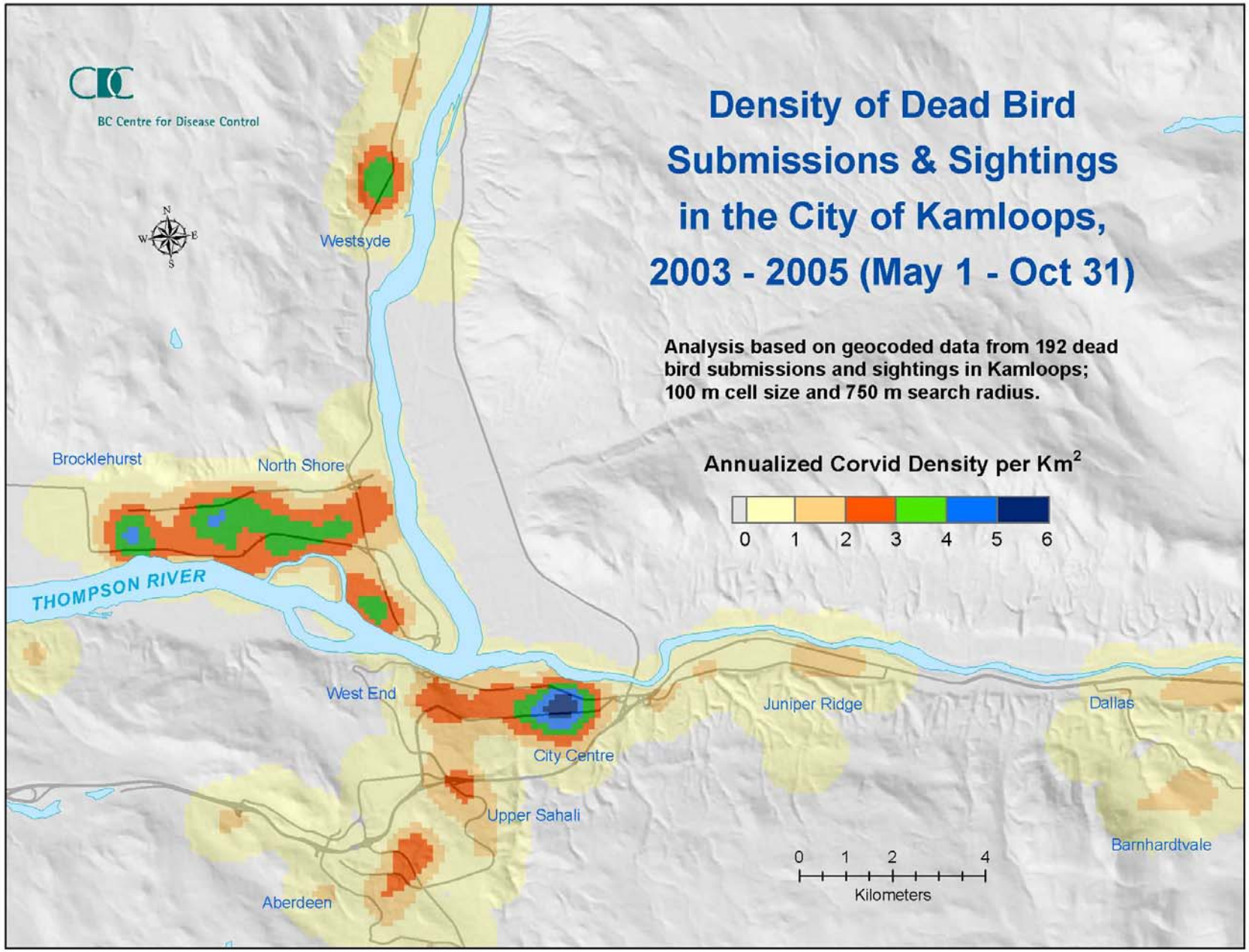


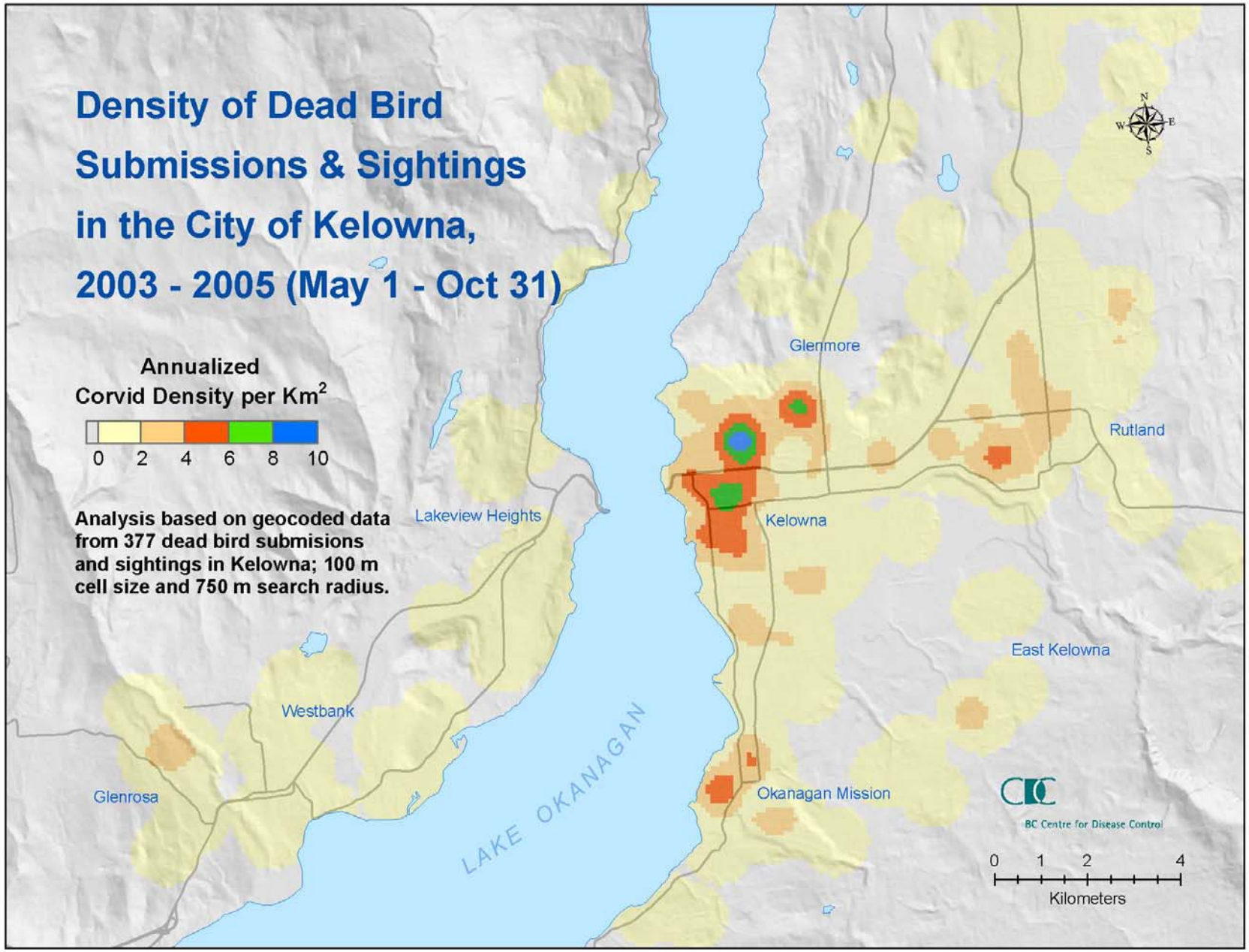
Density of Dead Bird Submissions and Sightings in the Vancouver Lower Mainland, 2003 - 2005 (May 1 - Oct 31)

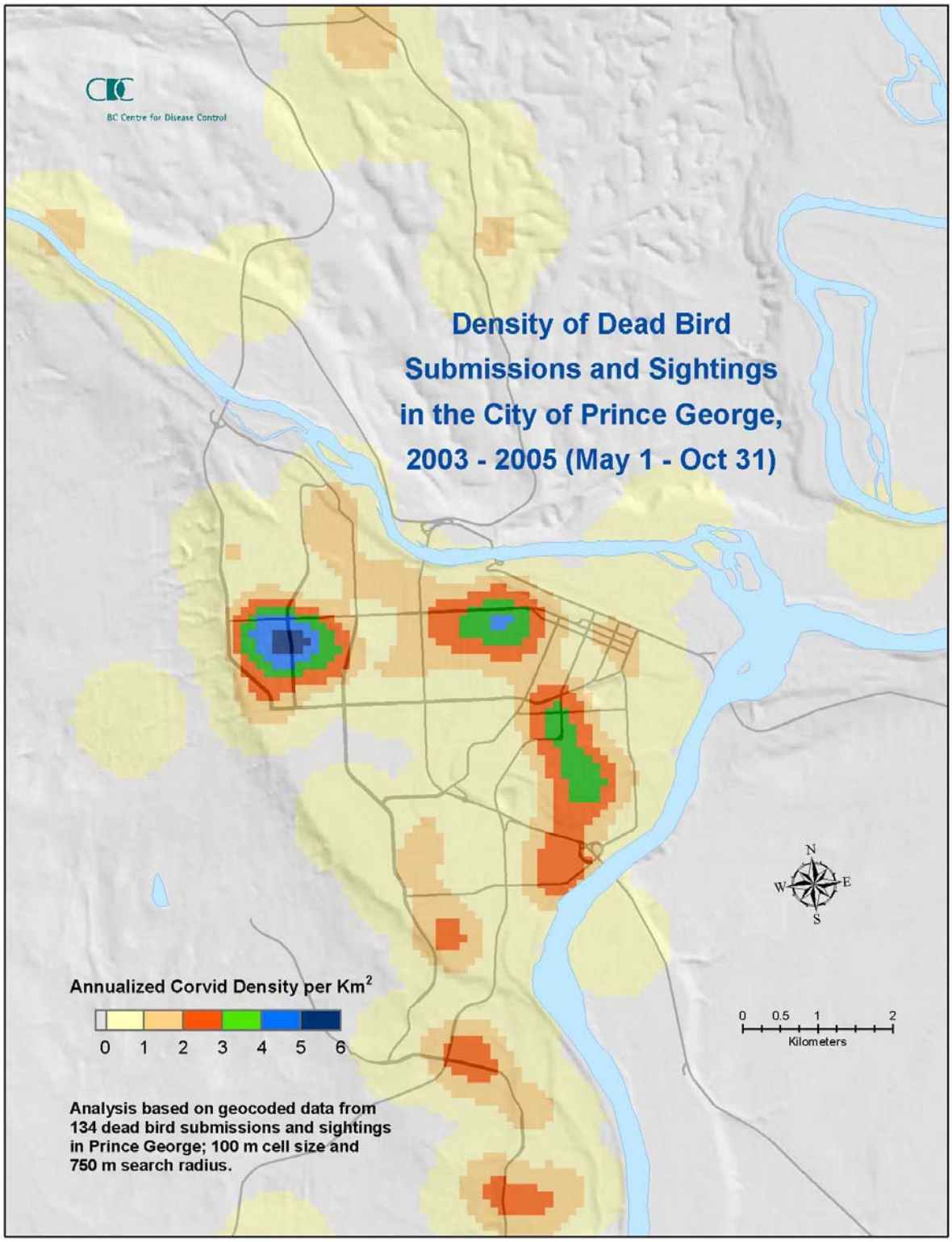
BC Centre for Disease Control

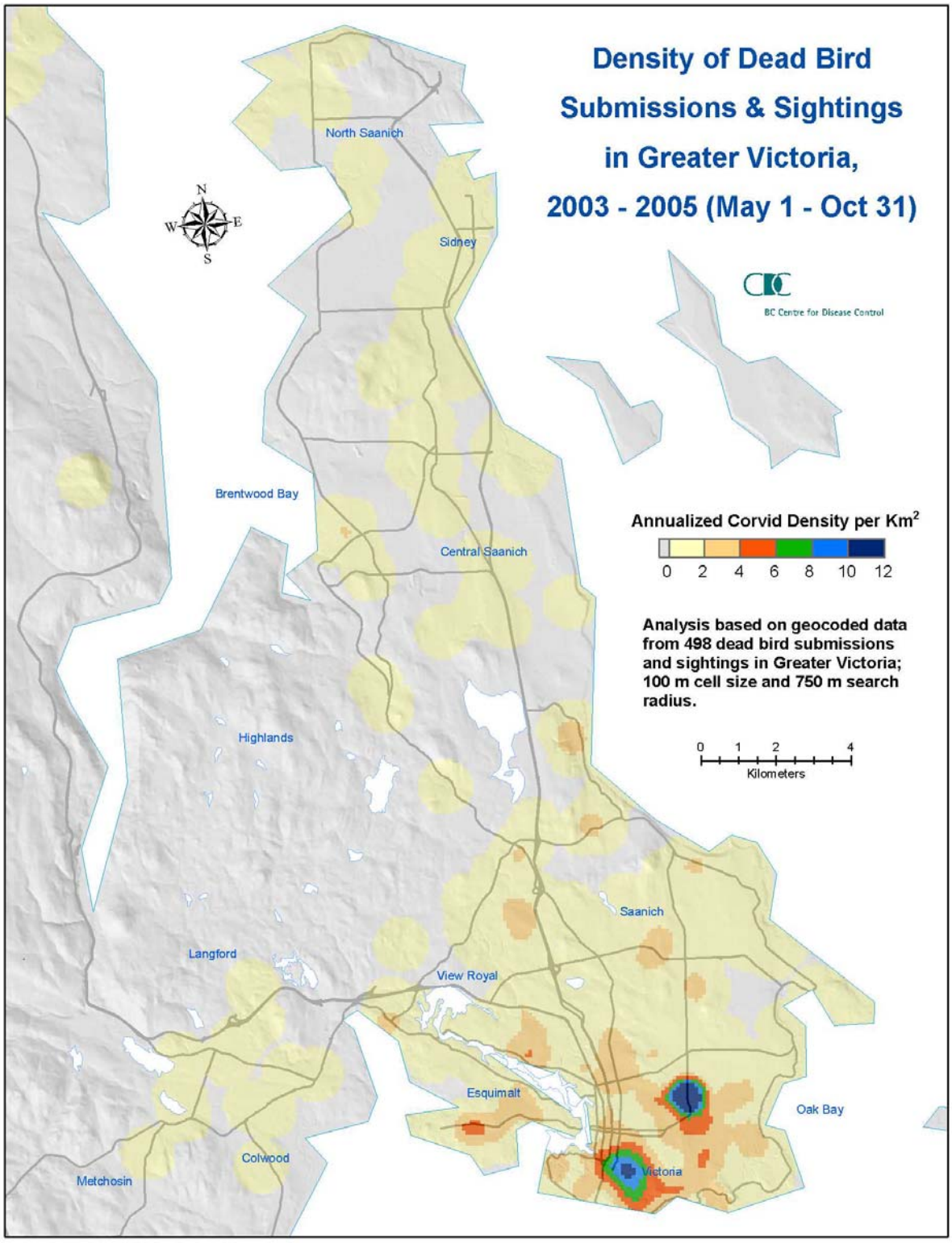
Analysis based on geocoded data from 4340 dead bird submissions and sightings in the Vancouver Lower Mainland; 200 m cell size and 1000 m search radius.

0 5 10 20
Kilometers

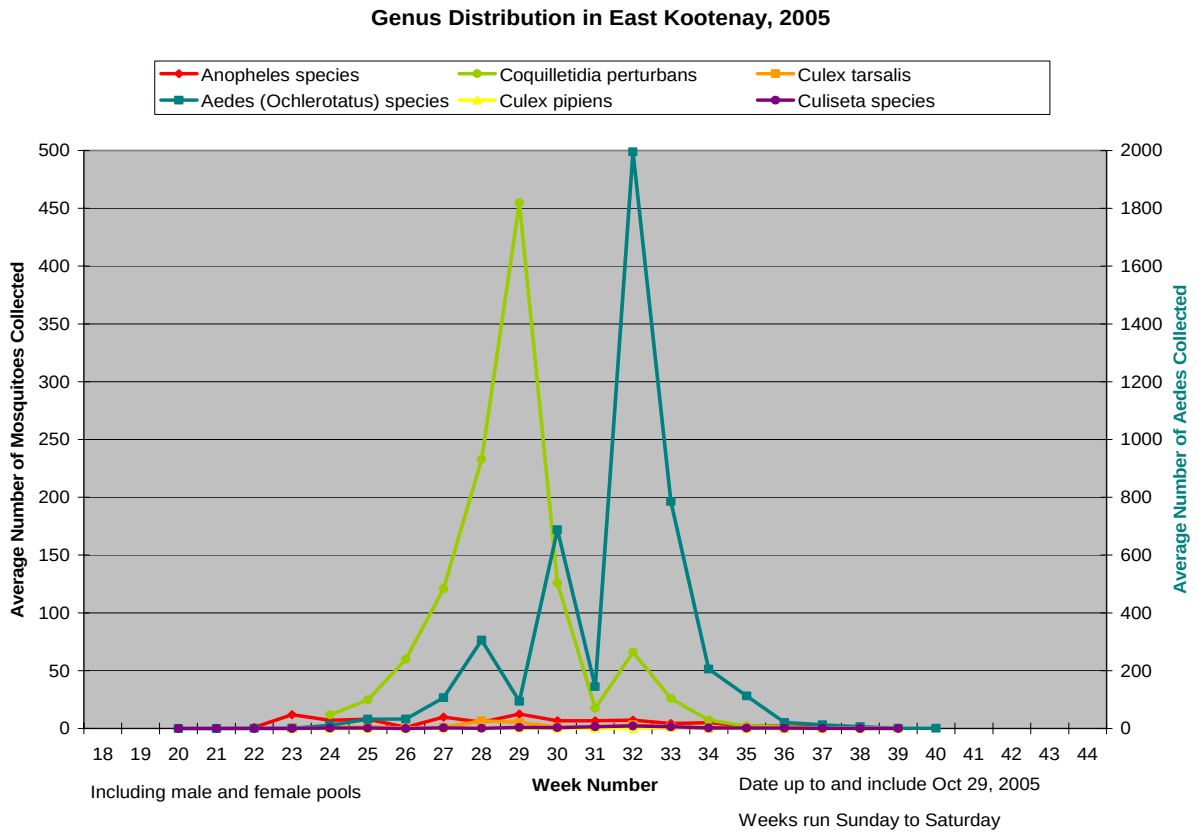

BC Centre for Disease Control
Density of Dead Bird Submissions & Sightings in the City of Kamloops, 2003 - 2005 (May 1 - Oct 31)
Analysis based on geocoded data from 192 dead bird submissions and sightings in Kamloops; 100 m cell size and 750 m search radius.
Annualized Corvid Density per Km2
0 1 2 3 4 5 6
Westsyde
Brocklehurst
North Shore
THOMPSON RIVER
West End
City Centre
Juniper Ridge
Dallas
Upper Sahali
Barnhardtvale
Aberdeen
0 1 2 4
Kilometers

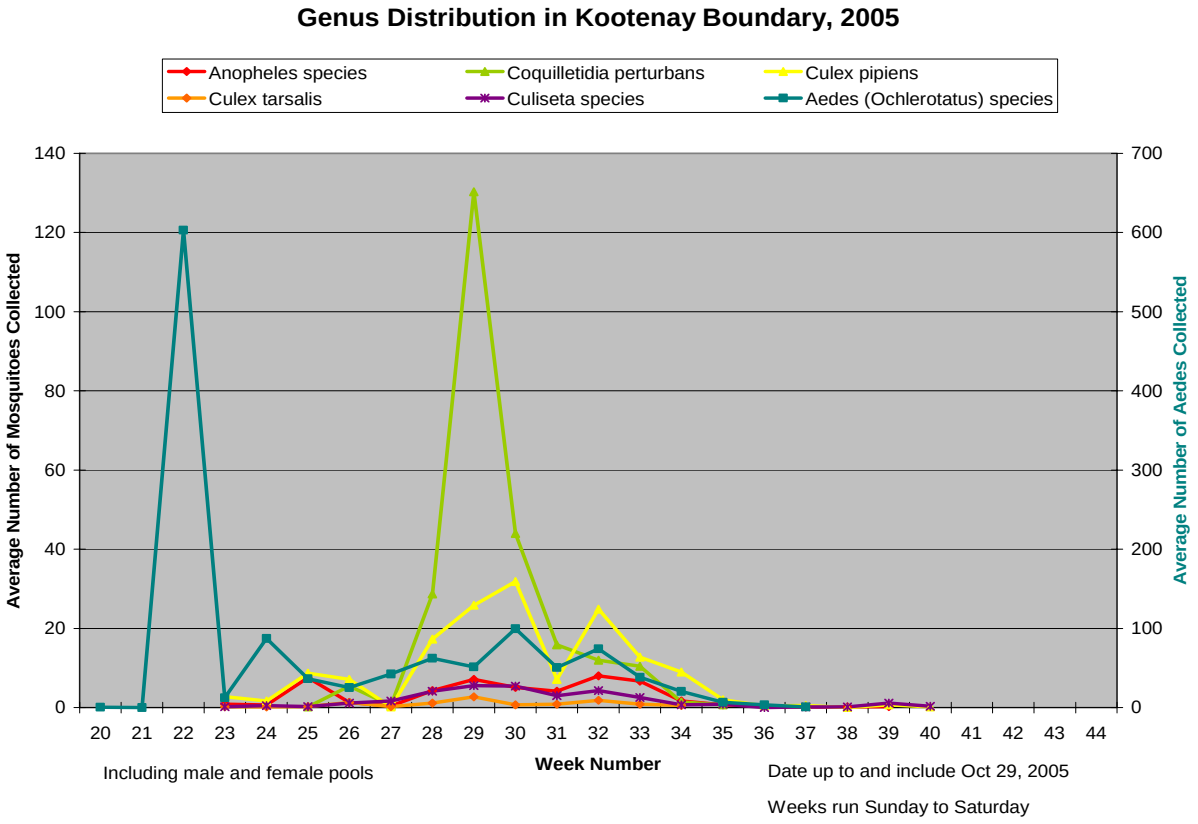

Density of Dead Bird Submissions & Sightings in the City of Kelowna, 2003 - 2005 (May 1 - Oct 31)
Annualized Corvid Density per Km2
0 2 4 6 8 10
Analysis based on geocoded data from 377 dead bird submisions and sightings in Kelowna; 100 m cell size and 750 m search radius.
N
W
E
S
Glenmore
Rutland
Lakeview 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 - 2005 (May 1 - Oct 31)
N
W
E
S
Annualized Corvid Density per Km2
0 1 2 3 4 5 6
0 0.5 1 2
Kilometers
Analysis based on geocoded data from 134 dead bird submissions and sightings in Prince George; 100 m cell size and 750 m search radius.

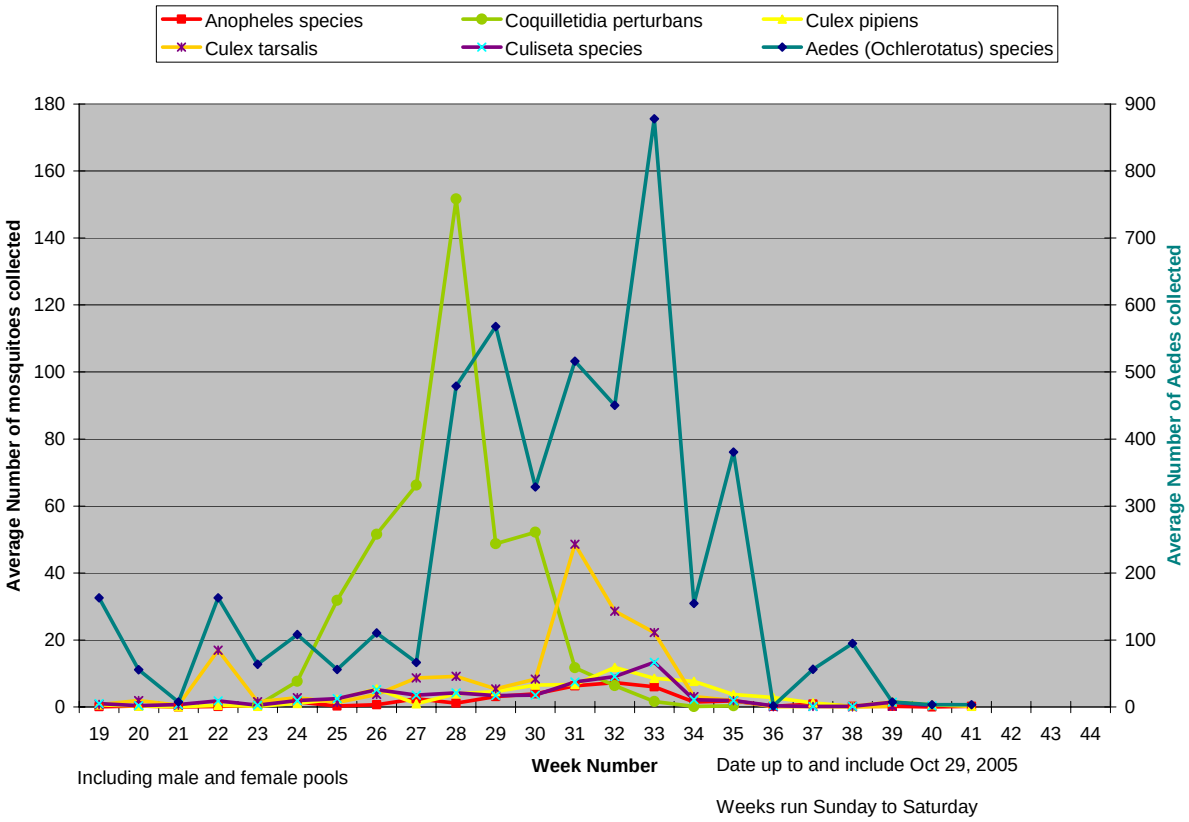

Density of Dead Bird Submissions & Sightings in Greater Victoria, 2003 - 2005 (May 1 - Oct 31)
BC Centre for Disease Control
North Saanich
Sidney
Brentwood Bay
Central Saanich
Highlands
Saanich
Langford
View Royal
Esquimalt
Oak Bay
Colwood
Metchosin
Victoria
N
S
E
W
Annualized Corvid Density per Km2
0 2 4 6 8 10 12
Analysis based on geocoded data from 498 dead bird submissions and sightings in Greater Victoria; 100 m cell size and 750 m search radius.
0 1 2 4
Kilometers

Appendix 4 – Average Mosquito Count for all Genus/Species





Genus Distribution in Okanagan, 2005

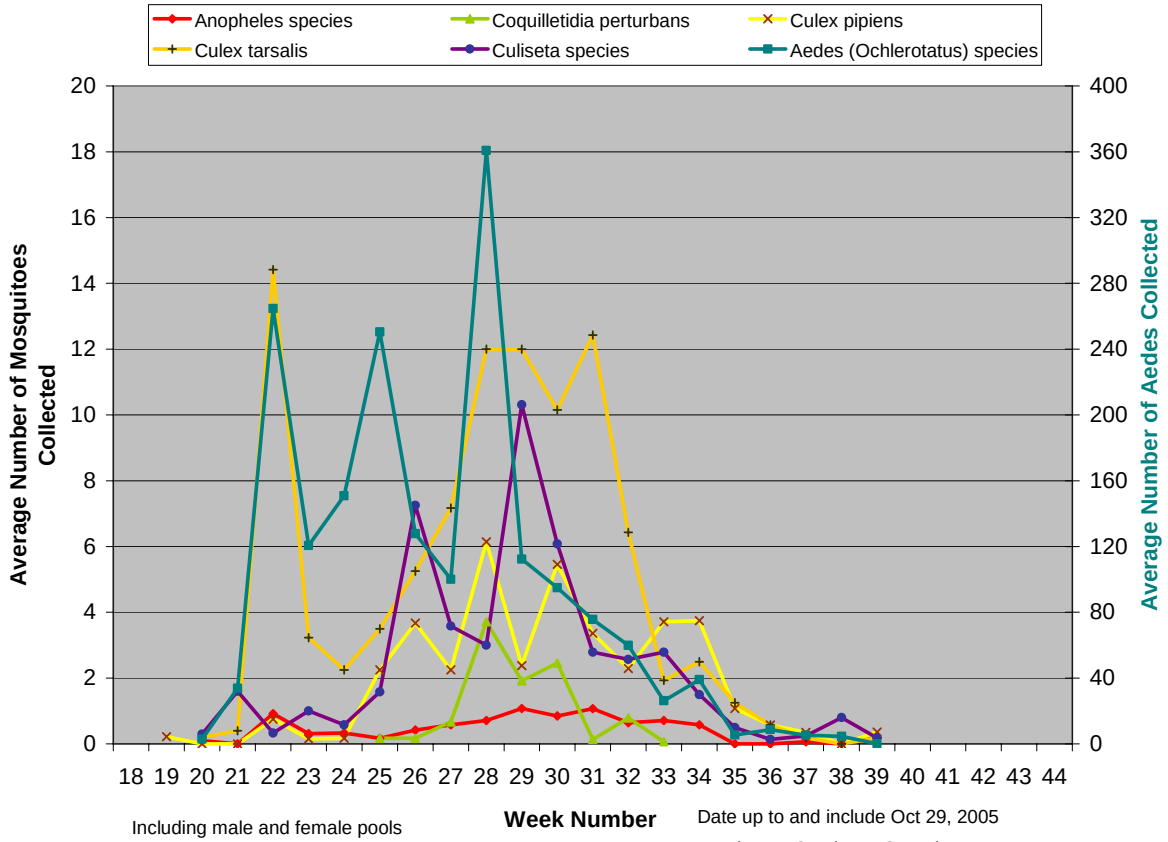


Including male and female pools

Date up to and include Oct 29, 2005

Weeks run Sunday to Saturday

Genus Distribution in Thompson Cariboo Shuswap, 2005

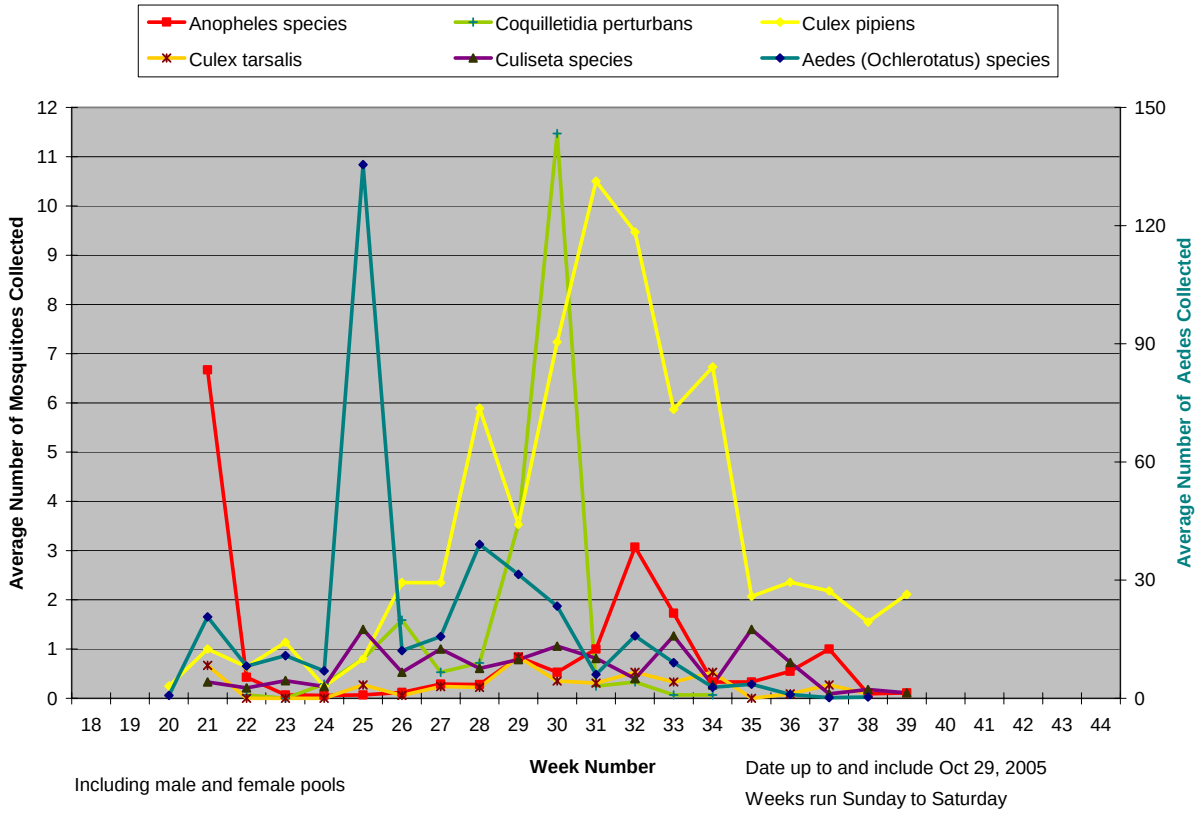


Including male and female pools

Date up to and include Oct 29, 2005

Weeks run Sunday to Saturday

Genus Distribution in East Fraser, 2005

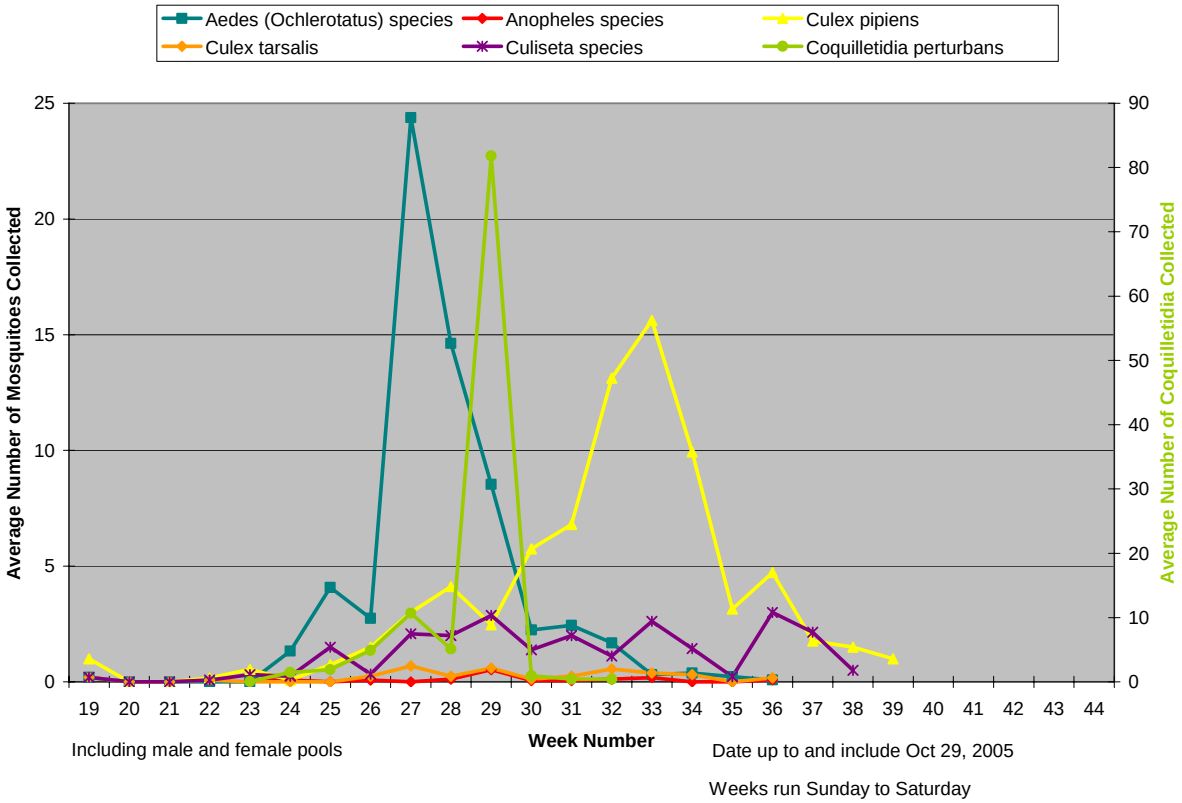


Including male and female pools

Date up to and include Oct 29, 2005

Weeks run Sunday to Saturday

Genus Distribution in North Fraser, 2005

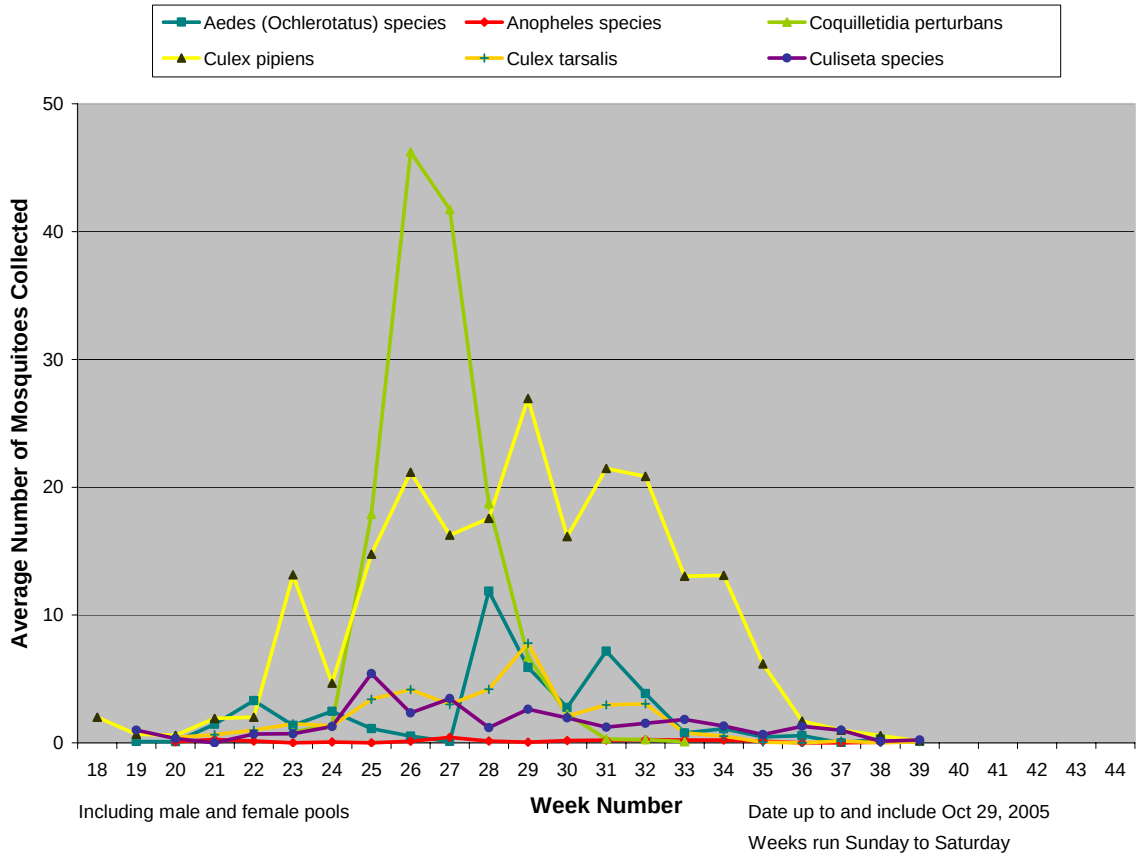


Including male and female pools

Date up to and include Oct 29, 2005

Weeks run Sunday to Saturday

Genus Distribution in South Fraser, 2005

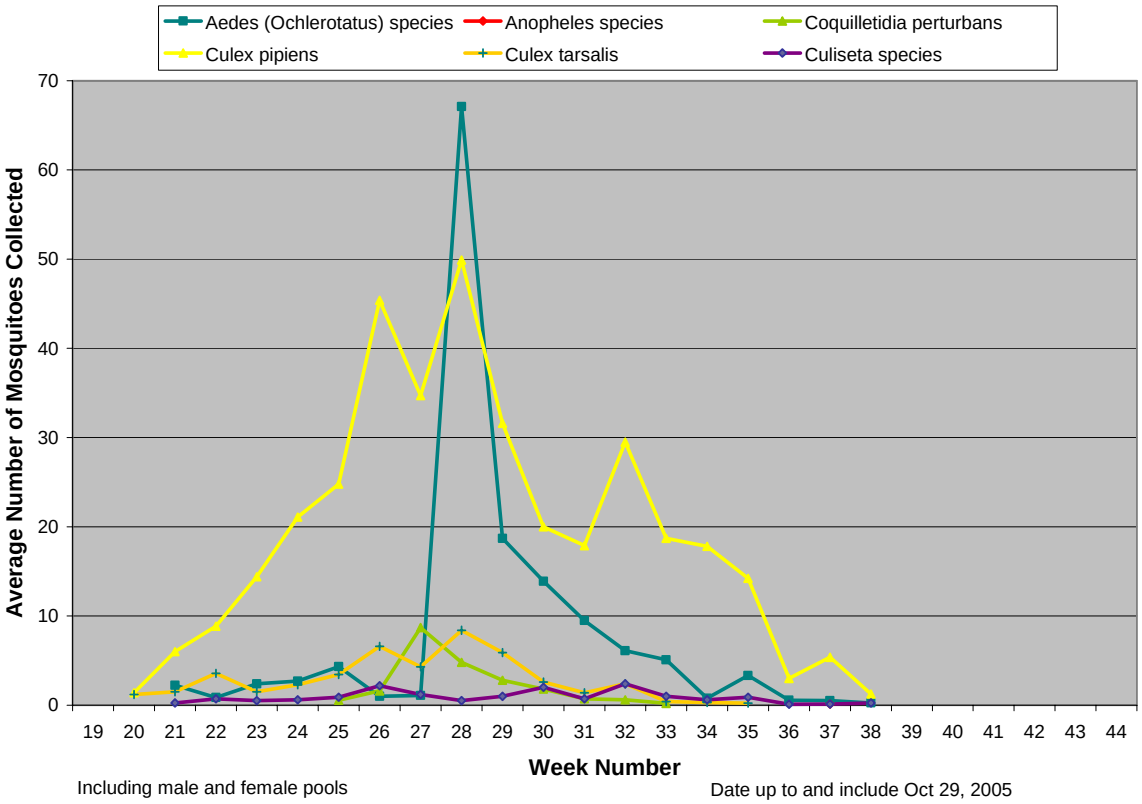


Including male and female pools

Date up to and include Oct 29, 2005

Weeks run Sunday to Saturday

Genus Distribution in Richmond, 2005

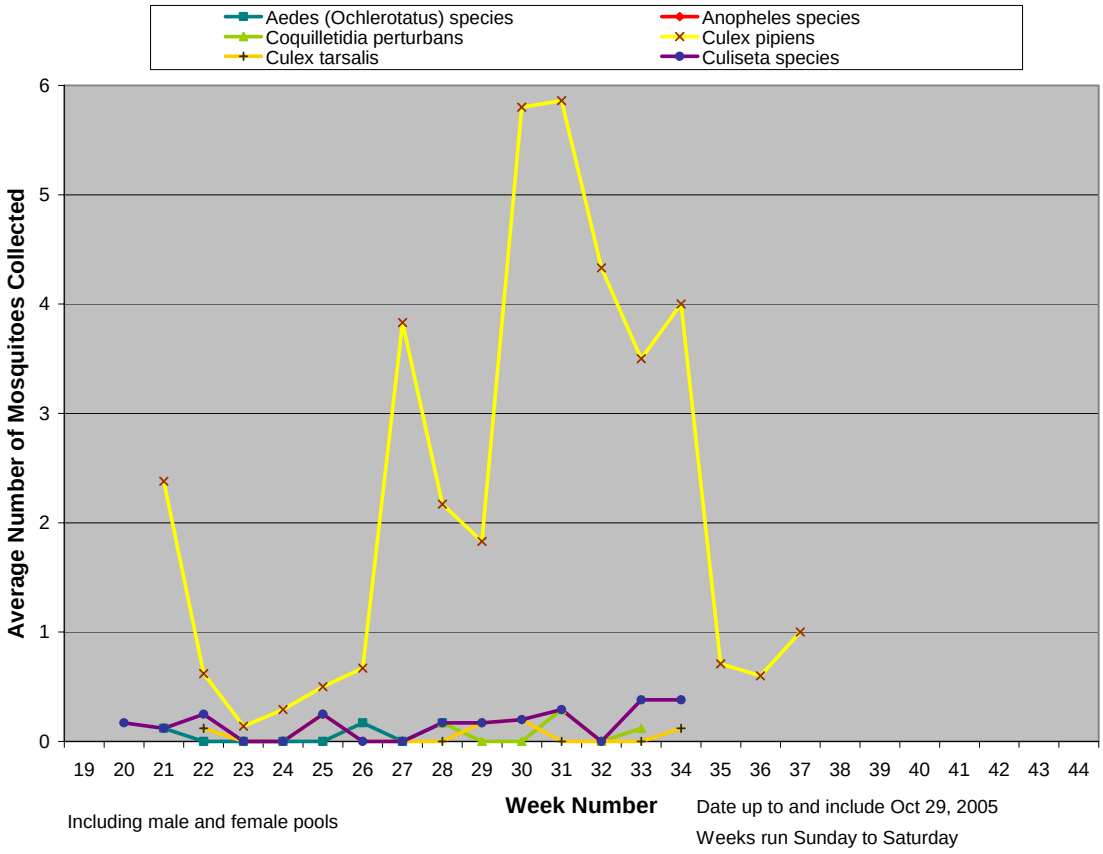


Including male and female pools

Date up to and include Oct 29, 2005

Weeks run Sunday to Saturday

Genus Distribution in Vancouver, 2005

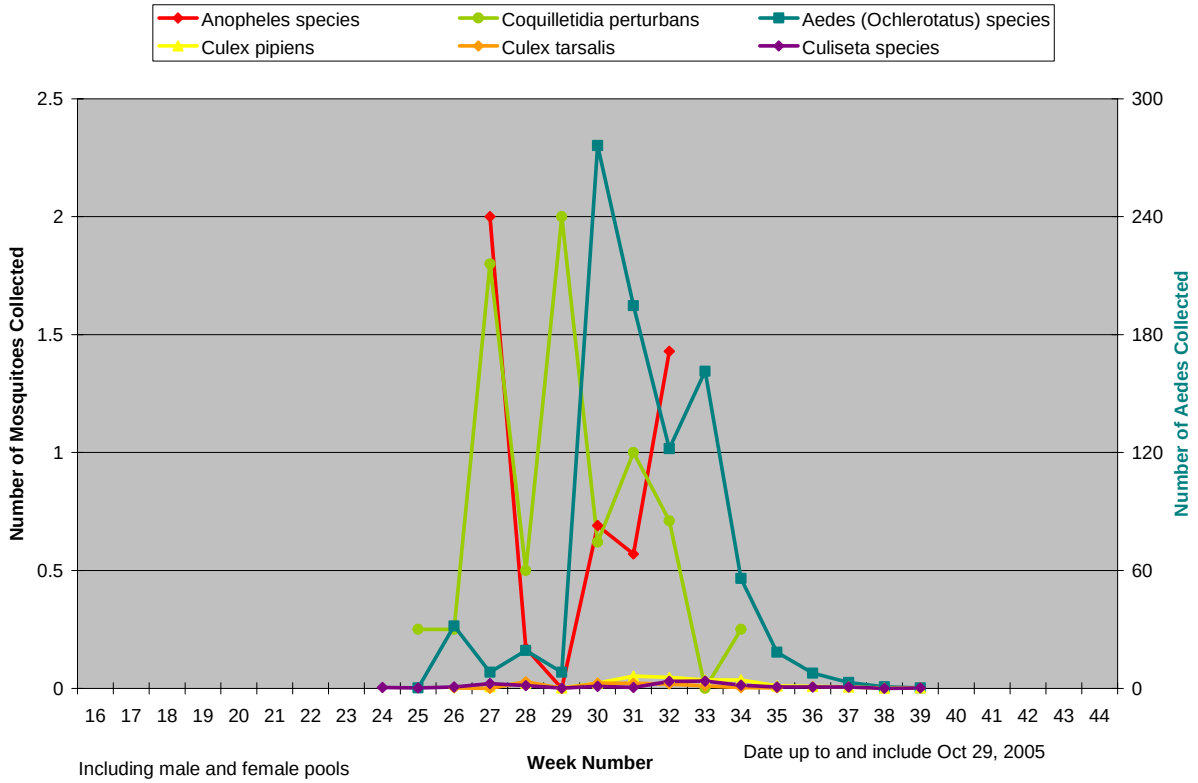


Including male and female pools

Date up to and include Oct 29, 2005

Weeks run Sunday to Saturday

Genus Distribution in North Shore/Coast Garibaldi, 2005

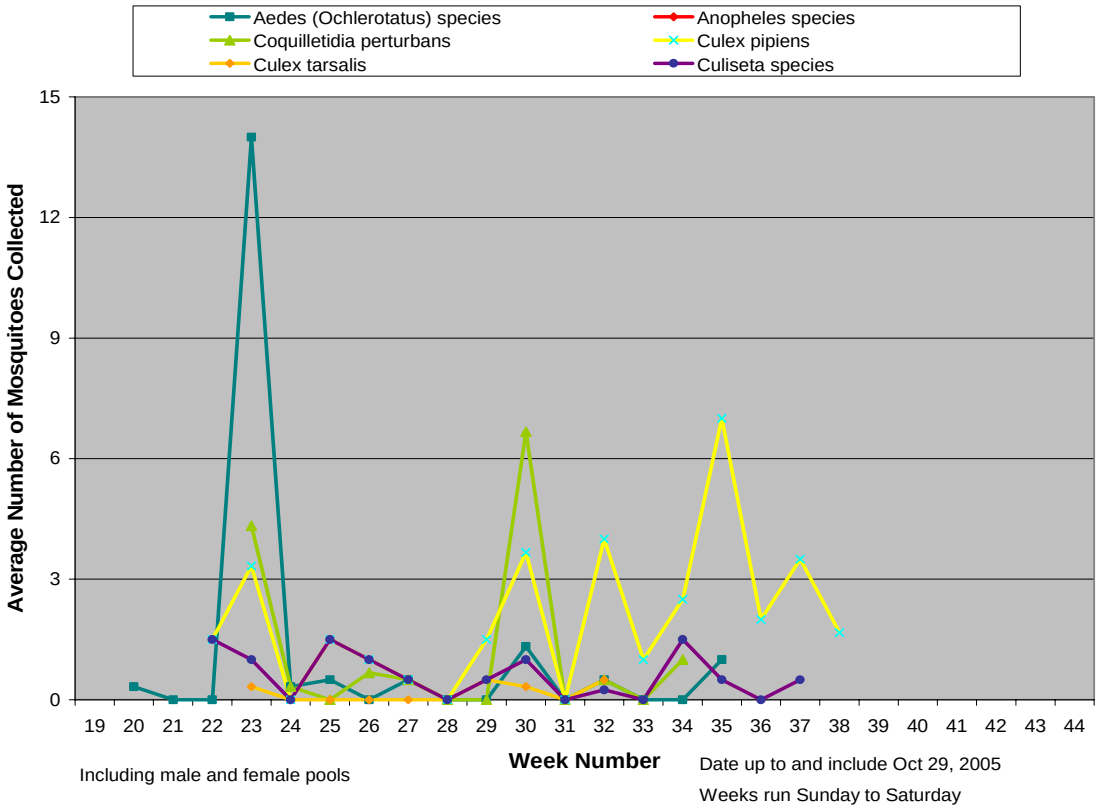


Including male and female pools

Date up to and include Oct 29, 2005

Weeks run Sunday to Saturday

Genus Distribution in South Vancouver Island, 2005

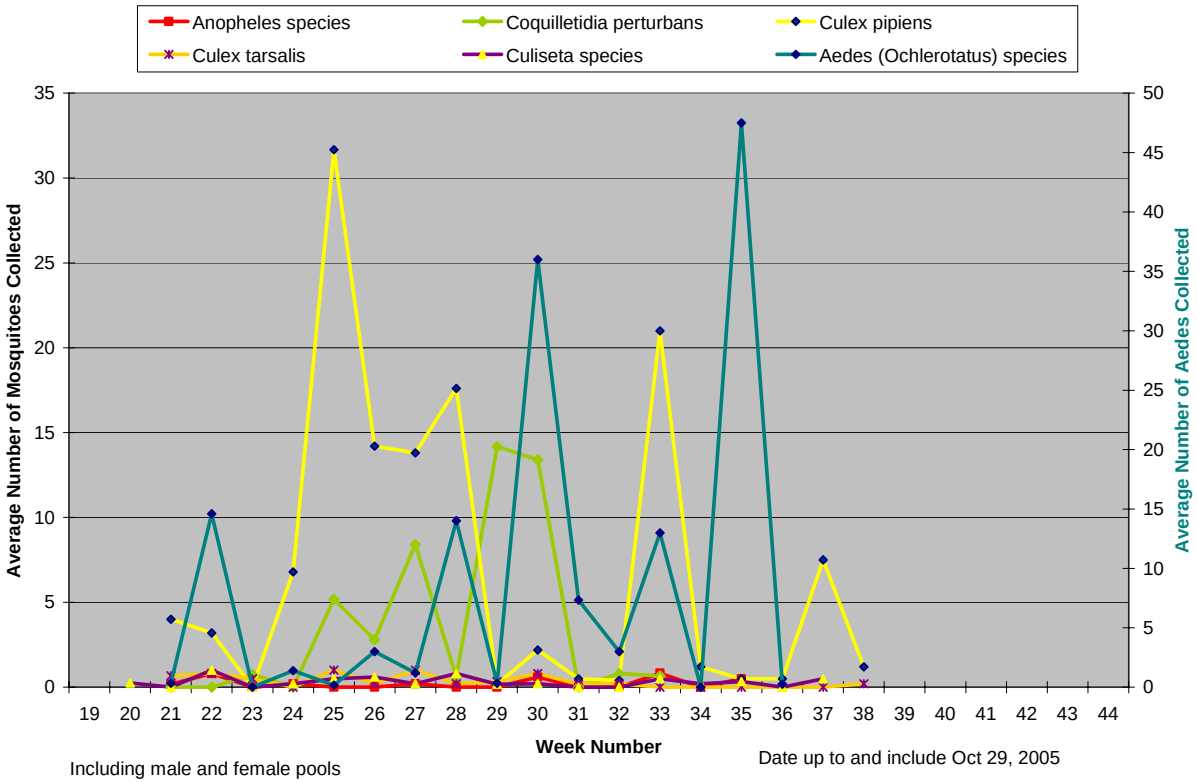


Including male and female pools

Date up to and include Oct 29, 2005

Weeks run Sunday to Saturday

Genus Distribution in Central Vancouver Island, 2005

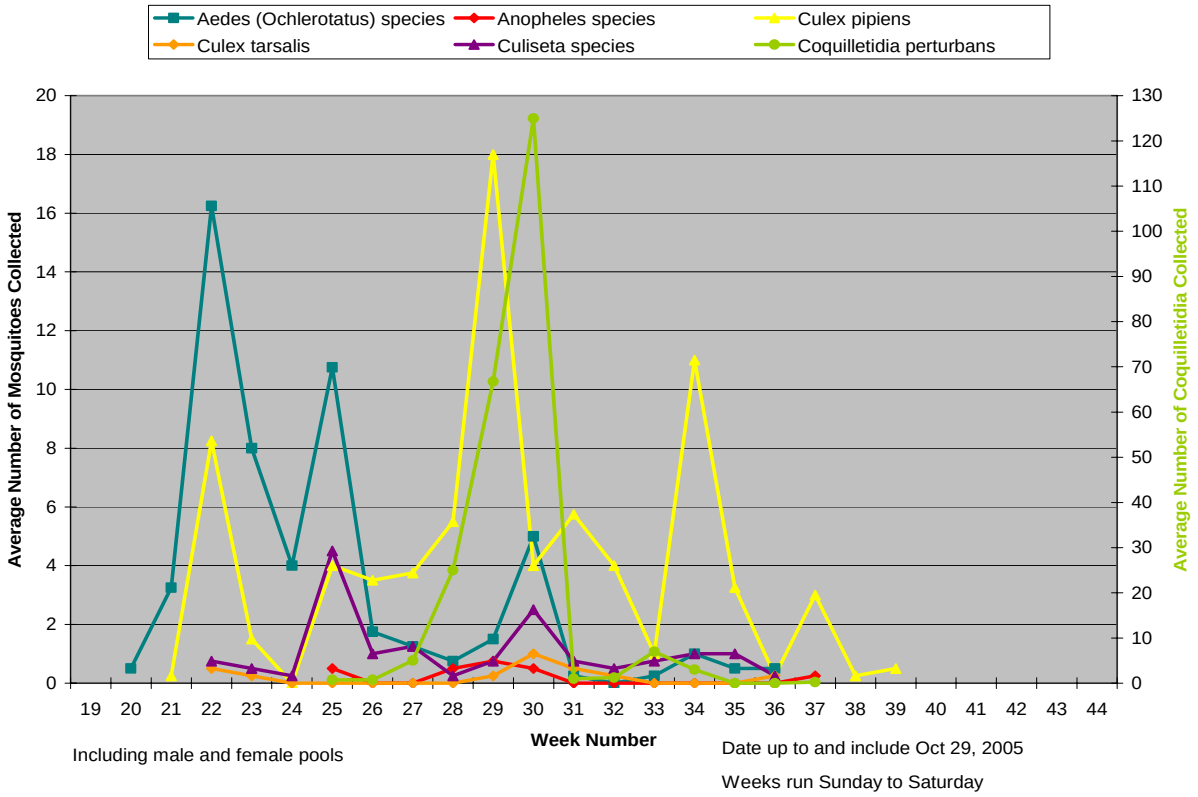


Including male and female pools

Date up to and include Oct 29, 2005

Weeks run Sunday to Saturday

Genus Distribution in North Vancouver Island, 2005

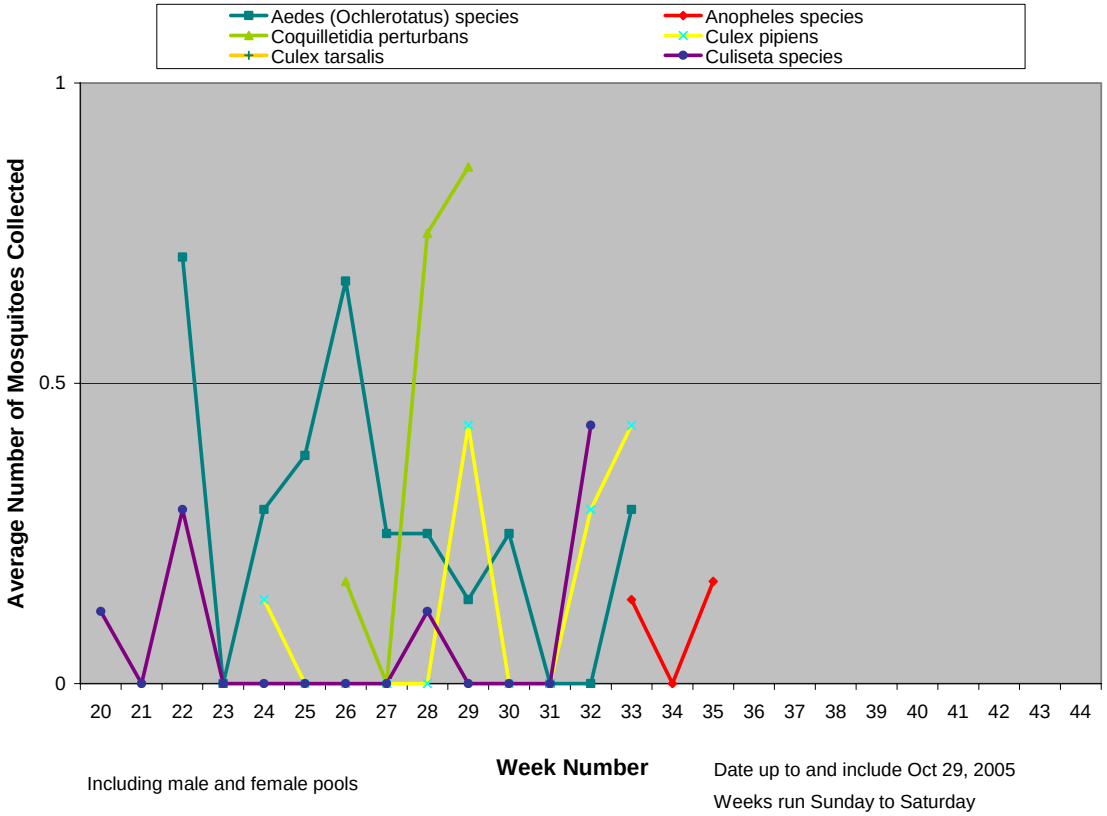


Including male and female pools

Date up to and include Oct 29, 2005

Weeks run Sunday to Saturday

Genus Distribution in North West, 2005

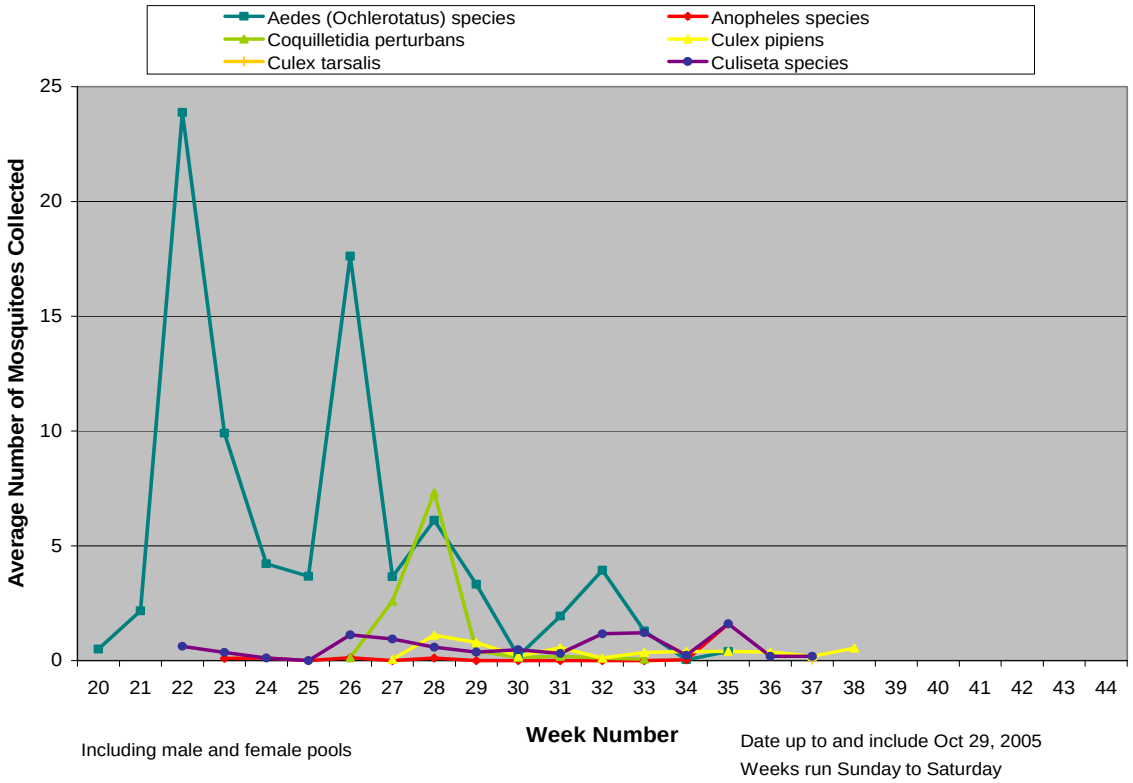


Including male and female pools

Date up to and include Oct 29, 2005

Weeks run Sunday to Saturday

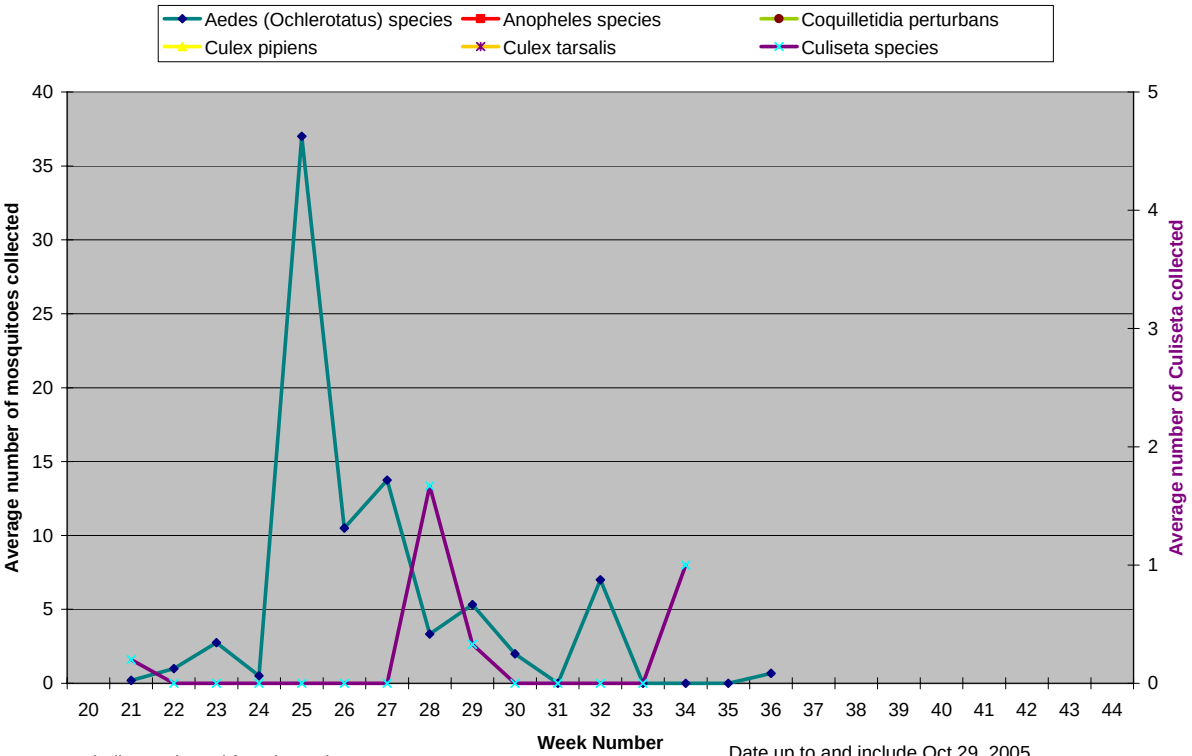
Genus Distribution in Northern Interior, 2005



Including male and female pools

Date up to and include Oct 29, 2005
Weeks run Sunday to Saturday

Genus Distribution in North East, 2005



Including male and female pools

Date up to and include Oct 29, 2005
Weeks run Sunday to Saturday

Appendix 5: 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 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 and 2004, 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:

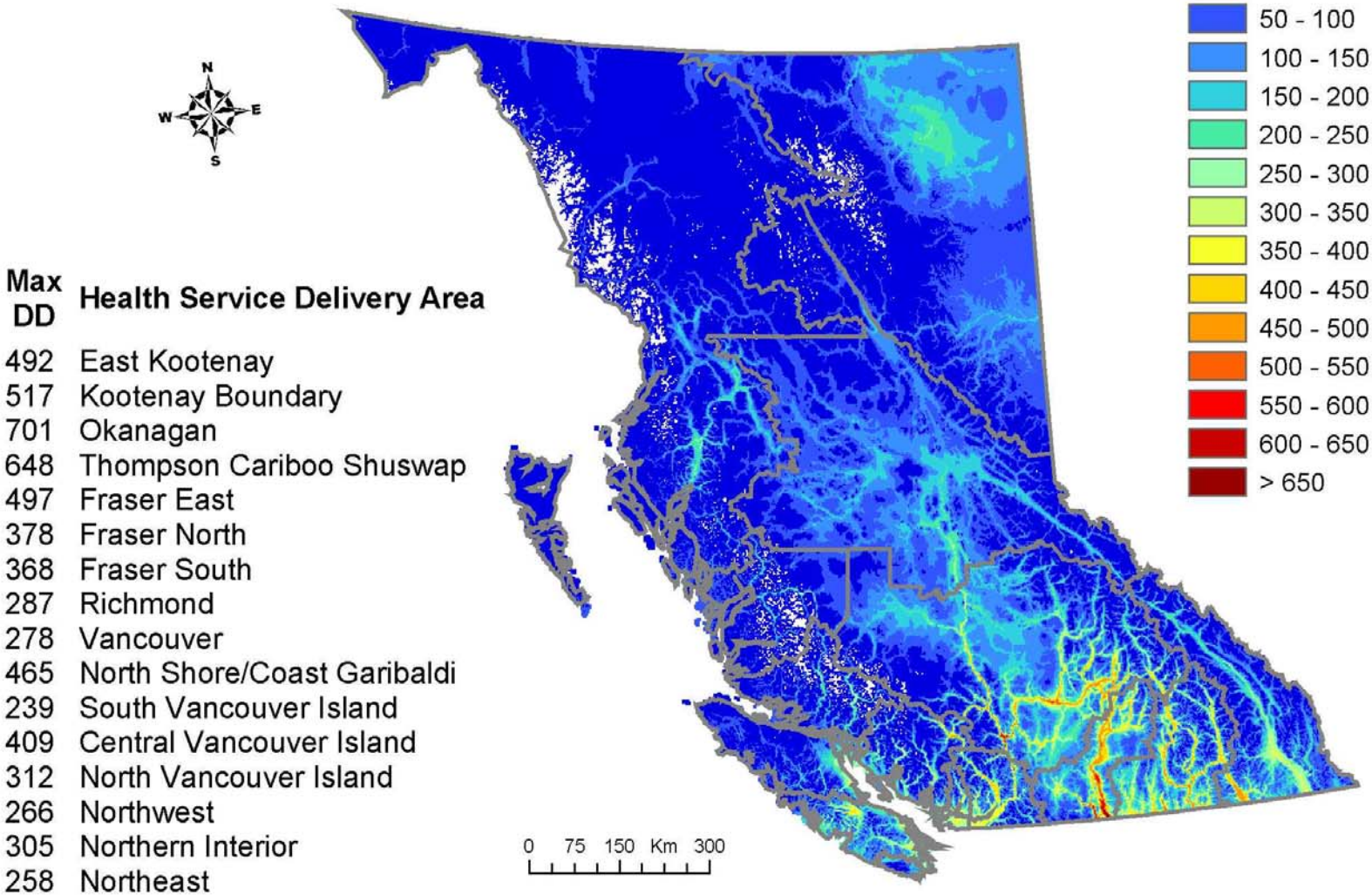
1. University of California and California State Department of Agriculture and Natural Resources Integrated Pest Management Program. "Degree-Days." Webpage accessed 21 January 2005. http://www.ipm.ucdavis.edu/WEATHER/ddconcepts.html

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

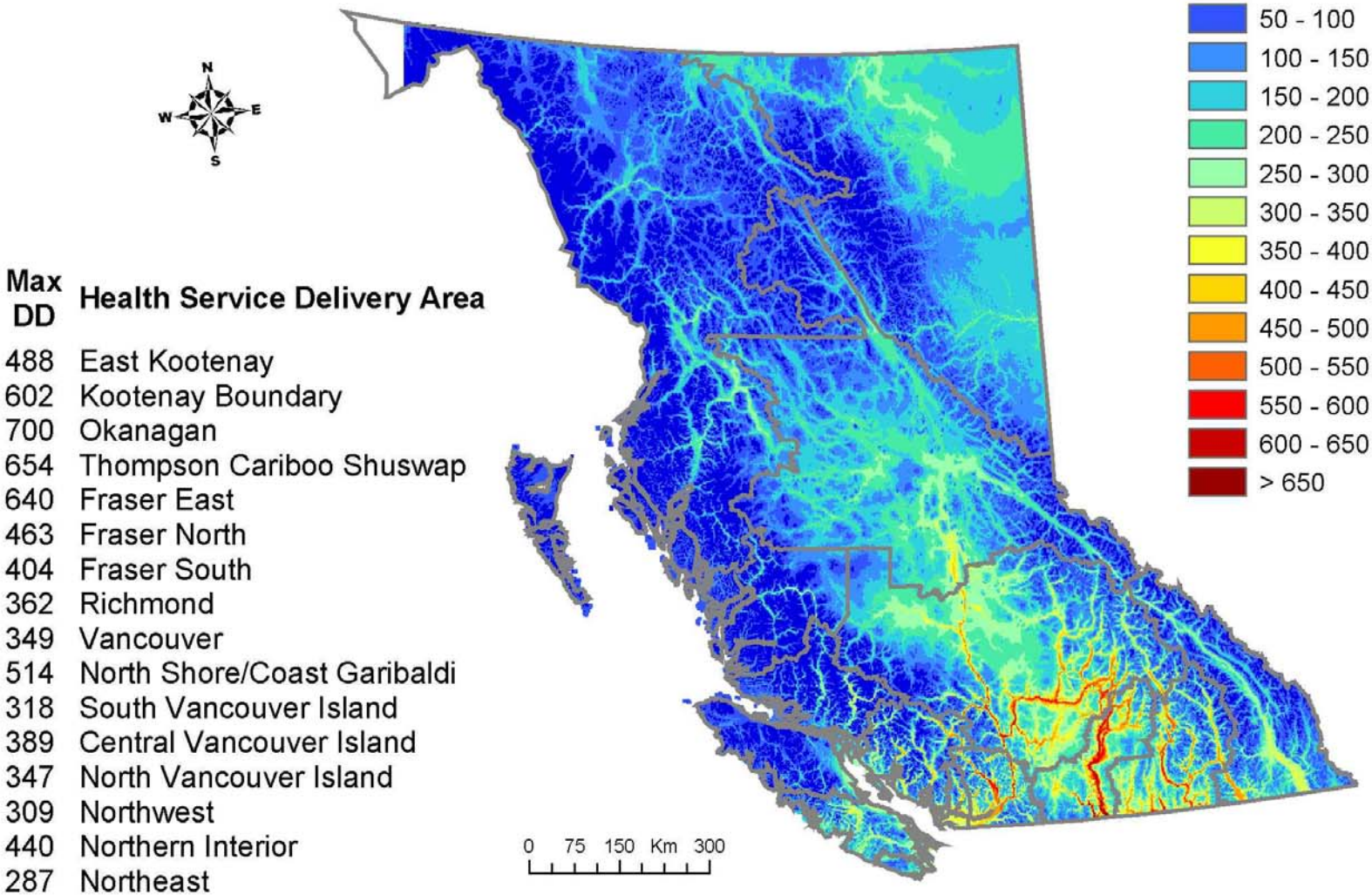
4. Environment Canada. "Canadian Climate Normals or Averages 1971-2000" and "Canadian Climate Data Online". Webpage accessed 21 January 2005. http://www.climate.weatheroffice.ec.gc.ca/climate_normals/index_e.html http://www.climate.weatheroffice.ec.gc.ca/climateData/canada_e.html

August 31, 2005 Accumulated Degree Days over 16°C



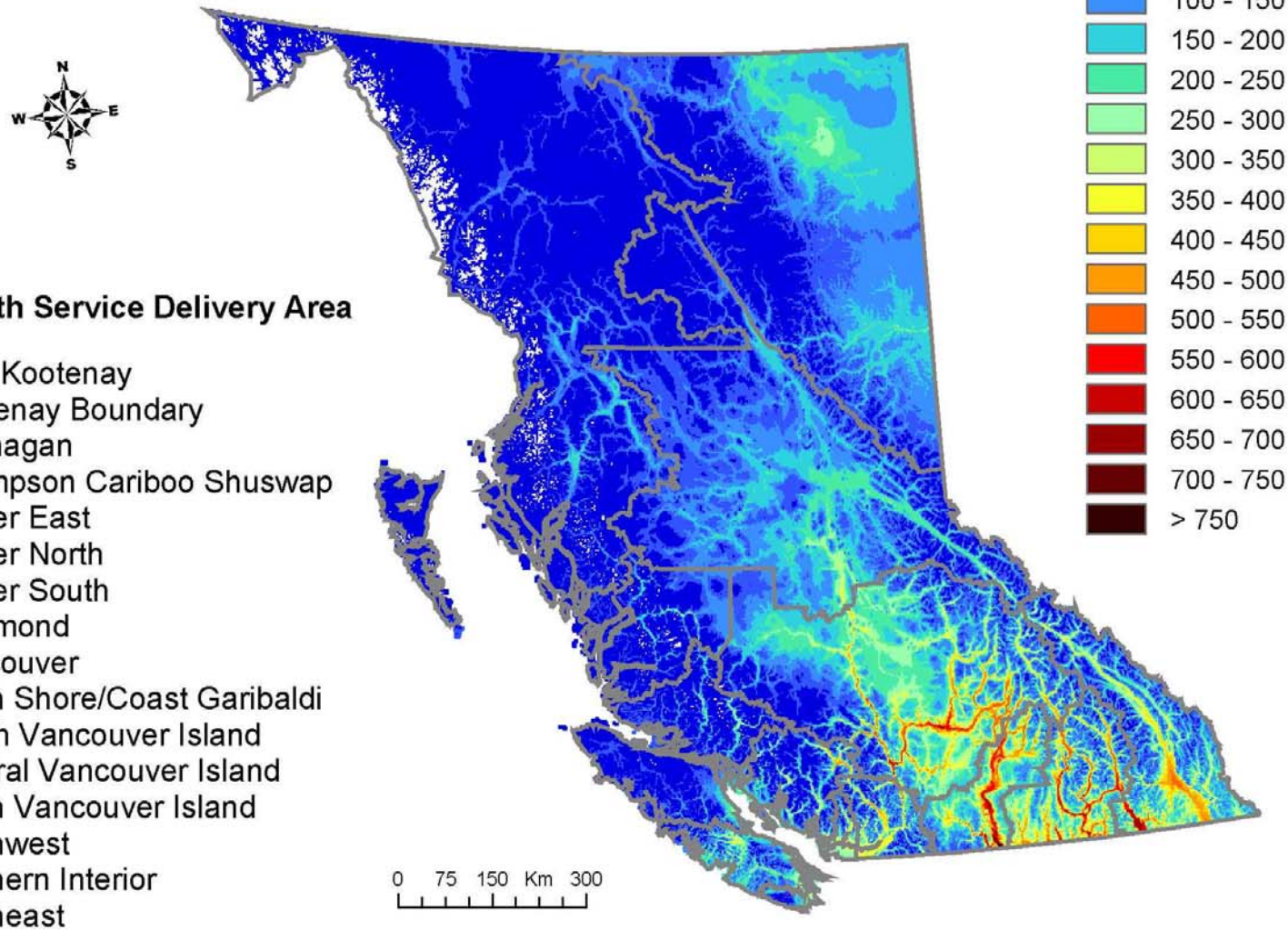
Max DD	Health Service Delivery Area
492	East Kootenay
517	Kootenay Boundary
701	Okanagan
648	Thompson Cariboo Shuswap
497	Fraser East
378	Fraser North
368	Fraser South
287	Richmond
278	Vancouver
465	North Shore/Coast Garibaldi
239	South Vancouver Island
409	Central Vancouver Island
312	North Vancouver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

August 31, 2004 Accumulated Degree Days over 16°C



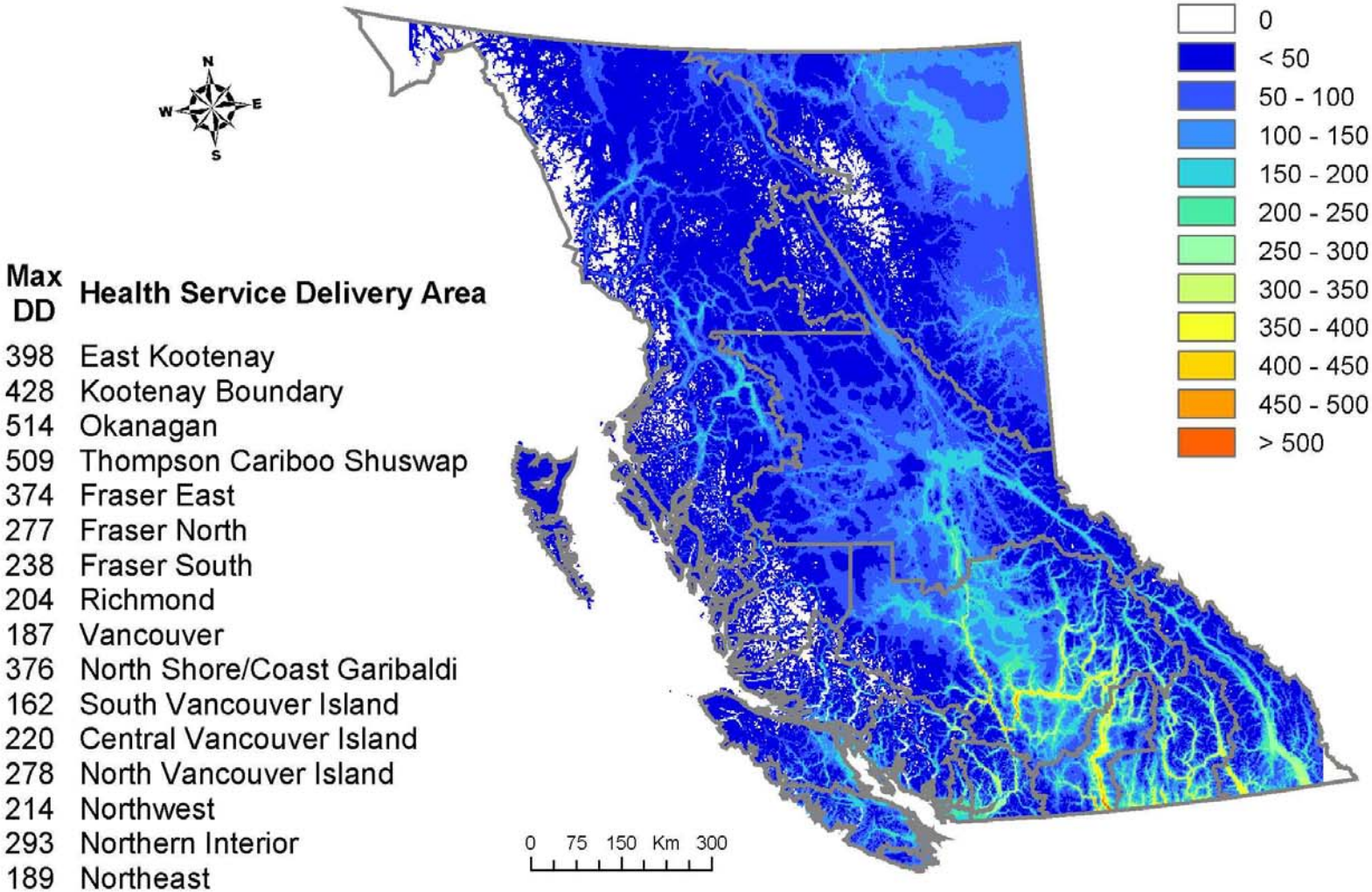
Max DD	Health Service Delivery Area
488	East Kootenay
602	Kootenay Boundary
700	Okanagan
654	Thompson Cariboo Shuswap
640	Fraser East
463	Fraser North
404	Fraser South
362	Richmond
349	Vancouver
514	North Shore/Coast Garibaldi
318	South Vancouver Island
389	Central Vancouver Island
347	North Vancouver 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 6

WEST NILE VIRUS DATABASE

WEEK CODES - 2005

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

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

Weeks run Sunday to Saturday

APPENDIX 7

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