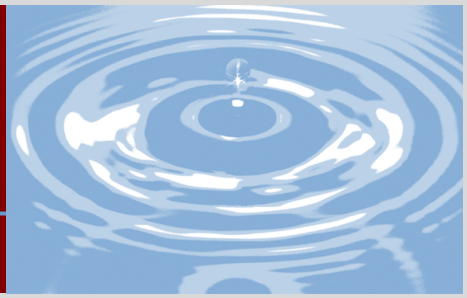
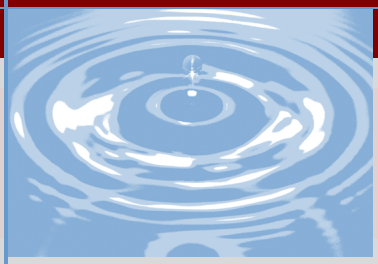


King County West Nile Virus Surveillance Report 2008

Public Health
Seattle & King County
Zoonotic Disease Program
Environmental Health Services



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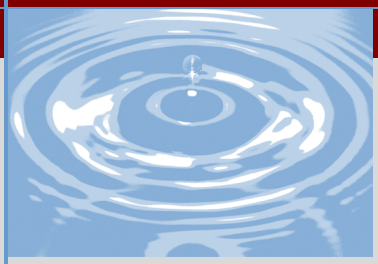


Introduction

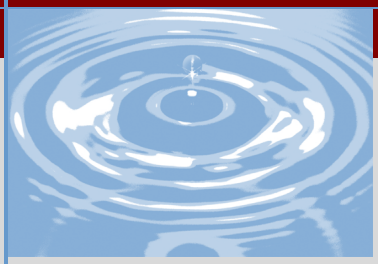
West Nile virus (WNV) is a mosquito-borne virus which has the potential to cause debilitating disease or death. Fortunately, most people infected with the virus are asymptomatic and quickly clear the virus. Of those that experience symptoms, illness is often mild with flu-like symptoms with fever, headache, fatigue, loss of appetite, and muscle aches. In some people, this WNV fever form of the infection can be more severe and last 2-3 weeks.

Approximately 1 in 150 people infected with WNV will develop a more serious neurologic illness with symptoms that include severe headaches, neck stiffness, convulsions or coma, decreased level of alertness, muscle weakness, tremors, paralysis, and even death. Many people who survive this neurologic form of WNV disease are left with lingering after effects or disabilities. Elderly people are more susceptible to serious disease or death due to West Nile virus.

Birds are the natural reservoir of WNV. Over 150 types of birds are known to become infected with WNV. The virus is amplified as mosquitoes feed on infected birds and transmit it to other birds. Humans and other mammals enter the disease cycle only when infected mosquitoes feed on them.

While it had been recognized in Africa, Europe and the Middle East for decades, West Nile virus was first detected in North America in 1999 in New York City. Since its arrival, WNV has spread in all directions across the continent. According to the federal Centers for Disease Control and Prevention, WNV has resulted in 11,706 reported cases of neurological illness and killed 1,124 people in the United States as of December, 2008. Canadian provinces have also been impacted, especially in 2007 when over 2,200 cases were recorded there.

West Nile virus has been detected intermittently at low levels in birds, mosquitoes and horses in parts of Washington State since 2002. The year 2006 marked the first year that people were believed to have acquired WNV infections within the state. That same year, the first signs of WNV were detected within King County by Public Health—Seattle & King County's surveillance program, which had been monitoring for WNV since 2001. In 2006, six birds and 1 horse testing positive for the virus. There were no signs of West Nile virus in King County in 2007, despite expectations of more cases. However, the virus was found again in dead birds in several parts of King County in mid-September of 2008, several weeks sooner than the first cases in 2006.



Bird Mortality Surveillance

Corvid birds (crows, jays, ravens, magpies) and raptors (owls, hawks, eagles) are especially sensitive to WNV and commonly die as a result of infection. Several studies [Mostashari et al, 2003; Johnson et al, 2006)] have shown that bird mortalities may be useful in predicting human WNV infections. In response to this observation and federal CDC recommendations, Public Health-Seattle & King County (Public Health) actively solicits and receives online and phone reports year-round from the public about observed bird deaths in the county. During the WNV season (July through October), a selection of corvid birds are collected for WNV testing based on bird type, condition, geographic location, and worker availability. In order for a bird to be successfully tested it must be freshly dead and in good condition. Only corvid samples are submitted for lab testing because these birds have the highest likelihood of dying from WNV infection. Through an interagency cooperative agreement, dead birds reported to Public Health meeting the criteria for avian influenza dead bird reporting (as determined by Washington State Department of Agriculture (WSDA) for domestic poultry and Washington Department of Fish & Wildlife (WDFW) for wild birds and waterfowl) are referred to the appropriate agency.

Oral swab samples from the birds to be tested for WNV are mailed to the Washington Animal Disease Diagnostic Laboratory (WADDL), in cooperation with the DOH, for West Nile virus testing. Results of WNV testing are received on a weekly basis from the Washington State Department of Health. There is approximately a two week lag time between submission and receipt of results, although the lag is reduced to one week if a sample tests positive, as results are immediately phoned to Public Health. In addition to testing, the locations of all bird mortality reports are mapped on a weekly basis using ArcMap GIS software in order to identify unusual clustering of bird deaths. Clustering may signify the beginning of a WNV outbreak among the birds and indicate the need for more intense sampling and testing in the area to determine if WNV is causing the bird deaths.

In 2008, we received 1,381 bird mortality reports from the public reporting 1,611 dead birds. There was a 42% decrease in the number of bird mortality reports from 2007. The number of bird mortality reports tends to peak biannually **(**Figure 1). Bird mortality reporting peaked in Week 29 (July 13-19) with 144 dead birds being sighted (Figure 2). Seventy-six percent of bird mortalities reported were crows, which did not appear to be unusual compared to previous years (Figures 3, 4). When bird mortality reports were mapped by zip code, the greatest number of bird morality reports came from Northeast Seattle and Kirkland (Figure 5). No significant clusters of bird mortalities suggestive of a WNV outbreak were observed when bird reports were analyzed on a weekly basis.

Due to reduced funds available for laboratory testing, we began bird submissions in July and moved to oral swab collection in place of shipping the entire bird carcass. Seventy-one birds were submitted for testing as compared to 125 in 2007 (a 43% decrease). Despite the decrease in number tested, 3 American Crows tested positive for WNV in 2008 compared to none in 2007. The first bird was found dead on September 14, 2008. This is the earliest WNV has been detected in King County and indicates that WNV was present in King County by at least the first week of September. Seventy American Crows (*Corvus brachyrhynchos*) and one Stellar's Jay were submitted for testing . Nearly half of the birds submitted were collected in Seattle. Between one and twelve birds were collected from 24 other cities throughout King County (Figure 5).

Future Directions

It is anticipated that there will be changes in the bird mortality surveillance in the 2009 WNV season due to reductions in funding for Public Health activities in both King County and statewide. In King County, we will continue to receive and map dead bird sightings but we will start collecting birds later in the season and test fewer birds. Starting later will allow us to concentrate the highest levels of surveillance during the period we are most likely to have positive birds present in the county. We will continue to assist WSDA and WDFW in conducting avian influenza surveillance by referring calls about certain types of dead birds, especially waterfowl and poultry, to the appropriate agency.

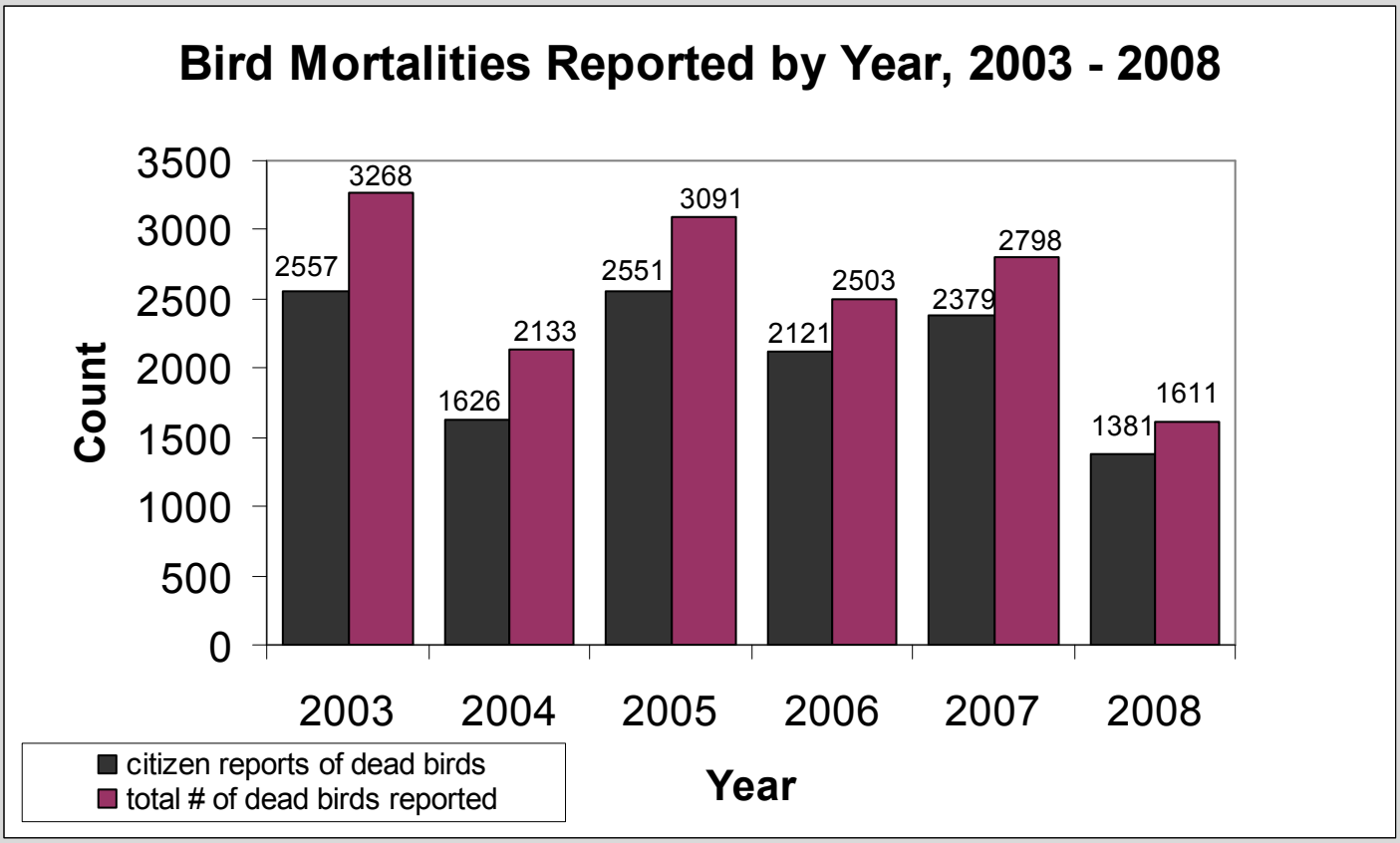


Figure 1. Count of citizen reports of bird mortalities and the number of bird mortalities associated with these reports by year.

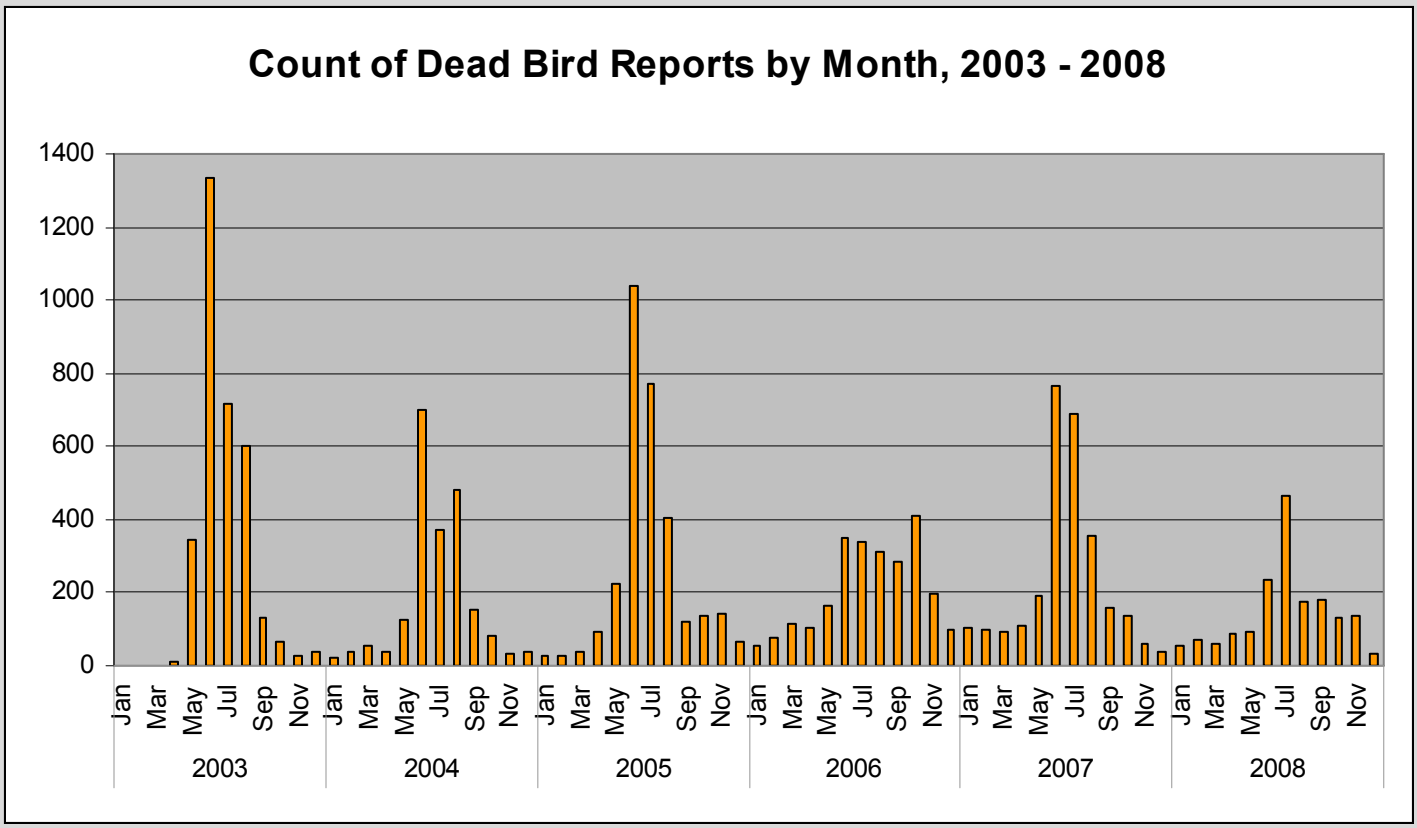


Figure 2. Count of bird mortalities reported to Public Health each month from 2003—2008.

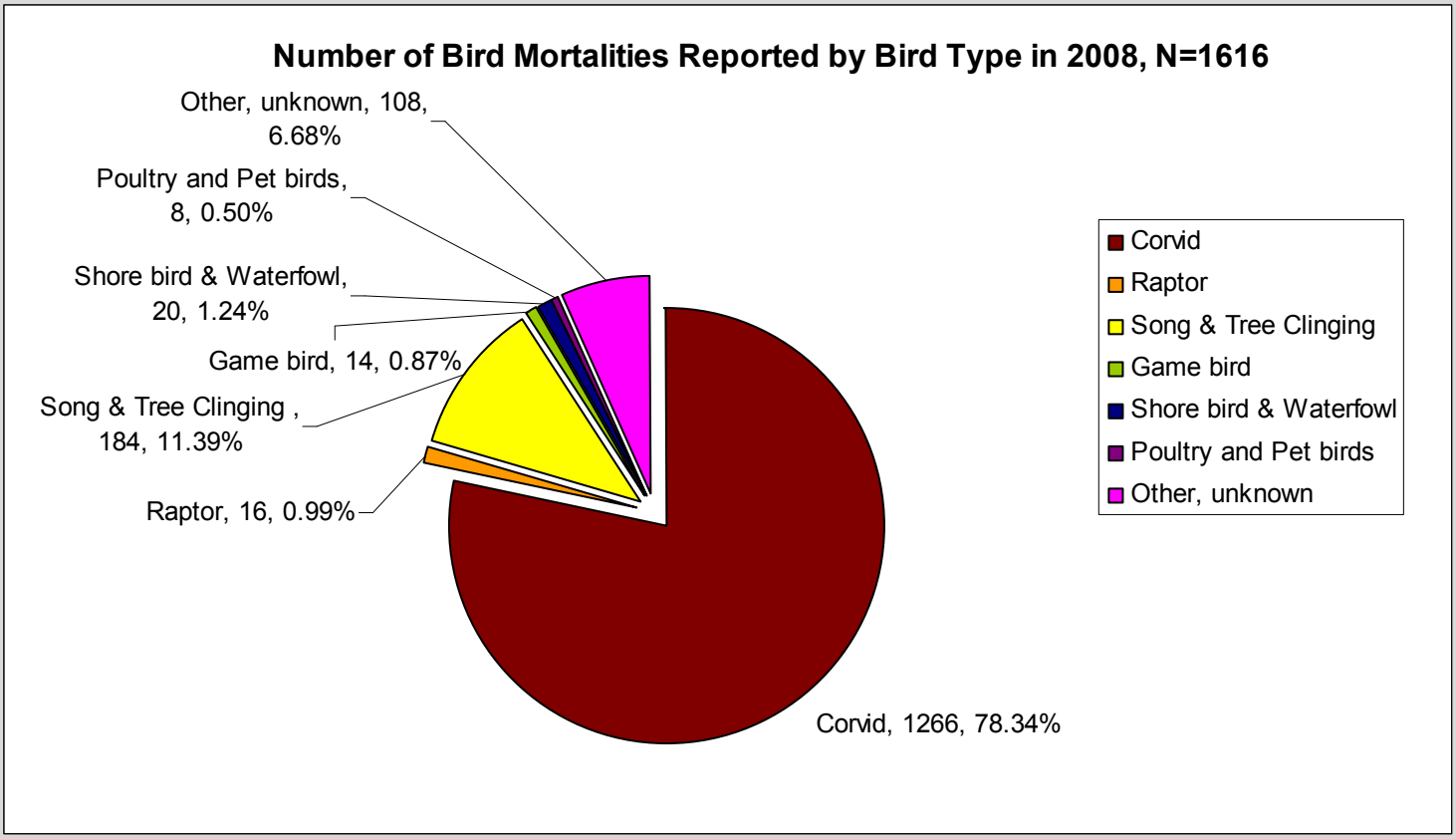


Figure 3. Distribution of bird mortalities by bird type. Three-quarters of bird mortalities reported were crows.

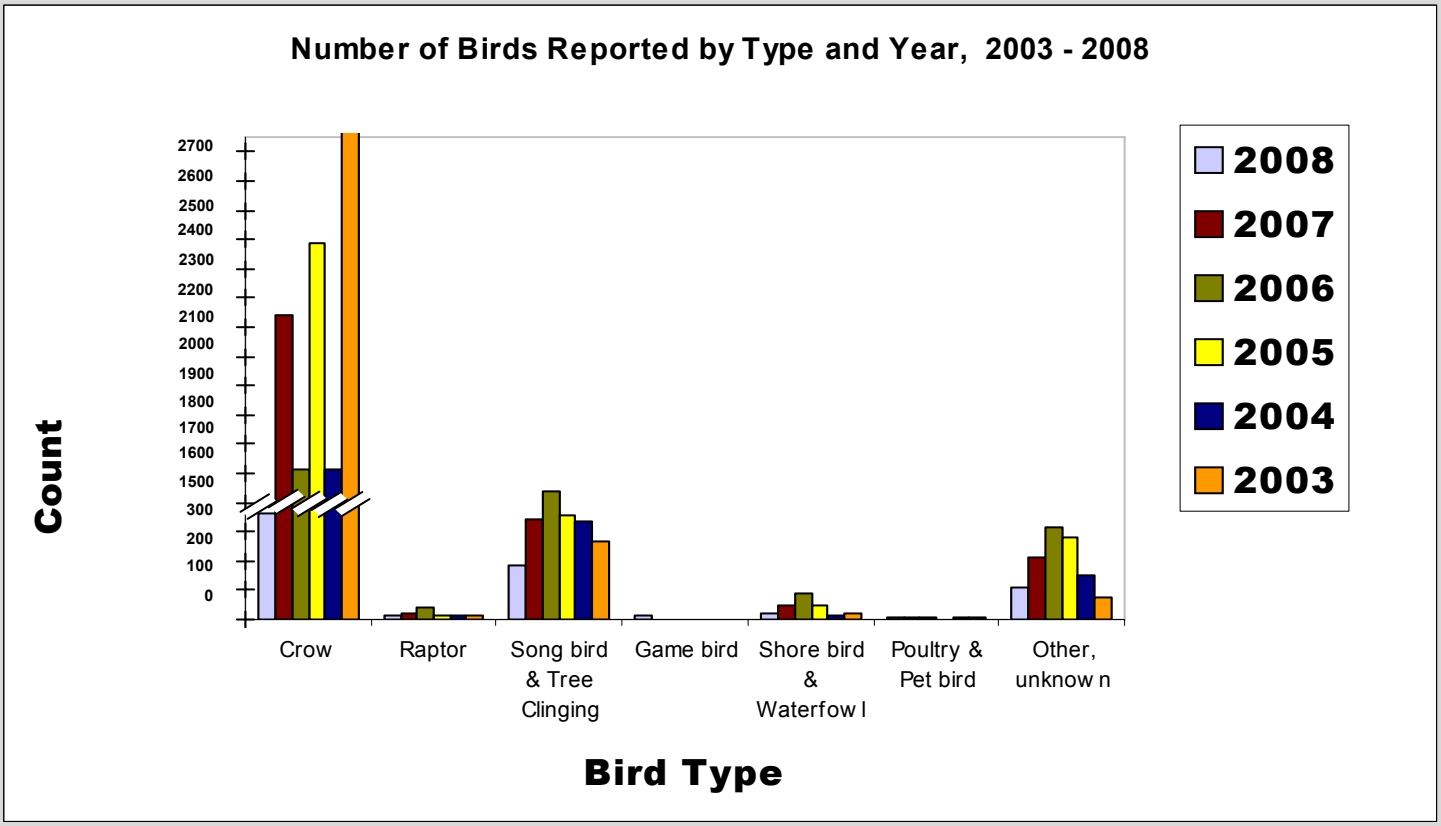


Figure 4. Bird mortalities by bird type between 2003 and 2008. Many more crows than any other bird types were reported each year, although the margin of this majority seemed to alternate every other year.

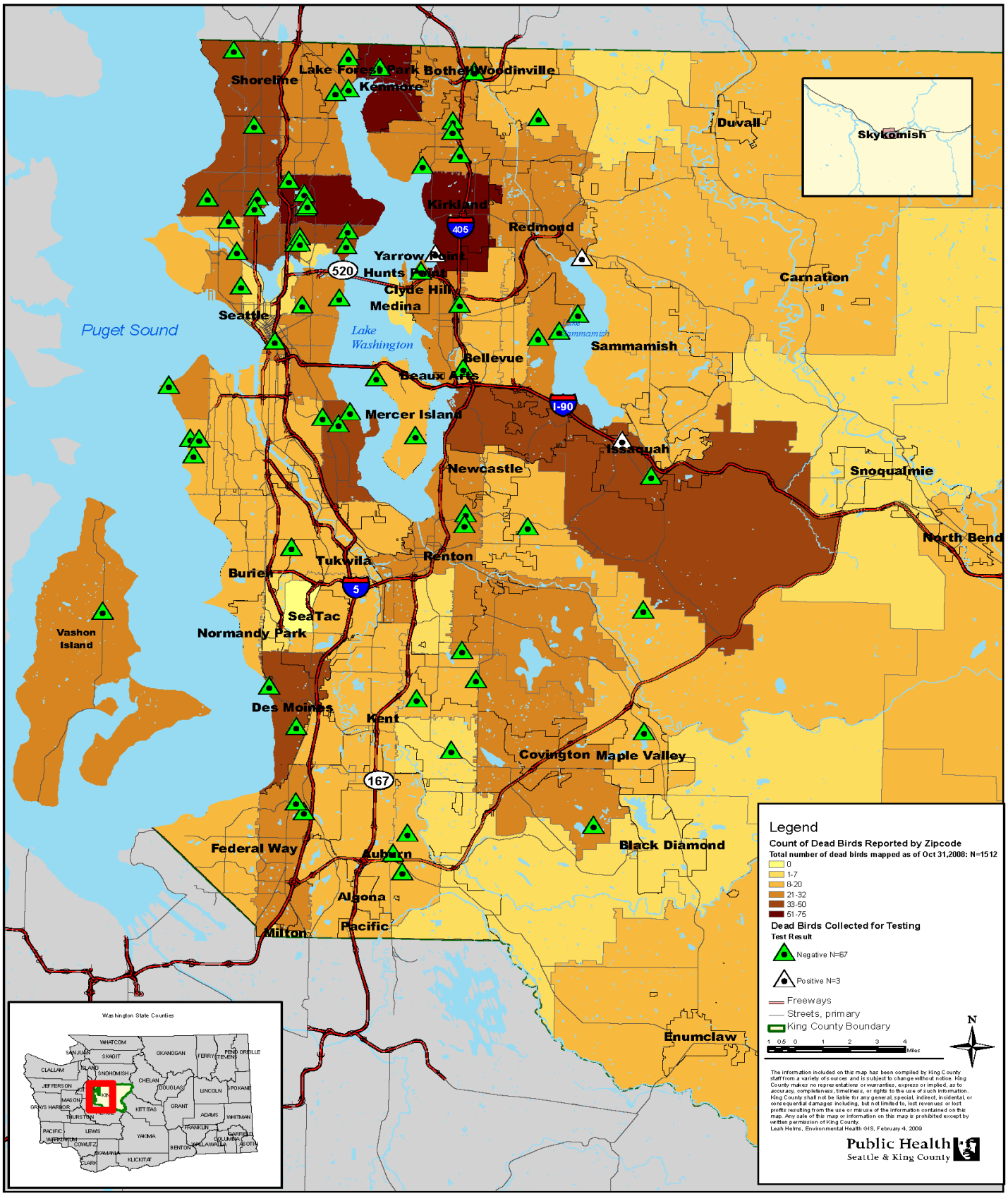
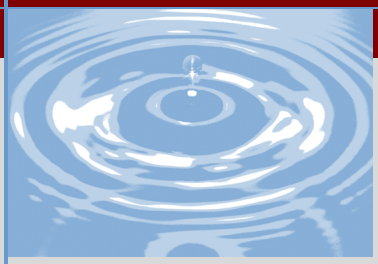


Figure 5. Map showing the density of bird mortalities reported to Public Health as of 10/31/2008, by zip code. The location of birds collected and submitted for testing are marked by the points on the map (N=71). Three of the 71 birds submitted for WNV testing were positive, one each from Kirkland, Redmond and Issaquah.



Mosquito Surveillance

The 2008 mosquito surveillance program involved collecting adult mosquitoes in Encephalitis Vector Survey (EVS) traps baited with dry ice and set overnight at sites throughout King County (Figure 6) at regular time intervals during the summer months. Identification of mosquitoes by species and sex was performed by trained Public Health staff via microscopic examination of freshly-caught mosquitoes held on a cold tray. After identification and sorting, batches of female mosquitoes of species capable of transmitting WNV were immediately sent to a laboratory at the University of California at Davis for testing. Samples with unidentifiable or rare mosquito species were sent to the medical entomologist at the WA State Department of Health for species confirmation. Results of identification and testing were maintained by Public Health in a database for analysis and mapping.

Species identification allows Public Health to determine the presence of vector mosquitoes in an area and select only those species for lab testing. In Washington, the primary mosquito vector species are *Culex pipiens* and *Culex tarsalis*. Mosquito surveillance provides information about the relative abundance of mosquitoes at the trap locations, geographic locations holding vector species, changes in abundance and species type over the course of the season, rates of WNV infection, and how early in the season initial positive mosquitoes are found (earlier positives indicates a higher risk of a human epidemic). WNV positive findings, particularly if they occur in August or earlier, would also be used to target areas of the County for more intensive mosquito control measures and public education on WNV prevention, as described in our WNV Phased Response guidelines and WNV Response Plan.

In 2008, we were able to greatly increase surveillance in terms of number of trapping sites and frequency of trapping compared to 2007 by hiring two UW Environmental Health student interns to assist in mosquito trapping and preparation of specimens for shipping. In addition to the seasonal interns, Public Health continued a successful partnership with the Seattle Public Utilities Department (SPU) for mosquito surveillance activities. SPU has been conducting research on the effectiveness and fate of larvicides applied to catch basins to destroy mosquitoes in their larval stages. As part of this research project, SPU hired an environmental consultant firm to conduct adult mosquito trapping at geographically distributed sites within the city of Seattle. This also allowed Public Health staff to concentrate trapping in other cities and unincorporated King County. The table below shows the breakdown of trapping results for the city of Seattle and the remainder of King County.

	# Trapping Events	# Mosquito Pools (with >0 mosquitoes)	# Mosquitoes	# Pools of Vector Species Tested	% of Pools Tested
City of Seattle	295	601	6,560	122	20
King County outside Seattle	142	373	4,684	81	22
Totals	437	974	11,244	203	41

No mosquito pools tested positive for WNV in 2008.

Conducting species identification allows us to have a better understanding of mosquito ecology in our area, which has diverse topography and mosquito habitats. Sixteen species of mosquitoes were identified in King County in 2008. It is believed that the variation in abundance and species collected at different trapping sites is due to a number of factors. Some potential variables are: setting of the trapping site (e.g., urban, wooded, moist, windy, presence of predators), availability of preferred larval habitat (e.g., water in containers, irrigation waters, wetlands, catch basins) within flight range, and availability of the preferred host during the mosquitoes' active periods. These inferences are based on the knowledge that different mosquito species vary in preferred sites for depositing eggs, active periods, flight ranges, and preferred hosts.

Future Directions

2008 was the second year that systematic mosquito trapping was conducted in both Seattle and King County outside of Seattle. The program for 2008 was expanded compared to 2007 because of the importance of understanding the ecology of mosquito disease vectors in this area, a field that has been relatively neglected in recent decades, and the usefulness of the data in directing West Nile virus prevention and control activities. Ongoing mosquito surveillance is a fundamental public health tool in the control of vector-borne diseases, and can be expected to increase in importance with the influences of climate change and changing patterns of human habitation. However, due to budget constraints currently being experienced in Public Health and in many other government agencies, it has become necessary to suspend mosquito surveillance activities for 2009.

A look at the mosquito species in King County

Recently a project was undertaken to create accurate logs of the mosquito species that have been identified throughout Washington State over the past several years (Sames et al, 2007). Using historical records and mosquito collections dating as early as 1917 to as recent as 2005, 29 species of mosquitoes were identified as occurring in King County. Sixteen of these species were identified in King County during the course of the 2008 mosquito surveillance season.

Table 1. Comparison of mosquito species identified during 2008 mosquito surveillance (N=16[a]) to historical log of mosquito species identified in King County (N=29).

Mosquito Species identified historically in King County	Mosquito Species identified by Public Health in 2008	Mosquito Species identified historically in King County	Mosquito Species identified by Public Health in 2008
Ae. cinereus		*Cx. tarsalis*	X
Ae, vexans	X	*Cx. territans*	X
An. freeborni	X	*Oc. aboriginis*	
An. punctipennis	X	*Oc. aloponoium*	
Cq. perturbans	X	*Oc. communis*	
Cs. impatiens	X	*Oc. dorsalis*	X
Cs. incidens	X	*Oc. excrucians*	
Cs. inornata	X	*Oc. fitchii*	X
Cs. minnesotae		*Oc. hexodontus*	
Cs. morsitans	X	*Oc. increpitus*	X
Cs. particeps	X	*Oc. japonicus japonicus*	
Cx. apicalis		*Oc. pullatus*	
Cx. boharii		*Oc. sierrensis*	X
Cx. pipiens	X	*Oc. sticticus*	
Cx. stigmatasoma			

[a]Some mosquitoes were not identified down to the species level.

Many of the species that have been identified in King County, either historically or currently, are potential primary and bridge vectors for diseases including:

- Eastern Equine encephalitis (*Ae. vexans*, *Cq, perturbans*)
- St. Louis encephalitis (*Cx. pipiens*, *Cx. tarsalis*),
- West Nile virus (*Cx. pipiens*, *Cx. tarsalis*, *Oc. japonicus*, *Ae. vexans*),
- La Crosse encephalitis (*Cs. inornata*, *Oc. communis*, *Oc. dorsalis*, *Oc. japonicus*),
- Dog heartworm (*Oc. sierrensis*),
- Malaria (*An. freeborni*, *An. punctipennis*)

Historically, vector-borne diseases have been relatively rare in King County, possibly because conditions have not been appropriate for the necessary vectors to thrive. With changes in the climate and other environmental conditions, mosquito population dynamics may change such that they increase the potential for vector-borne disease transmission in King County. Therefore it will important in the coming years to continue monitoring the abundance and composition of the mosquito populations in the area.

Reference: Sames W, Duffy A, Maloney FA, Townzen JS, Brauner JM, Mchugh CP, Lilja J. 2007. Distribution of mosquitoes in Washington State. *Journal of the American Mosquito Control Association*. 23:442-448.

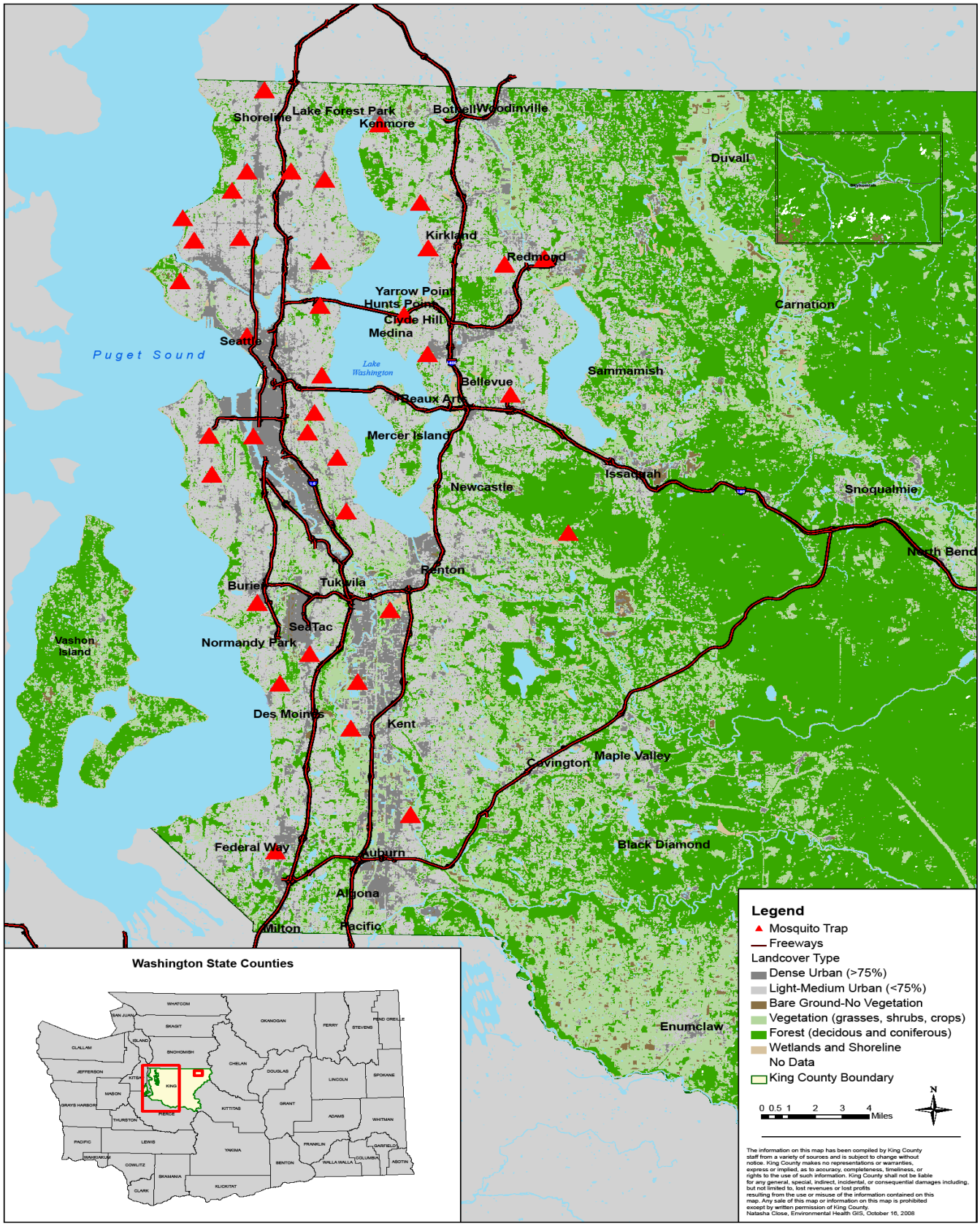


Figure 6. Mosquito trap locations in King County in 2008. Trapping in more eastern parts of King County was not feasible due to staffing and budget which limited travel times. Coloration of the map indicates the landcover type.

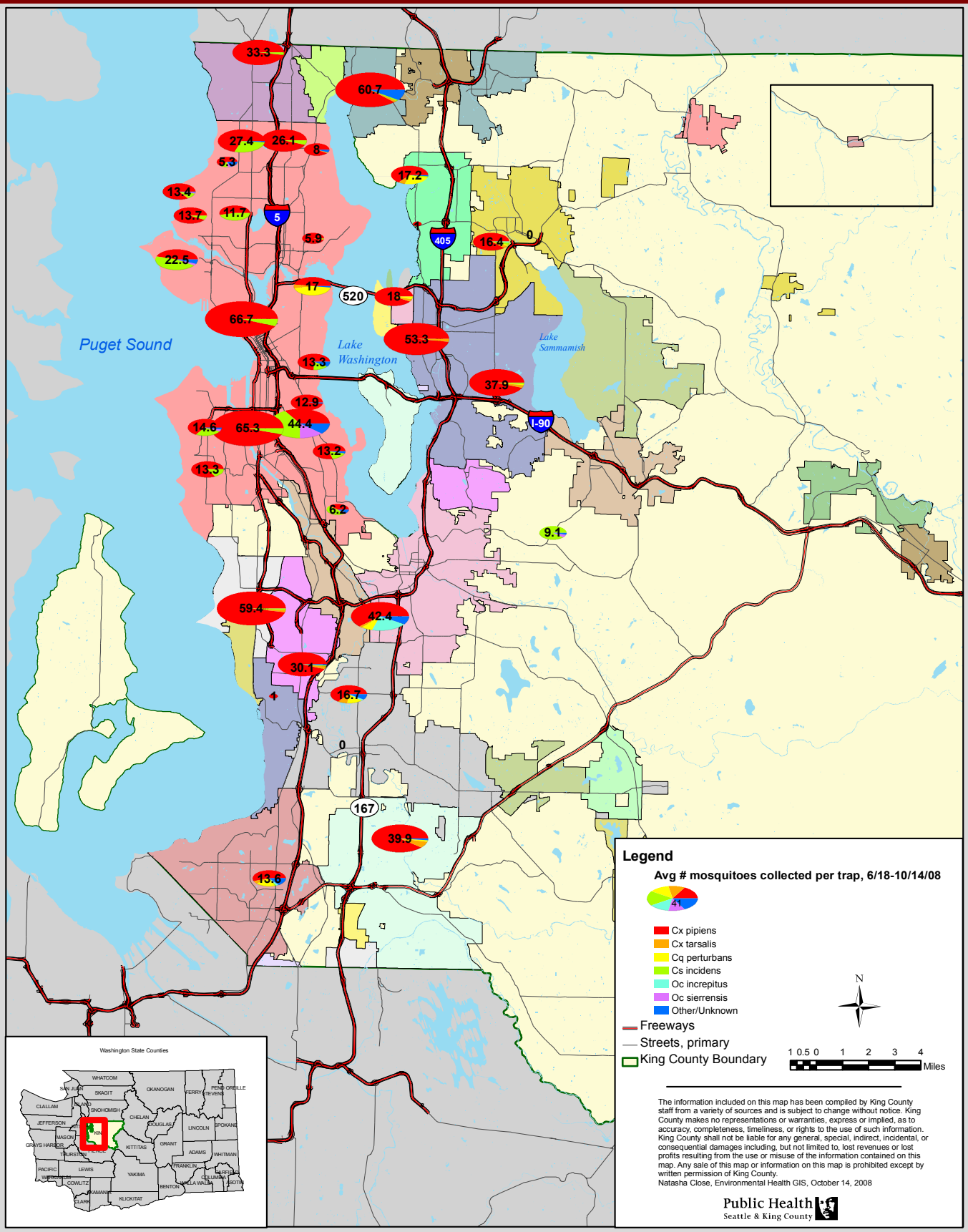


Figure 7. Map of trap sites in King County with the size of the pie charts depicting the average abundance of mosquitoes per trap night and the colors showing species distribution. Notice the extremely high proportion of the prime WNV vector species Culex pipiens (indicated in red) at nearly all trap sites compared to non-vector species.

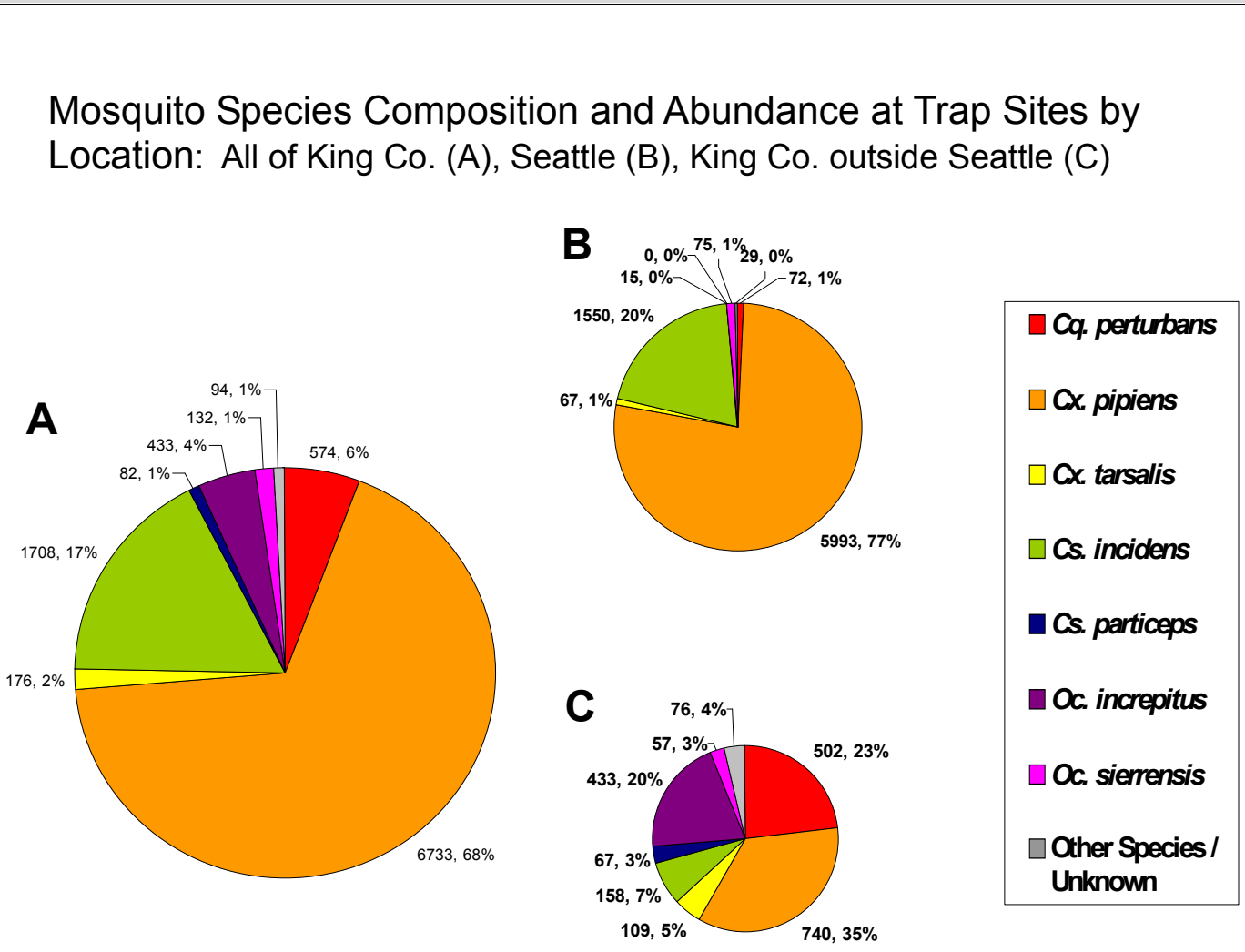


Figure 8. Total number and % of each mosquito species collected at trapping sites in King County in 2008. The size of the pie depicts abundance. Notably: 1) *Culex. pipiens* (orange) was the most frequently collected mosquito species, especially in Seattle; 2) the diversity of mosquitoes collected outside of Seattle is greater (although total abundance is lower) than within the city of Seattle.

Legend: A = All trapping sites within King County. B = City of Seattle. C = King County excluding city of Seattle.

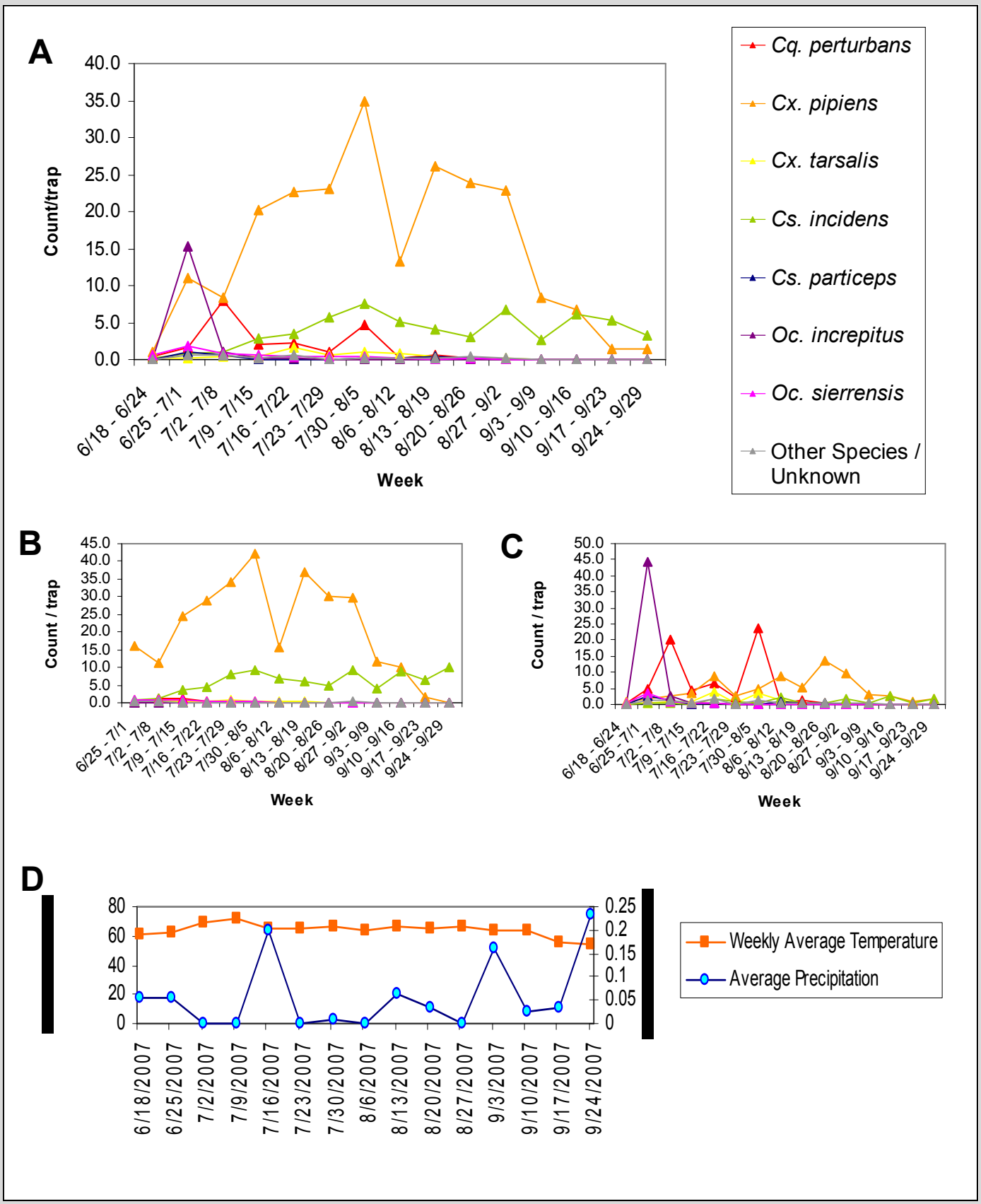
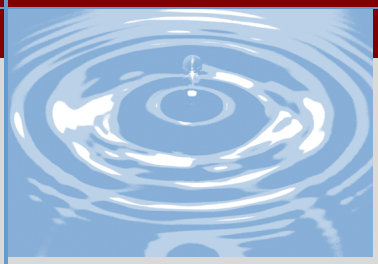


Figure 9. Average no. of mosquitoes by species collected per trap during 2008 summer season.
Legend: A = All trapping sites within King County. B = City of Seattle. C = King Co excluding Seattle. D = Weekly precipitation and weekly average temperature.



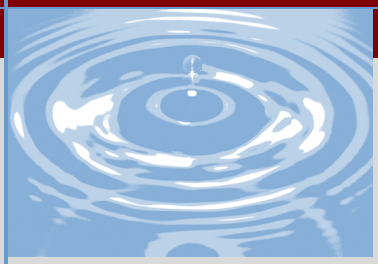
Other Surveillance

Non-human Mammalian Surveillance

Through reporting by veterinarians and veterinary laboratories and in cooperation with the WA State Department of Agriculture, State Veterinarian's Office, we monitor non-human mammals for infection with West Nile virus. The primary mammals at highest risk are equines including horses, mules, burros, and donkeys. In 2008, we received no reports of horses tested for the presence of a WNV infection, compared to 2006 when several horses were tested and one King County horse died of WNV disease. In 2008, we received no reports on other mammals confirmed with WNV infection.

Human Surveillance

West Nile virus disease is a reportable condition in Washington State. In 2008, two residents were diagnosed with West Nile virus infection, although neither case was thought to have been contracted in King County. One County resident developed West Nile neuroinvasive disease in August, was hospitalized and has since recovered from the illness. In this case, epidemiologic investigation by Public Health staff revealed a history of vacationing in Eastern Washington during the time period consistent with the WNV incubation period (3-14 days between the bite of an infected mosquito and onset of illness). West Nile virus was also detected in July in one King County blood donor who had traveled to both eastern Washington and Oregon during their incubation period. Thus it is unknown exactly where this infection was acquired. Because WNV can be transmitted by blood transfusion from a person with active virema (virus in the blood), all blood donations are screened for WNV before being used for transfusions.



Appendix A: Washington State 2008 WNV Surveillance Summary

Table 1. Positive West Nile virus surveillance results in Washington State, 2008

County	Bird	Mosquito Pools	Horse or Other Mammal	Human	Total
Benton	10	14	4	0	28
Grant	1	2	10	0	13
King	3	0	0	2[a]	5
Kittitas	0	0	1	0	1
Lewis	1	0	0	0	1
Pierce	3	0	0	0	3
Thurston	1	0	0	0	1
Yakima	3	41	26	1[b]	71
Washington State	24	57	41	3	117

[a]West Nile virus infection acquired outside of King County.
[b]Locally-acquired infection