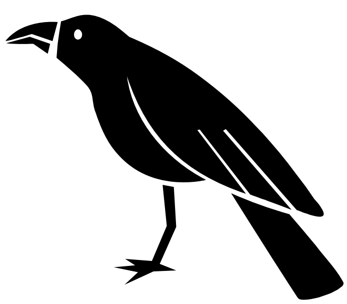
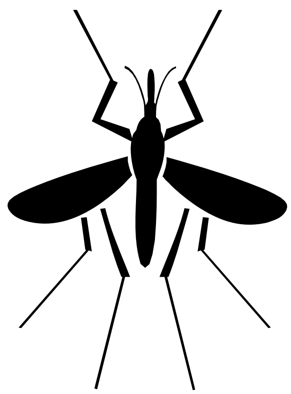
West Nile Virus Activity in British Columbia: 2008 Surveillance Program Results





www.bccdc.org/westnile

Executive Summary

Despite advancing westward across the US and Canada since its introduction to North America's east coast in 1999, West Nile Virus (WNV) has thus far not been detected in British Columbia (BC) in six years of intensive surveillance. In 2008, endemic WNV activity was noted in central and western Canada including Ontario, Manitoba and Saskatchewan (excluding travel-related cases in Alberta and BC), and in states bordering BC (Montana, Idaho and Washington) (Figure 1). There were very few positive indicators in Canada, including human cases and relatively few in the United States (US) (Table 1). Washington, however, saw their busiest season yet, with 57 positive mosquito pools, 22 birds, 40 horses and 2 humans.

Table 1: Human WNV Infections in North America, 2003-2008

	2003	2004	2005	2006	2007	2008
Canada	1388	20	239	127	2353	36
United States	9862	2344	2949	4052	3404	1301

Sources: Public Health Agency of Canada and US CDC as of Dec 9, 2008

The later arrival of vector populations in BC, the relative size of these populations, microclimate differences and biologic diversity/land use patterns may be limiting factors for the establishment of efficient viral transmission in the province. These issues, and other comparisons between BC and jurisdictions where the virus is present are being evaluated. This report, however, summarizes surveillance findings from human, avian and mosquito populations in 2008. Recommendations for substantial changes in surveillance activities were considered at a meeting with health authority (HA) partners in November and will be shared at the annual WNV planning meeting in the spring.

One travel-related (Saskatchewan) infection was diagnosed in a BC resident in August 2008.

Annual corvid collections (corvid bird family includes crows, ravens, magpies and jays) have steadily decreased over the last six years, signaling a waning public interest and/or local public health emphasis on this surveillance activity. Collections were sparse in areas bordering US states with WNV activity, except in the Fraser Valley. The number of dead birds reported online (458) was more than twice the number sent in for testing (205 province-wide). Receipt of corvid specimens from the field took up to 54 days with a median of 5 days for all the HAs combined. This means some people were keeping the specimens in freezers for a length of time before having them sent in.

Overall the numbers of mosquitoes trapped are down from last year, but taking into account that the surveillance season has been starting later, and that fewer trap sites were monitored in 2008, the numbers are not significantly reduced.

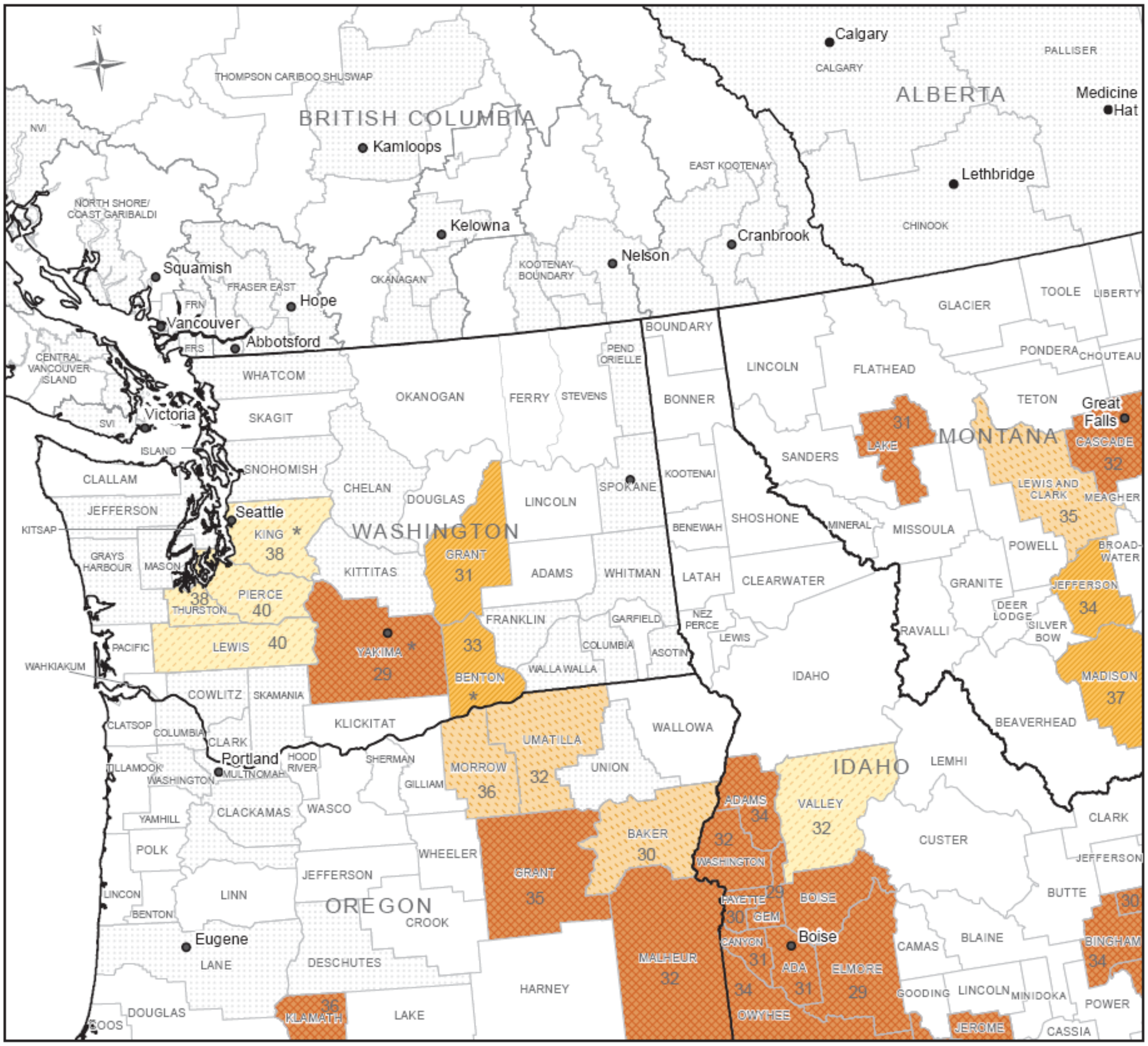
BCCDC did not make any press releases this year, but did field a few media calls for interviews. The communications fan-out remains the same, but the contacts have been updated (Appendix 2).

Work has proceeded on GIS-based reporting and monitoring, and a new raster-based map for determining and expressing risk with significant resolution has been developed. It will need validation using data from other jurisdictions.

Answers are still lacking to the question "Why has BC not seen any locally transmitted WNV activity to date?" Research into that question has been initiated by a PhD student working with the WNV team.

The value of surveillance has been affirmed by the four geographic HAs that had attendees at a planning meeting held in November. The plan for the future is to continue targeted surveillance for WNV as well as to expand and customize the scope of surveillance to include pathogens of interest at the local level, including indicators and pathogens which may see their range increased due to climate change.

Figure 1: West Nile Virus Activity in the Pacific Northwest, 2008



November 13, 2008

0 50 100 150 200 KM

0 30 60 90 120 Miles

Data Sources:
British Columbia Centre for Disease Control: www.bccdc.org/westnilevirus
Alberta: http://www.health.alberta.ca/public/west-nile-virus.html
Washington: http://www.doh.wa.gov/ehp/ts/Zoo/WNV/WNV.html
Oregon: http://www.oregon.gov/DHS/ph/acd/diseases/wnile/survey.shtml
Idaho: http://www.healthandwelfare.idaho.gov/site/4278/default.aspx
Montana: http://www.dphhs.mt.gov/PHSD/epidemiology/commun-disease-epi-index.shtml
USGS: http://diseasemaps.usgs.gov/wnv_us_human.html

- No data
- No positive submissions
- WNv positive corvid
- WNv positive mosquito
- WNv positive equine
- WNv positive human

Week of first positive is listed within each positive region if available.

*Two King county human cases:
1 travelled to Yakima, and Oregon,
1 travelled to Yakima and Benton

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Summary of Surveillance Activities

Surveillance Planning Sessions

On February 15, 2008, a surveillance planning session was held with WNV coordinators and medical health officers (MHOs) at the BC Centre for Disease Control (BCCDC). The health authorities (HAs) presented their proposals for mosquito and corvid surveillance for the 2008 season at that time. On April 30, BCCDC hosted their annual Provincial WNV Meeting, which includes coordinators, MHOs, and other stakeholders. The HAs presented their surveillance proposals to the wider audience at this meeting.

Surveillance Activities

Surveillance activities for WNV focused on three target groups – humans, dead corvids and mosquitoes. The objectives for WNV surveillance are two-fold:

1. To monitor WNV activity in various species in BC 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 development sites

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

Information on any probable human cases would be 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 (WN-non-NS) or West Nile Neurological Syndrome (WNNS) according to both self-reported symptoms and 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 at http://www.phac-aspc.gc.ca/wnv-vwn/hmncasedef_e.html.

The human testing algorithm entails screening acute serum samples for Flavivirus EIA - IgM. Convalescent sera would be requested and tested in parallel with the acute sample for both IgM and IgG. Hemagluttinin Inhibition testing was to be performed on positive IgM and/or IgG samples, as required. All possible and probable positive cases would be referred to the National Microbiology Laboratory (Winnipeg) for the confirmatory plaque-reduction neutralization testing (PRNT). Cerebral spinal fluid, plasma and samples from organ transplant donors would be tested by reverse transcriptase-polymerase chain reaction testing (PCR). All submissions of cerebral spinal fluid from patients admitted for encephalitis/meningoencephalitis (regardless of test requested) would also be tested for WNV by PCR.

Corvid (crows, ravens, magpies and jays) surveillance was achieved through two mechanisms. Samples of dead corvids from Interior Health Authority (IHA), Fraser Health Authority (FHA), Vancouver Coastal Health (VCH) and Vancouver Island Health Authority (VIHA) were submitted each week for WNV testing. HAs 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, BC Ministry of Agriculture and Lands (MAL) in Abbotsford, using a commercially available dipstick test (VEC test) for initial screening. In addition to birds tested, an on-line form was available at the BCCDC website (http://westnile.bccdc.org/) for the public to report sightings of dead corvids. With few exceptions, dead corvids sighted by the public and reported through the online form were different from those picked up for testing. The locations of birds tested and reported online were used to create corvid density maps for regions of the province with sufficient data (see Figure 19). These can be used as baseline values against which to assess corvid mortality, a potential indicator that virus has been introduced into an area.

Mosquito surveillance focused on WNV testing, identification and distribution of adult mosquitoes. Based on several years of baseline data, the start of mosquito surveillance activities was delayed until June 1st from 2006 forward (was previously May 1st). Also, NHA chose not to participate in mosquito sampling, while IHA, VCH and VIHA reduced their trap site locations. FHA retained all their existing trap sites. Some traps were operated in more than one location on two different days of the week. Traps were run overnight and the catches sent in coolers to BCCDC for identification and WNV testing. The BCCDC laboratory separated mosquito submissions into sex and taxonomic groupings: 1) *Aedes,* 2) *Anopheles,* 3) *Coquillettidia,* 4) *Culiseta* and 5) *Culex*. Mosquitoes were sorted on a chill table (to prevent denaturation of any viral RNA) and identified to genus or, in the case of *Culex*, to species. If a trap failed to capture any mosquitoes, the information (i.e. trap malfunctioned, no mosquitoes trapped or trap was not run) was faxed to the lab and recorded. Beginning in 2006, only female *Culex* mosquitoes were tested for the virus in groups of up to 50 mosquitoes per pool, by PCR. The remaining mosquitoes were identified but not tested. When traps contained more than 500 mosquitoes, the entire sample was sorted to selectively pick out all the female *Culex* mosquitoes for PCR testing. Five hundred mosquitoes from large volume traps were initially identified and reported; the remainder was saved for identification at the end of the season. A fraction of the remainder (½, ¼, ⅛, etc.) was identified and the total number for each genus in the trap extrapolated.

Ongoing, prospective, cumulative temperature degree-day maps were used 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 and the speed of virus replication.

Mosquito, bird, geographic and temperature data were integrated using an interactive online mapping tool (https://maps.bccdc.org/). This was developed to assist users with geo-spatial risk assessment to help target appropriate mosquito control activities. Larval data, collected by independent mosquito control contractors is included in this mapping tool for use by health authorities when making mosquito control decisions. Unlike adult surveillance data, larval data is not available for viewing by the public.

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

Surveillance Results

Results at a Glance

Table 2: Summary of BC Surveillance Statistics, 2008

	Human[1]	Corvids Submitted[1]	Corvids Sighted[1]	Mosquito Pools[2]
# Tested	530	205	458	1873
# Positive	1 (*1)	0		0

1. Surveillance started on June 1st.
2. A pool may contain up to 50 mosquitoes that are tested at one time.

* The number of cases in brackets denotes the number of cases considered to be travel-related. For example, 6 (*2) would indicate a total of 6 probable cases, 2 of which are travel-related.

Surveillance of WNV in Humans

Epidemiology of Travel-Related Infections

One travel-related infection was diagnosed in a BC resident in 2008 (Table 2). The case was classified as WN-non-NS, who had traveled to Saskatchewan in early August.

While Canadian case definitions were broadened after the 2003 surveillance season, the US case definition of West Nile Fever (i.e. WN-non-NS in Canada) continues to require fever, thus potentially under-reporting this presentation.

Interpreting Laboratory Results on Human Cases

The testing for WNV is complex, involving multiple types of tests. A case definition is assigned to cases based on a combination of clinical symptoms and laboratory results. A table has been developed by BCCDC laboratories to assist in interpretation of human laboratory results (Appendix 1). In 2008, avidity testing was performed in-house. The interpretation of this new test in combination with serology and PCR results was added to the table in 2008.

Protecting the Blood Supply from WNV – Testing at CBS

CBS performs year-round WNV nucleic acid testing on every donation. Although routine screening is performed in mini-pools (MP) of six specimens, more sensitive, single unit (SU) testing is selectively done for blood donations collected from regions of higher WNV risk (Busch et al. 2005). CBS uses two criteria for implementing SU testing: either a positive donor test result or an incidence of public health-reported symptomatic WNV in a health region over a two week period exceeding either 1:1000 in rural areas or 1:2500 in urban settings. SU testing is then implemented for a minimum one week period for all donor clinics in proximity to an affected region; WNV testing reverts to routine MP screening if neither criterion is met over the ensuing one week period.

Blood Donor WNV Screening in British Columbia

There was no positive WNV screening test result from any blood donation in British Columbia in 2008.

Blood Donor WNV Screening and Transfusion-Transmitted WNV Surveillance across Canada

Nationally, CBS detected WNV in only one blood donation from the Brandon, Manitoba area, during August 2008. Héma-Québec also detected one WNV viremic blood donor near Montreal. In total, 38 cases of clinical and asymptomatic human WNV cases were reported to the Public Health Agency of Canada (PHAC 2008). As in the previous 5 years, no case of suspected transfusion-transmitted WNV was reported in Canada during 2008.

Integrated WNV Surveillance in British Columbia

In BC, CBS, BCCDC and BC Ministry of Health Services (MHS) continued their close co-operation in WNV planning, preparation and surveillance. A comprehensive WNV Action Plan is updated each year; the 2008 edition is available at www.pbco.ca.

From June 1 to Sep 30 2008, BCCDC provided daily reports to CBS, BC and Yukon Centre on WNV test requests received by BCCDC. This enabled rapid identification of donors who may have recently donated potentially WNV infectious blood, so that a product recall could be carried out as quickly as possible and, to defer donors for a 56 day period to prevent affected donors from donating while potentially infectious. A total of 720 reports were received by CBS, of which 23 (3.2%) were donors. None of these donors had donated within the previous 56 days so no product recall was required. In addition, for public health human WNV surveillance purposes, CBS, BC and Yukon Centre provided BCCDC with aggregate, regional blood donor WNV testing updates for BC collections throughout the WNV season. This reporting provides the most geographically comprehensive and timely, ongoing human WNV surveillance data available to public health.

Anonymized Data Linkage Project (ADL)

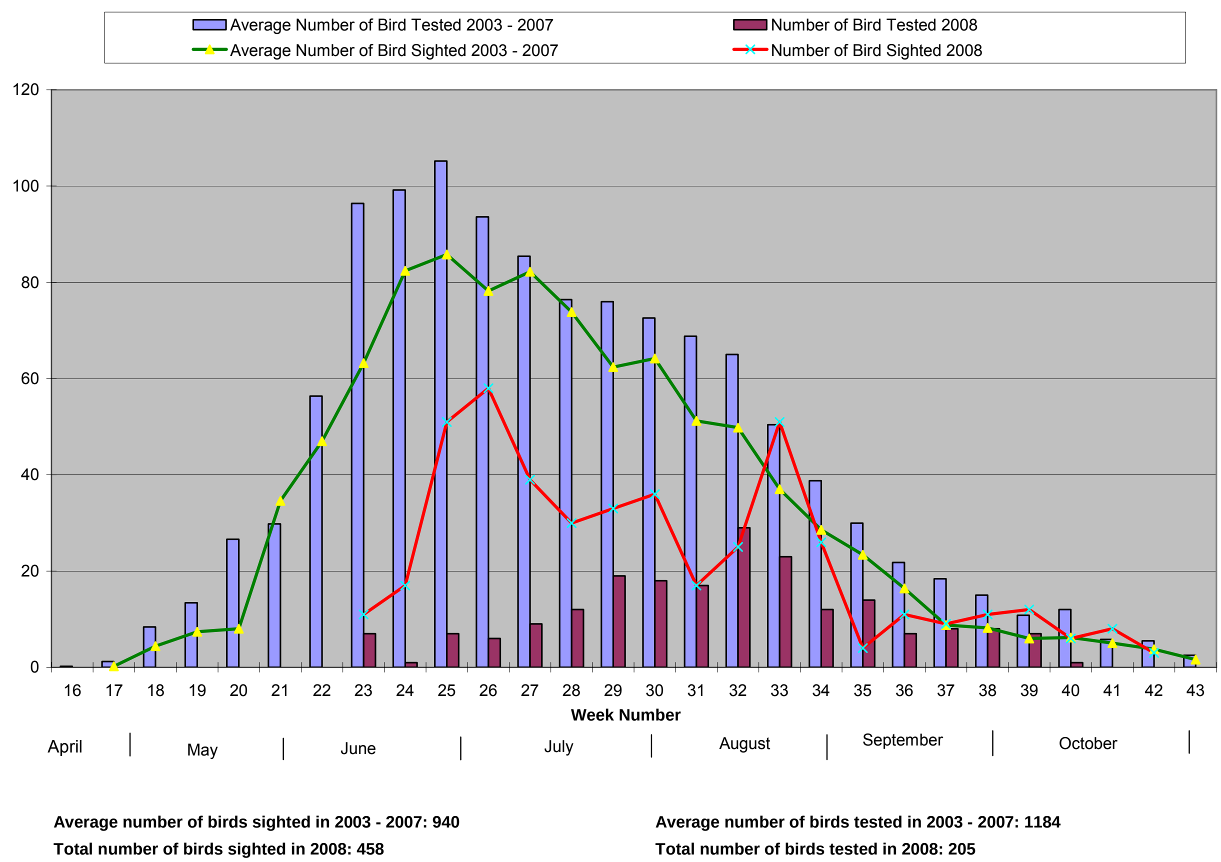
An aim of this project, using WNV as a sentinel blood-borne pathogen, is to demonstrate that timely, accurate, secure data linkage can be performed between the BCCDC laboratory and CBS donor databases to identify potential hazards to blood safety while simultaneously protecting patient confidentiality. This year, further "tuning" of the ADL matching algorithm was carried out to optimize its sensitivity and specificity, by concurrently matching persons undergoing WNV testing at BCCDC against the national CBS donor database. There was a total of 31 donor matches (including several duplicates), from which 23 unique donors were identified. The ADL successfully matched 30, with only one missed match due to a misspelled first name. The plan for 2009 is to roll out and operate ADL as designed, with BCCDC transmitting daily encrypted, anonymized WNV test requests to CBS for matching against the national donor database.

Surveillance of WNV in Corvids

Distribution of Corvid Deaths

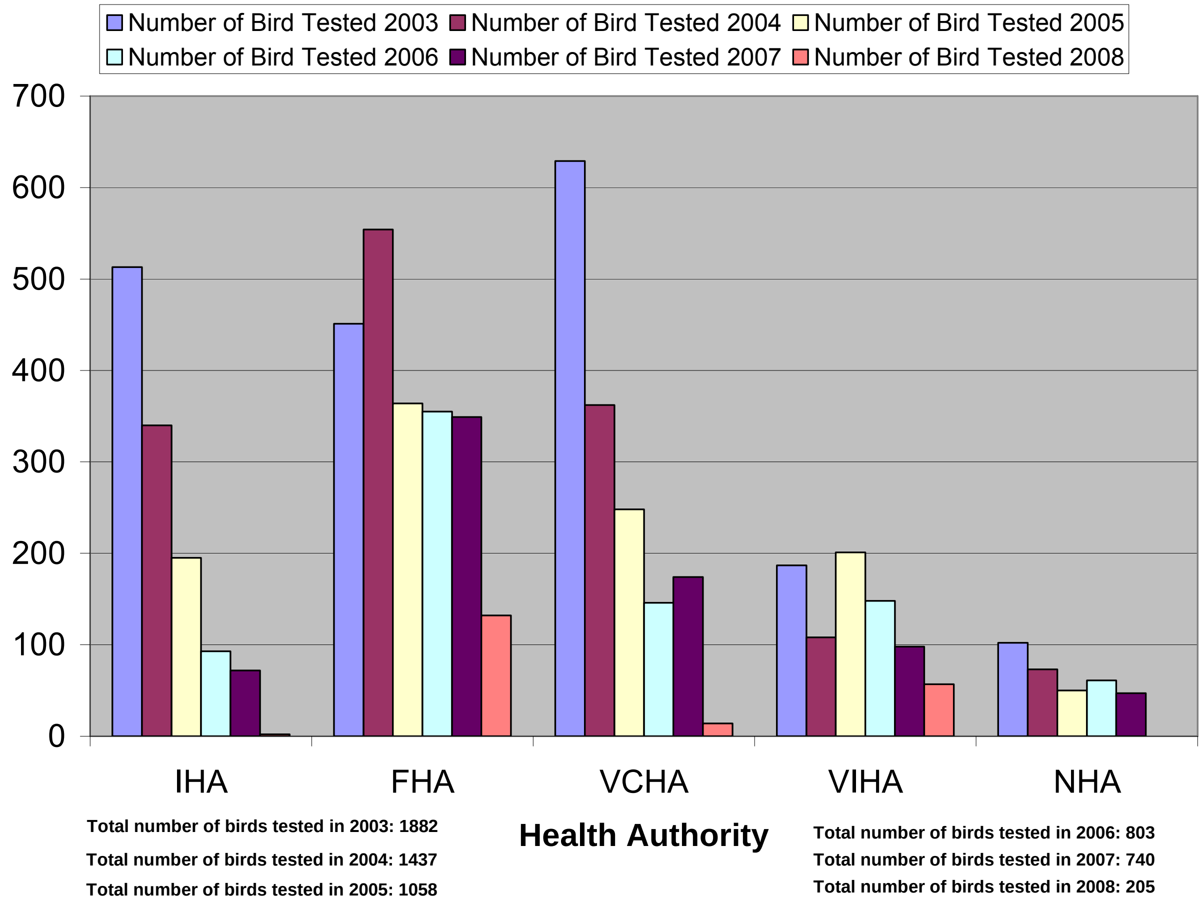
Overall, 205 corvids were collected and tested from June 1 to October 4, 2008 (Figure 2). Annual corvid collections have steadily decreased over the last four years. This is due, in large part, to waning public interest in the program as WNV fails to emerge in BC, as some regional programs depend on public reporting. Decreases are also partly the result of changes in the start of seasonal surveillance from May 1st to June 1st which started in 2006.

Figure 2: Comparison of Birds Sighted and Tested, 2003-2008



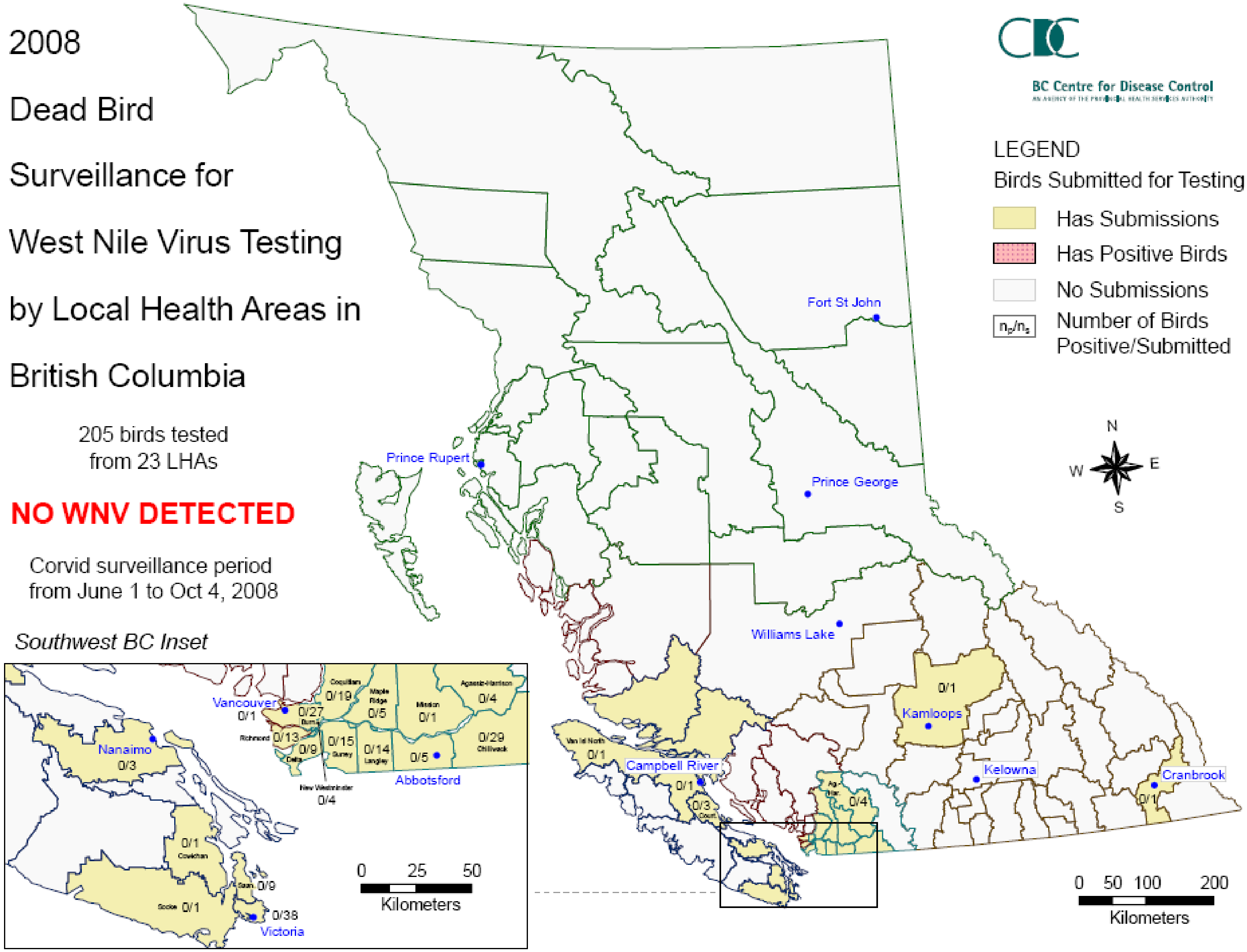
The decline in the number corvids tested from year to year is most notable in IHA. At the same time, this region has been identified as the highest risk region of the province. This year, NHA opted out of corvid testing, as did most portions of VCH, except for Richmond (Figure 3). FHA has been relatively consistent in corvid testing over time, with a significant drop in 2008. A decrease comparable to IHA occurred in VCH (Figure 3).

Figure 3: Comparison of Birds Tested by HA, 2003 - 2008



Spatial representation of dead corvid submissions was patchy in 2008 (Figure 4). The most notable gap occurred in Southern local health areas (LHAs) along the US border. Given that WNV activity is typically detected in neighboring states – northwestern Montana, Idaho and this year, significantly in Washington, there is a concern that we adequately monitor border areas. It is recognized that these areas have low human and corvid densities, therefore other surveillance measures, such as targeted mosquito sampling may be equally effective.

Figure 4: Geographic Distribution of Corvid Test Results, 2008



Appropriateness of Specimens Submitted

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 cannot be swabbed), among others. High levels of suitability have been achieved in all years of the program and continued in 2008.

Table 2: Appropriateness of Bird Specimens Submitted for Testing by Health Service Delivery Area (HSDA), 2003 - 2008

HSDA	2003	2004	2005	2006	2007	2008	Ratio Difference				
							2003 - 2004	2004 - 2005	2005 - 2006	2006 - 2007	2007 - 2008
Overall %	98.5	97.8	94.8	96.2	98.4	100.0	-0.8	-3.0	1.4	2.2	1.6

Lag Times for Corvid Submission and Testing

The timeliness of corvid submissions has been steady over the last 4 years (Table 3), taking an average of 4 days from the date a dead bird is found to receipt at the laboratory. In half of all corvid samples, results were reported by the Animal Health Centre (AHC) the same day as samples were received.

Table 3: Lag Times for Submission of Corvid Specimens, 2003-2008

HSDA	Median Transit Lag Time (days)						Max Transit Lag (days)					
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
EK	14	6	7	9	4	2	73	31	44	48	0	2
KB	6	7	5	6	4	NA	35	42	14	35	7	NA
OK	7	4	5	3	4	NA	38	29	28	12	7	NA
TCS	7	6	6	3	6	38	61	26	39	84	11	38
FRE	5	3	2	3	3	3	27	13	12	8	11	18
FRN	7	6	4	3	4	4	72	19	32	33	22	26
FRS	7	6	3	5	3	5	93	18	10	9	7	13
RICH	7	4	6	7	6	6	18	27	10	17	4	22
VAN	6	4	5	7	5	10	29	16	14	23	25	10
NSCG	5	5	4	7	9	NA	32	58	46	17	8	NA
SVI	4	6	3	4	6	12	18	34	32	18	7	54
CVI	5	3	4	6	17	6	39	31	14	12	2	33
NVI	7	6	5	7	13	9	22	17	12	29	5	19
NW	2	3	3	2	2	NA	10	10	7	13	0	NA
NI	4	4	2	5	3	NA	30	13	33	20	0	NA
NE	2	3	6	5	7	NA	6	19	29	50	0	NA
BC	**6**	**5**	**4**	**4**	**4**	**5**	**93**	**58**	**46**	**84**	**25**	**54**

Note: - NA means no birds submitted this year.
- Transit Lag represents # of days between when a bird is found and received by AHC; including frozen storage before shipping.
- BC: 1st six numbers are column medians; 2nd six are column maximums.

Surveillance of WNV in Mosquitoes

Many regions use the collection of mosquitoes and testing for infection as the cornerstone of their WNV program and as part of arbovirus surveillance. Random sampling in potentially active areas may give an early warning of the arrival of the virus before other animals become sick, but sampling in known endemically infected areas can offer vector population estimates and some insight into risk for the upcoming season. In addition to information about the spread of the virus, an active mosquito surveillance program can identify which species are present, which can lead to intuitive assessment about the type of habitat producing that species.

In BC, there was a total of 1,471 submissions from miniature CO_2-baited (from dry ice), CDC mosquito light traps in 2008, resulting in 1,873 pools tested. A total of 202,460 mosquitoes was identified from these trap collections. We saw high numbers of nuisance species of *Aedes* along the Fraser and Columbia Rivers and a provincial average of 21.6 *Culex* per trap night (all *Culex*. species, including males). This was slightly higher than last year's average *Culex* count. The increase of 3.6 mosquitoes per trap night over last year was likely due to the focused surveillance in the urbanized Fraser Valley, Lower Mainland where *Culex pipiens* exploit the many storm water catch basins. Also, the IHA did surveillance from July to September, when *Culex pipiens* are at their highest levels. Trapping only during the period of greatest numbers and in the most strategic locations resulted in the average number of *Culex* per trap to increase.

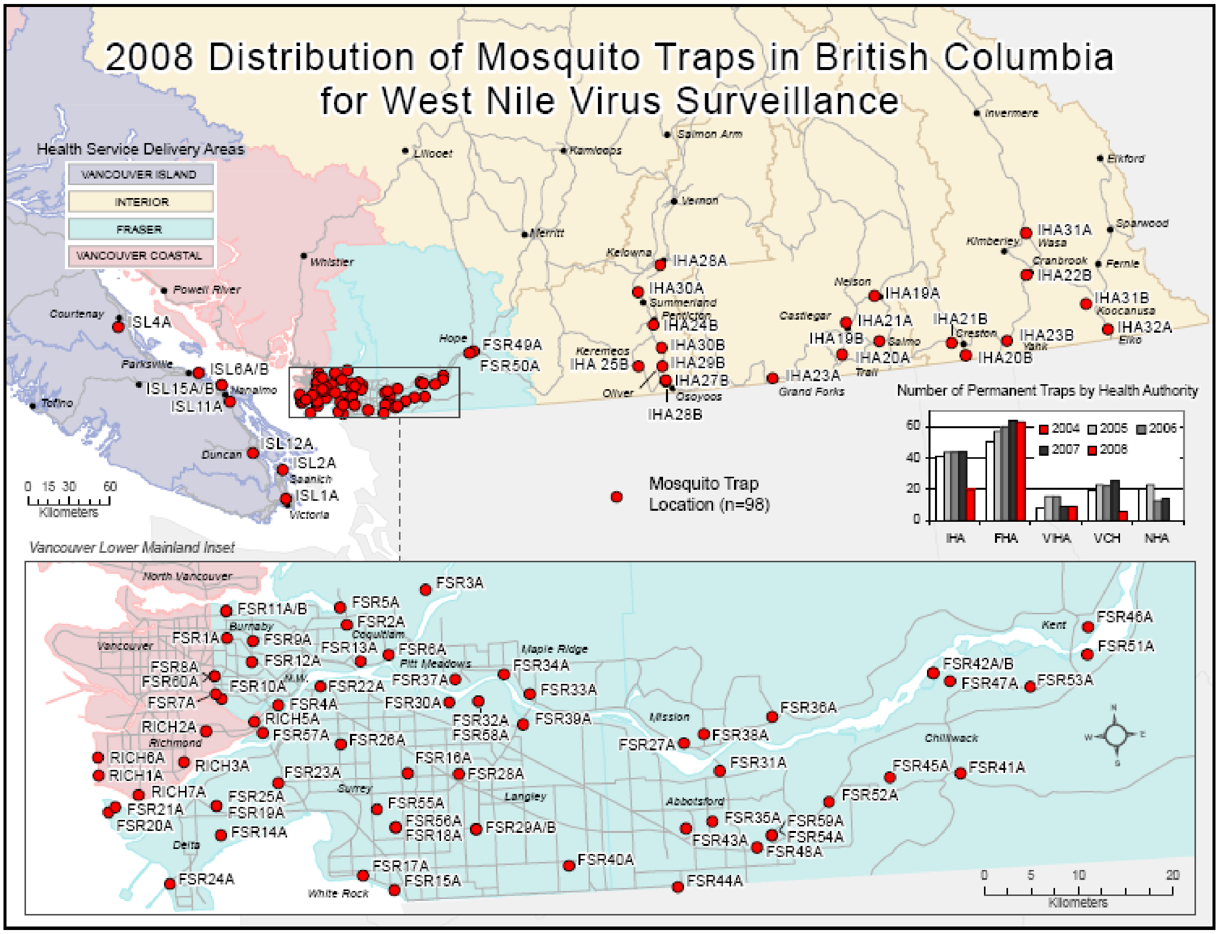
Trap Coverage

The placement of traps is used across North America for the surveillance of arbovirus, yet there is no standardized methodology to determine number and placement of traps. This dilemma probably stems from the fact there are many different vector species and each will behave in a different manner according to available habitat. The two primary vector species that drive WNV activity in Canada are *Culex pipiens* and *Culex tarsalis*, and trap selection is based primarily on the known geographic distribution of these vectors.

Even though WNV has not been found naturally in BC, we have done due diligence by completing a province-wide survey of mosquitoes, as well as carrying out extensive testing of many different mosquito species for the virus over several years (from 2006 on we have tested only female *Culex* species). Mosquito trapping has been suspended in some regions, based on the data obtained, and those HAs will wait for the virus to appear before beginning active surveillance of mosquitoes. The purpose of this report is to review the mosquito surveillance in 2008 and contrast that to previous years.

Figure 5 depicts the locations of adult mosquito traps in 2008. Since adult mosquito surveillance began in 2003, the geographic coverage of traps has increased and the strategic placement of traps in mosquito rich environments has improved, reducing the

Figure 5: Geographic Distribution of Mosquito Traps in BC, 2008



number of low yield traps and providing better capture of high risk species like *Culex pipiens* (Table 5). A more focused surveillance effort was undertaken this year, and sampling was reduced to the southern border of the province. As a result, the number of submissions was the lowest since trapping began in 2003. Regardless, the total number of mosquitoes was still significantly large for the number of trapping submissions if compared to 2004 or 2005.

Table 5: Changes in Mosquito Trap Coverage, 2003-2008

Parameter	2003	2004	2005	2006	2007	2008
# Permanent locations	59	145	189	148	155	98
# Mosquitoes	6,840	52,657	198,228	394,047	242,215	202,460
# Pools tested	296	2980	6631	2329*	2568*	1873*
Submissions	818	2262	2778	1861	2184	1471
Ave # *Cx. tarsalis*^	0.3	0.8	1.9	4.8	3.49	1.39
Ave # *Cx. pipiens*^	1.5	4.6	5.1	8.6	14.32	10.5

* Only *Culex* species tested for WNV.
^ Including male and female mosquitoes during the season. It is calculated by:
Total number of *Culex* ÷ Total number of trap submissions = # per trap-night.

Geographic Distribution of Species

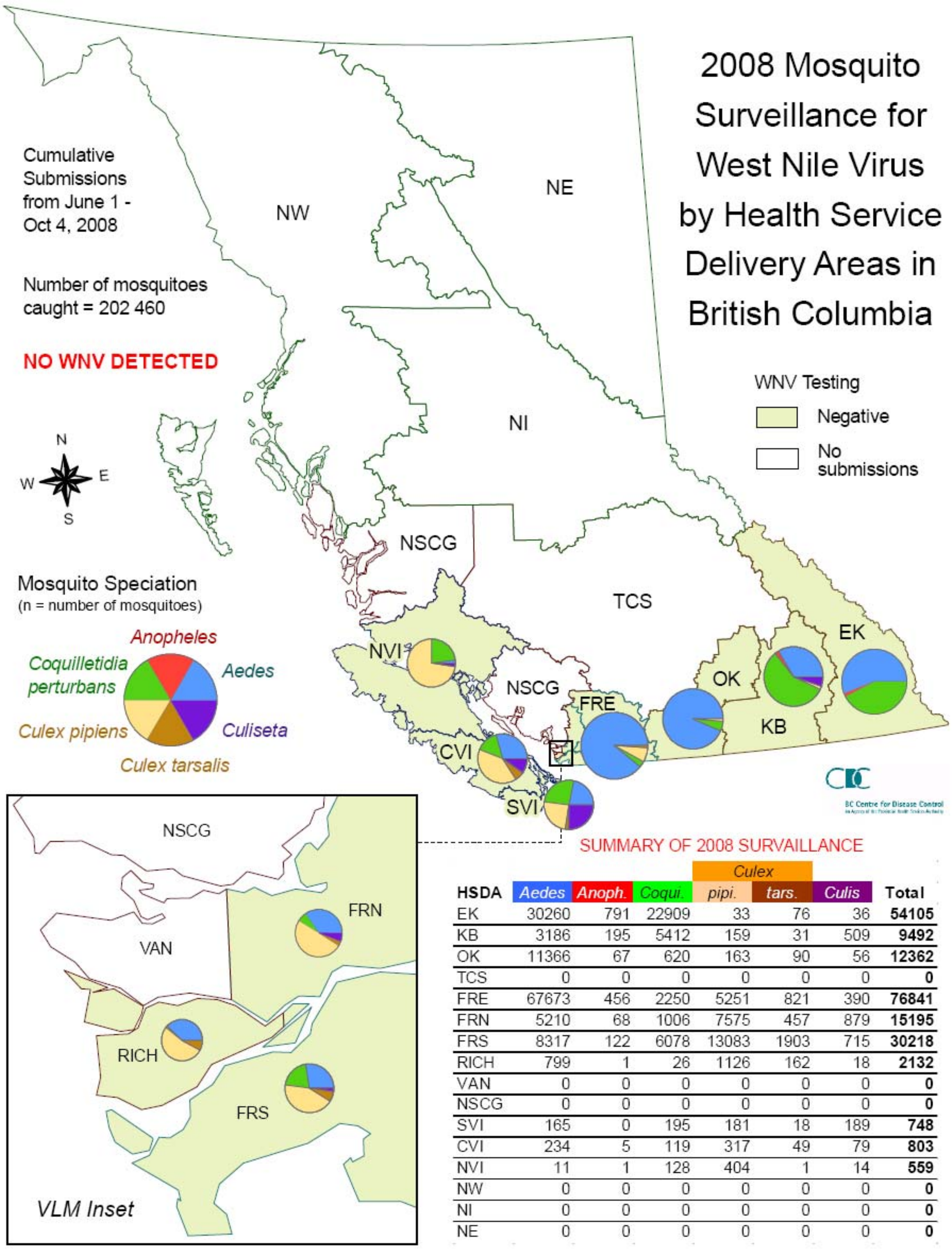
Mosquitoes have been collected from across the southern half of the province since the beginning of surveillance in 2003. The most competent vectors of WNV are only occasionally found in NHA and this has guided the surveillance to focus on the southern reaches of the province. The most northerly WNV report in Canada is from Meadow Lake, Saskatchewan (approximately N 54° 07' 59.62").

Figure 6 illustrates the distribution of 202,460 mosquitoes collected in 2008. As previously noted the focus was along the southern border of the province, the most northerly traps were near Mission Creek near Kelowna (49° 50') in the OK, and at Wasa Lake (49° 46') in the East Kootenays. In the Lower Mainland, a trap in Hope (49° 22') was the furthest north for FHA, and the trap near Cumberland, in VIHA, was the 4th most northerly trap (49° 37'). This restricted distribution of traps precludes any speculation about the distribution of mosquito species on a provincial scale as discussed in previous years.

The Effect of Rainfall and Snowpack on Mosquito Abundance

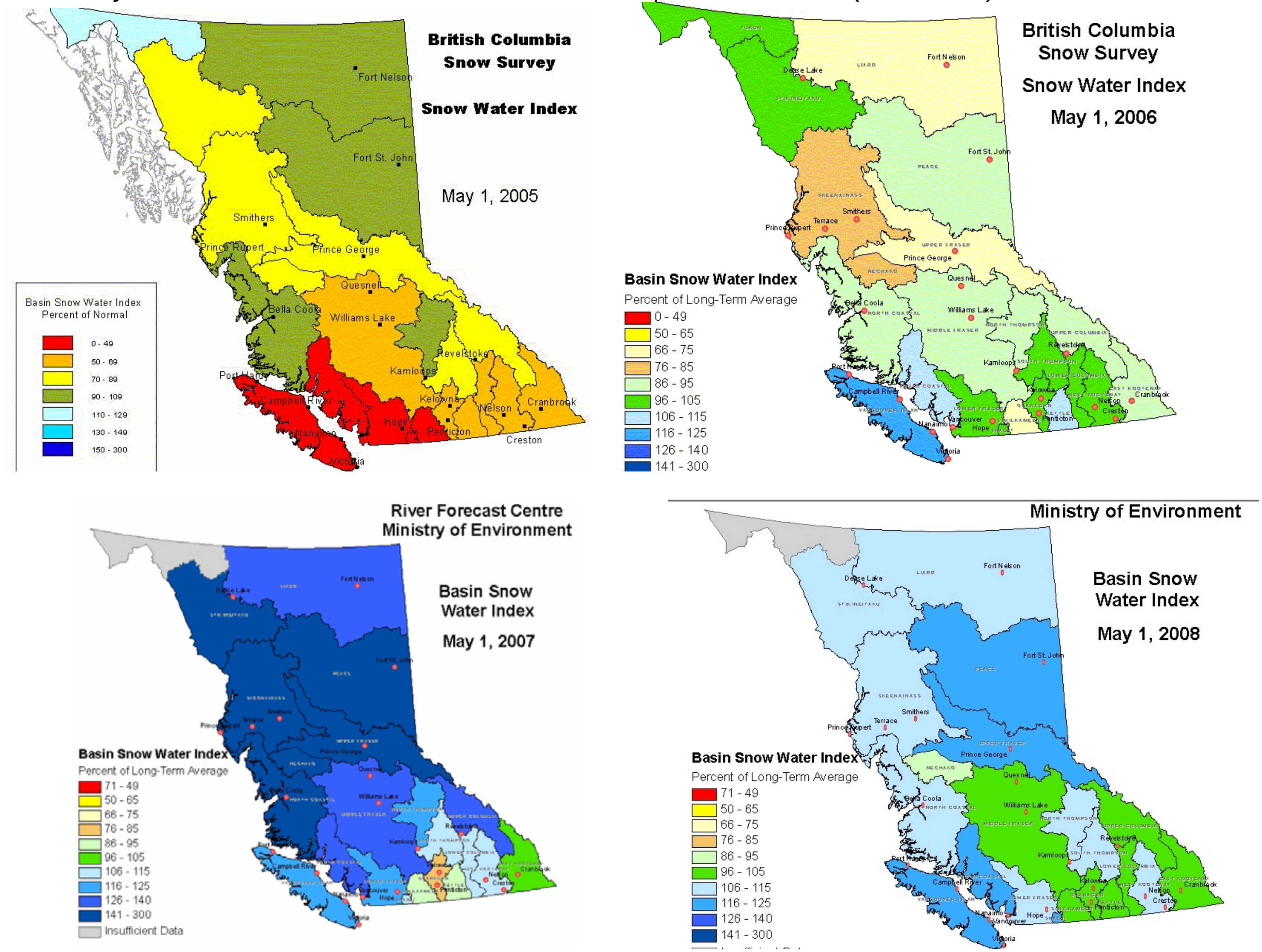
Environmental factors can be used to predict mosquito populations, and therefore can be used to predict the potential for arbovirus diseases. In BC, snow accumulation and melting of the snowpack affects the hydrology along the mountainous corridors as spring unfolds. Reisen et al (2008) recently proposed a model for conditions in California that are similar in some respect to BC. By the beginning of May, the subsequent melt of accumulated snow is a clue to the potential standing water for early mosquito development. In Figure 7, the accumulated precipitation is illustrated (unfortunately the colour scales vary with these 4 maps). Generally speaking, any light green, orange, yellow or red colouration reflects below average moisture content, whereas dark green is average content and blue is above average in Figure 7 (MOE 2008). For the last 2 years moisture accumulation has been above average for May 1 through much of the province. In 2006 the SW coast and south central Interior were the only regions with average and above average moisture. In 2005 most of the province had below average moisture accumulation by May and the total number of mosquitoes was less than that collected for the last 3 years, even though there were more traps and submissions (Table 5). 2003 and 2004 were extremely dry years in BC and the total mosquito counts were quite low.

Figure 6: Geographic Distribution of Mosquito Species in BC, 2008



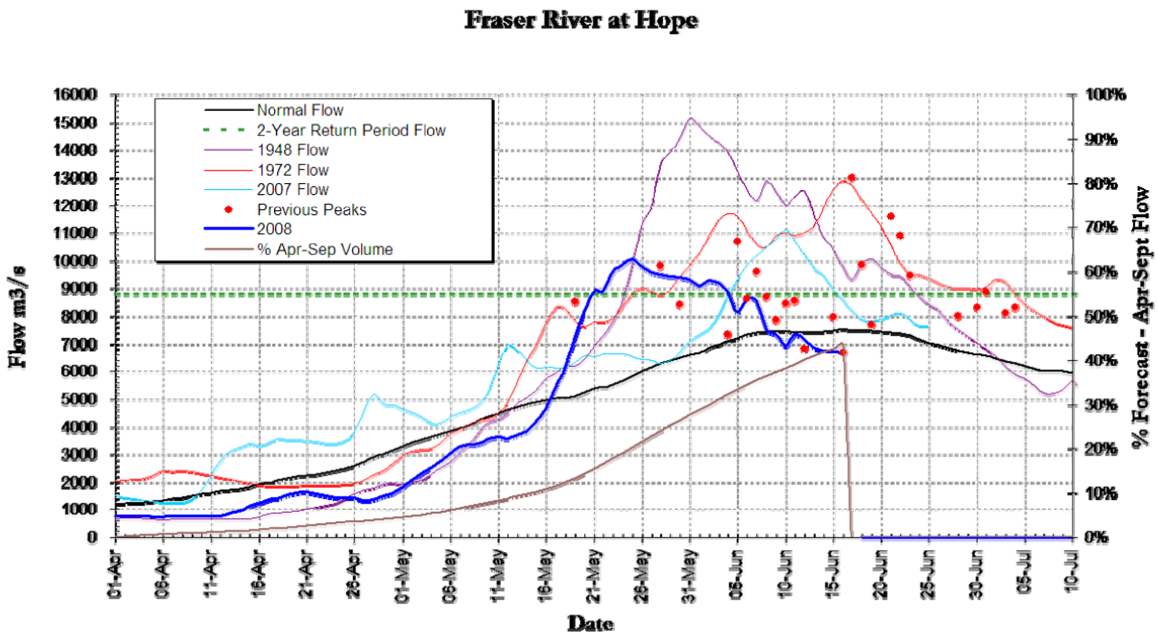
HSDA	Aedes	Anoph.	Coqui.	Culex pipi.	Culex tars.	Culis	Total
EK	30260	791	22909	33	76	36	**54105**
KB	3186	195	5412	159	31	509	**9492**
OK	11366	67	620	163	90	56	**12362**
TCS	0	0	0	0	0	0	**0**
FRE	67673	456	2250	5251	821	390	**76841**
FRN	5210	68	1006	7575	457	879	**15195**
FRS	8317	122	6078	13083	1903	715	**30218**
RICH	799	1	26	1126	162	18	**2132**
VAN	0	0	0	0	0	0	**0**
NSCG	0	0	0	0	0	0	**0**
SVI	165	0	195	181	18	189	**748**
CVI	234	5	119	317	49	79	**803**
NVI	11	1	128	404	1	14	**559**
NW	0	0	0	0	0	0	**0**
NI	0	0	0	0	0	0	**0**
NE	0	0	0	0	0	0	**0**

Figure 7: Ministry of Environment Basin Snow Water Index Maps 2005 to 2008 (MOE 2008)



The Fraser River discharge (Figure 8) remained above normal levels for almost 3 weeks, from mid-May to the first week of June. This was sufficient moisture to saturate soils and create an unusually large amount of habitat for nuisance *Aedes* species in areas bordering the Fraser River. If the late May and early June temperature had remained hot, the potential for flooding would have been quite high this year in the Fraser basin.

Figure 8: Fraser River Water Level as Recorded at Hope



Climate Data – Growing Degree Day Calculations

A base 16°C growing degree day model 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. 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. Compared with the last five summers, cooler temperatures were observed in 2008.

Table 6: Accumulated Growing Degree Days for Select Communities up to August 31st

Community	2008	2007	2006	2005	2004	2003	30YR
Cranbrook	366	442	423	307	360	476	276
Creston	414	607	554	446	517	620	351
Osoyoos	649	687	687	680	809	786	540
Kamloops	580	579	657	575	704	662	475
Abbotsford	280	295	342	340	430	360	222
Vancouver	204	221	239	245	329	275	170
Victoria	189	207	237	239	296	263	153
Prince George	185	189	237	184	264	196	139

Note: Degree day calculations beyond August 31st are not meaningful for WNV risk prediction as newly emerged *Culex* will likely enter diapause (a state where they do not seek a blood meal) by this time, and therefore the effect of temperature on mosquito development and viral replication after this time does not contribute to WNV risk.

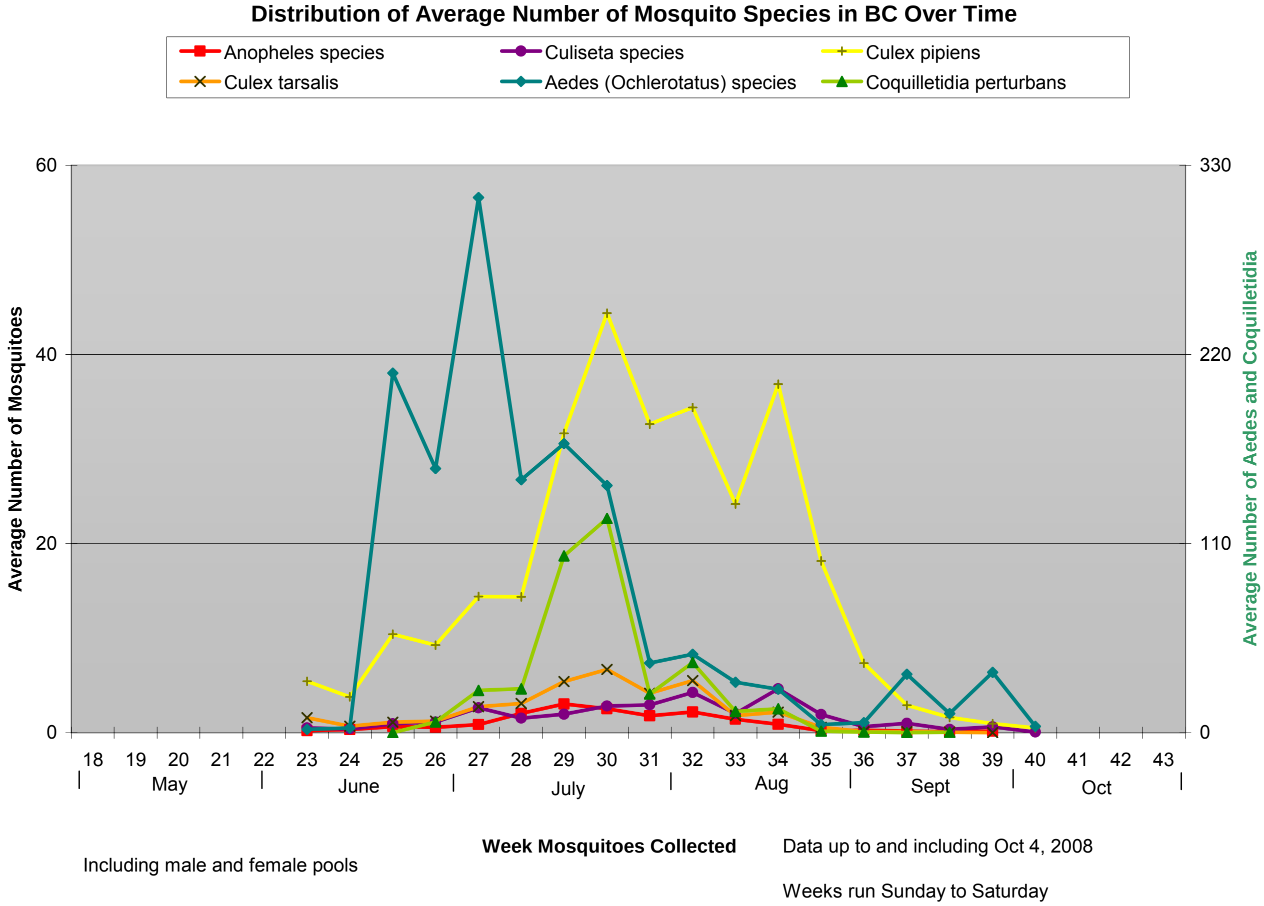
Temporal Distribution of Mosquitoes

Over the last 6 years, trap deployment has varied from the beginning of May to the end of October. This window of surveillance can serve 2 basic functions: to give a record of populations as they progress through the season and to give an advanced estimate of risk of WNV infection based on the number of infected vector specimens during the most active time of the year. Without any knowledge of the virus in BC, surveillance is now focused on the period when vector species are most active.

In 2004 and 2005, traps were deployed in May, but in subsequent years, trapping has started in June. This year IHA focused deployment between July and September, the period when WNV infection is most prevalent in other jurisdictions. Figure 9 illustrates the changes of species groups in BC over the time for all traps. Caution should be used trying to compare 2008 to other years because the sampling is heavily biased by the larger proportion of traps being used in the Lower Mainland, rather than across the entire province (Figure 5).

Aedes was the most common species group collected in 2008 in BC, as has been the case in every year of this program. This year, *Coquillettidia perturbans* was the second most common species collected, as has occurred in each year of surveillance since 2004. *Culex pipiens* exploits the many storm water catch basins, this may be the reason it is the third most common mosquito collected. *Culex tarsalis* was the next most numerous mosquito, followed by *Culiseta* and *Anopheles*, with *Culex territans* being the least common, with only 5 specimens being identified.

Figure 9: Average Number of Mosquitoes Species Trapped per Week, 2008



Most *Aedes* overwinter as eggs and their numbers will depend on moisture accumulation and snowmelt. This year, *Aedes* numbers peaked about 1 month after the Fraser River peaked in the Lower Mainland. Water remained high for 3 weeks, which resulted in many of the low lying ditches along the edge of the river filling from the hydrostatic pressure of the spring freshet. *Coquillettidia perturbans* overwinter as larvae, and the adult population always seems to peak around the second to third week of July in BC. This trend has been repeated ever since surveillance began in 2003. Most of the other species of mosquitoes in BC overwinter as adults and their success in our northern latitude depends on spring temperature. Recent work in Colorado has estimated the degree-day temperature accumulation required for *Culex pipiens* to emerge from their hibernacula (Bolling et al. 2007). In BC, *Culex pipiens* seem to build up to a peak by the middle of August and then drop off when the photoperiod decreases to about 14 hours. We did not get any numbers of *Culex tarsalis* until the middle of July, unlike other years when there was an early June peak, probably due to the cold spring. April was very cold – one of the coldest Aprils in the last 50 years.

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

The first positive results for WNV in other regions of close proximity, or similar latitude where WNV is endemic is a useful indicator for when the virus might appear in BC. In Canada, Alberta had no WNV positive birds, horses, mosquitoes or people but positive mosquitoes were found in Saskatchewan at the beginning of August, Manitoba at the end of July and Ontario at the beginning of July (Table 7). In the US, Washington and Idaho had positive mosquito pools by the middle of July, Oregon by the end of July and Montana by the end of August in Lewis and Clarke County (Table 8).

Table 7: First Recorded Dates of Positive Mosquitoes in Canada

Year	AB	SK	MN	ON	QC
2008		8-Aug	25-Jul	4-Jul	
2007	15-Jul	20-Jun	5-Jun	15-Jul	
2006	18-Jul	17-Jul	4-Jun	5-Jul	10-Aug
2005	7-Aug	28-Jul	15-Jul	26-Jul	3-Aug
2004	10-Aug	13-Aug	28-Jul	3-Aug	19-Aug
2003	23-Jul	12-Aug	25-Jul	23-Jul	29-Jul
2002			15-Aug	16-Jul	16-Aug
2001				22-Oct	

NOTE - information extracted from Provincial and Public Health Agency of Canada websites

Table 8: Earliest Positive Surveillance Findings in Washington and Oregon

Year	Washington State	Oregon
2008	Wk 29 (Jul 16), mosquitoes	Wk 30 (Jul-26), mosquitoes
2007	Wk 33 (Aug 12-18), horse	Wk 18 (Apr 29-May 5), horse
2006	Wk 29 (July 16-22), human	Wk 25 (Jun 18-24), human
2005	Wk 34 (Aug 21-27), mosquito	Wk 28 (Jul 10-16), human
2004	None	Wk 31, bird/horse
2003	None	None
2002	October, bird	None

NOTE - information extracted from state health department websites

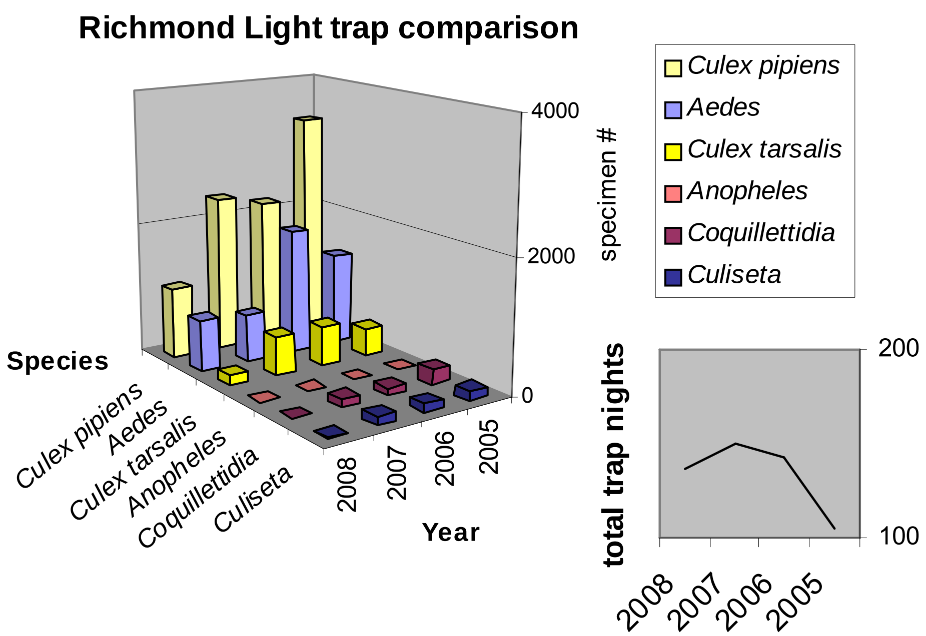
Relative Abundance of Mosquito Species Compared with Previous Years

With surveillance focused on mosquitoes this year, both the total trapping effort and the area sampled were reduced in an effort to consolidate operations. Therefore the best way to assess different years is to compare only traps that have been in the same general locations. Fortunately, some have been in the same general locations for 4 years. The information is presented as total catch from these traps for each year.

Vancouver Coastal Health Authority

In this region, there were 5 traps in Richmond that have been in the same locations for 4 years. The total number of mosquitoes caught this year is less than in previous years. This is a result of a reduced number of "trap nights" (number of nights that traps were placed in the field from beginning to end of season) and possibly the cold spring at the start of the mosquito season.

Figure 10: Species Abundance from 2005-2008 in Representative Light Traps, Richmond HSDA



Culex pipiens was the dominant mosquito collected in these traps (Figure 10). This species takes advantage of artificial containers, especially catch basins. Each year this species was the most abundant species in the surveillance program.

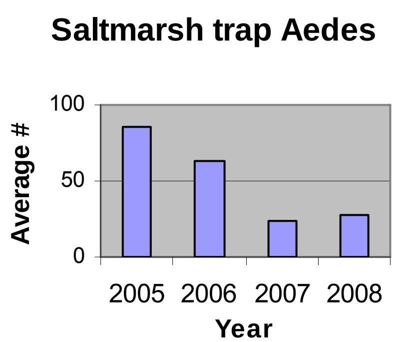
Richmond is known to have a number of salt marsh mosquito development sites that produce large numbers of *Aedes dorsalis*. One trap (salt marsh location), adjacent to this area, catches more *Aedes* than any other mosquito. This species overwinters as eggs and will hatch in spring if water levels rise high enough to flood them – usually at high flood tides. With the higher tides, more area will become flooded and more eggs will hatch. Over the last 5 years, 2005 had the highest high tides due to variation of the yearly period (8.85 and 18.6 year spread). Table 9 shows the mean May height at 2 different gauges (7735 and 7120 at DFO Tide and Level Inventory website: http://www.meds-sdmm.dfo-mpo.gc.ca/meds/Databases/TWL/TWL_inventory_e.htm). Figure 11 below shows that 2005 had the highest average catch per night of *Aedes* at the salt marsh location, even though general snowpack from the province was low in May of that year.

Table 9: Mean Monthly High Tide Height (in meters) for May at Vancouver and Victoria Harbour

Year	Vancouver	Victoria
2003	3.00	1.80
2004	3.04	1.84
2005	3.13	1.94
2006	3.02	1.83
2007	2.98	1.76
2008	2.96	1.79

See website: http://www.meds-sdmm.dfo-mpo.gc.ca/MEDS/Databases/TWL/TWL_station_list_e.asp?user=MEDS&region=PAC&tst=1

Figure 11: Average Aedes Collected in Salt Marsh Trap Richmond



Regardless of the coastal *Aedes* population, *Culex pipiens* is the dominant mosquito collected in the sum total taken from across the region. The third most common species is *Culex tarsalis,* which like *Culex pipiens*, overwinters as adults. Having considerable habitat on the coastal Pacific flyway it is believed there is considerable potential for WNV to appear in this region.

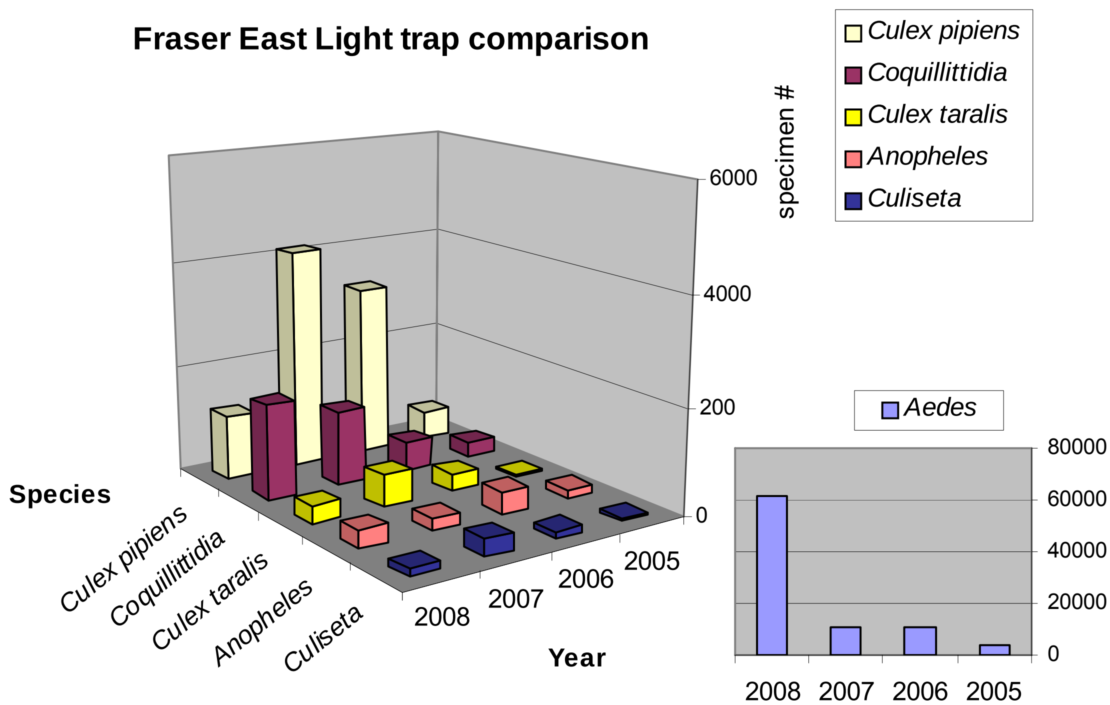
The ratio of *Culex pipiens* to *Culex tarsalis* was similar in 2008, 2007 and 2006 but not in 2005 where there was significantly more *Culex pipiens* than *Culex tarsalis.*

Fraser Health Authority

In this region there is a mix of urban and rural habitat for mosquitoes. The Fraser River is a prominent feature that affects mosquito biology, especially in eastern portions of the Fraser Valley where multiple islands flood creating large mosquito development sites. In 2005, when the province had a low snow basin forecast (Figure 7), there were generally fewer mosquitoes in the eastern portion of the Lower Mainland (Figure 12). There are 6 traps that have been in the same general locations for the last 4 years. This year, local mosquito control agents noted that two species accounted for the dramatic increase in catch numbers: *Aedes sticticus* – the woodland mosquito, and to a lesser degree *Aedes vexans* – the floodwater mosquito. With the high water, *Aedes* were about 6 times as numerous as those collected in each of the previous 2 years

(Figure12). A separate graph was used to present their numbers since the scale was 10 fold the size of other species groups.

Figure 12: Species Abundance from 2005-2008 in Representative Light Traps, Fraser East HSDA

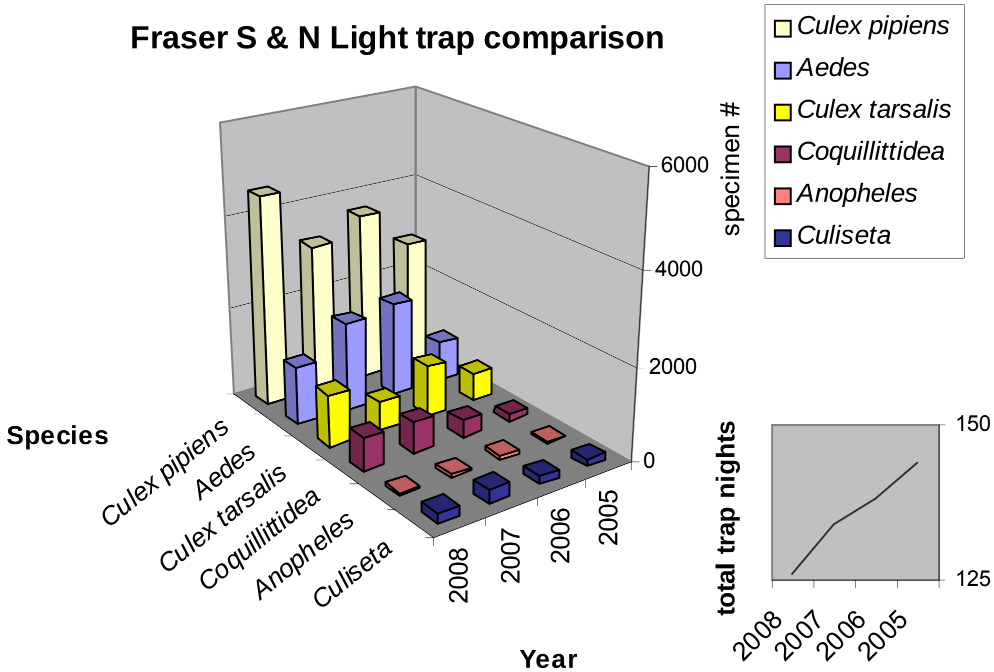


Coquillettidia perturbans was the next most commonly encountered species of mosquitoes. This is different from previous years when *Culex pipiens* was more common.

The cold spring might have set back the emergence of those mosquitoes that overwinter as adults. The fourth most abundant group was *Culex tarsalis*, which had the greatest numbers in the Chilliwack and Agassiz region of Fraser East. In years when *Culex pipiens* had a greater number, so did *Culex tarsalis* although proportionately less. Both *Culiseta* and *Anopheles* are present but in smaller numbers compared to *Culex tarsalis*.

In Fraser North and Fraser South, there are 8 trap sites that have been sampled at the same locations for the last 4 years. *Culex pipiens* was the most common mosquito and its numbers have increased over the last 3 years, even though the total number of trap nights has decreased (Figure 13). The decrease in trap nights is because the surveillance window now runs only from June to end of September rather than from May to October. The large *Aedes* increase in Fraser East did not appear in these Fraser North and Fraser South traps because most of the trap sites were far enough away from the river not to be affected.

Figure 13: Species Abundance from 2005-2008 in Representative Light Traps, Fraser South and Fraser North HSDA



Culex tarsalis was the third most abundant species, and as observed in the eastern valley, their numbers were smaller, but in similar proportions to *Culex pipiens* as in previous years. Environmental factors affecting *Culex pipiens* also seem to affect *Culex tarsalis* over this broad region. Between Richmond, in VCHA and FHA the mosquito surveillance for West Nile virus in the Lower Mainland is as effective as anywhere in Canada.

In 2002 there was a positive horse reported in Whatcom County, but no reports since that time have appeared close to the border. Positive corvids have been identified in Snohomish and King Counties in 2002, 2006 and 2008 but not until August. Several surveys have been done, but few *Culex tarsalis* were found along the west coast of Washington (Pecoraro et al. 2007; Stansbury et al. 2004; Sames et al. 2007).

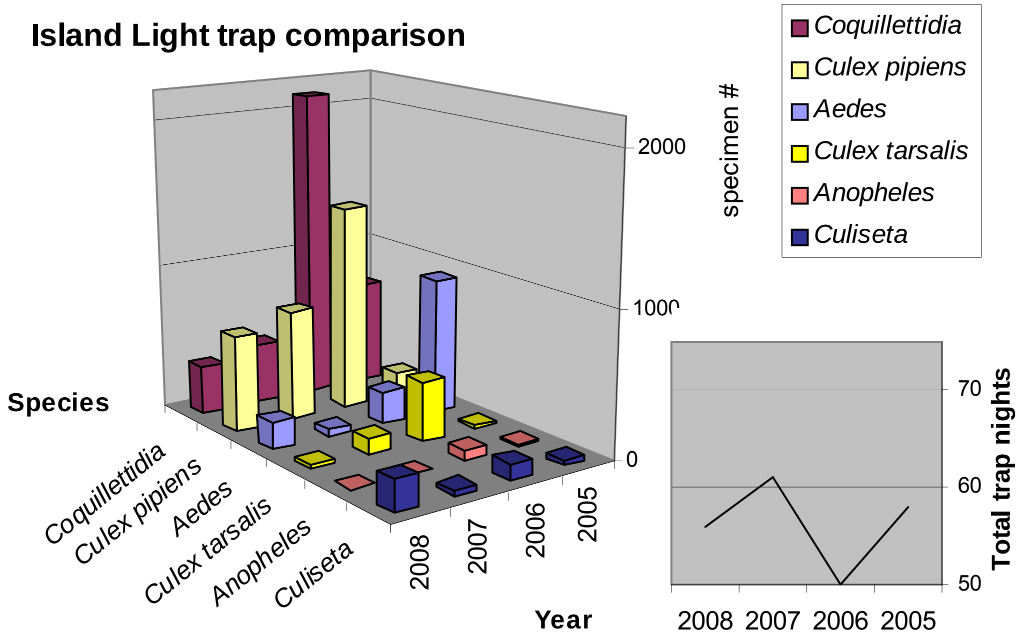
Vancouver Island Health Authority

On Vancouver Island, there are 4 traps that have operated in the same general locations for the last 4 years, and the number of trap nights has not changed significantly over this period of time (Figure 14).

Coquillettidia was a frequently collected mosquito in these traps. This mosquito overwinters as larvae underneath the surface of the water. The Cumberland trap site has a number of marshy areas surrounding it, including Woodhus Slough to the north in Courtenay. Near the trap site in Saanich, Swan Lake's perimeter is lined with cattails.

These are likely habitats for this mosquito to survive the winter. The Cumberland trap is close to the community sewage treatment plant, therefore the attraction of *Culex pipiens* to this site makes it almost as common as *Coquillettidia* in that trap.

Figure 14: Species Abundance from 2005-2008 in Representative Light Traps, VIHA



On Vancouver Island, little freshwater had accumulated by May 2005, but in that year they had the highest *Aedes* mosquito numbers in the 2005-08 period. Most of the *Aedes* collected in these traps were from Duncan, which is close to a salt marsh by the ferry terminal. As previously noted, in May of 2005 tides were the highest since surveillance was begun in 2003. The tides likely flooded more area at a critical time to generate higher *Aedes dorsalis* at this VIHA trap site. In subsequent years, there was above average snow accumulation, but this did not affect *Aedes* near the traps. As tides increase from their lowest low last year we can expect more *Aedes* in upcoming years from the trap in Duncan.

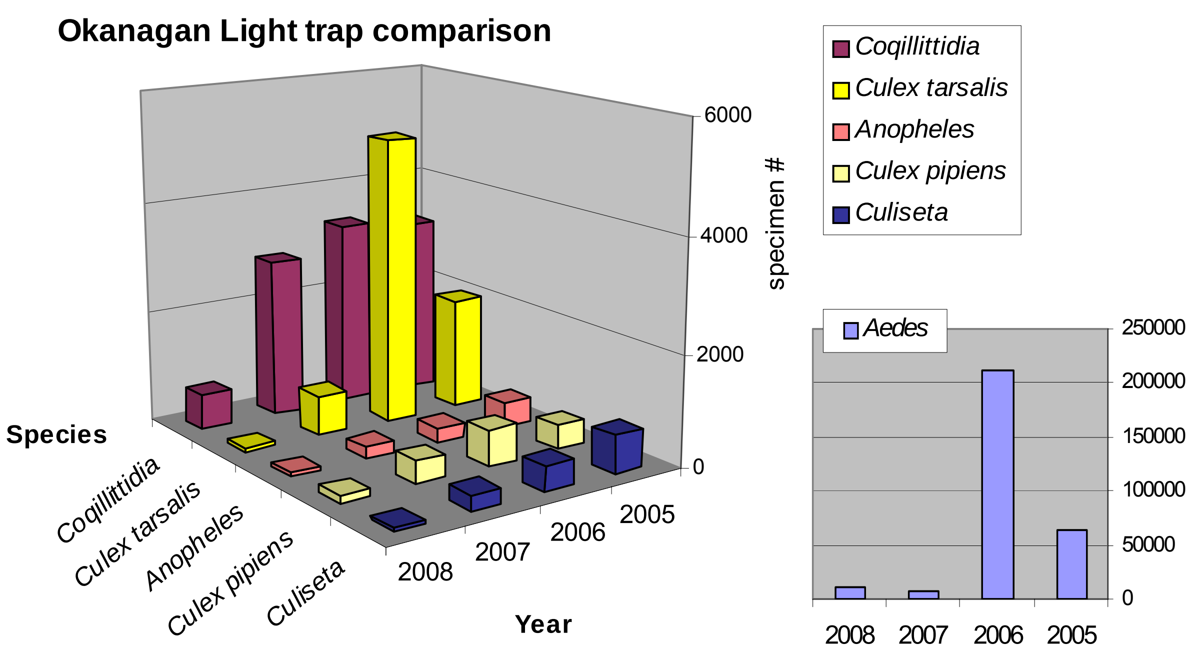
Positive birds have been reported from Island County, Washington, south of Vancouver. These positives did not occur until late in the season, after *Culex* is in overwintering diapause. This may have had something to do with birds migrating back to the coast after nesting in the central plains of North America. Enzootic amplification of the virus is unlikely with *Culex* vector hosts at that time of year.

Interior Health Authority

This region of the province is strongly affected by snowmelt and river discharge. In this region the snowmelt and floodwater *Aedes* mosquitoes dominated the catch from 30 sentinel light traps (Figure 15). This year *Aedes* counts were down but this trend can be influenced in some years by large hatches caused by localized weather events. For example, in 2005 and 2006 there has been record numbers collected from two traps in the Osooyos region (refer to past reports http://www.bccdc.org/content.php?item=203 for 2006 and http://www.bccdc.org/content.php?item=265 for 2005) this is reflected in large *Aedes* counts for those years in Figure 15.

In the Okanagan region there were 6 traps that have been in the same general area for the last 4 years. *Coquillettidia* is often the second most common species collected in these traps, except in 2006 when *Culex tarsalis* appeared in larger numbers. Alberta noted *Culex tarsalis* started to increase that year after almost disappearing from surveillance, but Manitoba numbers dropped significantly in 2006. Since *Culex tarsalis* is considered the primary vector species for this disease, a dramatic increase in numbers would signal significant risk if the virus was circulating in that area. This year, very few *Culex tarsalis* were collected. It has been speculated it could have been the cold spring weather that delayed activity or Integrated Pest Management of potential vector mosquitoes by Okanagan-Similkameen Regional District (OSRD). Some regions in the province are doing pre-emptive control for vector species even before the virus arrives, in an effort to reduce those populations.

Figure 15: Species Abundance from 2005-2008 in Representative Light Traps, Okanagan HSDA

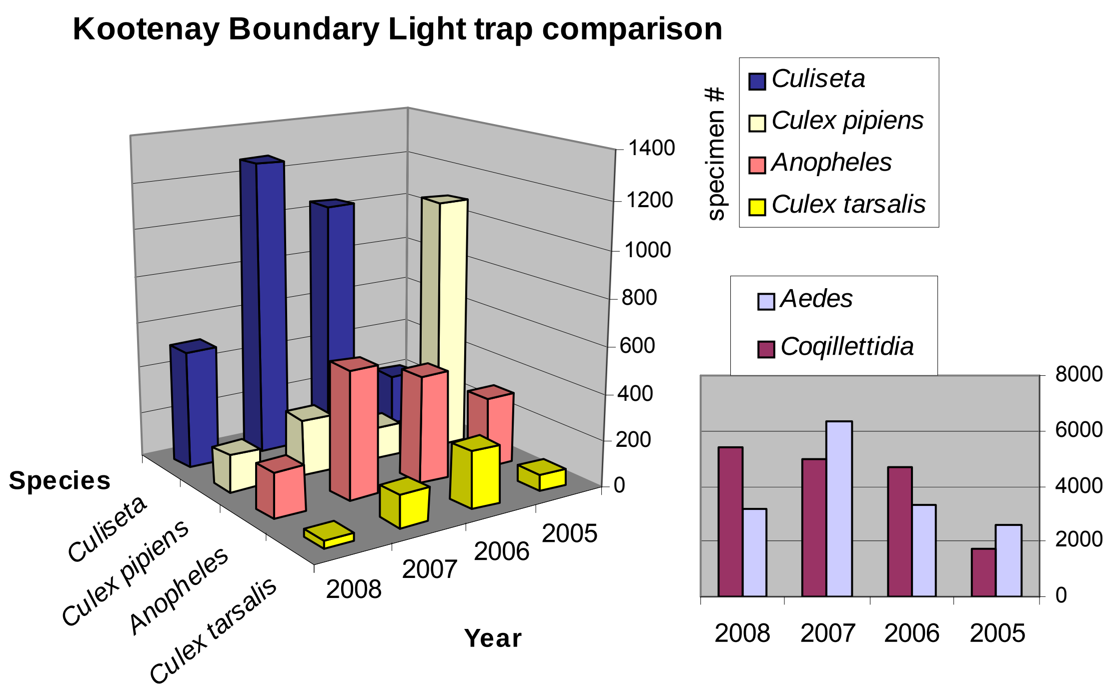


Although *Culex pipiens, Anopheles* and *Culiseta* do not appear to be present, these 6 traps did collect an accumulated total of at least 400 to 600 per season. The abundance of other more abundant species present tends to distort the graph in their favour, and diminish the apparent abundance of other species. This year their numbers were less than that of previous years but the reduction in nights the traps were used dropped from about 100 to 57 in 2008.

This year there was considerable WNV activity just south of where the Okanagan River meets the Columbia River in Washington. Even though this is well over 100 Km from the border there is no reason not to expect the virus to migrate north along this valley. We strongly recommend surveillance continue in this area if there is desire to detect the virus before people report sickness.

In the Kootenay Boundary HSDA there are 5 trap sites that have generally been in the same locations for the last 4 years (Figure 16). *Aedes* and *Coquillettidia* are the most common species at these trap sites. Castlegar and Salmo trap sites produce the most *Aedes*, whereas the Trail site yields more *Coquillettidia* and *Anopheles*. Most of these can be a bridge vector for WNV but are not implicated as the primary vector.

Figure 16: Species Abundance from 2005-2008 in Representative Light Traps, Kootenay Boundary HSDA

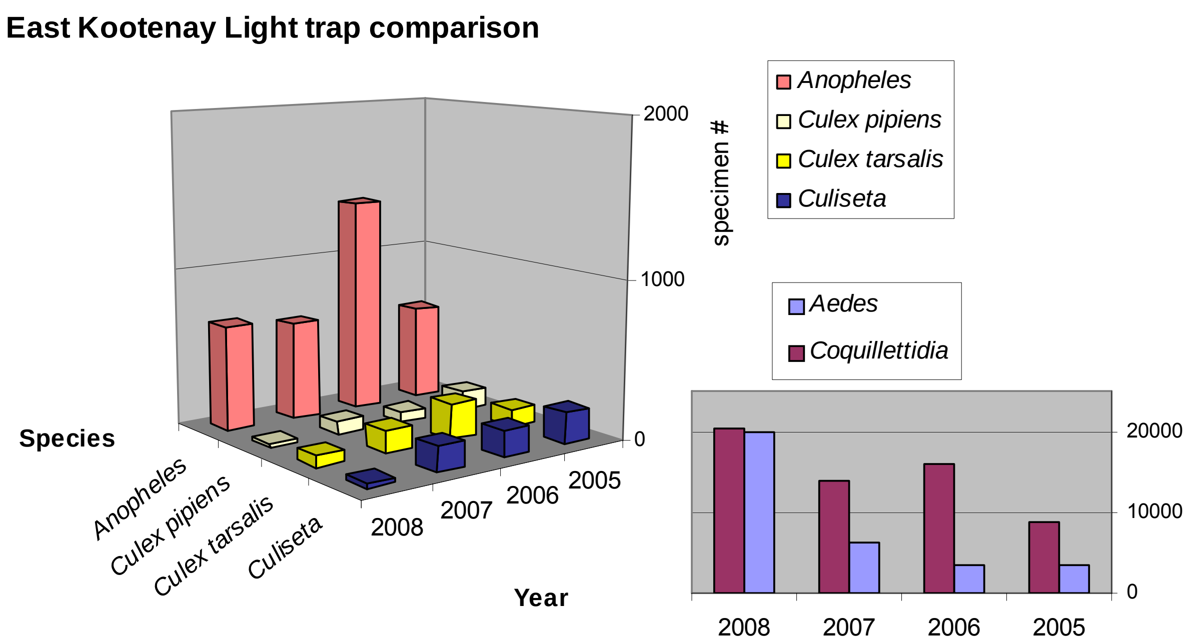


Castlegar and Trail are in a relatively narrow valley which the Columbia River flows through. The valley does not widen out until south of the US border in Northport, WA. Since the arrival of WNV, there has only been one positive bird reported from Pend Oreille County (2002) and no positives from Stevens County where Northport is situated. No trap in Kootenay Boundary caught more than 70 specimens of *Culex tarsalis* over the entire season. Considering the general absence of vector species and the absence of WNV south of the border, this region would appear to have limited capacity for circulating the virus.

To the west in Grand Forks there is a wider valley which offers more opportunity for suitable manmade habitat. Even though the trap at that location did not collect any more *Culex* species than the other Kootenay Boundary traps, it is surrounded by an area with a greater accumulation of Degree Days. This offers the virus more opportunity to incubate within mosquitoes and would increase the general feeding rate of vector species.

There are 4 traps that have operated in the same general area of the East Kootenays for the last 4 years. Two of these traps have been in the Creston Valley (Figure 17). Extensive marshlands in this region produced up to one half of the total *Coquillettidia perturbans* collected in the traps in the IHA region. This species increased in numbers particularly in Creston in 2008, more than 4 times the 2007 total, even though the trap ran for 3 fewer weeks. This species has occasionally been implicated as a bridging vector for WNV, but only in areas where the virus is widely circulating in *Culex* populations.

Figure 17: Species Abundance from 2005-2008 in Representative Light Traps, East Kootenay HSDA



Culex pipiens numbers dropped slightly this year, but generally numbers are small compared to the more urbanized Metro Vancouver region. *Culex tarsalis* did not appear in large numbers – the most was 109 in 2006 at Creston over a period of 17 weeks of trapping. Although *Culex* is present in this region, it is not considered a major component of the mosquito populations. *Anopheles* and *Culiseta* are found in greater numbers than *Culex* species in this region.

This region is in closer proximity to virus activity than any other region of the province, yet the Great Divide has presumably kept the virus from coming west from Alberta, and the narrow valleys have presumably kept the virus from coming north from Lake County in Montana. Much of the region is pristine wilderness and not the typical habitat that *Culex* thrives well in. Even though this region is in close proximity to positive indicators, the low *Culex* numbers and undeveloped environment probably protects this region to some extent from the virus taking hold.

Summary

Sentinel traps are a very useful tool in determining changes in mosquito populations from year to year. An active surveillance program is used across North America to predict the risk of an impending outbreak. For example, Manitoba uses surveillance information as part of a strategy to determine when WNV may cause a major epidemic. In this program they use mosquito population information to make recommendations for pre-emptive mosquito control to reduce the impact of this virus. Without any active surveillance, Manitoba would not be able to react until after the risk has passed, since people are usually not confirmed infected until weeks after the virus appears. Therefore, passive surveillance is not an option.

Physical conditions such as precipitation play an important role in assessing the potential for developing mosquito populations. Precipitation is one factor used in Winnipeg for their Adulticide Factor Analysis (AFA) and in California's Mosquito-Borne Virus Surveillance & Response Plan. In BC we see a dramatic increase in *Aedes* populations when rain and melting snowpack causes unusually high runoff. Watching the provincial River Forecast report can help predict trends early in the season. This year high water in the Fraser River over an extended period resulted in unusually high *Aedes* populations in the eastern FHA.

Early season temperature accumulation can give an indication of the activity of *Culex* species, which overwinter as adults. This year, the cold 2 weeks in April may have been a significant factor in the generally low *Culex tarsalis* populations found across the province, except for the Fraser North and Fraser South traps. We did see over the last 4 years that factors affecting *Culex tarsalis* also have the same effect on *Culex pipiens* in these 2 HSDAs.

The health authorities have focused surveillance this year by reducing the period of sampling to the most likely part of the season when WNV would appear. Also, the trapping locations were reduced and focused (particularly in IHA) along the Canada/US border. As pointed out, some positive indicators were found in close proximity to VIHA and FHA at some point over the last 5 years, in Washington State.

The BC Mosquito Control Subcommittee recommends that a strategy be in place for separating some *Aedes* to species where *Aedes togoi* and *Aedes dorsalis* are found. This could be a consideration for surveillance in subsequent years since the number of samples is reduced. Speciation could occur any time after *Culex* have been sorted and tested.

A continued focus on trapping and testing for the primary vector species, *Culex pipiens* and *Culex tarsalis*, is a good practice to reduce cost and maximize efficiency. Some trap reduction in regions with low vector populations could be refocused in more susceptible or high risk regions, while maintaining minimal sentinel trap surveillance where prudent. If WNV is known to be circulating, consider using gravid traps in regions know to have *Culex pipiens* in order to maximize the chances of getting a blood fed female. There is also evidence that *Culex pipiens* is drawn to gravid traps. New development of attractants that do not smell to people could make this a more appealing method to use (Leal et al. 2008). Tests in Brazil show that an odorant-binding protein binds to an oviposition pheromone binding site of *Culex qinquefasciatus.* In trials, nonanal and trimethylamine (TMA) mixture worked more effectively than a smelly infusion base mixture.

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 Regional Health Authority, and for maximum detection of the virus. This year for BC there was only a 1 day median turn around time (Table 10). This implies that the health authorities are serious about making the mosquito surveillance program work efficiently. The maximum delay from collection to submission was only 7 days. This is primarily attributed to statutory holidays when we ask the field staff to hold samples in freezers until after the holiday, rather than having them sit in a courier's storage facility when BCCDC staff are unable to accept submissions.

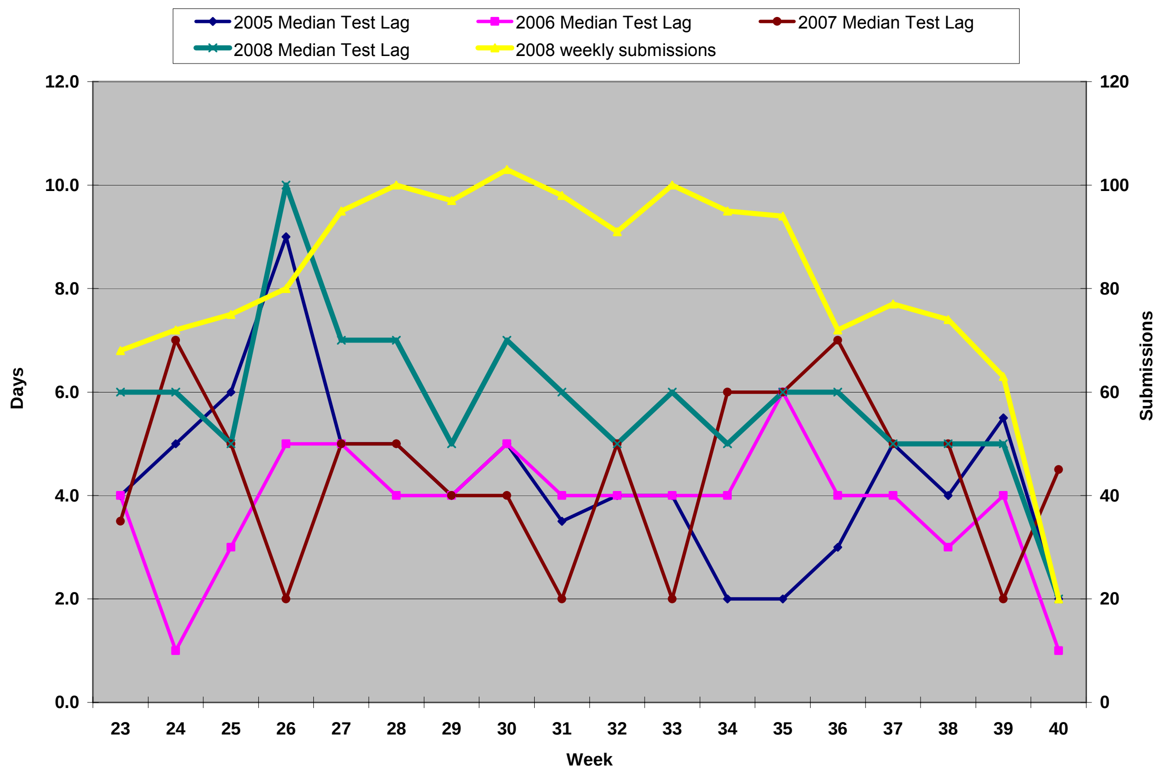
Table 10: Mosquito Lag Time for Sample Submission, 2003-2008

HSDA	Median of Submission						Max of Submission					
	2003	2004	2005	2006	2007	2008	2003	2004	2005	2006	2007	2008
EK	1	3	2	2	3	1	2	7	13	5	13	2
KB	1	1	2	1	2	2	6	5	6	2	4	3
OK	1	2	1	1	1	2	8	7	9	4	3	3
TCS	1	1	1	2	1	NA	8	6	5	7	5	NA
FRE	2	3	2	1	1	1	5	10	8	4	32	7
FRN	2	1	1	1	1	1	3	7	6	4	1	4
FRS	1.5	3	1	1	1	1	7	8	16	4	8	5
RICH	2	1	1	2	1	1	17	2	6	8	6	2
VAN	0.5	0	0	0	0	NA	6	5	1	1	2	NA
NSCG	4	2	1	3	4	NA	7	32	24	16	56	NA
SVI	1.5	1	1	1	1	2	3	7	11	2	6	7
CVI	1	2	1	1	1	2	5	9	6	7	7	7
NVI	1.5	2	2	2	1	1	2	2	3	3	7	5
NW	1	2	2	1	2	NA	1	15	7	10	7	NA
NI	1	1	3	0	NA	NA	6	6	14	1	NA	NA
NE	2	1	2	2	2	NA	2	5	7	12	14	NA
BC	**2**	**2**	**1**	**1**	**1**	**1**	**17**	**32**	**24**	**16**	**56**	**7**

Note: All numbers are in days. Includes time in frozen storage before shipping. BC row refers to annual medians (first 6 columns) and maximums (second 6 columns) across the province.

BCCDC laboratories received about 100 samples per week during July and August and 70 to 80 at other parts of the season. They managed to process these samples in about 6 days, except early in the season when there was the large hatch of *Aedes* in the eastern Fraser Valley (Figure 18). There is a very efficient system of sorting out *Culex* and testing for the virus. As with previous years, both field staff and laboratory staff have to be congratulated on making this system operate efficiently. Often there are seasonal staff that need to be trained in the submission routine and processing of samples. We would also like to acknowledge their efforts at making this system work so well.

Figure 18: Change in Laboratory Lag Time for Mosquito Identification and Testing



What's up and coming with mosquitoes in 2009?

The US Centers for Disease Control and Prevention and American Mosquito Control Association (AMCA) are sponsoring a meeting dedicated to West Nile virus entitled "WNV 10 years later." The meeting will be held in Savannah, Georgia (Feb 19-20, 2009). This meeting is preceded by a symposium dedicated to the Asian Tiger Mosquito in New Brunswick, New Jersey (Feb 12-13, 2009) sponsored by Rutgers University. Michelle Tseng from UBC is presenting "Environmental variation and virulence: A case study with *Ascogregarina taiwanensis* and *Aedes albopictus*". The 75th annual AMCA meeting is being held on April 5 to 9 in New Orleans, Louisiana.

Many areas in BC are doing pre-emptive control of potential WNV vector mosquitoes under a Pesticide Use Permit. The legislation that supports this permit has been replaced with the Integrated Pest Management Act. This will require a supporting Pest Management Plan before any control actions can take place in 2009. The Ministry of Health has developed a template of a plan but needs maps, introduction letter and public / native consultation before the plan can be implemented in 2009.

Geographic Information Systems – Applications to WNV

Geographic information systems (GIS) mapping has been an integral tool for WNV surveillance and planning in BC. Data from a variety of sources (health-related events, field sampling, municipal infrastructure, environmental, etc.) and technologies (global positioning systems, remote sensing, databases, etc.) can be integrated in a GIS for visualization and analysis. In addition to the weekly summary maps posted on the WNV website, the BCCDC has developed an interactive web-based GIS mapping system for public health officials and members of the public to view WNV surveillance data in spatial format. Please refer to http://www.bccdc.org/westnile and http://maps.bccdc.org/ for all WNV mapping related content.

Geographic Analysis of Dead Corvids Tested and Reported in 2008

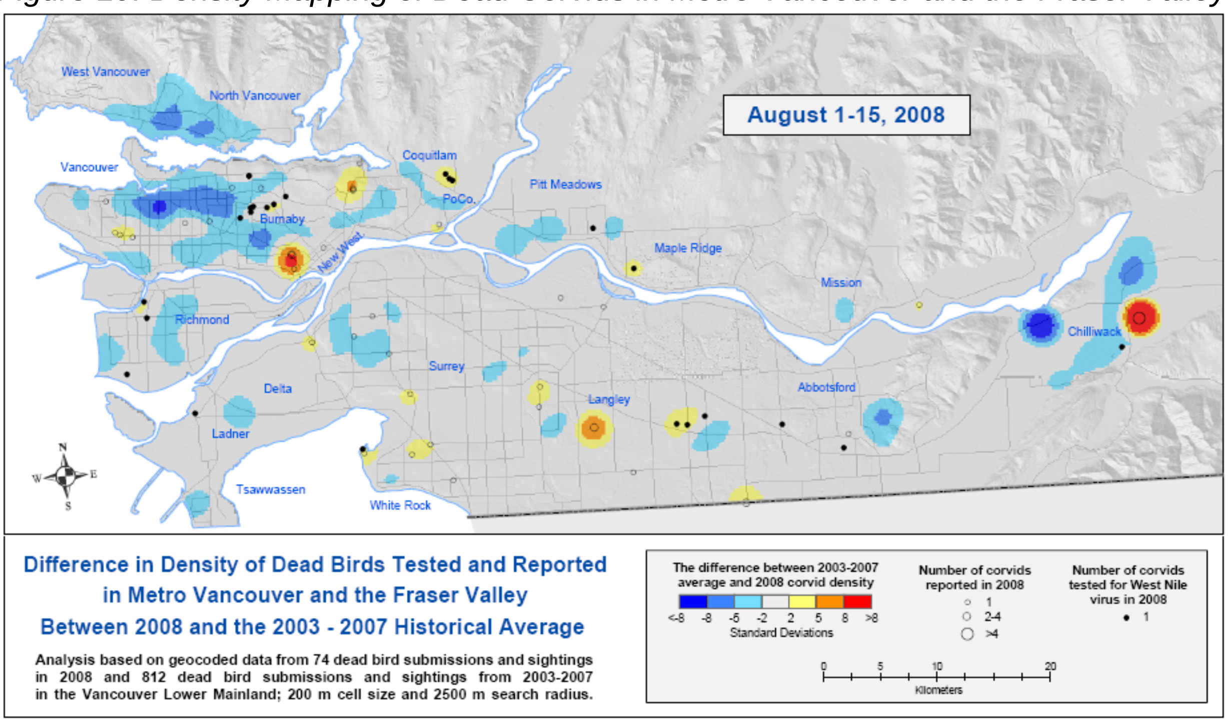
The purpose of corvid surveillance is to detect the appearance of WNV in a geographic area. Corvid surveillance can serve as an early warning system for WNV risk as the detection of positive corvids can precede human illness by up to 3 months (Eidson et al. 2001; Mostashari et al. 2003). Since it is not feasible to submit every bird for WNV testing, reporting of dead corvids to public health – via the online dead bird reporting form (http://westnile.bccdc.org) or contacting the regional health authorities – may assist in identifying endemic WNV activity. For example, unexpected "hotspots" of corvid mortality may indicate localized concentration of WNV in an area. Appropriate public health interventions such as communicating to the public to take personal protective measures, eliminating breeding habitat for mosquitoes and/or performing mosquito control activities can then be undertaken to reduce the risk of human illness. Conversely, in the absence of WNV activity, dead corvid reporting also serves as a baseline to allow future comparison of corvid mortality before and after the appearance of WNV in BC.

Kernel density mapping of reported corvid mortality has been performed for the past 5 years by BCCDC since public health departments in other jurisdictions have found this spatial analysis tool to be effective at highlighting areas of intense corvid mortality due to WNV (UC 2006). To produce the density map (Figure 19), point locations of dead corvid submissions and reports for a two week time frame (both for the 2003-2007 average and the current year) were used to create two continuous surfaces representing relative corvid mortality. The 2008 corvid mortality GIS data layer was then subtracted from the 5 year average corvid mortality data layer to produce a continuous surface map which identified areas that observed greater or fewer corvid deaths in 2008 than compared with the 5 year average. "Hotspots" and "coldspots" of corvid mortality, defined in the number of standard deviations away from 0 (no difference from the average), are highlighted in the map. The locations representing where dead corvids were submitted and reported in 2008 are also illustrated in the map (Figure 19).

The density map can then be used to identify hotspots of corvid mortality in time and space which can further be investigated by determining if the cluster represents a meaningful increase in deaths, and whether any corvids from that cluster have been submitted for WNV testing. The density map also identifies coldspots, or areas which have observed lower than expected corvid mortality. The regional WNV program coordinator may then consider increasing public participation of reporting dead corvids through a media release in the identified area to bolster coverage of corvid surveillance for detection of corvid mortalities and WNV in the area.

There are several limitations in using density mapping of corvid mortality in BC as a surveillance tool. Sufficient numbers of dead corvid reports are required for the creation of the continuous surface data layers. Therefore, density maps cannot be created in geographic areas with very few dead corvid reports in the current year as it would predominantly indicate fewer corvid deaths than observed previously, when in fact this is an artifact of reduced participation in the WNV Program. Also, maps cannot be created in areas which historically have had very low levels of corvid mortality; otherwise, false hotspots of corvid mortality may appear due to unstable data derived from a small denominator value. A further limitation in the use of density mapping is related to its timeliness. The map is created every two weeks, and online reporting of dead corvids had on average a 5 day lag between the time of discovery and reporting of dead corvids in 2008. The use of dead corvid surveillance as an early detection system for WNV is contingent on its timeliness of reporting and analysis. We therefore encourage the regional health authorities and public to report dead birds via the online form as soon as they observe them.

Figure 19: Density Mapping of Dead Corvids in Metro Vancouver and the Fraser Valley



Raster GIS-based Risk Model for WNV

Creating risk maps based on known environmental and ecological drivers of disease occurrence is one tool that can be used to guide provincial health programming for zoonotic diseases such as WNV. The current forecasted WNV risk model is based on surveillance and ecological data summarized at the HSDA geopolitical unit. Assigning levels of forecasted WNV risk by HSDA have been useful for the allocation of program funding since health care services are delivered and managed at this geographic level. However, a major limitation of this approach is the modifiable areal unit problem, whereby observed spatial patterns of data aggregated into political boundaries at one geographic scale may not exist at a different geographic scale or aggregation (Openshaw 1984; Unwin 1996).

An example of this challenge and limitation in assigning the appropriate WNV risk level using HSDAs is the homogeneous rating of risk within the entire HSDA. When using this approach, all geographical areas within the HSDA are classified as having the same level of WNV risk, when in fact there is much variability in ecology, climate, human development, etc. A solution to this problem is to perform a spatial risk assessment of WNV using a raster or cell-based approach via GIS modeling to yield a specific, local geographic level assessment of WNV risk across BC. The raster-GIS approach enables the representation of data as unique individual cells, and the collection of these cells in geographic space produces a continuous surface with varying data values of the phenomenon of interest.

Preliminary raster GIS-based models to forecast WNV risk in BC have been created and shared with the regional WNV coordinators. Further refinement and validation of the models are required before they are shared publicly and used for guiding surveillance and funding.

Communications Highlights

In 2008, BCCDC did not release any messages to the media on WNV, leaving that initiative to the health authorities.

Communications Planning

A diagram representing the communications fan-out protocol, which was developed based on regional feedback in 2007, can be found in Appendix 2. No planning activities were necessary for 2008, other than updating the communications contact list for the health authorities.

Media Activity

A few calls came in from the media for stories, and were handled by BCCDC Epidemiology Services staff. Health authorities were responsible for any local stories, as usual.

Educational Materials

Edits were made to the website material, to accurately reflect the 2008 program and enhance public education.

Research Highlights

In British Columbia

West Nile Virus: A Study of Public Health Responses and Perceptions (Negar Elmieh, UBC)

WNV provides a challenge to public health in that the frequency, location, and duration of outbreaks are not always readily identifiable. In the absence of such information, understanding risk perceptions that drive behaviors and attitudes will allow us to develop more effective and appropriate risk communication and public health messages. Described below are the results of two studies examining risk perceptions and decision trade-offs in relation to WNV, carried out in 2007 in collaboration with the BCCDC. This is the subject of Negar's PhD thesis, which she will be defending in 2009. Publications and detailed reports of both studies are forthcoming. In the meantime, for more information on either study please e-mail Negar Elmieh at nelmieh@interchange.ubc.ca.

1) Influences of demographics, exposure, and health beliefs on behaviors related to West Nile virus.

The purpose of this study was to examine health beliefs, their impact on health behaviors recommended to prevent WNV infection, and their implications for risk communication. A sub-objective was to determine how the health behaviors are impacted by WNV exposure. A randomized telephone survey was carried out in 3 Canadian provinces: British Columbia (n=351), Alberta (n=177), Manitoba (n=181). The provinces were chosen to reflect varying levels of WNV risk ranging from low to high respectively.

Using the health belief model we examined 5 personal protective behaviors recommended to prevent mosquito bites: (1) avoidance of the outdoors between dusk and dawn, (2) insect repellent use with DEET, (3) wearing protective clothing, (4) use of screens on windows and doors, and (5) source reduction. Using multivariable logistic regression models we found that:

- Perceived benefits to action were positively correlated in relation to all personal protective behaviors ($p<0.01$). As the perceived benefits increased an increase in the specific health behavior was observed.
- Perceived barriers to action were all negatively correlated to personal protective behavior outcomes with the exception of insect repellent use with DEET, which was positively correlated ($p<0.001$). This is likely a function of use despite perceived barriers (safe for health, bad for environment, cost, convenience, and whether it was unpleasant), perhaps an indicator of its effectiveness.
- Cues to action for when and how to engage in the specific behavior were positively correlated ($p<0.001$) to engaging in the behavior.

- Respondents who lived in areas exposed to WNV (Alberta and Manitoba) were more likely to engage in insect repellent use with DEET, having screens on windows and doors, and avoiding the outdoors between peak mosquito hours of dusk to dawn. The same effect was not seen for source reduction and wearing protective clothing.

In summary, we found that individuals who received timely information, understood the benefits of a particular health behavior, and had experience with the disease were more likely to engage in the recommended health behaviors. This has implications for WNV planning and public health risk communication campaigns.

2) Multi-Criteria Decision Analyses and re-emerging infectious diseases: a case study of West Nile virus.

The purpose of this study was to examine decision trade-offs and their implications for WNV Program planning and risk communication strategies. A multi-criteria decision analysis survey of the general public (in BC, AB, and MB) and health professionals was carried out to determine preferences for interventions aimed at controlling WNV. This was carried out as part of the health behavior study described above.

In collaboration with BCCDC, 5 performance criteria were selected to evaluate the 5 intervention possibilities. The performance criteria were: (1) cost, (2) environmental consequences, (3) effectiveness, (4) ease and speed of implementation, and (5) public acceptance. WNV program intervention options included: no WNV Program, public education, source reduction, larviciding, and adulticiding. A simple weighted additive model was used to develop performance matrices to examine decision trade-offs.

Results showed that the general public was more sensitive to decision trade-offs, while health professionals were most concerned about program effectiveness. Both the general public (in all study provinces) and health professionals chose larviciding as the most preferred option. As expected, no WNV Program was the least preferred option. The findings highlight the willingness of the public to consider different evaluation criteria and trade-offs for interventions. Large gaps in risk perception between the general public and health professionals for (1) no WNV Program and (2) adulticiding were also found. Through risk communication we can educate the public on these interventions bridging the gap between current perceptions. This would lead to public support resulting in more effective WNV Program implementation.

An Environmental and Ecological Assessment of West Nile Virus Risk (David Roth, UBC)

The spatial distribution of WNV is strongly impacted by environmental and ecological factors owing to the importance of both birds and mosquitoes in disease transmission. Understanding the disease ecology of WNV can therefore allow for predictions to be made regarding the spatial distribution of disease risk. However, the accuracy of such predictions depends on our understanding of the key environmental-disease associations underlying viral transmission. While much is known about the disease ecology of WNV, transmission dynamics are often regionally specific, and patterns from the US may not necessarily be generalizable to the Canadian context. Despite the significant resources put towards disease surveillance and prevention, the current understanding of WNV ecology in Western Canada is limited. Specific information is needed regarding the associations between landscape and vector abundance, reservoir community structure and human disease, and the role of agricultural activities in promoting WNV occurrence.

David Roth is a second year PhD student at UBC's School of Population and Public Health who will be carrying out a series of ecological and epidemiological analyses aimed at strengthening our understanding of WNV disease ecology in Western Canada. His thesis will be comprised of three parts:

In the first part, David will examine the relationship between landscape and WNV vector community structure in the Osoyoos region. This area is predicted to be at high risk of WNV establishment owing to warm weather and the presence of key WNV vectors. Disease risk in this area may be further elevated due to rapid development that may increase the amount of suitable mosquito habitat. This project will involve vector sampling in pre-selected landscape classes (e.g. agricultural versus suburban development versus natural shrub-land) in order to estimate the degree to which heterogeneity in vector community structure may be explained by landscape variation.

The second portion of David's thesis will focus on the association between agriculture on the occurrence of WNV at a community level. Work from the US suggests that certain agricultural activities may promote the occurrence of WNV at a county level. In order to determine if similar patterns are occurring here in Western Canada, David will combine human WNV incidence data from Saskatchewan at the level of rural municipality with information from the Agricultural Census of 2006 to examine the association between key agricultural practices such as irrigation and the presence of cattle feedlots, and WNV incidence.

The final part of David's thesis will examine associations between avian community structure and WNV incidence. Recent work suggests that diverse avian communities may lead to lower WNV incidence owing to an increase in the proportion of non-competent disease reservoirs. David's work will examine this association in a Canadian context by comparing WNV incidence with several measures of regional avian biodiversity. Avian biodiversity will be calculated for each rural municipality using data from the yearly Breeding Bird Survey, which is a yearly nation-wide bird survey that records abundance data on all North American bird species across the continent.

From the Literature

Surveillance

- Areas of the country which had consistently high annual incidence and cumulative incidence of WNV neuroinvasive disease were identified. These were determined by state and county level. South Dakota had the highest cumulative incidence at 32.2 per 100,000 population. Other high ranking states (>10 per 100,000) for cumulative incidence include Wyoming, Nebraska, North Dakota, Colorado, Louisiana, Mississippi and Montana. When the measure of median annual incidence was applied the same states were in the highest ranking, with one addition: New Mexico. The highest incidence of WNV neuroinvasive disease (2002-2006) has occurred in the Great Plains and mid-South regions of the US. The 2003 WNV outbreak in the Great Plains likely influenced these results. (Lindsey et al. 2008)

- The temporal relationship between equine and human WNV infection was assessed in Texas during 2002. For each human case, the nearest equine case was selected, and dates of onset determined for each. Dates of onset for human and equine cases were positively associated. While there was no significant difference between the date of onset in human and equine cases, it was shown that equine cases in urban areas were reported significantly earlier than corresponding human cases. The authors suggest that the monitoring of equine populations near human settlements may be a useful method of predicting WNV risk. (Ward and Scheurmann 2008)

Clinical Studies

- An examination of the prognosis of WNV infection, specifically relating to patterns of physical and mental function, was undertaken in order to further the understanding of factors associated with recovery from WNV infection. A longitudinal cohort study with a total of 156 patients was carried out, with patients assessed on a variety of physical and mental scales. It was found that physical and mental function, as well as mood and fatigue, returned to normal within 1 year of initial symptoms. Physical recovery was slower in those with neuroinvasive disease than in those with non-neuroinvasive disease, whereas recovery of mental function was similar in both groups. Lack of comorbid conditions was associated with faster recovery of physical function, while both lack of comorbidity and being male were associated with faster recovery of mental function. Severity and time-course of disease did not appear to vary between those with meningoenchephalitis and those with encephalitis. (Loeb et al. 2008)

Climate and Landscape

- An evaluation of how WNV antibody prevalence in avian communities varies with regards to urban land use was undertaken in Atlanta, GA. Songbirds were sampled from 14 sites along a rural-urban gradient. It was found that 14.6% of tested birds were positive for the virus, with rates between sites varying between 6.3-30.8%. WNV prevalence was found to increase with urbanization in adult birds, with a weaker trend being observed in juveniles. Antibody prevalence in urban and rural sites was found to be 18.5% and 9.6% respectively, with seroprevalence rates in adult birds being on average 2.5 times greater in urban sites than in non-urban sites. Northern Cardinals were the most commonly sampled species in this study, and had higher WNV seroprevalence than all other species combined – the authors suggest that the Northern Cardinals, may therefore, be a useful surveillance species in this part of the country. (Bradley et al. 2008)

- Gomez et al. performed field trapping in selected urban to rural sites to test WNV seroprevalence in mammals. The trap sites were quantified by the "urbanization index" formula in which percent tree cover and impervious surface are variables. The quantification of these variables was achieved by estimation of land types in Landsat satellite imagery. 244 samples were collected from 11 mammal species and tested for WNV seroprevalence. WNV seroprevalence varied significantly by species (highest in Eastern Gray Squirrels, Virginia Opossums, Raccoons, and Norway Rats), by capture date within the season (positive relationship only within the juvenile sampling subset), and by urbanization index (positive relationship). It is suggested that variability of WNV seroprevalence between species may be due to host death, spatial variability in prevalence and vector abundance, or vector feeding preferences. (Gomez et al. 2008)

- The authors derived landscape classes in Chicago and Detroit by principal component analysis of environmental and socio-economic factors believed to be associated with WNV and compared the defined classes to the distribution of human WNV illness in 2002. The similarities between the two cities were also compared. There were 5 landscape classes which were identified in each city; one of which, Inner Suburbs (common to both cities) had the highest WNV human case rates. The features of this high risk area included moderate population density, 1940's and 1950's era housing, and moderate vegetative cover. The lower WNV rates in outer suburb land classes was suggested may be due to higher biodiversity of the ecosystem, more native species, and higher vegetative cover. (Ruiz et al. 2007)

- An examination of the relationship between biotic/abiotic conditions and WNV incidence at the level of census tract in Iowa, USA, was undertaken using data from 2002-2006. A combination of GIS and epidemiological methods were used. It was found that census blocks with WNV had statistically higher mean stream density and proportion of agricultural land, and a significantly lower road density and proportion of wetlands, forest, commercial land-use, and residential land use. WNV incidence was greater in rural settings than in urban settings, which is in contrast to much of the previous research in the US. While no consistent association was found between WNV incidence and climate, it is suggested by the authors that drier conditions in the western part of the state may lead to higher reliance on irrigation, which in turn provides development sites for *Culex tarsalis*. (DeGroote et al. 2008)

- The authors describe spatial epidemiology and identify risk factors for disease in the Northeast US based on 8 years of human WNV case data. The model that was used controlled for human population density, surveillance bias and spatial proximity. Risk for WNV was found to increase by 0.25% for each 1% reduction of forest cover. The lowest category of forest cover was <38.29% and was found to have 4.4 times greater odds of having an above median disease incidence than the highest category of forest cover (>69.59%). In addition to the percent forest cover, the percent of urban land was also a significant predictor of incidence. (Brown et al. 2008a)

- The authors performed canonical correlation analysis to determine how vegetation indices (normalized difference vegetation index (NDVI), disease/water stress index (DWSI), and distance to water) were related to WNV vector adult mosquitoes trapped in 2004 in New Haven, CT. The environmental variables explained 86% of the variation in the vector mosquitoes sampled. The environmental variables were also used to identify clusters of similar areas and vector communities. The results suggest that certain vegetated areas contained only enzoonotic vectors, but it was the residential areas which contain both enzoonotic and bridge vectors where human WNV outbreaks have occurred in the past. (Brown et al. 2008b)

Biology and Transmission

- The authors review what is known about impacts of WNV on ecology, and how climate and landscape play a role in outbreaks. This is a good overview of research that has been done and what still needs attention. Focus is on impacts of WNV on avian communities, and potential reasons for spatial and temporal differences in WNV prevalence with the goal of management of disease risk, conservation of host communities, and forecasting future risk in the context of climate change. (LaDeau et al. 2008)

- The strain WNV02 was found to replicate faster compared to the NY99 strain (WNV02 has a shorter extrinsic incubation period). At 32°C WNV02 transmission was detected at 21, 36, 60 hours, while NY99 transmission was detected at 72 hours. Higher temperatures further increased the advantage of WNV02 over NY99. A small change in temperature for both strains was found to have a large effect on transmission similar to an exponential relationship. In the lab it was shown that increases in temperature have 2 times the impact on transmission (increased viral replication + increased speed of the replication cycle = increased transmission). In addition a very small temperature increase (2°C) was able to increase transmission substantially. This has implications in light of increasing global temperatures; WNV02 may have increased transmission even with relatively small increases in temperature. Small temperature differences may therefore explain spatial variability in transmission of WNV. (Kilpatrick et al. 2008)

- The authors tested the roles of bird diversity (a measure of community reservoir competence), vector abundance, and human population density on vector infection prevalence and human infection incidence (measures of WNV risk). It was found that WNV infection in both humans and mosquitoes increased in areas with decreasing bird diversity and increasing bird competence. Decreasing bird diversity would increase infection in vectors and humans through increased vector/competent host encounter rates (less diverse communities also tended to have higher community competence) and reduced host population regulation (intraspecific competition for resources or predation limit the highly competent host population). Increasing bird competence would increase host to vector transmission (birds to mosquitoes). In addition to vector control programs for WNV, conservation of bird diversity should be encouraged to increase the ecosystem's resilience to WNV. (Allan et al. 2009)

- The relationship between avian community structure and WNV incidence rates at a county level were examined in the Eastern United States. This association was examined using measures of avian community structure prior to the introduction of WNV, and subsequent to its introduction, using data from the Breeding Bird Survey. Study findings suggest that WNV incidence is lower in counties with high avian diversity than in areas with low avian diversity. Furthermore, it appears that there is a stronger relationship between human incidence and avian species richness (defined as the number of unique species within an area) than between human incidence and species evenness (which take into account relative abundance of avian species within a community). The results of this study also suggest that non-passerine species may be more important in disease transmission than previously thought, especially after the virus has become established in an area. The authors suggest that these findings support the notion that avian biodiversity may buffer human populations from WNV, and that avian community structure should be considered in public health planning. (Swaddle and Calos 2008)

- The longitudinal infection in mosquitoes, birds and humans is quantified around Chicago, IL in 2005 and 2006. It was observed that mosquito infection rate was correlated with proportion of virus positive birds, proportion of hatch-year birds caught (2006 only), seroprevalence of hatch-year birds, and number of human WNV cases. The relative abundance of hatch-year birds increased just before the peak of WNV infection in humans, mosquitoes and birds. In addition, there was a significant cross-correlation between hatch-year bird seropositivity and *Culex* infection 2 weeks later. This leads to the conclusion that hatch-year birds are important in the amplification of WNV by increasing the susceptible host population. (Hamer et al. 2008)

Future Surveillance Activities

BCCDC staff met with the 4 southern health authorities and the Ministry of Healthy Living and Sport on November 18 to discuss future plans and provide some input to the Ministry's budgeting. WNV was not detected in BC for the sixth consecutive season of active and passive surveillance activities. Over the past 6 years, BCCDC and the health authorities have developed and refined surveillance techniques, and learned much from our collaborative experiences and the experiences of other jurisdictions in Canada and the US.

Surveillance activities and results were reviewed, and the implementation and utility of a new raster-based risk map was discussed. There was also discussion about the utility of pre-emptive larviciding by communities. The group confirmed the value of work done to date in building relationships with the local governments, expanding capacity to react to an outbreak of WNV and the increase in knowledge and expertise in both surveillance and mosquito control activities.

There was interest in pursuing other arbovirus and pathogen surveillance (and surveillance of their indicators), to cast a wider net for zoonoses that could enter BC due to global climate change. Some communities do not face a significant threat from WNV, but may have issues with Lyme Disease, Hantavirus or other zoonoses. Therefore, it would be beneficial for them to receive UBCM support for activities in their jurisdictions, in conjunction with and cooperative input from the local MHOs.

At the meeting it was generally agreed that:

- Pre-emptive larviciding was not beneficial until WNV arrives in BC;
- Routine monitoring of mosquito development sites is not necessary;
- The basic pillars of reducing the risk of WNV (education, habitat modification activities) are still important;
- We should try to maintain the capacity that we have gained to work with municipalities on population public health issues;
- Funding for local government activities is valuable and should continue, but that it could be used for non-WNV activities as the MHO and local governments determine, including addressing zoonoses arising from climate change;
- The new risk model should be validated against other jurisdictions' WNV activity; and
- BCCDC should explore the management of corvid and mosquito surveillance and surveillance for other diseases and their vectors in the field, for those health authorities that would prefer to have it managed centrally.

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Appendix 1: Reference Tables for Interpretation of Human Laboratory Test Results

Interpretation of Acute/Convalescent West Nile Virus Test Results 2008

WNV IgM EIA	**WNV IgG EIA**	**WNV IgG Avidity EIA**	**EDTA blood WNV RT-PCR**	**CSF WNV RT-PCR**	**Interpretation**
any	any		RNA DETECTED		This patient is viremic and is a **confirmed** case of West Nile virus infection. There is no cross-reactivity with other flaviviruses in the BCCDC WNV RT-PCR.
				RNA DETECTED	
				RNA not detected	Viral **RNA not detected** in the CSF. This test has a low sensitivity and does not rule out WNV infection. Please refer to blood tests.
REACTIVE	REACTIVE	LOW	RNA not detected (or not tested)		**Probable*** acute West Nile virus infection. The presence of Low Avidity IgG antibodies is consistent with a recent Flavivirus infection. A convalescent serum taken 10 – 14 days after the acute is required for confirmation.
REACTIVE	Nonreactive	Not applicable	RNA not detected (or not tested)		**Probable*** acute West Nile virus infection. A convalescent serum taken 10 – 14 days after the acute is required in order to demonstrate seroconversion and Low Avidity IgG.
REACTIVE	REACTIVE	HIGH	RNA not detected (or not tested)		The presence of High avidity IgG antibodies is consistent with a Past infection with WNV A convalescent serum taken 10 – 14 days after the acute is recommended.
Nonreactive	REACTIVE	HIGH	RNA not detected (or not tested)		The presence of High avidity IgG antibodies is consistent with a Past infection with flavivirus or vaccine response. A convalescent serum taken 10 – 14 days after the acute is recommended.
Nonreactive	Nonreactive		RNA not detected (or not tested)		Not an infection with WNV A convalescent serum taken 10 – 14 days after the acute is recommended.

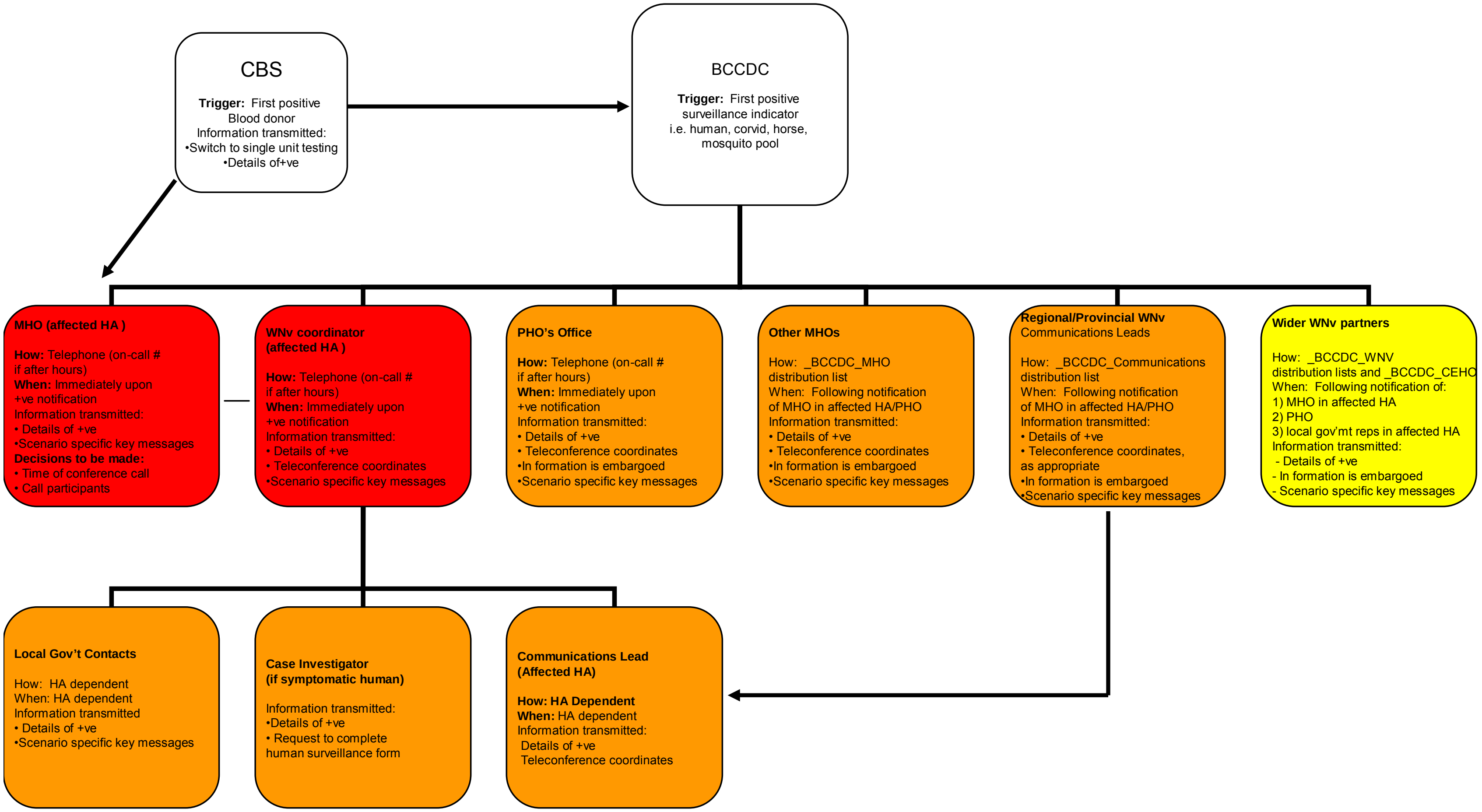
*****First 5 BC cases will be confirmed by HI and PRNT

For test patterns not included above, please refer to the interpretation included on BCCDC reports.
For consultation call Dr. Morshed at 604-660-6074

EIA: Enzyme Immunoassay
HI: Hemagglutination Inhibition
PRNT: Plaque Reduction Neutralization Test
RT-PCR: Reverse Transcriptase Polymerase Chain Reaction

Appendix 2: Communications Fan-Out: Notification of First Positive WNV Result in BC

BCCDC Communications Fan-Out: Notification of FIRST POSITIVE



Colour gradient indicates rapidity of notification

Red=fastest; yellow=slowest