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

West Nile Virus Activity in British Columbia: 2004 Surveillance Program Results

Executive Summary

In 2004, West Nile Virus (WNv) activity was noted in central and western Canada including Ontario, Manitoba, Saskatchewan, and Alberta. However, viral activity levels were considerably lower across North America in 2004 compared with the dramatic expansion of previous years. While source reduction, mosquito control, and public education may have contributed to decreased activity, cooler temperatures across central N. America meant fewer mosquito breeding cycles and reduced amplification and transmission of the virus this year. In all, 20 human cases were reported in Canada in 2004 compared with 1388 the year before. Similarly, the United States reported 2344 cases in 2004 (as of November 23) compared with 9862 the year previous, a more than 4-fold decrease. Despite lower activity levels, the virus did spread over 1200 km from southern California northwards to Oregon State during 2004; approximately 500 km separate the virus from the BC border. South of the 60^{th} parallel, British Columbia and Washington State remain the only areas of western N. America without evidence of infection in avian, mosquito or human populations.

Despite an intensive surveillance program, no evidence of West Nile Virus infection was detected in humans, birds or mosquitoes in British Columbia during 2004.

Although over 27,000 samples from potential BC blood donors were screened for the virus, and 481 symptomatic patients were tested, no evidence of infection was found. Similarly, samples from all organ donors also tested negative for the virus.

While corvid deaths were monitored closely and almost 1,470 specimens were collected across the province and tested for the presence of virus, no positive birds were detected. Seventy-five percent of corvid submissions stemmed from urban areas of the province; poorer coverage was achieved in rural areas around the US and Alberta borders. 97% of submissions were in acceptable condition for testing and 97% had sufficient location information to allow GIS mapping. On average, 15/16 HSDAs received results within one week of identifying a dead corvid (based on median lag times in collection, shipping and laboratory testing). This represents a considerable improvement from 2003.

The abundance and species distribution of mosquitoes collected during 2003/04 is indicative of dry seasons. In 2004, 52,657 mosquitoes were trapped from 145 registered locations across the province. Mosquitoes were separated into 5 genus groupings: *Aedes*/*Ochlerotatus*, *Anopheles*, *Coquilletidia (Mansonia)*, *Culex*, and *Culiseta.* Three species of *Culex* mosquito were further confirmed: *Culex pipiens*, *Culex tarsalis*, *Culex territans.* No mosquito pools tested positive for the presence of West Nile Virus by PCR. The combined median turn around time from collection of a sample in the field to testing is 6 days.

Both *Cx. pipiens* and *Cx. tarsalis* are considered important in WNv transmission in North America. As it breeds largely in catch basins, *Cx. pipiens* dominated in urban areas of the province while *Cx. tarsalis* was found in greater numbers in more open areas with drainage ditches and irrigation. In 2004, *Cx. pipiens* was identified in Prince George, representing a northward extension of the known range of this species.

2004 surveillance data indicated that only 13% of all mosquitoes collected were caught in gravid traps. However, gravid traps caught proportionally more *Cx. pipiens* than any other species – they represented almost 85% of all mosquitoes caught in gravid traps. Surveillance data also indicate significant improvements in trap catch when CO_2 is used as an attractant. This information will inform recommendations for change to trap type and placement for 2005.

Climatic and environmental factors such as day length impact mosquito populations. In 2004, increases in mosquito populations were found to correlate with increases in temperature and rises in the water levels of major bodies of water such as the Fraser River and Okanagan Lake. Significant reductions in *Cx. pipiens* populations occurred when day length dropped below 14 hours.

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Summary of Surveillance Activities

During 2004, surveillance activities for West Nile Virus (WNv) focused on three target groups – humans, dead corvids and mosquitoes. The objectives for WNv surveillance were two-fold:

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

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

Human surveillance involved several stakeholders including BCCDC Epidemiology and Laboratory Services, the Canadian Blood Services (CBS) and the BC Transplant Society. Physician requests for West Nile testing received by BCCDC labs were tracked. Data sharing protocols with Canadian Blood Services were developed to ensure prompt deferral of blood collected from suspected WNv-infected persons and to allow BCCDC to monitor asymptomatic infections identified through screening of the blood supply. All organs intended for transplant were screened by BCCDC labs.

Although no probable cases were identified in 2004, had they been identified, this information would have been communicated to the requesting physician as well as to public health to enable administration of a case questionnaire to collect information on symptoms, travel history, and likely mode of transmission. Cases would be classified as a case of West Nile Fever (WNF) or West Nile Neurological Syndrome (WNNS) according to self-reported symptoms as well as clinical information collected from the patient's physician. Cases would be further categorized as probable or confirmed depending on the level of specificity associated with the laboratory test performed. Case definitions can be found in Appendix 1.

The human testing algorithm used in 2004 entailed screening acute serum samples by Flavivirus EIA - IgM. Convalescent sera were requested and tested in parallel with the acute sample for both IgM and IgG. HI testing was performed on both positive IgM and/or IgG samples as required. All possible and probable positive cases were referred to National Microbiology Laboratory (Winnipeg) for the confirmatory PRNT assay. Cerebral spinal fluid, plasma and samples from organ transplant donors were tested by PCR. All submissions of cerebral spinal fluid (regardless of test requested) were also tested for WNv by PCR. Organs intended for donation were also screened by BCCDC labs prior to transplantation.

Corvid surveillance was achieved through two mechanisms. A sample of dead corvids from across the province was collected each week for West Nile Virus testing. Health Authorities achieved bird collection 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 in Abbotsford using a commercially available dipstick test (VEC test). In addition to birds tested, an on-line form was available at the BCCDC website (www.bccdc.org) for the public to report sightings of dead corvids. With few exceptions, dead corvids sighted by the public and reported through the on-line form were different from those picked up for testing. On-line reports were used to create corvid density maps for regions of the province with sufficient sightings. These will be used as baseline values against which to assess excess corvid mortality in future years, an indicator that virus has been introduced into an area.

During 2004, mosquito surveillance focused on the identification and distribution of adult mosquitoes. From May 1 to October 31, 88 traps collected mosquitoes weekly from 145 registered permanent locations (an increase of 40 publicly funded traps over 2003). Some traps were operated in more than one location on two different days of the week. Traps were run overnight and the catches sent in coolers to BCCDC for identification and WNv testing. Mosquitoes were sorted on a chill table (to prevent denaturation of any viral RNA) and identified to genus or, in the case of *Culex*, to species. Once identified, mosquitoes in the same group were pooled to a maximum of 50 mosquitoes/pool, ground and tested for WNv by PCR. If mosquitoes were not trapped for any reason, the information (i.e. trap malfunctioned, no mosquitoes trapped or trap was not run) was faxed to the lab and recorded.

In 2004, ongoing, prospective, cumulative temperature degree-day maps were developed to help forecast higher risk areas for WNv. Degree day assessments will assist in predicting the number of generations of mosquitoes expected in a given area.

Integration of mosquito, bird, geographic and temperature data was achieved through development of an interactive on-line mapping tool in 2004. This will assist users with geo-spatial risk assessment and help target appropriate mosquito control activities.

Those involved in WNv surveillance and control activities included Regional Health Authority staff, mosquito experts, 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 1: Summary of BC surveillance statistics, 2004

	Human Cases	Corvids Submitted	Corvids Sighted	Mosquito Pools
# Tested		1437	1292	2980
# Positive	0	0		0

Surveillance of WNv in Humans

Laboratory Testing at BCCDC

From May 1 to October 31st, IgG and IgM EIA tests were performed on 481 unique patients. No locally-acquired or travel-related WNv infections were identified.

From April 1 to Dec 2, 2004 26 solid organ donors, 43 living organ transplants and 814 Lifebank (stem cell) specimens were tested for WNv. None were positive.

Laboratory Testing at Canadian Blood Services

During the 2004 transmission season (June 28-Sept 26), Canadian Blood Services screened 27,680 BC and Yukon blood donations for WNv. No cases of asymptomatic infection were detected.

In 2004, a provincial Order-in-Council provided the legal framework allowing BCCDC to inform CBS BC and Yukon Centre about suspect WNv cases for which specimens were submitted to BCCDC for WNv testing. BCCDC provided daily reports to CBS between 20 June and 31 Oct 2004. Overall, 4.5% of suspect cases reported to CBS were blood donors. These donors were deferred for 56 days from the date of testing. One of these donors subsequently attended a CBS clinic within the 56-day deferral period and was not allowed to donate. In addition one donor had donated in the previous 56 days and inventory retrieval was done. No reported transfusion-associated adverse event was reported from recipients of blood products from that donation. A deterministic risk assessment estimates that a small but measurable (~1%) incremental risk reduction for transfusion-transmitted WNv could be gained by public health reporting of suspect cases (individuals with specimens submitted for WNv testing), rather than waiting for positive test results. Based on 2004 data, a further CBS review is underway to compare the risk reduction achieved under different public health reporting scenarios (i.e. between provinces that reported test requests vs. those that reported confirmed infections only).

This year a new process of rolling, weekly WNv blood risk assessments was done by CBS. Public health mosquito, bird and human data and donor test data from Canadian and US blood collection agencies were integrated and stratified by health region in all provinces to estimate region-specific risk to the blood supply. Based on booked donor clinics for the following week, and CBS's capacity to undertake single unit testing for about 15% of total collections, this information enabled CBS to target more sensitive single unit WNv testing to blood collections in areas assessed as having higher relative WNv risk. All other collections underwent WNv minipool (pools of 6 specimens) testing. The light WNv season across Canada in 2004 enabled CBS to target single unit testing to collections from all regions where human cases were reported by public health. No clinics had to be cancelled (which would have been considered had the number of collections from higher risk regions exceeded single unit testing capacity, depending on blood inventory levels and demand).

New in 2004, CBS provided to BCCDC weekly counts of blood donations by HSDA which would have allowed calculation of quasi-population-based infection rates had WNv infections occurred (Table 2).

Table 2: CBS blood donations collected and tested for WNv by HSDA (June 28 to Sept 26, 2004)

HSDA	# Donations Collected
EAST KOOTENAY	0
KOOTENAY BOUNDARY	0
OKANAGAN	3144
THOMPSON CARIBOO SHUSWAP	609
FRASER EAST	1608
FRASER NORTH	2737
FRASER SOUTH	4247
RICHMOND	534
VANCOUVER	5744
NORTH SHORE/ COAST	933
SOUTH VANCOUVER ISLAND	3810
CENTRAL VANCOUVER ISLAND	1159
NORTH VANCOUVER ISLAND	646
NORTHWEST	0
NORTHERN INTERIOR	1617
NORTHEAST	0
Total Collections*	**26788**

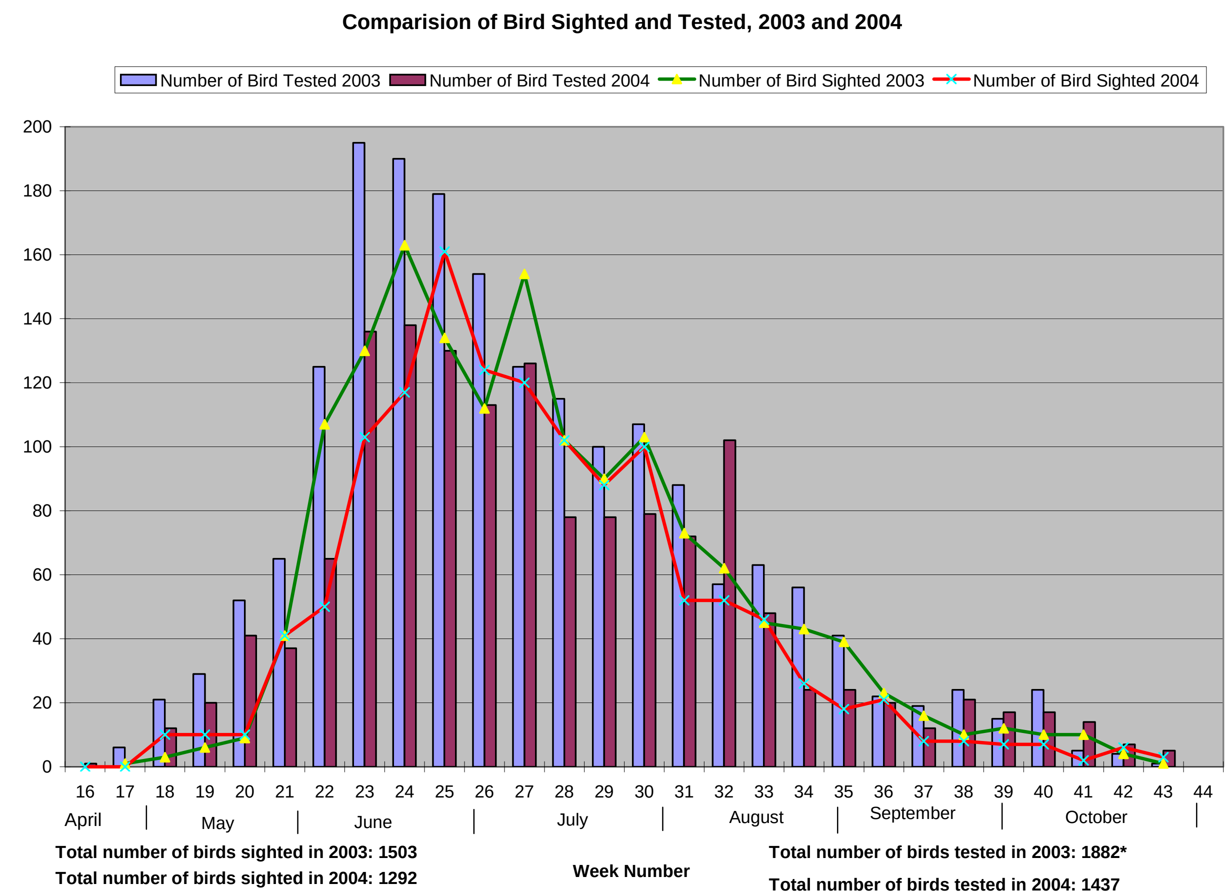
* Total donations do not include plateletphoresis donations, also tested for WNV. Total units tested between 28 June and 26 Sept = 27,680

Surveillance of WNv in Corvids

Reporting of Corvid Deaths

Overall, 1437 corvids were collected and tested in BC from May 1 to October 31, 2004, a decrease of 445 (23.6%) from 2003. A similar decrease was noted in dead corvid sightings across the province (1292 in 2004 vs. 1503 in 2003), a decrease of (14%). Decreases in the number of sightings and specimens tested were not time dependent, occurring throughout the surveillance season. As such, the overall distribution and shape of the curve remain similar from year to year. Increases in dead corvid deaths begin in late May, peak in mid-June and begin a steady decline through October. The provincial distribution of deaths as recorded by the public closely mirrors the weekly distribution of specimens collected for testing (Figure 1).

Figure 1: Comparison of Birds Sighted and Tested, 2003 and 2004



* 1913 total birds tested in 2003; 1882 reported a date the bird was found and were tested within the WNv surveillance season (weeks 17-43; May 1-Oct 31).

97.3% of corvid submissions (1398/1437) were accompanied by sufficient location information to allow GIS mapping. Submission locations were compared with Statistics Canada census metropolitan area boundaries that distinguish urban from rural areas. Approximately 75% of corvids were collected from urban areas of the province (the Vancouver lower mainland, Greater Victoria, Nanaimo, Kelowna, Kamloops and Prince George); this proportion has not changed from 2003 to 2004 (Table 3, 2003 data not shown). As the primary usefulness of corvid surveillance is as an early indicator of WNv in an area, rural corvid surveillance, especially along the border with the United States and Alberta, must be improved in 2005 if detection of the virus is to be timely enough to trigger effective public health action (i.e. increased larviciding and public communications re: protective behaviours). Rural areas present a significant challenge for corvid collections as it is less likely that dead birds will be observed and reported with a sparser population base. In addition, large distances may need to be traveled to pick-up corvids in remote areas and may not always be feasible.

Table 3: Distribution of corvid collections by urban vs. rural setting, 2004.

Birds Submission, Urban Vs. Rural

HSDA	Urban	Rural	Total	Average Weekly Submission*	% Urban	% Rural
EK	0	41	41	1.6	0.0	100.0
KB	0	44	44	1.7	0.0	100.0
OK	89	49	138	5.3	64.5	35.5
TCS	49	67	116	4.5	42.2	57.8
FRE	92	9	101	3.9	91.1	8.9
FRN	268	0	268	10.3	100.0	0.0
FRS	184	0	184	7.1	100.0	0.0
RICH	68	0	68	2.6	100.0	0.0
VAN	210	0	210	8.1	100.0	0.0
NSCG	65	19	84	3.2	77.4	22.6
SVI	41	5	46	1.8	89.1	10.9
CVI	18	16	34	1.3	52.9	47.1
NVI	0	30	30	1.2	0.0	100.0
NW	0	19	19	0.7	0.0	100.0
NI	20	15	35	1.3	57.1	42.9
NE	0	19	19	0.7	0.0	100.0
Total	**1104**	**333**	**1437**	**55.3**	**76.8**	**23.2**

Note:
* Assume the birds were evenly submitted during the 26 weeks of this surveillance season.

Decreases in corvid submissions were noted in all HSDAs in 2004 compared with 2003, except Fraser East and North (Figure 2). This may be a reflection of a true fluctuation in the provincial corvid population but is more likely the result of reduced public participation in the surveillance program. Certainly, media interest was lower in 2004, engendering only 29 interviews compared with over 100 the year before. Good spatial representation was achieved for dead corvid submissions in 2004 when considering cumulative totals. However, individual HSDAs did not always submit consistently over time (Appendix 2). Only urban areas of the province were able to submit at least one corvid per week over the course of the surveillance season.

Public use of the on-line form began somewhat earlier this year than last (Figure 1). In several weeks in June and July, public users reported more dead corvids than were collected for testing (Figure 1). The largest drop in public use of the on-line form from 2003 to 2004 occurred in NSCG, SVI and VAN. FRE and FRN saw the biggest gains in use (Table 4).

Figure 2: Comparison of Birds Tested by HSDA, 2003 and 2004

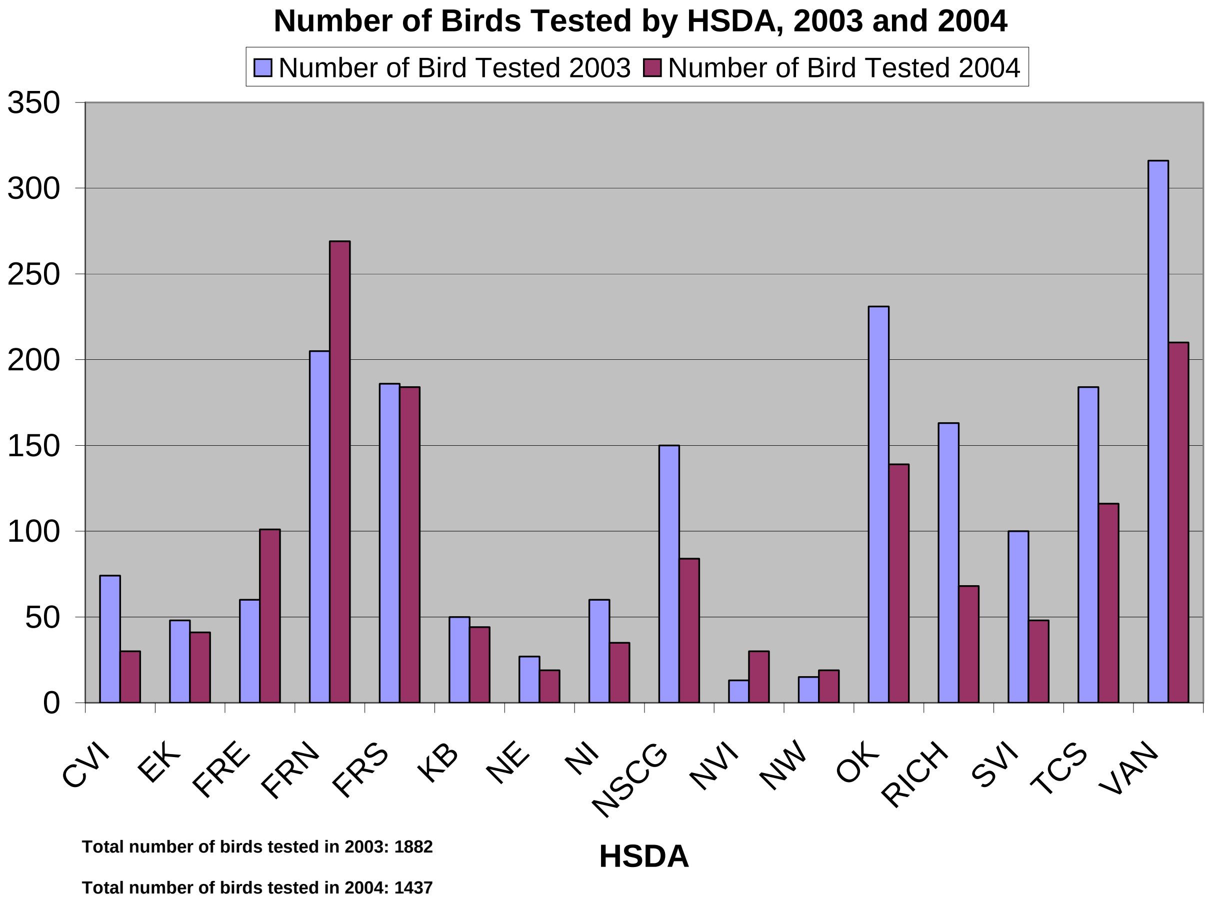


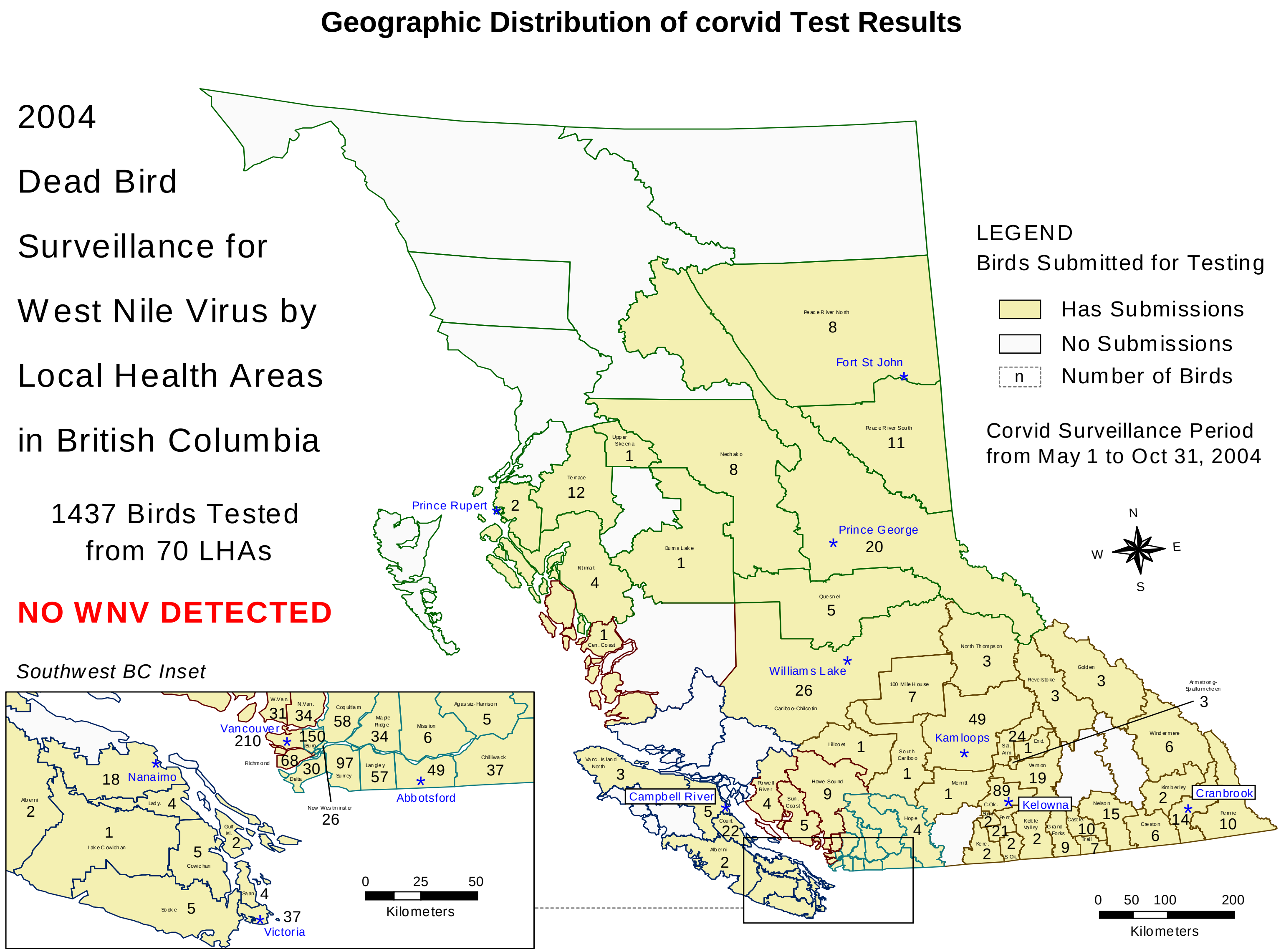
Table 4: Change in number of corvid sightings reported on-line, 2003 to 2004.

Number of Birds Sighted by HSDA, 2003 and 2004

HSDA	Number of Bird Sighted 2003	Number of Bird Sighted 2004	Change (2004-2003)
CVI	34	40	6
EK	20	5	-15
FRE	69	131	62
FRN	146	286	140
FRS	183	158	-25
KB	37	5	-32
NE	2	4	2
NI	6	17	11
NSCG	372	160	-212
NVI	13	4	-9
NW	9	26	17
OK	165	147	-18
RICH	38	28	-10
SVI	115	59	-56
TCS	87	83	-4
VAN	207	139	-68
Total	**1503**	**1292**	**-211**

Note: all public calls to NSCG health unit entered in 2003; practice discontinued in 2004.

Figure 3: Geographic Distribution of corvid Test Results, 2004



Bird Species Breakdown by Region

Close to 90% of all corvid submissions in 2004 were American Crows (*Corvus brachyrhynchos*). The second most commonly submitted bird was the Black Billed Magpie (*Pica pica hudsonia*), comprising almost 5% of total submissions. Magpies made up a large proportion of dead bird submissions from eastern regions of the province – the Northeast (55%), the Okanagan (34%) and Thompson Cariboo Shuswap (7%). The Common Raven (*Corvus corax*) was most often submitted by the Kootenays, and the Northern areas of the province. The species composition of dead bird submissions did not change from 2003 to 2004.

Figure 4: Proportion of Total Corvids Tested by Species, 2004

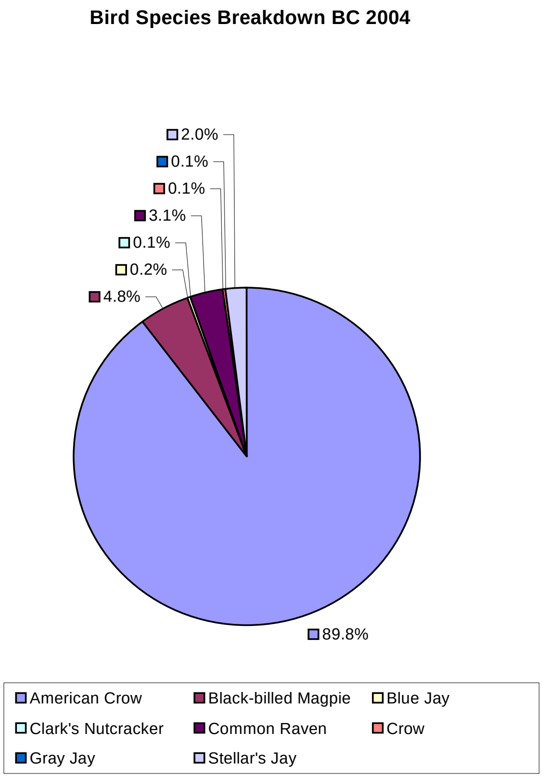


Figure 5: Corvid Species Submitted for Testing, 2004

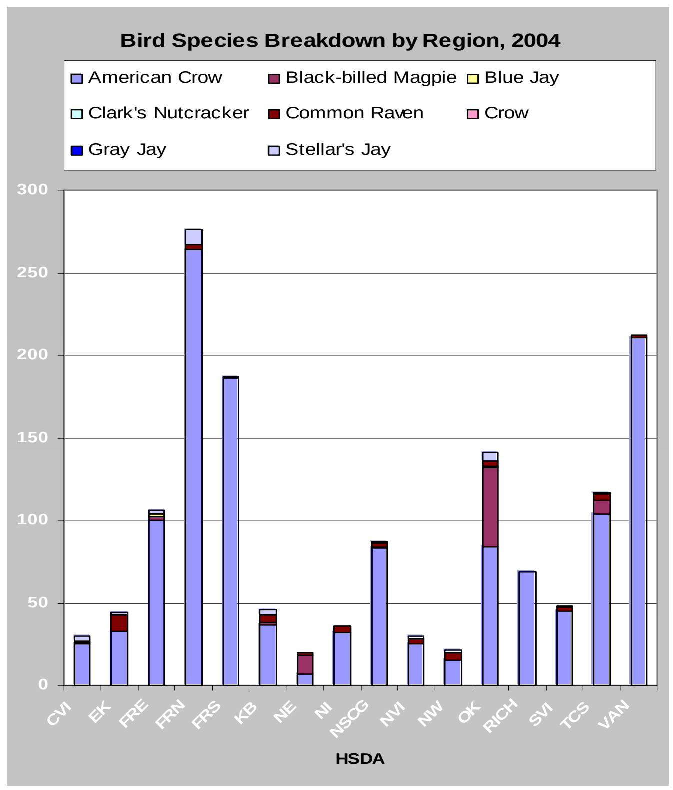


Figure 6: Distribution of Cx. pipiens in BC, 2004

Appropriateness of Specimens Submitted

Sometimes, corvid specimens can arrive at the laboratory in a state unsuitable for testing. This can occur for a variety of reasons including desiccation, decomposition and the submission of headless birds (which are unable to be swabbed), among others. Over the last two years, very few corvids submitted in BC were unable to be tested; the appropriateness of specimens was 98.5% and 97.8% in 2003 and 2004, respectively (Table 5). In 2004, only Alberta achieved a higher proportion of appropriate specimens (99.6%) however they tested less than half the number done in BC (670 vs. 1437). Appropriateness of specimens in other provinces ranged from 92.2% to 99.6%. The success experienced by the BC surveillance program is likely due to regular bi-weekly teleconferences between the Animal Health Centre and field staff involved in surveillance where problems with specimen submissions were discussed. Although, EK, NE and NW saw the biggest drops in appropriateness from 2003 to 2004(from 5% - 10%), the absolute change was small.

Table 5: Appropriateness of Bird Specimens Submitted for Testing by HSDA, 2003 and 2004.

Comparision of Appropriateness of Bird Specimen Submitted by HSDA, 2003 and 2004

HSDA	2003	2004	Ratio Difference (2004 - 2003)
CVI	100.0%	100.0%	0.0%
EK	100.0%	93.2%	-6.8%
FRE	98.4%	95.3%	-3.1%
FRN	98.6%	97.5%	-1.1%
FRS	95.7%	98.4%	2.7%
KB	98.0%	95.7%	-2.4%
NE	100.0%	95.0%	-5.0%
NI	96.8%	97.2%	0.4%
NSCG	98.7%	96.6%	-2.2%
NVI	100.0%	100.0%	0.0%
NW	100.0%	90.5%	-9.5%
OK	97.9%	98.6%	0.7%
RICH	100.0%	98.6%	-1.4%
SVI	100.0%	100.0%	0.0%
TCS	97.9%	99.1%	1.3%
VAN	99.4%	99.1%	-0.3%
Overall %	**98.5%**	**97.8%**	**-0.8%**
Overall Number	**1942**	**1470**	

Table 6: Reasons for which corvids were not able to be tested, 2003/4.

Reasons Birds not Tested, 2003 and 2004

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

Lag Times for Corvid Submission and Testing

Considerable improvement was made between 2003 and 2004 with respect to the timeliness of corvid submissions (Table 7). The elapsed time between when a corvid was found until it was received by the lab was reduced by an average of two days province-wide (from 8 days in 2003 to 6 days in 2004). Encouragingly, improvements were also seen in median delays, which are less affected by outliers (i.e. one or two birds with severe submission delays). This indicates that reductions in observed lag times were not simply the result of reducing a few severe submission delays, but that improvements were more consistent. Improvements in median delays were most evident in East Kootenay (5.5 days faster than 2003), the Okanagan (3 days faster than 2003) and Richmond (3 days faster than 2003).

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

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

Table 7: Lag times in the submission and testing of corvid specimens, 2004.

Bird Transit Lag Time by HSDA, 2003 and 2004

HSDA	Avg Transit Lag		Max Transit Lag		Min Transit Lag		Median Transit Lag	
	2003	2004	2003	2004	2003	2004	2003	2004
CVI	5.8	5.7	39	31	1	1	5.0	3.0
EK	16.9	8.2	73	31	1	2	13.5	6.0
FRE	5.6	3.7	27	13	0	0	4.5	3.0
FRN	12.2	6.3	72	19	1	0	7.0	6.0
FRS	12.0	6.8	93	18	1	1	7.0	6.0
KB	9.3	8.4	35	42	1	2	6.0	7.0
NE	2.5	5.6	6	19	1	1	2.0	3.0
NI	6.1	4.5	32	13	1	1	4.0	4.0
NSCG	6.4	8.2	32	58	1	1	5.5	5.0
NVI	7.8	6.5	22	17	2	1	7.0	6.0
NW	2.7	3.6	10	10	1	1	2.0	3.0
OK	7.9	6.1	38	29	1	1	7.0	4.0
RICH	6.6	6.3	18	27	1	2	7.0	4.0
SVI	4.6	7.1	18	34	1	2	4.0	6.0
TCS	9.7	7.5	61	26	0	1	7.0	6.0
VAN	6.2	5.4	29	16	0	1	6.0	4.0
Total	**8.2**	**6.3**	**93**	**58**	**0**	**0**	**6.0**	**5.0**

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

Density Maps of Bird Submissions and Sightings

The locations of dead birds submitted for testing and sighted by the public were mapped using a Geographic Information System (GIS). Kernel density mapping of dead corvids was performed to identify areas of concentrated bird mortality (Appendix 3). In the event of West Nile virus (WNv) activity, "hotspots" of corvid mortality may indicate localized concentration of the virus in an area. Studies from other parts of North America have shown corvid surveillance to be a reliable early warning system for WNv appearance/introduction in a region. The corvid density data collected in 2003 and 2004, prior to introduction of WNv, is useful for identifying areas with higher baseline bird mortality.

Recommendations for Corvid Surveillance in 2005

- Efforts must be made to increase corvid collections in rural areas of the province, especially along the US and Alberta borders. Consideration may be given to more active surveillance in sentinel rural communities.

- Baseline data from 2003/4 on dead bird sightings/week (from the on-line form) will be used to generate surveillance alerts in 2005. When the number of on-line reports exceeds baseline values, increased corvid testing from the affected geographic area should be initiated.

Surveillance of WNv in mosquitoes

The BCCDC laboratory received collections of adult mosquitoes from Regional Health Authorities and municipal staff, and then separated them into sexes and taxonomic groupings before processing females for the presence of West Nile virus. Five taxonomic groupings were found: 1) *Aedes* and *Ochlerotatus,* 2) *Anopheles,* 3) *Coquilletidia perturbans,* 4) *Culiseta* and 5) *Culex*. The *Culex* was separated into species because two of them are highly competent vectors of West Nile virus in North America. There were a total of 2262 submissions from mosquito traps in 2004 (resulting in 2980 pools tested), more than twice the samples in 2003. A total of 52,657 mosquitoes were identified from these trap collections.

Geographic Distribution of Species

Culex pipiens

Species in the genus *Culex* have been identified as the primary vector for WNv across North America. There are likely four species from this genus in BC; the most common is the northern house mosquito, *Culex pipiens.* This is an urban species that prefers an avian host and is thought to amplify the virus by feeding on and infecting birds. This species has become adapted to using storm sewer Catch Basins (CB) as egg laying habitat - even pools associated with highly polluted sanitary systems are used.

Cx. pipiens was only collected in one spot at the turn of the last century in the Fraser River Lower Mainland (Hearle, 1926). This may simply reflect the undeveloped state of the Lower Mainland at that time. According to Wood, et al., 1979 and Belton 1983 there are two populations of *Cx. pipiens* in Canada, a west coast population and an eastern, St Lawrence River population; however, *Cx. pipiens* is found across the northern United States. Our most recent published distributions of mosquitoes in BC and their vector competence can be found on Belton's 2004 web page (http://www.sfu.ca/~belton). The collection of specimens from Chetwynd and Meziadin Lake in northern BC is noteworthy as *Culex pipiens* is previously unknown from such northern locations (Figure 6). The specimens were limited and this will require more investigation in 2005; samples should be submitted to the National Collection.

Figure 6 depicts the distribution of *Cx. pipiens* in 2004. The map insert of the Lower Mainland, shows that *Cx. pipiens* was the dominant species in trap collections from urban settings. In the rural Fraser Valley there are fewer catch basins and fewer specimens of *Cx. pipiens* were collected. In the Interior of the province we caught more *Cx. pipiens* in the urban settings of Kelowna and Penticton than in most of the other surrounding area.

Culex tarsalis

In Canada, where the central, Missouri Coteau plateau extends north from the US, *Cx. tarsalis* is widely distributed. Wood et al. (1979) even confirmed a specimen from the Mackenzie Delta in the north. For decades *Cx. tarsalis* was implicated as the primary vector of Western Equine Encephalitis (WEE) in Canada, and is now considered the primary vector of WNv in most of Canada, especially in the Prairie Provinces. One reason *Cx. tarsalis* is important is its tendency to bite birds and mammals, and therefore amplify the virus in the avian population and "bridge" the virus from a bird to other animals. This species is found in open prairie ponds or can take advantage of man-made pools, like drainage ditches or irrigation projects. The distribution map (Figure 7) for *Cx. tarsalis* indicates two such areas where we collect larger numbers of this species – among drainage ditches in Richmond and in the Thompson Cariboo Shuswap where irrigation activities are occurring.

Culex tarsalis is considered the most competent vector for WNv in Canada. The largest numbers of this species were collected in three areas of the province: Richmond, Fraser South, Thompson Cariboo Shuswap and the Okanagan (Figure 9).

Culex territans

A third species from this genus, *Cx. territans* does not seem to pose a problem vectoring WNv in North America. This species feeds exclusively on amphibians and reptiles and might act in amplifying WNv in these populations but is not known to be a competent vector for this virus.

Coquilletidia perturbans

There are some other species of mosquito that are of concern in British Columbia. For example, *Coquilletidia perturbans* is a competent vector of WNv and its feeding preferences include both birds and mammals. As previously mentioned, this species has one generation per year and survives the winter as larva attached to the submerged root or stem of a Cat-tail. The popular *Bacillus thuringiensis* larvicides do not work with *Cq. perturbans* because larvae are not feeding at the surface of the water where the pesticide is actively distributed. Figure 8 illustrates two regions in the province where this species is abundant and where Cat-tails are common.

Other mosquito species

The Fraser River flows almost 1400 kilometers from Mount Robson to Vancouver. Its annual inundation produces enormous populations of the floodwater mosquito *Aedes vexans* and woodland mosquito *Ochlerotatus sticticus*, this seasonal cycle accounts for the large numbers in Thompson Cariboo Shuswap (TCS) and Eastern Fraser Valley (FRE) regions of BC (Figure 9). *Ochlerotatus togoi* is found in rock pools above the splash zone, near ports around Georgia Strait and many Gulf Islands. This species is not that abundant but might be important as a bridging vector because it is a known vector for Japanese encephalitis.

Culiseta incidens is a very common mosquito of artificial containers or drainage ditches. This is another species whose ability to vector WNv is unknown. In 2004 we did not catch many *Culiseta*, probably because this was another dry summer.

Ochlerotatus togoi and *Culiseta incidens* both have multiple generations during the year. They have the potential to be important species in the transmission of WNv to humans. Not knowing their vector competence is an important gap in our knowledge about mosquitoes in BC. The vector competence of *Culex pipiens* on the West Coast is also uncertain.

Figure 6: Distribution of Cx. pipiens in BC, 2004

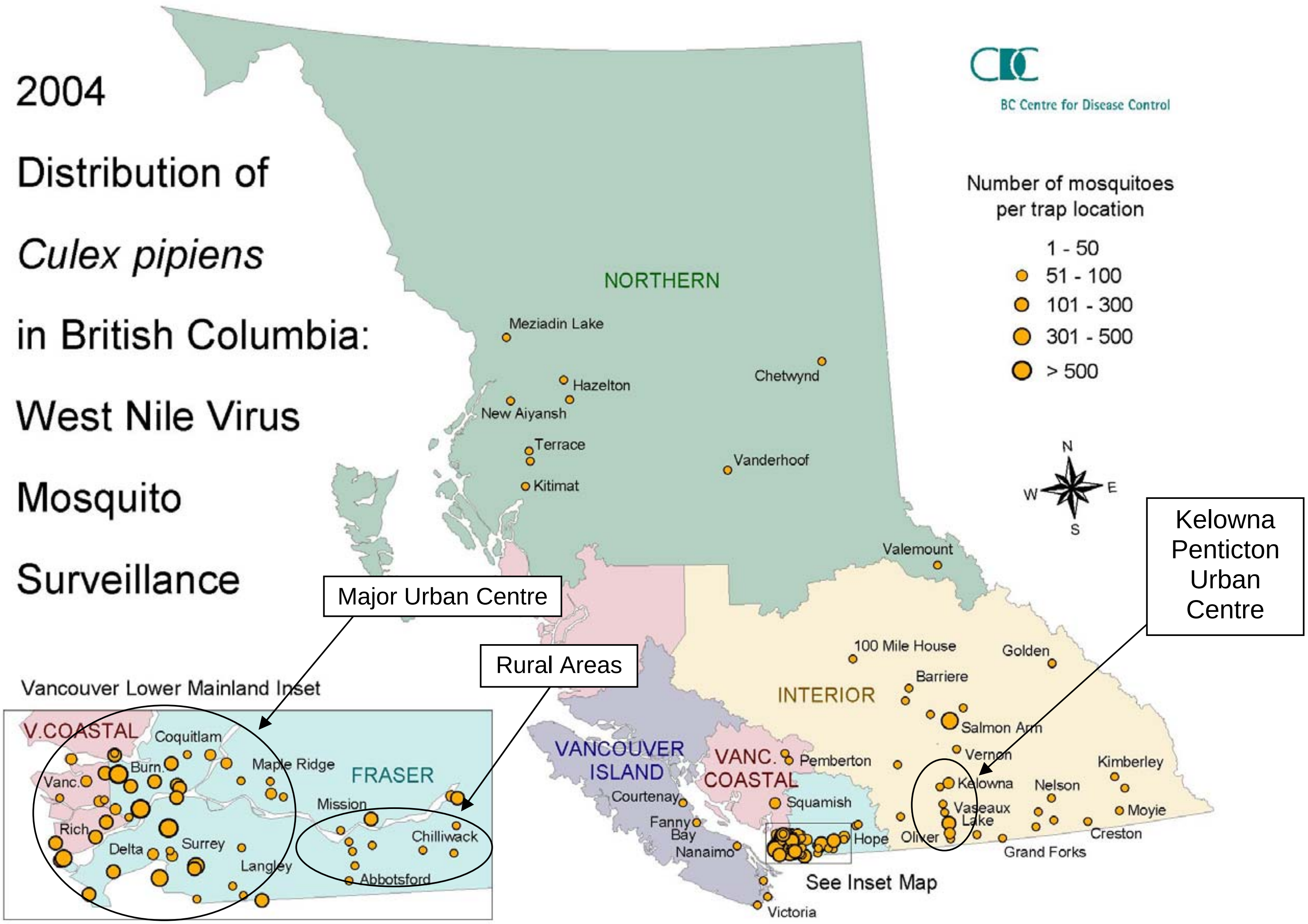


Figure 7: Distribution of Cx. tarsalis in BC, 2004

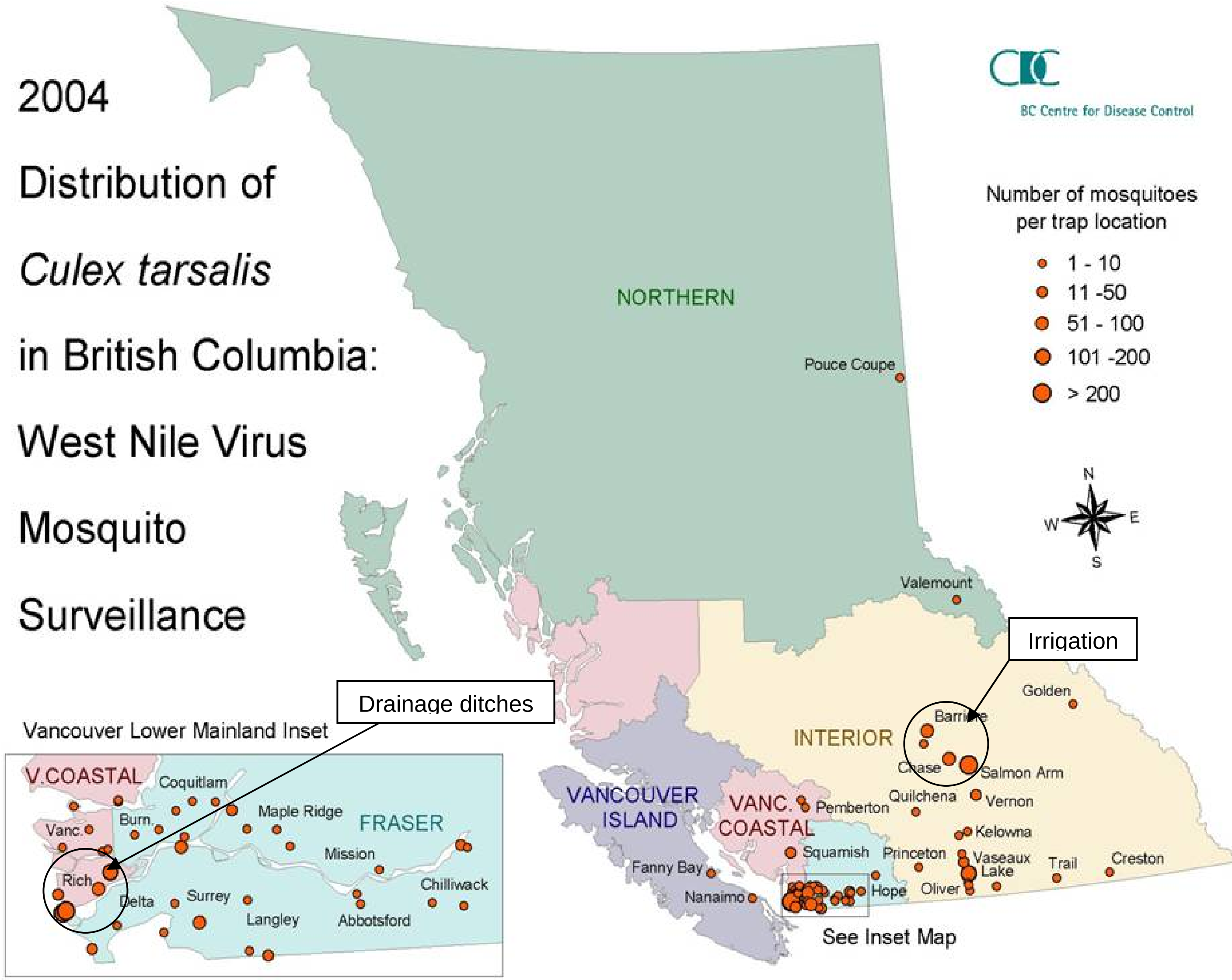


Figure 8: Distribution of Coquilletidia perturbans in BC, 2004

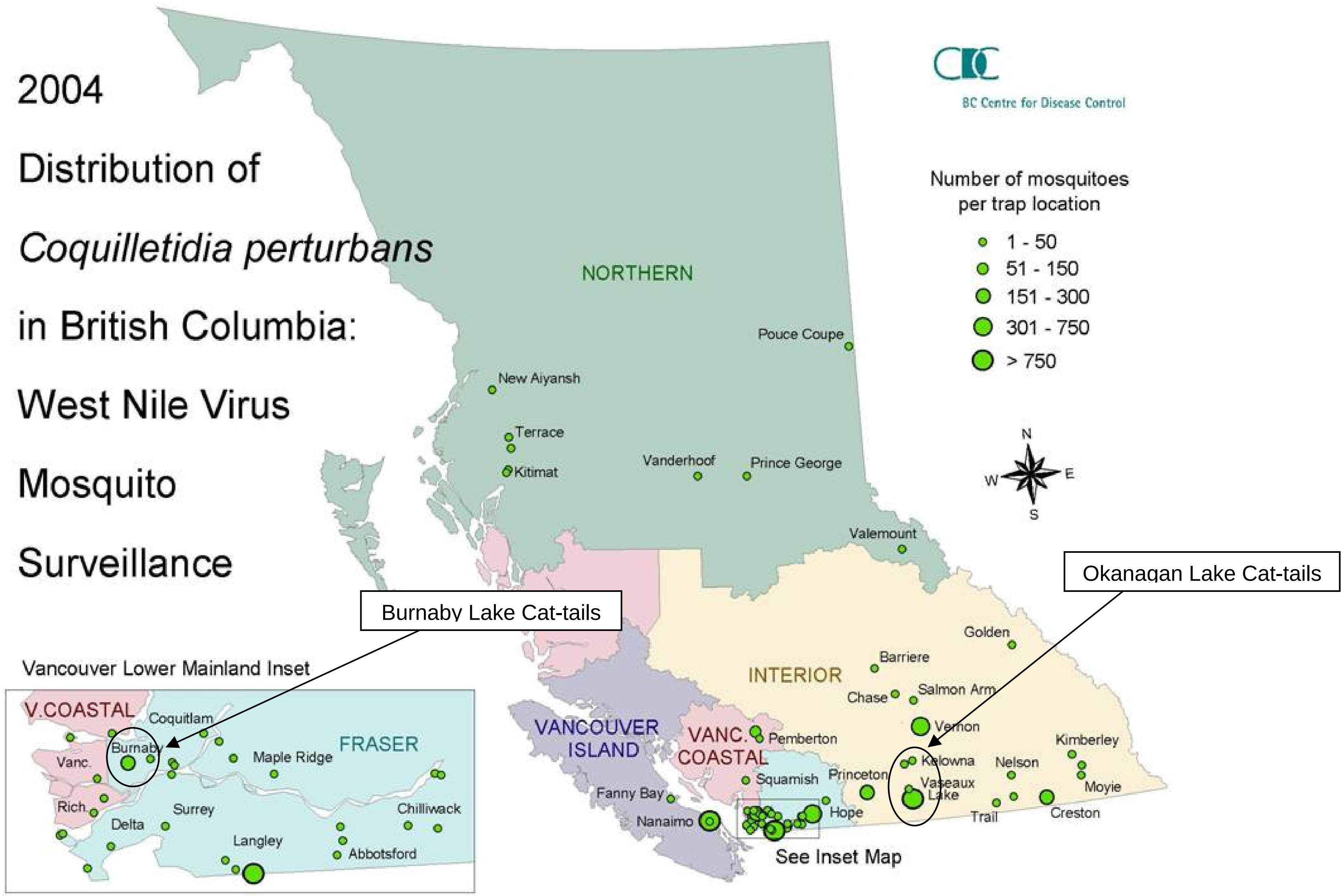
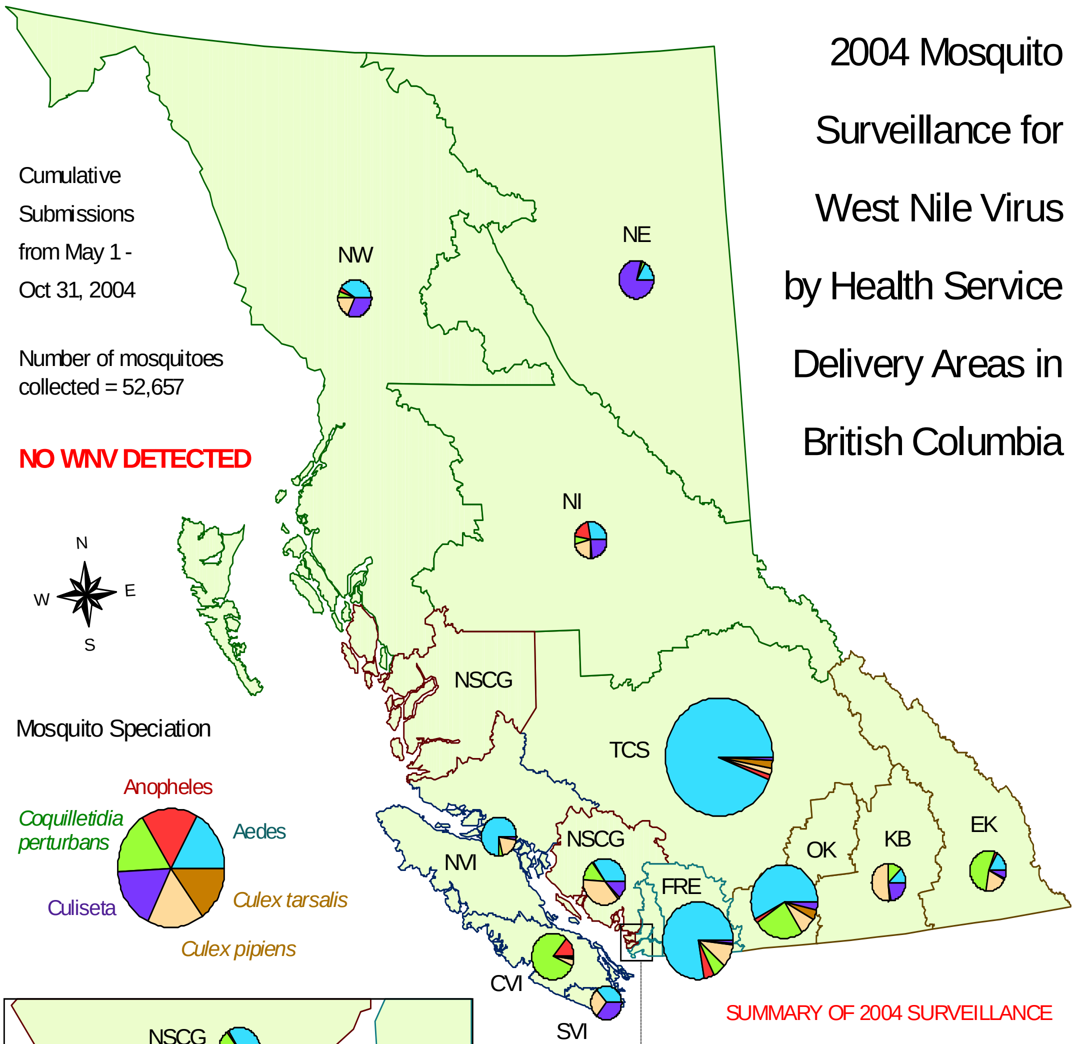
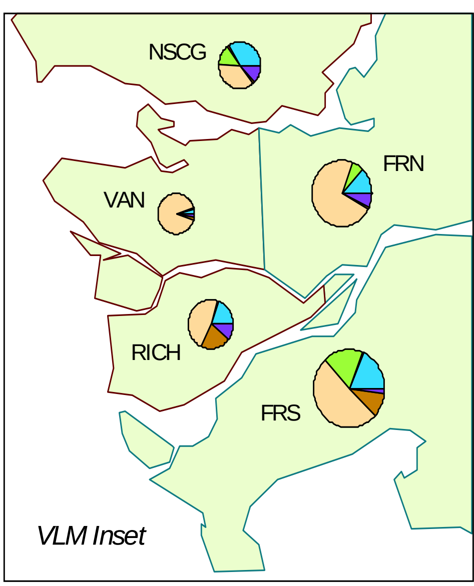


Figure 9: Distribution of Mosquito Species in BC, 2004





SUMMARY OF 2004 SURVEILLANCE

HSDA	Aedes	Anoph.	Coqui.	Culex pipi.	Culex tars.	Culex terr.	Culis.
EK	63	9	202	76	3	0	18
KB	31	0	28	108	3	5	52
OK	3862	121	1454	516	239	0	190
TCS	20056	237	42	540	362	0	167
FRE	6280	329	423	645	65	0	84
FRN	651	20	281	3219	62	1	222
FRS	1309	75	1305	3750	728	7	147
RICH	257	1	14	686	299	0	134
VAN	18	1	5	373	8	0	9
NSCG	336	9	142	366	23	0	123
SVI	14	0	0	11	0	0	14
CVI	4	148	797	41	7	0	10
NVI	211	3	9	53	1	0	8
NW	67	6	10	30	0	0	54
NI	37	23	9	28	1	0	31
NE	39	0	5	2	3	0	190

Phenology of BC mosquitoes

The phenology of mosquitoes is the relationship of biological phenomena to climatic conditions. This section will discuss the effects of overwintering, the temporal distribution of mosquito species in BC and the impacts of temperature and daylight on mosquito populations.

Overwintering

There are 3 strategies used by mosquitoes to survive the winter. As previously mentioned, *Coquilletidia perturbans* survives as a larva attached to the stem of Cat-tails under the surface of the water and produces one generation per year. Most of the *Aedes* and *Ochlerotatus* spend the winter as eggs. All other *Anopheles, Culex and Culiseta* with the exception of *Culiseta morsitans*, overwinter as an adult, and usually only females survive the winter. The farther north these species occur, the longer they spend as overwintering adults and the shorter the subsequent breeding season (resulting in fewer generations in northern regions). *Culex pipiens* is one such a species and this year we have some northern distribution records which may indicate how adaptable this species is becoming.

Temporal distribution of mosquito species

In 2004 some traps were set-up for surveillance at the end of April, but the majority in the beginning of May. Over-wintering adult mosquitoes may appear as early as February or March in a warm year. Almost all taxa were collected in early May at some location in the province (see Table 8) but there is only one generation of *Coquilletidia perturbans* in BC and they did not appear until June.

Figures 10 and 11 illustrate the distribution of all taxa over time for 2004 and 2003, respectively. Although the scales are different the general pattern is similar. The biggest differences are the numbers of *Culiseta* (lower in 2004), and *Aedes/Ochlerotatus* (higher in 2004). These graphs give a good indication of expected trends that will occur in adult mosquitoes in dry years.

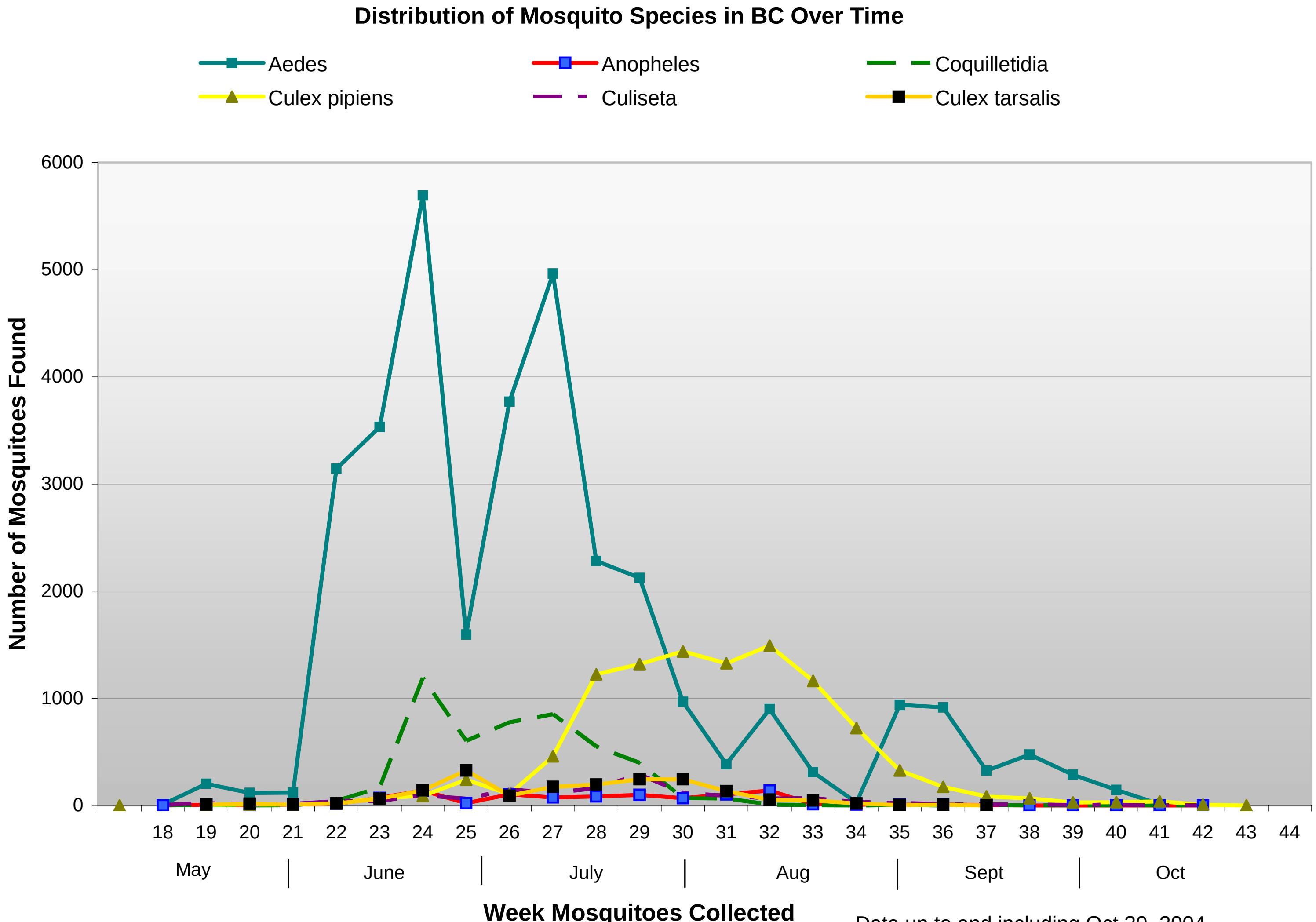
Table 8: Earliest Date and Location of Different Mosquito Species in BC, 2004

Comparison of time and location of first identification of mosquito by HSDA, 2004

HSDA	Aedes and Ochlerotatus species	Anopheles species	Coquilletidia perturbans	Culex pipiens	Culex tarsalis	Culex territans	Culiseta species
CVI	12-May-04	12-May-04	02-Jun-04	25-Jun-04	12-May-04		25-Jun-04
EK	27-May-04	22-Jun-04	08-Jun-04	08-Jun-04	17-Jun-04		17-Jun-04
FRE	03-Jun-04	26-May-04	08-Jun-04	01-Jun-04	03-Jun-04		15-Jun-04
FRN	10-Jun-04	15-Jul-04	15-Jun-04	10-Jun-04	17-Jun-04	20-May-04	20-May-04
FRS	04-Jun-04	04-Jun-04	08-Jun-04	18-May-04	14-May-04	10-Jun-04	20-May-04
KB	13-May-04		20-Jul-04	10-Jun-04	10-Jun-04	10-Jun-04	15-Jun-04
NE	21-Jun-04		05-Jul-04		28-Jun-04		03-Jun-04
NI	02-Jun-04	17-Jun-04	29-Jun-04	28-Jul-04	19-Aug-04		10-Jun-04
NSCG	19-Jun-04	20-Jun-04	20-Jun-04	10-Jun-04	20-Jun-04		16-Jun-04
NVI	13-May-04	16-Jun-04	16-Jun-04	13-May-04	13-Jul-04		19-May-04
NW	09-Jun-04	23-Jun-04	30-Jun-04	18-Jul-04			31-May-04
OK	20-May-04	20-May-04	01-Jun-04	15-Jun-04	20-May-04		11-May-04
RICH	20-May-04	19-Aug-04	24-Jun-04	13-May-04	13-May-04		13-May-04
SVI	08-Jun-04			24-Jun-04			14-May-04
TCS	20-May-04	20-May-04	10-Jun-04	10-Jun-04	20-May-04		20-May-04
VAN	16-Jun-04	14-Jul-04	24-Jun-04	18-May-04	28-Jun-04		16-Jun-04

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

Figure 10: Distribution of Mosquito Species in BC over Time, 2004

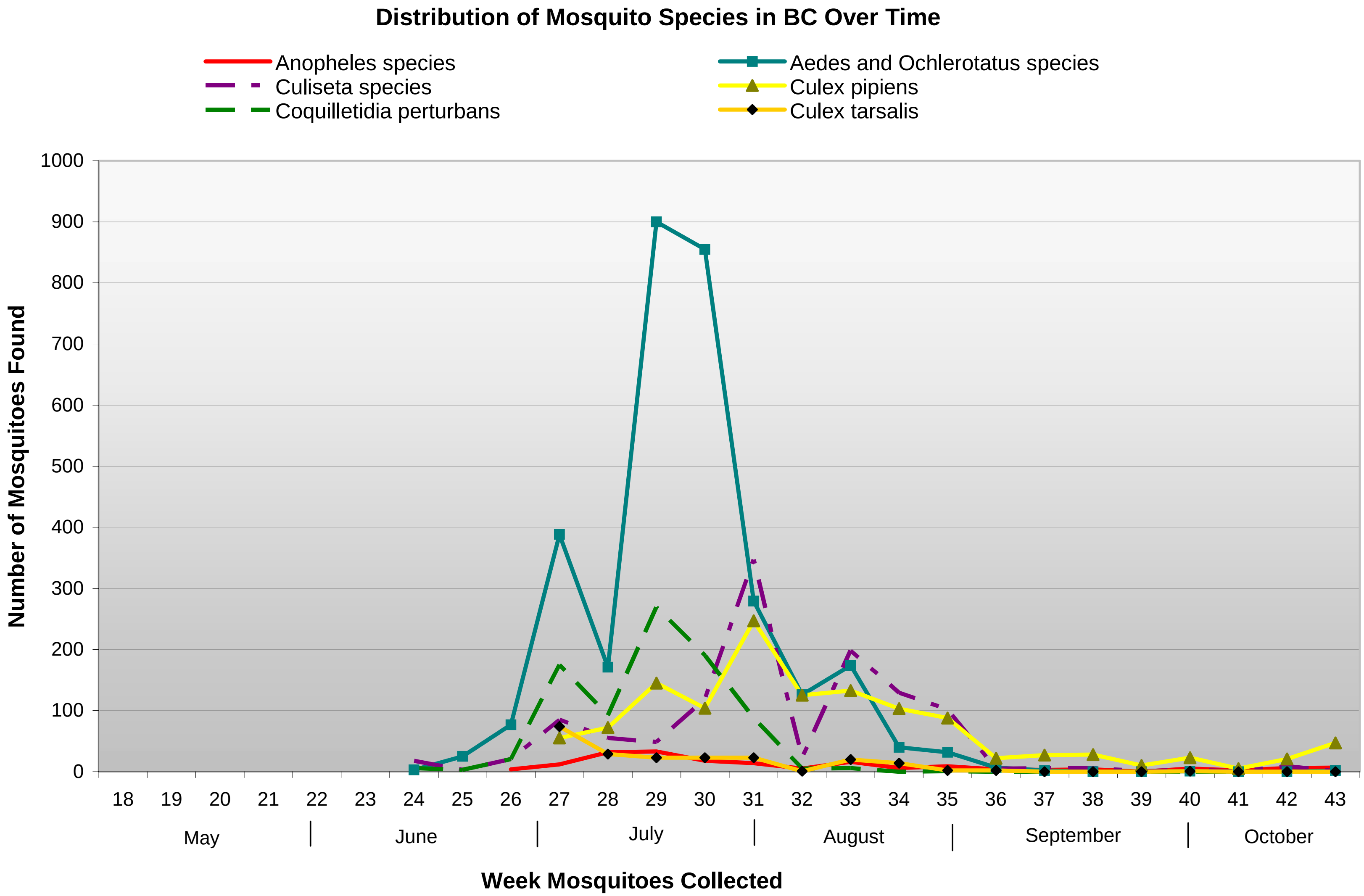


Total Number of Mosquitoes Collected = 52643
Including male and female pools

Data up to and including Oct 30, 2004

Weeks run Sunday to Saturday

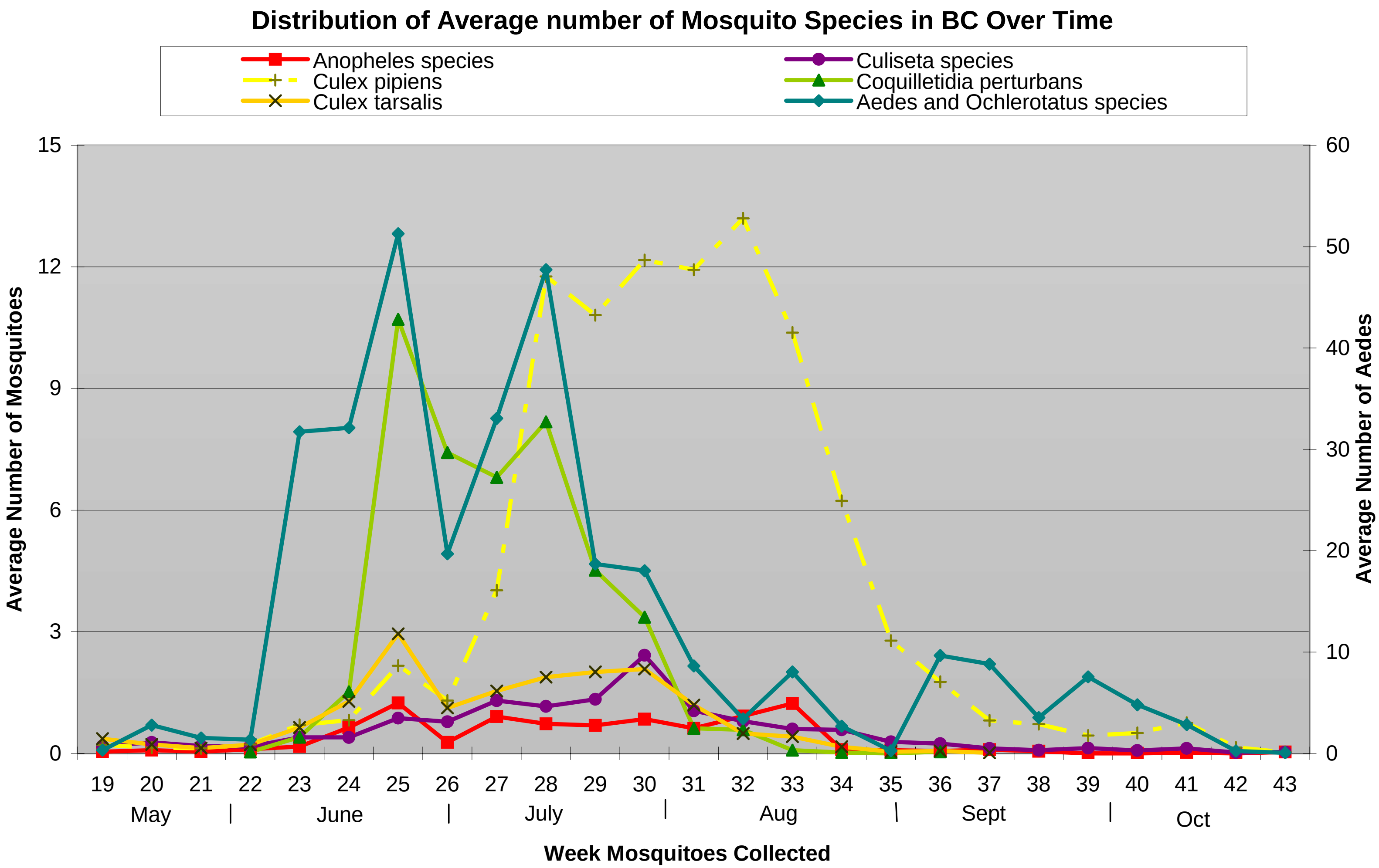
Figure 11: Distribution of Mosquito Species in BC over Time, 2003



Total Number of Mosquitos Collected = 6766

Data up to and including Nov 5, 2003
Weeks run Sunday to Saturday

Figure 12: Average Number of Mosquitoes Species Trapped per Week, 2004



Including male and female pools

Data up to and including Oct 30, 2004

Weeks run Sunday to Saturday

Figure 12 shows the average number of mosquitoes of each species caught per week. This is calculated as the total number of mosquitoes of a given species divided by the number of traps operated in a particular week. Plotting averages smoothes out any large peaks from single traps. The smaller numbers for most taxa have been amplified by plotting them with a larger scale than *Aedes/Ochlerotatus* group. Species distribution over time for individual HSDA's can be found in Appendix 5.

Impact of climate, temperature and daylight on mosquito populations

In each region of the province different environmental factors drive the cycle of mosquitoes. For example, changes in the hydrological cycle can affect mosquito populations. The accumulation of precipitation over the winter and the rate of snowmelt (influenced by temperature) affect the volume of water discharged during the spring. Rainfall during the spring and summer is also important but the effect is very localized and difficult to track. For many mosquitoes that overwinter as eggs (*Aedes* and *Ochlerotatus*), a large melt of snow with exceptionally warm weather will flood more area and hatch more eggs. Temperature is important not just to the hydrological cycle but also for the development of cold blooded insects like mosquitoes. The sooner optimal temperatures occur, the earlier the development cycle will begin for overwintering adult mosquitoes and the greater the number of possible generations. Many animals use cues from the environment to predict the approach of winter; with multivoltine (multiple generations) mosquitoes, day length is used to signal the overwintering stage called diapause. Successive generations continue throughout the summer until the decreased day length forces them into diapause.

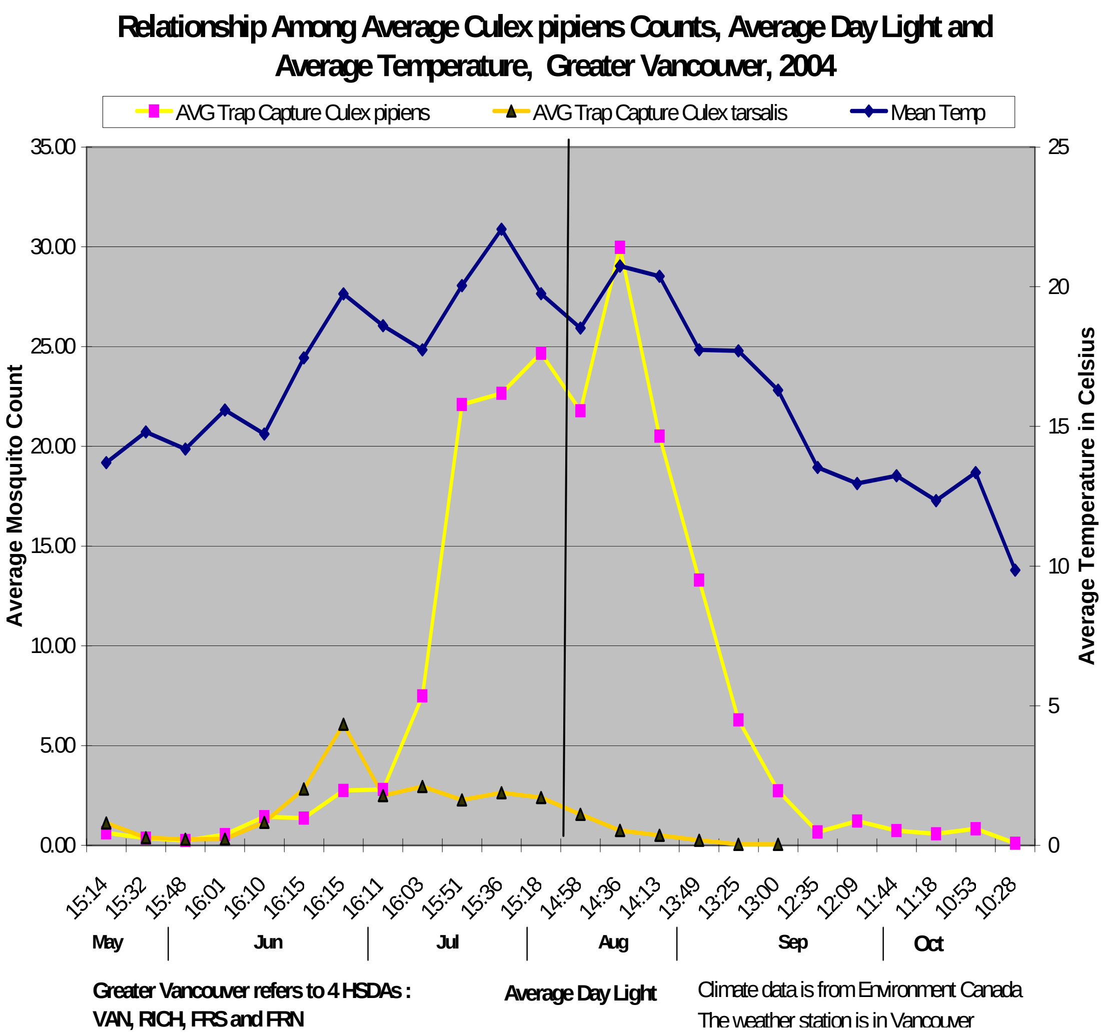
Weather station data can be compared with information on adult mosquitoes in regions of the province with a sufficient distribution of traps. The following 3 'case studies' explore the relationship between climate, temperature and day length in the GVRD, Thompson Cariboo Shuswap and Okanagan regions of the province. In the lower Fraser Valley we compared collections from around the mouth of the Fraser river to the Vancouver weather station. In the middle Fraser and Okanagan regions we used the Kelowna weather station.

I. Greater Vancouver Regional District

In most of the Lower Mainland, the Fraser River drives the hydrological cycle which affects mosquito populations in this area. Figure 13 plots the catch of *Culex* species in the region surrounding the mouth of the Fraser River (Vancouver, Richmond, Surrey and the Tri-City region) along with temperature and day length. *Culex tarsalis* appear about the middle of June; this corresponds with a rise in temperature above 16 ºC. The National mosquito subcommittee has been using this as a base temperature for degree day calculations to predict the number of generations of *Cx. tarsalis* during a year. The catch of *Cx. tarsalis* trails off by the middle of August, the data offer no real estimate at the number of generations that occur during this period. The early June peak corresponds closely with an early rise in temperature in the Lower Mainland and a similar rise in the Fraser River which causes many of the drainage ditches in this region to fill.

Culex pipiens numbers grew rapidly after the 1st week in July, and then dropped off dramatically at the end of August. This species has adapted to winters by entering an overwintering diapause state, we see a dramatic reduction after the day length reached about 14 hours. Unpublished research in the Lower Mainland is suggesting the 14 hours of day length is an important cue for the onset of diapause. Some females that emerged prior to this photoperiod will continue to lay eggs but all others that emerge will hibernate. These last remaining long-day females may be the most dangerous because they are more likely to be infected with WNv than unfed overwintering specimens, and there is some evidence that they will bite humans during this stage even though they prefer an avian host.

Figure 13: Relationship Among Average Culex pipiens Counts, Average Daylight and Average Temperature, Greater Vancouver, 2004

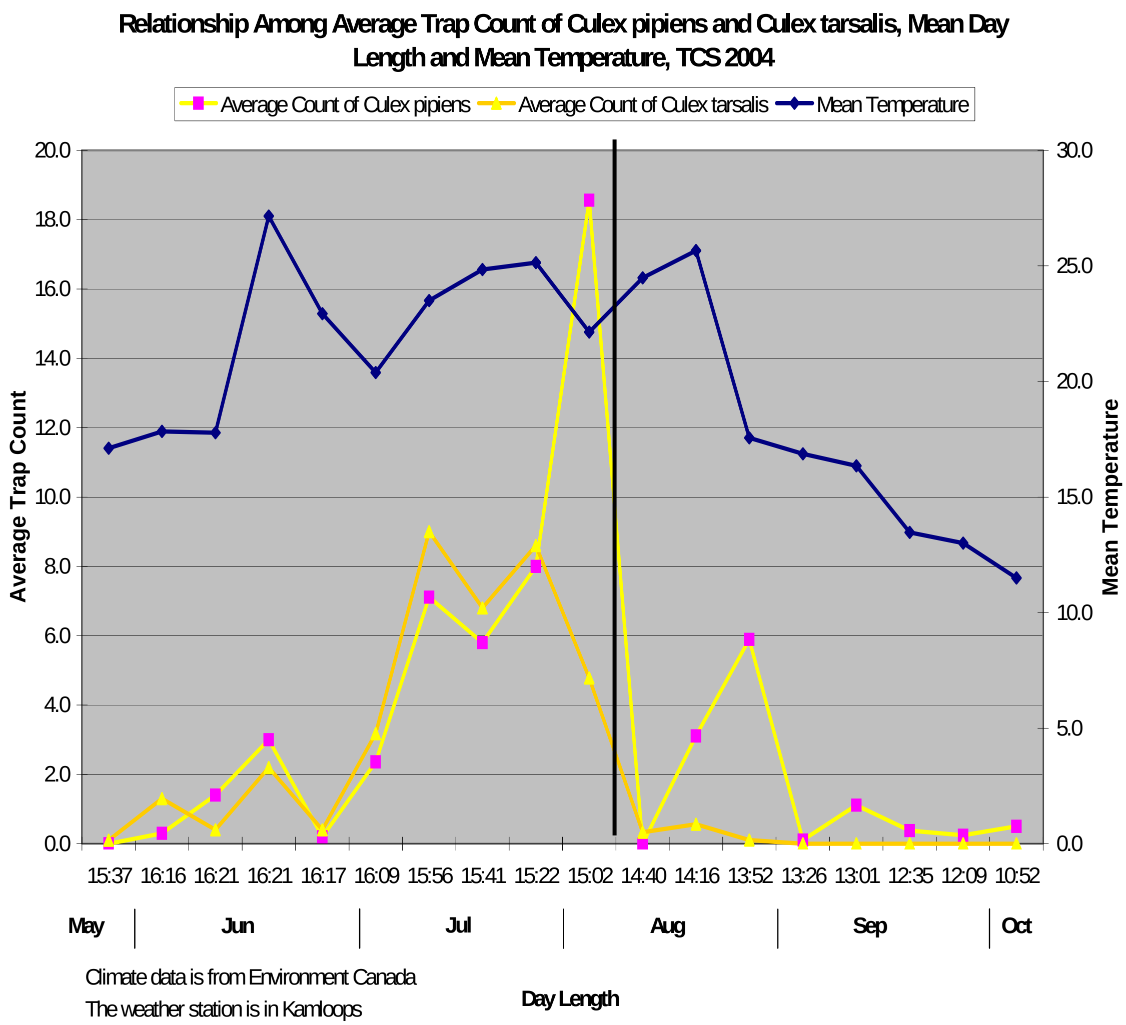


II. Thompson Cariboo Shuswap

The Thompson and part of the Cariboo/Shuswap area lie along the middle Fraser River. *Cx. tarsalis* began to be collected in May for this region and a similar peak to the lower Fraser (GVRD) occurred in June, when temperatures were already beyond the 16 degree base for *Cx. tarsalis* activity. By mid August this species dramatically decreased in numbers. The average numbers of *Cx. tarsalis* were higher in Thompson Cariboo Shuswap (TCS) than in the Lower Mainland (average highs of 9 mosquitoes/trap were reached in TCS as opposed to 3 in the Lower Mainland). The surveillance chart shows 4 distinct peaks for this region.

Cx. pipiens trend in the mid Fraser was different from the Lower Fraser and this may well reflect the difference between a highly urbanized area and a rural setting. Average numbers of *Cx. pipiens* were less in TCS than in the lower Fraser Valley as would be expected since fewer Catch Basins breeding sites exist. As well, the number of *Cx. pipiens* did not steadily increase as the season progressed, but peaked in early July. Unlike the lower Fraser there was another slight rise in numbers after the 14 hour photoperiod.

Figure 14: Relationship Among Average Culex pipiens Counts, Average Daylight and Average Temperature, Thompson/Cariboo/Shuswap, 2004



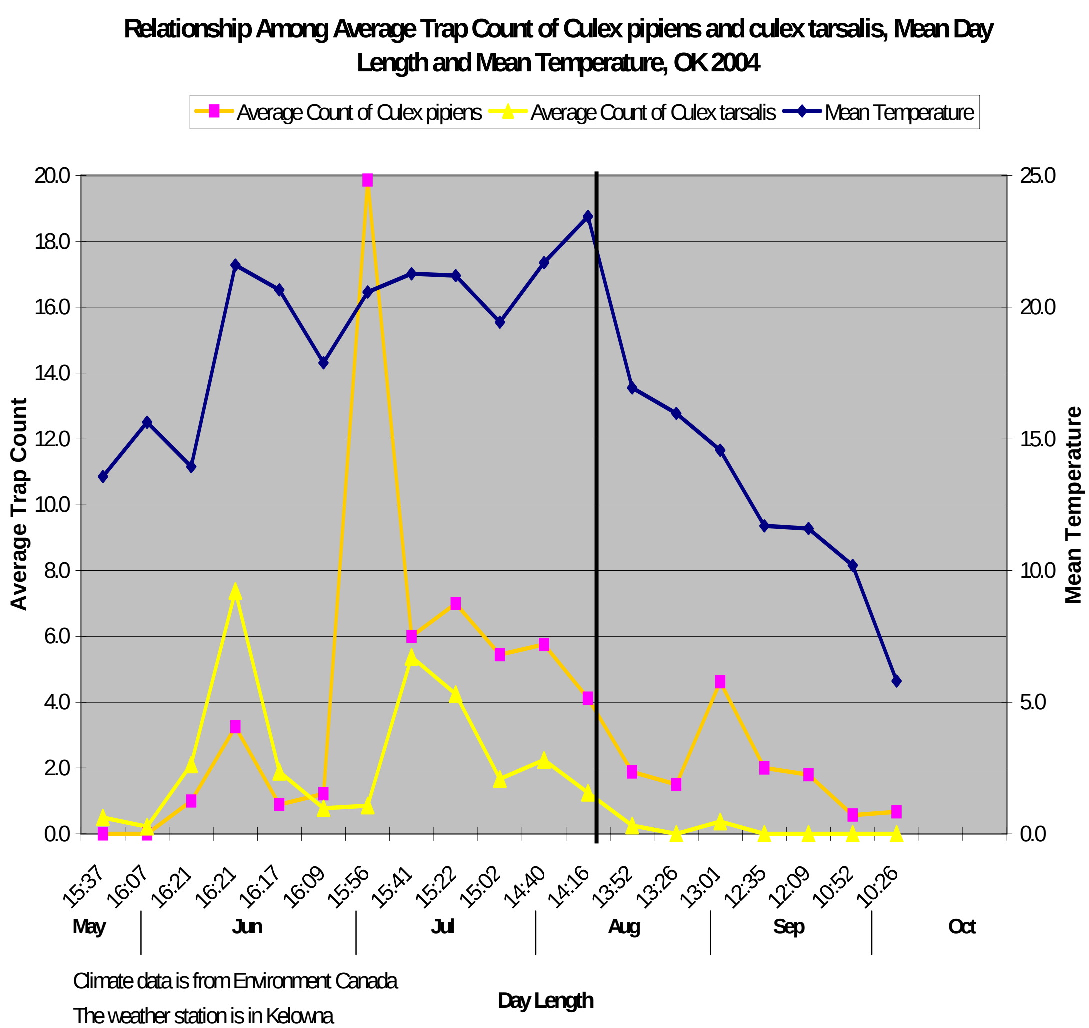
III. Okanagan

Lake Okanagan dominates the hydrological cycle in the Okanagan region of the province in a manner similar to the Fraser River in the GVRD and TCS. The maximum lake level occurred between the end of June and the beginning of July (Figure 15). Our *Cx. tarsalis* populations followed a similar trend to the other two regions with an early peak in June after temperatures rose above 16 ºC and another in mid July with a decrease in numbers by the middle of August (Figure 16).

In this region *Cx. pipiens* peaked at the same time Okanagan Lake reached its maximum level, then dropped off dramatically. Kelowna, Vernon and Penticton are reasonably urbanized areas that can produce lots of *Cx. pipiens*. The difference in abundance of mosquitoes for the Okanagan is driven by the lake level rather than river discharge. In this area we saw another small peak in specimens after the 14 hour photoperiod when *Cx. pipiens* is expected to enter diapause.

Figure 15: Okanagan Lake Level for 2004

Figure 16: Relationship Among Average Culex pipiens Counts, Average Daylight and Average Temperature, Okanagan, 2004



Trap Type and Location

Gravid versus Light traps

Two trap designs were used in 2004, the CDC light trap (Ultra Violet Blacklight) and the gravid trap. Across BC we used 88 traps, 52 were CDC light and 36 were gravid traps. Some were used twice in one week but in different locations. Most of the light traps used CO_2 as an attractant; this is especially important to attract females that would be seeking a blood meal. Light traps that caught either *Cx. pipiens* or *Cx. tarsalis* accounted for 555 submissions, 423 that were baited with CO_2 and 132 that were not. Using CO_2 in the traps yielded a significant increase in the catch up to August, but after this time no difference was noticed (Table 9). We might attribute this to *Culex pipiens* entering into an over-wintering diapause after day length drops below 14 hours. In diapause, the majority of females being captured are not looking for a blood meal (i.e. not using CO_2 as a cue to locate a host) so the addition of CO_2 to the traps does not affect the number of mosquitoes collected.

Table 9: Average Number of Culex Mosquitoes Captured Over Time With and Without the Use of CO_2 Attractant

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

	May (n)	June (n)	July (n)	Aug (n)	Sep (n)	Oct
CO2	4.9 (10)	12.68 (77)	21.17 (116)	17.77 (132)	3.32 (66)	2.5 (22)
Non CO2	1.11 (9)	2.88 (25)	3.65 (40)	5.67 (43)	6.23 (13)	1.5 (2)

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

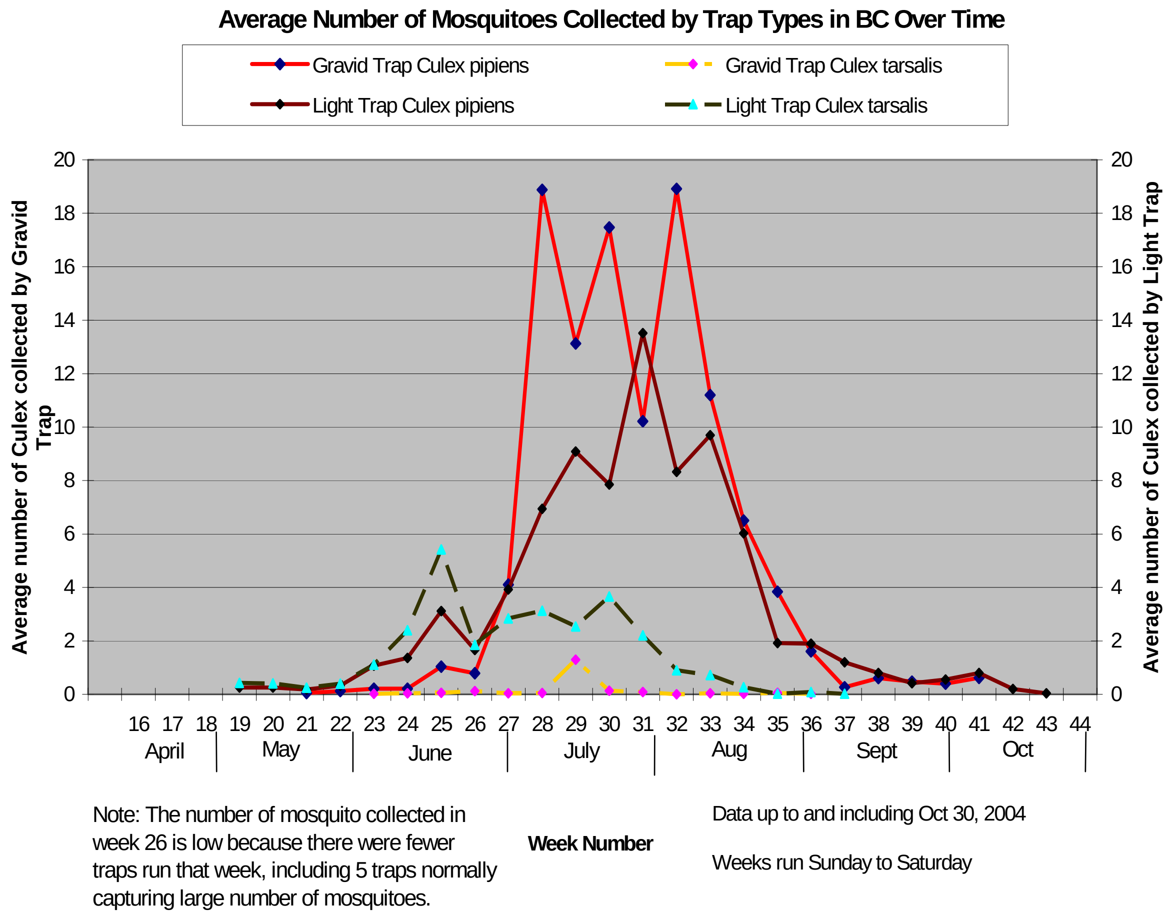
A gravid trap is based on a different attractant principle; the tub offers an organically enriched solution that attracts female mosquitoes that lay eggs on the surface of the water. This suggests that only a blood-fed female will be caught and the probability of getting a positive WNv specimen is greater. In 2004, only 13% of all mosquitoes collected were caught in gravid traps. A comparison between the yields obtained with light vs. gravid traps revealed that *Culex tarsalis,* considered the most common and competent vector of WNv in Canada, was not well represented in the gravid traps (Figure 17). Only 5.6 % of the *Cx. tarsalis* were collected in gravid traps. However, gravid traps caught proportionally more *Cx. pipiens* than any other species – they represented almost 85% of all mosquitoes caught in gravid traps. *Culex pipiens* were equally represented in both the light and gravid traps. This is expected because they are well adapted to using artificial containers for egg laying. Most of the *Aedes* and *Ochlerotatus* species lay their eggs on the ground, in places they anticipate will flood at a future period, so they will not be using these traps. Many of the other taxa lay their eggs on the surface of the water, especially *Culiseta incidens*, a common inhabitant of artificial containers. We found the gravid traps caught 33% of *Culiseta* but only 6.4 % of the *Anopheles*.

Abundance of WNv vectors: Comparison between BC and other provinces

Other provinces have already experienced the arrival of WNv and each area has unique characteristics that facilitate the spread of the disease. The structure of mosquito populations in BC begs comparison with other regions of North America. In the Prairie Provinces, the primary vector appears to be *Culex tarsalis*. The Manitoba website offers some values for surveillance in 2004. In the second week in July the CDC baited light traps started to increase from 0-5 per night to 20-190 for different Health Authorities. At the peak of *Cx. tarsalis* activity in the end of July, most regions ranged from 100-300 specimens per night. In comparison, BC averaged only 5 *Cx. tarsalis* in our light traps during June, with usually 3 during most of July (see Figure 17).

In Saskatchewan in 2003 during a case study at a Forestry Farm, they caught 5-40 *Cx. tarsalis* per night but had a high incidence of WNv in people throughout the southern portion of the province. The importance of competent vector species is key to WNv but this example illustrates that even low numbers can affect people.

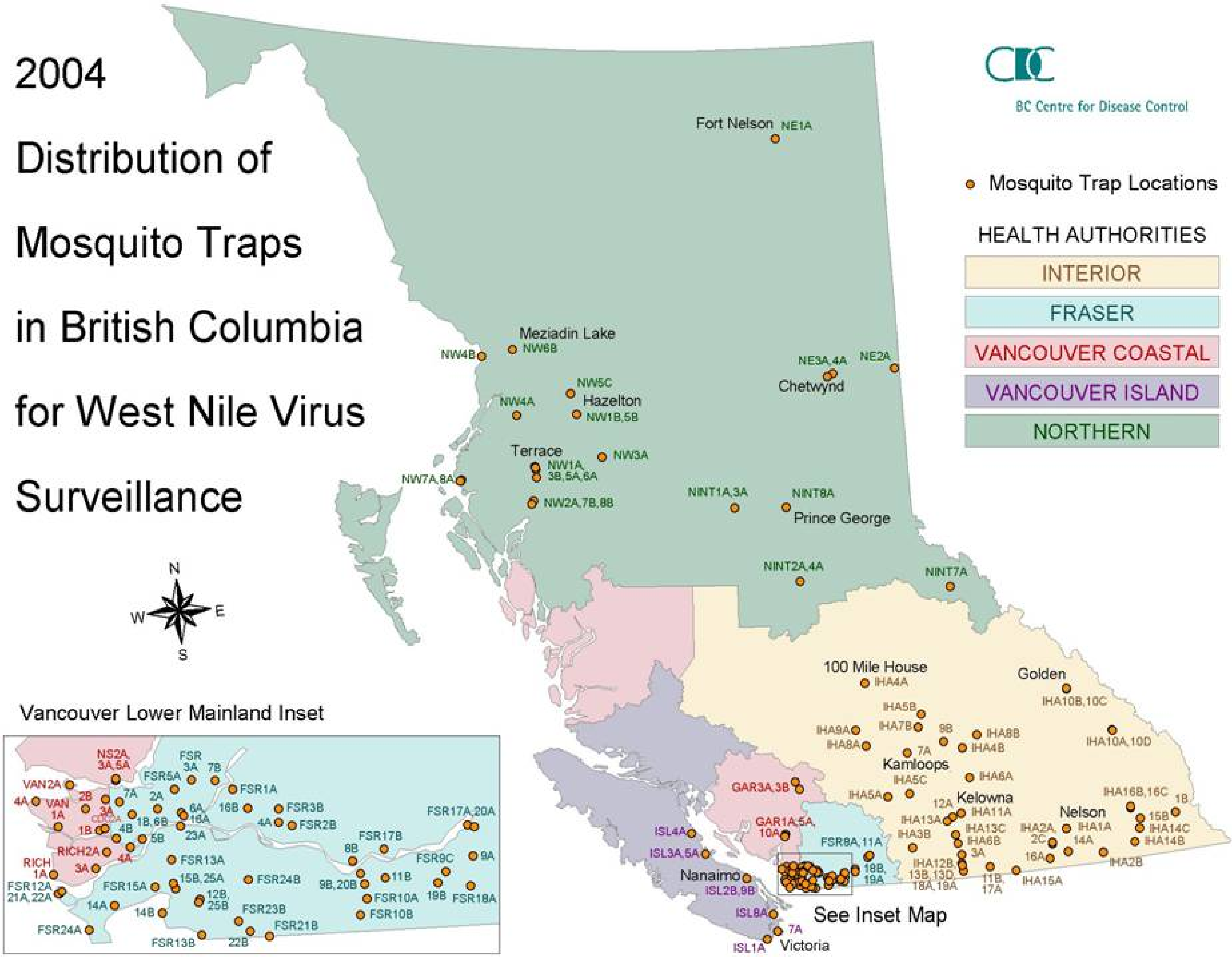
Figure 17: Average Number of Mosquitoes Collected by Trap Type in BC over Time



Location of traps

In anticipation of WNv arriving in British Columbia in 2004 more effort was directed at the surveillance of adult mosquitoes. More than twice as many submissions were made to the lab in 2004 as in 2003. Figure 18 illustrates all of the 145 registered mosquito trap locations (note that some traps were run at multiple locations). The Fraser River Lower Mainland had the best coverage of any region in the province and also encompasses the largest population. South and central Vancouver Island have fairly high population but very few traps. The East Kootenay and Kootenay Boundary have very few traps and a more rural population; most of their community centres have less than 10,000 residents. By all indications this area is most vulnerable due to neighbouring WNv, migratory bird presence and temperatures high enough to support multiple generations.

Figure 18: Distribution of Mosquito Traps in BC, 2004



Low Yield Traps

In any given year, some traps will outperform others. In an effort to identify low yielding traps, we flagged traps with average trap yields in the lower 25th percentile (Table 10). From these, we excluded those locations that had only been used once as they likely represented trial locations. From this list, traps were run in 22 locations on 10 or more nights (in green) and in 15 locations on 2 to 9 nights (in yellow). One of the reasons we mentioned for light traps giving lower yield is the use of CO_2 as an attractant for these traps. From the list of low yield traps FRS 24, GAR 1, IHA1, ISL4, NE3 and NS2 were operated the majority of the time without CO_2 baiting. These traps might simply need additional baiting to increase yields. Any other light traps running for 10 or more nights should probably be moved to a better location in 2005. Changing from gravid to light trap may also give a better yield, especially in areas where *Cx. pipiens* is not common.

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

Label	City	Location	TrapType	Number of Trap Running	Average Trap Count
NW 3	Terrace	B	Gravid Trap	10	0.1
IHA 8	Cache Creek	A	Gravid Trap	18	0.11
NW 2	Kitimat	A	Light Trap	12	0.17
ISL 1	Victoria	A	Light Trap	12	0.17
IHA 9	Clinton	A	Gravid Trap	15	0.2
IHA 14	Yaak	C	Gravid Trap	10	0.2
ISL 4	Courtenay	A	Light Trap	16	0.25
NW 1	Terrace	A	Light Trap	14	0.29
ISL 8	North Saanich	A	Gravid Trap	11	0.36
IHA 7	Kamloops	A	Gravid Trap	19	0.37
FSR 24	Langley	B	Light Trap	21	0.43
FSR 9	Matsqui	B	Gravid Trap	13	0.54
NS 2		A	Light Trap	11	0.55
RICH 4	Richmond	A	Gravid Trap	15	0.6
IHA 10	Edgewater	A	Gravid Trap	12	0.67
IHA 7	McLure	B	Gravid Trap	16	0.75
VAN 4	Vancouver	A	Gravid Trap	18	0.78
FSR 8	Mission	B	Gravid Trap	15	0.8
NW 6	Lakelse	A	Light Trap	11	0.82
IHA 1	Nelson	A	Light Trap	19	0.89
FSR 11	Abbotsford	B	Gravid Trap	13	0.92
FSR 2	Maple Ridge	B	Light Trap	18	0.94
IHA 14	Moyie	B	Gravid Trap	8	0.12
IHA 5	Merritt	A	Light Trap	5	0.2
NINT 4	Quesnel	A	Gravid Trap	4	0.25
NE 3		CHETWYND	Light Trap	4	0.25
NW 7	Prince Rupert	A	Light Trap	4	0.25
NE 4	Cheywynd	A	Gravid Trap	4	0.25
IHA 17	Rock Creek	A	Light Trap	3	0.33
NW 5	Terrace	A	Light Trap	7	0.43
FSR 3	Chilliwack	A	Gravid Trap	8	0.5
ISL 7		RITHITS BOC	Gravid Trap	2	0.5
FSR 9	Greendale	C	Gravid Trap	4	0.5
NW 4	Stewart	B	Light Trap	4	0.75
GAR 1		A	Light Trap	6	0.83
IHA 10	Edgewater	D	Gravid Trap	8	0.88
FSR 10	Abbotsford	B	Gravid Trap	9	0.89

Lag Times for Mosquito Submission and Testing

The period of time from collection of specimens to the arrival at the lab for analysis is critical for the timely surveillance of the presence of West Nile virus in British Columbia. The median value in 2004 of 2 days is a good response and field operatives should be congratulated for their efforts. The median submission delay remains unchanged from 2003. In some instances there can be longer delays in submission. Samples being misplaced or regular staff going on vacation may account for these delays, so establishing a fixed routine and training of replacement staff might be considered to minimize delays.

Table 11: Mosquito Lag Time for sample submission and laboratory processing, 2004

Mosquito Lag Time for Sample Submission by HSDA, 2003 and 2004

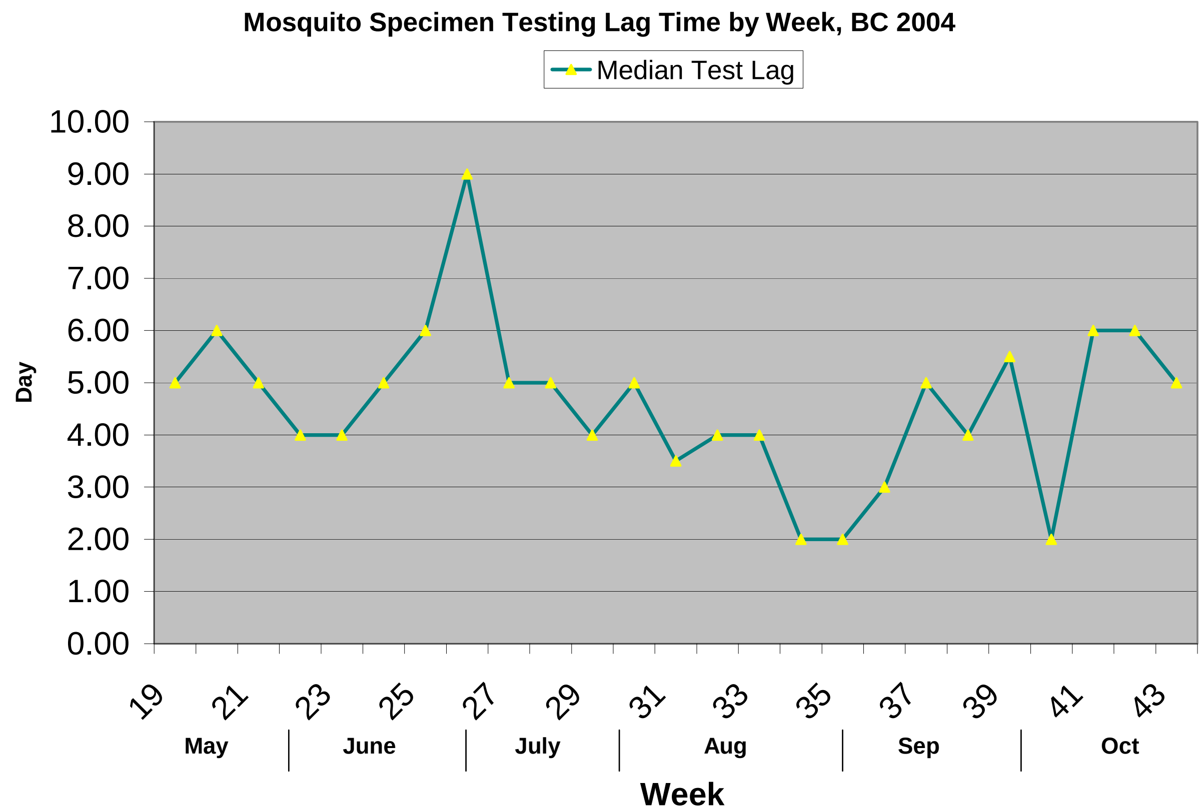
HSDA	Avg Of Submission		Min Of Submission		Max Of Submission		Median of Submission	
	2003	2004	2003	2004	2003	2004	2003	2004
CVI	1.5	2.9	1	1	5	9	1.0	2.0
EK	1.0	2.6	0	0	2	7	1.0	3.0
FRE	2.5	3.1	1	0	5	10	2.0	3.0
FRN	1.9	1.8	0	0	3	7	2.0	1.0
FRS	1.8	3.6	0	1	7	8	1.5	3.0
KB	1.4	1.9	0	1	6	5	1.0	1.0
NE	1.8	1.3	1	1	2	5	2.0	1.0
NI	1.8	1.4	1	0	6	6	1.0	1.0
NSCG	4.3	3.8	2	1	7	32	4.0	2.0
NVI/UVI	1.5	1.7	1	0	2	2	1.5	2.0
NW	1.0	3.5	1	1	1	15	1.0	2.0
OK	1.5	1.8	0	1	8	7	1.0	2.0
RICH	2.9	1.1	1	0	17	2	2.0	1.0
SVI	1.5	2.1	0	1	3	7	1.5	1.0
TCS	1.5	1.4	0	1	8	6	1.0	1.0
VAN	0.7	0.6	0	0	6	5	0.5	0.0
Total	**1.8**	**2.4**	**0**	**0**	**17**	**32**	**2**	**2**

Note: All numbers are in days.

In 2004, the median period of time to identify and test samples in the lab was 4 days, representing a drop of 2 days from 2003, even with a doubling of sample submissions. This reflects a development of expertise in mosquito identification and efforts to streamline operations. Considering the increase in the number of specimens collected this year the improvement is an accomplishment worth noting. Lag times for identification and testing were highest at the end of June when large quantities of *Aedes* mosquitoes were being submitted to the lab (Figure 19). Mosquito collections in 2003 and 2004 reflect abundance during dry summers. The next challenge for laboratory staff will come when we have a wet year producing larger numbers of adult mosquitoes.

The combined median lag time from mosquito collection to processing is only 6 days; giving the province a real-time window to report on the presence of WNv in mosquitoes.

Figure 19: Change in Laboratory Lag Time, Mosquito Identification and Testing, May – October 31, 2004



Climate Data – Growing Degree Day Mapping

The concept of degree days for mosquito forecasting involves the amount of accumulated heat required for mosquitoes to complete their growth and development. Mosquitoes are unable to regulate their body temperature and are dependent on the temperature of their surroundings for warmth. Researchers from Saskatchewan use a base temperature of 16 ^{o}C for *Culex tarsalis*. For every day where the average temperature is above 16 ^{o}C, degree days are accumulated. For example, if the average temperature on June 1st is 18 ^{o}C, 2 degree days are accumulated (18-16 ^{o}C = 2 DD). This calculation is repeated for every calendar day and a running total is kept for the duration of the growing season or year. No degree days are accumulated or subtracted if the average daily temperature is less than 16 ^{o}C. In 2003, some parts of Saskatchewan had accumulated up to 600 degree days and experienced 4 generations of *Culex tarsalis*. Therefore, according to this model ~150 degree days produce one generation of *Culex tarsalis*.

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

The results of this analysis are the 2004 and 30 year average accumulated degree day maps for BC (Figures 20 and 21, respectively). As expected, the Okanagan, Upper Columbia River and Kamloops regions have the warmest climate in BC. The highly populated Vancouver Lower Mainland and Fraser Valley also have enough heat units to produce multiple generations of *Culex tarsalis*. BC experienced a very hot summer in 2004 and every region of the province accumulated higher than average degree days (Figure 22).

Figure 20: Accumulated Degree Days over 16^{0}C, 2004

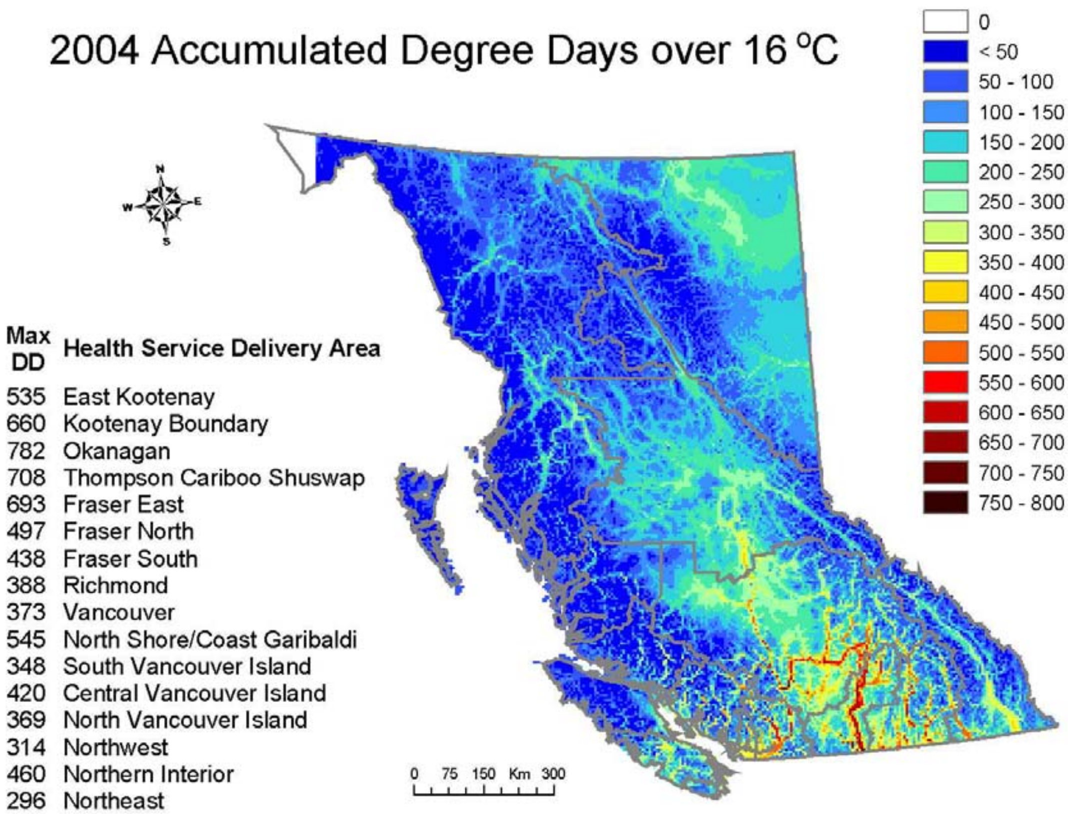


Figure 21: Average Accumulated Degree Days over 16^{0}C, 1971-2000

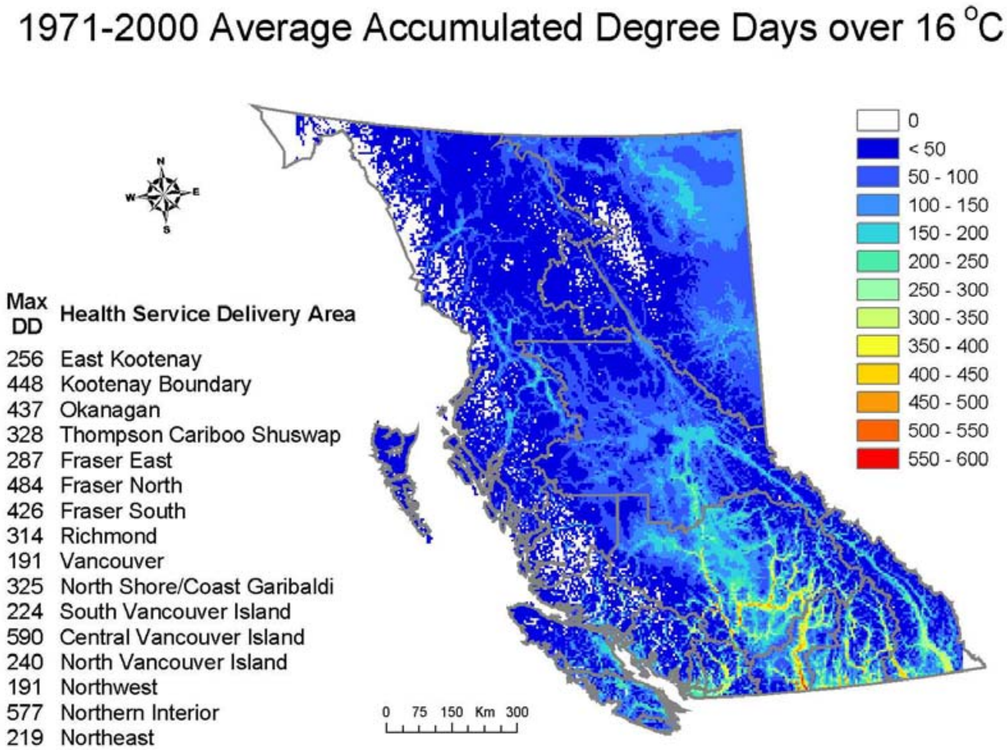
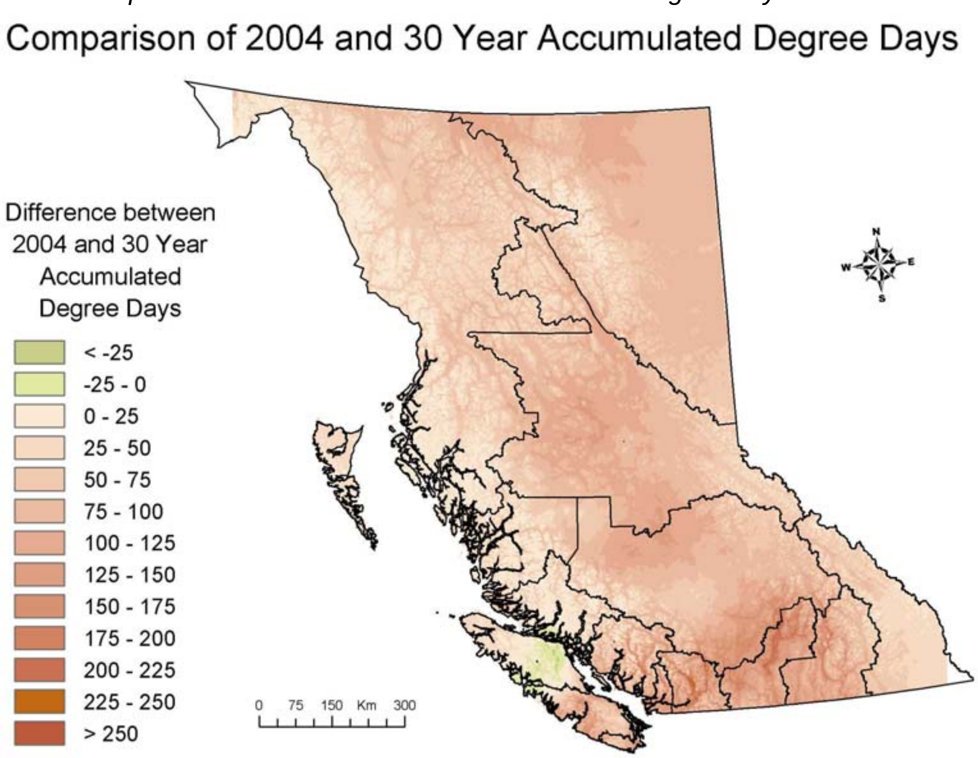


Figure 22: Comparison of 2004 and 30 Year Accumulated Degree Days



Recommendations for Mosquito Surveillance in 2005

British Columbia now has two years of baseline information collected prior to the arrival of West Nile Virus in the province. While we are not in a position to prevent the arrival of WNv nor completely eliminate the vector, we can use surveillance information to reduce the risk of disease. From the experience of other jurisdictions in North America we are now focusing attention on *Culex* species as the primary vector for West Nile virus. The following are recommendations for mosquito surveillance in 2005:

Biological and geographical considerations

- Two species, *Culiseta incidens* and *Ochlerotatus togoi* are potential WNv vectors in BC, however their competence in transmitting this disease requires investigation. Both species have multiple generations and are common enough to play a significant role in amplifying the virus and transmitting the disease to people.

- The northern distribution record of *Culex pipiens* requires investigation; specimens from the northern latitude should be submitted to the National Collection for reference. The presence of competence vectors in northern communities carries implications for disease preparedness.

- Close monitoring of *Coquilletidia perturbans* populations is important because they present a challenge to using standard methods to control larvae with *Bti* because they live well below the surface of the water where the product might not penetrate.

- Degree Day calculations incorporate latitude, geography and temperature to give a real-time predictive tool in assessing the number of potential generations of *Culex tarsalis*. Real time degree day monitoring should be implemented in 2005.

    - Note: There is some debate with respect to using degree day calculations for urban species in catch basins because the cement structure may retain heat better than an open pond. The role that *Cx. pipiens* will play in WNv transmission in BC is unknown and close surveillance is recommended.

Recommendations for Trap Operation, Trap Type and Placement

- Use baseline information to guide trap collections. Figure 10, 12 and Appendix 5 illustrate when the 1st and last generation of each species should appear. If, when running your traps, your catch is out of line with the known occurrence of mosquitoes then check the trap for proper functioning. If mechanical function is not an issue then consider moving the trap to another location, 1st locally and then to completely new location if results do not change. Do not forget to notify BCCDC of any change in location.

- Surveillance data reaffirmed that using CO_2 in the CDC light traps improved trap yield for *Culex* mosquitoes (although the benefits were not sustained beyond August). Dry Ice gives the best results but unfortunately this product is not always available, so consider using a CO_2 packet in remote areas where Dry Ice is not available.

    - From the list of low yield traps FRS 24, GAR 1, IHA1, ISL4, NE3 and NS2 were operated the majority of the time without CO_2 baiting, consider using CO_2 to increase yields.

- Determine which traps are in a similar geographic habitat and send this grouping to BCCDC prior to starting 2005 surveillance. This information will be used for Minimum Infection Rate calculations. At least 3 traps per grouping are required to complete this calculation with statistical significance.

- Surveillance data indicate that CO_2 baited CDC light traps give the best representation of mosquito species. In general, gravid traps should be replaced with higher yielding CO_2-baited CDC light traps. However, if *Culex pipiens* is abundant in your area you should also use the gravid traps from the middle of June to the last week of August.

    - In the tub of a gravid trap, use water from a known breeding site as a base before adding the hay infusion, and consider adding some bird manure if available.

- Low yield traps should be moved to new locations in 2005.

- Aim for sequential night sampling and submit samples by Wednesday so that the lab can process or store specimens before the weekend.

- Establish a fixed routine and train new personnel if vacation leave is expected. Consider writing a simple procedure manual for your specific office that others can follow if an emergency arises where others are required to take over the surveillance process.

Additional traps

- The Interior Health region of the province is at highest risk for introduction of WNv due to the complex valley setting and close proximity to potential migration from infected avian populations in Alberta and the US. There is a reasonably good distribution of traps for this region but low numbers of specimens (see Appendix 4, EK and KB charts) are reflected in the graphs for surveillance. As communities are small and dispersed over a large area, another 3 CO_2 baited light traps would strengthen surveillance in Kootenay and Kootenay Boundary regions.

- Southern Vancouver Island is another region with a large population and very few traps. Some consideration might be given to marginally increasing the number of traps in this region; however it is considered at much lower risk of WNv.

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Appendix 1: Human Case Definitions, 2004

Surveillance for West Nile Virus

A. CASE DEFINITIONS:

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

A.1) West Nile (WN) Virus Neurological Syndromes (WNNS):

Clinical Criteria:

i) History of exposure in an area where WN virus activity is occurring[i] **OR** history of exposure to an alternate mode of transmission[ii] **AND**

ii) *New onset* of illness consistent with a diagnosis of:

- viral encephalitis
- viral meningitis, or
- acute flaccid paralysis (poliomyelitis-like syndrome or Guillain-Barré-like syndrome).[iii] or
- movement disorder (e.g. tremor, myoclonus) or
- Parkinsonism (e.g. cogwheel rigidity, bradykinesia, postural instability).
- Other associated neurological syndromes. *For a description of other possible neurological syndromes, see endnote*[iv]

A.1.a) Suspect WNNS Case:

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

A.1.b) Probable WNNS Case:

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

A.1.c) Confirmed WNNS Case:

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

A.2) West Nile virus Fever (WNF):

Clinical Criteria:

(i) History of exposure in an area where WN virus activity is occurring[1] **OR** history of exposure to an alternate mode of transmission[2] **AND**

(ii) Onset of illness that includes AT LEAST TWO of the following[v]:

- fever
- myalgia,
- arthalgia,
- headache,
- fatigue,
- lymphadenopathy,
- maculopapular rash

A.2.a) Probable WNF Case:

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

A.2.b) Confirmed WNF Case:
Clinical criteria AND AT LEAST ONE of the confirmed case diagnostic test criteria (see below – Section B)

A.3) West Nile virus Asymptomatic Infection (WNAI)[vi]:

A.3.a) Probable WNAI Case:
Probable case diagnostic test criteria[6] (see below – Section B) IN THE ABSENCE of clinical criteria

A.3.b) Confirmed WNAI Case:
Confirmed case diagnostic test criteria (see below – Section B) IN THE ABSENCE of clinical criteria

B. WEST NILE VIRUS DIAGNOSTIC TEST CRITERIA:

B.1 Probable Case Diagnostic Test Criteria:[vii]

AT LEAST ONE of the following:

Reactive IgM flavivirus ELISA[viii] in a single serum or CSF sample **OR**
Seroconversion of IgG flavivirus ELISA from non-reactive to reactive in paired acute and convalescent sera **OR**
A 4-fold or greater change in flavivirus haemagglutination inhibition (HI) in paired acute and convalescent sera **OR**
A titre of $\geq$ 1:320 in a single WN virus HI test, **OR**
A reactive IgG flavivirus ELISA in a single serum sample[viii,ix] with a confirmatory PRNT result **OR**
Demonstration of Japanese encephalitis (JE) serocomplex-specific genomic sequences in blood by NAT screening tests on donor blood, by Blood Operators in Canada.

After 5 confirmed, locally acquired cases in an area, further probable cases from the area may be considered confirmed[x].

B.2 Confirmed Case Diagnostic Test Criteria:[7]

AT LEAST ONE of the following:

Isolation of WN virus from, or demonstration of WN virus antigen or WN virus-specific genomic sequences in tissue, blood, CSF or other body fluids **OR**
Seroconversion of flavivirus IgG ELISA from non-reactive to reactive ***or*** a 4-fold or greater change in flavivirus HI ***AND*** the demonstration of WN specific antibody (using a PRNT assay) in the convalescent serum sample **OR**

A single serum or CSF sample with a reactive flavivirus IgM ELISA confirmed by the documentation of a PRNT antibody titre to West Nile virus.

Confirmatory testing is not recommended after 5 cases have been confirmed in a regional health authority.

---

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

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

[iii] A person with West Nile virus-associated acute flaccid paralysis may present with or without fever or mental status changes. Altered mental status could range from confusion to coma with or without additional signs of brain dysfunction (e.g. paresis or paralysis, cranial nerve palsies, sensory deficits, abnormal reflexes, generalized convulsions and abnormal movements).

[iv] A significant feature of West Nile viral encephalitis may be marked muscle weakness, therefore WN virus should be considered in the differential diagnosis of all suspected cases of acute flaccid paralysis that is more frequently unilateral, but could be bilateral, with or without sensory deficit. Emerging clinical syndromes, identified during 2002, included: movement disorders (e.g., tremor, myoclonus); parkinsonism (e.g., cogwheel rigidity, bradykinesia, postural instability); rhabdomyolysis (acute destruction of skeletal muscle cells). Other clinical syndromes that were identified during 2002 included, but were not limited to the following: peripheral neuropathy; polyradiculopathy; optic neuritis; and acute demyelinating encephalomyelitis (ADEM). During 2003 an additional clinical syndrome that was recorded in case-patients was facial weakness.

[v] It is possible that other clinical symptoms could be identified that have not been listed and may accompany probable case or confirmed case diagnostic test criteria.

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

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

[viii] Longitudinal studies of encephalitis cases due to West Nile virus have shown that WN virus-specific IgM antibody may persist in serum for 12 months or longer. Thus, the presence of serum anti-WN viral IgM antibody may not be diagnostic of *acute* WN viral infection in some cases, particularly in areas where WN virus is known to have circulated previously. Additional testing may be required in these cases, such as repeat serology or even CSF for IgM (if clinically indicated).

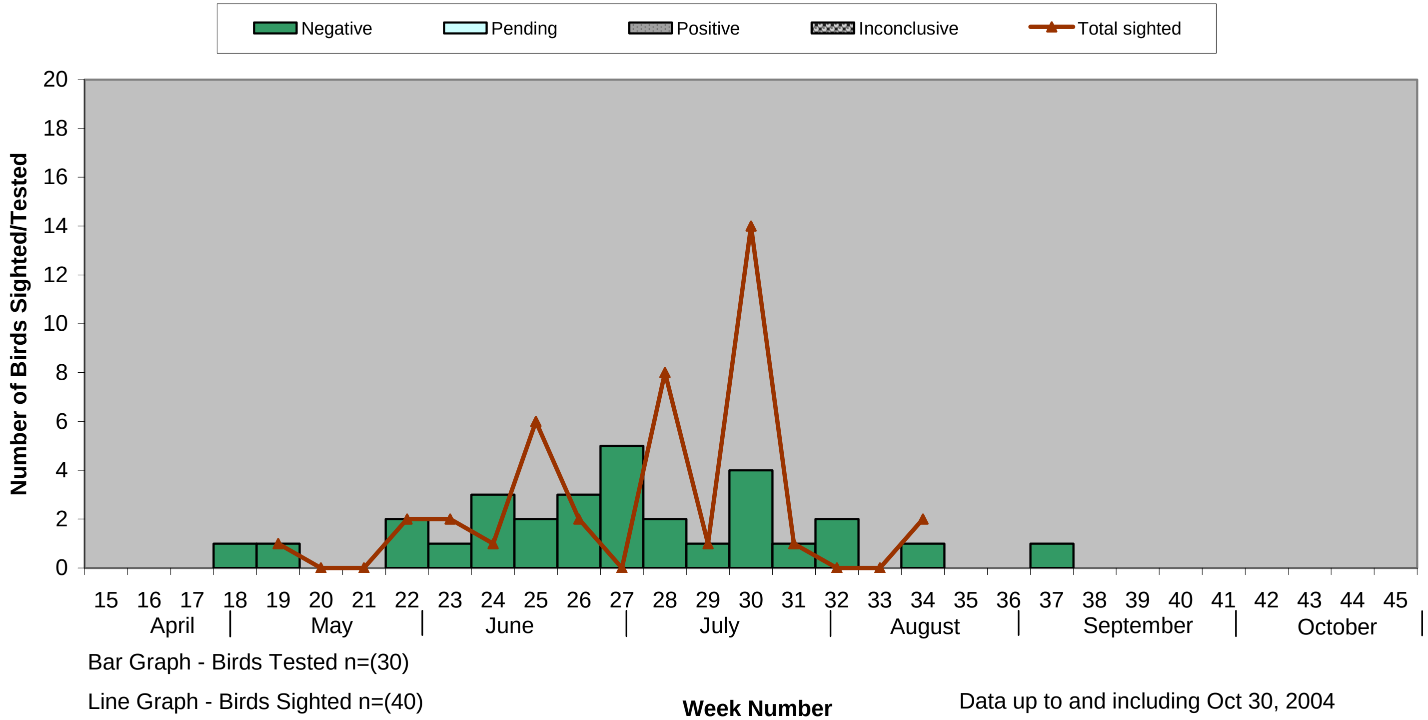
[ix] An IgG ELISA will not normally be performed on a single serum sample. A request for this test on a single serum sample may be made by contacting the BCCDC Laboratory Services.

[x] Confirmatory testing using PRNT (PRNT = Plaque-Reduction Neutralization Test) assay is performed

by the National Microbiology Laboratory and may take 2 weeks. It is therefore currently recommended that regional health authorities use the **Confirmed Case Diagnostic Test Criteria** to confirm the **first five (5) cases** (locally acquired) in their area each year. After 5 cases have been confirmed in a RHA, subsequent cases meeting the **Probable Case Diagnostic Test Criteria** can be classified as "confirmed" ***for the purposes of surveillance.*** Throughout the remainder of the transmission season, in order to rule-out the possibility of concurrent activity of other flaviviruses in BC, BCCDC Laboratory Services will document PRNT antibody titres to West Nile virus from 1 in 5 cases meeting the Probable Case Diagnostic Criteria. [For further information on diagnostic testing algorithms for West Nile virus, see the section entitled Laboratory Specimen Diagnostic Testing Algorithm in Appendix 4 of the National Guidelines for Response to West Nile virus.]

APPENDIX 2

Comparison of Number of Birds Sighted and Birds Tested in Central Vancouver Island, 2004



Bar Graph - Birds Tested n=(30)

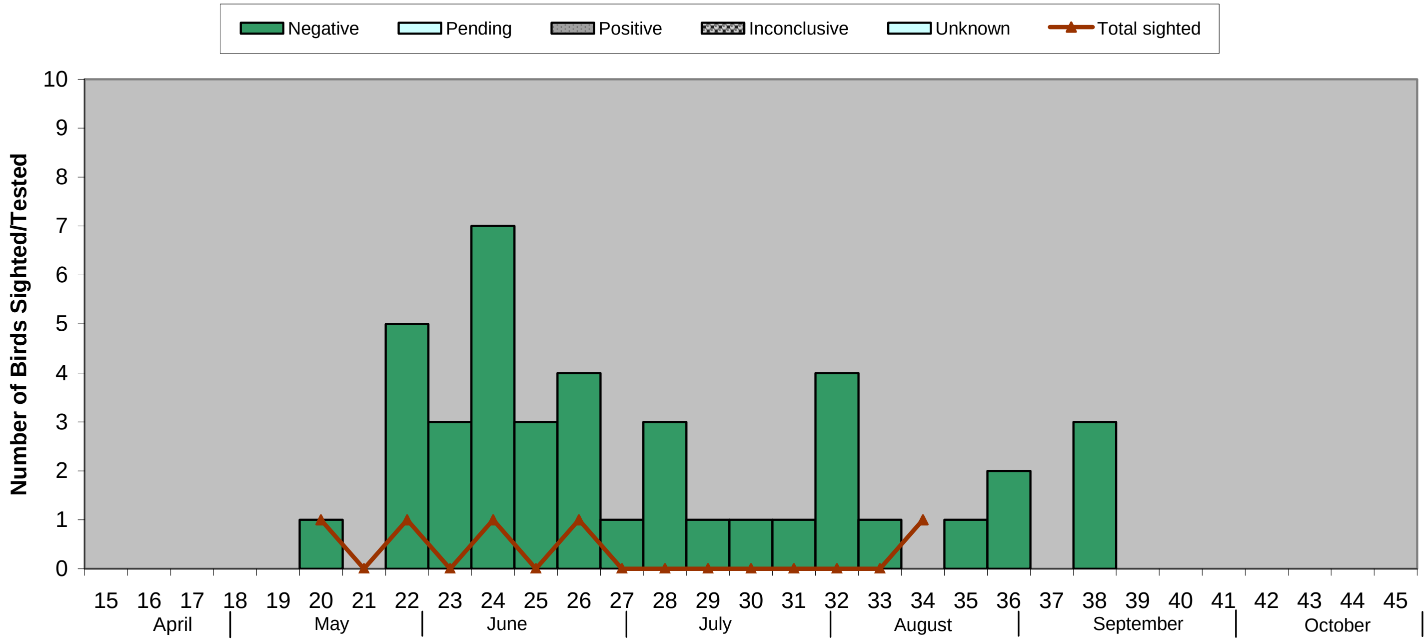
Line Graph - Birds Sighted n=(40)

Data up to and including Oct 30, 2004

Weeks run Sunday to Saturday

*0 birds submitted without date found;

Comparison of Number of Birds Sighted and Birds Tested in East Kootenay, 2004



Bar Graph - Birds Tested n=(41)

Line Graph - Birds Sighted n=(5)

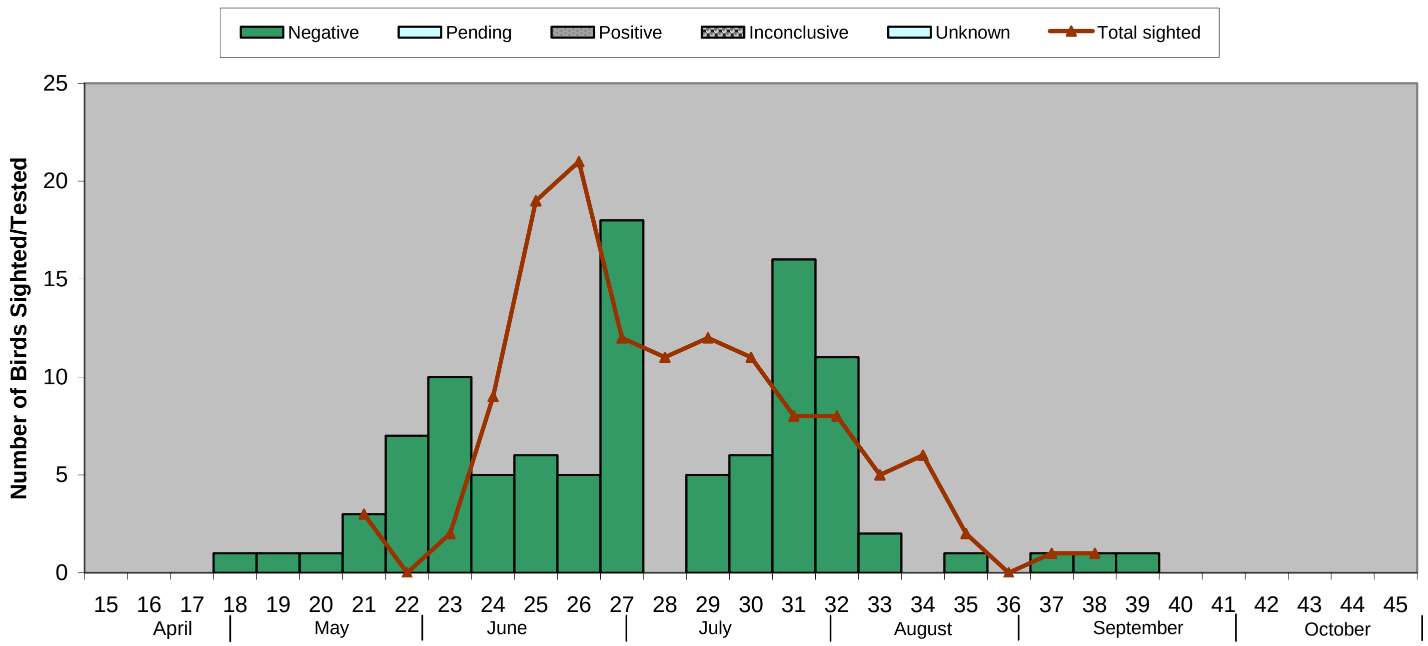
Week Number

Data up to and including Oct 30, 2004

Weeks run Sunday to Saturday

*0 birds submitted without date found;

Comparison of Number of Birds Sighted and Birds Tested in Fraser East, 2004



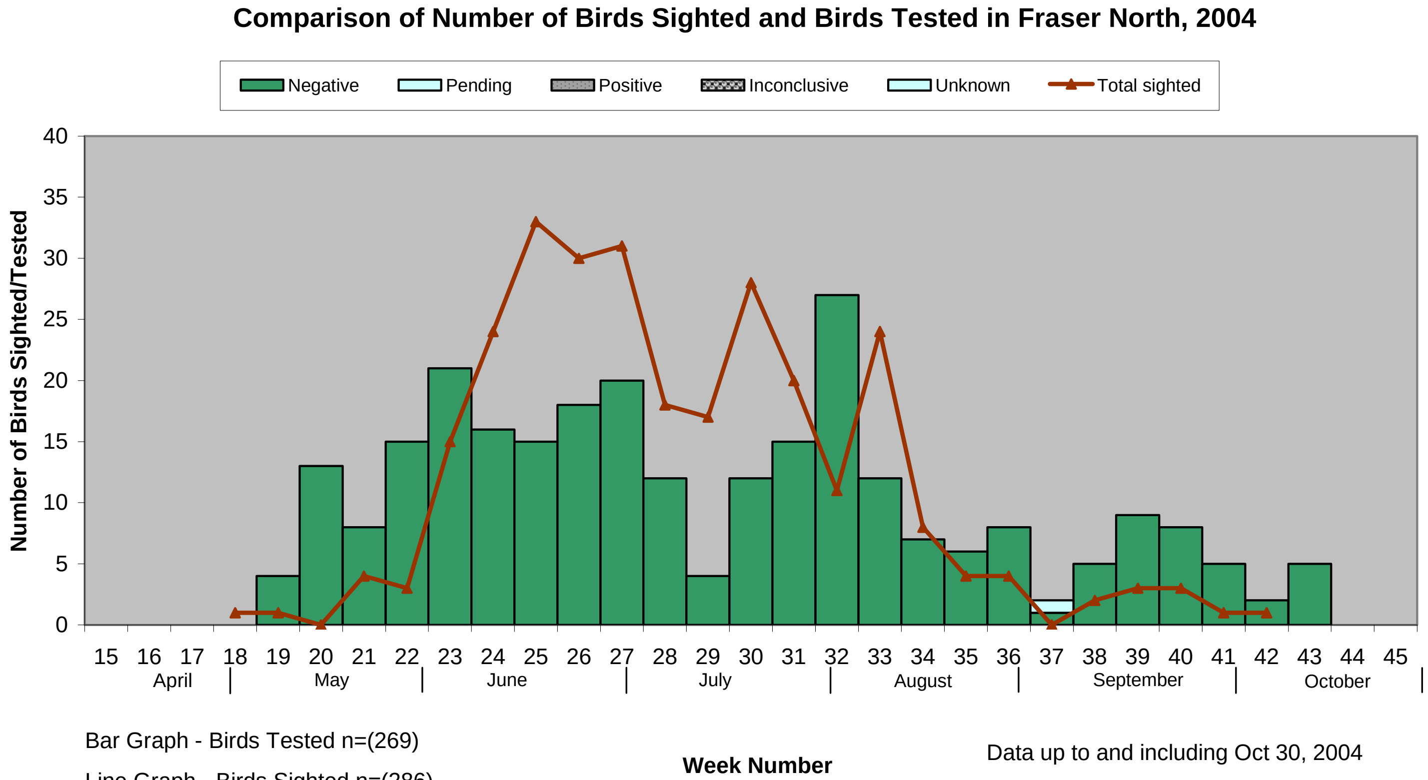
Bar Graph - Birds Tested n=(101)

Line Graph - Birds Sighted n=(131)

*0 birds submitted without date found;

Data up to and including Oct 30, 2004

Weeks run Sunday to Saturday



Bar Graph - Birds Tested n=(269)

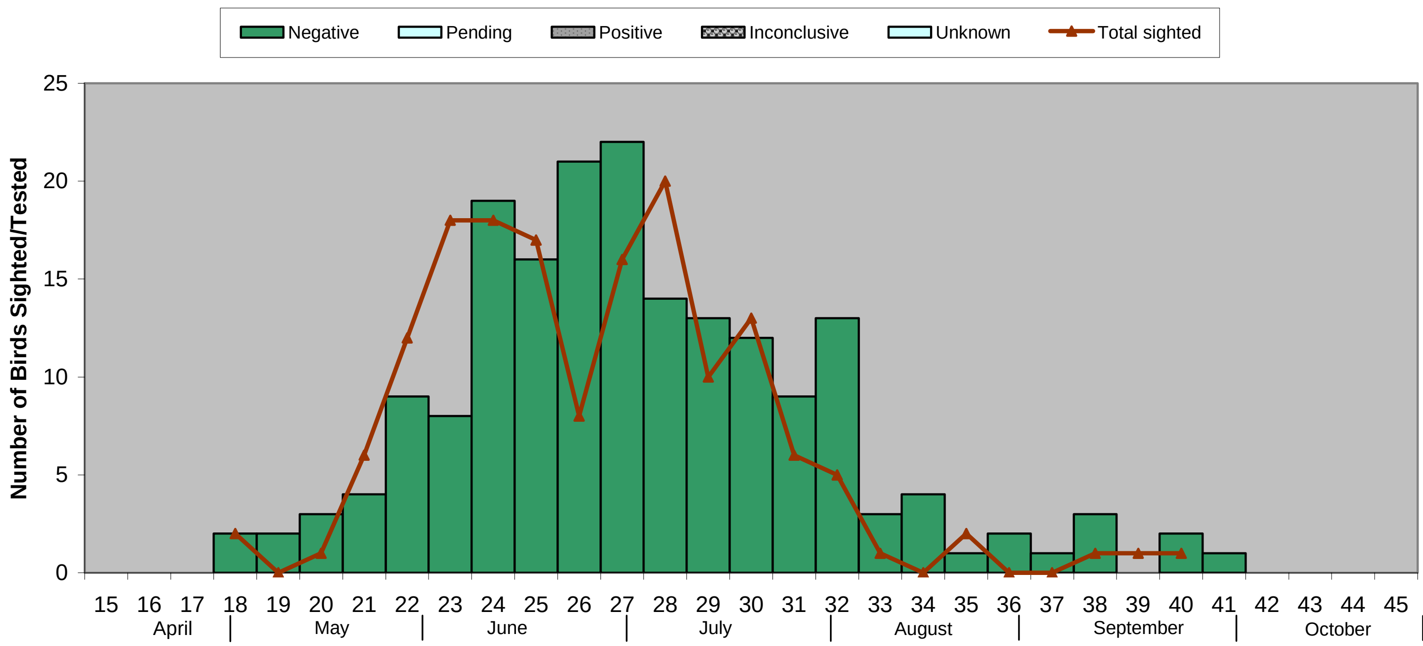
Line Graph - Birds Sighted n=(286)

*1 birds submitted without date found;

Data up to and including Oct 30, 2004

Weeks run Sunday to Saturday

Comparison of Number of Birds Sighted and Birds Tested in Fraser South, 2004



Bar Graph - Birds Tested n=(184)

Line Graph - Birds Sighted n=(158)

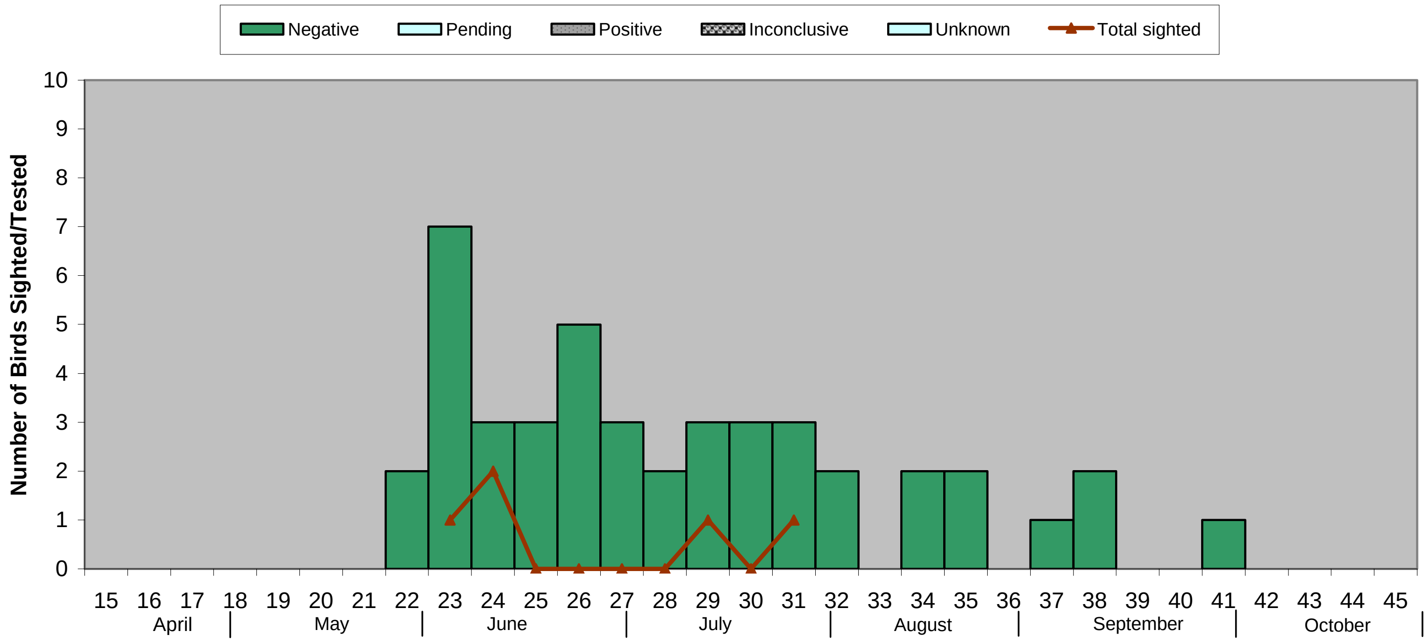
*0 birds submitted without date found;

Week Number

Data up to and including Oct 30, 2004

Weeks run Sunday to Saturday

Comparison of Number of Birds Sighted and Birds Tested in Kootenay Boundary, 2004



Bar Graph - Birds Tested n=(44)

Line Graph - Birds Sighted n=(5)

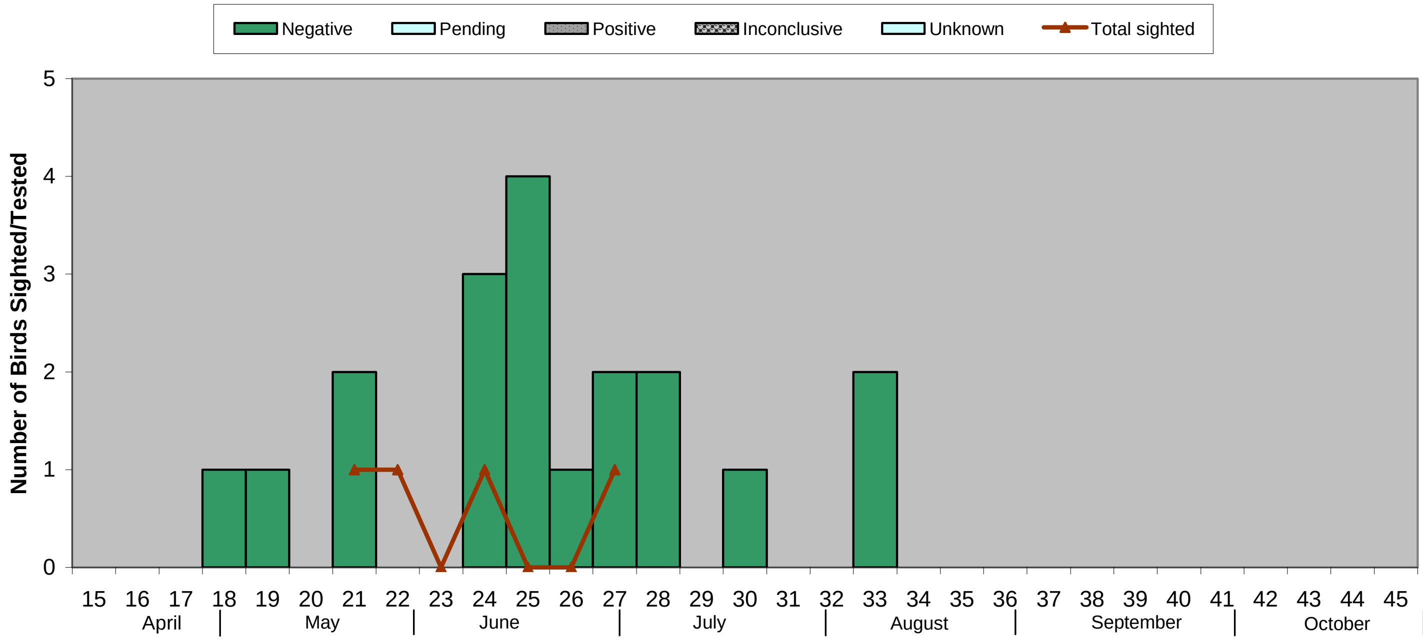
Week Number

Data up to and including Oct 30, 2004

Weeks run Sunday to Saturday

*0 birds submitted without date found;

Comparison of Number of Birds Sighted and Birds Tested in Northeast, 2004



Bar Graph - Birds Tested n=(19)

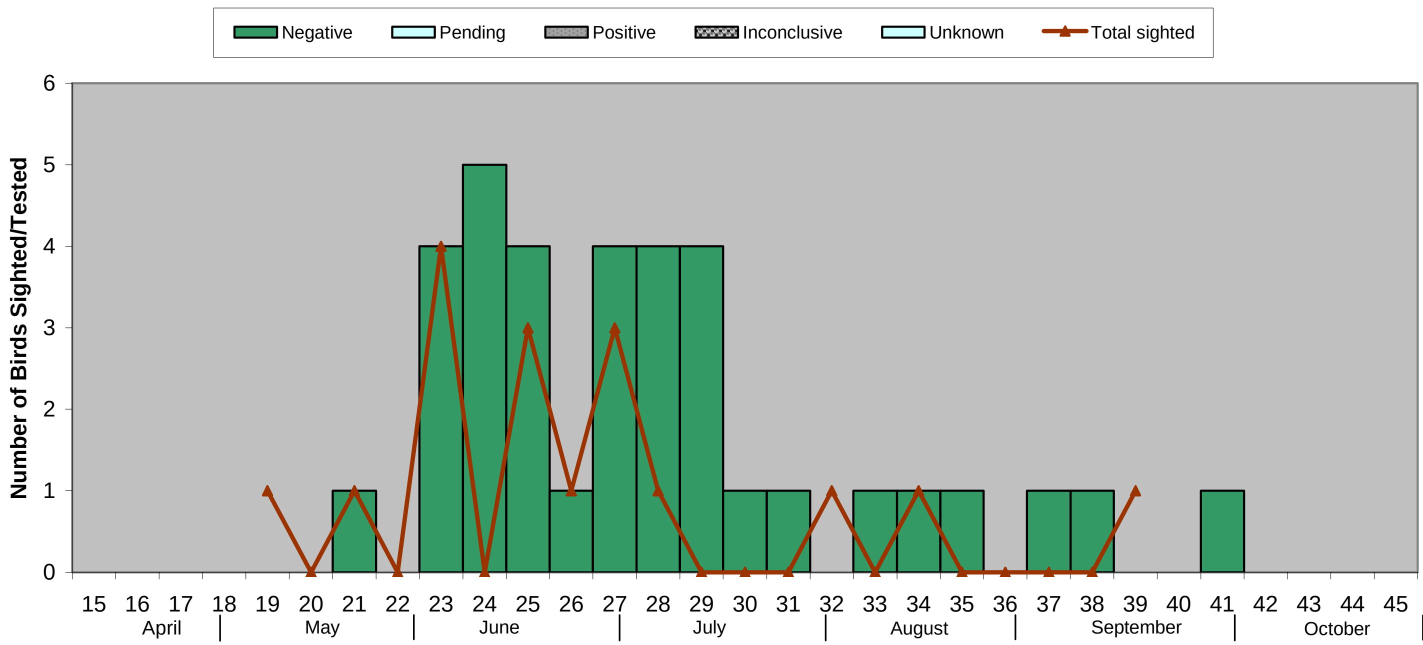
Line Graph - Birds Sighted n=(4)

Data up to and including Oct 30, 2004

Weeks run Sunday to Saturday

*0 birds submitted without date found;

Comparison of Number of Birds Sighted and Birds Tested in Nothern Interior, 2004



Bar Graph - Birds Tested n=(35)

Line Graph - Birds Sighted n=(17)

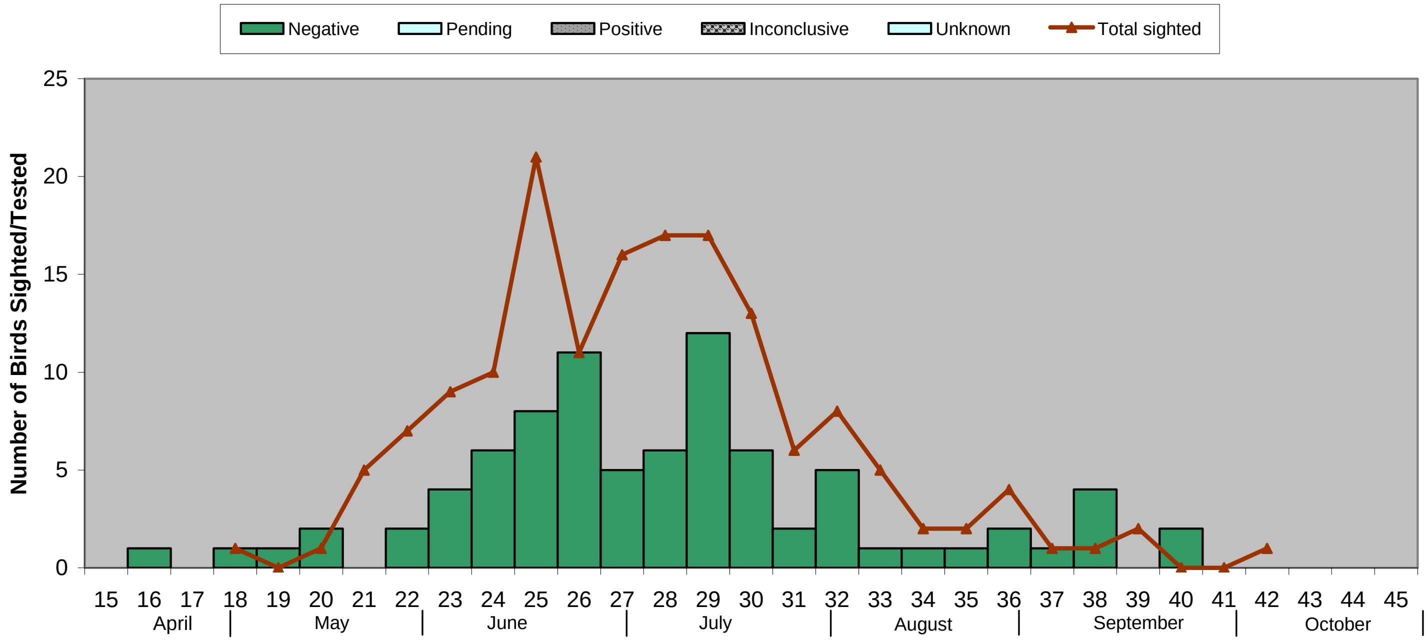
Week Number

Data up to and including Oct 30, 2004

Weeks run Sunday to Saturday

*0 birds submitted without date found;

Comparison of Number of Birds Sighted and Birds Tested in North Shore/Coast Garibaldi, 2004



Bar Graph - Birds Tested n=(84)

Line Graph - Birds Sighted n=(160)

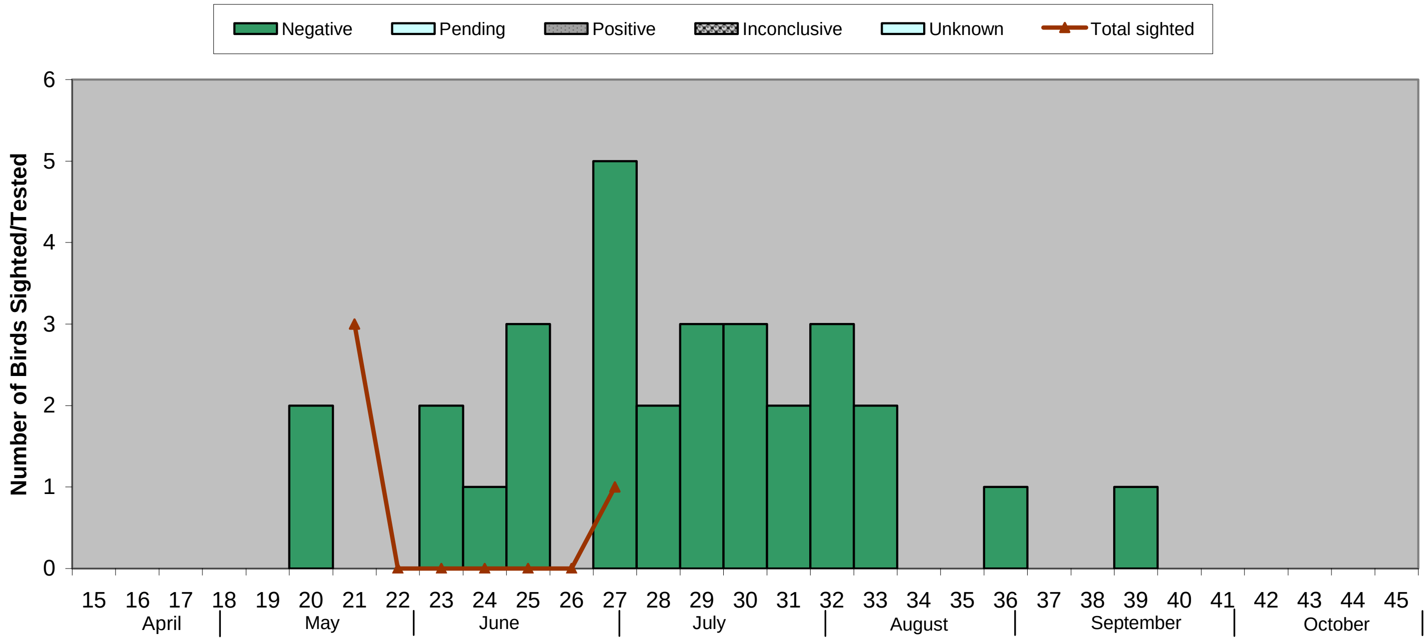
Week Number

Data up to and including Oct 30, 2004

Weeks run Sunday to Saturday

*0 birds submitted without date found;

Comparison of Number of Birds Sighted and Birds Tested in North Vancouver Island, 2004



Bar Graph - Birds Tested n=(30)

Line Graph - Birds Sighted n=(4)

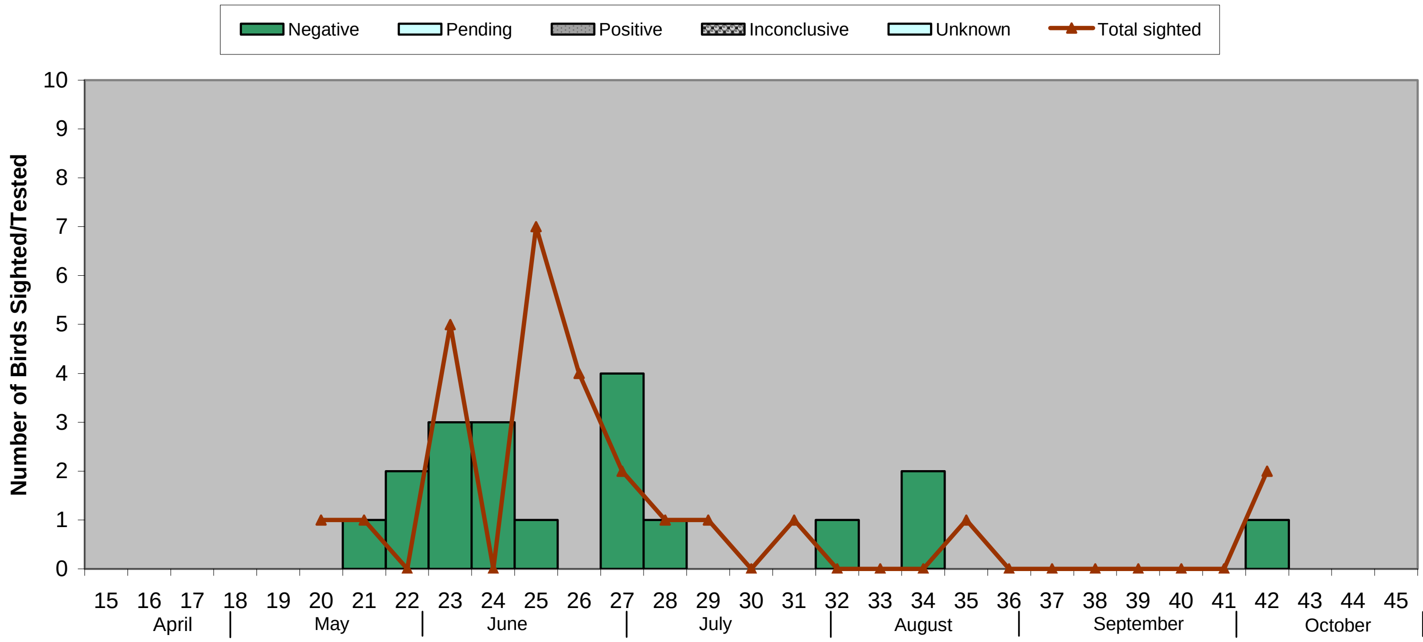
Week Number

Data up to and including Oct 30,

Weeks run Sunday to Saturday

*0 birds submitted without date found;

Comparison of Number of Birds Sighted and Birds Tested in Northwest, 2004



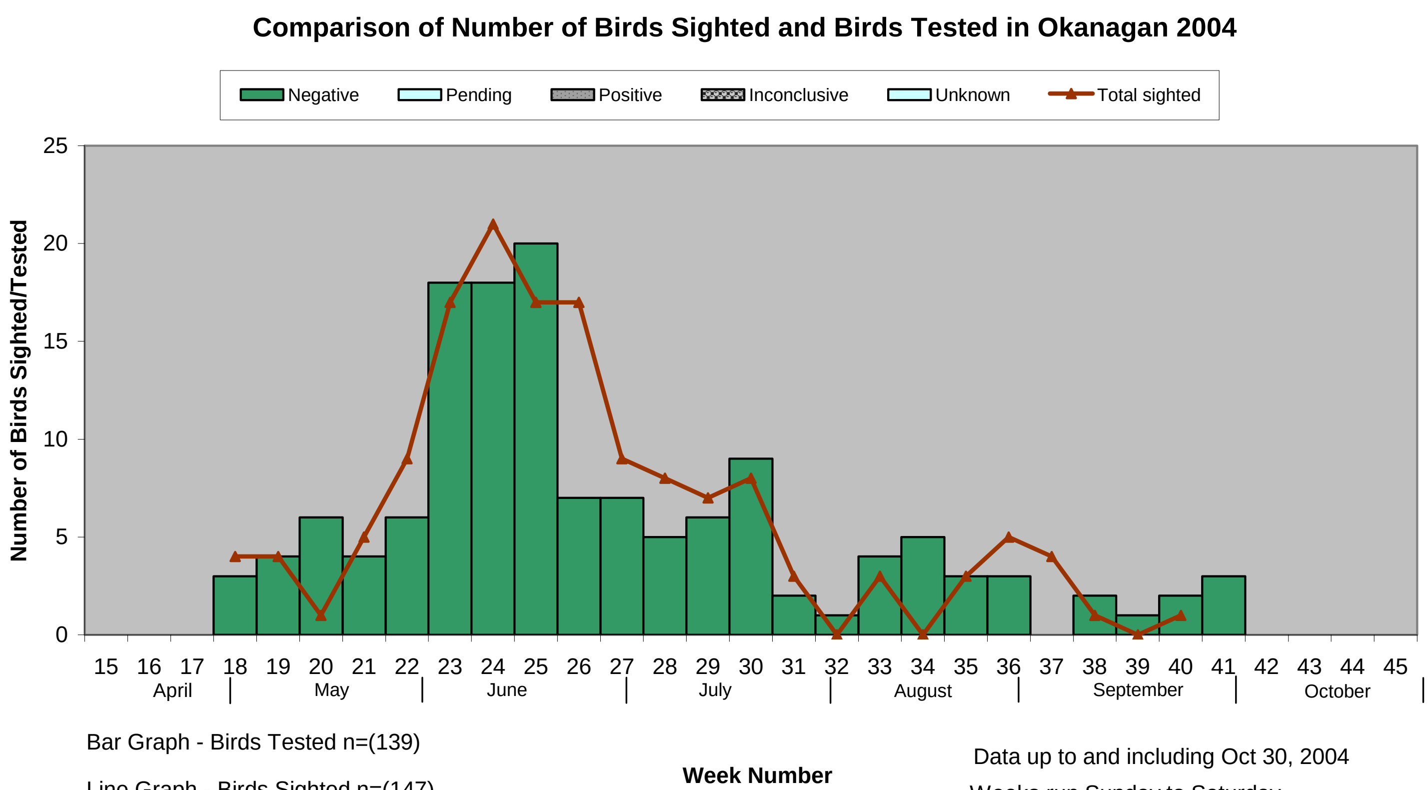
Bar Graph - Birds Tested n=(19)

Line Graph - Birds Sighted n=(26)

Data up to and including Oct 30, 2004

Weeks run Sunday to Saturday

*0 birds submitted without date found;



Bar Graph - Birds Tested n=(139)

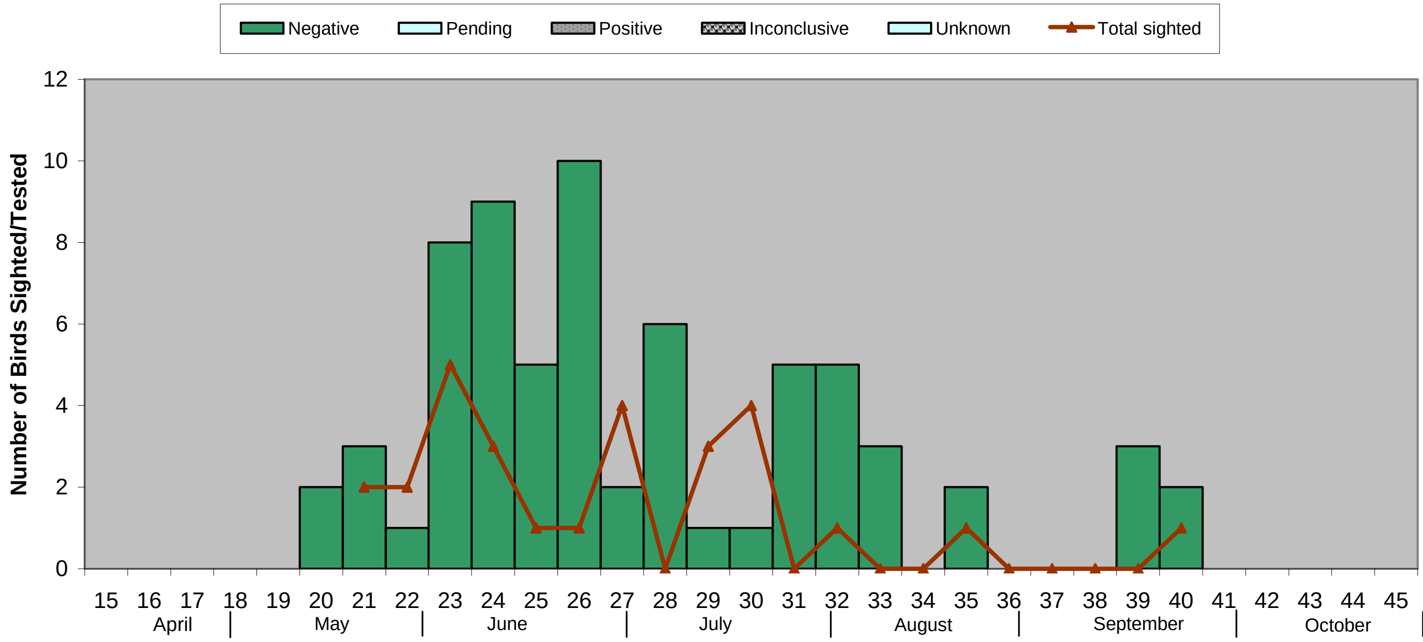
Line Graph - Birds Sighted n=(147)

*0 birds submitted without date found;

Data up to and including Oct 30, 2004

Weeks run Sunday to Saturday

Comparison of Number of Birds Sighted and Birds Tested in Richmond, 2004



Bar Graph - Birds Tested n=(68)

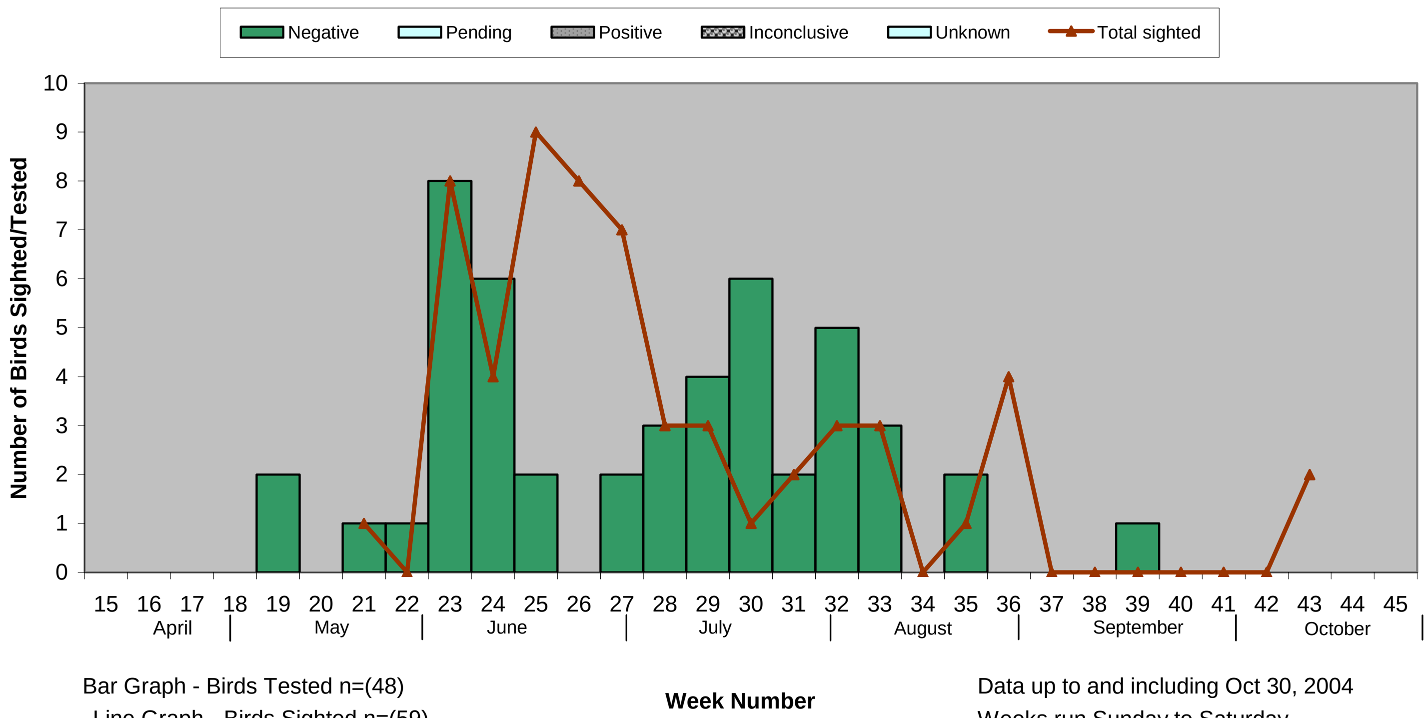
Line Graph - Birds Sighted n=(28)

*0 birds submitted without date found;

Data up to and including Oct 30, 2004

Weeks run Sunday to Saturday

Comparison of Number of Birds Sighted and Birds Tested in South Vancouver Island, 2004

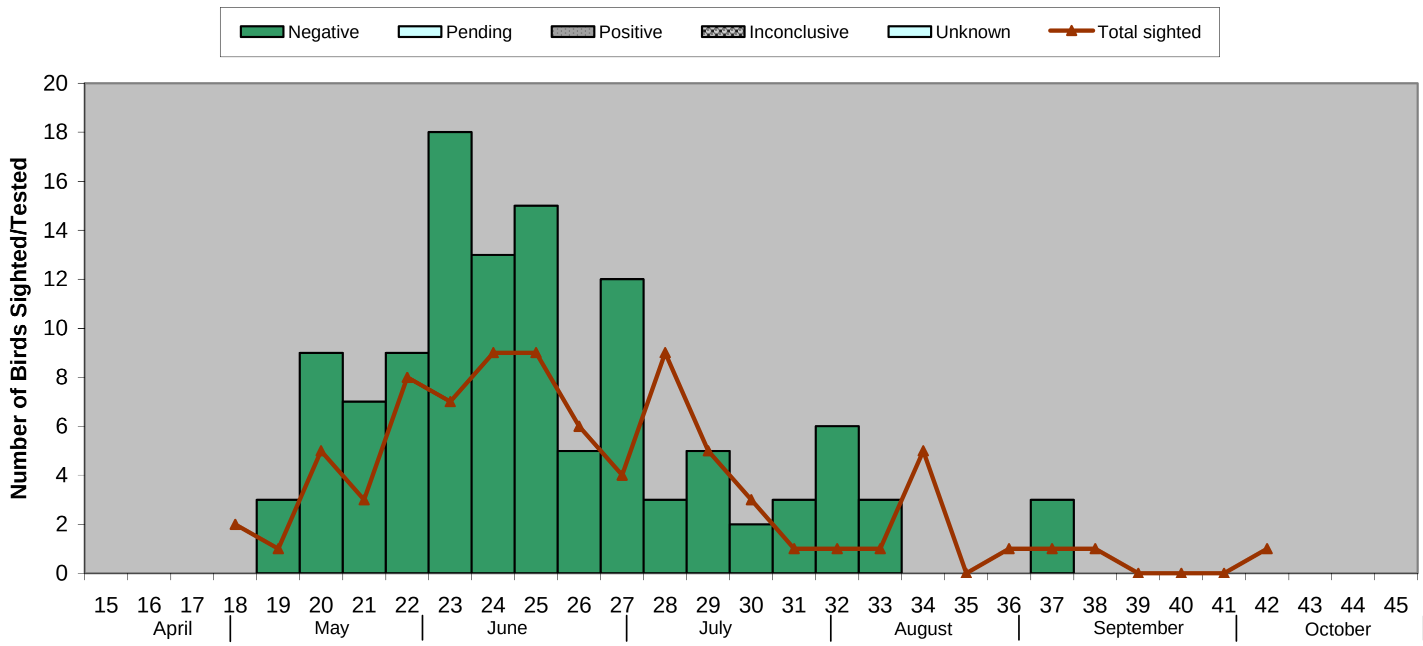


Bar Graph - Birds Tested n=(48)
Line Graph - Birds Sighted n=(59)

*0 birds submitted without date found;

Data up to and including Oct 30, 2004
Weeks run Sunday to Saturday

Comparison of Number of Birds Sighted and Birds Tested in Thompson Cariboo Shuswap, 2004



Bar Graph - Birds Tested n=(116)

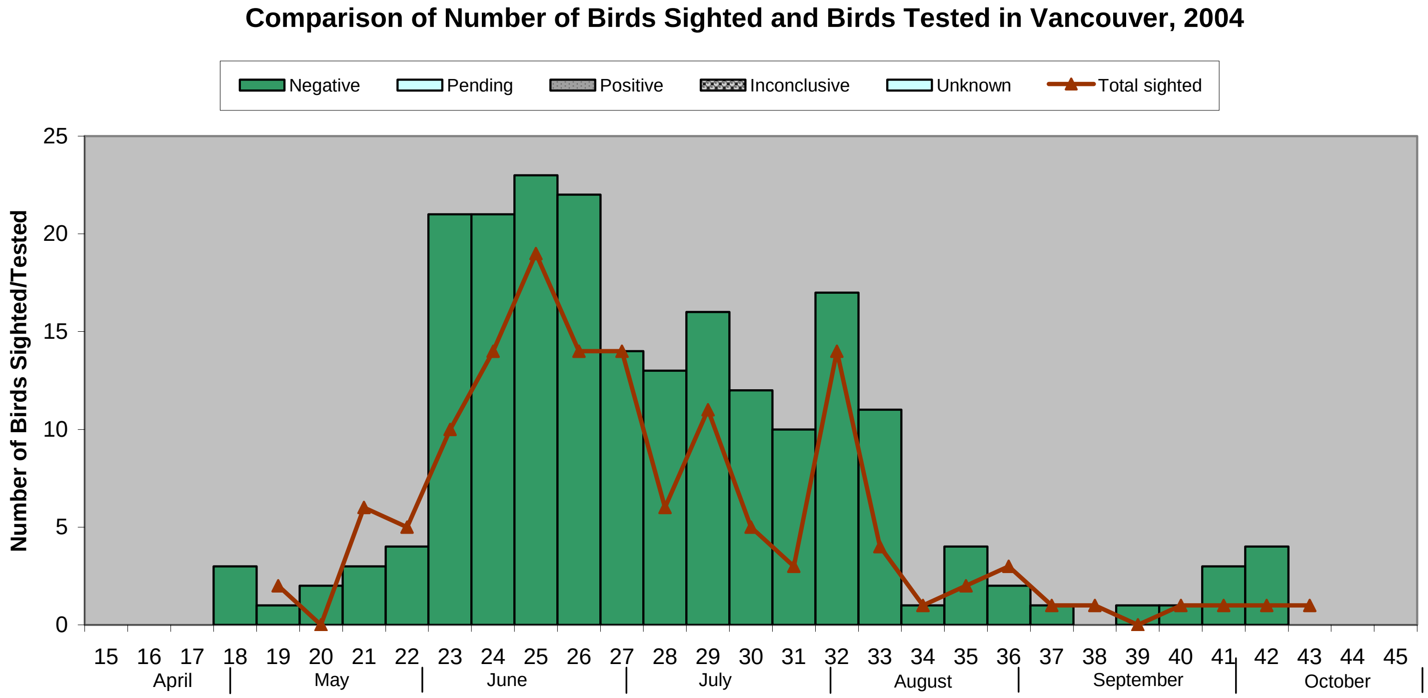
Line Graph - Birds Sighted n=(83)

Week Number

Data up to and including Oct 30, 2004

Weeks run Sunday to Saturday

*0 birds submitted without date found;



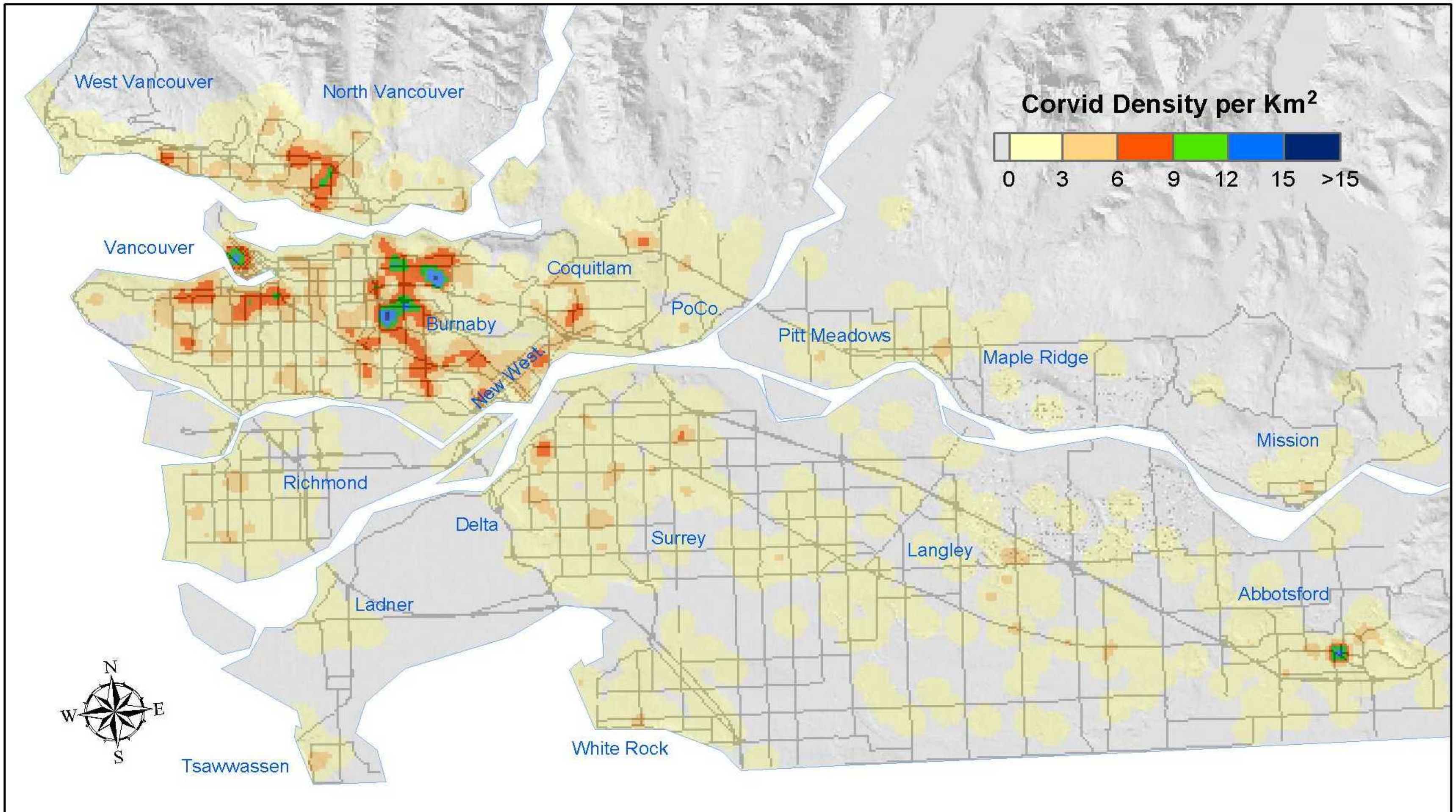
Bar Graph - Birds Tested n=(210)

Line Graph - Birds Sighted n=(139)

Data up to and including Oct 30, 2004

Weeks run Sunday to Saturday

*0 birds submitted without date found;

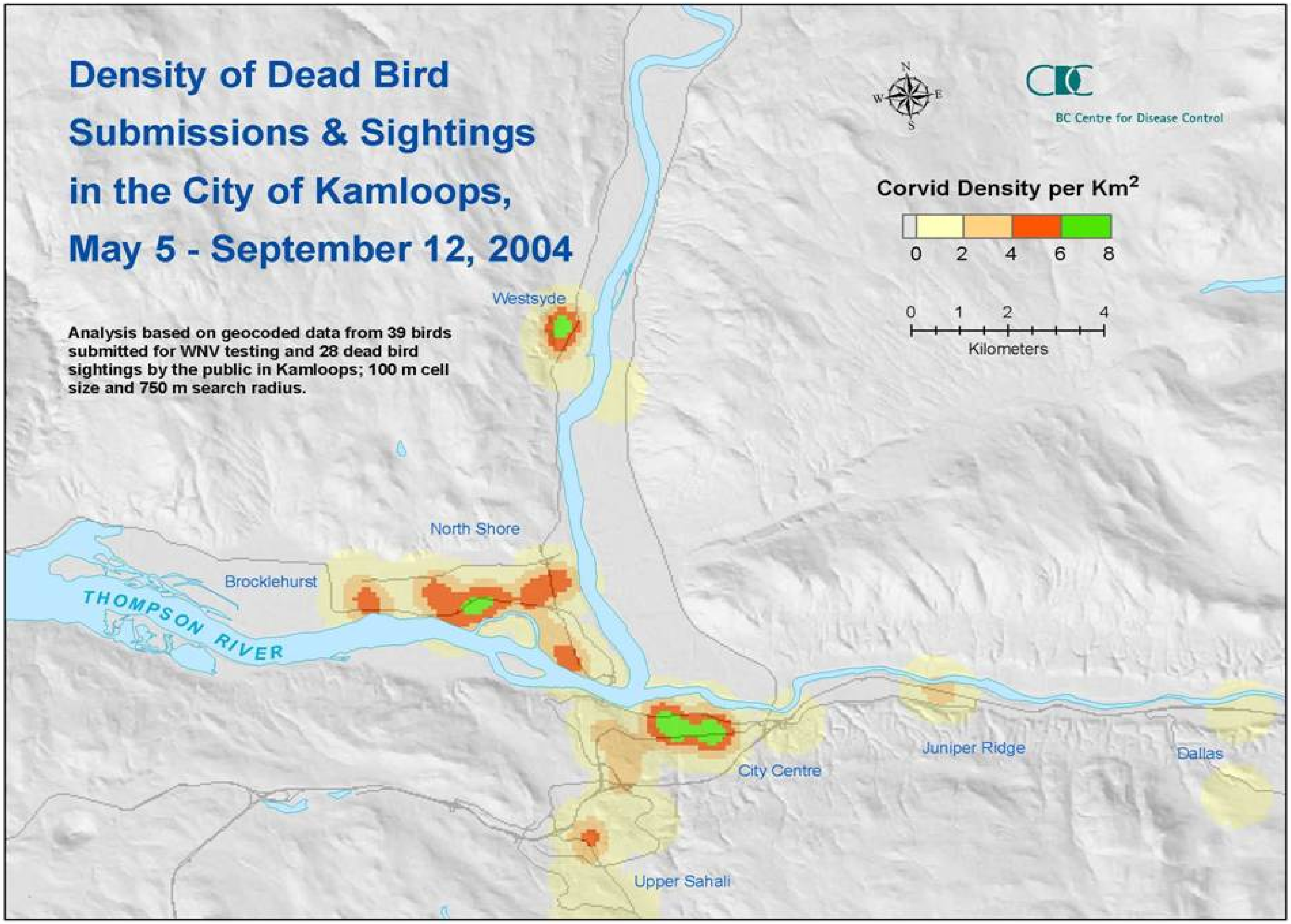


Density of Dead Bird Submissions and Sightings in the Vancouver Lower Mainland, May 2 - October 30, 2004

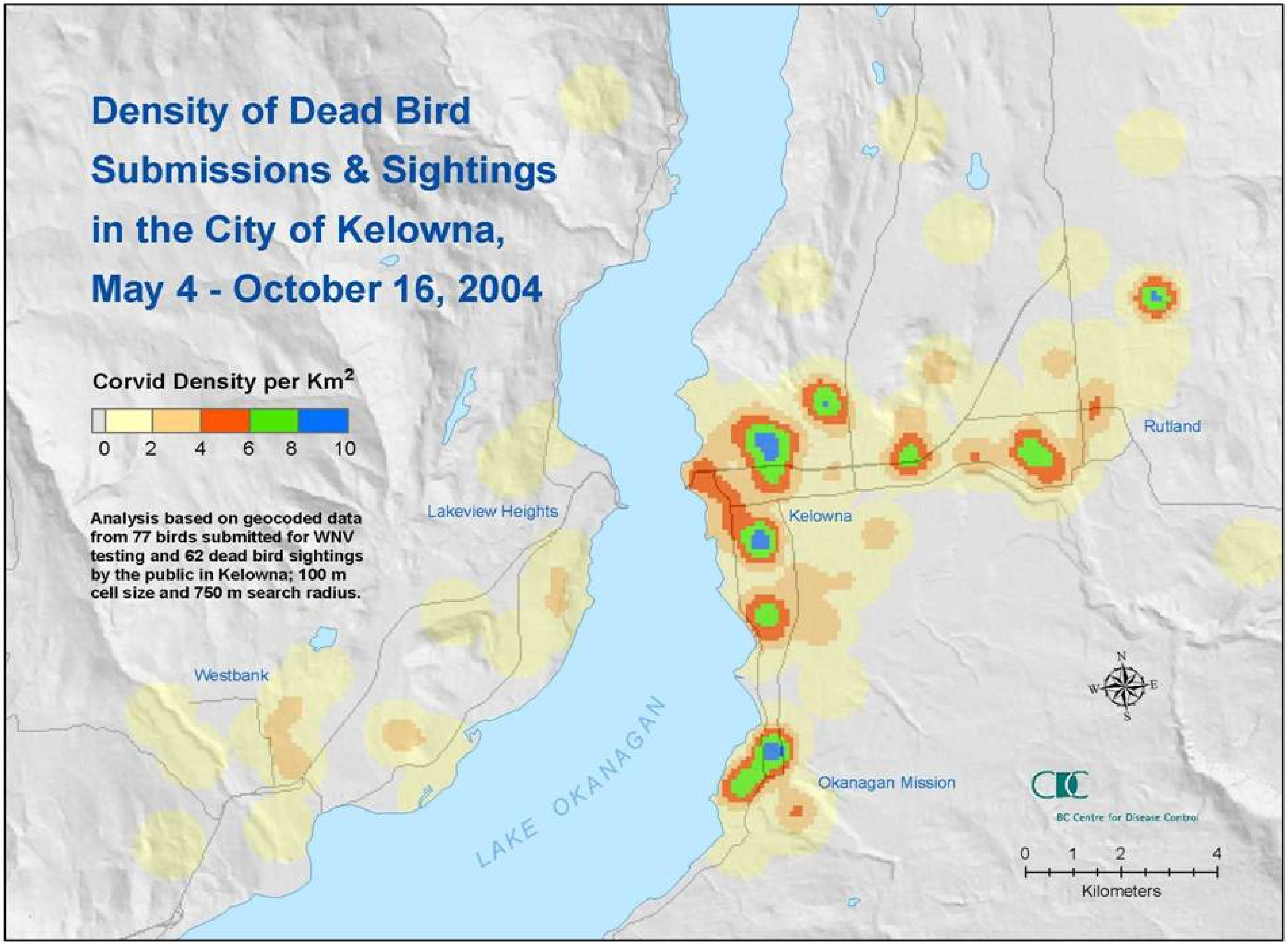
BC Centre for Disease Control

Analysis based on geocoded data from 844 birds submitted for WNV testing and 749 dead bird sightings by the public in the Vancouver Lower Mainland; 200 m cell size and 1000 m search radius.

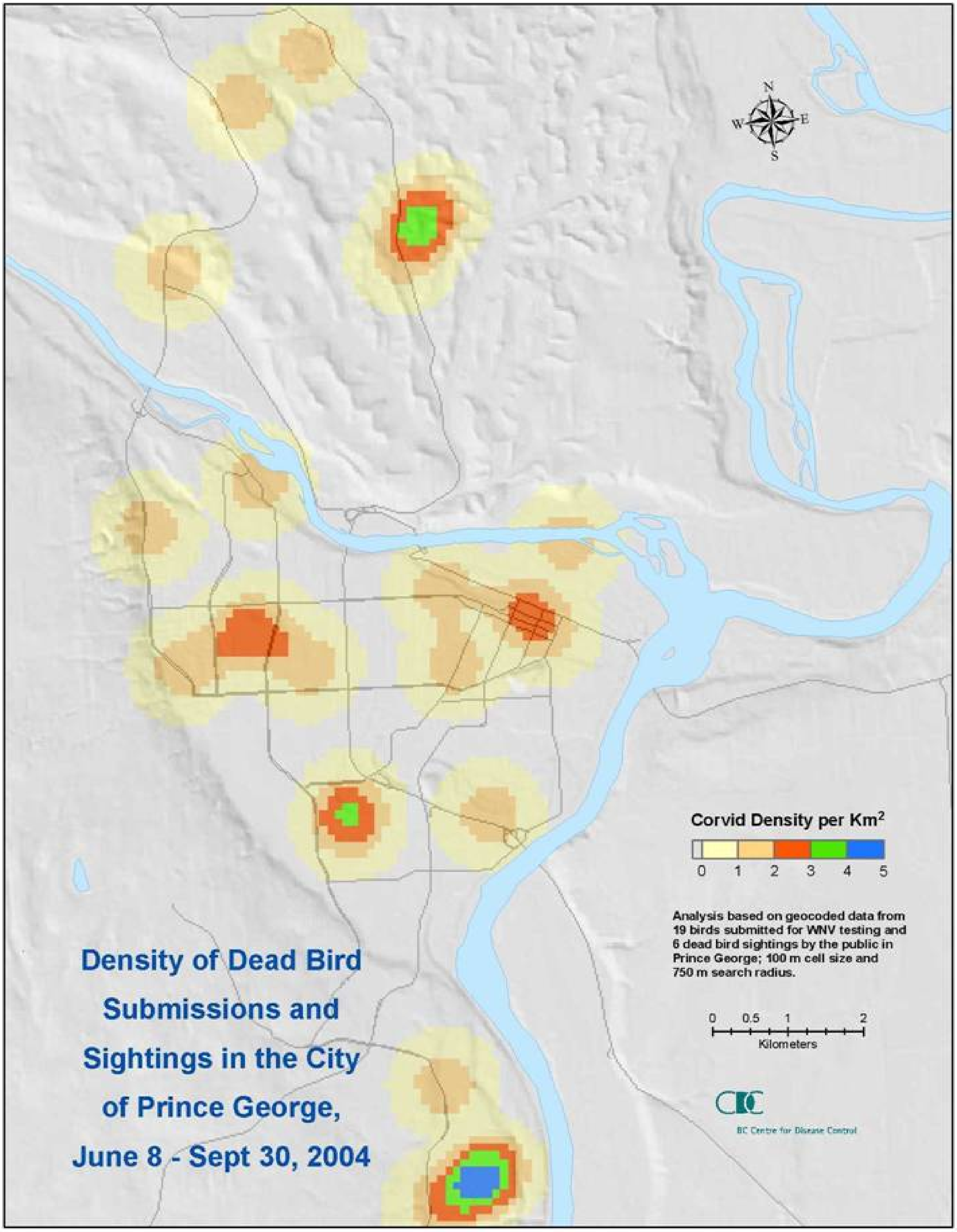
0 5 10 20
Kilometers



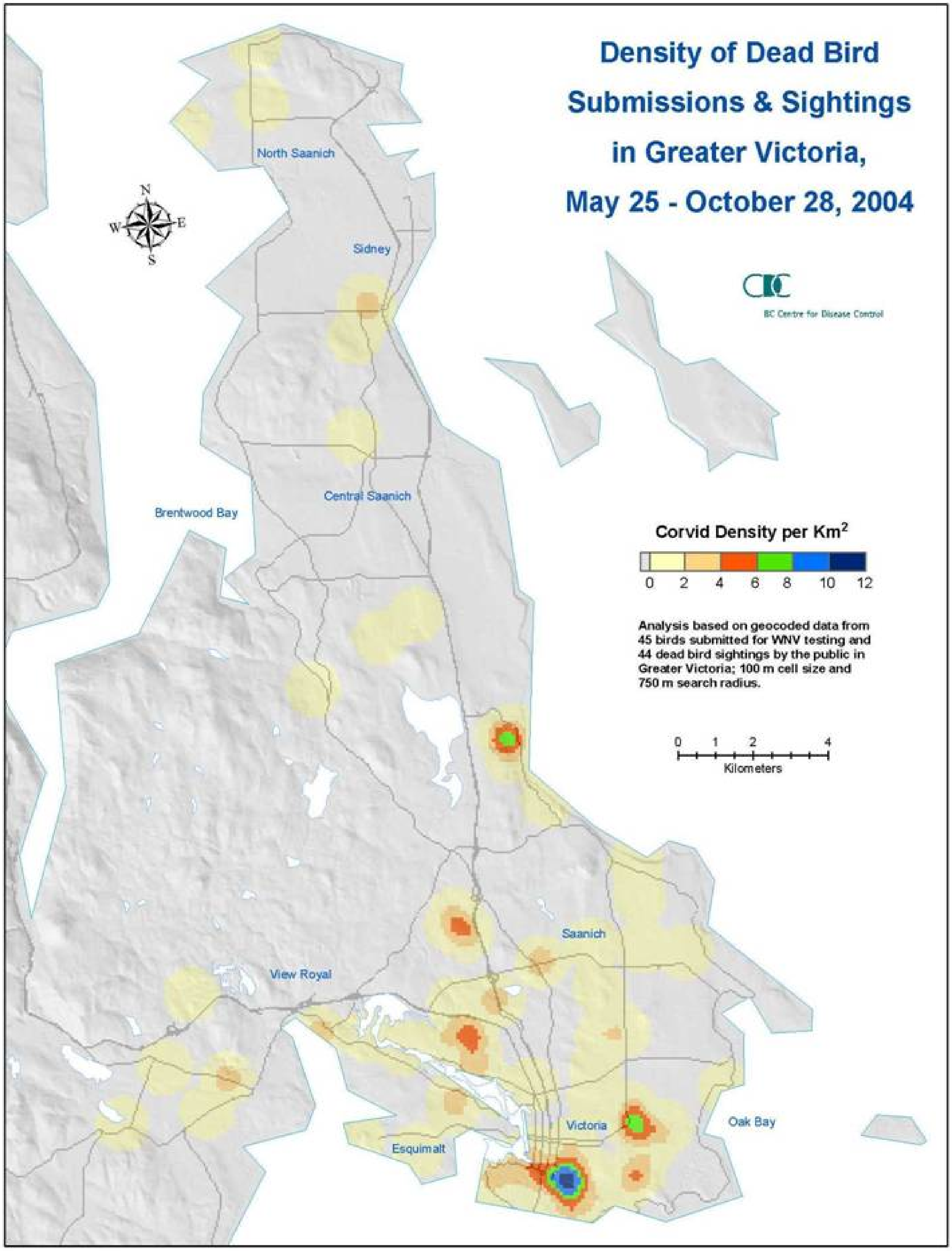
Density of Dead Bird
Submissions & Sightings
in the City of Kamloops,
May 5 - September 12, 2004
Analysis based on geocoded data from 39 birds submitted for WNV testing and 28 dead bird sightings by the public in Kamloops; 100 m cell size and 750 m search radius.
N
W
E
S
BC Centre for Disease Control
Corvid Density per Km²
0 2 4 6 8
0 1 2 4
Kilometers
Westsyde
North Shore
Brocklehurst
THOMPSON RIVER
City Centre
Juniper Ridge
Dallas
Upper Sahali



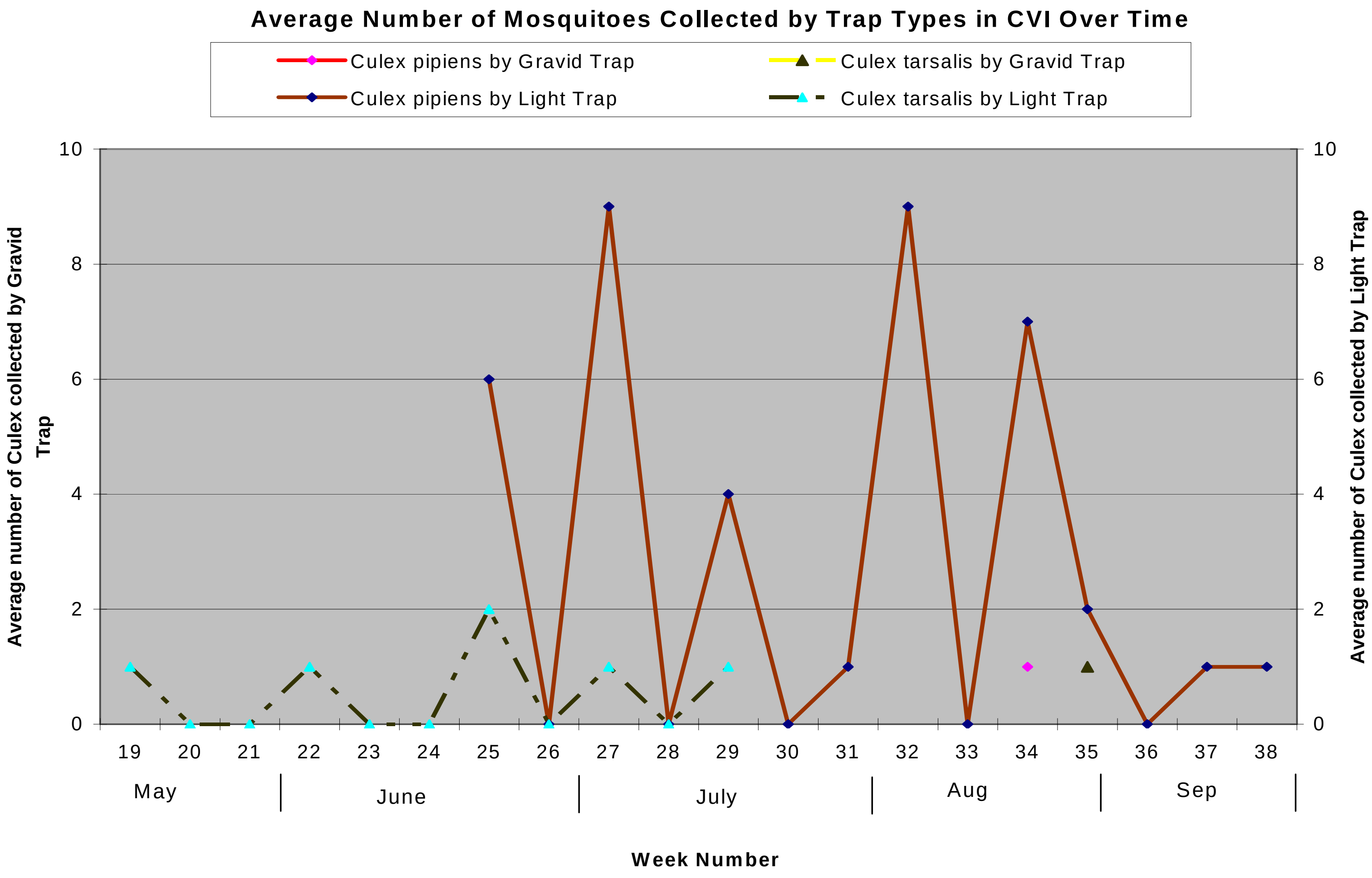
Density of Dead Bird Submissions & Sightings in the City of Kelowna, May 4 - October 16, 2004
Corvid Density per Km²
0 2 4 6 8 10
Analysis based on geocoded data from 77 birds submitted for WNV testing and 62 dead bird sightings by the public in Kelowna; 100 m cell size and 750 m search radius.
Lakeview Heights
Kelowna
Rutland
Westbank
LAKE OKANAGAN
Okanagan Mission
N
W
E
S
BC Centre for Disease Control
0 1 2 4
Kilometers


Density of Dead Bird Submissions and Sightings in the City of Prince George, June 8 - Sept 30, 2004
N
W
E
S
Corvid Density per Km²
0 1 2 3 4 5
Analysis based on geocoded data from 19 birds submitted for WNV testing and 6 dead bird sightings by the public in Prince George; 100 m cell size and 750 m search radius.
0 0.5 1 2
Kilometers
BC Centre for Disease Control

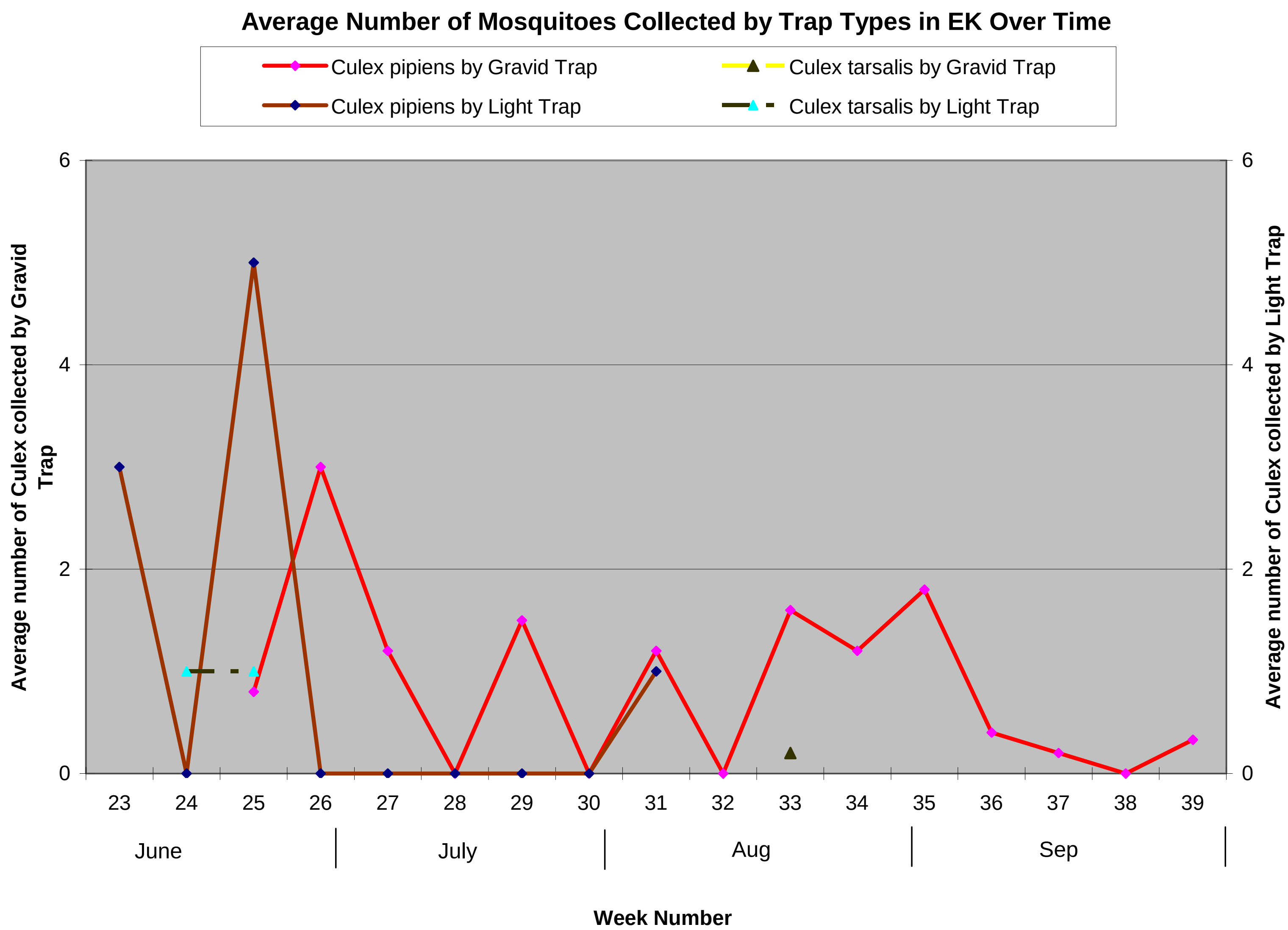
Appendix 3: Dead Bird Density Maps



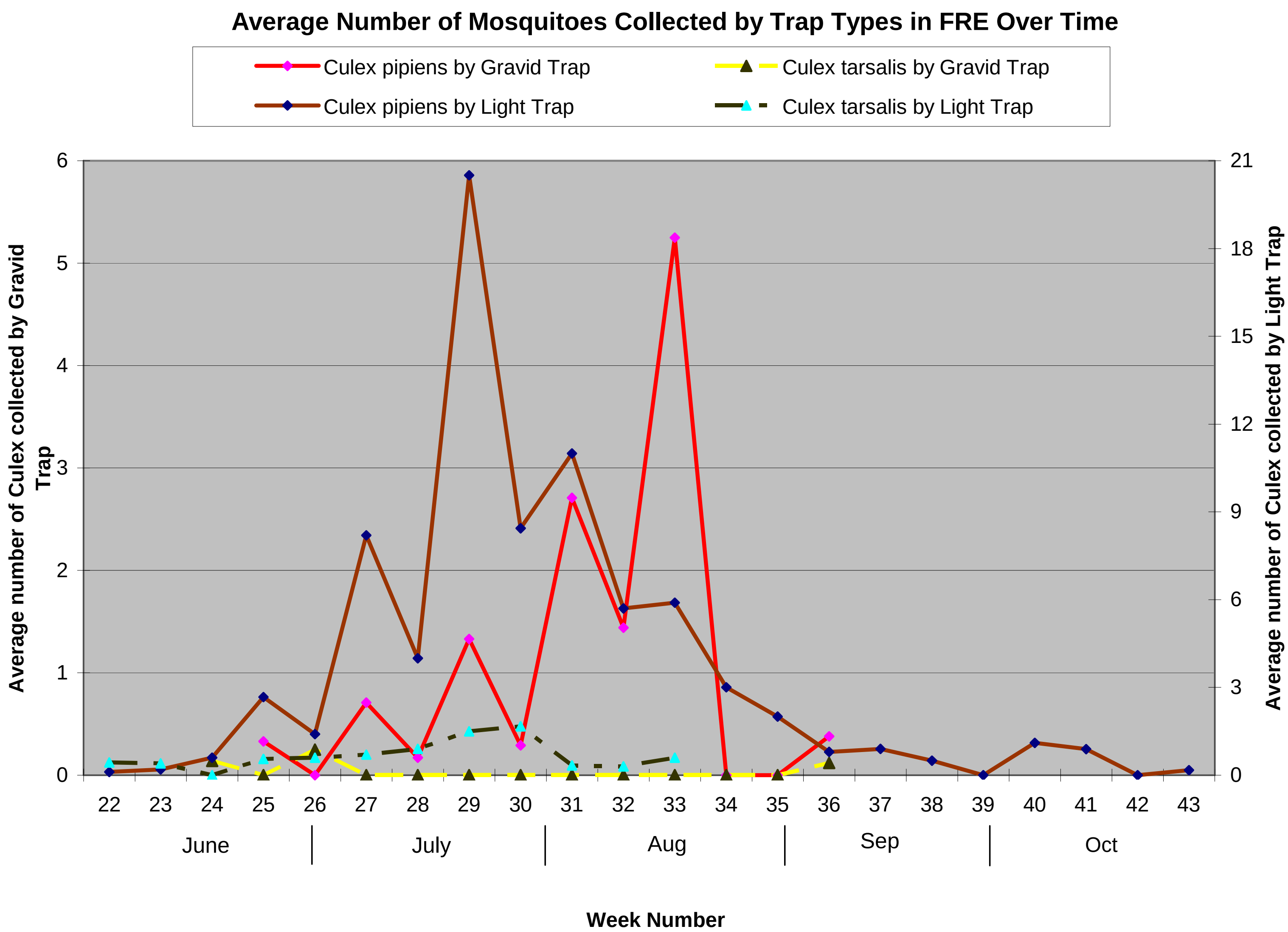
Appendix 4



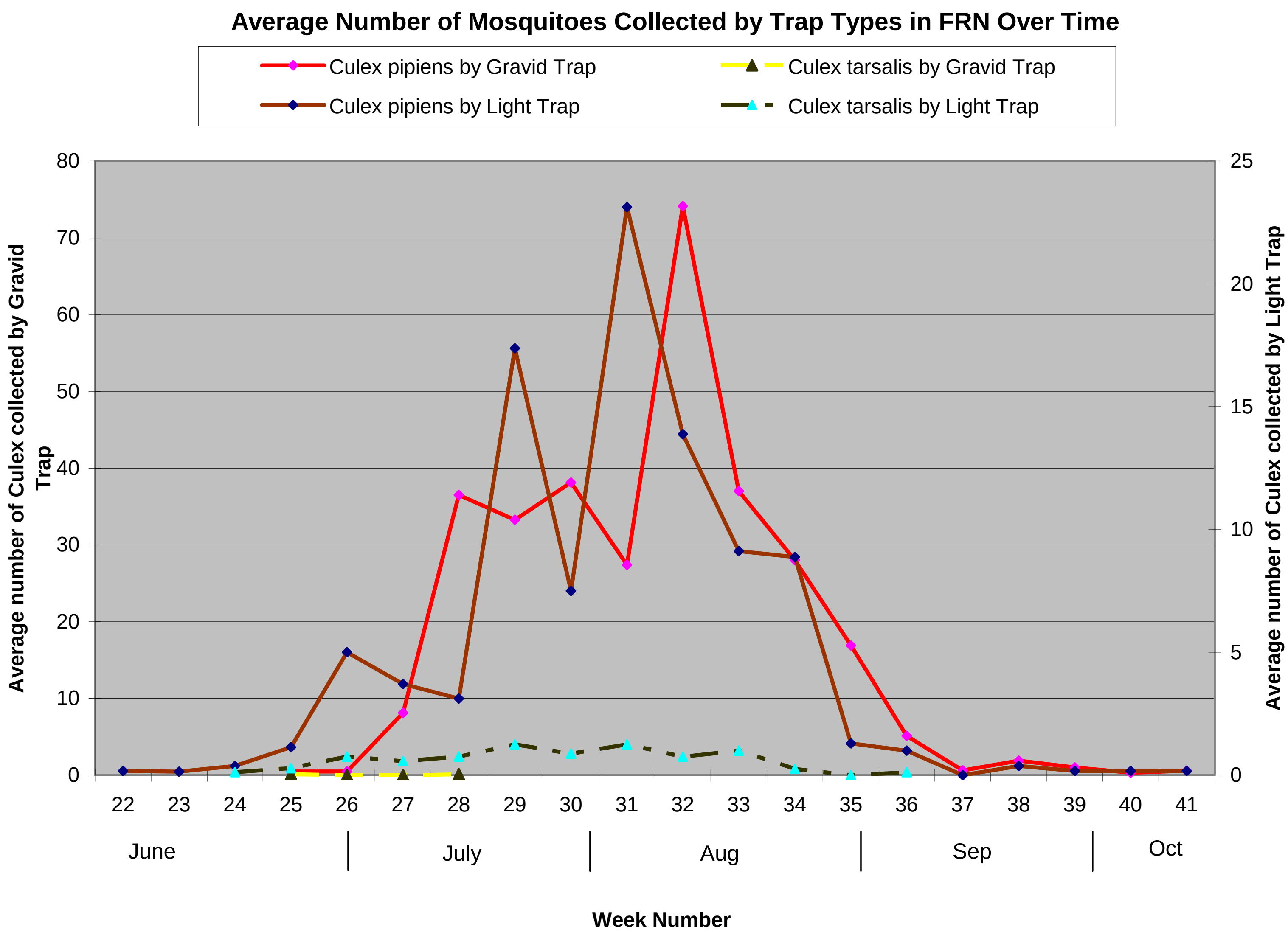
Average Number of Mosquitoes Collected by Trap Types in CVI Over Time
Culex pipiens by Gravid Trap
Culex tarsalis by Gravid Trap
Culex pipiens by Light Trap
Culex tarsalis by Light Trap
Average number of Culex collected by Gravid Trap
Average number of Culex collected by Light Trap
0
2
4
6
8
10
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
May
June
July
Aug
Sep
Week Number



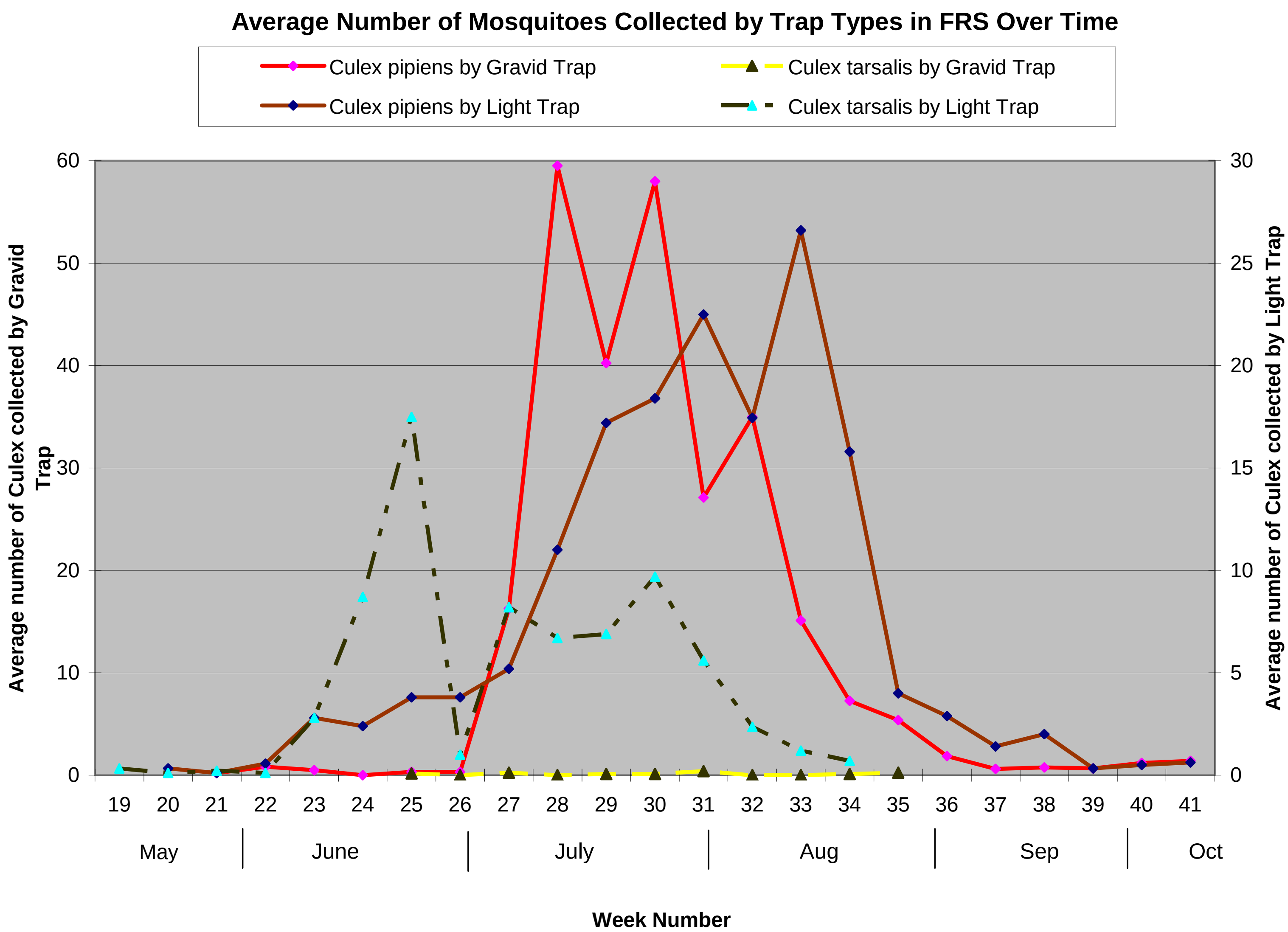
Average Number of Mosquitoes Collected by Trap Types in EK Over Time
Culex pipiens by Gravid Trap
Culex tarsalis by Gravid Trap
Culex pipiens by Light Trap
Culex tarsalis by Light Trap
Average number of Culex collected by Gravid Trap
Average number of Culex collected by Light Trap
0
2
4
6
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
June
July
Aug
Sep
Week Number

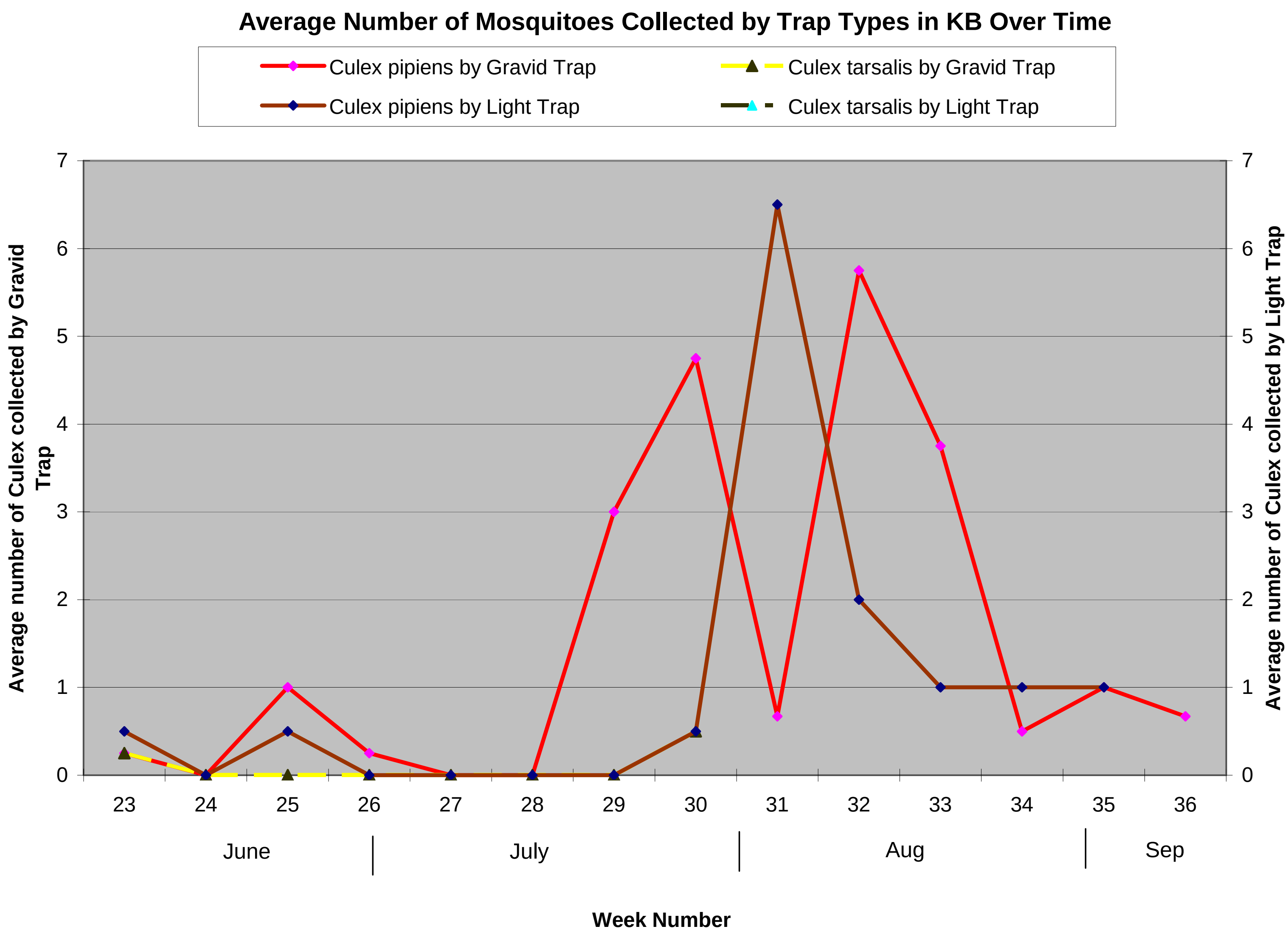


Average Number of Mosquitoes Collected by Trap Types in FRE Over Time
Culex pipiens by Gravid Trap
Culex tarsalis by Gravid Trap
Culex pipiens by Light Trap
Culex tarsalis by Light Trap
Average number of Culex collected by Gravid Trap
Average number of Culex collected by Light Trap
0
1
2
3
4
5
6
0
3
6
9
12
15
18
21
22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43
June
July
Aug
Sep
Oct
Week Number

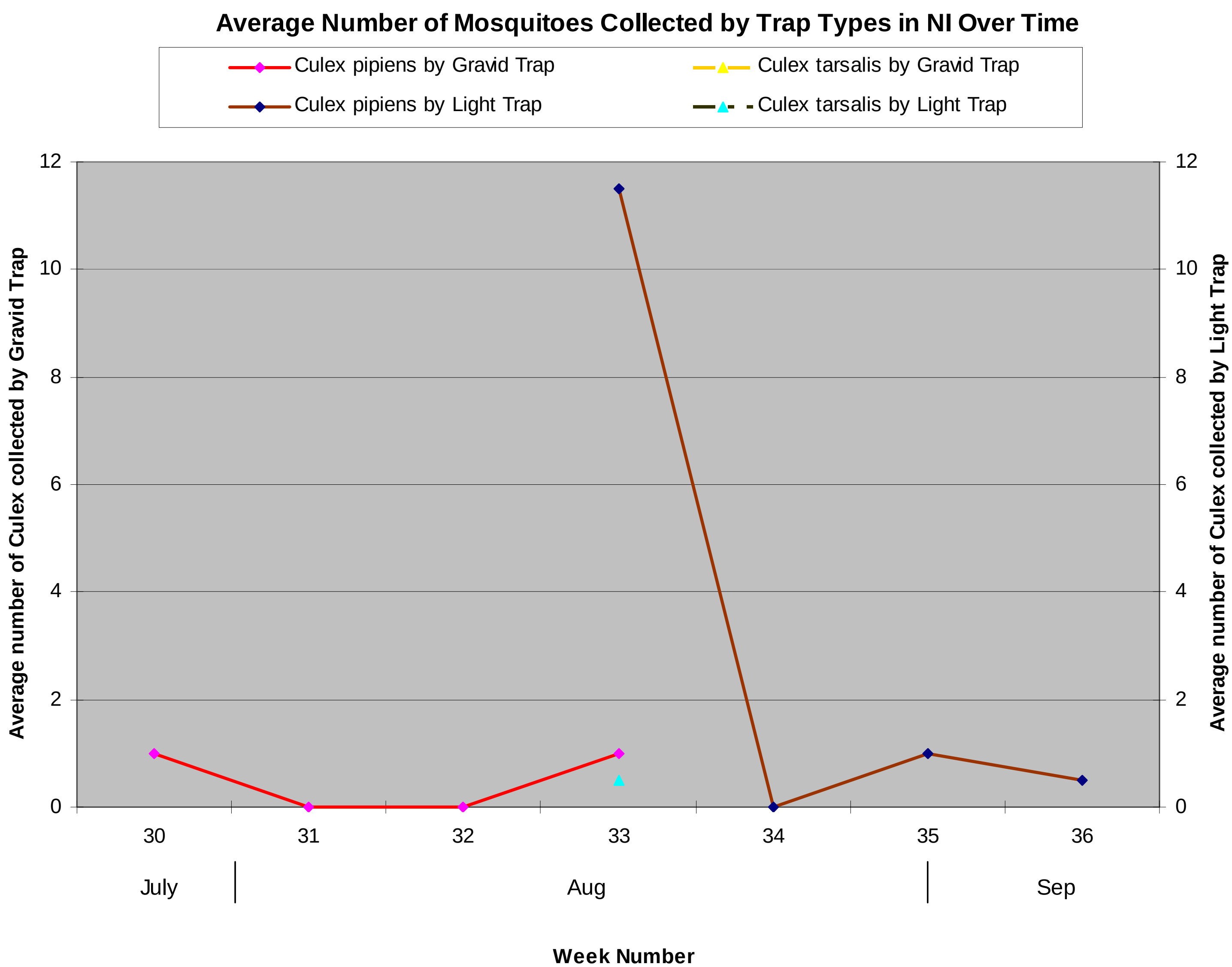


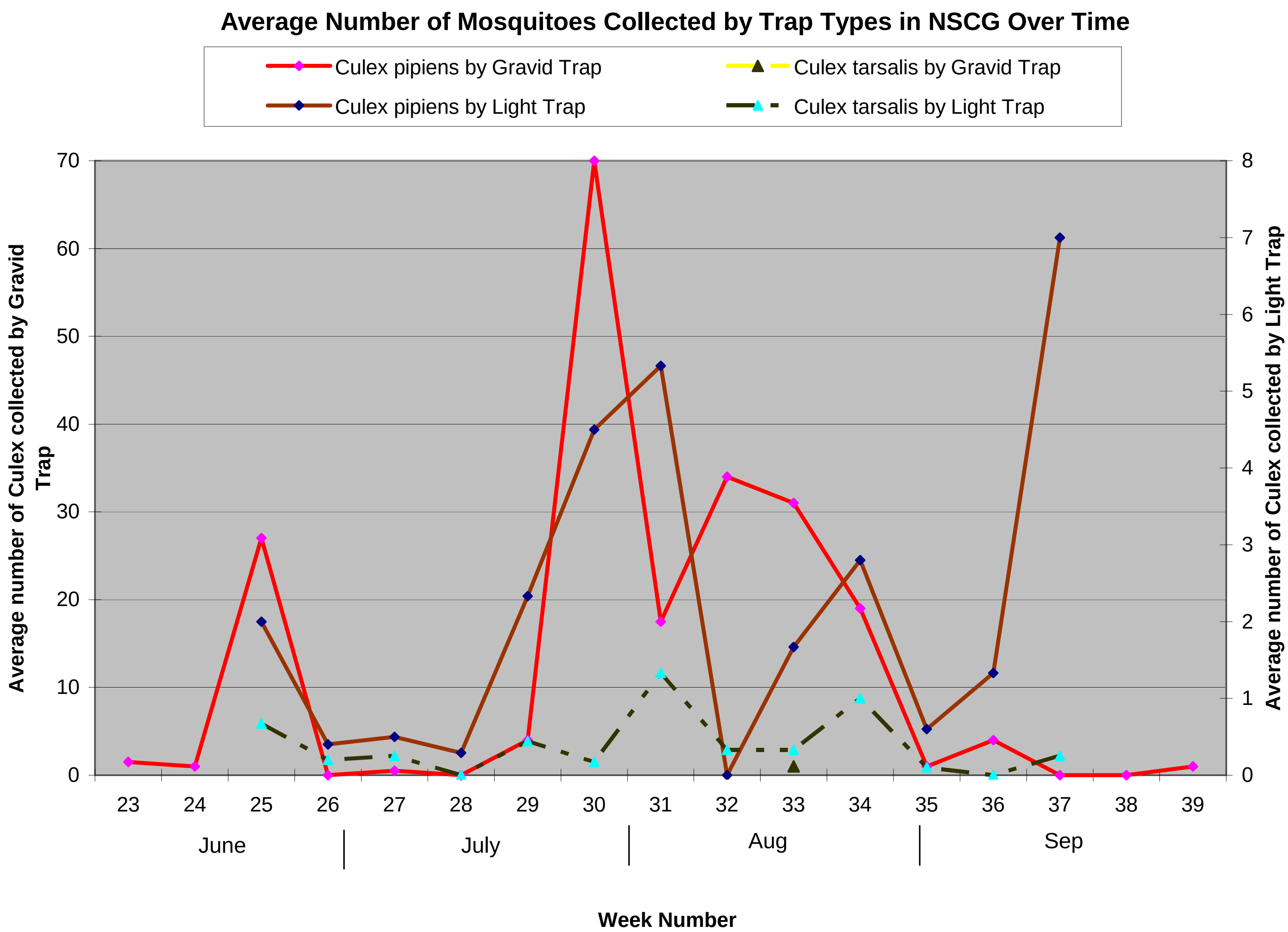
Average Number of Mosquitoes Collected by Trap Types in FRN Over Time
Culex pipiens by Gravid Trap
Culex tarsalis by Gravid Trap
Culex pipiens by Light Trap
Culex tarsalis by Light Trap
Average number of Culex collected by Gravid Trap
Average number of Culex collected by Light Trap
80
70
60
50
40
30
20
10
0
25
20
15
10
5
0
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
June
July
Aug
Sep
Oct
Week Number


Average Number of Mosquitoes Collected by Trap Types in FRS Over Time
Culex pipiens by Gravid Trap
Culex tarsalis by Gravid Trap
Culex pipiens by Light Trap
Culex tarsalis by Light Trap
Average number of Culex collected by Gravid Trap
Average number of Culex collected by Light Trap
0
10
20
30
40
50
60
0
5
10
15
20
25
30
19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41
May
June
July
Aug
Sep
Oct
Week Number

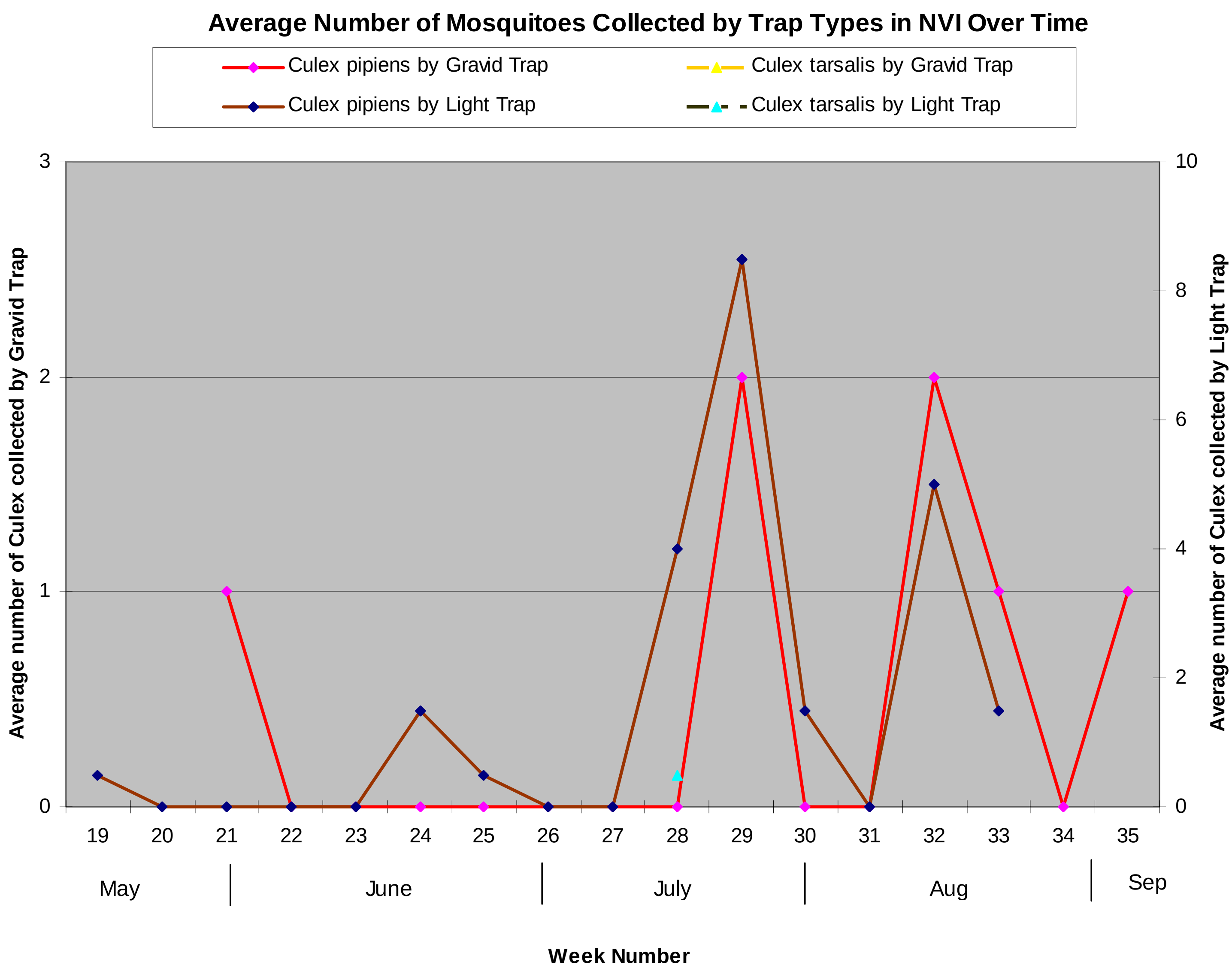


Average Number of Mosquitoes Collected by Trap Types in KB Over Time
Culex pipiens by Gravid Trap
Culex tarsalis by Gravid Trap
Culex pipiens by Light Trap
Culex tarsalis by Light Trap
Average number of Culex collected by Gravid Trap
Average number of Culex collected by Light Trap
0
1
2
3
4
5
6
7
23
24
25
26
27
28
29
30
31
32
33
34
35
36
June
July
Aug
Sep
Week Number


Average Number of Mosquitoes Collected by Trap Types in NI Over Time
Culex pipiens by Gravid Trap
Culex tarsalis by Gravid Trap
Culex pipiens by Light Trap
Culex tarsalis by Light Trap
Average number of Culex collected by Gravid Trap
Average number of Culex collected by Light Trap
0
2
4
6
8
10
12
30
31
32
33
34
35
36
July
Aug
Sep
Week Number

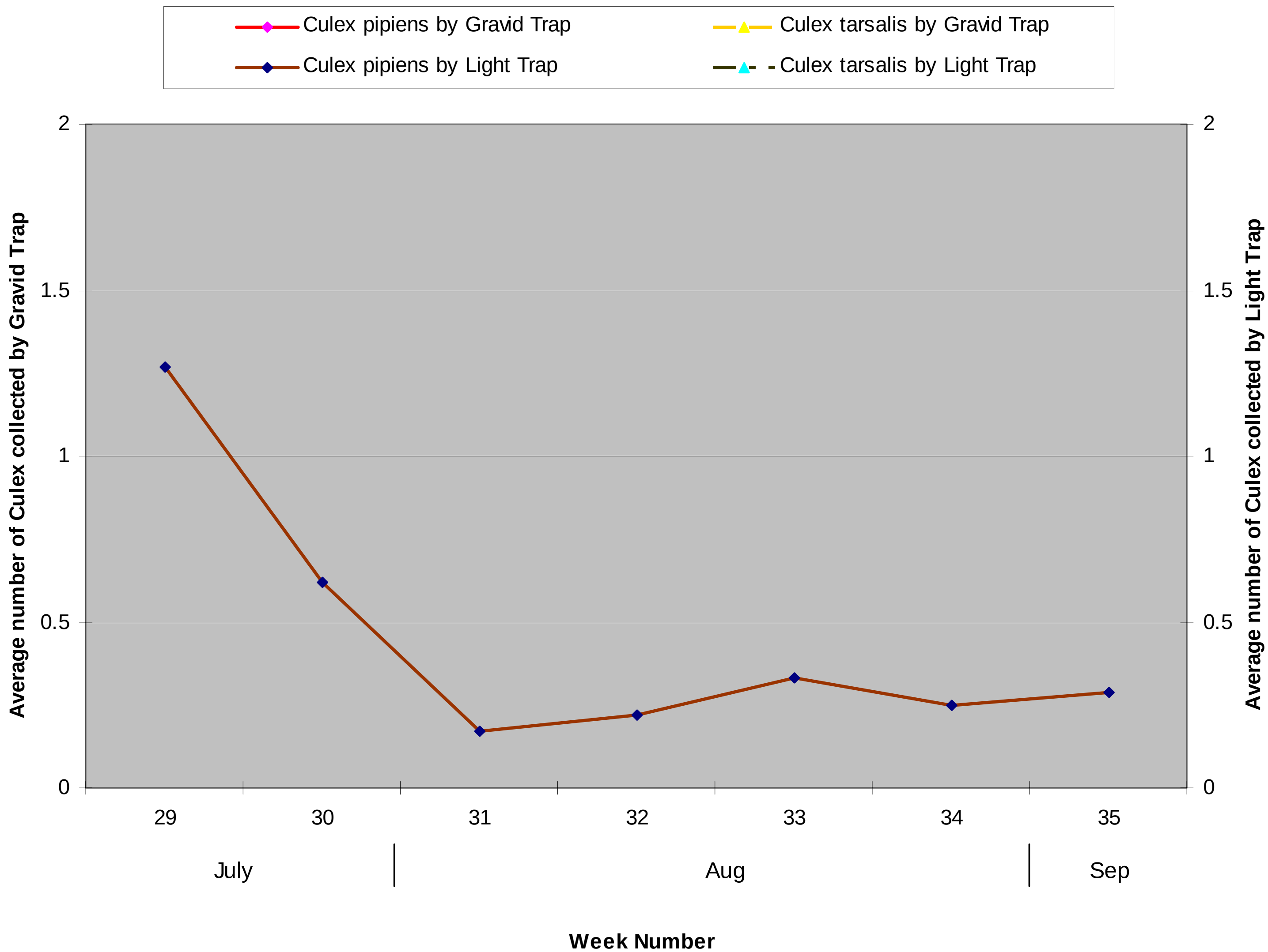


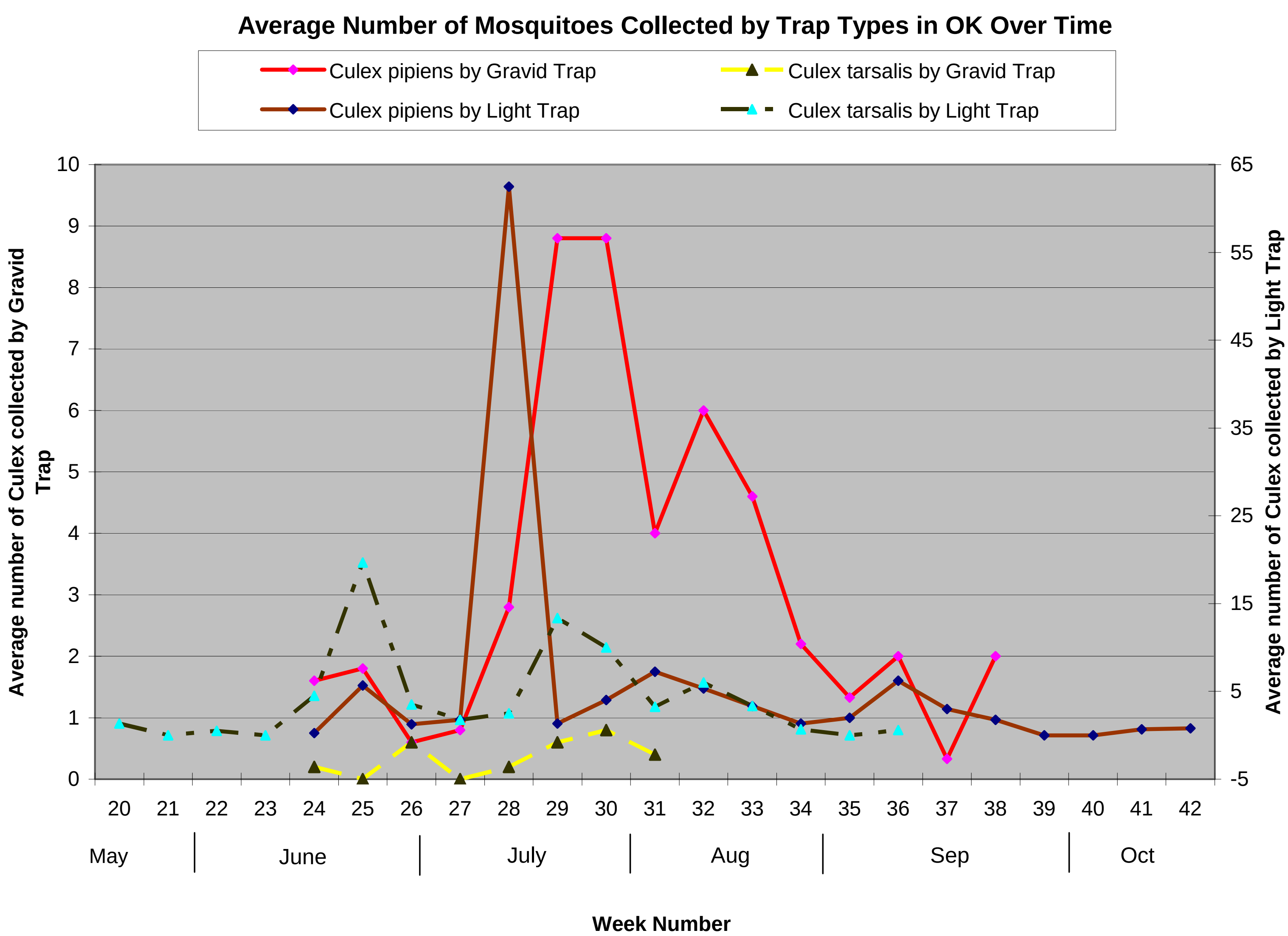
Average Number of Mosquitoes Collected by Trap Types in NSCG Over Time
Culex pipiens by Gravid Trap
Culex tarsalis by Gravid Trap
Culex pipiens by Light Trap
Culex tarsalis by Light Trap
Average number of Culex collected by Gravid Trap
Average number of Culex collected by Light Trap
0
10
20
30
40
50
60
70
0
1
2
3
4
5
6
7
8
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
June
July
Aug
Sep
Week Number

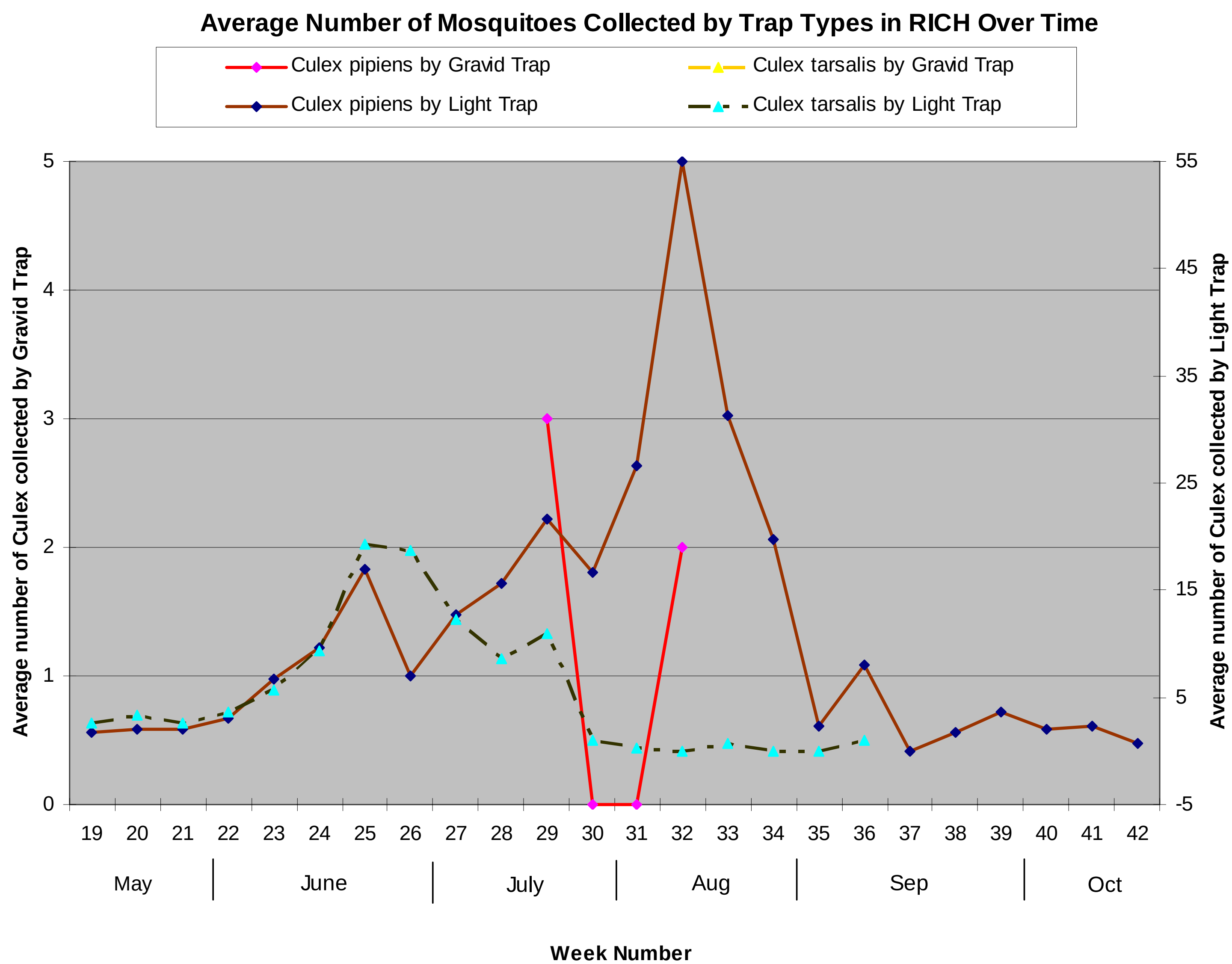


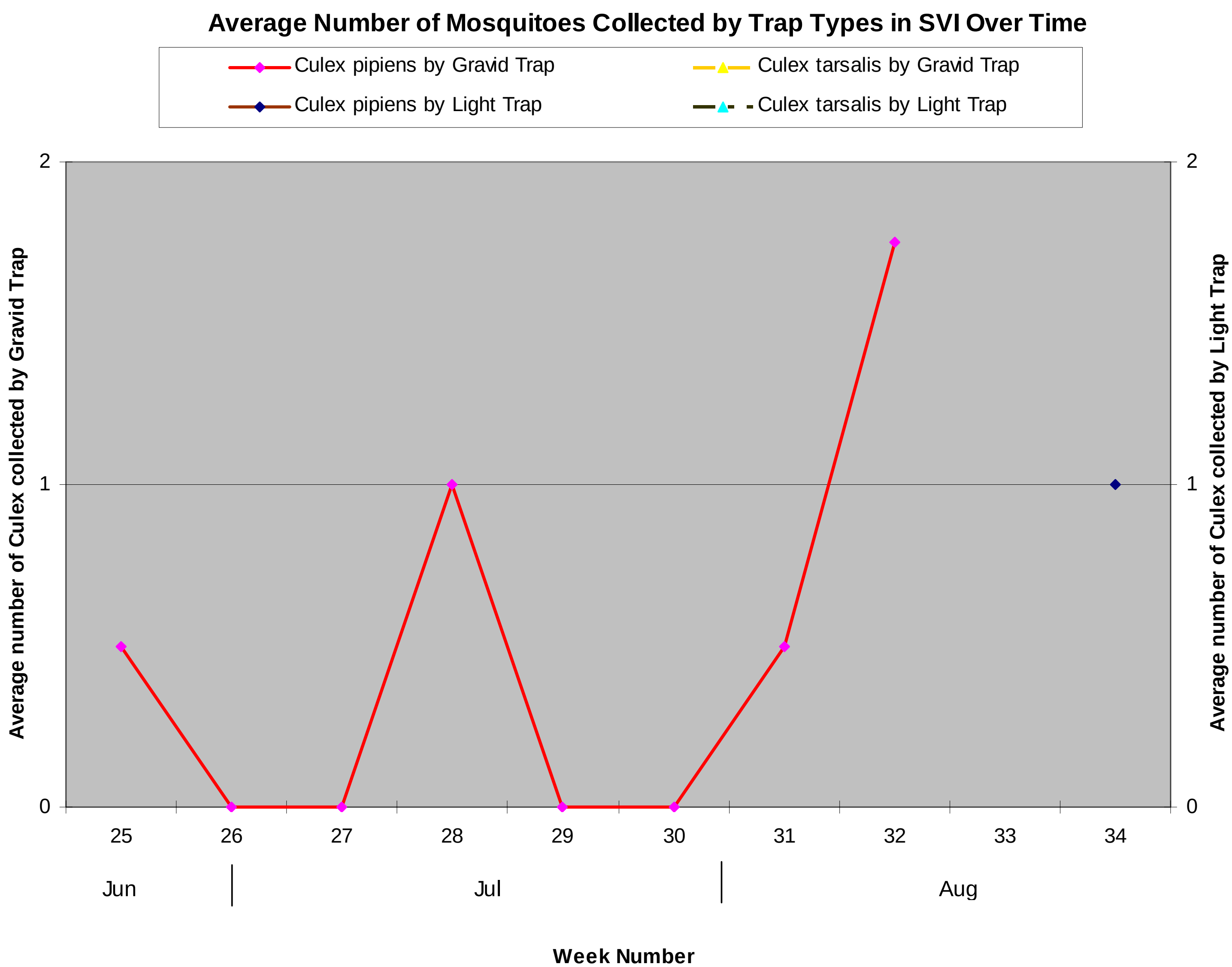
Average Number of Mosquitoes Collected by Trap Types in NVI Over Time
Culex pipiens by Gravid Trap
Culex tarsalis by Gravid Trap
Culex pipiens by Light Trap
Culex tarsalis by Light Trap
Average number of Culex collected by Gravid Trap
Average number of Culex collected by Light Trap
0
1
2
3
0
2
4
6
8
10
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
May
June
July
Aug
Sep
Week Number

Average Number of Mosquitoes Collected by Trap Types in NW Over Time

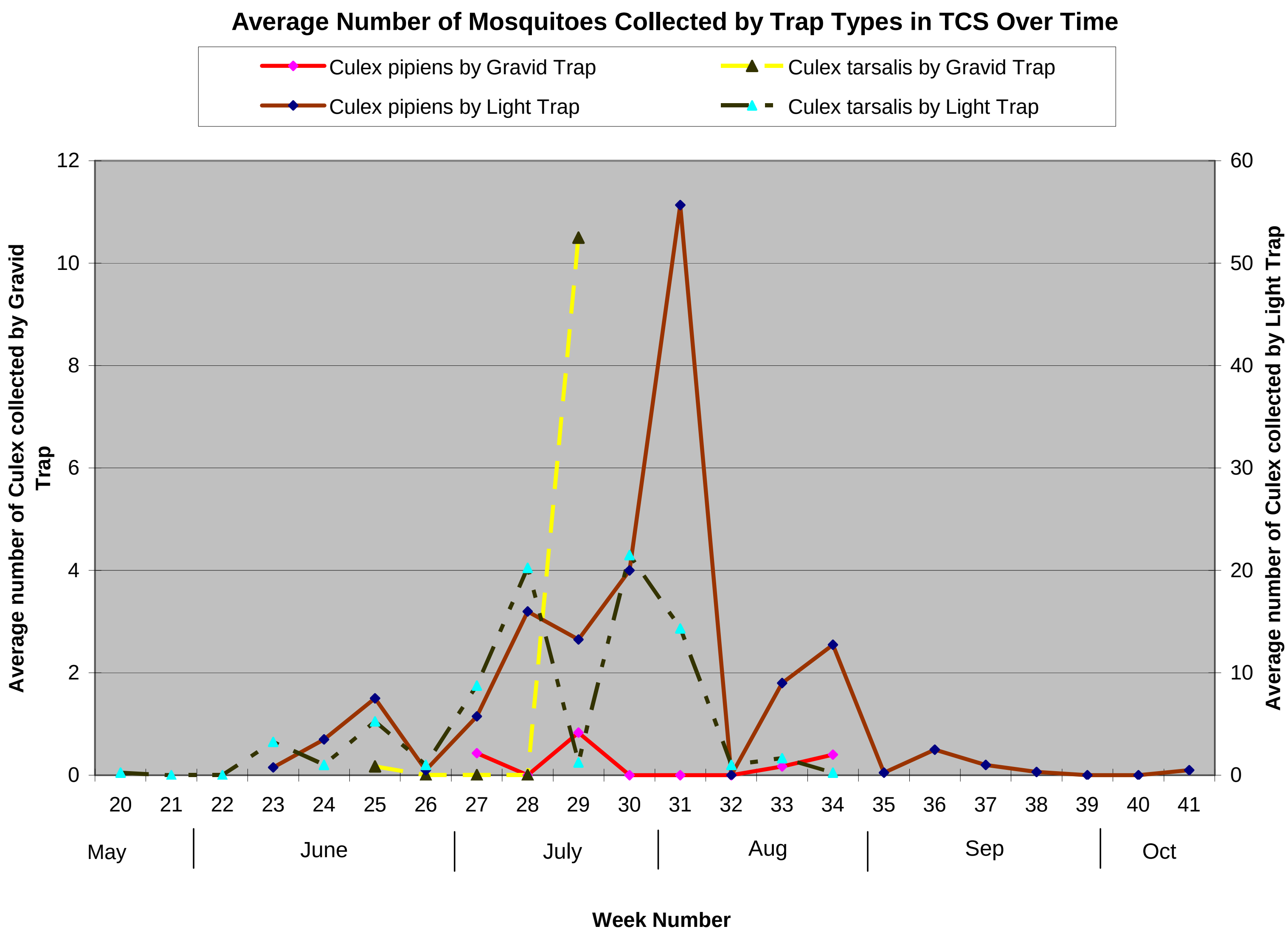



Average Number of Mosquitoes Collected by Trap Types in OK Over Time
Culex pipiens by Gravid Trap
Culex tarsalis by Gravid Trap
Culex pipiens by Light Trap
Culex tarsalis by Light Trap
Average number of Culex collected by Gravid Trap
Average number of Culex collected by Light Trap
0
1
2
3
4
5
6
7
8
9
10
-5
5
15
25
35
45
55
65
20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42
May
June
July
Aug
Sep
Oct
Week Number

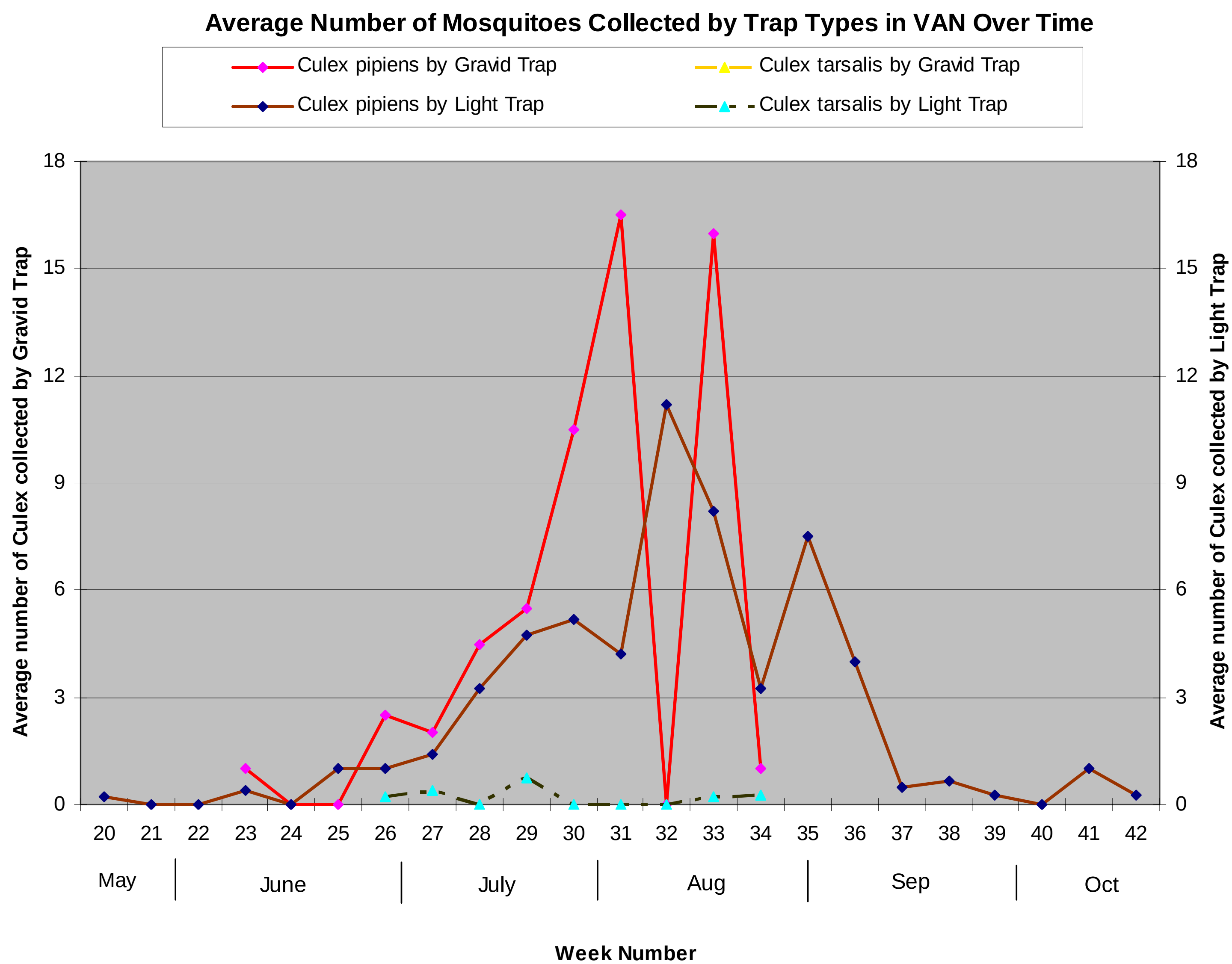

Average Number of Mosquitoes Collected by Trap Types in RICH Over Time
Culex pipiens by Gravid Trap
Culex tarsalis by Gravid Trap
Culex pipiens by Light Trap
Culex tarsalis by Light Trap
Average number of Culex collected by Gravid Trap
Average number of Culex collected by Light Trap
0 1 2 3 4 5
-5 5 15 25 35 45 55
19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42
May
June
July
Aug
Sep
Oct
Week Number



Average Number of Mosquitoes Collected by Trap Types in SVI Over Time
Culex pipiens by Gravid Trap
Culex tarsalis by Gravid Trap
Culex pipiens by Light Trap
Culex tarsalis by Light Trap
Average number of Culex collected by Gravid Trap
Average number of Culex collected by Light Trap
0
1
2
25
26
27
28
29
30
31
32
33
34
Jun
Jul
Aug
Week Number

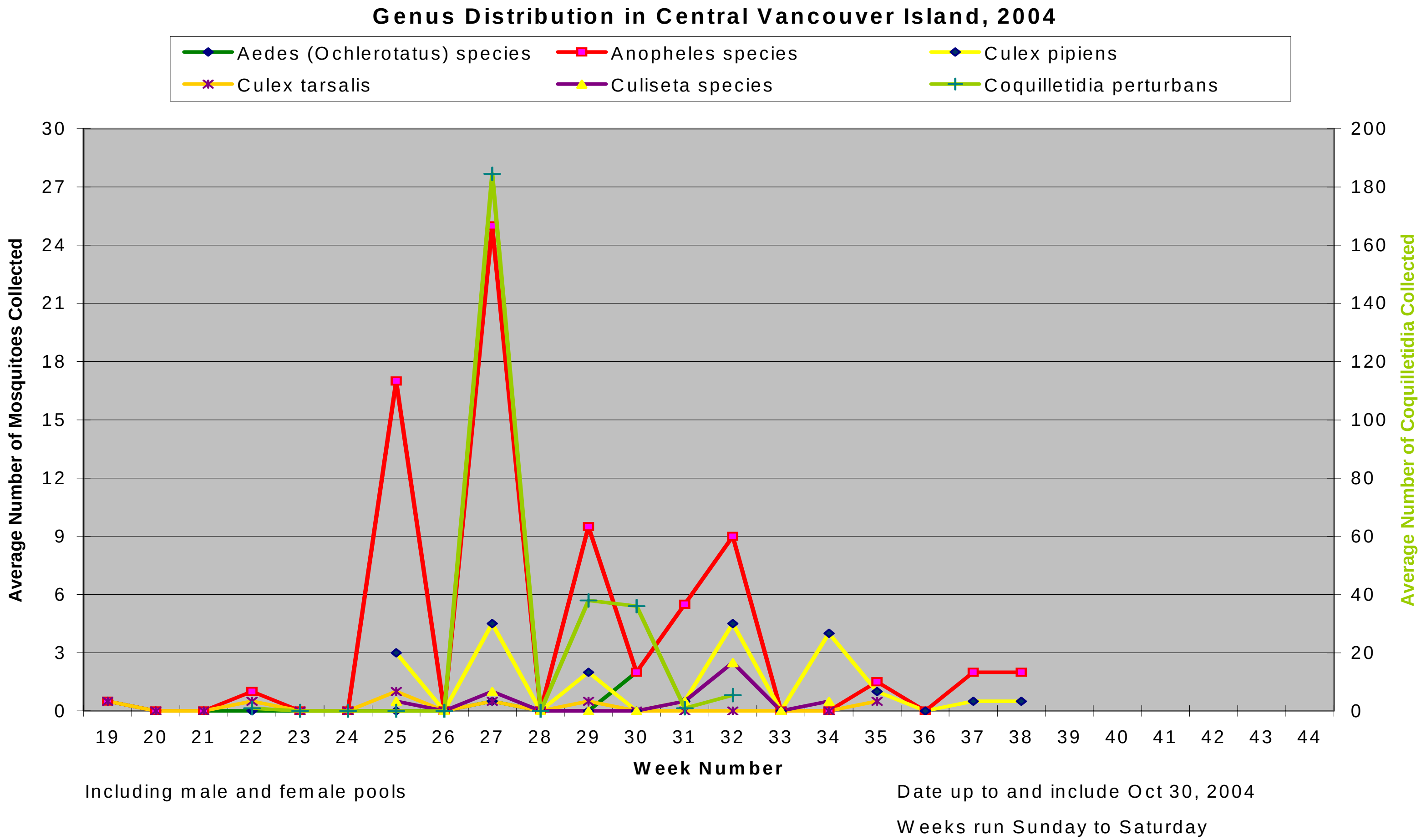


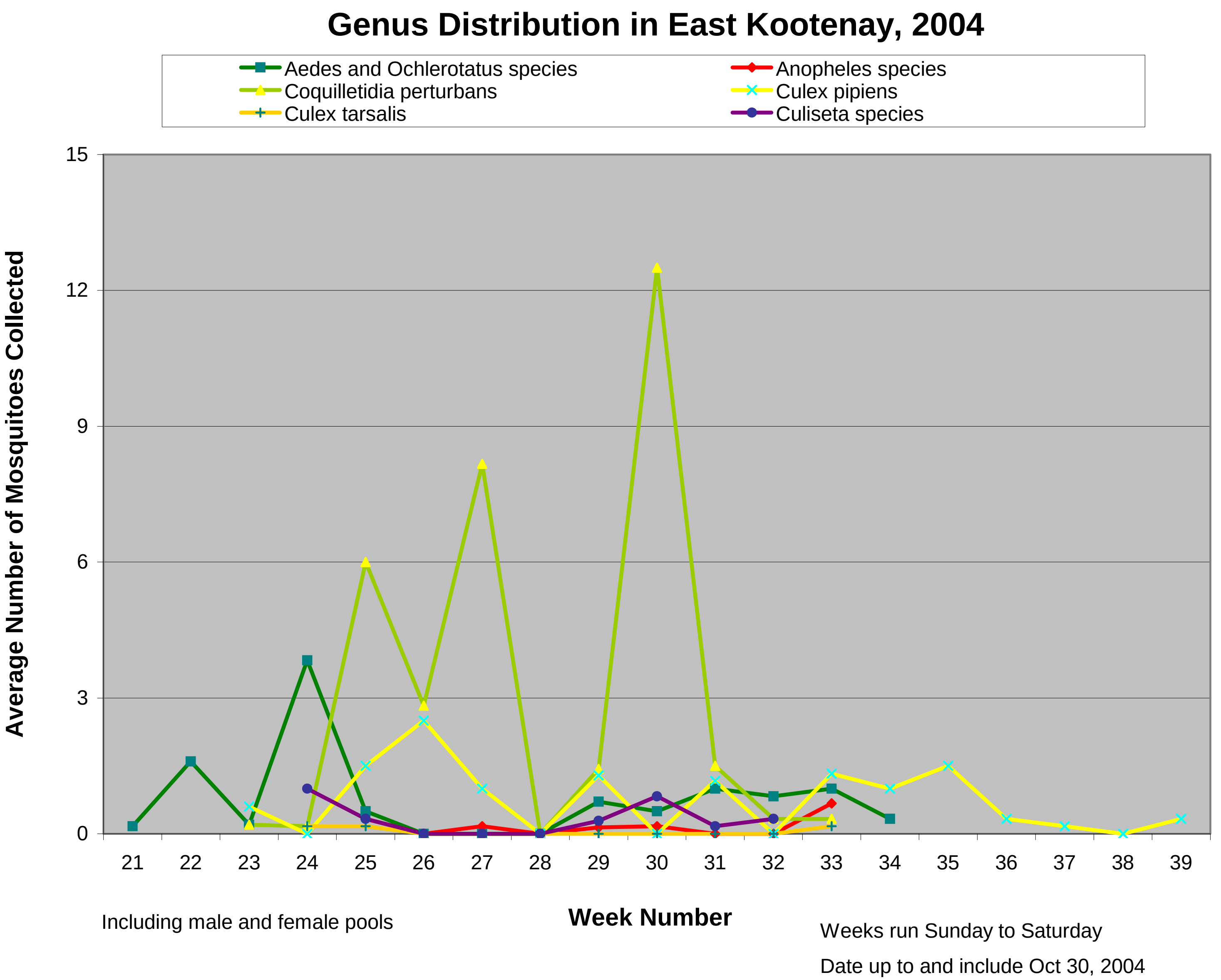
Average Number of Mosquitoes Collected by Trap Types in TCS Over Time
Culex pipiens by Gravid Trap
Culex tarsalis by Gravid Trap
Culex pipiens by Light Trap
Culex tarsalis by Light Trap
Average number of Culex collected by Gravid Trap
Average number of Culex collected by Light Trap
0
2
4
6
8
10
12
0
10
20
30
40
50
60
20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41
May
June
July
Aug
Sep
Oct
Week Number



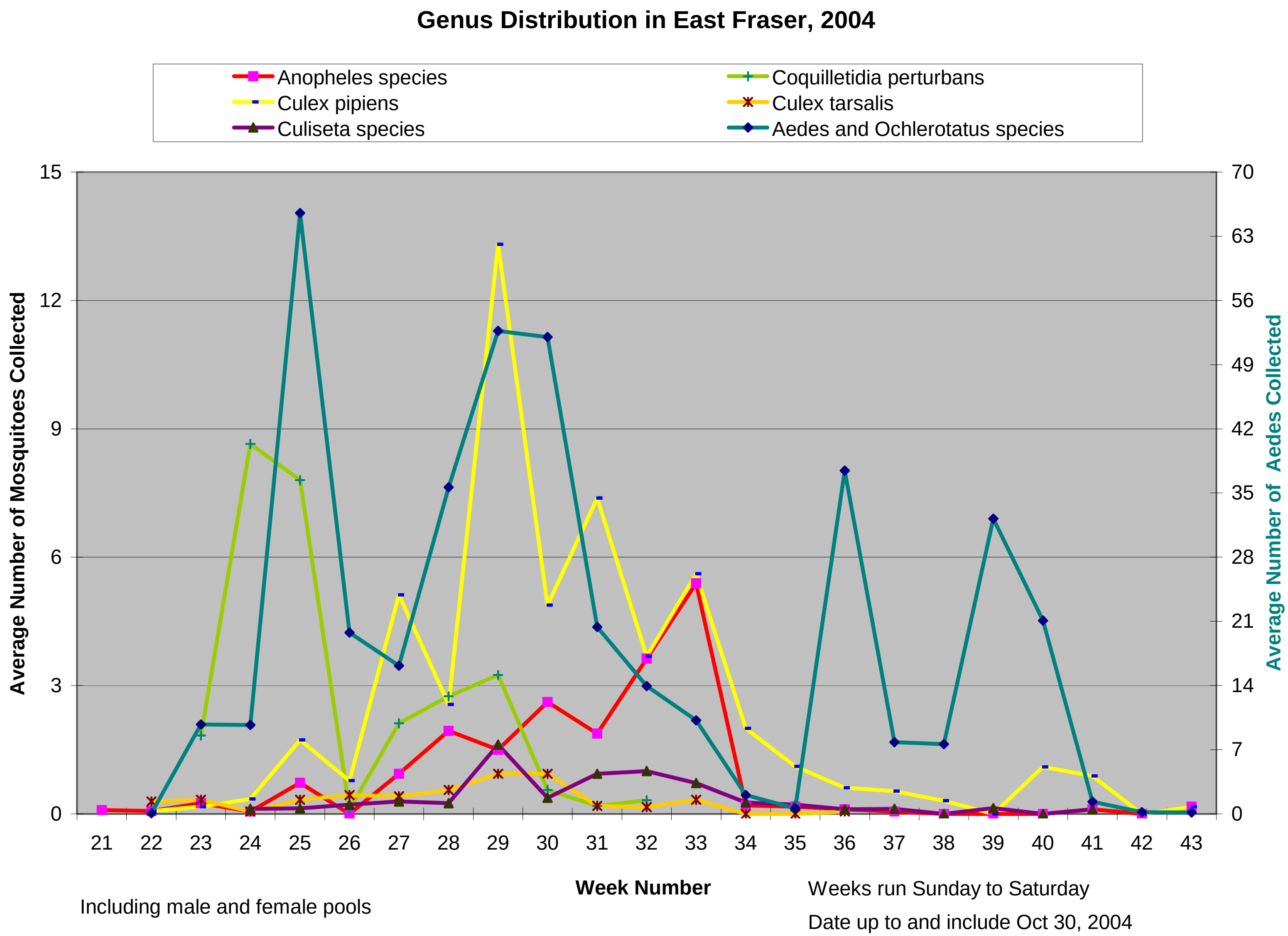
Average Number of Mosquitoes Collected by Trap Types in VAN Over Time
Culex pipiens by Gravid Trap
Culex tarsalis by Gravid Trap
Culex pipiens by Light Trap
Culex tarsalis by Light Trap
Average number of Culex collected by Gravid Trap
Average number of Culex collected by Light Trap
0
3
6
9
12
15
18
20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42
May
June
July
Aug
Sep
Oct
Week Number

Appendix 5 – Average Mosquito Count for all Genus-species



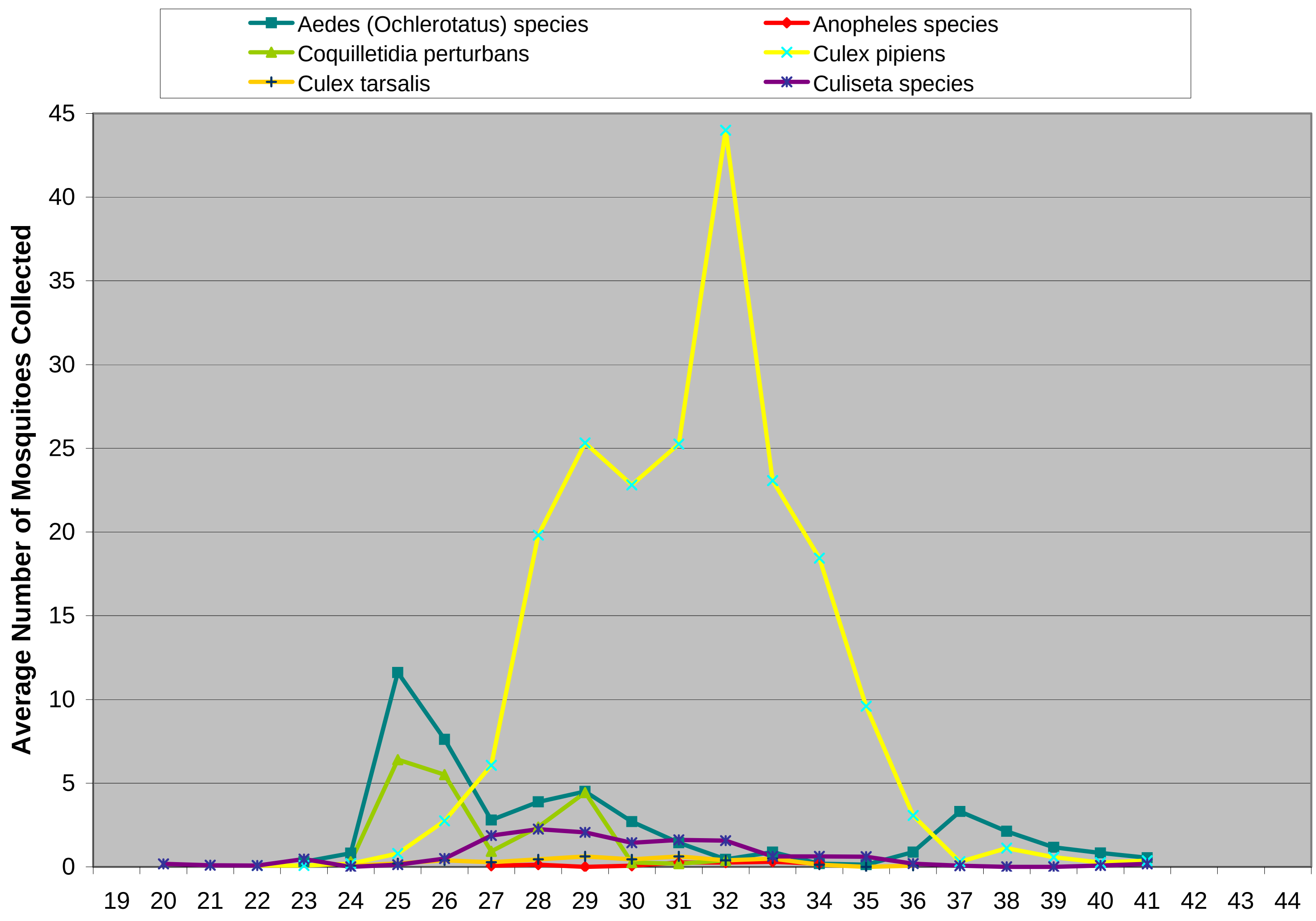


Genus Distribution in East Kootenay, 2004
Aedes and Ochlerotatus species
Anopheles species
Coquilletidia perturbans
Culex pipiens
Culex tarsalis
Culiseta species
Average Number of Mosquitoes Collected
0
3
6
9
12
15
21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39
Week Number
Including male and female pools
Weeks run Sunday to Saturday
Date up to and include Oct 30, 2004



Genus Distribution in East Fraser, 2004
Anopheles species
Coquilletidia perturbans
Culex pipiens
Culex tarsalis
Culiseta species
Aedes and Ochlerotatus species
Average Number of Mosquitoes Collected
Average Number of Aedes Collected
0
3
6
9
12
15
0
7
14
21
28
35
42
49
56
63
70
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
Week Number
Including male and female pools
Weeks run Sunday to Saturday
Date up to and include Oct 30, 2004

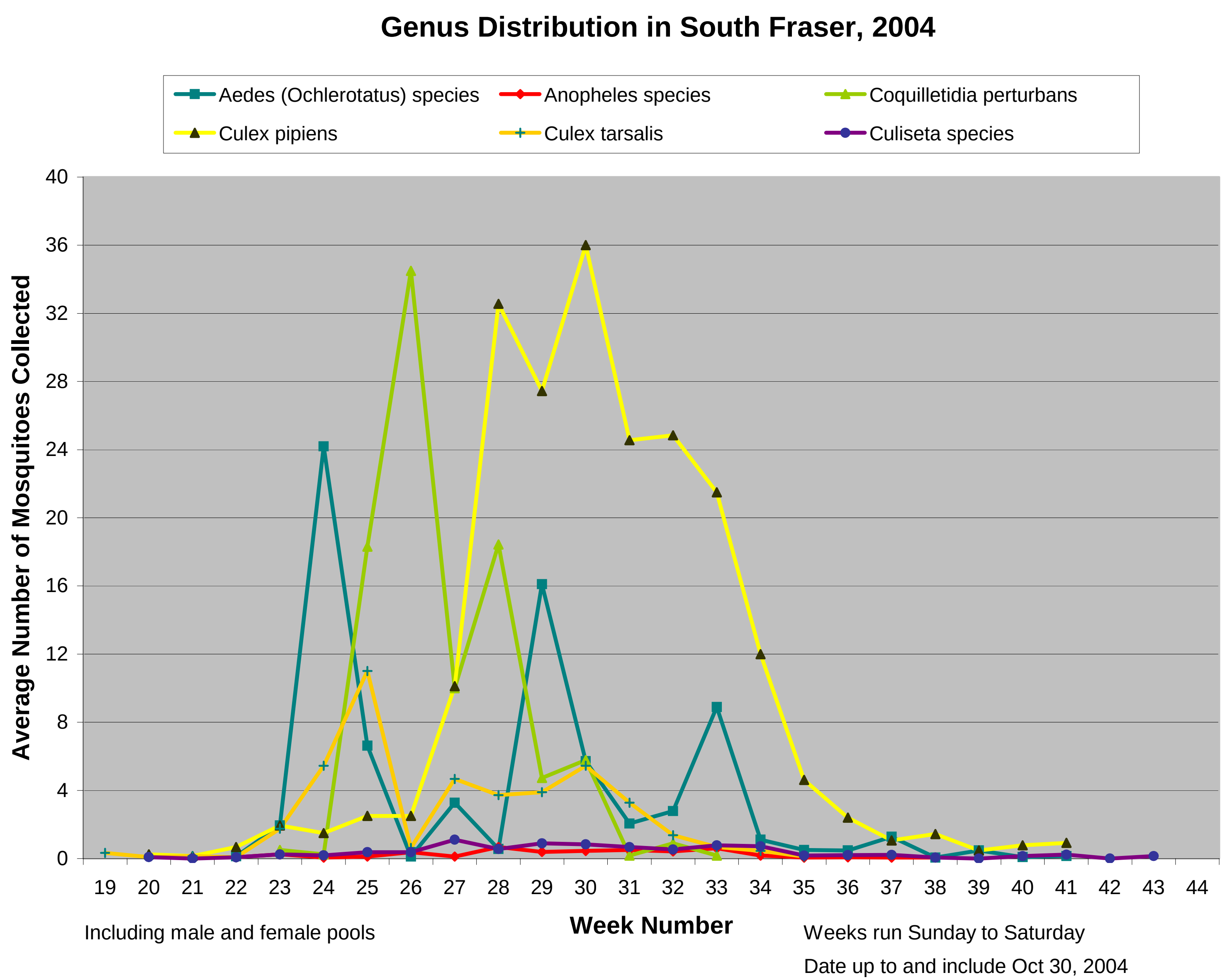
Genus Distribution in North Fraser, 2004



Including male and female pools

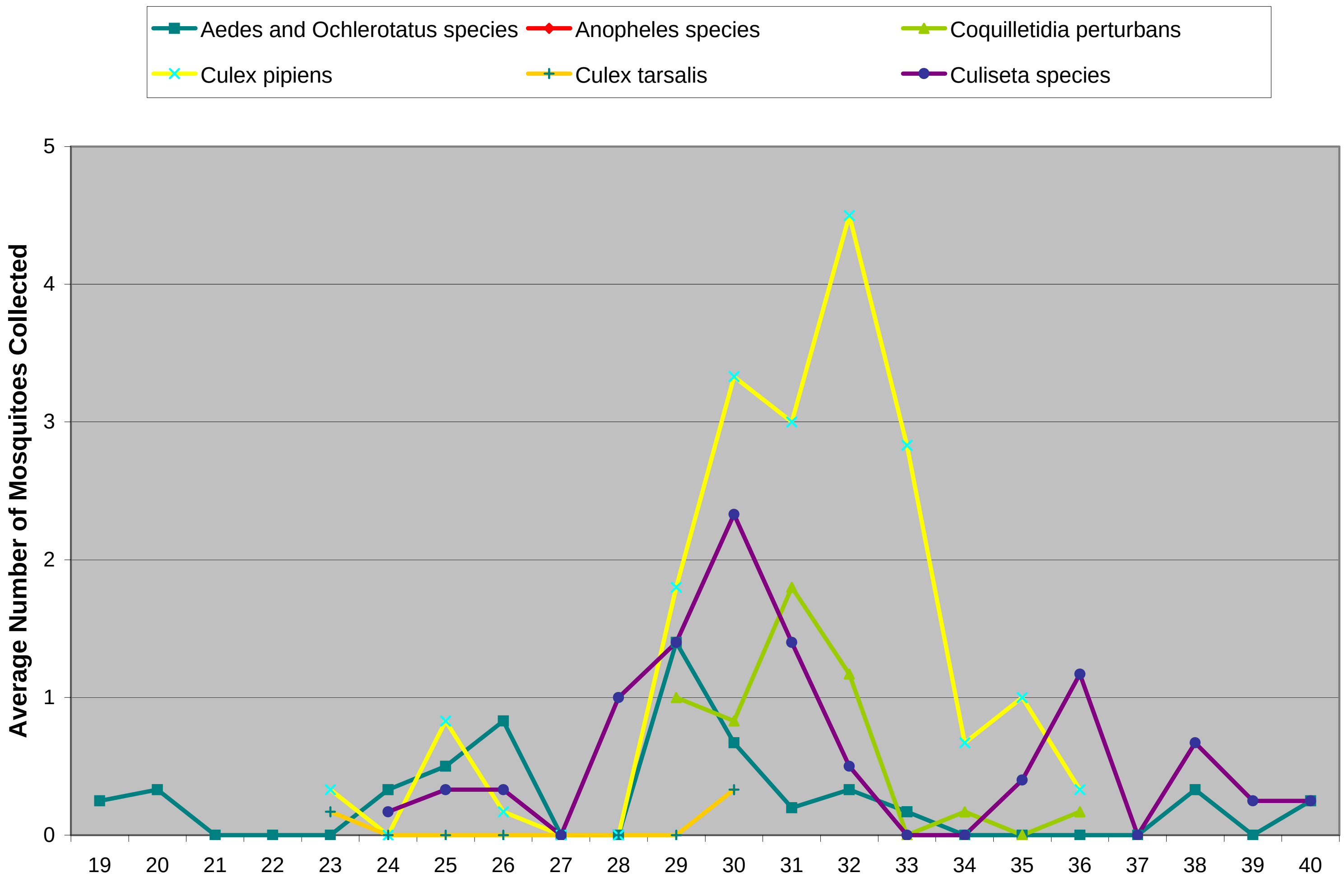
Weeks run Sunday to Saturday

Date up to and include Oct 30, 2004



Genus Distribution in South Fraser, 2004
Aedes (Ochlerotatus) species
Anopheles species
Coquilletidia perturbans
Culex pipiens
Culex tarsalis
Culiseta species
Average Number of Mosquitoes Collected
0
4
8
12
16
20
24
28
32
36
40
19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44
Week Number
Including male and female pools
Weeks run Sunday to Saturday
Date up to and include Oct 30, 2004

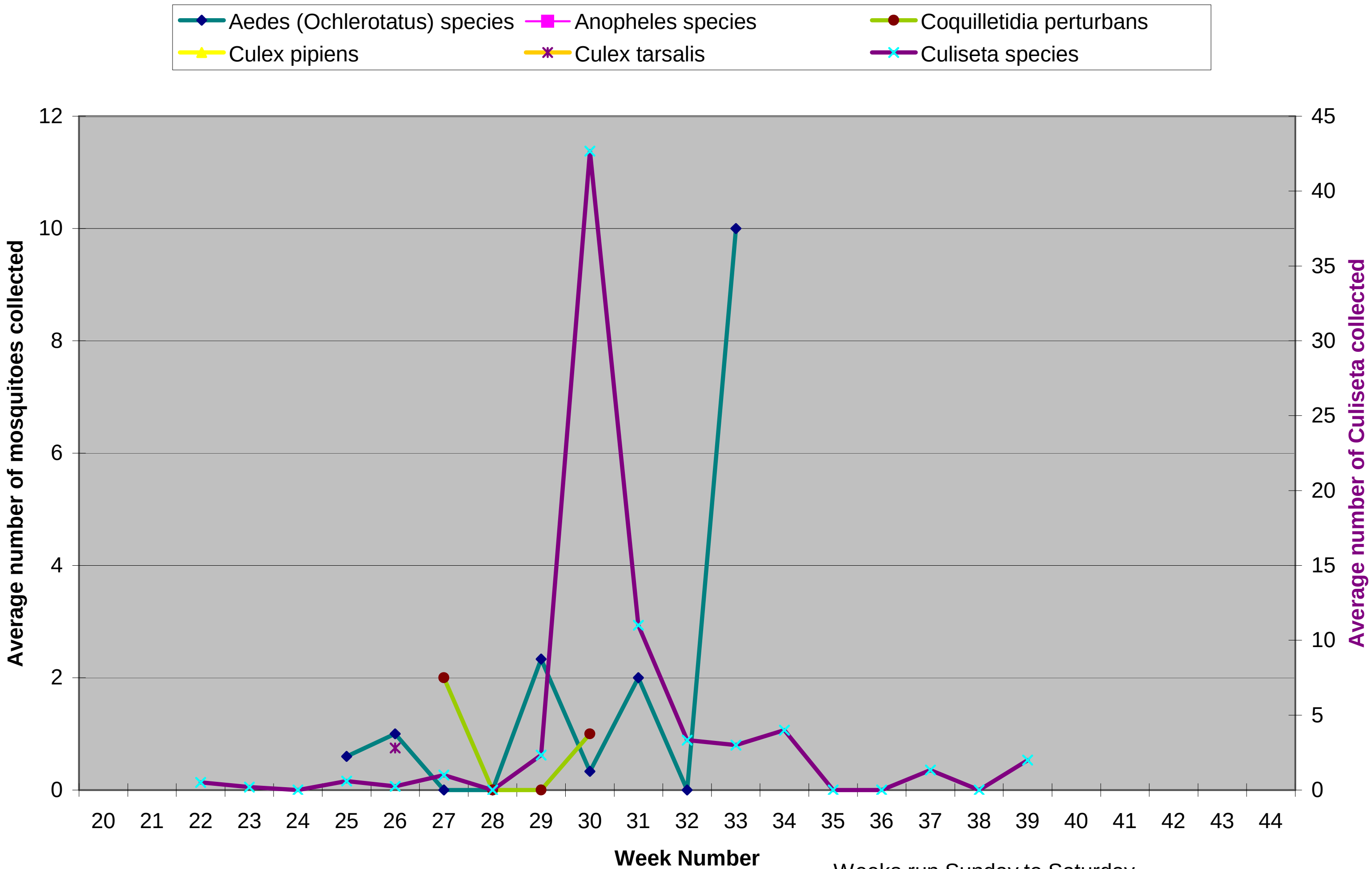
Genus Distribution in Kootenay Boundary, 2004



Including male and female pools

Weeks run Sunday to Saturday
Date up to and include Oct 30, 2004

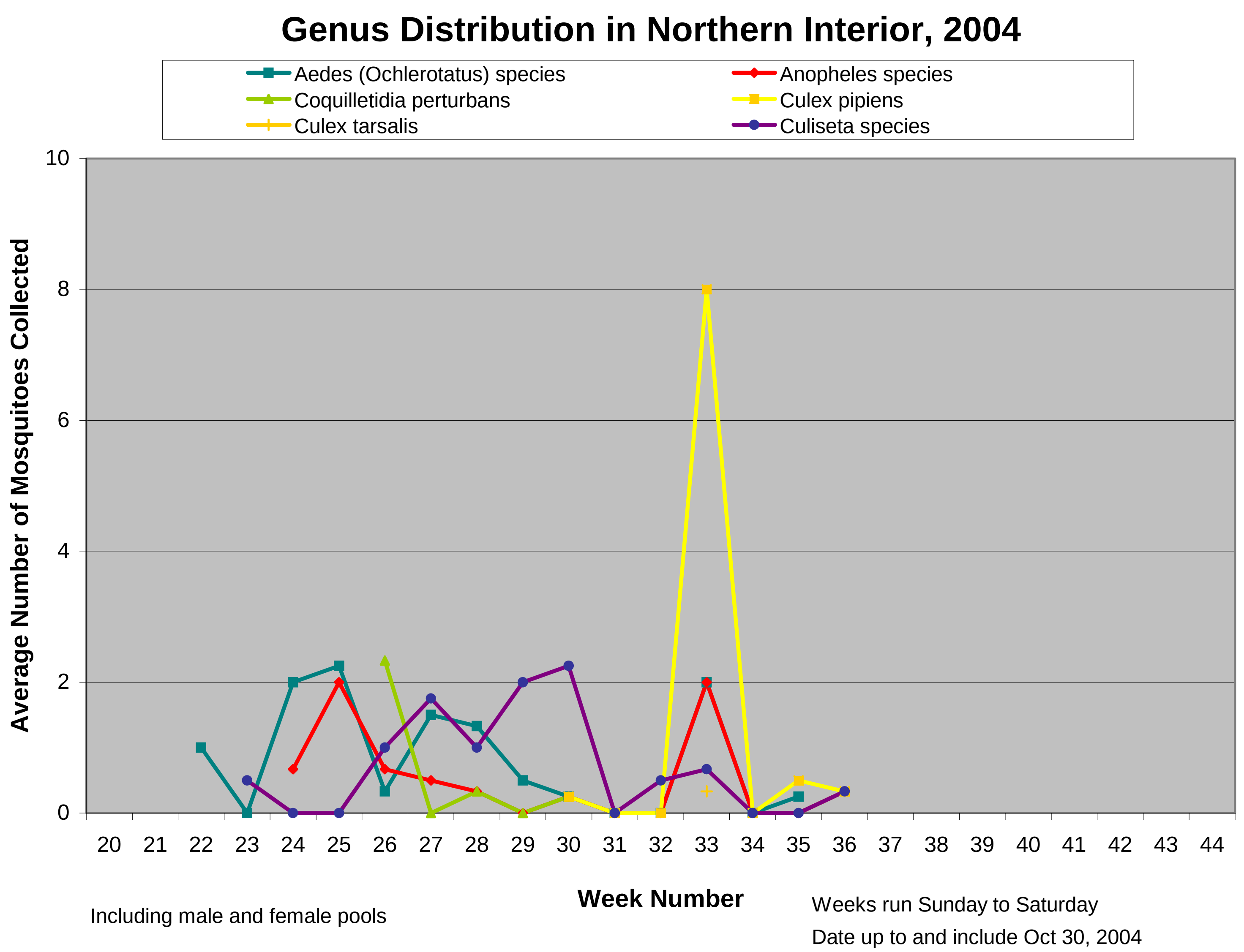
Genus Distribution in North East, 2004



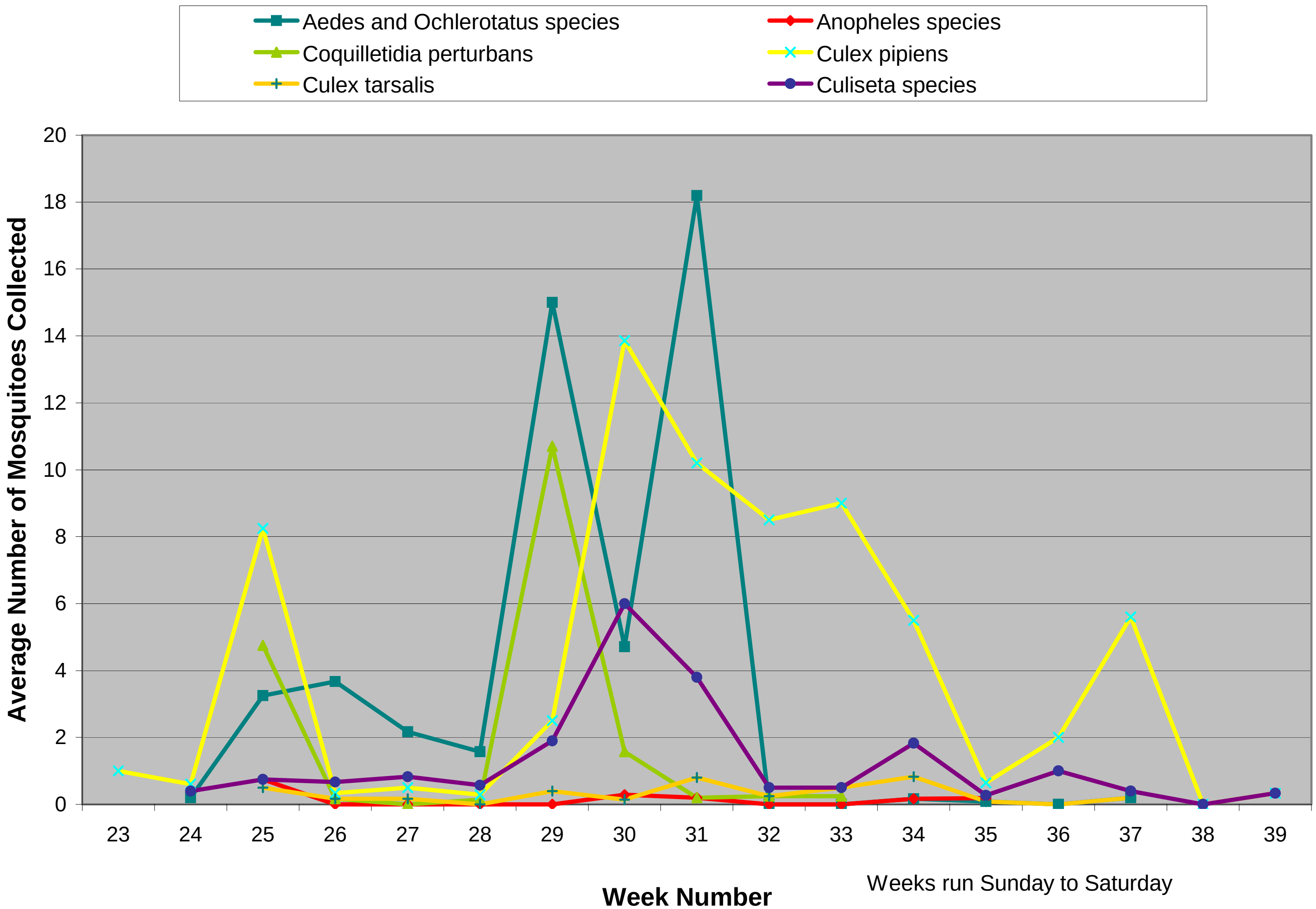
Including male and female pools

Weeks run Sunday to Saturday

Date up to and include Oct 30, 2004


Genus Distribution in Northern Interior, 2004
Aedes (Ochlerotatus) species
Anopheles species
Coquilletidia perturbans
Culex pipiens
Culex tarsalis
Culiseta species
Average Number of Mosquitoes Collected
0
2
4
6
8
10
20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44
Week Number
Including male and female pools
Weeks run Sunday to Saturday
Date up to and include Oct 30, 2004

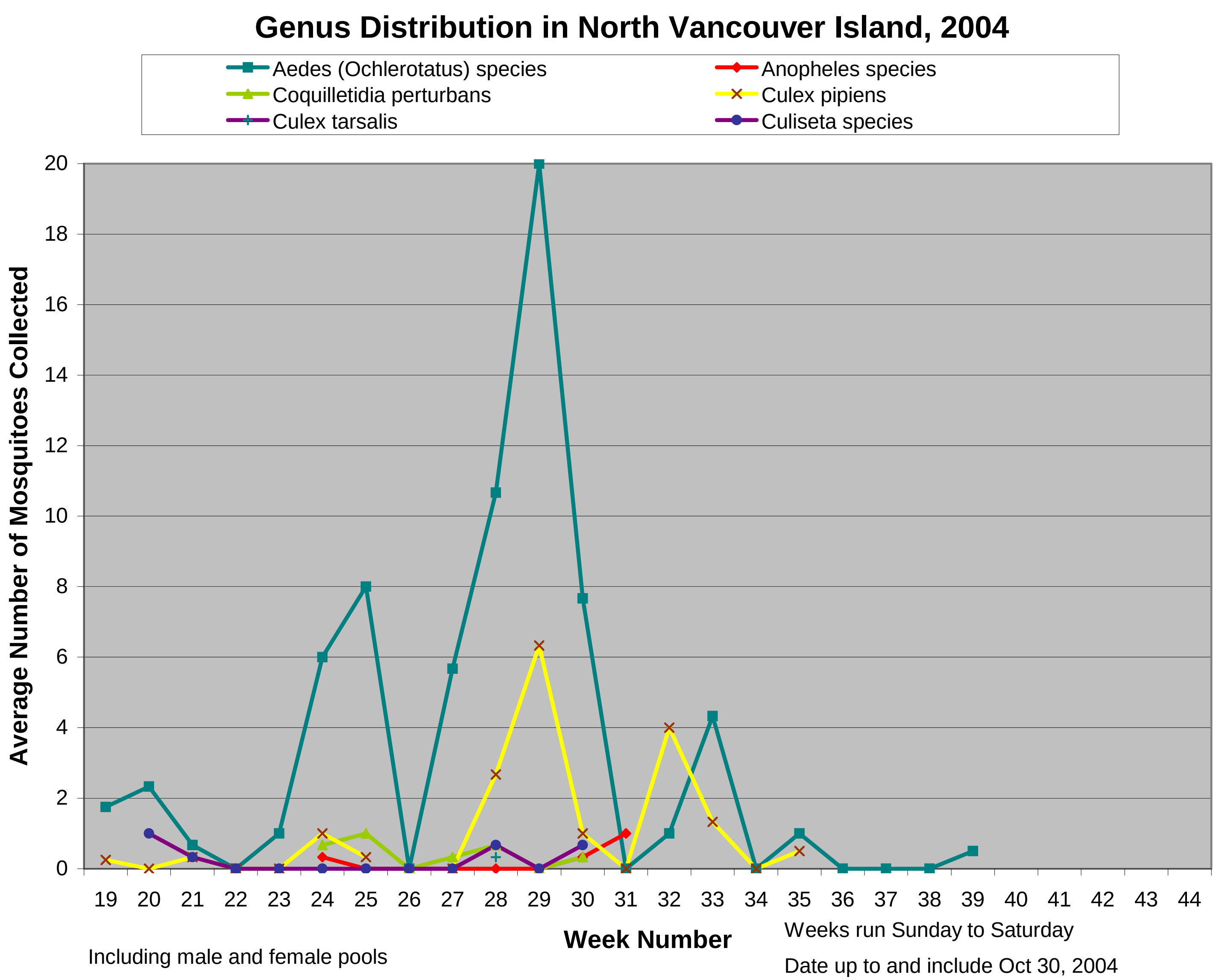
Genus Distribution in North Shore/Coast Garibaldi, 2004



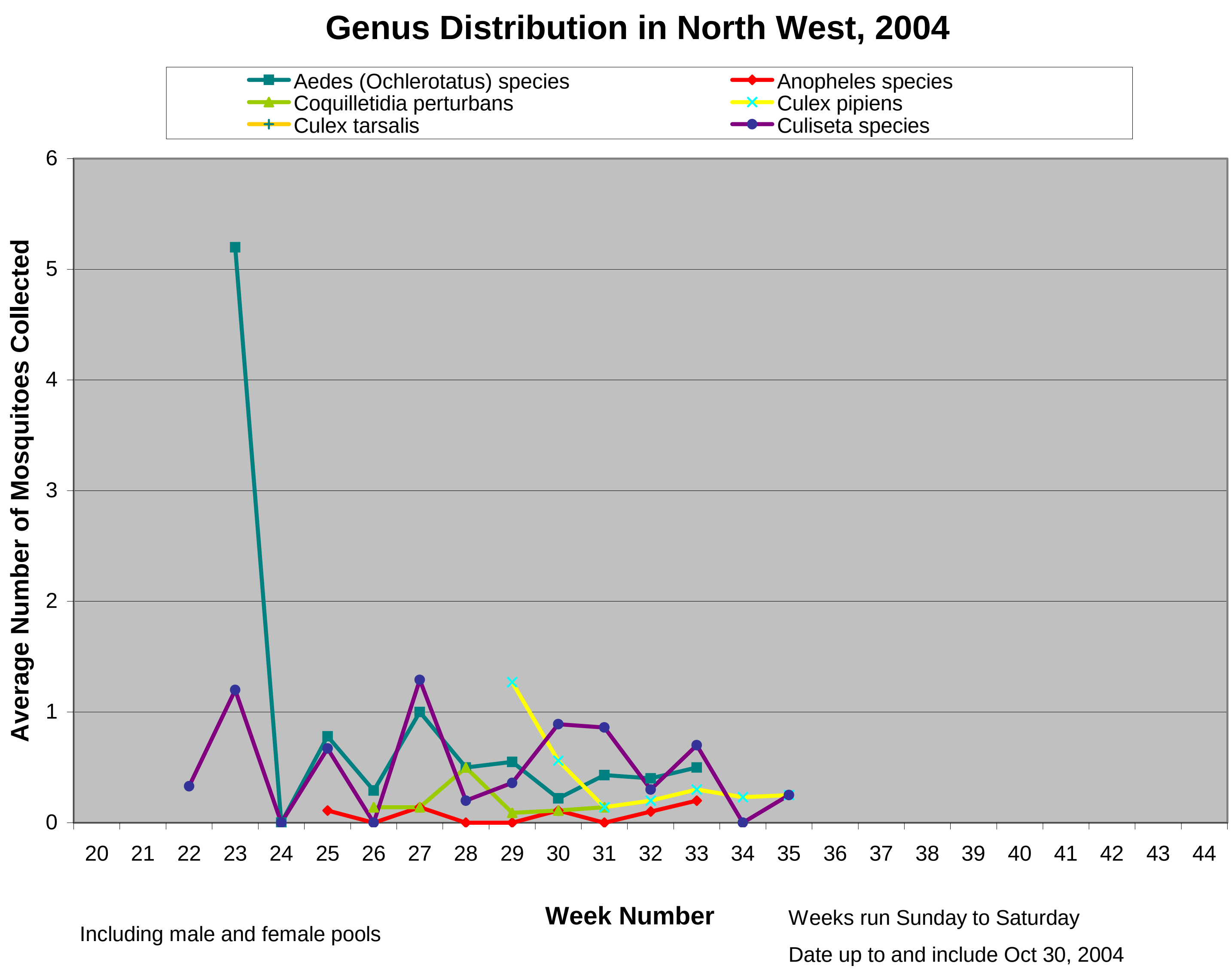
Including male and female pools

Weeks run Sunday to Saturday

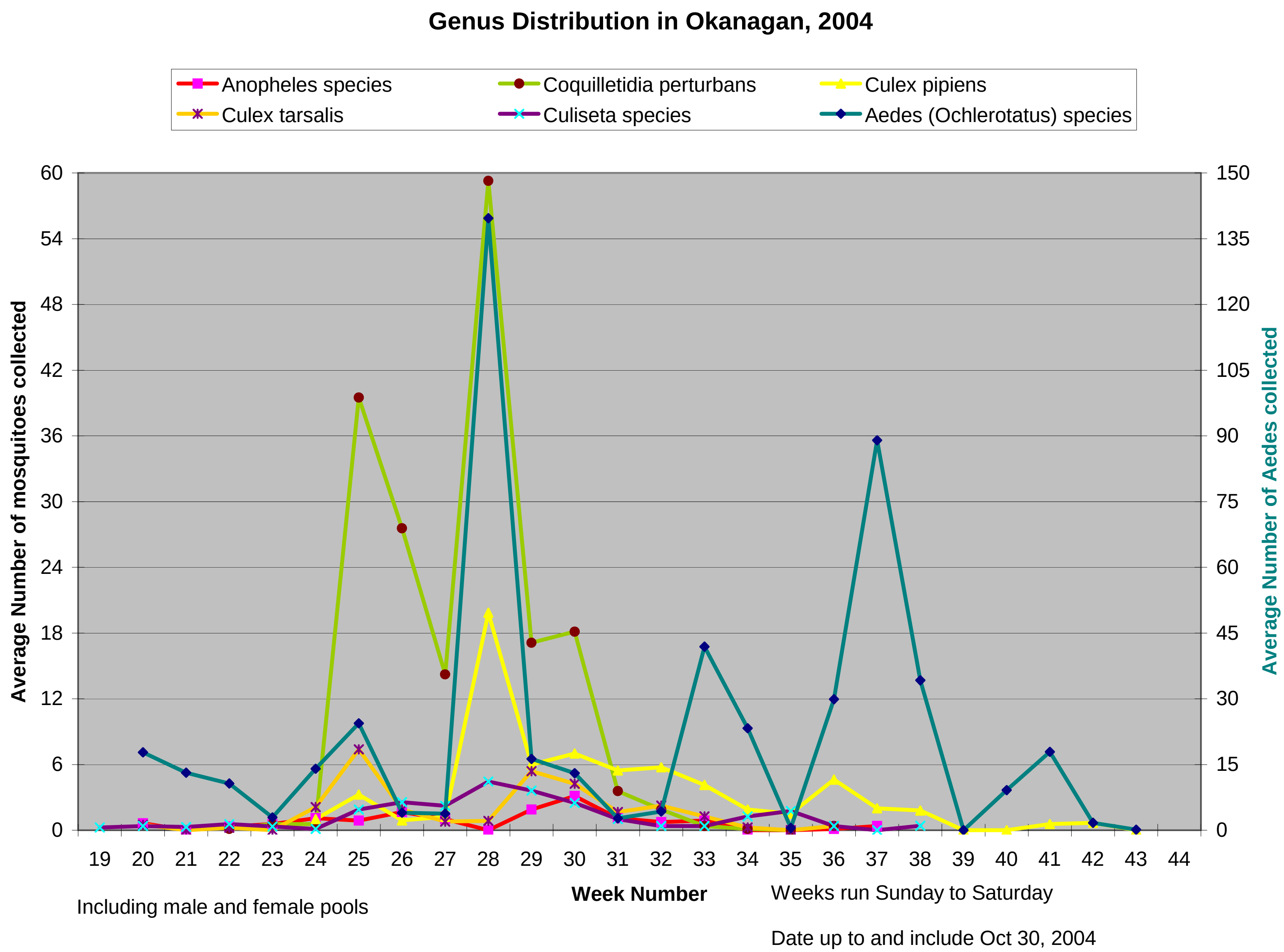
Date up to and include Oct 30, 2004



Genus Distribution in North Vancouver Island, 2004
Aedes (Ochlerotatus) species
Anopheles species
Coquilletidia perturbans
Culex pipiens
Culex tarsalis
Culiseta species
Average Number of Mosquitoes Collected
0
2
4
6
8
10
12
14
16
18
20
19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44
Week Number
Weeks run Sunday to Saturday
Date up to and include Oct 30, 2004
Including male and female pools

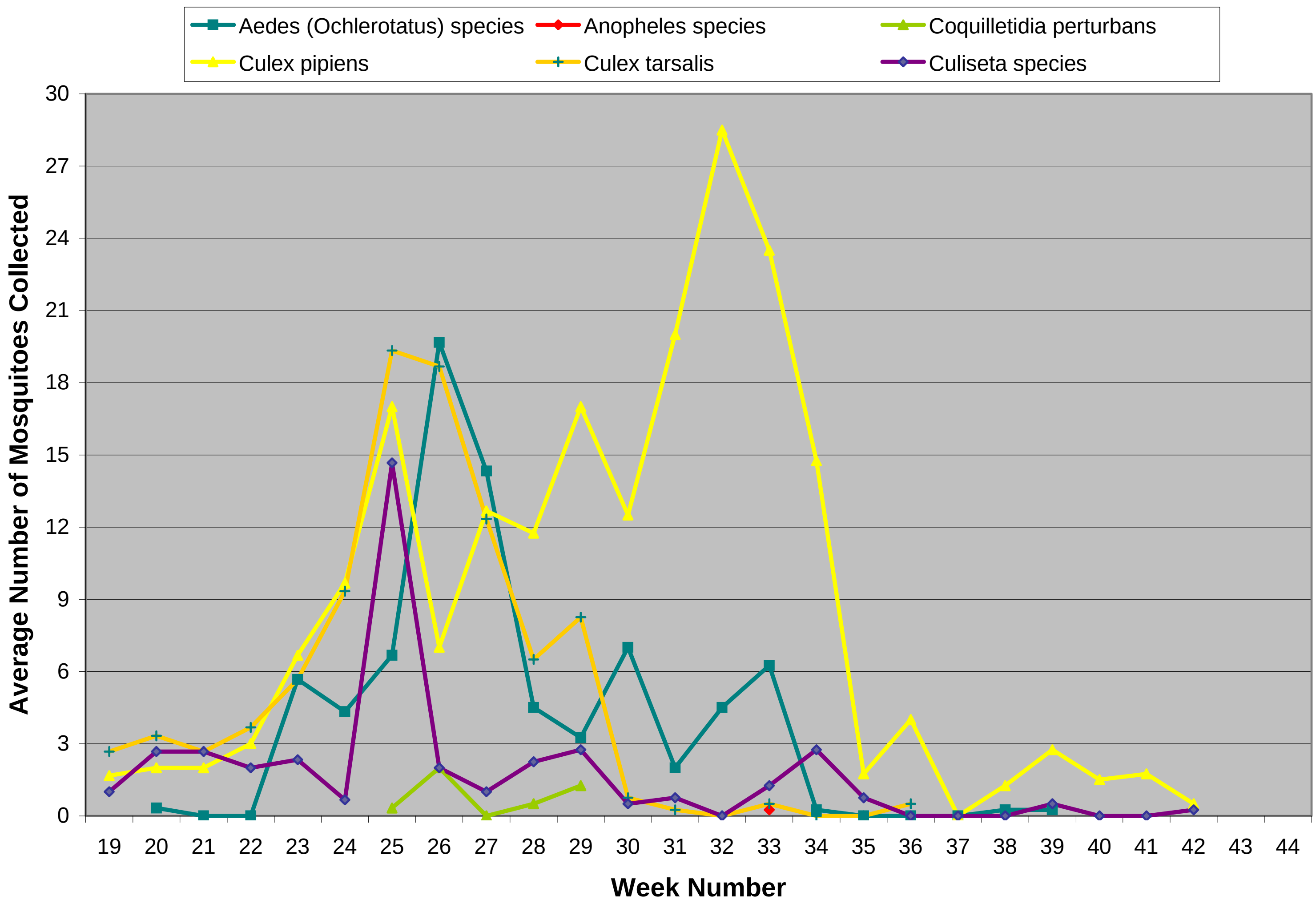


Genus Distribution in North West, 2004
Aedes (Ochlerotatus) species
Anopheles species
Coquilletidia perturbans
Culex pipiens
Culex tarsalis
Culiseta species
Average Number of Mosquitoes Collected
0
1
2
3
4
5
6
20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44
Week Number
Including male and female pools
Weeks run Sunday to Saturday
Date up to and include Oct 30, 2004



Genus Distribution in Okanagan, 2004
Anopheles species
Coquilletidia perturbans
Culex pipiens
Culex tarsalis
Culiseta species
Aedes (Ochlerotatus) species
Average Number of mosquitoes collected
Average Number of Aedes collected
0
6
12
18
24
30
36
42
48
54
60
0
15
30
45
60
75
90
105
120
135
150
19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44
Week Number
Including male and female pools
Weeks run Sunday to Saturday
Date up to and include Oct 30, 2004

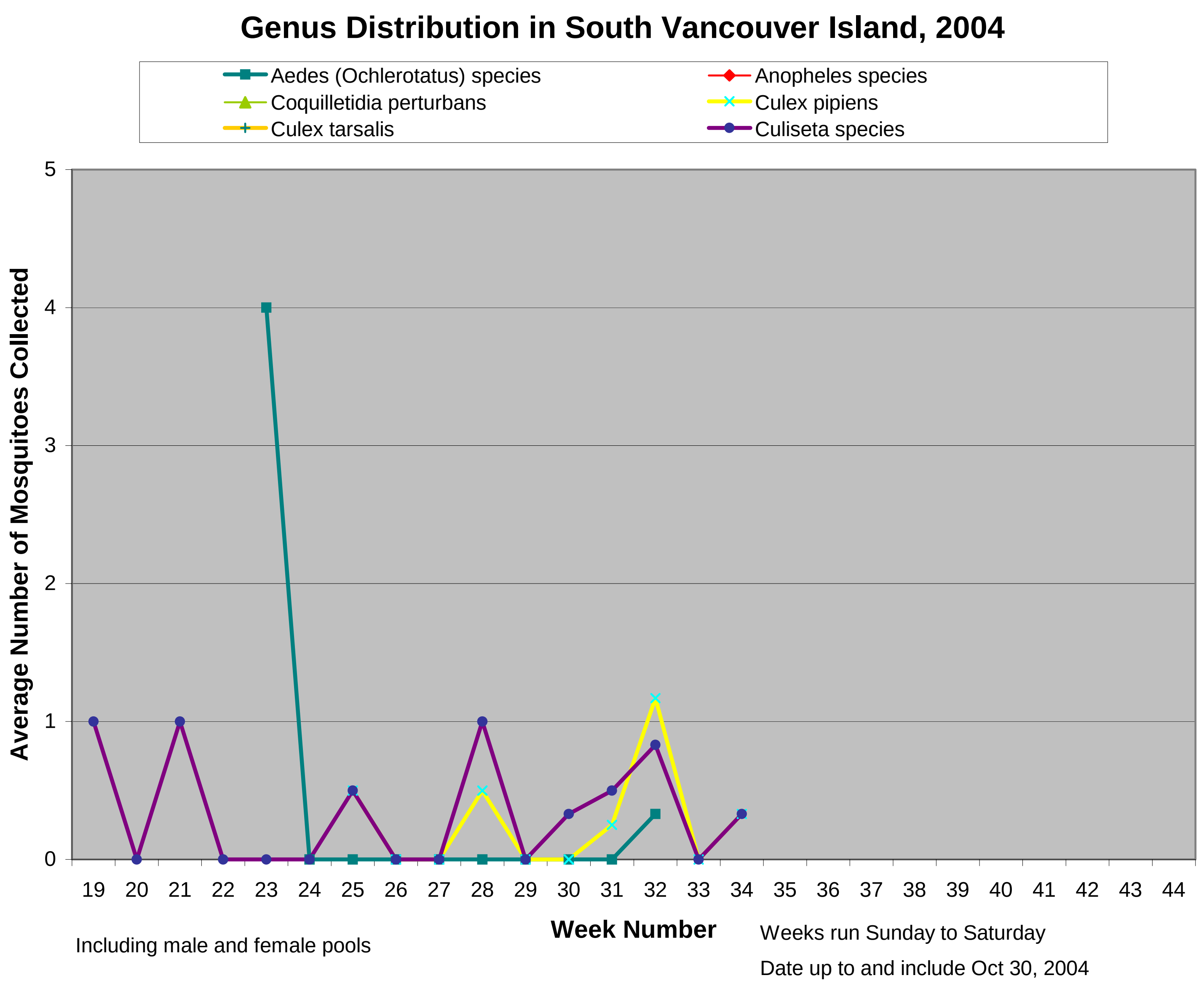
Genus Distribution in Richmond, 2004



Including male and female pools

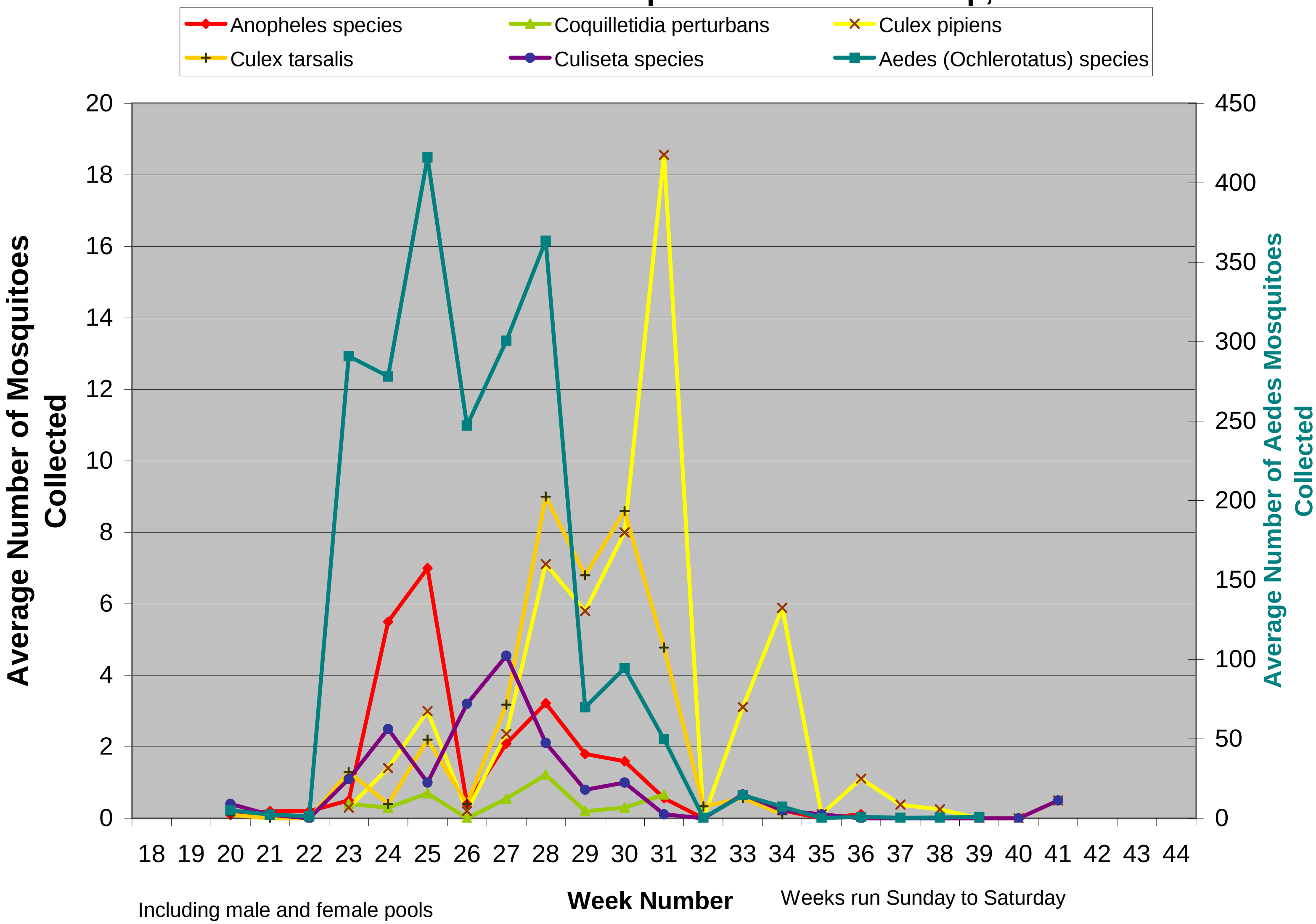
Weeks run Sunday to Saturday

Date up to and include Oct 30, 2004



Genus Distribution in South Vancouver Island, 2004
Aedes (Ochlerotatus) species
Anopheles species
Coquilletidia perturbans
Culex pipiens
Culex tarsalis
Culiseta species
Average Number of Mosquitoes Collected
0
1
2
3
4
5
19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44
Week Number
Including male and female pools
Weeks run Sunday to Saturday
Date up to and include Oct 30, 2004

Genus Distribution in Thompson Cariboo Shuswap, 2004

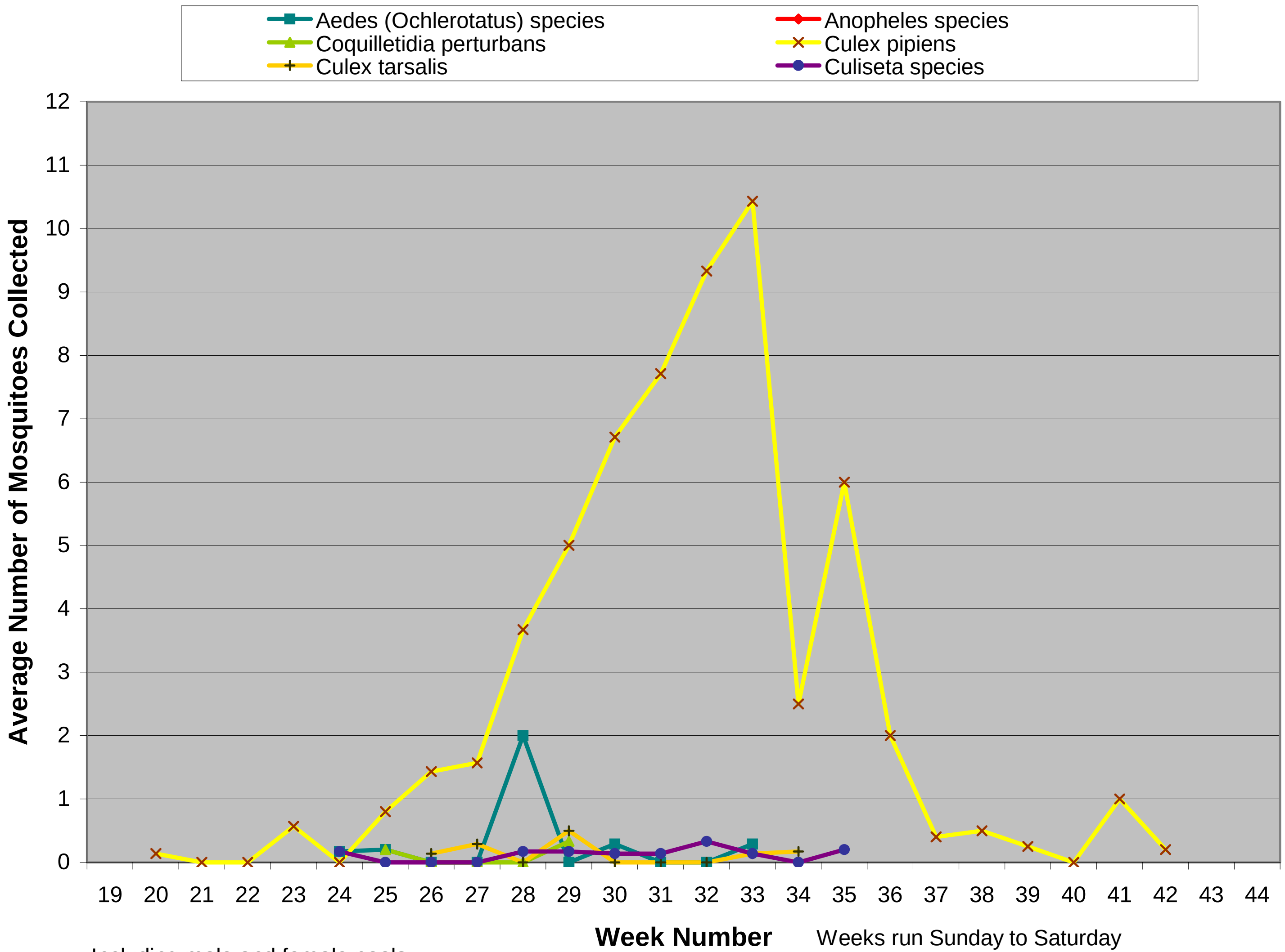


Including male and female pools

Weeks run Sunday to Saturday

Date up to and include Oct 30, 2004

Genus Distribution in Vancouver, 2004



Including male and female pools

Weeks run Sunday to Saturday

Date up to and include Oct 30, 2004

APPENDIX 6
WEST NILE VIRUS DATABASE
WEEK CODES - 2004

Code	Week Starting	Week Ending
1	04-Jan-04	10-Jan-04
2	11-Jan-04	17-Jan-04
3	18-Jan-04	24-Jan-04
4	25-Jan-04	31-Jan-04
5	01-Feb-04	07-Feb-04
6	08-Feb-04	14-Feb-04
7	15-Feb-04	21-Feb-04
8	22-Feb-04	28-Feb-04
9	29-Feb-04	06-Mar-04
10	07-Mar-04	13-Mar-04
11	14-Mar-04	20-Mar-04
12	21-Mar-04	27-Mar-04
13	28-Mar-04	03-Apr-04
14	04-Apr-04	10-Apr-04
15	11-Apr-04	17-Apr-04
16	18-Apr-04	24-Apr-04
17	25-Apr-04	01-May-04
18	02-May-04	08-May-04
19	09-May-04	15-May-04
20	16-May-04	22-May-04
21	23-May-04	29-May-04
22	30-May-04	05-Jun-04
23	06-Jun-04	12-Jun-04
24	13-Jun-04	19-Jun-04
25	20-Jun-04	26-Jun-04
26	27-Jun-04	03-Jul-04

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

Weeks run Sunday to Saturday

APPENDIX 7

Health Authority and Health Service Delivery Area Reference Table

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

Note:
* Name used in 2003