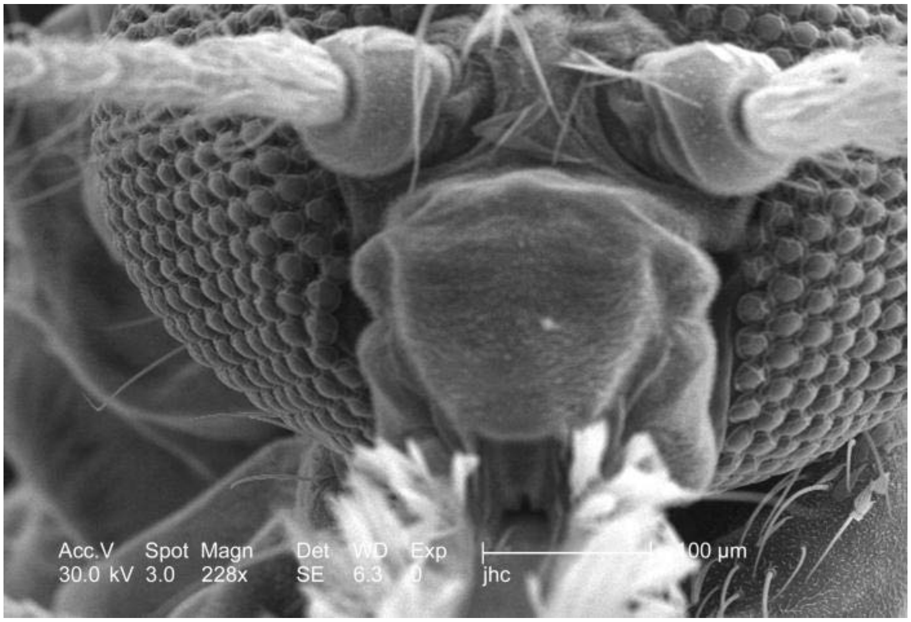
2013 OPERATIONAL REVIEW & PLANS FOR 2014

Annual Report to the Technical Advisory Board

METROPOLITAN MOSQUITO CONTROL DISTRICT



Scanning electron micrograph of the anterior head region of an *Anopheles* mosquito. Visible are the two bilaterally located antennae, the proboscis, and two bilateral multifaceted compound eyes.

Source: CDC Public Health Image Library
Content provided by Paul Howell, photo by Janice Carr

Metro Counties Government Center ~ 2099 University Avenue West ~ St. Paul, MN 55104-3431
www.mmcd.org

Metropolitan Mosquito Control District

Mission

The Metropolitan Mosquito Control District′s mission is to promote health and well-being by protecting the public from disease and annoyance caused by mosquitoes, black flies, and ticks in an environmentally sensitive manner.

Governance

The Metropolitan Mosquito Control District, established in 1958, controls mosquitoes and gnats and monitors ticks in the metropolitan counties of Anoka, Carver, Dakota, Hennepin, Ramsey, Scott, and Washington. The District operates under the eighteen-member Metropolitan Mosquito Control Commission (MMCC), composed of county commissioners from the participating counties. An executive director is responsible for the operation of the program and reports to the MMCC.

Metropolitan Mosquito Control Commission 2014

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Robyn West	Anoka County
James Ische	Carver County
Tom Workman	Carver County
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Technical Advisory Board

The MMCC formed the TAB in 1981 to provide annual, independent review of the field control programs, to enhance inter-agency cooperation, and to facilitate compliance with Minnesota State Statute 473.716.

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Metropolitan Mosquito Control District Contributing Staff

Bill Caesar	Interim Executive Director
Stephen Manweiler	Director of Operations/Tech. Serv.
Sandy Brogren	Entomologist
Diann Crane	Assistant Entomologist
Janet Jarnefeld	Technical Services/Tick
Kirk Johnson	Vector Ecologist
Carey LaMere	Technical Services
Mike McLean	Public Affairs
Nancy Read	Technical Services Coordinator
Mark Smith	Tech. Serv./Control Materials
John Walz	Technical Services/Black Fly

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In Memoriam

Michael P. Kramer, 44, of St. Charles, Minnesota
1969-2013

Michael P. Kramer died Wednesday, June 19, 2013 as a result of a helicopter accident in Maplewood, MN. Mike was born Feb. 24, 1969, in Rochester, MN to Edward Kramer and Mary (Siebenaler) Kramer and was raised on a farm near Elba. Mike graduated from St. Charles High School in 1987 and from the University of Minnesota in 1992.

Mike served in the US Army from 1993-1997 and achieved the rank of captain. Mike and his wife Tricia moved to Clear Lake, WI in 1997 and purchased a dairy farm. In 1998, Mike and Tricia purchased a Victorian home in Clear Lake and operated an adult foster care for adults with developmental disabilities. In 2006, they sold their farm and group home to move to Sevierville, TN where he began his helicopter-flying career.

Mike flew helicopters in Australia for cattle roundup, scenic tours over the Smokey Mountain National Park in Tennessee, and for SKY 13 News in Orlando, FL. By 2009, Mike was flying for Scott’s Helicopter Services, which included the Metropolitan Mosquito Control District. During this time, he also flew for news choppers, Fox 9, KARE 11, and WCCO 4 as needed. By 2010, he used his flying skills for Air Evac Lifeteam, EMS (Emergency Medical Service) in Alabama and Kentucky. He loved combining his love for flying and care for others, and in 2011 he flew for Wings Air Rescue, EMS Helicopter in Jenkins, KY and in 2012 for UT Knoxville Lifestar EMS Helicopter.

In 2013, Mike and Tricia moved with their family back to St. Charles where he flew for Mercy Air Med of Mason City and Scott's Helicopter Services for the Metropolitan Mosquito Control District (MMCD).

MMCD staff describe Mike as professional, courteous, and respectful to everyone. He was cautious but not timid and always flew with safety being his number one concern. He always asked for feedback to make sure he was doing the job correctly. Mike was a friendly person who enjoyed socializing with staff as much as flying. We lost more than a pilot – we lost a friend.

Mike is survived by his wife, Tricia; a daughter, Katherine, and a son, Daniel; his mother, Mary Kramer of St. Charles; father, Edward (JoAn) Kramer of St. Charles; paternal grandmother, Evabell Kramer of St. Charles; 12 siblings; mother-in-law, Adrean Barnes, 75 cousins and 28 nieces and nephews; Rose Riggins to whom Mike and Tricia were foster parents; and many other relatives.

Executive Summary

The Metropolitan Mosquito Control District (MMCD or the District) strives to provide cost-effective service in an environmentally sound manner. This report presents MMCD staff efforts to accomplish that goal during 2013 through mosquito, black fly and tick surveillance, disease monitoring, mosquito and black fly control, new product testing, data management, and public information. In 2014, MMCD will continue to review all aspects of its integrated mosquito management program while complying with the National Pollutant Discharge Elimination System (NPDES) and other regulatory requirements.

The 2013 season was characterized by an extremely late spring with heavy snowfall into May. This was followed by a wet early summer but ended with a hot and dry August and September. These conditions resulted in a major mosquito population peak in mid-July. Statewide, West Nile virus activity remained strong with 79 human cases recorded, 15 of which occurred within the District. There was also a significant resurgence of La Crosse encephalitis activity in Minnesota during 2013.

The first fatal incident since 1968 involving a contracted District helicopter pilot occurred June 19, 2013. The pilot, Mike Kramer, died when his helicopter crashed in Maplewood. The National Transportation Safety Board is investigating the incident. Air operations were suspended for several days out of respect for the pilot and his family. This suspension did have a measureable affect for a time on mosquito levels throughout the District.

Surveillance

Altogether, the District experienced rainstorms that produced four major mosquito broods in 2013. The major mosquito population peak occurred in July.

District lab staff identified 19,462 larval mosquito samples, a significant decline from 2012. Only seven *Culex erraticus*, a competent vector of eastern equine encephalitis and suspected maintenance vector of WNV, were found in adult samples this year, down from 599 in 2012. High populations of *Anopheles quadrimaculatus*, however, another species rare to the District, were identified in samples submitted to the lab in 2013.

The District continued to sample the distribution of ticks in the metro area and preliminary indications are that *Ixodes scapularis* continued to become more widespread. The number of ticks collected per mammal this year, however, was significantly lower than has been typical since 2000.

Disease

A resurgence in mosquito-borne disease cases in the upper-Midwest, which began in 2012, continued in 2013. Besides the WNV cases, there were five La Crosse encephalitis (LAC) cases reported in Minnesota, three in District residents. Prior to 2012, LAC was last reported in the District in 2005. Staff followed up on LAC case reports with extensive monitoring, site clean-up, and treatment where appropriate. In all, 17,812 waste tires (larval habitat for the LAC vector) were collected and recycled by District staff.

Early indications are that tick-borne illness totals in 2013 may parallel those reported by the Minnesota Department of Health in 2012. To help educate the public about risk of tick-borne illness, MMCD posts the regularly updated “Tick Risk Meter” on the District’s website (www.mmcd.org) and Facebook page. Signs are also posted in several metro-area dog parks to educate the public about tick-borne disease risk, and to remind people about MMCD’s tick identification service.

Control

Due to the large geographic area of the metropolitan region, the District has always considered larval control its most cost-effective mosquito control strategy. As part of an overall operating budget reduction started in 2011, some shifts were made in treatment thresholds and control materials used in different situations to reduce cost. Those program ajustments continued through 2013.

Late onset of mosquito production, coupled with another dry latter-half of the season, resulted in 52,251 fewer acres worth of larvicides applied to wetlands in 2013 than in 2012. Overall adulticide acreage, however, increased by 38,082 acres in 2013.

The 3,863.5 gallons of *Bti* used in 2013 to treat black fly larvae on the large rivers was above the yearly average used between 1997 and 2012. The amount used to treat small streams in 2013 was well below the yearly average, probably due to the late, cold spring experienced in 2013.

Product and Equipment Testing

Quality assurance processes focused on product evaluations, equipment, and waste reduction. Before being used operationally, all products must complete an internal certification process that consists of tests to demonstrate how to use the product to effectively control mosquitoes. The District continued certification testing of two larvicides and two new adulticides. The larvicides and adulticides have been tested in different control situations in the past. The goal is to determine whether different larvicides can control two or more target mosquitoes in multiple control situations. One adulticide was tested as an alternative ULV material and the other as an alternative barrier material. These additional control materials will provide MMCD with more operational tools.

Data Management and Public Information

The District values data-based decision making and is continually improving data and mapping systems. Calls, e-mails, and other contacts from citizens are important ways to identify areas of high service demand. Direct citizen input also supports disease control through requests for tire disposal and dead bird reporting. MMCD also tallies and responds to citizen complaints and requests for limited or no treatment. As is usually the case, calls requesting treatment closely tracked overall mosquito numbers as measured by Monday night sweep net counts of human biting mosquitoes.

Ongoing impacts from decreasing natural resources and climate change have served to deepen MMCD’s longstanding commitment to sustainability and social responsibility. In 2013, MMCD established a formal sustainability strategy, and formed a steering committee to assist in guiding staff’s efforts. We identified key opportunity areas and created small work groups to establish specific quantifiable sustainability goals in each of these areas: 1) reducing energy usage; 2) reducing waste; 3) identifying and using renewable resources; and 4) social responsibility/health and wellness.

Chapter 1 Mosquito Surveillance

2013 Highlights

- Rainstorms produced four major mosquito broods
- Cool, wet, late spring. Wet May and June. Hot, dry summer
- Major mosquito peak occurred in July
- Identified 19,462 larval samples
- High populations of rare species *Anopheles quadrimaculatus*
- Collected 7 *Culex erraticus* adults, down from 599 in 2012
- *Aedes albopictus* larvae found in one container

2014 Plans

- Evaluate placement of CO_2, gravid, and New Jersey traps
- Continue to monitor and study *Ae. japonicus*
- Maintain surveillance for *Ae. albopictus* and remain aware of other potential invasive species
- Continue to refine *Cs. melanura* surveillance

Background

The Metropolitan Mosquito Control District (MMCD or the District) conducts larval and adult mosquito surveillance to determine levels of mosquitoes present, measure annoyance, and to detect the presence of disease vector species. A variety of surveillance strategies are used since different mosquito species have different habits and habitat preferences. The District strives to obtain a complete picture of the mosquito population by weekly monitoring of host-seeking, resting, egg laying, and larval mosquitoes. By knowing which species are present in an area, and at what levels, the District can effectively direct its control measures.

There are 51 known mosquito species in Minnesota, all with a variety of host preferences. Forty-five species occur in the District, 24 of which are human-biting. Other species prefer to feed on birds, large mammals, reptiles, or amphibians. Mosquitoes differ in their peak activity periods and in how strongly they are attracted to humans or trap baits (e.g., light or CO_2); therefore, a variety of adult mosquito collection methods is used to capture targeted species.

The District focuses on four major groups of human-biting mosquito species: spring *Aedes*, summer *Aedes*, *Coquillettidia perturbans*, and disease vectors. Snowmelt induces spring *Aedes* (15 species) eggs to hatch in March and April and adults emerge in late April to early May. These species have one generation each season and adults can live for three months. Rainfall prompts the summer *Aedes* (five species) to begin hatching in early May. These species can have several generations throughout the summer and adults can live up to two weeks. *Coquillettidia perturbans*, the cattail mosquito, develops in cattail marshes and has one generation per year, peaking in early July. Disease vectors include *Aedes triseriatus*, *Culiseta melanura*, and *Culex* mosquitoes (four species). Adults are evident in early summer and they can produce multiple generations per year. Appendix A contains a species list and detailed descriptions of the mosquitoes occurring in the District.

2013 Surveillance

Rainfall

Rainfall surveillance is an important tool used to estimate the amount of larval production and to determine where to dispatch work crews following a rain event. Generally, an inch or more of rain can produce a hatch of floodwater mosquitoes. Historically, the District has operated a network of rain gauges from May to September. In 2011, April and October readings were added to detect precipitation events that could influence mosquito development at the beginning and end of the season. The May-September rainfall will continue to be used as the average to compare with previous years.

In 2012, MMCD joined the Community Collaborative Rain, Hail, and Snow (CoCoRaHS) network, a group of thousands of volunteers throughout the country who input their precipitation data into one database. MMCD recognized that by joining this network we would be able to eliminate some MMCD gauges that were difficult to monitor, fill gaps with observers in CoCoRaHS, and share data in a timely manner. Data from 122 gauges were used for summaries in this document.

Average rainfall in the District from May 4 through September 27, 2013 was 17.77 inches, which is 1.64 inches below the 54-year District average of 19.41 inches. The majority of the rainfall occurred mid-May to mid-July (Figure 1.1). Much of the April precipitation was in the form of snow, which delayed hatching. Precipitation decreased by late July and was significantly lower in August and September. This is the second year of drought conditions starting in August.

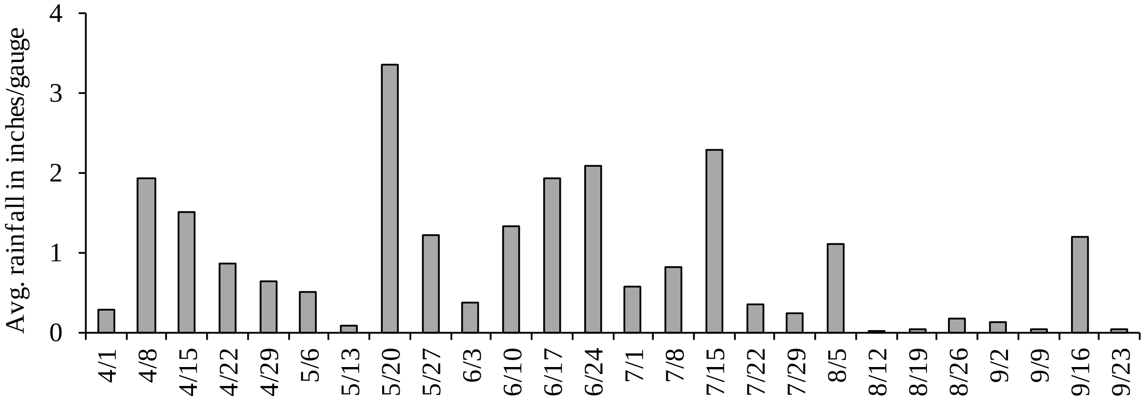


Figure 1.1 Average rainfall amounts per gauge per week (Saturday – Friday), 2013. Dates represent the Monday of each week.

Typically, spring *Aedes* mosquitoes larvae develop over a period of months (mid-March to early May), and summer species develop over a period of days (7-10). Water temperature influences how quickly larvae develop in sites. March and April had below average temperatures and above normal precipitation, mostly in the form of snow (Fig. 1.2). These weather conditions delayed the start of the mosquito season, the complete opposite of last year.

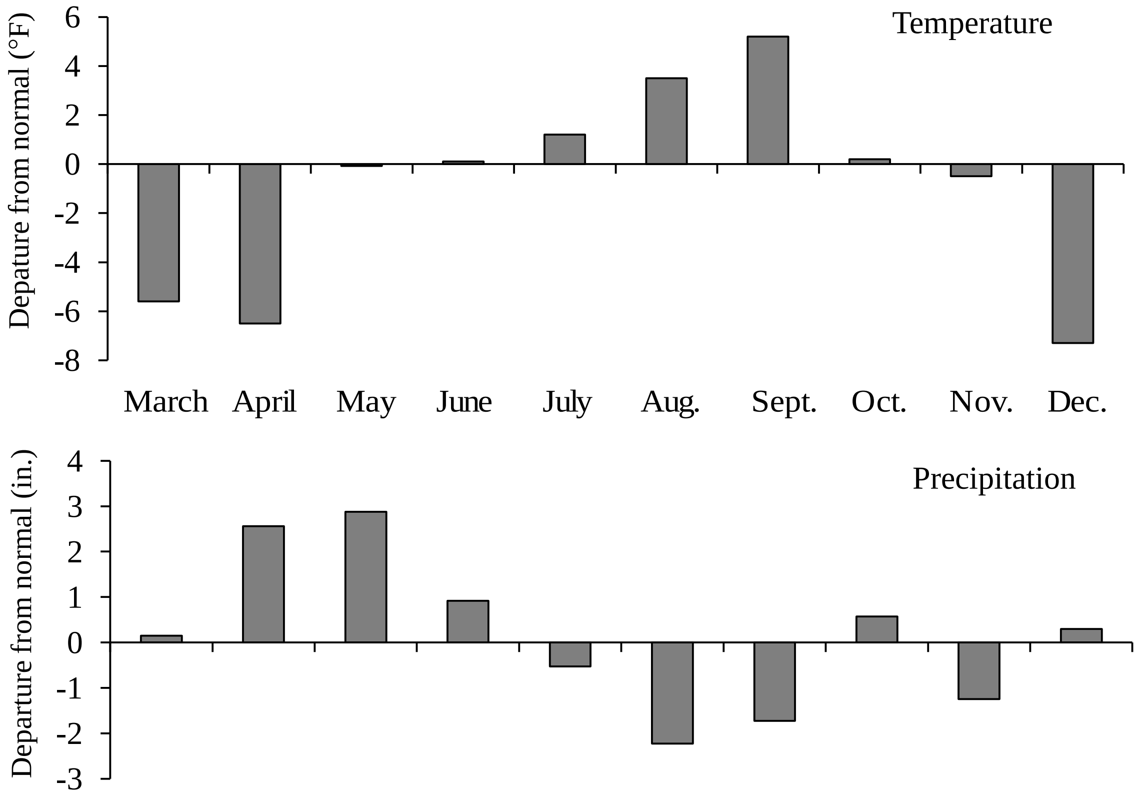
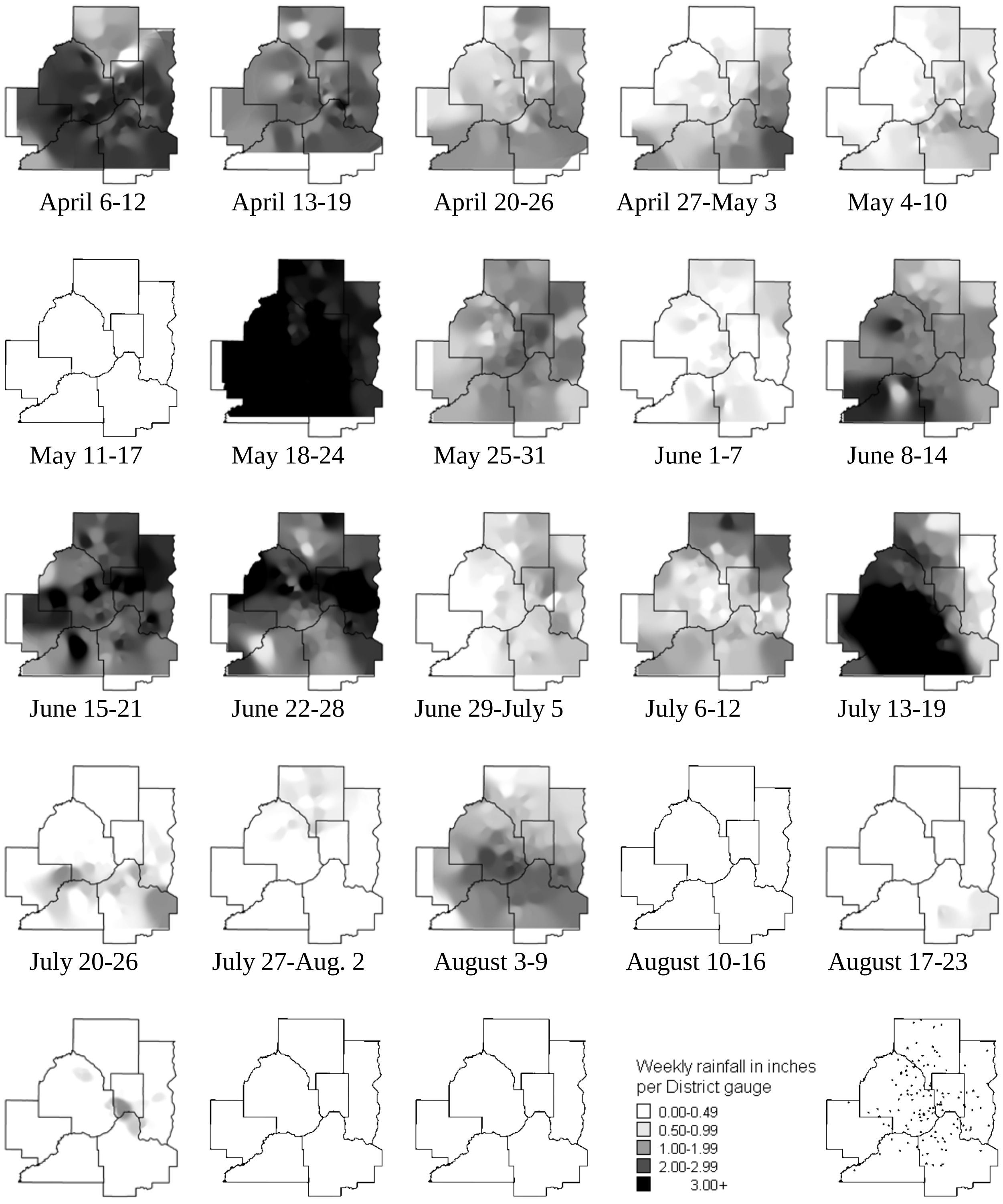


Figure 1.2 Monthly departures from normal for temperature and precipitation March-December, 2013 (source: National Weather Service, Twin Cities Station).

The first larval sample in 2013 was taken on April 9, 27 days later than in 2012. April was the fifth coldest in history and also the fifth wettest of all time in the Twin Cities. Much of April's precipitation fell as snow with record-setting amounts at many locations. The overall spring temperatures (March-May) were the third coldest in state history. The Freshwater Society declared ice-out on Lake Minnetonka on May 2, only the fifth time in history the lake has lost ice cover in May. The last time was 1965. Many northern lakes were still holding ice in May.

In 2013, there were 11 rainfall events sufficient to produce mosquito broods – 4 large broods and 7 small to medium sized broods. Brood size is determined by the amount of area affected by rainfall, the amount of rainfall received, and the amount of mosquito production that resulted. Figure 1.3 depicts the geographic distribution and magnitude of weekly (Saturday-Friday) rainfall received in District gauges from April through September 2013. Some weeks had multiple rain events and broods. The cumulative weekly rainfall does not identify individual rain events however.

As is typical, there was one large spring *Aedes* brood. The spring *Aedes* brood coincided with a large summer floodwater *Aedes* brood that hatched in response to weekend rainstorms of two-three inches on May 19-20. Rainfall in June produced two large broods, including a big storm with high winds that toppled many trees. The fourth large brood was a result of two-six inches of rain on July 13-14. After that storm, we experienced only two small broods in August.



April 6-12
April 13-19
April 20-26
April 27-May 3
May 4-10
May 11-17
May 18-24
May 25-31
June 1-7
June 8-14
June 15-21
June 22-28
June 29-July 5
July 6-12
July 13-19
July 20-26
July 27-Aug. 2
August 3-9
August 10-16
August 17-23
August 24-30
Aug. 31-Sept. 6
Sept. 7-13
Gauge Locations

Figure 1.3 Weekly rainfall in inches per District gauge, 2013. The number of gauges varied from 56-92. A map of the rain gauge locations is included. Inverse distance weighting was the algorithm used for shading of maps.

Larval Collections

Larval mosquito inspections are done to determine if targeted species are present at threshold levels or to obtain species history in development sites. A variety of habitats is inspected to monitor the diverse fauna. Habitats include wetlands for *Aedes* and *Culex*, catch basins and stormwater structures for *Cx. pipiens* and *Cx. restuans*, cattail marshes for *Cq. perturbans*, tamarack bogs for *Cs. melanura*, and containers, tires, and tree holes for *Ae. triseriatus*, *Ae. albopictus*, and *Ae. japonicus*. The majority of larval collections are taken from floodwater sites using a standard 4-inch dipper. Threshold levels are determined by counting the number of larvae in each dip. Larvae are placed in sample vials and sent to the Entomology Lab for species identification.

To accelerate the identification of samples from sites to be treated by helicopter, larvae are identified to genus only, except for *Culex* larvae, which are identified to species to differentiate vectors. Staff process lower priority samples as time permits and those are identified to species. In 2013, lab staff identified 19,462 larval collections, very close to the average for the last 23 years, but down considerably from the last three years (Fig. 1.4).

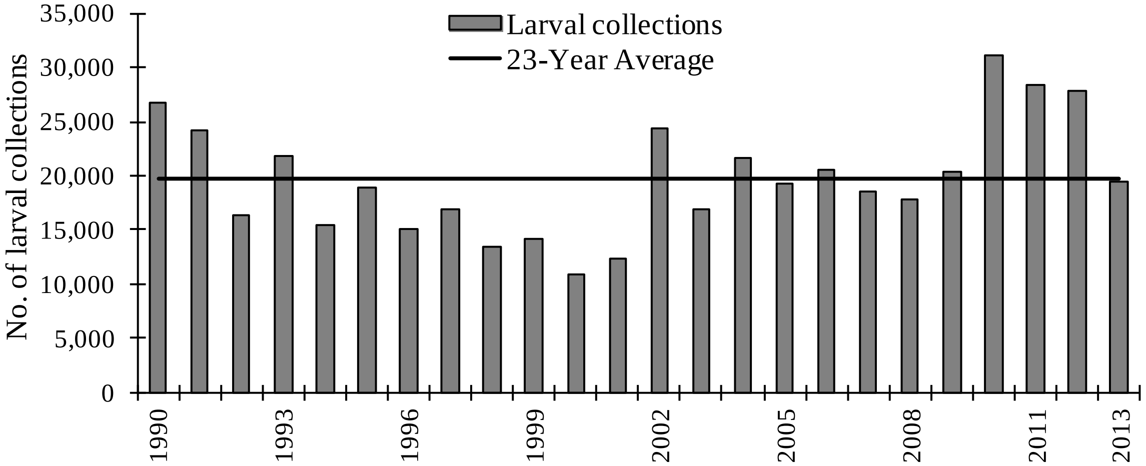


Figure 1.4 Yearly total larval collections, 1990-2013, and 23-year average.

The results of the 10,557 samples identified to species, calculated as the percent of samples in which the species was present, is shown in Table 1.1. Most larval sampling takes place in natural wetlands but a significant amount of sampling is done in catch basins, stormwater structures, and other man-made features (e.g., swimming pools, culverts, artificial ponds). Those results are displayed separately (shaded column) from the natural wetlands results in Table 1.1.

The most frequently collected species from natural development areas was *Ae. vexans*, occurring in 55.7% of the samples (Table 1.1). *Aedes cinereus*, which occurs in the spring and summer, was the second place winner in 13.8% of the samples. Two non human-biting species, *Culex territans* and *Culiseta inornata*, were very close together in third and fourth place. The fifth place winner was *Culex restuans*.

Table 1.1 Percent of samples where larval species occurred in wetland collections by facility and District total, and the District total for structure samples, 2013; the total number of samples processed to species is in parentheses.

	Percent of samples where species occurred by facility							
Species	North (1,721)	East (2,217)	South Rosemount (2,462)	South Jordan (1,111)	West Plymouth (1,069)	West Maple Grove (650)	Wetland Total (9,230)	Structures Total (1,327)
*Aedes abserratus**	0.2	0.5	0.2		0.7		0.3	
*aurifer**	<						<	
*canadensis**	0.2	0.5	1.1	0.5	0.4	0.2	0.5	
cinereus	18.6	15.8	6.4	10.4	19.1	20.0	13.8	0.7
*communis**								
dorsalis	<	<	<		<	0.3	<	
*euedes**								
*excrucians**	4.5	6.8	2.8	0.9	12.5	4.5	5.1	
*fitchii**	1.1	2.9	0.9	0.2	0.5	1.2	1.3	
*flavescens**								
*implicatus**	0.2	0.4	<		0.2		0.2	
*intrudens**								
japonicus[1]	0.1	<					<	4.0
nigromaculis								
*punctor**	0.1	0.7	0.2		0.9		0.3	
*riparius**	0.4	0.9	<		2.2	1.7	0.7	
*spencerii**	<						<	
sticticus	2.8	0.7	1.1	0.7	0.6	0.8	1.2	
*stimulans**	4.9	7.6	4.2	5.6	14.5	7.1	6.7	
*provocans**	1.4	1.0	0.3	<	0.6	0.9	0.7	
triseriatus[1]	0.1	<	<			0.2	<	3.1
trivittatus	4.1	3.7	7.5	10.3	3.2	1.5	5.4	0.5
vexans	69.6	48.1	62.6	50.7	45.1	44.6	55.7	12.1
Ae. species	28.8	22.9	21.3	11.8	19.1	24.3	21.9	4.0
Anopheles earlei								
punctipennis	0.6	0.9	0.2	0.5	<	0.2	0.5	1.0
quadrimaculatus	1.6	0.5	<	0.8	0.3	0.5	0.6	0.2
walkeri			<				<	
An. species	4.4	4.6	1.0	2.5	1.4	1.40	2.7	4.1
Culex erraticus								
pipiens	3.1	1.8	0.7	1.6	2.2	3.1	1.9	44.5
restuans	7.8	12.2	9.5	13.2	12.4	8.6	10.6	66.8
salinarius	0.1	<		<	<	0.2	<	0.3
tarsalis	1.7	1.1	1.3	2.8	1.6	1.4	1.5	2.4
territans	16.2	18.7	7.3	23.0	5.8	8.0	13.4	14.4
Cx. species	4.1	3.5	3.0	5.0	3.7	2.0	3.6	42.7
Culiseta inornata	2.8	16.6	19.5	10.6	14.1	11.1	13.4	4.7
melanura								
minnesotae	0.3	1.8	0.1	0.5	0.5	0.2	0.7	
morsitans		0.2				0.2	<	
Cs. species	0.9	4.1	0.5	0.5		0.6	1.4	0.2
Ps. columbiae								
ferox	0.1	0.2	0.3	0.6	<		0.2	<
horrida								
Ps. species	0.3	<	0.5	<		0.2	0.2	
Ur .sapphirina	6.5	3.0	1.4	6.0	0.7	1.8	3.3	0.7

< = percent of total is less than 0.1%

*denotes spring *Aedes* species

[1] Species not normally found in wetlands. Natural habitat is tree holes, tires, containers.

Spring *Aedes* are usually in the top five but their occurrence was reduced by the late arrival of spring. The disease vector, *Culex tarsalis,* occurred in only 1.5% of samples, ranking 11th.

A few mosquitoes can be identified to species in the first instar stage, but most cannot. The high amount of "*Aedes* species" and "*Culex* species" is normal and represents first instar larvae that are not identifiable to species.

Culex pipiens and *Cx. restuans* are the dominant species developing in catch basins and other stormwater structures. *Culex restuans* was found in 66.8% of the structure samples and *Cx. pipiens* in 44.5% (Table 1.1). We do collect a small amount of *Aedes* (24.4%) in stormwater structures, even though it is not their preferred habitat. A detailed discussion of larval *Culex* surveillance in structures can be found in Chapter 2: Vector-borne Disease.

The most exciting event in the Entomology Lab this season was identifying larval specimens of *Aedes albopictus,* a rare invasive species that is unable to overwinter in the District. The larvae were collected on September 27 in Burnsville, but the sample was not identified until two weeks later. Subsequent sampling of the area was negative for any additional *Ae. albopictus*.

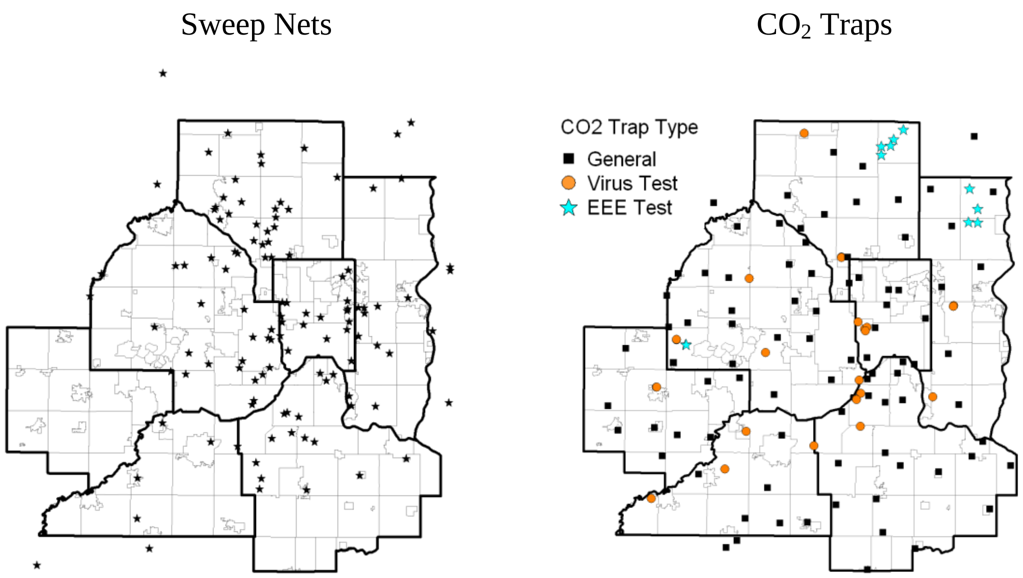
Adult Mosquito Collections

As stated earlier, the District employs a variety of surveillance strategies to target different behaviors of adult mosquitoes. Sweep nets are used to survey the mosquitoes attracted to a human host. We use carbon dioxide-baited (CO_2) traps with small lights to monitor host-seeking, phototactic species. New Jersey (NJ) light traps monitor only phototactic mosquitoes. Large hand-held aspirators are used to capture mosquitoes resting in the understory of wooded areas in the daytime. Gravid traps with liquid bait are used to attract and capture egg-laying *Culex* and *Aedes* species and ovitraps are used to collect eggs of container-inhabiting vector species (i.e., *Ae. triseriatus, Ae. japonicus, Ae. albopictus*). The information obtained from sampling is used to direct control activities and to monitor vector populations and disease activity (i.e., specimens collected are tested for disease). Treatment thresholds are discussed in Chapter 3: Mosquito Control.

Monday Night Network The sweep net and CO_2 trap data reported here are weekly collections referred to as the Monday night network. Employees took 2-minute sweep net collections and/or set overnight CO_2 traps in their yards every Monday night from May - September. To achieve a District-wide distribution of CO_2 traps, other locations such as parks or wood lots are chosen for surveillance as well. Figure 1.5 shows the sweep net and CO_2 trap locations and their uses (i.e., general monitoring, virus testing, eastern equine encephalitis (EEE) vector monitoring). CO_2 traps were operated once weekly for 20 weeks, starting the same week as the sweeps and continuing three weeks later.

Most of the mosquitoes collected are identified to species, but in some cases, species are grouped together to expedite sample processing. *Aedes* mosquitoes are grouped by their seasonal occurrence (spring, summer). Others are grouped because species-level separation is very difficult (e.g., *Ae. abserratus/punctor, Cx. pipiens/restuans*). Generally, the most abundant species captured in sweep nets and CO_2 traps are the summer *Aedes, Cq. perturbans,* and spring *Aedes*.

Culex tarsalis, unlike the other *Culex* species that prefer birds as hosts, is also attracted to mammals and is important in the transmission of West Nile virus (WNV) to humans.


Sweep Nets

CO_2 Traps

Figure 1.5 Locations of weekly sweep net and CO_2 traps locations used to monitor general mosquito populations and disease vectors (virus test and EEE test), 2013.

Sweep Net The District uses sweep net collections to monitor mosquito annoyance to humans during the peak mosquito activity period, which is 35-40 minutes after sunset for most mosquito species. The number of collectors varied from 60-91 per evening.

In 2013, staff took 1,379 collections containing 2,943 mosquitoes. The average number of summer *Aedes* collected in the evening sweep net collections was the highest of the past four years, and above the 10-year average (Table 1.2). Populations of *Cq. perturbans* were very low, well below the 10-yr average. The delayed hatch of spring *Aedes* due to cool spring temperatures, followed by sudden warm temperatures, resulted in low numbers of spring *Aedes* adults in 2013. *Culex tarsalis*, which are infrequently collected in sweep net samples, were below average levels as well.

Table 1.2 Average number of mosquitoes collected per evening sweep net collection within the District, 2009-2013 and 10-year average, 2003-2012 (±SE)

Year	Summer *Aedes*	*Cq. perturbans*	Spring *Aedes*	*Cx. tarsalis*
2009	0.20	0.20	0.15	0.003
2010	1.10	0.10	0.13	0.009
2011	1.54	0.38	0.23	0.007
2012	1.63	0.75	0.02	0.004
2013	1.87	0.12	0.03	0.005
10-yr Avg.	1.45 (±0.15)	0.32 (±0.02)	0.14 (±0.02)	0.007 (±0.0003)

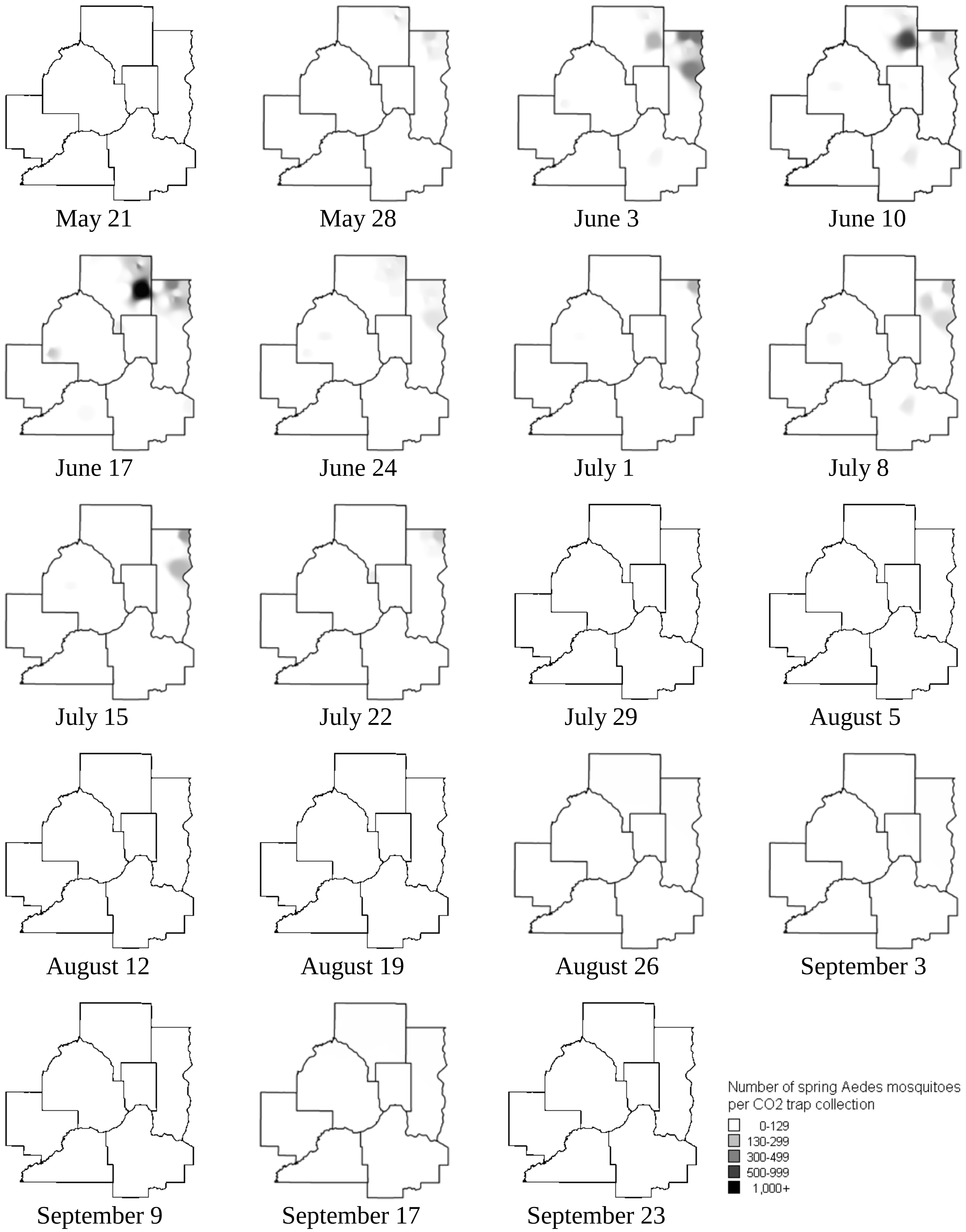
CO_2 Trap CO_2 traps baited with dry ice are used to monitor host-seeking mosquitoes and the presence of disease vector species. The standard placement for these traps is approximately 5 ft off the ground, the level where *Aedes* mosquitoes fly. In 2013, we placed 130 traps at 117 locations to allow maximum coverage of the District (Figure 1.5). The General trap type locations are used to monitor non-vector mosquitoes. Thirteen locations have the low traps paired with elevated traps placed in the tree canopy (~25 ft above ground) to collect *Culex* species, which are active where birds are resting. All *Culex* specimens collected from those locations and an additional 17 locations (5 ft elevation) are tested for WNV (Figure 1.5, Virus Test trap type); however, *Cx. tarsalis* from all locations are tested. Ten trap locations in the network, one also with an elevated trap, have historically captured *Cs. melanura*, and are used to monitor this vector's populations and to obtain specimens for EEE testing (Figure 1.5, EEE Test trap type).

A total of 2,105 trap collections taken contained 723,809 mosquitoes. The total number of traps operated per night varied from 101-109. Summer *Aedes* was the predominant species collected in CO_2 traps, the highest of the past four years and above the 10-year average (Table 1.3). *Coquillettidia perturbans* populations dropped to less than half the average. More spring *Aedes* were captured than last year but were below the 10-year average. *Culex tarsalis* numbers were slightly above the 10-year average and are discussed later in the vector surveillance section of this chapter.

Table 1.3 Average numbers of mosquitoes collected in CO_2 traps within the District, 2009-2013 and 10-year average, 2003-2012 (± 1 SE)

Year	Summer *Aedes*	*Cq. perturbans*	Spring *Aedes*	*Cx. tarsalis*
2009	28.4	30.4	7.2	0.8
2010	191.4	15.3	9.4	4.6
2011	181.0	110.0	5.1	1.4
2012	215.8	68.0	2.3	1.0
2013	303.6	22.5	5.7	2.4
10-yr Avg.	182.4 (±46.7)	54.4 (±10.5)	8.2 (±1.7)	2.1 (±0.5)

Geographic Distribution The weekly geographic distributions of the three major groups of nuisance mosquitoes (i.e., spring *Aedes*, summer *Aedes*, and *Cq. perturbans*) collected in CO_2 traps are displayed in Figures 1.6, 1.7, and 1.8. The computer software extrapolates the data between collection points, so some dark areas are the result of one collection without another close by. What little populations of spring *Aedes* we had were confined to a few locations on the outer edges of the District or in localized areas (Figure 1.6). The trap collections of summer *Aedes* remained above threshold throughout the District in June and July, with some locally high populations in the first part of August, and remained at low levels the remainder of the season (Figure 1.7). *Coquillettidia perturbans* populations occurred in their usual hot spots in the northern counties and near the District borders of Carver, Scott, and SW Hennepin counties (Figure 1.8).



May 21 May 28 June 3 June 10

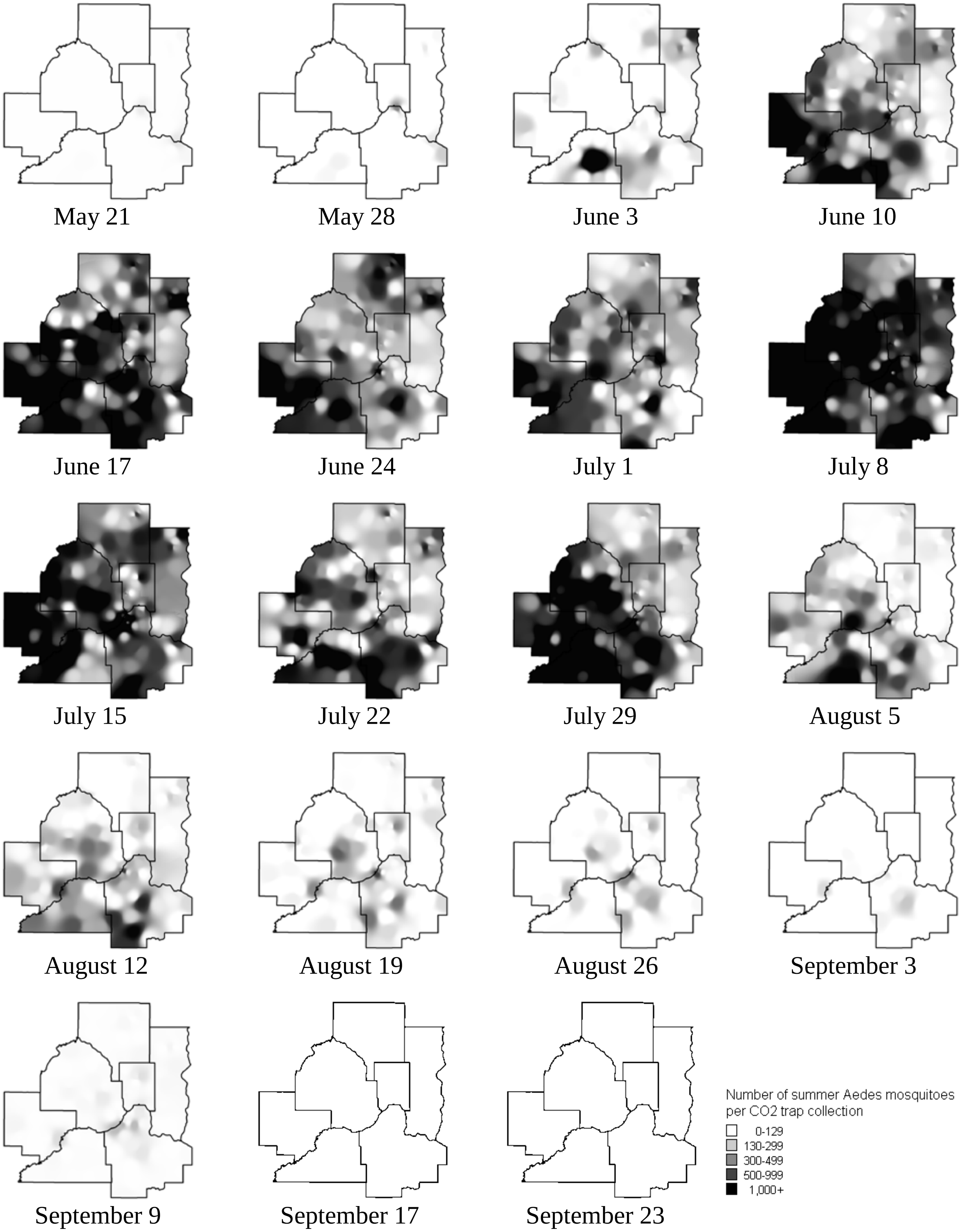
June 17 June 24 July 1 July 8

July 15 July 22 July 29 August 5

August 12 August 19 August 26 September 3

September 9 September 17 September 23

Figure 1.6 Number of spring *Aedes* in District low (5 ft) CO_2 trap collections, 2013. The number of traps operated per night varied from 101-109. Inverse distance weighting was the algorithm used for shading of maps. Treatment threshold is >130 mosquitoes/trap night



May 21 May 28 June 3 June 10

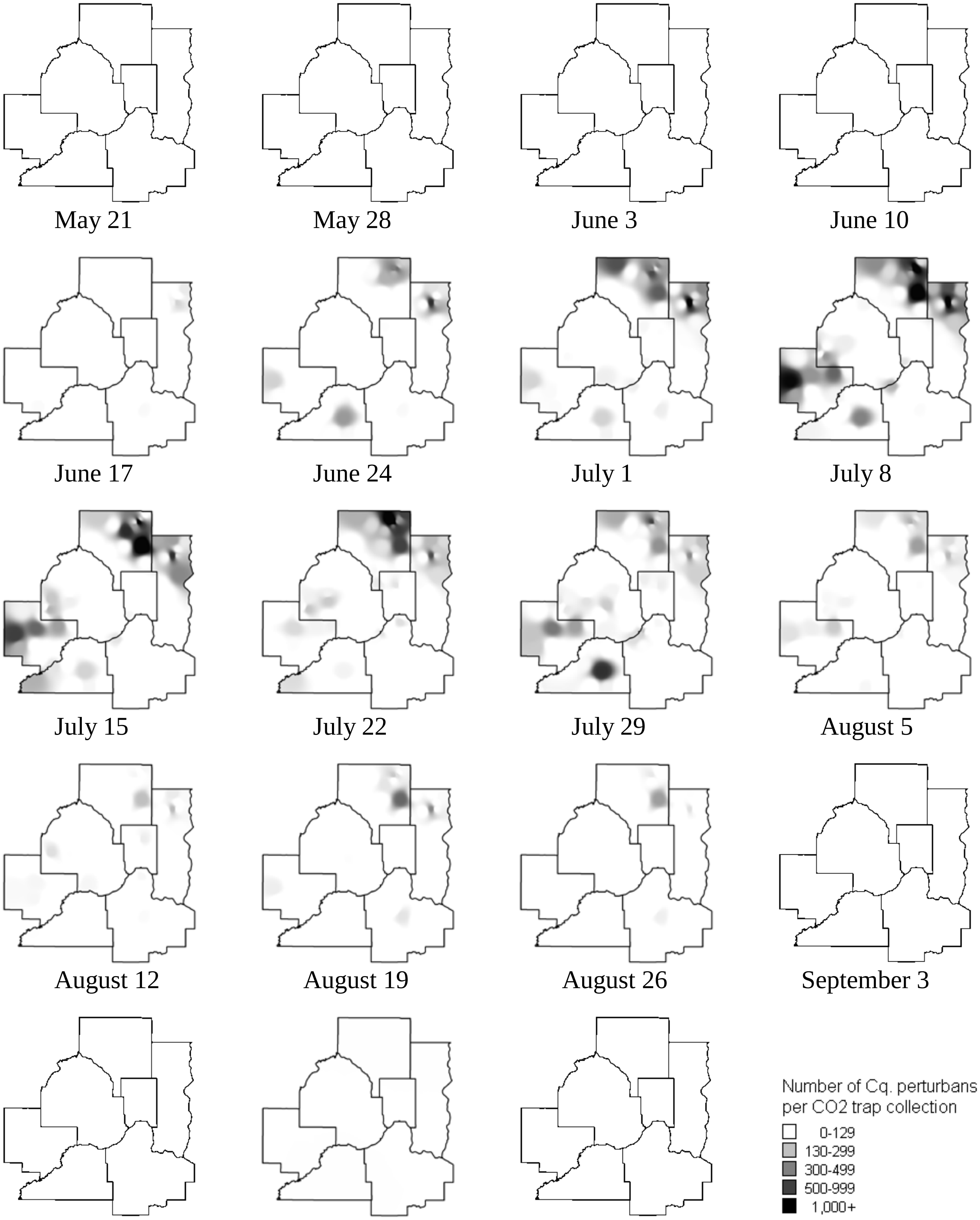
June 17 June 24 July 1 July 8

July 15 July 22 July 29 August 5

August 12 August 19 August 26 September 3

September 9 September 17 September 23

Figure 1.7 Number of summer *Aedes* in District low (5 ft) CO_2 trap collections, 2013. The number of traps operated per night varied from 101-109. Inverse distance weighting was the algorithm used for shading of maps. Treatment threshold is >130 mosquitoes/trap night



May 21 May 28 June 3 June 10

June 17 June 24 July 1 July 8

July 15 July 22 July 29 August 5

August 12 August 19 August 26 September 3

September 9 September 17 September 23

Figure 1.8 Number of *Cq. perturbans* in District low (5 ft) CO_2 trap collections, 2013. The number of traps operated per night varied from 101-109. Inverse distance weighting was the algorithm used for shading of maps. Treatment threshold is >130 mosquitoes/trap night.

Seasonal Distribution As described earlier, spring *Aedes,* summer *Aedes,* and *Cq. perturbans* have different patterns of occurrence during the season based on their phenology and the surveillance method used. Additionally, temperatures can affect mosquito flight activity. The first night of sampling was the only one this season when the temperature was below the 55 °F minimum for mosquito activity (Fig. 1.9). Very warm nights in the 70°s and 80°s extended from July into mid-September.

Figure 1.9 Temperature at 9:00 P.M. on Monday night surveillance dates.

Figure 1.10 shows the seasonal distribution of the three major groups of mosquitoes from mid-May through early September, detected by sweep netting and CO_2 traps. The peak of spring *Aedes* activity was detected on July 1 in the sweeps and June 17 in CO_2 traps, later than usual due to the delayed emergence. The long-lived spring *Aedes* were present until early August.

Summer *Aedes* populations detected in CO_2 traps fluctuated up and down on the way to their peak on July 8, which coincided with peak collections of *Cq. perturbans* (Figure 1.10). The peak of summer *Aedes* in sweep collections was also July 8, but the peak for *Cq. perturbans* in sweep nets occurred one week earlier (July 1) than the CO_2 traps. Mosquito presence greatly diminished by the end of August and remained low for the rest of the season. The end date for the sweep net collections is earlier than the CO_2 traps (September 9 for sweeps and September 30) due to the availability of seasonal staff to perform the sweep collections.

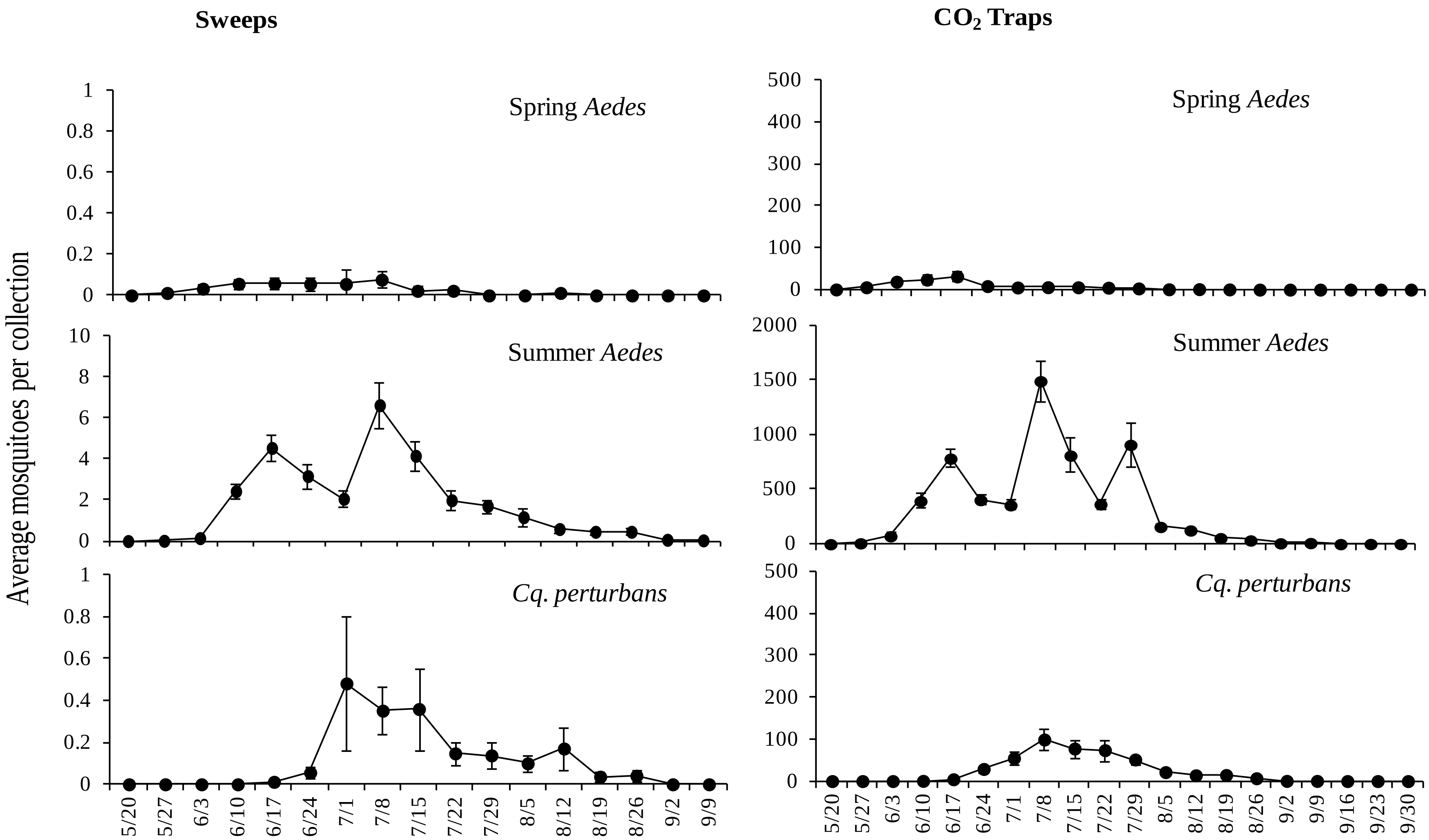


Fig. 1.10 Average number of spring *Aedes*, summer *Aedes, a*nd *Cq. perturbans* per sweep net and CO$_2$ trap, 2013. Bars equal $\underline{+}$ 1 standard error of the mean.

New Jersey (NJ) Traps For many years, mosquito control districts used the NJ light trap as their standard surveillance tool. The trap uses a 25-watt light bulb to attract mosquitoes and many other insects as well, making the samples messy and time-consuming to process. The number of traps used by the District has varied over the years; in the early 1980s, the District operated 29 traps. After a western equine encephalitis (WEE) outbreak in 1983, the District reduced the number to seven to alleviate the regular workload due to the shift toward disease vector processing.

The number of locations and traps has fluctuated since then. The District currently operates seven NJ light traps at the following locations: trap 1 in St. Paul, trap 9 in Lake Elmo, trap 13 in Jordan, trap 16 in Lino Lakes, trap CA1 in the Carlos Avery State Wildlife Management Area, trap AV at the Minnesota Zoo in Apple Valley, and trap MN in Minnetrista (Figure 1.11). Trapping occurs nightly for 20 weeks from May through September and staff identify all adult female mosquitoes to species. Traps 1, 9, 13, and 16 have operated each year since 1965. A comparison of the major species collected from 1965-2013 from those four traps is shown in Appendix B.

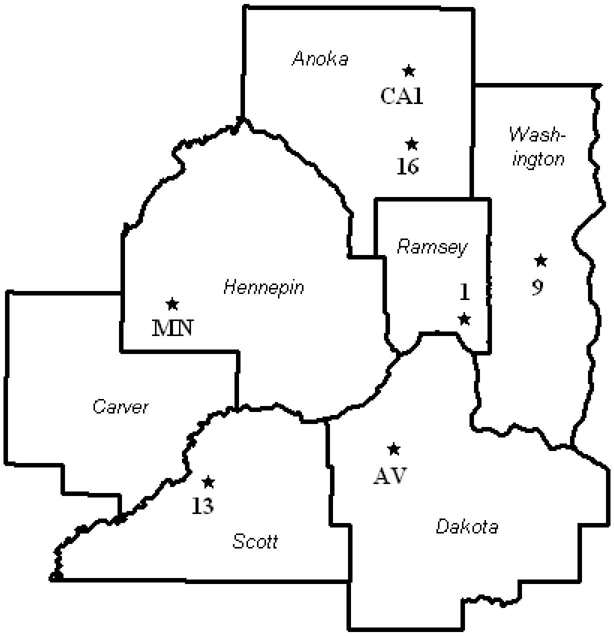


Figure 1.11 NJ light trap locations, 2013

The most numerous species collected in NJ traps was *Ae. vexans*, whose total was 79% of all female mosquitoes captured (Table 1.4). The Minnetrista trap contributed 69% and the Carlos Avery trap comprised 20% of all *Ae. vexans* captured. *Coquillettidia perturbans* ranked second and comprised 12% of the females captured. The Carlos Avery trap, placed within many acres of untreatable cattail habitat, contributed 86% of the overall *Cq. perturbans* collected. The spring *Aedes* species combination of *Ae. absserratus* and *Ae. punctor* (*Ae. abs/punct*) barely made third place over the combination of *Cx. pipiens* and *Cx. restuans*, which has never ranked higher than fifth place. *Anopheles quadrimaculatus* were numerous again this season but slipped from third to fifth place.

The first collection of *Ae. japonicus* in a NJ light trap was in 2009 (Minnetrista). Since then, *Ae. japonicus* has increased in frequency of occurrence and has been found in six of seven NJ traps, most frequently in the Minnetrista trap. In 2013, *Ae. japonicus* was collected in four NJ trap locations: St. Paul, Lake Elmo, Lino Lakes, and Minnetrista (Table 1.4)

Table 1.4 Total number and frequency of occurrence for each species collected in New Jersey light traps, May 11-September 27, 2013

	Trap Code, Location, and Number of Collections							Summary Statistics		
	1	9	13	16	CA1	AV	MN	Season		
	St. Paul	Lk. Elmo	Jordan	Lino Lakes	Carlos	Apple Valley	Minnetrista	Total	Female	Avg per
Species	135	126	140	140	140	131	136	948	Total	Night
Ae. abserratus	0	0	0	28	289	0	7	324	0.18%	0.34
aurifer	0	0	0	0	9	0	0	9	0.01%	0.01
canadensis	0	1	0	2	9	0	1	13	0.01%	0.01
cinereus	5	10	3	247	268	5	333	871	0.49%	0.92
dorsalis	0	0	0	0	0	0	0	0	0.00%	0.00
excrucians	0	3	0	4	51	0	9	67	0.04%	0.07
fitchii	0	0	0	0	0	0	0	0	0.00%	0.00
flavescens	0	0	0	0	0	0	0	0	0.00%	0.00
implicatus	0	0	0	0	0	0	0	0	0.00%	0.00
japonicus	3	3	0	1	0	0	21	28	0.02%	0.03
nigromaculus	0	0	0	0	0	0	0	0	0.00%	0.00
punctor	0	0	0	0	45	0	3	48	0.03%	0.05
riparius	0	1	0	0	6	0	11	18	0.01%	0.02
spencerii	0	0	0	0	0	0	0	0	0.00%	0.00
sticticus	4	18	28	32	179	1	19	281	0.16%	0.30
stimulans	0	3	0	1	2	0	8	14	0.01%	0.01
provocans	1	0	0	0	2	0	0	3	0.00%	0.00
triseriatus	8	18	0	4	2	0	187	219	0.12%	0.23
trivittatus	15	310	101	11	7	39	231	714	0.40%	0.75
vexans	2,157	5,619	1,630	5,176	28,495	1,267	96,622	140,966	79.48%	148.70
abserratus/punctor	2	1	0	142	1,227	0	21	1,393	0.79%	1.47
Aedes species	118	13	16	50	199	34	2,752	3,182	1.79%	3.36
Spring *Aedes*	1	0	1	10	48	0	33	93	0.05%	0.10
Summer *Aedes*	0	2	2	1	23	6	18	52	0.03%	0.05
An. barberi	0	0	0	0	0	0	2	2	0.00%	0.00
earlei	0	0	0	0	0	0	0	0	0.00%	0.00
punctipennis	15	37	2	2	89	4	354	503	0.28%	0.53
quadrimaculatus	104	451	30	55	390	18	594	1,642	0.93%	1.73
walkeri	0	4	2	9	260	0	38	313	0.18%	0.33
An. species	6	11	0	2	57	0	20	96	0.05%	0.10
Cx. erraticus	0	0	0	0	0	0	0	0	0.00%	0.00
pipiens	0	0	0	0	8	0	0	8	0.00%	0.01
restuans	62	115	7	47	64	13	222	530	0.30%	0.56
salinarius	1	3	1	0	2	0	57	64	0.04%	0.07
tarsalis	23	12	11	21	14	7	85	173	0.10%	0.18
territans	14	73	4	16	27	13	403	550	0.31%	0.58
Cx. species	26	17	1	9	5	4	144	206	0.12%	0.22
Cx. pipiens/restuans	197	199	7	57	129	37	604	1,230	0.69%	1.30
Cs. inornata	29	16	0	4	14	8	215	286	0.16%	0.30
melanura	0	0	0	0	2	0	0	2	0.00%	0.00
minnesotae	14	12	2	41	237	1	72	379	0.21%	0.40
morsitans	13	27	0	2	66	3	64	175	0.10%	0.18
Cs. species	5	0	0	8	11	2	7	33	0.02%	0.03
Cq. perturbans	48	253	8	667	18,379	9	1,910	21,274	12.00%	22.44
Or. signifera	0	0	0	0	0	0	3	3	0.00%	0.00
Ps. ferox	0	1	0	0	0	0	0	1	0.00%	0.00
horrida	0	0	0	0	0	0	0	0	0.00%	0.00
Ps. species	0	0	0	0	0	0	0	0	0.00%	0.00
Ur. sapphirina	60	235	5	16	48	38	596	998	0.56%	1.05
Unidentifiable	24	6	3	19	75	2	459	588	0.33%	0.62
Female Total	2,955	7,474	1,864	6,684	50,738	1,511	106,125	177,351	100.00%	187.08
Male Total	1,122	3,535	325	12,027	2,910	633	32,480	53,032		
Grand Total	4,077	11,009	2,189	18,711	53,648	2,144	138,605	230,383		

Rare Detections *Culex erraticus*, considered rare in the District, was first detected by NJ traps in 1988. This species occurred sporadically since then in low numbers and in recent years has been collected in CO_2 traps more frequently (Fig. 1.12). In 2012, we were surprised to collect them in extremely high numbers throughout the District. In 2013, we were just as surprised to collect them in such low numbers. Their name is truly descriptive of their occurrence. The reason for the 2012 peak remains a mystery. *Culex erraticus* is common in southern United States, with the District at the northern edge of its range. The unusually warm spring and summer in 2012 may have resulted in favorable conditions conducive to their large population expansion. Because *Cx. erraticus* is usually extremely rare, it has not been targeted for control. It is, however, a competent vector of eastern equine encephalitis and a suspected maintenance vector of West Nile virus, so it is still worthy of our attention.

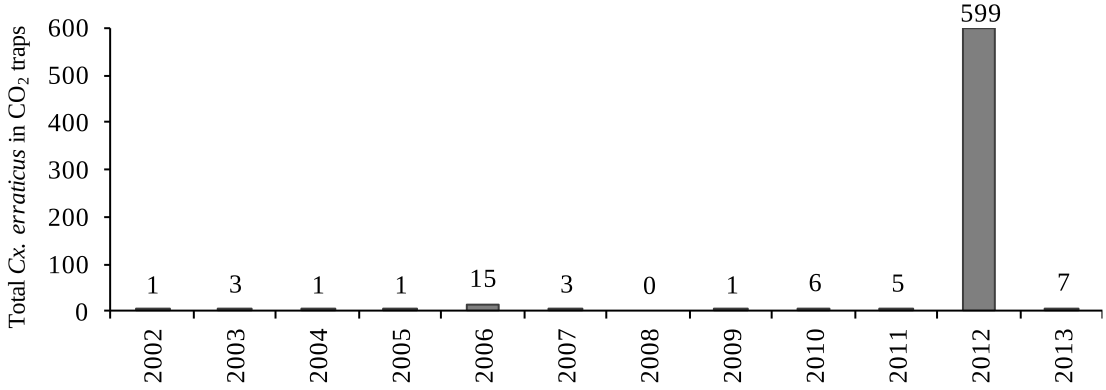


Fig. 1.12 Yearly total of *Culex erraticus* in CO_2 traps, 2002-2013.

Anopheles quadrimaculatus is notable because it is a WNV maintenance vector and capable of transmitting dog heartworm and malaria. Historically, it is rare in the District, but in recent years, it has occurred in traps throughout the District more frequently than in the past (Fig. 1.13). Since 2002, *An. quadrimaculatus* has appeared with increasing frequency, reaching the highest amount ever in 2012, then down slightly in 2013. They are known to bite humans, but are not directly targeted for larval control or included in the adult threshold. In each of the last four years, adults were collected in 5% of the sweep collections. If they were included in the adult threshold, only 0.08% more samples would have reached threshold.

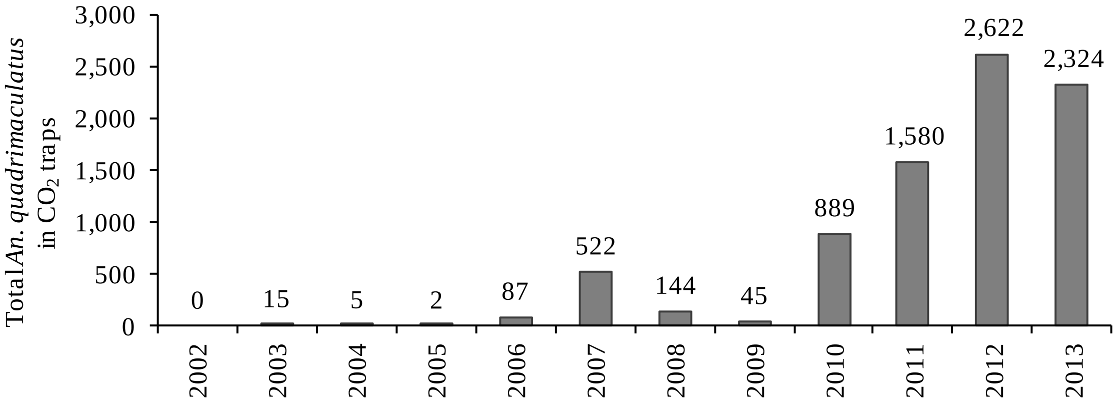


Fig. 1.13 Yearly total *Anopheles quadrimaculatus* in CO_2 traps, 2002-2013.

Targeted Vector Mosquito Surveillance

Aedes triseriatus Staff use a mechanical aspirator (pictured at left) to sample the understory for resting mosquitoes in the daytime. This method is used primarily for *Ae. triseriatus,* the La Crosse encephalitis (LAC) vector, which can be difficult to capture by other methods. Sampling began during the week of May 27 and continued through the first week of October.

Cool spring temperatures delayed the emergence of the season's first *Ae. triseriatus* generation by approximately two weeks (Figure 1.14). The peak rate of capture of 3.9 *Ae. triseriatus* per sample occurred during the week of July 8, also about two weeks later than is typical. This was the highest weekly rate of capture in the District since June 1999, although the yearly mean was similar to last year. The adult *Ae. triseriatus* population appeared to crash during the week of July 15, the warmest week of the month with high temperatures in the upper 80°Fs to mid 90°Fs. Similar observations have been made during warm periods in the District many times in the past. Because of frequent rain in June and July, the *Ae. triseriatus* population recovered quickly with the emergence of a new generation. Our surveillance indicated that the population remained near normal from late July until the end of the season.

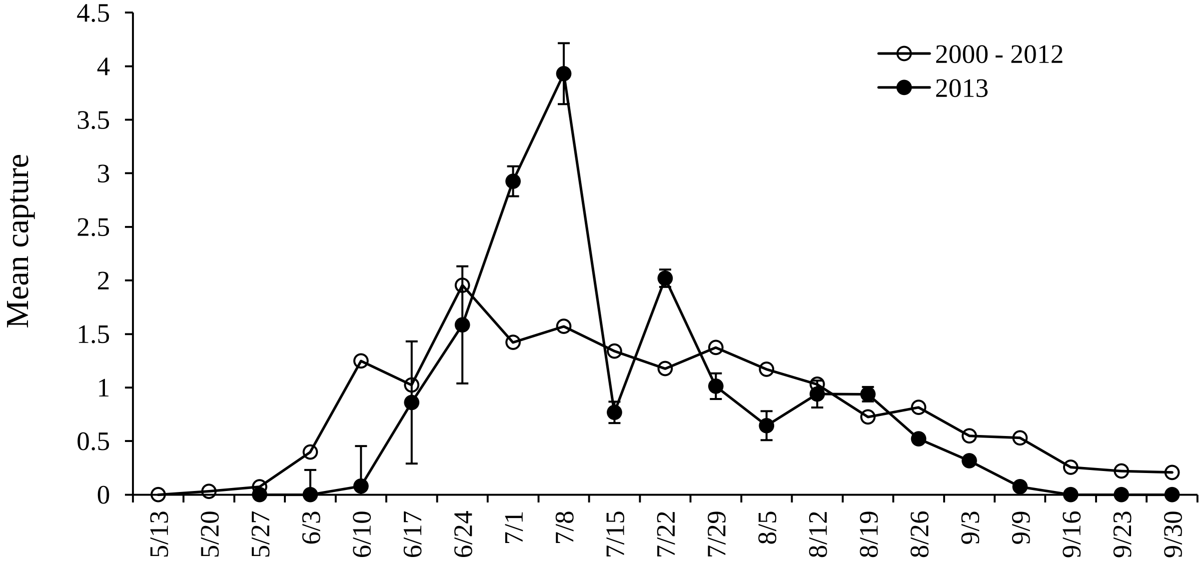


Figure 1.14 Mean number of *Ae. triseriatus* adults in aspirator samples plotted by week in 2013 compared to mean captures for the corresponding weeks of 2000-2012. Dates listed are Monday of each week. Error bars equal ± 1 standard error of the mean.

Culiseta melanura *Culiseta melanura*, the enzootic vector of eastern equine encephalitis (EEE), feeds primarily on birds. Locally, the most common larval habitat is spruce-tamarack bog or other acidic habitat. Larvae can occur in caverns in sphagnum moss supported by tree-roots. Overwintering is in the larval stage with adults emerging in late spring. There are multiple generations per year, and the late summer cohort supplies the next year's first generation. Most adults disperse a short distance from their larval habitat, although a few may fly in excess of five miles from their larval habitat.

District staff monitored adult *Cs. melanura* at 10 locations using 11 CO_2 traps. Five sites are in Anoka County, four sites are in Washington County, and one site is in Hennepin County. *Culiseta melanura* have been collected from each location in the past. Two traps are placed at the Hennepin County location – one at ground level and one elevated 20 ft into the tree canopy, where many bird species roost at night.

The first *Cs. melanura* adults were collected in a CO_2 trap on June 3 (Figure 1.15). The population remained low throughout the season with a maximum capture of 1.18 per trap on August 5.

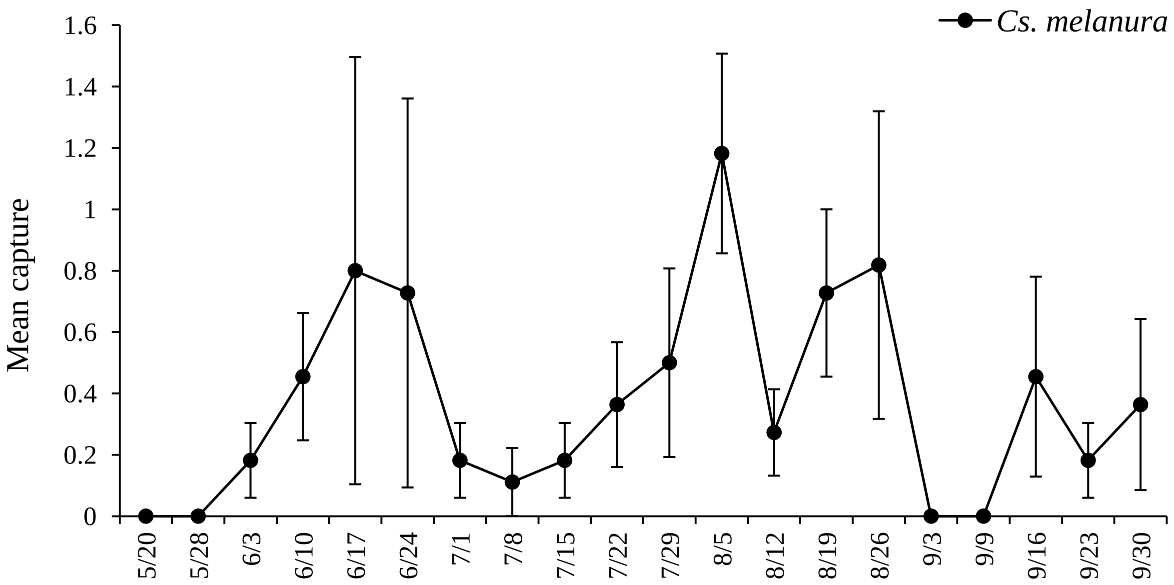


Figure 1.15 Mean number of *Cs. melanura* adults in CO_2 traps from selected sites, 2013. Dates listed are the Monday of each sampling week. Error bars equal ± 1 standard error of the mean.

District staff collected 320 *Cs. melanura* in 431 aspirator collections in wooded areas near bog habitats. As with the CO_2 traps, aspirator surveillance detected the emergence of the first *Cs. melanura* generation in June, declining numbers during the first half of July, and the emergence of a second generation in late July (Figure 1.16). Aspirator captures fluctuated for the remainder of the season with a peak rate of capture during the week of August 26 at 2.7 per sample.

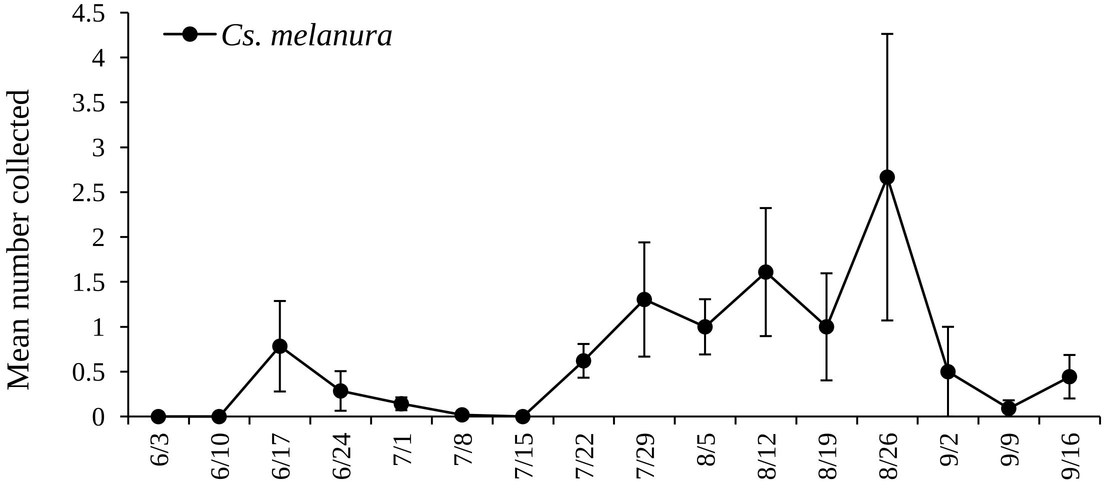


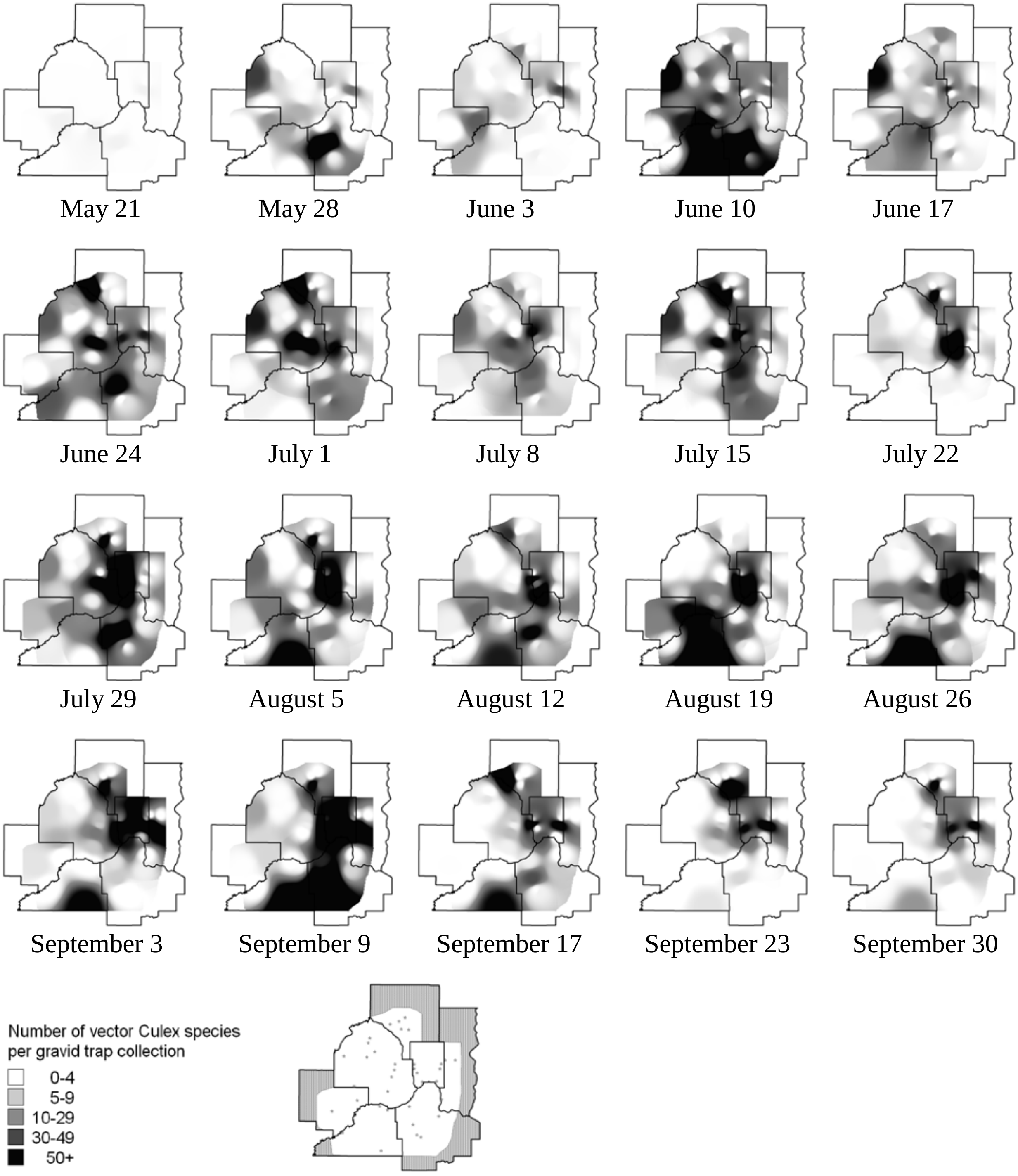
Figure 1.16 Mean aspirator collections of *Cs. melanura*, 2013. Error bars equal ± 1 standard error of the mean.

Culiseta melanura develop in a narrow range of aquatic habitats in the District, and larvae are difficult to collect. In May and June of 2013, 54 sites were inspected for *Cs. melanura*. Larval samples were collected from 23 sites; only one sample contained *Cs. melanura*.

***Culex* Species** *Culex* species are important for the amplification and transmission of WNV and WEE virus in our area. The District uses CO_2 traps to monitor host-seeking *Culex* mosquitoes and gravid traps to monitor egg-laying *Culex* mosquitoes. Many *Culex* specimens collected in the network were tested for WNV. Concentrations of *Culex* in the District as detected through gravid trap monitoring are displayed in Figure 1.17.

Culex tarsalis is the most likely WNV vector to humans in our area. *Culex tarsalis* specimens from Monday night CO_2 traps were tested for WNV in 2013 (see Chapter 2, Table 2.3). Capture rates for *Cx. tarsalis* in CO_2 traps fluctuated during the first half of the 2013 season with June and July weekly means ranging from 2.0 to 10.3 (Figure 1.18). The peak capture rate of 14.4 occurred late in the season on August 20. That week was the warmest of the season with a weekly mean of 83.9 °F at the Minneapolis/St. Paul International Airport. Few *Cx. tarsalis* were collected by gravid trap, as is typical since the bait used is not ideally attractive to the species.

Culex restuans is another important vector of WNV in Minnesota. The species is largely responsible for the early season amplification of the virus and likely for season-long maintenance of the WNV cycle. Moderate numbers of *Cx. restuans* were collected in CO_2 traps in 2013 (Figure 1.19). The CO_2 trap capture peaked at 4.4 per trap on June 24 — a month later and more than five times higher than the 2012 season peak. Gravid trap collections of *Cx. restuans* in 2013 peaked during the week of June 10 at 15.4 per trap, three times higher than the 2012 peak.



May 21 May 28 June 3 June 10 June 17

June 24 July 1 July 8 July 15 July 22

July 29 August 5 August 12 August 19 August 26

September 3 September 9 September 17 September 23 September 30

Gravid Trap Locations

Figure 1.17 Number of vector *Culex* species in District gravid trap collections, 2013. The number of traps operated per week varied from 31-36. Inverse distance weighting was the algorithm used for shading of maps within an area of the District near the traps. A map of the gravid trap locations showing the area of District used to generate the weekly maps is also included.

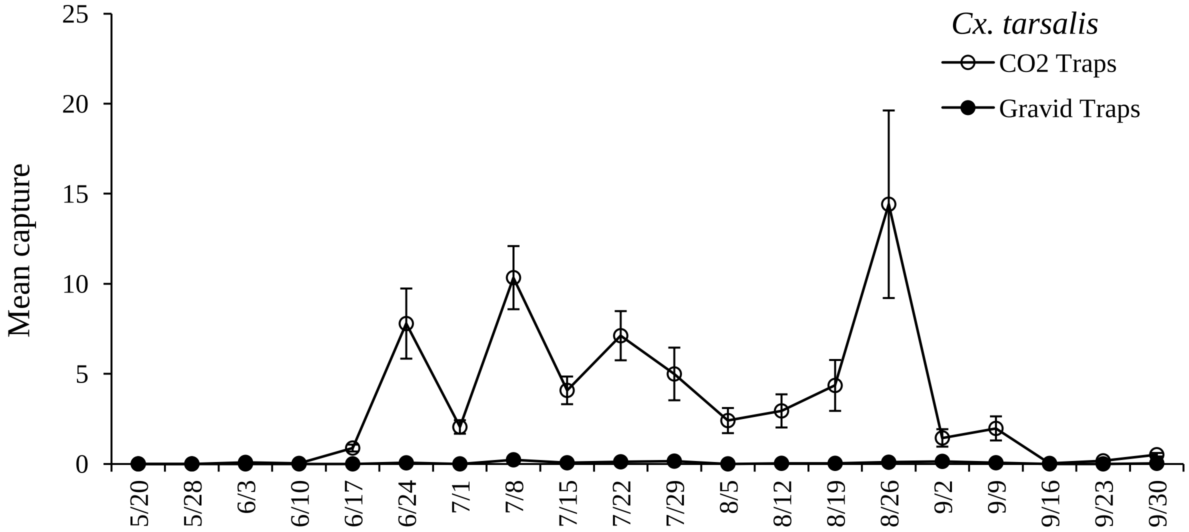


Figure 1.18 Average number of *Cx. tarsalis* in CO_2 traps and gravid traps, 2013. Dates are the Monday of each sampling week. Error bars equal ± 1 standard error of the mean.

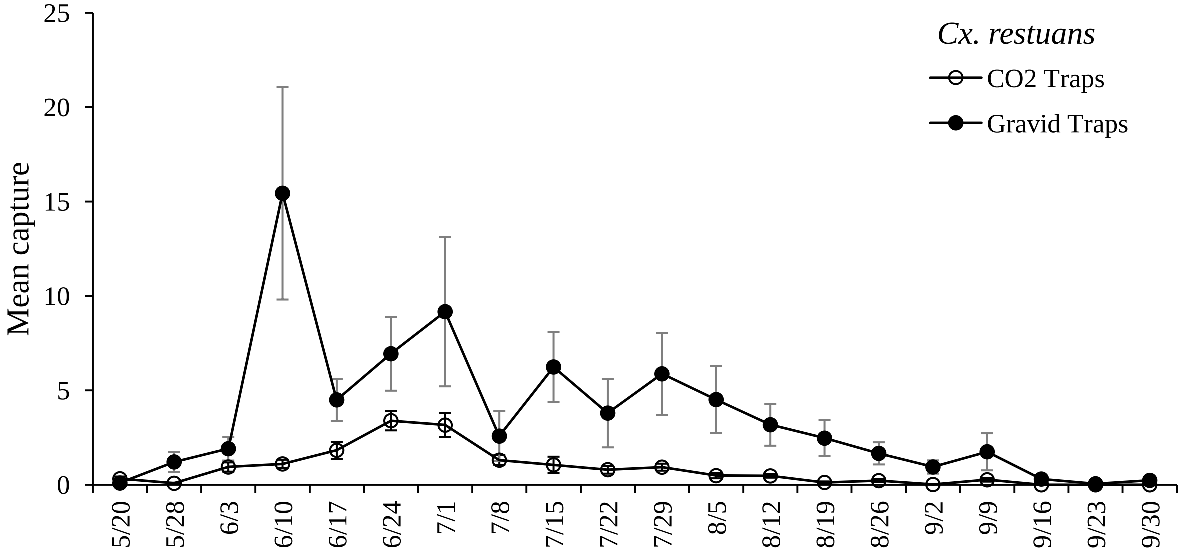


Figure 1.19 Average number of *Cx. restuans* in CO_2 traps and gravid traps, 2013. Dates are the Monday of each sampling week. Error bars equal ± 1 standard error of the mean.

Culex pipiens has been an important vector of WNV in much of the United States. The species prefers warmer temperatures than *Cx. restuans*; therefore, populations of *Cx. pipiens* in the District tend to remain low and peak late in the summer when temperatures are typically warmer. Both gravid traps and CO_2 traps collected similar numbers of *Cx. pipiens* in 2013 with few specimens obtained until late July (Figure 1.20). From then on, both surveillance methods consistently returned low numbers of the species.

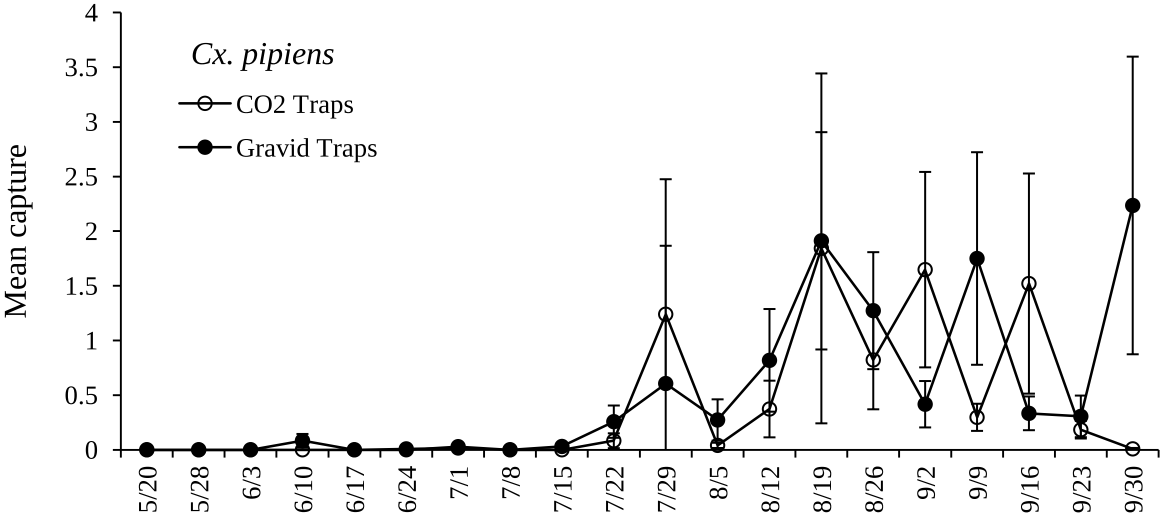


Figure 1.20 Average number of *Cx. pipiens* in CO_2 traps and gravid traps, 2013. Dates are the Monday of each sampling week. Error bars equal ± 1 standard error of the mean.

When *Cx. pipiens* and *Cx. restuans* are difficult to distinguish from each other, they are grouped together and identified as *Cx. pipiens/restuans*; when only a genus level identification can be made, they are classified as *Culex* species. Both groups usually consisted largely of *Cx. restuans* during the early and middle portions of the season with *Cx. pipiens* contributing more to the collections during the middle and later portions of the season. The late season collections of *Cx. pipiens/restuans* (Figure 1.21) captured in gravid traps and CO_2 traps and *Culex* species (Figure 1.22) captured in gravid traps when compared to the *Cx. pipiens* collections (Figure 1.20 and the *Cx. restuans* collections (Figure 1.19) suggest that *Cx. pipiens* comprised a large proportion of both groups in 2013.

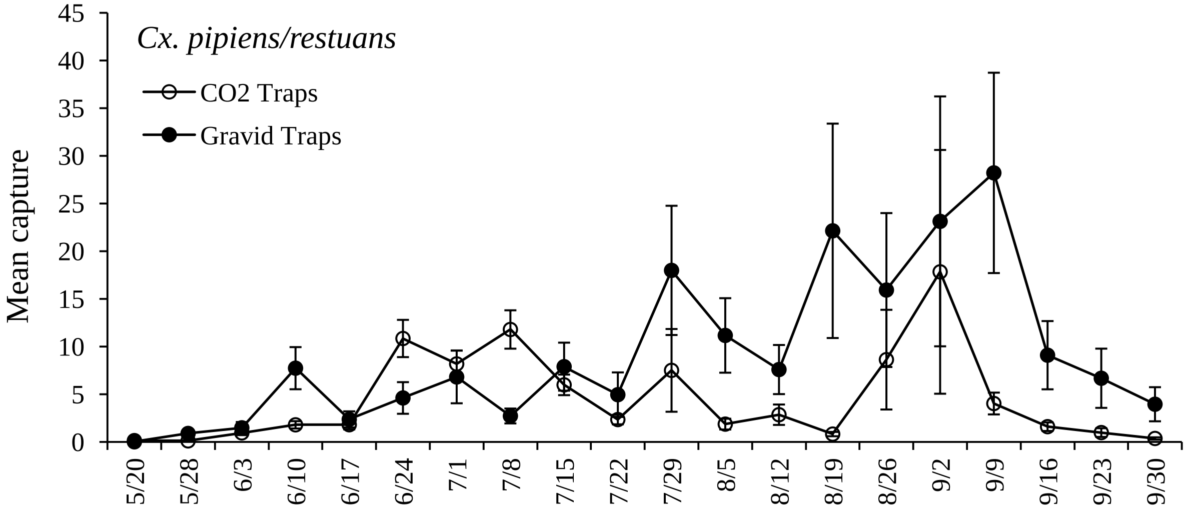


Figure 1.21 Average number of *Cx. pipiens/restuans* in CO_2 traps and gravid traps, 2013. Dates are the Monday of each sampling week. Error bars equal ± 1 standard error of the mean.

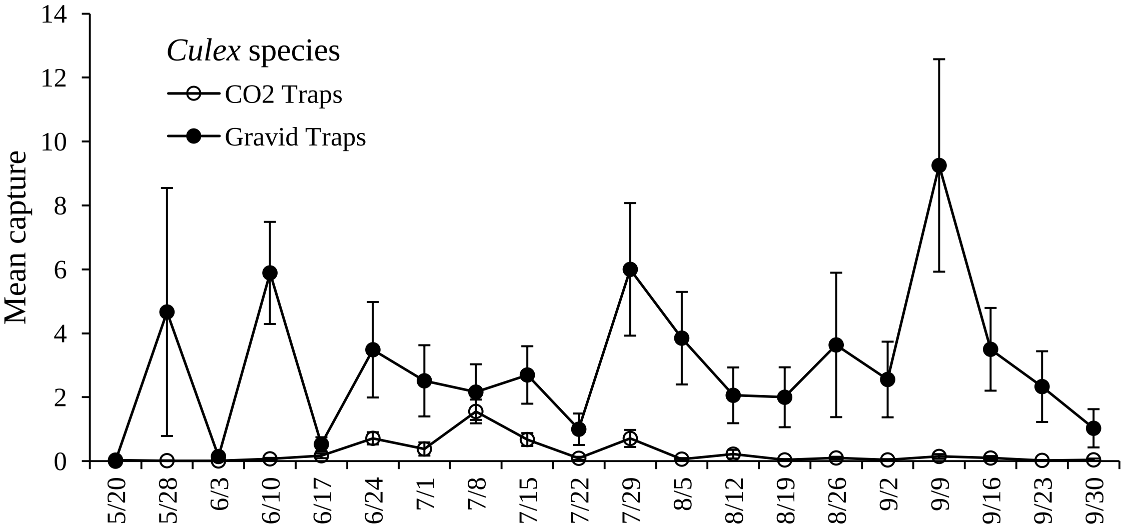


Figure 1.22 Average number of *Culex* species in CO_2 traps and gravid traps, 2013. Dates are the Monday of each sampling week. Error bars equal ± 1 standard error of the mean

Exotic Species Each season, MMCD conducts surveillance for exotic or introduced mosquito species. There are also opportunities to collect unexpected species through a variety of surveillance techniques used to monitor local mosquito species. MMCD laboratory technicians are trained to recognize exotic species in their adult and larval forms so that the mosquitoes can be spotted in any of the tens of thousands of samples processed each year.

The two exotic species most likely to be found here are *Ae. albopictus* and *Ae. japonicus*. Both are native to Asia and use tree holes or rock pools as oviposition sites and larval habitat, but both have adapted to use artificial habitats such as tires and other containers as well. These adaptations allow for easy transportation over great distances. *Aedes albopictus*, first introduced in the United States in 1985, are established in many states south and east of Minnesota and are occasionally introduced to the District in shipments of used tires or by transport of other water-holding containers. *Aedes japonicus* were first collected in the eastern United States in 1998, and were first found in the District in 2007. They are now commonly collected throughout the District.

Aedes albopictus *Aedes albopictus* were found in one Burnsville larval sample in 2013. The sample was collected from a container found in a wooded area on September 27. Property inspections in the area of the original sample during the weeks of October 6 and October 13 did not result in additional collections of *Ae. albopictus*. During those two weeks, 12 larval samples were collected from 42 identified habitats.

This was the tenth year since 1991 when *Ae. albopictus* were collected by MMCD staff. *Aedes albopictus* have been found in four Minnesota counties: Carver, Dakota, Scott, and Wright. The species has not successfully overwintered at any of the Minnesota locations where previously discovered.

Aedes japonicus Since their arrival in the District in 2007, *Ae. japonicus* have spread throughout the District and they are commonly found in areas with adequate habitat. The species is routinely collected through a variety of sampling methods. Our preferred surveillance methods when targeting *Ae. japonicus* are container/tire/tree hole sampling for larvae, and aspirator sampling of wooded areas for adults.

Aedes japonicus larvae were found in 635 samples. Most were from containers (456) and tires (124). Larvae were found in other habitats as well, including: artificial or ornamental ponds (25), stormwater structures (9), catch basins (4), wetlands (3), stagnant stream (1), tree hole (1), swimming pool (1), and 11 from unspecified habitats. For the first time since *Ae. japonicus* arrived in the District, we observed a decrease from the previous year in the total number of larval samples collected and the frequency in which *Ae. japonicus* were found in container, tire, and tree hole habitats (Table 1.5).

Table 1.5 Percentage of samples from containers, tires, and tree holes containing *Ae. japonicus* larvae, 2009 – 2013

Habitat type	2009	2010	2011	2012	2013
Containers	4.2%	23.5%	36.2%	39.4%	35.7%
Tires	2.9%	15.5%	21.3%	26.7%	21.2%
Tree holes	0	8.8%	9.3%	4.7%	1.8%

Aedes japonicus adults were identified in 286 samples. They were found in 183 aspirator samples, 35 CO_2 trap samples, 31 gravid trap samples, 23 NJ trap samples, and 14 two-minute sweep samples.

Aedes japonicus were collected from 336 District sections (one square mile) in 2013 (Fig. 1.23). This was the first year without an observed increase in the number of sections with the species (Fig. 1.24). Many of the observations from 2013 *Ae. japonicus* surveillance were similar to those from 2011 and most measures indicated that the species was more prolific in 2012 than during any other year. Whether this suggests the *Ae. japonicus* population is reaching a homeostatic level in the District remains to be determined by future observations. The decrease in detections in 2013 could be related to weather conditions such as the cool spring and low rainfall amounts during the second half of the season. Extensive control efforts and habitat reduction by MMCD staff are also inhibiting the proliferation of the species.

2014 Plans – Surveillance

Surveillance will continue as in past years with possible adjustments to monitor disease vector presence in the District, including refining *Cs. melanura* surveillance. The placement of CO_2, gravid, and New Jersey traps will be evaluated.

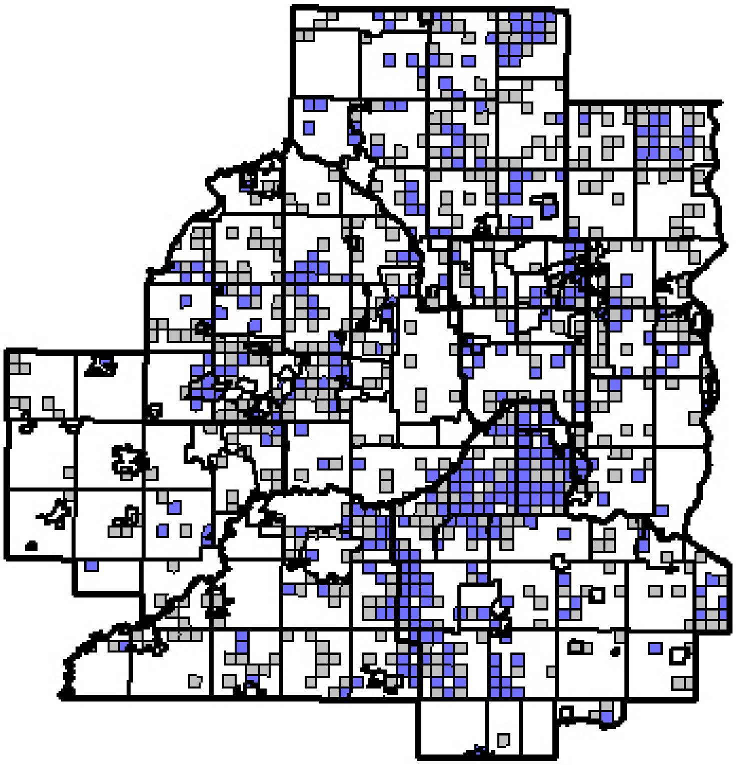


Figure 1.23 Locations of *Ae. japonicus* collections. Blue shaded areas are square mile sections where *Ae. japonicus* were collected in 2013. Gray shaded areas represent sections where the species occurred in previous years, but not in 2013.

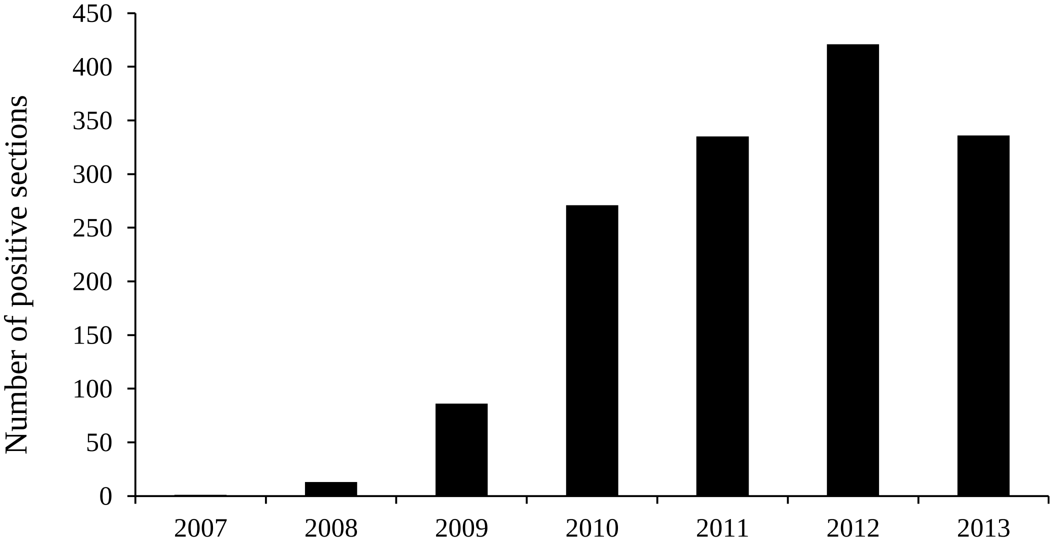


Figure 1.24 Number of MMCD sections with *Aedes japonicus* by year, 2007-2013.

Chapter 2 Vector-borne Disease

2013 Highlights

- There were five La Crosse encephalitis cases in Minnesota, three in District residents
- WNV illness confirmed in 79 Minnesotans,15 cases in District residents
- WNV detected in 77 District mosquito samples
- Collected and recycled 17,812 waste tires
- Average *I. scapularis* per mammal was 0.40, lower than typical since 2000
- Three reports of *A. americanum* in MMCD: Afton, Scandia, and western WI
- Signs posted in dog parks to educate & facilitate tick collections from the public
- 2013 tick-borne illness totals not yet available but may parallel the 911 Lyme and 512 HGA cases from 2012 (source MDH)
- Tick Risk Meter estimates posted weekly at mmcd.org & on Facebook

Background

District staff provides a variety of disease surveillance and control services, as well as public education, to reduce the risk of mosquito-borne illnesses such as La Crosse encephalitis (LAC), western equine encephalitis (WEE), eastern equine encephalitis (EEE), and West Nile (WNV) encephalitis, as well as tick-borne illnesses such as Lyme disease and human granulocytic anaplasmosis (HGA). Past District efforts have also included determining metro-area risk for infections of Jamestown Canyon virus (JC), babesiosis, Rocky Mountain spotted fever, and Sin Nombre virus (a hantavirus).

La Crosse encephalitis prevention services were initiated in 1987 to identify areas within the District where significant risk of acquiring this disease exists. High-risk areas are defined as having high populations of the primary vector *Aedes triseriatus* (eastern tree hole mosquito), *Aedes japonicus* (Japanese rock pool mosquito) a possible vector, or a history of LAC cases. MMCD targets these areas for intensive control including public education, larval habitat removal (e.g., tires, tree holes, and containers), and limited adult mosquito treatments. Additionally, routine surveillance and control activities are conducted at past LAC case sites. Surveillance for the invasive species *Aedes albopictus* (Asian tiger mosquito) routinely occurs to detect infestations of the potential disease vector.

The District collects and tests *Culex tarsalis* to monitor WEE activity. Western equine encephalitis can cause severe illness in horses and humans. The last WEE outbreak in Minnesota occurred in 1983.

Culex tarsalis and other *Culex* species are vectors of WNV, a virus that arrived in Minnesota in 2002. Since then MMCD has investigated a variety of mosquito control procedures to enhance our comprehensive integrated mosquito management strategy to prevent West Nile illness. We do limited in-house testing of birds and mosquitoes for WNV, and use that information along with other mosquito sampling data to make mosquito control decisions.

2014 Plans

- Continue to provide surveillance and control for La Crosse encephalitis prevention
- Continue to improve surveillance and control of *Ae. japonicus*
- Continue catch basin larvicide treatments to manage WNV vectors
- Communicate disease prevention strategies to other local governments
- Continue surveillance for WNV and other mosquito-borne viruses
- Continue to monitor for *Ae. albopictus* and other exotic species
- Continue *Cs. melanura* surveillance and evaluate control options for EEE prevention
- Continue *I. scapularis* surveillance at 100 sampling locations
- Continue with tick-borne disease education, tick identifications, and homeowner consultations
- Continue to update the Tick Risk Meter and provide updates on Facebook
- Continue to post signs at dog parks and expand to additional locations
- Continue to track collections of *A. americanum* or other new or unusual tick species

The first occurrence of EEE in Minnesota was in 2001. Since then, MMCD has conducted surveillance for *Culiseta melanura*, which maintains the virus in birds. A "bridge vector" such as *Cq. perturbans* can acquire the virus from a bird and pass it to a human in a subsequent feeding.

On the tick front, in 1989 the state legislature mandated the District "*to consult and cooperate with the MDH in developing management techniques to control disease vectoring ticks*." The District responded by beginning tick surveillance and forming the Lyme Disease Tick Advisory Board (LDTAB) in 1990. The LDTAB includes MMCD and Minnesota Department of Health (MDH) staff, local scientists, and agency representatives who offer their expertise to the tick-borne effort.

MMCD initiated tick surveillance to determine the range and abundance of the black-legged tick (*Ixodes scapularis*, also known as the deer tick) and the Lyme disease spirochete, *Borrelia burgdorferi,* within the District. To date, MMCD has mapped the current distribution of black-legged ticks (545 total sites sampled) and continues to monitor their populations in the metropolitan area. Additionally, District employees have assisted the University of Minnesota with spirochete and anaplasmosis studies. All collected data are summarized and presented to the MDH for their risk analysis.

Because wide-scale tick control is neither ecologically nor economically feasible, tick-borne disease prevention is limited to public education activities which emphasize tick-borne disease awareness and personal precautions. District employees continue to provide tick identifications upon request and are used as a tick referral resource by agencies such as the MDH and the Minnesota Department of Natural Resources (MnDNR).

As described in this and prior operational reports, the MMCD uses sophisticated surveillance techniques to determine the geographic distribution and estimated population levels of both mosquito and tick vectors in the metropolitan area. We continue to modify our surveillance efforts as new or different diseases and disease vectors are detected. This information is used to direct vector control and public education where needed. However, knowing the location and population levels of the vectors is only one part of the vector-borne disease cycle; understanding where vector-borne disease pathogens may be circulating is also important. Because MMCD lacks the equipment to test vectors or reservoir hosts for tick-borne and most mosquito-borne pathogens, samples are sent to MDH for testing.

In 2009, MMCD began examining ways to expand its programs to be more proactive in the area of vector-borne diseases. We contacted various agencies and held a Lyme Disease Tick Advisory Board meeting to solicit technical expertise. We would ultimately like to increase our ability to serve metro citizens given that in recent years we have received reports of rarely detected vector-borne illnesses (EEE, Powassan, Jamestown Canyon, Rocky Mountain spotted fever). Additionally, we frequently detect invasive vector species (*Ae. albopictus*, *Ae. japonicus*, *Amblyomma americanum*). *Aedes japonicus* are now established throughout the District.

2013 Mosquito-borne Disease Services

Source Reduction

Water-holding containers such as tires, buckets, tarps, and even plastic toys provide developmental habitat for many mosquito species including the LAC vector *Ae. triseriatus*, the invasive species *Ae. albopictus,* and *Ae. japonicus,* and the WNV vectors *Cx. restuans* and *Cx. pipiens*. Eliminating these container habitats is an effective strategy for preventing mosquito-borne illnesses. In 2013, District staff recycled 17,812 tires that were collected from the field (Table 2.1). Since 1988, the District has recycled 591,103 tires. In addition, MMCD eliminated 2,410 containers and filled 386 tree holes in 2013. This reduction of larval habitats occurred while conducting a variety of mosquito, tick, and black fly surveillance and control activities, including the 1,992 property inspections by MMCD staff.

Table 2.1 Number of tire, container, and tree hole habitats eliminated during each of the past ten seasons

Year	Tires	Containers	Tree holes	Total
2004	15,751	1,415	1,128	18,294
2005	10,614	2,656	1,008	14,278
2006	10,513	2,059	228	12,800
2007	14,449	1,267	107	15,823
2008	16,229	1,615	93	17,937
2009	39,934	8,088	529	48,551
2010	23,445	5,880	275	29,600
2011	17,326	3,250	219	20,795
2012	21,493	3,908	577	25,978
2013	17,812	2,410	386	20,608

La Crosse Encephalitis (LAC)

La Crosse encephalitis is a viral illness that is transmitted in Minnesota by *Ae. triseriatus*. *Aedes albopictus* and *Ae. japonicus* are also capable of transmitting the La Crosse virus. Small mammals such as chipmunks and squirrels are the vertebrate hosts of LACV; they amplify the virus through the summer months. The virus can also pass transovarially from one generation of mosquitoes to the next. Most cases of La Crosse encephalitis are diagnosed in children under the age of 16. In 2013, there were 81 La Crosse illnesses documented in the United States.

***Aedes triseriatus* Surveillance and Control** *Aedes triseriatus* will lay eggs in water-holding containers, but the preferred natural habitat is tree holes. MMCD staff use an aspirator to sample wooded areas in the daytime to monitor the diurnal adults. Results are used to direct adult and larval control activities.

Cool spring conditions delayed the initial emergence of *Ae. triseriatus* adults, however once temperatures increased, the conditions were ideal for rapid population growth. Collections of *Ae. triseriatus* were well above average in early July. After a mid-July heat wave helped reduce the population, collections of *Ae. triseriatus* were near normal for the remainder of the season (see Chapter 1, Fig. 1.14).

In 2013, MMCD staff collected 2,905 aspirator samples to monitor *Ae. triseriatus* populations. Inspections of wooded areas and surrounding residential properties to eliminate larval habitat were provided as follow-up service when *Ae. triseriatus* adults were collected. Five hundred fifty-eight samples met the District's adulticide treatment threshold (≥ 2 adult *Ae. triseriatus* per aspirator collection). Adulticides were applied to wooded areas in 402 of those cases. Adult *Ae. triseriatus* were captured in 928 of 2,359 wooded areas sampled. This ratio, as well as the mean number of *Ae. triseriatus* captured per sample was similar to 2012 (Table 2.2).

Table 2.2 *Aedes triseriatus* aspirator surveillance data, 2000 – 2013

Year	Total areas surveyed	No. with *Ae. triseriatus*	Percent with *Ae. triseriatus*	Total samples collected	Mean *Ae. triseriatus* per sample
2000	1,037	575	55.4	1,912	1.94
2001	1,222	567	46.4	2,155	1.32
2002	1,343	573	42.7	2,058	1.70
2003	1,558	470	30.2	2,676	1.20
2004	1,850	786	42.5	3,101	1.34
2005	1,993	700	35.1	2,617	0.84
2006	1,849	518	28.0	2,680	0.78
2007	1,767	402	22.8	2,345	0.42
2008	1,685	495	29.4	2,429	0.64
2009	2,258	532	24.0	3,125	0.56
2010	1,698	570	33.6	2,213	0.89
2011	1,769	566	32.0	2,563	0.83
2012	2,381	911	38.3	3,175	1.10
2013	2,359	928	39.3	2,905	1.22

La Crosse Encephalitis in Minnesota There were five LAC cases reported in Minnesota in 2013. Three cases occurred in residents of the District: two Hennepin County residents and one Dakota County resident. Two cases occurred in Wright County residents. Investigations by MDH and MMCD concluded that the Dakota County resident was not exposed to LAC virus near home, but likely in Nicollet County. Since 1970, the District has had an average of 2.3 LAC cases per year (range 0 – 10, median 2). Since 1990, the mean is 1.5 cases per year (range 0 – 8, median 0).

While *Ae. triseriatus* is known as the primary vector of LAC, the role *Ae. japonicus* might play in the LAC cycle is less understood. *Aedes japonicus* is a competent vector of LAC virus in laboratory settings, but has not been implicated as a vector in nature. The species was collected near the two LAC case sites investigated while mosquitoes were still active, one Hennepin County site investigated by MMCD and one Wright County site investigated by MDH. In 2013, MMCD submitted 31 pools of *Ae. japonicus* to MDH to be tested for LAC virus as well as WNV. Neither virus was detected.

MMCD La Crosse Case Responses MMCD was notified of the first Hennepin County LAC case on August 14. The District's field response was initiated the next day and continued through mid-September. The suspected exposure location is the child's residence, which is in a wooded suburban neighborhood. An aspirator sample collected on August 16 from the child's home property and surrounding lots contained nine *Ae. triseriatus*. The woodlot containing the child's home and four other woodlots in the neighborhood were treated by backpack application of permethrin on August 19. An aspirator sample on September 9 from the child's home area contained no *Ae. triseriatus*.

Ninety-one property inspections in the immediate neighborhood of the child's residence resulted in staff eliminating 22 containers and three tree holes. Weather conditions during that time were quite dry and as a result, only eight of the 25 habitats found actually had mosquito larvae when inspected. Many of the containers were dry, but likely produced mosquitoes earlier in the year. Of the eight containers with larvae, two contained *Ae. triseriatus* and five had *Ae. japonicus*.

On September 27, MMCD was informed of the Dakota County LAC case. Initial interviews of the child's mother by both MMCD and MDH helped determine that there were multiple locations to evaluate for LACV exposure. MMCD staff inspected the child's Dakota County residential area. Three other areas, all outside of the District, were identified as possible sites of exposure. After inspection of the child's neighborhood, which lacked habitat for *Ae. triseriatus* adults and where no larval habitats were identified, it was determined that exposure to LACV likely occurred at a site outside of the District.

On October 23, MMCD was informed of the second Hennepin County LAC case. On October 29, MMCD staff inspected the wooded, rural development which contained the child's residence. The child's home, the ten nearest properties, and three woodlots were surveyed. Due to the cold conditions prior to the field response, mosquito activity had ceased for the year. Still, 15 container habitats and 15 tires were located. On October 2, prior to learning of the LAC case, a larval sample collected from a tire in the neighborhood contained *Ae. japonicus* larvae.

We plan to continue our surveillance for LACV vectors next spring in the residential areas of both 2013 Hennepin County LAC cases.

Eastern Equine Encephalitis (EEE)

Eastern equine encephalitis is a viral illness of humans, horses and some other domestic animals such as llamas, alpacas, and emus. The EEE virus circulates among mosquitoes and birds and is most common in areas near the habitat of its primary vector, *Cs. melanura*. These habitats include many coastal wetlands, and in the interior of North America, tamarack bogs and other bog sites. The first record of EEE in Minnesota was in 2001 when three horses were diagnosed with the illness, including one from Anoka County. Wildlife monitoring by the Minnesota Department of Natural Resources (MnDNR) has detected antibodies to the EEE virus in wolves, moose, or elk in northern Minnesota each year since 2007.

In 2013, the EEE virus was detected in 22 states. There were six human illnesses diagnosed: two in Florida and one each in Arkansas, Georgia, Massachusetts, and North Carolina. There were 182 veterinary reports of EEE illnesses in domestic animals, primarily horses, from 22 states. An equine case in southwest Michigan was the nearest report of illness to Minnesota.

***Culiseta melanura* Surveillance** *Culiseta melanura* are relatively rare in the District and are restricted to a few bog-type larval habitats. The greatest concentration of this type of habitat is in the northeast part of MMCD in Anoka and Washington counties. Still, *Cs. melanura* specimens are occasionally collected in other areas of the District.

The *Cs. melanura* population remained low in 2013 with a season total of only 81 adult females collected by CO_2 trap from designated surveillance locations (see Chapter 1, Figure 1.5). Twelve pools containing 68 *Cs. melanura* were submitted to MDH for viral analysis. All samples were negative for EEE and WNV.

Western Equine Encephalitis (WEE)

Western equine encephalitis circulates among mosquitoes and birds in Minnesota. Occasionally, the virus causes illness in horses and less frequently in people. *Culex tarsalis* is the species most likely to transmit the virus to people and horses. In both 2004 and 2005, the virus was detected in *Cx. tarsalis* specimens collected in southern Minnesota. The virus has not been detected in Minnesota since then. *Culex tarsalis* collections were moderately high during the 2013 season (see Ch 1, Fig. 1.23) and while 354 samples were tested for West Nile virus, there were no samples tested for WEE.

Jamestown Canyon Virus (JC)

MDH confirmed Minnesota’s first known JC illness in a Sherburne County resident with onset of symptoms on August 14, 2013. Nationally, there were 16 JC illnesses confirmed, nine of which occurred in Wisconsin. The virus is not new to Minnesota, and there is past serologic evidence of JC in the District from white-tailed deer (Neitzel, D.F. and P.R. Grimstad, 1991). Like La Crosse virus, JC virus is a California serogroup Bunyavirus. The virus’ vertebrate hosts are white-tailed deer and other ungulates and most mosquito isolates have come from samples of *Aedes* species. Jamestown Canyon virus has also been isolated from samples of *Anopheles*, *Culiseta*, *Coquillettidia*, *Culex*, and *Psorophora* species. MMCD already targets *Aedes* spp. and *Cq. perturbans,* the mosquitoes most likely to infect humans.

West Nile Virus (WNV)

West Nile virus circulates among many mosquito and bird species. It was first detected in New York in 1999 and has since spread through the continental U.S., much of Canada, Mexico, Central America, and South America. The virus causes many illnesses in humans and horses each year. West Nile virus was first detected in Minnesota in 2002. It is transmitted locally by several mosquito species, but most frequently by *Cx. tarsalis*, *Cx. pipiens* and *Cx. restuans*.

WNV in the United States Each of the 48 contiguous states documented West Nile virus transmission in 2013. The U.S. Centers for Disease Control and Prevention received reports of 2,374 West Nile illnesses from 46 states and the District of Columbia. There were 114 fatalities attributed to WNV infections. California had the greatest number of cases with 368; however, South Dakota’s 149 cases resulted in the highest rate of illness per population. Nationwide screening of blood donors detected WNV in 420 individuals from 35 states. Of the 420 presumptively viremic blood donors, 68 eventually developed clinical illnesses and are also included in the confirmed cases reported to CDC. Additionally, West Nile illness was diagnosed in 356 domestic animals, mainly horses, from 39 states.

WNV in Minnesota MDH reported 79 WNV illnesses from 39 Minnesota counties. Three cases were fatal. The earliest onset of a WNV illness in the state was July 9. There were 25 presumptively viremic blood donors reported from 16 Minnesota counties. Additionally, there were five reports of WNV illness in horses from four Minnesota counties. Seventy-seven mosquito samples from six counties and one bird also returned positive results for WNV.

West Nile in the District There were 15 WNV illnesses reported in residents of the District. Hennepin and Ramsey counties each had four cases. One of the Minnesota fatalities occurred in Ramsey County. Scott County had three cases, Anoka County two, and Dakota and Washington counties each had one case. At least two of the cases (Dakota Co., Washington Co.) were likely exposed outside of the District. Since WNV arrived in Minnesota, the District has experienced an average of 10.1 WNV illnesses each year (range 0 – 25, median 13). When cases with suspected exposure locations outside of the District are excluded, the mean is 7.6 cases per year (range 0 – 17, median 11).

Surveillance for WNV Despite a cool spring and a slow start to the mosquito season, MMCD experienced an active WNV season for the second consecutive year. The earliest detection of WNV in the District was from a pool of *Culex* mosquitoes collected in a CO_2 trap on June 25. The first virus detection in a bird was from an American crow collected on July 5.

Several mosquito species from 43 CO_2 traps (13 elevated into the tree canopy) and 36 gravid traps were tested for viral analysis each week. In addition, we processed *Cx. tarsalis* collected by any of the CO_2 traps in our Monday night network for viral analysis. MMCD tested 945 mosquito pools using the RAMP® method, 77 of which were positive for WNV. We also submitted 46 mosquito pools to MDH for WNV analysis by PCR. The samples sent to MDH were tested for LAC or EEE as well and consisted of *Ae. japonicus, Ae. triseriatus*, and *Cs. melanura*. Table 2.3 is a complete list of mosquitoes MMCD processed for WNV analysis.

Table 2.3 Number of MMCD mosquito pools tested for WNV and minimum infection rate (MIR) by species, 2013

Species	Number of mosquitoes	Number of pools	WNV+ pools	MIR per 1,000
Aedes japonicus	186	32	0	0
Aedes triseriatus	78	9	0	0
Culex pipiens	623	17	3	4.82
Culex restuans	1,392	51	5	3.59
Culex salinarius	502	28	0	0
Culex tarsalis	6,769	355	14	2.07
Culex species	4,921	215	26	5.28
Culex pipiens/restuans	7,235	269	29	4.01
Culiseta melanura	68	12	0	0
Total	21,774	988	77	3.54

The 77 WNV positive mosquito samples collected in 2013 was the fourth greatest number of positive samples in a season, topped only by 2012 (105), 2006 (89) & 2007 (85). However, the minimum infection rate of 3.54/1000 mosquitoes tested this year was exceeded only by the 2012 rate of 6.72/1000.

The first four WNV positive mosquito samples of 2013 were collected in the western portion of the District (Waconia 6/25, Watertown 7/2, Minnetrista 7/9, & Independence 7/10). By the end of July, the virus had been detected in mosquitoes collected from Carver, Dakota, Hennepin, Ramsey, and Scott counties. By the end of the season, more WNV positive mosquito samples were collected in Ramsey County (31) than any other county in the District. Dakota County mosquito collections produced 17 WNV positive samples, Hennepin had 13, Anoka had eight, and Scott had six. Interestingly, the only two WNV positive mosquito samples from Carver County were the first two positive samples collected in the District.

Amplification of WNV increased steadily from the first detection in late June through the first week of August (Figure 2.2). The subsequent decrease in the mosquito infection rate was related to a four-week period of unusually cool weather from late July through mid-August. A two week heat wave in mid- to late August stimulated another period of WNV amplification. The mosquito infection rate peaked late in the season, during the week of September 16 at 15.4/1,000 and remained high through the end of our testing period.

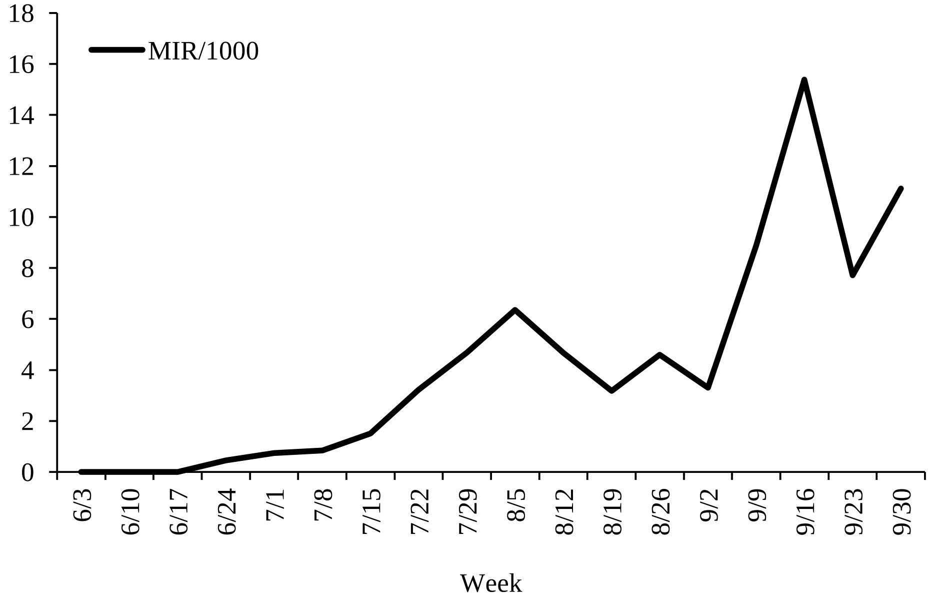


Figure 2.2 Weekly minimum WNV infection rates (MIR) per 1,000 *Culex* specimens tested in 2013. Dates listed are the Monday of each sampling week.

The District modified its bird surveillance plan in 2013 for more efficient use of reported information. Citizens reported dead birds to MMCD and birds meeting certain criteria were analyzed for WNV. We determined that we would stop collecting birds after the first WNV positive result. Two hundred seventy-nine reports of dead birds were received by telephone, internet, or from employees in the field. Response Biomedical Corporation’s RAMP® tests were done on two birds. The second bird tested, an American crow collected in Maple Grove on July 5, was positive for WNV. The District continued to monitor reports of dead birds for the remainder of the season and reports of corvids were geocoded for placement on maps (Figure 2.1).

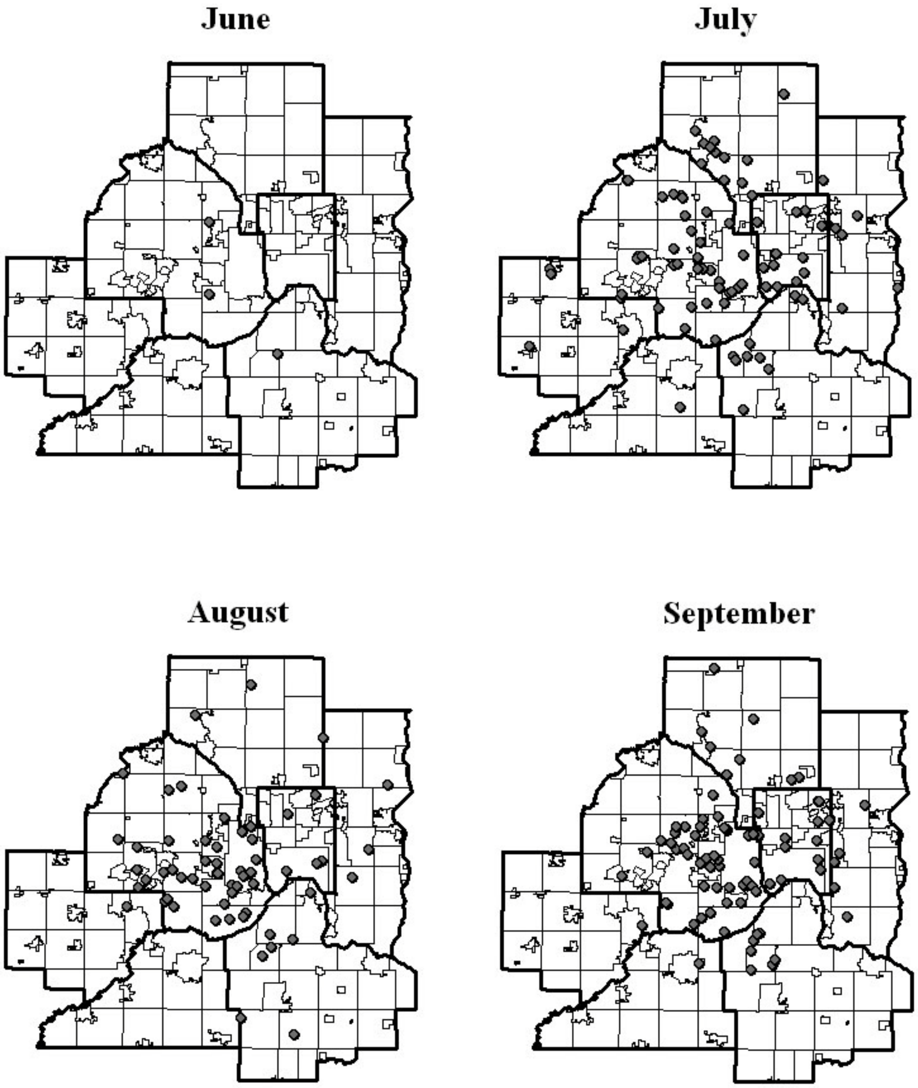


Figure 2.1 Locations of corvids reported to MMCD in 2013 by month

Larval *Culex* Surveillance

Culex mosquitoes lay rafts of eggs on the surface of standing water in both natural and man-made habitats. Detecting *Culex* mosquitoes can be challenging since larvae will not be present in a wet habitat unless adult, egg-laying females have been recently active, the area was wet and attractive for oviposition, and the characteristics of the site allow for survival of newly hatched mosquitoes. *Culex* are also less abundant than other types of mosquitoes in our area. Furthermore, in large wetlands larvae can disperse over a wide area or they may clump together in small, isolated pockets. They are generally easier to locate in small habitats (i.e., catch basins, stormwater management structures, etc.) where greater concentrations of larvae tend to be more evenly dispersed.

Stormwater Management Structures and Other Man Made Habitats Since 2006, MMCD field staff have been working to locate stormwater structures, evaluate habitat, and provide larval control. A classification system was devised to categorize potential habitats. Types of structures include culverts, washouts, riprap, risers (pond level regulators), underground structures, swimming pools, ornamental ponds, and intermittent streams.

Staff made 10,464 inspections of 6,833 structures in 2013. Mosquito larvae were found in 1,569 of the 5,881 habitats that were wet on the date of inspection. Inspectors collected 877 larval samples from stormwater structures and other constructed habitats. *Culex* vectors were found in 78.6% of the samples, which is similar to the past two seasons (Table 2.4). In 2013, *Cx. restuans* were found more frequently than in 2012 while *Cx. pipiens* were found less frequently than last year. *Culex salinarius* and *Cx. tarsalis* were observed as frequently as they were last year.

Table 2.4 Frequency of *Culex* vector species collected from stormwater management structures and other constructed habitats 2010 – 2013

	Yearly percent occurrence			
Species	2010 (N=2,020)	2011 (N=1,567)	2012 (N=1,080)	2013 (N=877)
Cx. pipiens	31.8	13.7	39.8	29.8
Cx. restuans	64.2	65.3	53.1	66.0
Cx. salinarius	0.0	0.1	0.6	0.5
Cx. tarsalis	4.5	3.8	3.4	3.9
Any *Culex* vector species	77.4	76.6	74.5	78.6

Mosquito Control in Underground Stormwater Structures Many stormwater management systems include large underground chambers to trap sediments and other pollutants. There are several designs in use that vary in dimension and name, but collectively, they are often referred to as BMPs from *Best Management Practices for Stormwater* under the U.S. Environmental Protection Agency's National Pollution Discharge Elimination System (NPDES). MMCD has worked with city crews to survey and treat underground BMPs since 2005.
In 2013, we continued the cooperative mosquito control plan for underground habitats. Twenty-two municipalities volunteered their staff to assist with material applications (Table 2.5). Altosid® XR briquets were used at the label rate of one briquet per 1,500 gallons of water retained. Briquets were placed in 745 underground habitats.

Prolific mosquito development has been documented in local underground BMPs. The majority of mosquitoes found in BMPs are *Culex* species and successfully controlling their emergence from underground habitats will remain an objective in MMCD's comprehensive strategy to manage WNV vectors. We plan to continue working with municipalities to limit mosquito development in stormwater systems.

Table 2.5 Cities that assisted in treating underground stormwater habitats in 2013; 745 structures were treated and a total of 1,032 briquets were applied

City	Structures treated	Briquets used	City	Structures treated	Briquets used
Arden Hills	6	6	Maplewood	180	180
Blaine	6	21	Mendota Heights	40	44
Bloomington	74	91	Minneapolis	166	166
Brooklyn Park	4	15	New Brighton	5	8
Columbia Heights	8	12	New Hope	6	12
Crystal	5	14	Plymouth	150	335
Eagan	20	20	Richfield	7	19
Eden Prairie	12	20	Roseville	11	14
Hastings	2	2	Savage	12	22
Lauderdale	13	13	Spring Lake Park	2	2
Lino Lakes	10	10	Woodbury	6	6

Larval Surveillance in Catch Basins Catch basin larval surveillance was delayed due to cool weather and frequent rainfall in May and early June. By late June, weather conditions were more favorable for larval development in catch basins.

Larval surveillance primarily in St. Paul catch basins began the week of June 3 and ended the week of September 9 (Figure 2.3). There were two weeks in mid-June with no catch basin larval surveillance. Larvae were found during 450 of 550 catch basin inspections (81.8%) in 2013.

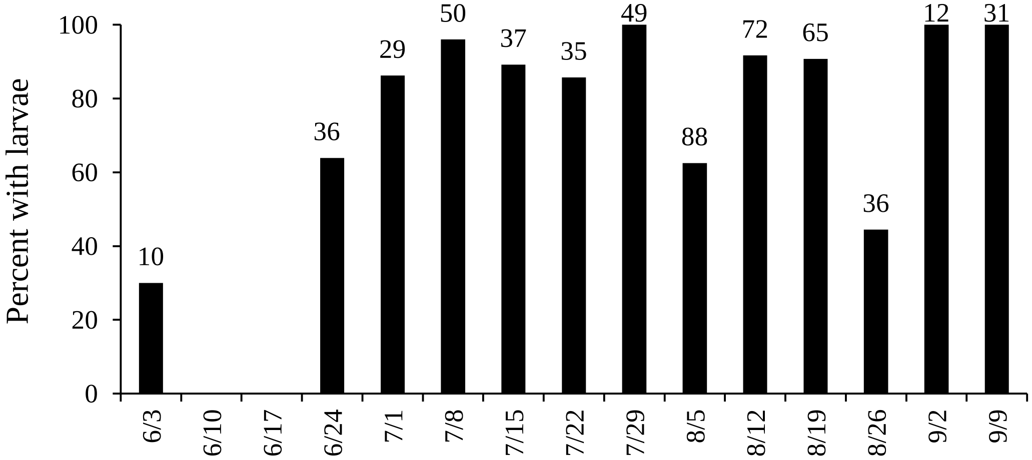


Figure 2.3 Percent of catch basins inspected with mosquitoes present in 2013. Bars are labeled with the number of inspections occurring during the week.

Mosquito larvae were identified from 449 catch basin samples. *Culex pipiens* were found in 73.1% of catch basin larval samples (Figure 2.4). *Culex restuans* were found in 67.9% of samples. At least one *Culex* vector species was found in 99.6% of samples. This was the second consecutive year when more catch basin larval samples contained *Cx. pipiens* than *Cx. restuans* and the third year overall.

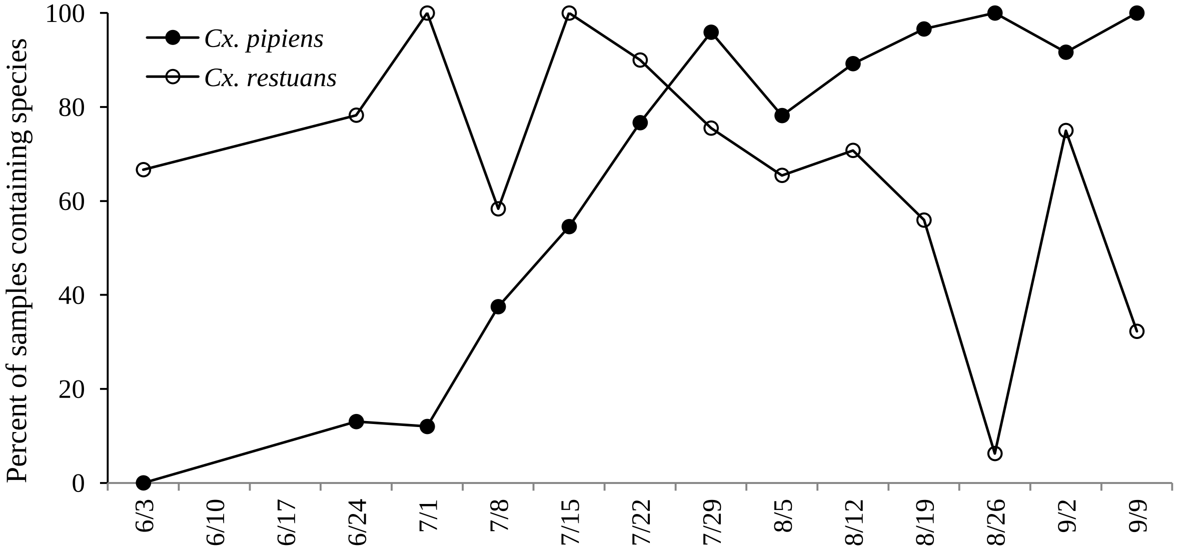


Figure 2.4 Occurrence of *Cx. pipiens* and *Cx. restuans* in catch basin larval samples by week.

2014 Plans – Mosquito-borne Disease

District staff will continue to provide mosquito surveillance and control services for the prevention of La Crosse encephalitis. Preventive measures include *Ae. triseriatus* adult sampling, adult control and, especially, tree hole and container habitat reduction. Eliminating small aquatic habitats will also serve to control populations of *Ae. japonicus*.

The District will continue to survey aquatic habitats for *Culex* larvae for use in design and improvement of larval control strategies. The WNV and WEE vector *Cx. tarsalis* will remain a species of particular interest. Cooperative work with municipalities within the District to treat underground stormwater structures that produce mosquitoes will continue. District staff will continue to target *Culex* larvae in catch basins in our efforts to reduce WNV amplification.

MMCD will continue to conduct surveillance for WNV and other mosquito-borne viruses in coordination with MDH and others involved in surveillance for WNV in Minnesota. We plan to work with other agencies, academia, and individuals to improve vector-borne disease prevention in the District, as well as to serve as a resource for others in the state.

References Cited

Neitzel, D. F. and P. R. Grimstad. 1991. Serological evidence of California group and Cache Valley virus infection in Minnesota white-tailed deer. J. Wildlife Diseases 27(2):230-237.

2013 Tick-borne Disease Services

Ixodes scapularis Distribution Study

The District continued to sample the network of 100 sites set up in 1991-1992 to monitor potential changes in tick distribution over time. As in previous years, the primary sampling method involved capturing small mammals from each site and removing any attached ticks. Collections from the northeastern metropolitan area (primarily Anoka and Washington counties) have consistently detected *Ixodes scapularis,* and in 1998 *I. scapularis* was detected in Hennepin and Scott counties for the first time. We collected at least one *I. scapularis* from all seven counties that comprise our service area for the first time in 2007. Since then we have continued to detect *I. scapularis* with greater frequency in sites located south of the Mississippi River and they appear to be prevalent now in many wooded areas. The 2013 report is available on our website (www.mmcd.org). Following are some 2013 highlights.

The average number of *I. scapularis* collected per mammal (0.40) in 2013 is low compared to the averages we have come to expect in recent years. Most years since 2000 have been ≥ .806 (Table 2.6). However, considering the record low number of sites (eight) without any small mammal captures, and the overall record low numbers of small mammals (n=596) and ticks (n=370) collected in 2013, assessment of the average should not be considered as low as it seems in this direct comparison.

The overall positive site total for 2013 was 43. Since 2000, the yearly positive site total has typically been in the 50s. However, considering only 92 sites had small mammals collected (and therefore potentially ticks) the percentage of positive sites in 2013 is 47%, which places 2013 only slightly below the typical positive site totals since 2000. Again in 2013, at least one *I. scapularis* was collected from all seven counties; with the exception of 2011, this has occurred in all years from 2007 to present. *Ixodes scapularis* was collected at 28 sites north of the Mississippi River (Anoka, Washington, and Ramsey counties), and at 15 sites south of the Mississippi River (Dakota, Hennepin, Scott, and Carver counties).

Tick-borne disease – Lyme disease and human granulocytic anaplasmosis cases The Minnesota Department of Health (MDH) has been documenting record-setting human tick-borne disease case totals since 2000. Pre-2000, the highest Lyme case total was 302 but since 2000 the Lyme totals have ranged from 463 to 1,293 cases and typically average >1,000 per year. Human granulocytic anaplasmosis (HGA) cases have also been on the rise. After averaging approximately 15 cases per year through 1999, the total HGA case numbers ranged from 78 to 186 from 2000 – 2006 then increased into the range of the 300s. The all-time high, statewide Lyme disease case record (1,293) was set in 2010 with the all time high HGA record of 782 set in 2011. Case data for 2013 is not yet available (as of January 8, 2014) but may parallel 2012, which had 911 Lyme and 512 HGA cases.

Table 2.6 Total number of mammals trapped and tick species collected by life stage and year, 1990-2013. The number of sites sampled was 250 in 1990, 270 in 1991, 200 in 1992, and 100 from 1993 to present.

			Dermacentor variabilis		*Ixodes scapularis*		
Year	No. mammals	Total ticks collected	No. larvae	No. nymphs	No. larvae	No. nymphs	No. other species[b]
1990 [a]	3651	9957	8289	994	573	74	27
1991	5566	8452	6807	1094	441	73	37
1992	2544	4130	3259	703	114	34	20
1993	1543	1785	1136	221	388	21	19
1994	1672	1514	797	163	476	67	11
1995	1406	1196	650	232	258	48	8
1996	791	724	466	146	82	20	10
1997	728	693	506	66	96	22	3
1998	1246	1389	779	100	439	67	4
1999	1627	1594	820	128	570	64	12
2000	1173	2207	1030	228	688	257	4
2001	897	1957	1054	159	697	44	3
2002	1236	2185	797	280	922	177	9
2003	1226	1293	676	139	337	140	1
2004	1152	1773	653	136	901	75	8
2005	965	1974	708	120	1054	85	7
2006	1241	1353	411	140	733	58	11
2007	849	1700	807	136	566	178	13
2008	702	1005	485	61	340	112	7
2009	941	1897	916	170	747	61	3
2010	1320	1553	330	101	1009	107	6
2011	756	938	373	97	261	205	2
2012	1537	2223	547	211	1321	139	5
2013	596	370	88	42	147	92	1

[a] 1990 data excludes one *Tamias striatus* with 102 *I. scapularis* larvae and 31 nymphs

[b] other species mostly *Ixodes muris.* 1999—second adult *I. muris* collected

Updates – New Strategies

Posting Signs, Dog Parks Since the initial suggestion of the Technical Advisory Board (TAB) in 2010, we have visited dog parks and vet offices as part of our outreach and have posted signs in approximately 21 dog parks with additional signs posted in active dog walking areas. We have also continued to work on expanding our sign placements into additional metro locations.

Targeted Education Material Distribution Brochures, tick cards, and/or posters were delivered to approximately 270 locations (city halls, libraries, schools, child care centers, retail establishments, vet clinics, parks) across the metro area as well as distributed at fair booths and city events, with many more mailed upon request.

***Amblyomma americanum* (Lone Star Tick), Found in Metro Area Again**
Amblyomma americanum is an aggressive human biter and can transmit human monocytic ehrlichiosis (HME), among other potential pathogens. Both the tick and HME are more common to the southern US, but *A. americanum*'s range is known to be moving northward. *Amblyomma* ticks have been submitted to MMCD from the public on a rare, sporadic basis. This species was first collected by MMCD in 1991 via a road kill examination of a white-tailed deer (*Odocoileus virginianus*). In 2009, however, citizens from Minneapolis and Circle Pines submitted *Amblyomma* specimens to MDH and MMCD. This trend continued in 2010; *Amblyomma* were submitted to MMCD from Eagan, Mound, and the Orono/Lake Minnetonka areas of the metro. In 2011, the MDH had submissions of adults from Shakopee, Lindstrom, and Hennepin County (unconfirmed location) and in 2012, three more *Amblyomma* were submitted to the MDH: Eden Prairie or Burnsville, Bloomington, and Rice County. MMCD did not receive any *Amblyomma* in 2011 or 2012. In 2013, the MDH did not receive any reports but MMCD received three *Amblyomma* (Afton, Scandia, and western Wisconsin). We notified the Wisconsin Department of Health and mailed the western Wisconsin tick to them.

Tick Identification Services/Outreach

The overall scope of tick-borne disease education activities and services were maintained in 2013 using previously described methods and tools, including weekly updates to our Tick Risk Meter on our website and via MMCD's Facebook page.

2014 Plans for Tick-borne Disease Services

Metro Surveillance

The metro-based *I. scapularis* distribution study that began in 1990 is planned to continue unchanged.

Tick Identification Services/Outreach

Education/Social Media We plan to maintain our tick-borne disease education activities and services (including tick identifications and homeowner consultations) using previously described methods and tools, including weekly website and Facebook updates of the Tick Risk Meter as well via social media. Since *I. scapularis* collections, as well as the MDH's tabulated human tick-borne disease case totals remain elevated, we will continue to stock local parks and other appropriate locations with tick cards, brochures and/or posters and signs along with targeting specific metro townships based on higher human case totals and/or numbers of *I. scapularis* collected. We will also distribute materials at local fairs and the Minnesota State Fair, set up information booths at events as opportunities arise, and continue to offer an encompassing slide presentation.

Posting Signs We will continue to post at dog parks and high traffic dog walking paths and plan to expand to additional areas. As in past years, signs will be posted in the spring and removed in late fall after *I. scapularis* activity ceases for the year.

***Amblyomma americanum* / New or Unusual Tick Species** MMCD and MDH continue to discuss possible strategies that would enable both agencies to detect possible establishment of *A. americanum* in Minnesota. MMCD will continue to monitor this tick in our surveillance and to track collections turned in by the public as part of our tick identification service. Both MMCD and MDH will continue to notify each other when *A. americanum* or other new or unusual tick species is found.

U of MN Collaboration – Rearing Bot Flies

As in 2013, in 2014 each facility will attempt to collect roughly 20 pupal bot flies and rear to adulthood. Pupae and/or adult flies will be given to Dr. Roger Moon (UM-St. Paul) for identification.

Chapter 3 Mosquito Control

2013 Highlights

- 52,251 fewer acres worth of larvicides were applied to wetlands in 2013 than in 2012
- Aerial *Aedes vexans* prehatch treatments in 2013 (15,667 acres) surpassed the previous record in 2010 (14,410 acres)
- A cumulative total of 246,300 catch basin treatments were made in three rounds to control vectors of WNV
- 38,082 more acres worth of adulticides were applied in 2013 than in 2012

2014 Plans

- Conduct large scale tests of MetaLarv™ S-PT to control spring *Aedes as a* prehatch
- Increase September VectoLex® CG treatments as part of our cattail mosquito control program
- Work closely with MPCA to fulfill the requirements of a NPDES permit
- Continue tests of Onslaught® and other alternate barrier adulticides; specifically target vector mosquitoes
- Maintain vector surveillance and control in response to the observed geographic expansion of *Ae. japonicus* within the District

Background: Integrated Mosquito Management

The District uses an integrated mosquito management (IMM) approach to control nuisance and vector species. According to the *Best Management Practices for Integrated Mosquito Management* (AMCA, 2009) “integrated mosquito management (IMM) is a comprehensive mosquito prevention/control strategy that uses all available mosquito control methods singly or in combination to exploit the known vulnerabilities of mosquitoes in order to reduce their numbers to tolerable levels while maintaining a quality environment. IMM does not emphasize mosquito elimination or eradication. Integrated mosquito management methods are specifically tailored to safely counter each stage of the mosquito life cycle. Prudent mosquito management practices for the control of immature mosquitoes (larvae and pupae) include such methods as the use of biological controls (native, noninvasive predators), source reduction (water or vegetation management or other compatible land management uses), water sanitation practices, as well as the use of EPA-registered larvicides. When source elimination or larval control measures are not feasible or are clearly inadequate, or when faced with imminent mosquito-borne disease, application of EPA-registered adulticides by applicators trained in the special handling characteristics of these products may be needed. Adulticide products are chosen based upon their demonstrated efficacy against species targeted for control, resistance management concerns, and minimization of potential environmental impact.”

The District’s IMM program targets the principal summer pest mosquito *Ae. vexans*, several species of spring *Aedes*, the cattail mosquito *Cq. perturbans*, and several disease vectors (*Ae. triseriatus*, *Cx. tarsalis*, *Cx. pipiens*, *Cx. restuans*, and *Cx. salinarius*). *Aedes japonicus*, another potential vector species, arrived on the scene in 2007 and has also increased control needs.

Due to the large size of the metropolitan region (2,975 square miles), larval control was considered the most cost-effective control strategy in 1958 and remains so today. Consequently, larval control is the focus of the control program and the most prolific mosquito habitats (over 77,000 potential sites) are scrutinized for all human-biting mosquitoes.

Larval habitats are diverse. They vary from very small, temporary pools that fill after a rainfall to large wetland acreages. Small sites (ground sites) are three acres or less, which field crews treat by hand. Helicopters are used to treat large sites (air sites) only after the following criteria are met: larvae occur in sufficient numbers (threshold), larvae are of a certain age (instar), and larvae are the target species (human biting or disease vector). This IMM approach ensures that only sites that contain threshold abundance of susceptible target species are treated.

The insect growth regulator methoprene and the soil bacterium *Bacillus thuringiensis* var *israelensis* or *Bti*, are the primary larval control materials. These active ingredients are used in the trade-named materials Altosid® and MetaLarv™ (methoprene) and VectoBac® (*Bti*). Other materials being integrated into the larval control program are *Bacillus sphaericus* (VectoLex® CG) and *Saccharopolyspora spinosa* or "spinosad" (Natular™ G30). Adult control augments the larval control program when necessary.

The District uses priority zones to focus service in areas where the highest numbers of citizens benefit (Figure 3.1). Priority Zone 1 (P1) contains the majority of the population of the Twin Cities metropolitan area and has boundaries similar to the Metropolitan Urban Service Area (MUSA, Metropolitan Council). Priority Zone 2 (P2) includes sparsely populated and rural parts of the District. We consider small towns or population centers in rural areas as satellite communities and they receive services similar to P1. Citizens in P1 receive full larval and adult vector and nuisance mosquito control. In P2, the District focuses on vector control and provides additional larval and adult control services as appropriate and as resources allow.

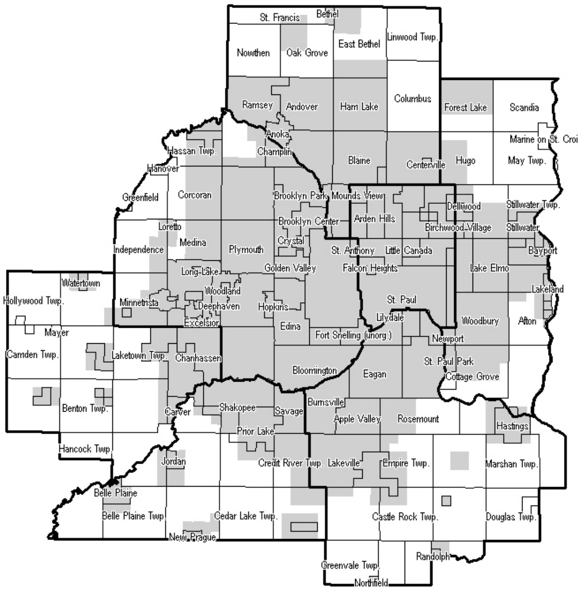


Figure 3.1 Priority Zones: P1 (shaded) and P2 (white), with District county and city/township boundaries, 2013.

To supplement the larval control program, adulticide applications are performed after sampling detects mosquito populations meeting threshold levels, primarily in high use park and recreation areas, for public events, or in response to citizen mosquito annoyance reports. Special emphasis is placed on areas where disease vectors have been detected, especially if there is also evidence of virus circulation.

Three synthetic pyrethroids are used: resmethrin, permethrin, and sumithrin. Sumithrin (Anvil®) can be used in agricultural areas. A description of the control materials is found in Appendix C. Appendix D indicates the dosages of control materials used by MMCD, both in terms of amount of formulated (and in some cases diluted) product applied per acre and the amount of active ingredient (AI) applied per acre. Appendix E contains a historical summary of the number of acres treated with each control material (2005-2013). Pesticide labels are located in Appendix F.

The total amount of larvicides and adulticides applied each season will vary depending upon mosquito abundance detected by larval and adult surveillance. The IMM plan employs surveillance to determine control needs.

2013 Mosquito Control

Larval Mosquito Control

Thresholds *Bti* treatments in small ground sites are only done when larval numbers meet treatment thresholds, as measured by taking 10 dips with a standard 4-inch diameter dipper. Treatments with materials formulated for application prior to flooding and egg hatch (‘prehatch materials’) are applied to sites with a history of larvae present. For helicopter *Bti* treatments, the average number of larvae per 10 dips must be over a threshold value to warrant treatment. P1 and P2 areas have different thresholds to help focus limited time and materials on productive sites near human population centers (Table 3.1). Spring *Aedes*, which tend to be long-lived, aggressive biters, have lower thresholds. In 2011, we increased the spring *Aedes* threshold to conserve larvicides. After mid-May, when most larvae found are floodwater summer species, thresholds are increased. If *Aedes* and *Culex* are both present in a site and neither meet threshold, the site can be treated if their combined count meets the threshold. We also increased the *Culex*4 (i.e., *Cx. restuans, Cx. pipiens, Cx. salinarius,* and *Cx. tarsalis* in combination or singly) threshold in 2011, primarily because many of these larvae are *Cx. restuans* (an amplifying vector) rather than bridge vectors (*Cx. tarsalis, Cx. salinarius*).

Table 3.1 Larval thresholds (average number of larvae per ten dips) in P1 and P2

	Spring *Aedes*		Summer*		*Culex*4	
Year	P1	P2	P1	P2	P1	P2
2008-2010	0.1	0.5	2.0	5.0	1.0	1.0
2011-2013	0.5	1.0	2.0	5.0	2.0	2.0

* Summer = Summer *Aedes* or *Aedes* + *Culex* 4

Season Overview The 2013 season was notable for its very late, cold spring. In 2013, spring *Aedes* larvae were not detected until April 9, twenty-seven days later than in 2012 when a very early arrival of warm temperatures greatly accelerated spring *Aedes* development. Aerial *Bti* treatments for spring *Aedes* began on May 9 (thirty-five days later than first such treatments on April 4, 2012). The switch to the summer floodwater *Aedes* threshold occurred on May 19 (about 10 days later than average) resulting in a shortened spring *Aedes* "season" which overlapped with the first summer floodwater brood.

In 2013, the very late, cold spring and abundant precipitation through mid-July (Chapter 1, Figure 1.1) condensed intense mosquito larval development into a shorter period (11 weeks: early May through mid-July) than in 2012 (17 weeks: early April through late July). This resulted in one large brood of spring *Aedes* and four large and seven small-medium broods of *Ae. vexans* (typical season has four large broods). Ninety-seven percent of total aerial larvicide treatments were applied by July 18 (Figure 3.2). Total larval control material use in 2013 was lower than 2012 (Table 3.2).

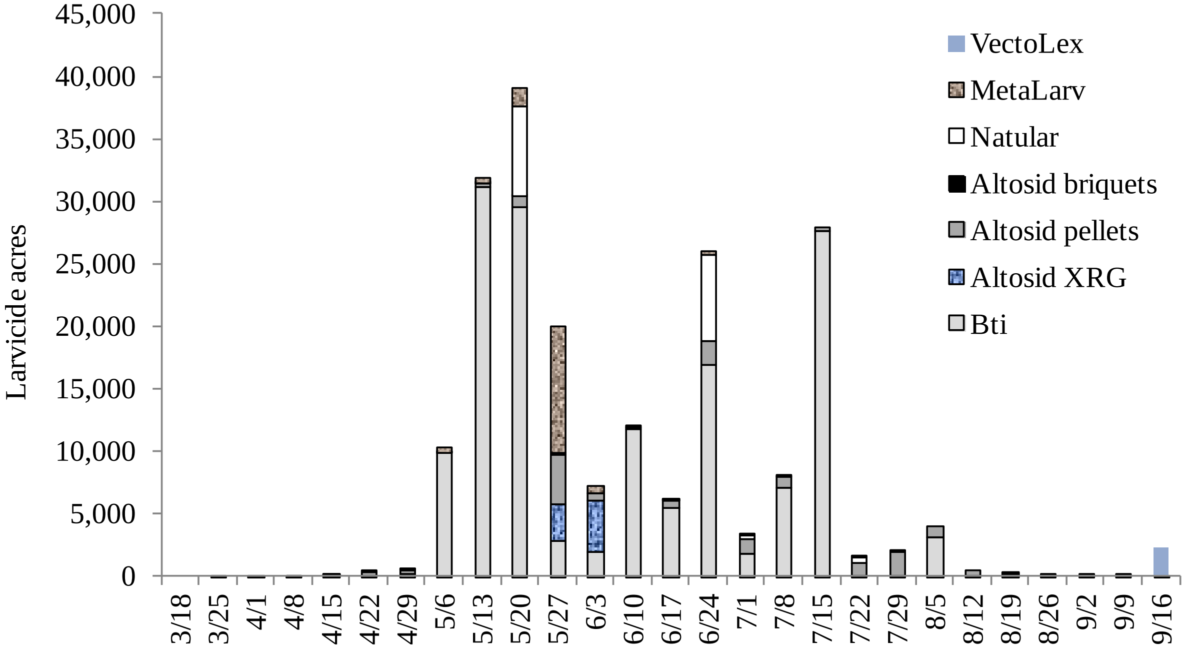


Figure 3.2 Acres treated with larvicide and each week (March-September 2013). Date represents start date of week.

Table 3.2 Comparison of larval control material usage in wetlands (including stormwater structures other than catch basins) and in stormwater catch basins for 2012 and 2013 (research tests not included)

		2012		2013	
Material	AI	Amount used	Area treated	Amount used	Area treated
Wetlands					
Altosid briquets	methoprene	228.71 cases	165 acres	252.26 cases	189 acres
Altosid pellets	methoprene	34,646.62 lb	13,172 acres	45,072.53 lb	15,813 acres
Altosid XR-G	methoprene	234,360.00 lb	23,436 acres	69,480.00 lb	6,948 acres
VectoLex CG	*B. sphaericus*	0.00 lb	0 acres	34,950.00 lb	2,330 acres
Natular G30	spinosad	47,629.65 lb	9,524 acres	75,000.00 lb	15,000 acres
MetaLarv S-PT	methoprene	10,865.65 lb	2,750 acres	40,012.54 lb	14,063 acres
VectoBac G	*Bti*	1,362,095.11 lb	207,827 acres	1,157,073.68 lb	150,280 acres
Larvicide subtotals			256,874 acres		204,623 acres
Catch basins					
Altosid briquets	methoprene	2.08 cases	458 CB[1]	1.70 cases	375 CB[1]
Altosid pellets	methoprene	1,751.30 lb	226,398 CB	1,956.18 lb	245,925 CB
VectoLex CG	*B. sphaericus*	0.61 lb	78 CB	0.00 lb	0 CB
CB subtotals			226,934 CB		246,300 CB

[1] CB=catch basin treatments

Aerial larvicide disruption due to a tragic helicopter crash resulted in significant areas remaining untreated during the *Ae. vexans* brood that began before aerial larvicide operations were able to resume. This likely impacted control enough to contribute to high adult mosquito abundance detected by surveillance beginning in early July, especially in P1 (Figure 3.3).

- The helicopter crash occurred on the morning of June 19, the third and final day of aerial *Bti* treatments to control a moderate *Ae. vexans* brood (6,660 acres). All *Bti* treatments were completed.
- No helicopters were available until the sixth day (June 25) after the crash.
- 7,640 acres worth of *Ae. vexans* prehatch (Natular G30 and MetaLarv S-PT) treatments planned to commence on June 20 were delayed five days. These treatments were completed between June 25 and July 1.
- Significant amounts of rain fell District-wide each day between June 20 and June 23; *Ae. vexans* larvae began to hatch between June 21 and June 24 resulting in a large brood containing mixed larval instars (instars 1-4).
- When aerial larvicide treatments resumed on June 25, some *Ae. vexans* larvae were too developed (mid-fouth instar) to still be susceptible to control with *Bti*.
- We reduced the *Bti* dosage from 8 lb/acre to 5 lb/acre to treat as many remaining acres as possible in the time remaining. This dosage reduction enabled helicopters to treat 37.5% more acres before returning to the landing site to refill hoppers with *Bti*.
- Increased larval thresholds from 2 larvae/dip to 5 larvae/dip in P1.
- We were able to treat 16,318 acres (74%) with *Bti* out of 22,035 acres that yielded above-threshold larval dip counts.
- Larvae in 5,717 acres were too developed to control with *Bti*.
- Adult mosquito abundance as measured by Monday night CO_2 traps was lower in P1 until July 8 when levels in P1 increased to P2 levels, presumably reflecting in part the impact of mosquitoes emerging from over 5,000 acres that could not be treated (Figure 3.3).

- We resumed *Bti* treatments at 8 lb/acre of sites with ≥2 larvae/dip during the next small brood (begin July 2).
- 34,210 acres worth of *Bti* was applied in P1 between July 10-18 (Figure 3.4). All sites containing threshold levels of larvae were treated successfully. No *Bti* was applied in P2.
- After July 15, adult mosquito abundance as measured by Monday night CO_2 traps in P1 again was lower than levels in P2; this pattern held through August 19 after which time, mosquito adundance District-wide dropped to very low levels (Figure 3.4).

Stormwater catch basin treatments to control *Culex* mosquitoes began in early June and ended in early September. Most catch basins were treated three times with Altosid pellets (3.5 grams per catch basin) from June through mid-September (Table 3.2).

Surveillance in 2013 suggests that *Ae. japonicus* abundance and distribution are leveling off throughout the District (details included in Chapter 1, Exotic Species). Although most larvae have been found in containers, they have also been found in a wide variety of habitats including stormwater structures and catch basins. Control efforts for this species continued to focus on removal of larval container habitats, and treatment of other habitat as needed.

We continued to work with Minnesota Pollution Control Agency (MPCA) to satisfy the requirements of our National Pollution Discharge Elimination System (NPDES) permit. We submitted our 2012 treatment report to MPCA after the beginning of 2013. Our report contained site-specific larval surveillance and larvicide treatment records and GIS-encoded locations of sites (more details included in Chapter 6). We submitted a similar report of 2013 activities in early 2014.

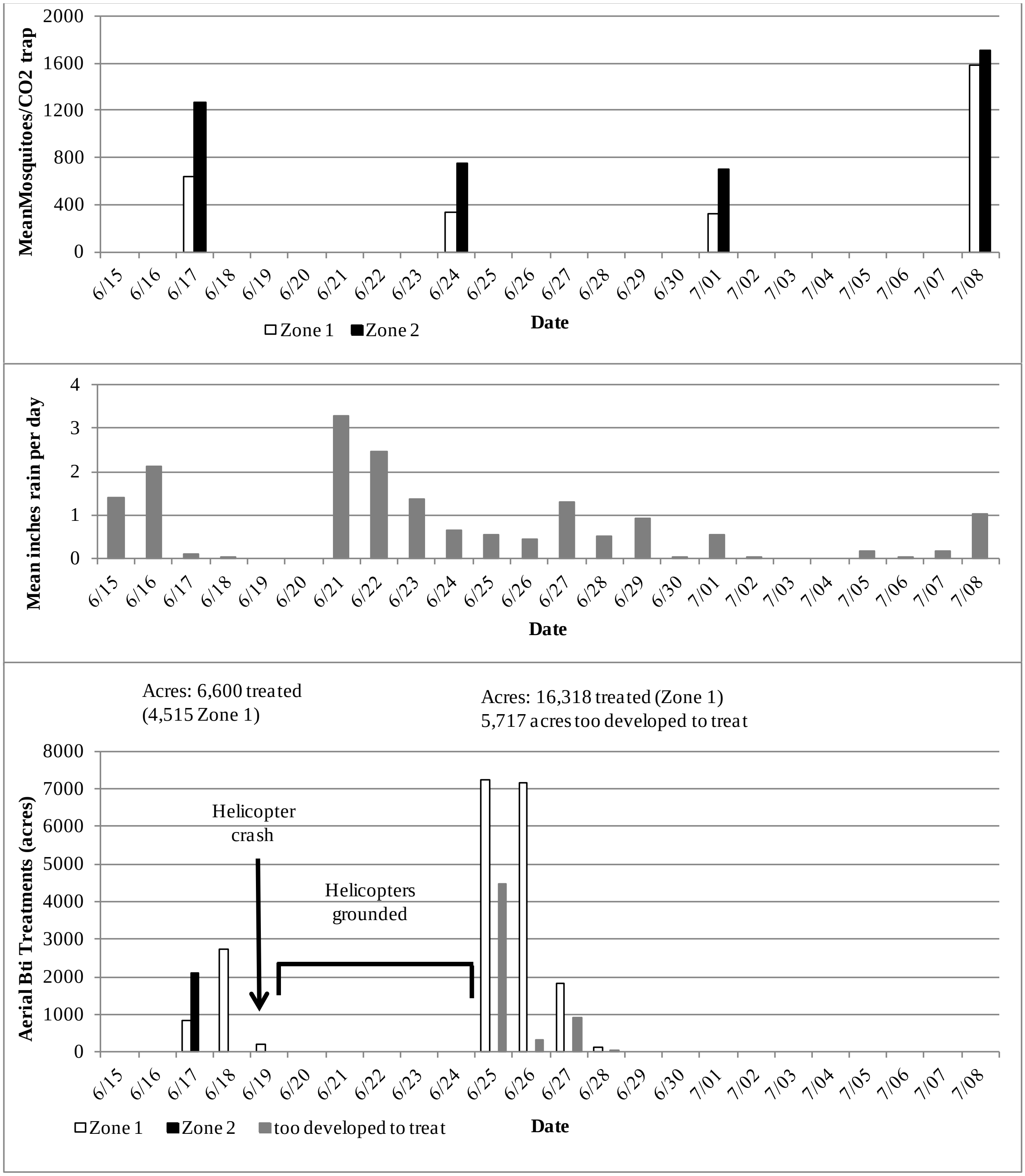


Figure 3.3 Monday night CO_2 trap results, daily rainfall, and aerial *Bti* treatments for P1 and P2 before and after the helicopter crash on June 19, 2013.

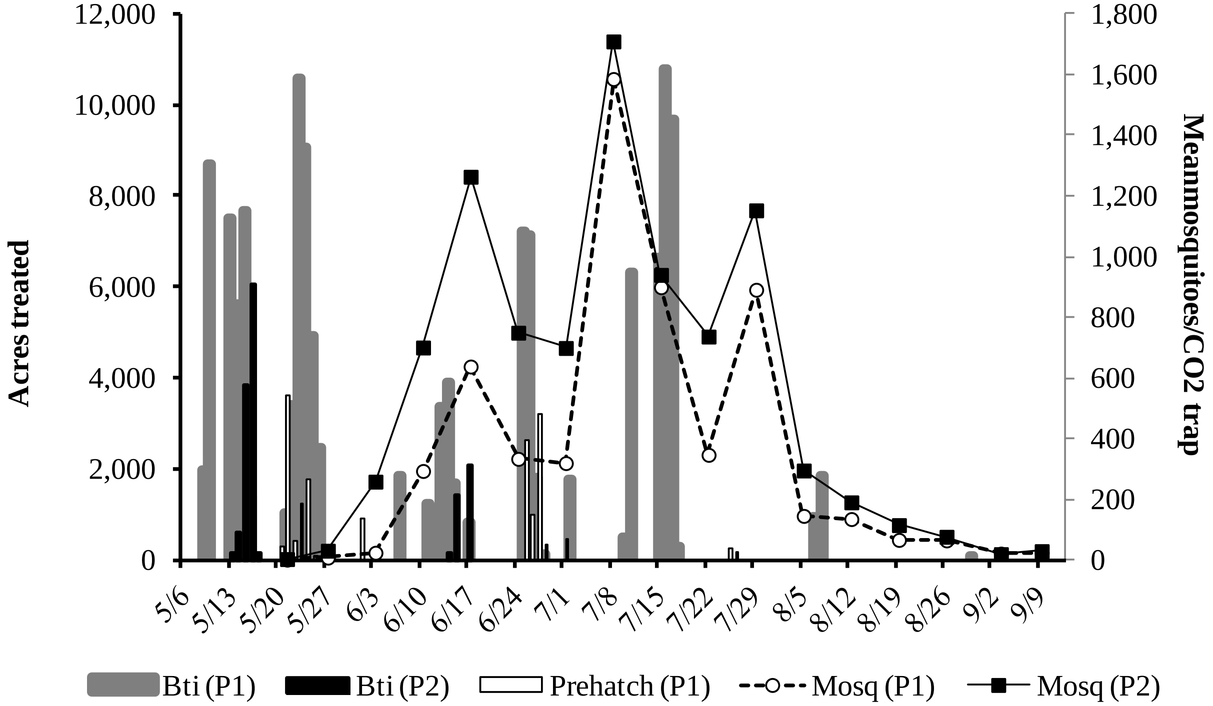


Figure 3.4 Monday night CO_2 trap results in P1 and P2, aerial *Bti* treatments for P1 and P2 and aerial prehatch treatments (P1 only, no prehatch applied in P2) in 2013.

Adult Mosquito Control

Thresholds Adult mosquito control operations are considered when mosquito levels rise above established thresholds for nuisance (*Aedes* spp. and *Cq. perturbans*) and vector species (Table 3.3). Staff conducted a study in the early 1990s that measured people's perception of annoyance while simultaneously sampling the mosquito population (Read et.al., 1994). Results of this study are the basis of MMCD's nuisance mosquito thresholds. The lower thresholds for vector species are designed to interrupt the vector/virus transmission cycle.

Table 3.3 Thresholds levels by sampling method for important nuisance and vector species detected in MMCD surveillance. *Aedes* spp. and *Cq. perturbans* are considered nuisance mosquitoes; all other species listed are disease vectors.

		Total number of mosquitoes			
Species	Date implemented	2-min sweep	CO_2 trap	5-min Aspirator	Gravid trap
Aedes triseriatus	1988			2	
Aedes spp. & *Cq. perturbans*	1994	2*	130		
*Culex*4	2004	1	5	1**	5
Ae. japonicus	2009	1	1	1	1
Cs. melanura	2012		5	5	

*2-minute slap count may be used

**Aspirator threshold only for *Cx. tarsalis*

Season Overview In 2013, adult mosquito levels rose in mid-June before peaking in late June through mid-July; at those times, counts over threshold were fairly widespread (Figure 3.5). Customer calls in 2013 (3,907) were higher than in 2012 (3,207). In 2013, MMCD applied 38,082 more acres worth of adulticides than in 2012 (Table 3.4, Appendix E). The increase was driven by adult mosquito surveillance that detected threshold levels in more areas of the District. Figure 3.5 shows weekly adulticide acres treated (line). The peaks in late June and early July reflect a response to both widespread *Ae. vexans* and *Cq. perturbans* emergence and increasing numbers of *Culex* (WNV vectors). The number of traps over the vector threshold remained high for much of the summer. Ninety-nine percent of adulticide treatments were associated with an identified pre-treatment adult mosquito sample (a two-minute slap was used to document treatment thresholds for the remaining 1%). For the entire season, about 30% of treatments were in response to threshold levels of vector mosquitoes. A greater proportion of ULV and barrier treatments later in the summer targeted vector mosquitoes.

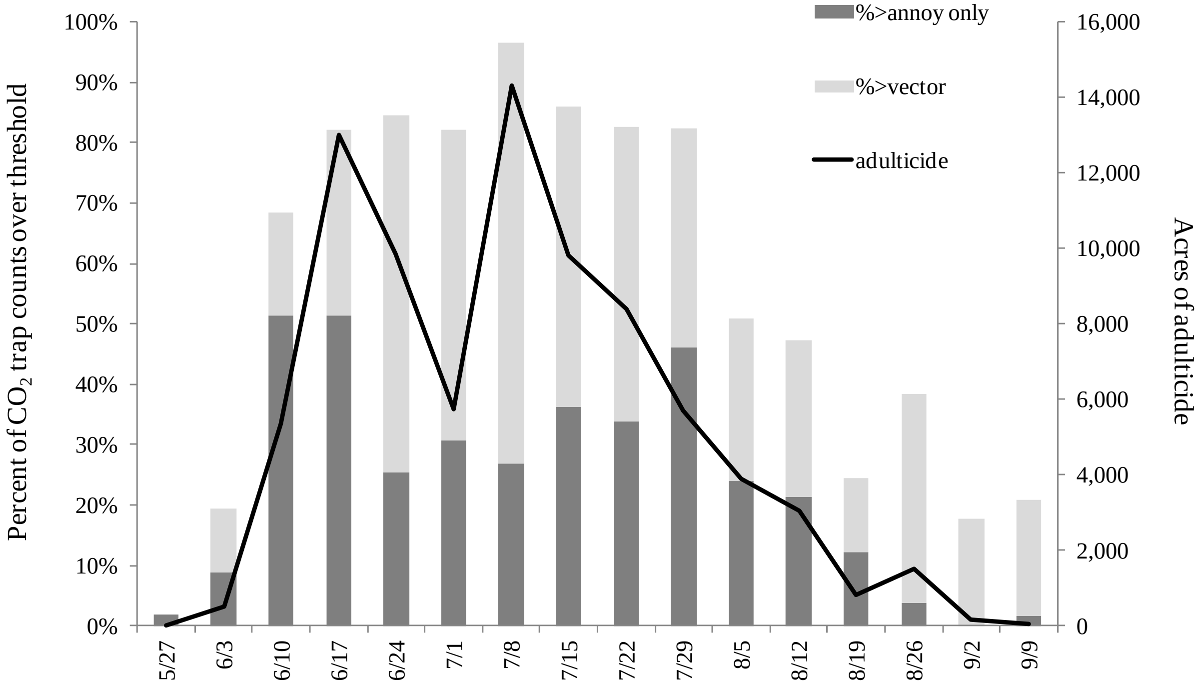


Figure 3.5 Percent of Monday CO_2 trap locations with counts over threshold (date is day of CO_2 trap placement), showing subtotals by annoyance or vector thresholds (*Culex*, *Ae. triseriatus*, *Ae. japonicus*), with acres of adulticides applied, 2013.

Table 3.4 Comparison of adult control material usage in 2012 and 2013

	2012		2013	
Material	Gallons used	Acres treated	Gallons used	Acres treated
Permethrin	1,675.27	8,578	1,761.67	9,020
Resmethrin	94.67	8,078	435.98	37,204
Sumithrin*	645.14	27,486	843.76	36,000
Total		44,142		82,224

* Products labeled for use in agricultural areas

2014 Plans for Mosquito Control Services

Integrated Mosquito Management Program

In 2014, MMCD will review all aspects of its integrated mosquito management program to ensure that budgetary resources are being used as effectively as possible with the goal of maximizing mosquito control services per budget dollar and complying with all NPDES-related permit requirements. Further discussion regarding the Clean Water Act's NPDES permit requirements is in Chapter 6. Our Control Materials budget in 2014 will be increased slightly compared to 2013. Most of the increase will be used to support larval control.

Larval Control

Cattail Mosquitoes In 2014, control of *Cq. perturbans* will use a strategy similar to that employed in 2013. MMCD will focus control activities on the most productive cattail marshes near human population centers. Altosid briquet applications will start in early March to frozen sites (e.g., floating bogs, deep water cattail sites, remotely located sites). Because of new control material prices, more acres will be treated with Altosid pellets and MetaLarv S-PT to minimize per-acre treatment costs. Altosid XR-G sand will not be used in 2014. Beginning in late May, staff will apply MetaLarv S-PT (3 lb/acre) and Altosid pellets (4 lb/acre) aerially. Ground sites will be treated with Altosid pellets (4 lb/acre) and MetaLarv S-PT (3 lb/acre). Staff will increase late summer VectoLex CG applications (15 lb/acre) into our cattail mosquito control program based upon site inspections completed between mid-August and mid-September.

Spring *Aedes* and Floodwater Mosquitoes The primary control material will again be *Bti* corn cob granules augmented with Altosid pellets, Natular G30, and MetaLarv S-PT. As in previous years, to minimize shortfalls, control material use may be more strictly rationed during the second half of the season, depending upon the amount of the season remaining and control material supplies. Regardless of annoyance levels, MMCD will maintain sufficient resources to protect the public from potential disease risk.

Staff will treat ground sites with methoprene products (Altosid pellets, Altosid briquets, MetaLarv S-PT), Natular G30, or *Bti* corncob granules. During a wide-scale mosquito brood, sites in highly populated areas will receive treatments first. The District will then expand treatments into less populated areas where treatment thresholds are higher. We will continue with the larval treatment thresholds used in 2013 (Table 3.1).

Budgeted larvicide needs in 2014, mainly *Bti* - VectoBac G, Altosid pellets, Natular G30, and MetaLarv S-PT, are expected to be similar to the five-year average larvicide usage (240,337 acres).

Each year staff review ground site histories to identify those sites that produce mosquitoes most often. This helps us to better prioritize sites to inspect before treatment, sites to pre-treat with Natular G30 or methoprene products before flooding and egg hatch, and sites not to visit at all. The ultimate aim is to provide larval control services to a larger part of the District by focusing on the most prolific sites.

Vector Mosquitoes Employees will routinely monitor and control *Ae. triseriatus*, *Ae. japonicus, Ae. albopictus, Cs. melanura, Cx. tarsalis, Cx. pipiens, Cx. restuans,* and *Cx. salinarius* populations (See Chapter 2).

MMCD has expanded control to four *Culex* species since the arrival of WNV in 2002. Ground and aerial larvicide treatments of wetlands have been increased to control *Culex*. Catch basin treatments control *Cx. restuans* and *Cx. pipiens* in urban areas. Most catch basins will be treated with Altosid pellets. Catch basins selected for treatment include those found holding water, those that potentially could hold water based on their design, and those for which we have insufficient information to determine whether they will hold water. Treatments could begin as early as the end of May and no later than the third week of June. We tentatively plan to complete a first round of pellet treatments by June 28 with subsequent Altosid pellet treatments every 30 days.

We intend to continue working cooperatively with cities to treat underground stormwater management structures (see Chapter 2) and slowly expand the kinds of structures we treat with larvicides beyond pond level regulators.

Intensive surveillance for *Ae. japonicus* and *Cs. melanura* will continue in 2014 to determine abundance and common larval habitats and refine potential larval control methods.

Adult Mosquito Control

Staff will continue to review MMCD's adulticide program to ensure effective resource use and minimize possible non-target effects. Budgeted adulticide needs in 2014 are similar to 2013 requirements. We will continue to focus efforts where there is potential disease risk, as well as provide service in high-use park and recreation areas and for public functions, and respond to areas where high mosquito numbers are affecting citizens.

We plan to use Anvil (sumithrin) as needed to control WNV vectors in agricultural areas because the updated label now allows applications in these areas. We will also be evaluating possible adulticide use in response to *Ae. japonicus* and *Cs. melanura*. We plan to continue testing additional ULV adulticides (see Chapter 5) to replace Scourge® (resmethrin), which the manufacturer, Bayer, has withdrawn from re-registration. We are working to ensure that all employees who may apply adulticides have passed applicator certification testing, in preparation for a shift in label status of permethrin to Restricted Use (certified applicators only).

References Cited

Read, N., J.R. Rooker, and J. Gathman. 1994. Public perception of mosquito annoyance measured by a survey and simultaneous mosquito sampling. J. Am. Mosq. Control Assoc. 10(1): 79-87.

Chapter 4 Black Fly Control

2013 Highlights

- Treated 34 small streams sites with *Bti* when the *Simulium venustum* larval population met the treatment threshold; a total of 14.6 gallons of *Bti* was used for these treatments
- Treated 69 large rivers sites with *Bti* when the larval population of the target species met the treatment threshold; a total of 3,863.5 gallons of *Bti* was used for these treatments
- Monitored adult populations using overhead net sweeps and CO_2 traps
- Completed report for Mississippi River non-target monitoring samples collected in 2011

2014 Plans

- The larval treatment threshold will be the same as previous years
- Monitor adult populations by the overhead net sweep and CO_2 trap methods
- Process Mississippi River non-target monitoring samples collected in 2013

Background

The goal of the black fly control program is to reduce pest populations of adult black flies within the MMCD to tolerable levels. Black flies develop in clean flowing rivers and streams. Larval populations are monitored at more than 170 small stream and at 28 large river sites using standardized sampling techniques during the spring and summer. Liquid *Bti* is applied to sites when the target species reach the treatment threshold.

The small stream treatment program began in 1984. The large river program began with experimental treatments and non-target impact studies in 1987. A full-scale large river treatment program did not go into effect until 1996. The large river treatment program was expanded in 2005 to include the South Fork Crow River in Carver County. Large river and small stream monitoring/treatment locations are shown in Figure 4.1.

2013 Program

Small Stream Program: *Simulium venustum* Control

Simulium venustum is the only human-biting black fly species that develops in small streams in the MMCD area that is targeted for control. It has one generation in the spring.

In April and May, 209 larval monitoring samples were collected from 25 streams to determine larval abundance using the standard grab sampling technique developed by the MMCD. The treatment threshold was 100 *S. venustum* per sample. A total of 34 sites on 16 streams met the threshold and were treated once with VectoBac® 12AS *Bti*. A total of 14.6 gallons of VectoBac was used for the treatments (Table 4.1). The average annual amount of *Bti* used to treat the small stream sites between 1996-2012 was 28 gallons.

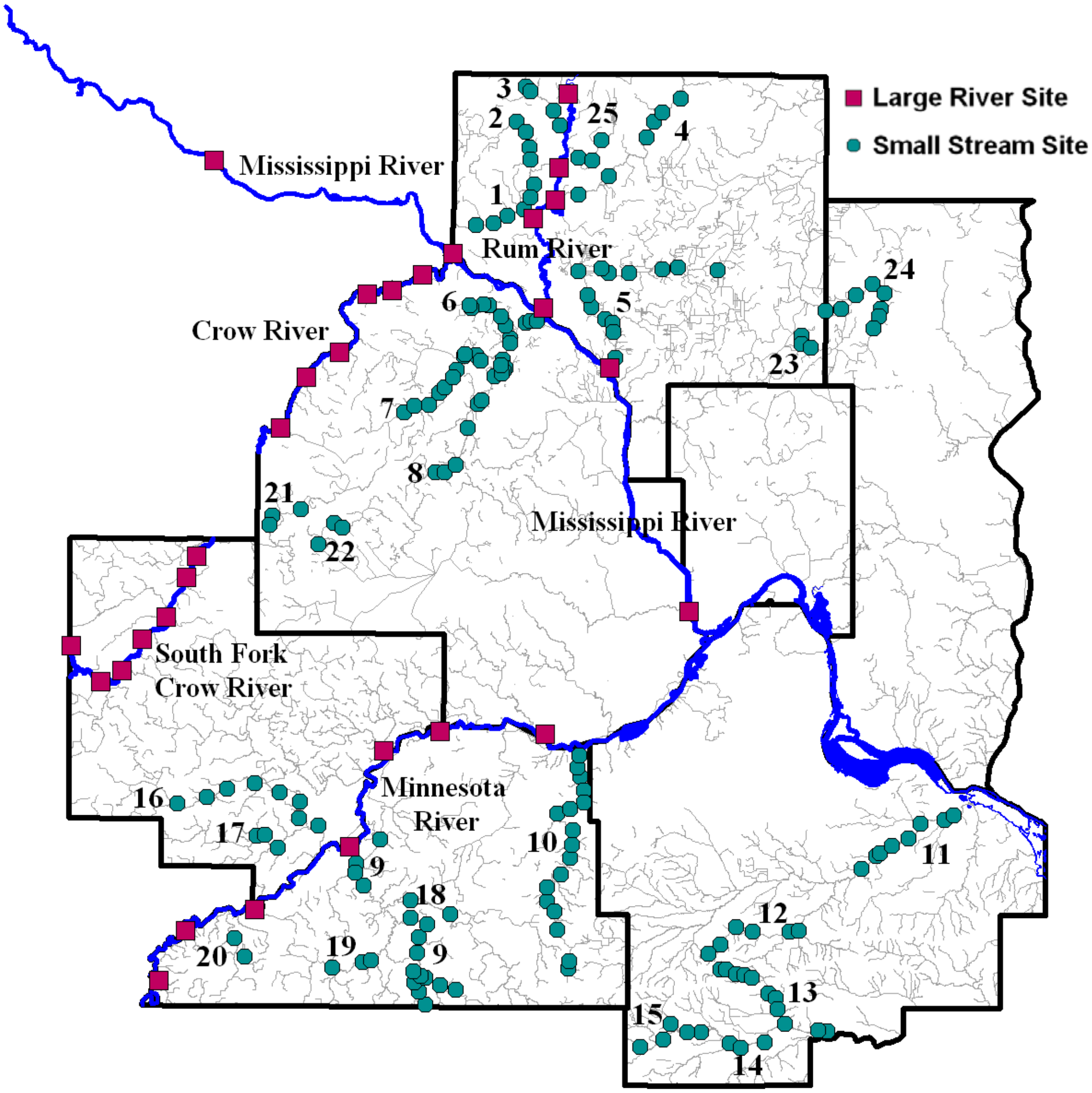


Figure 4.1 Large river and small stream black fly larval monitoring/treatment locations, 2013. Note: the large river site located outside the District on the Mississippi River is for monitoring only. Since 1991 more than 450 of the more than 600 original small stream treatment sites have been eliminated from the annual small stream sampling program. This is both due to the increased treatment threshold as well as our findings from years of sampling that some sites do not produce any, or very few, *S. venustum*. New sites are added periodically if larval monitoring confirms elevated *S. venustum* populations. The numbers on the map refer to the small stream names listed below:

1=Trott
2=Ford
3=Seelye
4=Cedar
5=Coon
6=Diamond
7=Rush
8=Elm
9=Sand
10=Credit
11=Vermillion
12=Vermillion So. Branch
13=Chub No. Branch
14=Chub
15=Dutch
16=Bevens
17=Silver
18=Porter
19=Raven W. Br.
20=Robert
21=Pioneer
22=Painter
23=Clearwater
24=Hardwood
25=Ditch 19

Table 4.1 Summary of *Bti* treatments for black fly control by the MMCD in 2012 and 2013

	2012			2013		
Water body	No. sites treated	Total no. treatments	Gallons of *Bti* used	No. sites treated	Total no. treatments	Gallons of *Bti* used
Small Stream Totals	29	29	6.9	34	34	14.6
Large River						
Mississippi	2	10	1,334.5	2	10	1,337.3
Crow	1	1	19.9	3	6	114.4
South Fork Crow	3	9	47.2	6	14	95.0
Minnesota	7	22	1,407.9	7	19	2,160.3
Rum	5	28	280.1	3	20	172.5
Large River Totals	18	70	3,089.5	21	69	3,863.5
Grand Total	47	99	3,096.5	55	103	3,878.1

Large River Program

MMCD targets three large river black fly species for control with *Bti*. *Simulium luggeri* larvae occur mainly in the Rum and Mississippi rivers, although they also occur in smaller numbers in the Minnesota and Crow rivers. Depending on river flow, *S. luggeri* is abundant from mid-May through September. *Simulium meridionale* and *Simulium johannseni* larvae occur primarily in the Crow, South Fork Crow, and Minnesota rivers. These species are most abundant in May and June, although *S. meridionale* populations may remain high throughout the summer if river flow is also high.

The large river black fly larval populations were monitored weekly between May and mid-September using artificial substrate samplers (Mylar tapes) at the 28 sites permitted by the MnDNR on the Rum, Mississippi, Crow, South Fork Crow, and Minnesota rivers to determine if the treatment threshold was met. The treatment threshold for *S. luggeri* was an average of 100 larvae/sampler at each treatment site location. The treatment threshold for *S. meridionale* and *S. johannseni* was an average of 40 larvae/per sampler at each treatment site location. These were the same treatment thresholds used since 1990.

A total of 432 larval monitoring samples were collected from the 28 permitted sites in 2013. The treatment threshold was met in 69 of these samples (from 21 of the 28 permitted sites) and the associated sites were treated with *Bti*. The average post-*Bti* treatment larval mortality (measured at least 250 m downstream of the point of the *Bti* application) was 100% on the Mississippi River, 91% on the Minnesota River, 95% on the Rum River, 95% on the Crow River, and 92% on the South Fork Crow River. A total of 3,863.5 gallons of VectoBac 12AS *Bti* was used in the 69 treatments in 2013 (Table 4.1). The average amount of *Bti* used to treat the large rivers annually between 1997 and 2012 was 2,956 gallons.

Adult Population Sampling

Daytime Sweep Net Collections The adult black fly population was monitored at 53 standard stations throughout the MMCD using the District's standard black fly over-head net sweep technique that was established in 1984. Samples were taken once weekly from early May to mid-September, generally between 8:00 A.M. and 10:00 A.M. The average number of all species of adult black flies captured in 2013 was 1.27 (Table 4.2). The average number of all adult black flies captured per net sweep sample from 1984 to 1986, when no large river *Bti* treatments were done, was 14.79. Between 1987 and 1995, when limited experimental *Bti* treatments were conducted on the large rivers, the average number of adult black flies captured per sample was 3.63. The average number of adult black flies captured per sample since the start of the District's full-scale large river larval black fly control program from 1996 to 2012 was 1.52.

The most abundant black fly collected in the overhead net-sweep samples in 2013 was *S. luggeri*, comprising 59% of the total captured. The average number of *S. luggeri* captured per net-sweep sample District-wide was 0.75 (Table 4.2). *Simulium luggeri* was most abundant in Anoka County, as it has been since black fly adult monitoring began in 1984, with an average of 3.39 per sample. The second highest number of *S. luggeri* were collected in Hennepin County with an average of 1.22 per sample. The average number of *S. luggeri* collected in the other MMCD counties (Carver, Dakota, Ramsey, Scott, and Washington) was between 0 and 0.51 per sample. The higher number of *S. luggeri* captured in Anoka County versus other areas of the MMCD each year is most likely due to the close proximity of prime *S. luggeri* larval habitat in the nearby Rum and Mississippi rivers.

The second most abundant black fly adult species captured in the net sweep samples in 2013 was *S. meridionale*, comprising 22% of the overall number of black flies captured. The overall average number of *S. meridionale* captured per sample was 0.28 per (Table 4.2). The highest number of *S. meridionale* were captured in Carver County (mean = 1.05/sample).

Black Fly Specific CO_2 Trap Collections Adult black fly populations were monitored in 2013 between mid-May and mid-June with CO_2 traps at four stations each in Scott and Anoka counties, and five stations in Carver County. The sites in Anoka and Scott counties have been monitored since 1998. Monitoring began in Carver County in 2004 when larval treatments were started on the South Fork Crow River. Black flies captured in the CO_2 traps are preserved in alcohol to facilitate species identification.

The CO_2 trap collection results are in Table 4.3. The most abundant black fly species captured in the traps were *S. venustum, S. johannseni,* and *S. meridionale*. These results are similar to those observed since CO_2 trap monitoring began in 1998 (Table 4.3). The average number of *S. venustum* captured per trap in 2013 was 14.61 in Anoka County, 3.09 in Scott County and 1.44 in Carver County. The average number of *S. venustum* captured per trap between 1998 and 2012 was 12.02 in Anoka County, 42.89 in Scott County and 88.77 in Carver County. The average number of *S. johannseni* captured per trap in 2013 was 1.18 in Anoka County, 4.88 in Scott County, and 14.03 in Carver County. The average number of *S. johannseni* captured per trap between 1998 and 2012 was 0.99 in Anoka County, 34.14 in Scott County, and 603.70 in Carver

County. The average number of *S. meridionale* captured per CO_2 trap in 2013 was zero in Anoka County, 111.45 in Scott County, and 322.42 in Carver County. The average number of *S. meridionale* captured per trap between 1998 and 2012 was 1.60 in Anoka County, 134.36 in Scott County and 314.52 in Carver County.

Table 4.2 Annual mean number of black fly adults captured in over-head net sweeps in samples taken at standard sampling locations throughout the MMCD between mid-May and mid-September; samples were taken once weekly beginning in 2004 and twice weekly in previous years

Year	All species[4]	*Simulium luggeri*	*Simulium johannseni*	*Simulium meridionale*
1984	17.95	16.12	0.01	1.43
1985	14.56	13.88	0.02	0.63
1986	11.88	9.35	0.69	1.69
1987	6.53	6.33	0.02	0.13
1988[1]	1.60	1.54	0.05	0.00
1989	6.16	5.52	0.29	0.18
1990[2]	6.02	5.70	0.01	0.24
1991	2.59	1.85	0.09	0.60
1992	2.63	2.19	0.12	0.21
1993	3.00	1.63	0.04	1.24
1994	2.41	2.31	0.00	0.03
1995	1.77	1.34	0.32	0.01
1996[3]	0.64	0.51	0.01	0.07
1997	2.91	2.49	0.00	0.25
1998	2.85	2.64	0.04	0.04
1999	1.63	1.34	0.04	0.06
2000	2.38	2.11	0.01	0.02
2001	1.30	0.98	0.04	0.18
2002	0.61	0.43	0.01	0.14
2003	1.96	1.65	0.01	0.20
2004	0.97	0.35	0.02	0.39
2005	0.74	0.58	0.01	0.08
2006	0.55	0.45	0.00	0.04
2007	0.82	0.60	0.00	0.12
2008	1.07	0.88	0.01	0.08
2009	1.80	1.60	0.01	0.07
2010	2.16	1.92	0.03	0.11
2011	1.96	1.31	0.04	0.45
2012	1.55	1.33	0.00	0.11
2013	1.27	0.75	0.00	0.28

[1] 1988 was a severe drought year and limited black fly production occurred.

[2] The first operational treatments of the Mississippi River began in 1990 at the Coon Rapids Dam.

[3] First year of full operational treatments on large rivers.

[4] All species includes *S. luggeri*, *S. meridionale*, *S. johannseni*, and all other species collected.

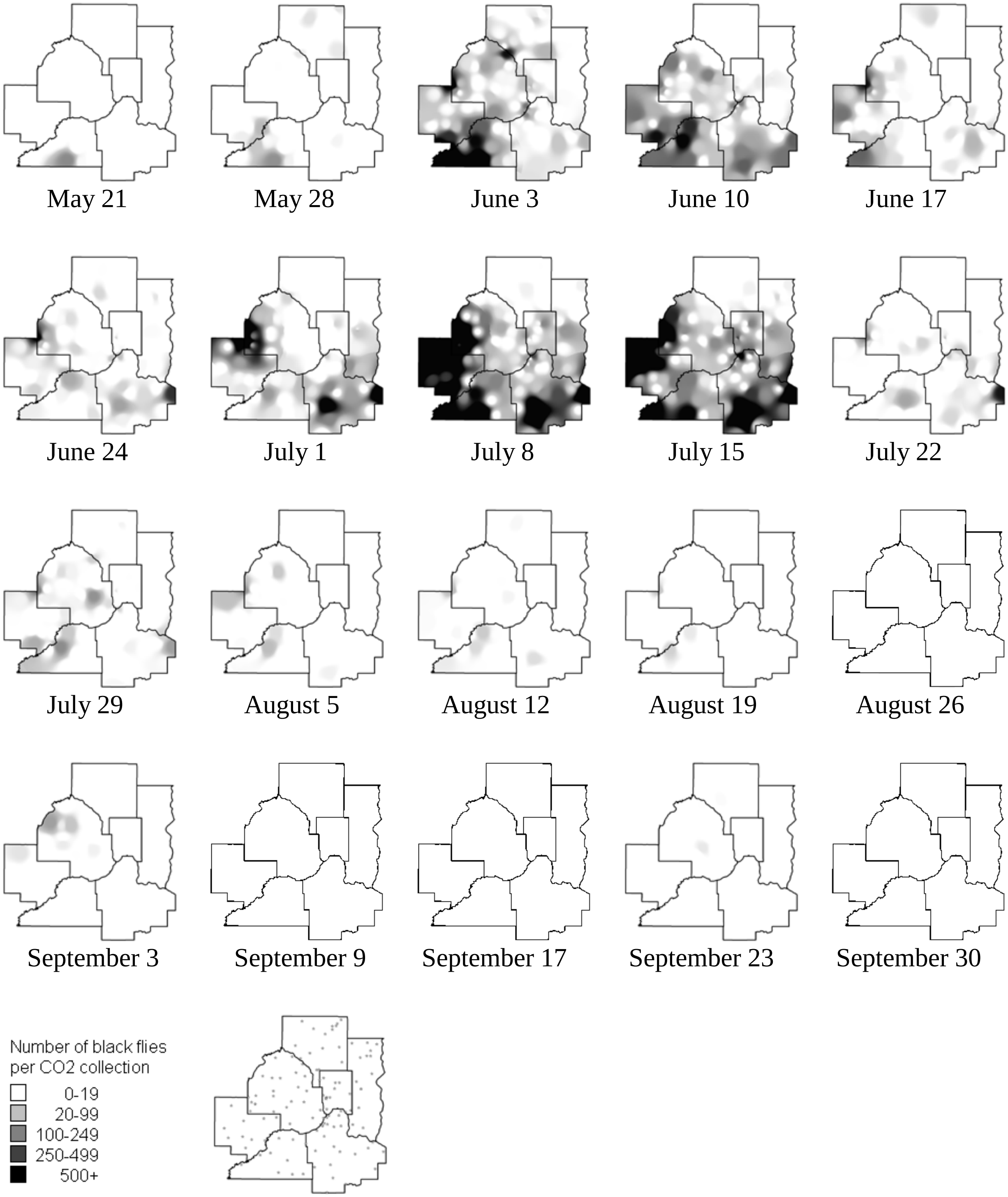
Table 4.3 Mean number of adult *S. venustum*, *S. johannseni*, and *S. meridionale* captured in CO_2 traps set twice weekly between May and mid-June in Anoka, Scott, and Carver counties

	S. venustum			*S. johannseni*			*S. meridionale*		
Year	Anoka	Scott	Carver[1]	Anoka	Scott	Carver[1]	Anoka	Scott	Carver[1]
1998	15.34	3.16		2.42	1.08		0.08	2.56	
1999	1.53	6.58		0.26	5.50		0.30	35.35	
2000	4.83	0.51		0.08	1.71		0.35	11.17	
2001	6.22	8.30		0.37	4.70		0.29	611.27	
2002	4.77	0.62		0.26	0.41		1.09	53.82	
2003	18.29	1.76		1.35	12.93		2.61	109.57	
2004	0.89	2.25	0.25	5.11	0.17	32.93	14.09	0.65	327.29
2005	2.31	3.40	0.84	0.03	3.50	99.04	1.23	23.25	188.02
2006	22.80	3.38	1.82	0.75	38.07	98.75	0.75	10.50	107.53
2007	37.62	35.59	75.67	0.2	32.50	112.77	0.51	172.48	388.64
2008	13.84	228.93	169.63	0.13	20.18	95.63	0.68	75.03	359.02
2009	18.32	238.16	425.00	0.34	22.80	35.92	0.70	98.77	820.25
2010	21.75	44.60	77.00	0.03	6.18	219.38	0.05	256.90	271.08
2011	8.90	60.64	48.30	2.61	280.64	4,584.72	0.93	311.55	268.28
2012	2.89	5.45	0.40	0.95	81.73	154.13	0.41	242.55	100.53
2013	14.61	3.09	1.44	1.18	4.88	14.03	0.00	111.45	322.43

[1] The first year of CO_2 trap monitoring in Carver County was 2004.

Monday Night CO_2 Trap Home Collections Black flies captured in District-wide CO_2 traps operated weekly for mosquito surveillance (see Chapter 1) were counted and identified to family level in 2013. Because these traps are operated for mosquito surveillance, samples are not placed in ethyl alcohol making black fly species-level identification difficult. Results are represented geographically in Figure 4.2.

The areas in dark gray and black represent the highest numbers collected, ranging from 250 to more than 500 per trap. The highest number of black flies was observed in June and July in parts of Carver, Scott, Dakota, and Hennepin counties (Figure 4.2). The results in Scott and Carver counties are similar to those obtained from the standard black fly CO_2 trap sampling.



May 21 May 28 June 3 June 10 June 17

June 24 July 1 July 8 July 15 July 22

July 29 August 5 August 12 August 19 August 26

September 3 September 9 September 17 September 23 September 30

CO_2 Trap Locations

Figure 4.2 Number of black flies collected in mosquito surveillance District low (5 ft) and elevated (25 ft) CO_2 traps, 2013. The number of traps operated per night varied from 113-122. Inverse distance weighting was the algorithm used for shading of maps.

Non-target Monitoring

The District has conducted biennial monitoring of the non-target invertebrate population in the Mississippi River as part of its MnDNR permit requirements since 1995. The monitoring program was designed as a long-term assessment of the invertebrate community in *Bti*-treated reaches of the Mississippi River. Results from the monitoring work done between 1995 and 2011 indicate that there have been no large-scale changes in macroinvertebrate community in the *Bti*-treated reaches of the Mississippi River. Monitoring samples were collected from the Mississippi River as scheduled in 2013. Sample processing and enumeration is ongoing.

2014 Plans – Black Fly Program

2014 will be the 30th year of black fly control in the District. The primary goal in 2014 will be to continue to effectively monitor and control black flies in the large rivers and small streams. The larval population monitoring program and thresholds for treatment with *Bti* will continue as in previous years. The 2014 black fly control permit application was submitted to the MnDNR in February. A report on the non-target monitoring sampling done in 2013 is scheduled for completion in 2015. Program development will continue to emphasize improvements in program effectiveness, surveillance, and efficiency

Chapter 5 Product & Equipment Tests

2013 Highlights

- Both 8- and 5-lb/acre dosages of VectoBac® G *Bti* achieved good control of *Ae. vexans* in air sites
- Natular™ G30 controlled *Ae. vexans* in air sites for four weeks
- MetaLarv™ S-PT controlled spring *Aedes* as effectively as Altosid® pellets
- MetaLarv S-PT effectively controlled cattail mosquitoes
- Permethrin and Onslaught® (barrier) controlled mosquitoes including WNV vectors for up to one week in woodlots
- Zenivex® (ULV) controlled mosquitoes including WNV vectors as effectively as Scourge

2014 Plans

- Increase late summer cattail treatments of VectoLex® CG to control the cattail mosquito
- Repeat tests of MetaLarv S-PT against spring *Aedes* to evaluate its effectiveness as a spring pre-hatch larvicide
- Continue tests of Natular G and G30 against spring *Aedes* and the cattail mosquito to explore control potential (including non-target sampling in spring sites).
- Continue tests of adulticides in different situations emphasizing control of vectors and effectiveness of barrier treatments.

Background

Evaluation of current and potential control materials and equipment is essential for MMCD to provide cost-effective service. MMCD regularly evaluates the effectiveness of ongoing operations to verify efficacy. Tests of new materials, methods, and equipment enable MMCD to continuously improve operations.

2013 Projects

Quality assurance processes focused on product evaluations, equipment, and waste reduction. Before being used operationally, all products must complete a certification process that consists of tests to demonstrate how to use the product to effectively control mosquitoes. The District continued certification testing of two larvicides and two new adulticides. The larvicides and adulticides have been tested in different control situations in the past. Our goal is to determine that different larvicides can control two or more target mosquitoes in multiple control situations. One adulticide was tested as an alternative ULV material and the other as an alternative barrier material. These additional control materials will provide MMCD with more operational tools.

Control Material Acceptance Testing

Larval Mosquito Control Products Warehouse staff collected random product samples from shipments received from manufacturers for active ingredient (AI) content analysis. MMCD contracts an independent testing laboratory, Legend Technical Services, to complete the AI analysis. Manufacturers provide the testing methodologies. The laboratory protocols used were CAP No. 311, “Procedures for the Analysis of S-Methoprene in Briquets and Premix”, CAP No. 313, “Procedure for the Analysis of S-Methoprene in Sand Formulations”, VBC Analytical Method: VBC-M07-001.1 Analytical Method for the Determination of (S)-Methoprene by High Performance Liquid Chromatography and Clarke Analytical Test Method

SP-003 Revision #2 “HPLC Determination of Spinosad Content in Natular G30 Granules.”

Altosid briquets underwent a formulation change in 2013. The carrier matrix changed from a black carbon plaster-based product to a white silica-based briquet. This formulation did not alter the active ingredient release characteristics, field life, or its mode of action. The resulting change increased shelf stability and produced a product that did not chip or break as easily. Field staff appreciated that this product was less dusty and much cleaner to apply.

All 2013 samples were within acceptable values of the label claim of percent AI (Table 5.1). Independent lab samples of the Altosid pellets were analyzed and results were found to be lower than the label claim. Technical Services notified the manufacturer, Central Life Sciences, and the company initiated an investigation. The manufacturer’s certificates of analysis at the time of manufacture were all within acceptable limits. Voucher samples of both Central Life Sciences and MMCD were retested in Dallas, Texas and found to be within specifications. Central Life Sciences visited Legend Technical Services to closely review the analytical process and did clarify a few minor procedural differences with their new analyst. Legend was able to duplicate Central’s results after this consultation. Technical Services staff will continue to work with manufacturers to monitor AI content of future purchases.

Table 5.1 AI content of Altosid® (methoprene) briquets, pellets, and sand; MetaLarv S- PT granules (methoprene); and Natular G30 granule (spinosad)

Product evaluated	No. samples analyzed	AI content		SE
		Label claim	Analysis average	
Altosid XR-briquet	12	2.10%	2.16%	0.0149
Altosid pellets	12	4.25%	4.22%	0.0463
Altosid XR-G sand	12	1.50%	1.61%	0.0118
MetaLarv S-PT granules	12	4.25%	4.23%	0.0689
Natular G30 granules	12	2.50%	2.58%	0.0510

Adult Mosquito Control Products MMCD requests certificates of AI analysis from the manufacturers to verify product AI levels at the time of manufacture. MMCD has incorporated AI analysis as part of a product evaluation procedure and will submit randomly selected samples of adulticide control materials to an independent laboratory for AI level verification. This process will assure that all adulticides (purchased, formulated, and/or stored) meet the necessary quality standards. In 2013, MMCD did not analyze adulticide products and saved expenses of analysis for additional larvicide analysis. Technical Services will submit adulticides samples in 2014 to continue to monitor and build our adulticide database.

Efficacy of Control Materials

VectoBac® G VectoBac G brand *Bti* (5/8 inch mesh size corncob granules) from Valent BioSciences was the primary *Bti* product applied by helicopter in 2013. Because of the very cold spring, aerial *Bti* treatments began on May 9 (35 days later than first such treatments on April 4, 2012). We applied 8 lb/acre to control a mixture of spring *Aedes* and *Ae. vexans*. We suspended aerial treatments after the helicopter crash on June 19. When aerial *Bti* treatments resumed six days later, we switched from 8 lb/acre to 5 lb/acre to treat as many acres of an ongoing very large *Ae. vexans* brood as possible. The lower dosage permitted each helicopter to treat 60% more acres before landing to refill its material hoppers. We resumed using the 8 lb/acre dosage during the next small brood (begin July 2).

In 2011, the 8 lb/acre rate achieved 93.3% control (Table 5.2). The lower mean effectiveness of the 8 lb/acre *Bti* rate in 2013 (83%) seems to be due in part to the atypical beginning of the 2013 mosquito season (Table 6.3). Cold conditions persisting into early May delayed the development of spring *Aedes*. Frequent rainfall events in May resulted in multiple overlapping broods of mosquitoes. Both spring *Aedes* and *Ae. vexans* larvae were present in sites together until late May. Post treatment dips (*Bti* 8 lb/acre) collected between May 9 and May 17 indicated only 79% effectiveness (n=221 which is 41% of total post treatment dips). Efficacy of *Bti* (8 lb/acre) treatments completed after *Ae. vexans* predominated was higher (May 21 – Aug 8, excluding treatments [5 lb/acre] completed June 25-28 immediately after helicopter crash).

Table 5.2 Efficacy of aerial VectoBac G applications in 2011 (8 lb/acre), 2012 (5 lb/acre), and 2013 (8 lb and 5 lb/acre) (SE=standard error)

Year, dosage rate	n	Mean mortality	±SE
2011, 8 lb/acre	531	93.3%	0.9%
2012, 5 lb/acre	282	84.4%	1.9%
2013, 5 lb/acre (June 25 – 28)	52	82.2%	4.8%
2013, 8 lb/acre (May 9 – 17)	221	79.0%	2.3%
2013, 8 lb/acre (May 21 – Aug 8)	317	84.9%	1.4%

Natular^{TM} G30 in Air Sites Results of tests completed between 2008 and 2011 suggested that Natular G30 (5 lb/acre) could be an effective pre-hatch larvicide for controlling *Ae. vexans* up to four weeks. Post treatment inspections (dips) of sites treated operationally in 2012 revealed efficacy lasting four weeks.

In 2013, we treated over 7,000 acres of air sites twice with Natular G30 (5 lb/acre) to control *Ae. vexans* (657 sites). Sites chosen had a history of larval production after rain. Natular treatments occurred on May 26 and June 28; 424 acres (62 sites) were treated a third time on July 26. To evaluate effectiveness, we compared larval dip counts in Natular-treated sites with pre-treatment dip counts in sites treated with *Bti* (Figure 5.1).

Dip counts in Natular-treated sites up to four weeks after each treatment were much lower than *Bti* pre-treatment dip counts collected on similar dates, strongly suggesting that each Natular G30 treatment was effective for at least four weeks (Figure 5.1). Weekly cumulative rainfall was highest between mid-May and mid-July with one to three inches falling most weeks. All sites remained wet until two weeks after the July 26 treatment. The Natular G30 remained effective when dry, treated sites were flooded by a rain event in late July (Figure 5.1).

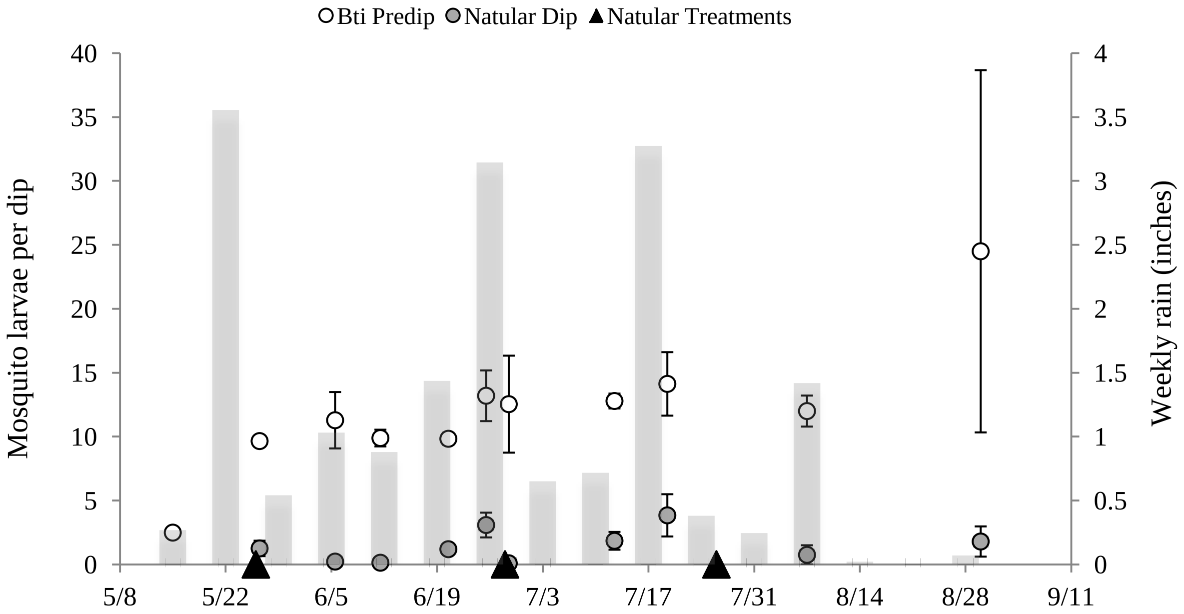


Figure 5.1 Control of *Aedes vexans* in air sites treated with Natular G30 (5 lb/acre) on May 26, June 28, and July 26, 2013 (dip counts in treated sites compared to *Bti* pre-treatment dips). Error bars equal ±1 SE; gray bars equal weekly cumulative rainfall. Natular (5/26 n=15 sites, 6/5 n=18, 6/11 n=39, 6/20 n=48, 6/25 n=39, 6/28 n=32, 7/12 n=23, 7/19 n=44, 8/7 n=4, 8/30 n=43)
Bti pre-treat dips (5/26 n=1,373 sites, 6/5 n=71, 6/11 n=587, 6/20 n=723, 6/25 n=85, 6/28 n=44, 7/12 n=1,457, 7/19 n=233, 8/7 n=166, 8/30 n=7)

New Control Material Evaluations

The District, as part of its Continuous Quality Improvement philosophy, strives to continually improve its control methods. Testing in 2013 was designed to evaluate how different segments of mosquito control programs can be modified to deliver more mosquito control services to a greater part of the District area using existing resources. Much testing has focused upon controlling multiple mosquito species including potential vectors of WNV.

Larval Control

Valent MetaLarv^{TM} S-PT in Ground Sites In 2010, MMCD tested MetaLarv S-PT (at that time an experimental larvicide designated as VBC-60215) in small ground sites. Results were promising enough to conduct larger scale aerial tests in 2011. MetaLarv S-PT received its EPA registration and label in late 2011. The active ingredient is S-methoprene, the same active ingredient as in Altosid products. In 2012, we applied MetaLarv S-PT to 2,750 acres (159 sites) to control *Ae. vexans*. Efficacy of MetaLarv S-PT as evaluated by bioassays collected from treated sites was similar to aerial Altosid pellet treatments (4 lb/acre) (see 2012 and 2005

Operational Reviews for details). Both MetaLarv S-PT and Altosid pellets are designed to have a 28-day field life.

In 2013, we treated 182 ground sites with MetaLarv S-PT (2.5 lb/acre) on May 2 and 805 sites with Altosid pellets (2.5 lb/acre) between April 17-29 to control spring *Aedes*. Efficacy was evaluated by comparing pupal bioassays collected from MetaLarv-treated, pellet-treated, and untreated sites. Bioassays from untreated and MetaLarv-treated sites were done in Dakota County; bioassays from pellet-treated sites were done primarily in Anoka. Overall efficacy was expressed as the mean emergence inhibition for treated sites and the proportion of bioassays from treated sites that were greater than the 95% confidence limit calculated for untreated bioassays (an estimate of mortality not due to larvicide treatment). Efficacy of MetaLarv S-PT and Altosid pellets was similar (Table 5.3, Figure 5.2). The single bioassay from a MetaLarv-treated site that was less than the 95% confidence limit was collected 33 days after treatment, which is beyond the 28-day field life of the product.

The extended cold conditions in 2013 that included significant snowfall the first week of May significantly delayed spring *Aedes* larval development which resulted in a very atypical spring brood. Larval samples collected between the last week of April and the third week of May contained a wide range of mosquitoes including spring *Aedes* and *Ae. vexans*, sometimes in the same site simultaneously. Finding enough pupae in both control and treated sites was difficult. Emergence inhibition in two bioassays successfully collected from untreated sites in 2013 was low; bioassay data derived from the same untreated sites during the same period in 2012 was included to calculate a more accurate upper 95% confidence limit for comparison with bioassay results from treated sites.

Table 5.3 Bioassay results (emergence inhibition=EI) of samples collected in MetaLarv S-PT and Altosid pellet treated sites compared to the upper 95% CL for untreated control bioassays*

Treatment	Bioassays (n)	Corrected EI mean (±SE)	Bioassays >95% CL (%)	Days after treatment mean (±SE)(min-max)
MetaLarv S-PT	16	78.06% (±7.27%)	15 (94%)	17.4 (±2.35) (3-33)
Altosid pellets	29	90.00% (±3.60%)	29 (100%)	23.4 (±1.39) (1-40)

*Untreated Control: mean EI=8.91% (SE=2.08%) (n=11); upper 95% CL=24.29%

These results suggest that both MetaLarv S-PT and Altosid pellets can effectively control spring *Aedes* and *Ae. vexans* during atypical seasons. These along with earlier results suggest that MetaLarv S-PT and Altosid pellets both are robust choices as an effective prehatch larvicide for spring *Aedes* and *Ae. vexans* in seasons with variable weather patterns. We plan to repeat these tests in 2014 to verify that control of spring *Aedes* is consistent during different seasons.

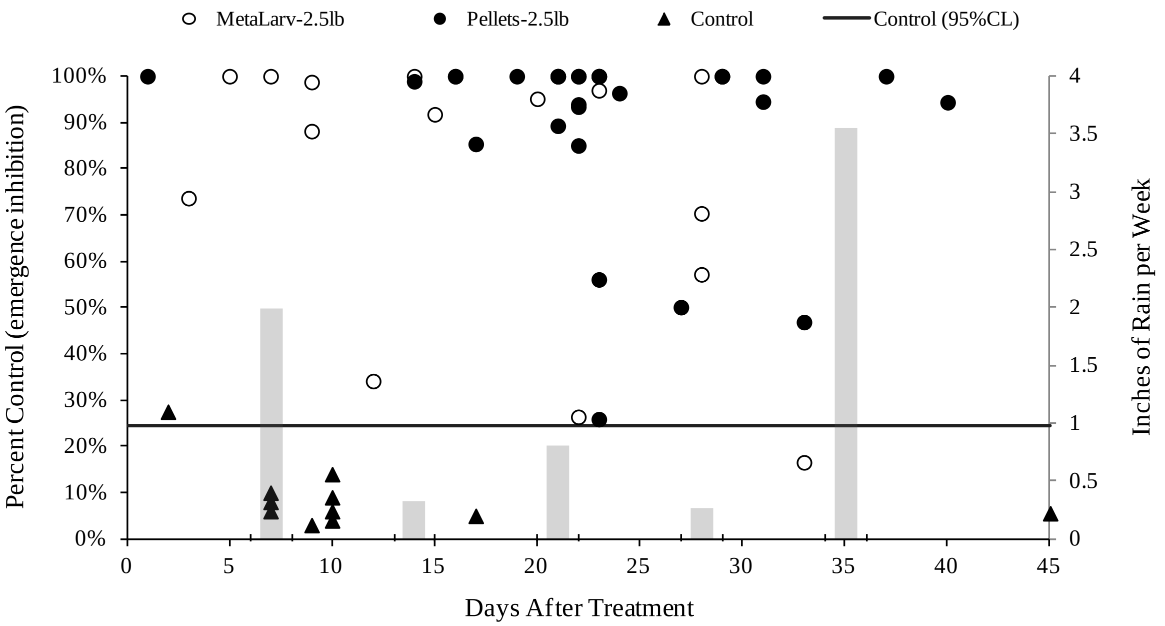


Figure 5.2 Bioassay results (emergence inhibition) of samples collected in untreated (control), MetaLarv S-PT and Altosid pellet treated sites. Emergence inhibition values from treated sites were corrected for untreated control mortality. Vertical gray bars equal weekly cumulative rainfall. “Days after Treatment” for control bioassays was determined by comparing the bioassay collection date to the MetaLarv treatment date (May 2).

***Coquillettidia perturbans* Control** *Coquillettidia perturbans* is an abundant pest that lays its eggs in mid- to late summer and overwinters as larvae attached to aquatic vegetation, primarily cattail roots. Our current control strategy includes large-scale ground and aerial treatments for this single brood mosquito in late May, just prior to its emergence. In 2012 we added aerial applications of VectoLex® CG (*B. sphaericus* 30-day granules) in mid-September, a second treatment window that can provide good control of the subsequent season’s cattail mosquitoes.

Valent MetaLarv S-PT—Late May Treatments We treated 9,320 acres of cattail sites aerially with MetaLarv S-PT (3 lb/acre) between May 28 and June 1, 2013. In mid-June 2013, emergence cages (five per site) were placed in six sites treated with MetaLarv S-PT and in three untreated sites. Adult mosquitoes were collected from all emergence cages twice each week beginning in mid-June through the end of July. Efficacy was evaluated by comparing cumulative emergence in each treatment with that of the untreated control.

Emergence of adult *Cq. perturbans* from untreated sites was high enough to reveal a clear impact of the MetaLarv S-PT treatments. (Figure 5.3, Table 5.4). The percentage of cages in which *Cq. perturbans* emerged was significantly lower in MetaLarv S-PT treated sites than in untreated sites (Table 5.4). These results verify the high effectiveness of MetaLarv S-PT measured in 2012.

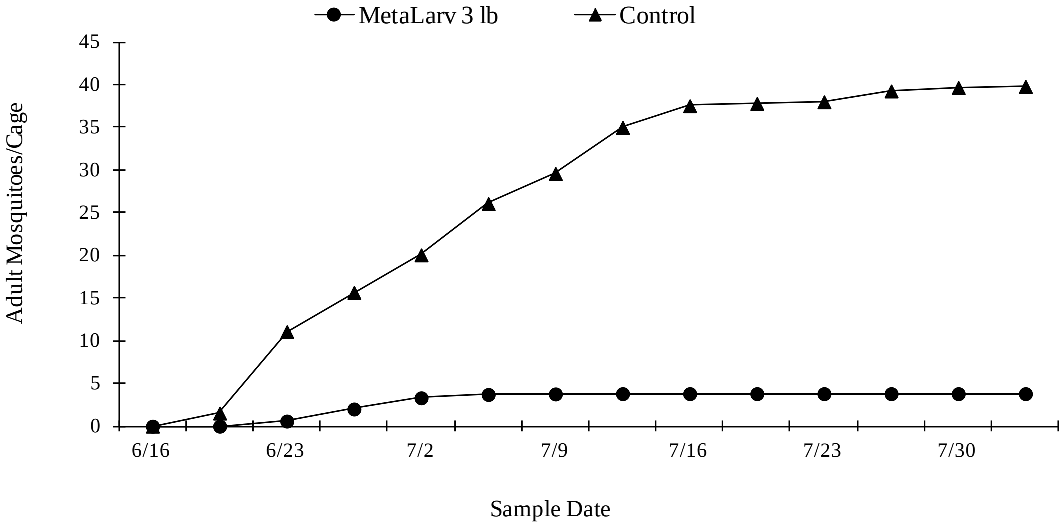


Figure 5.3 Mean cumulative emergence of *Cq. perturbans* in cages in sites treated with MetaLarv S-PT and in untreated sites, June – July 2013.

Table 5.4 Emergence of *Cq. perturbans* in MetaLarv S-PT treated and untreated sites, June-July 2013.

Treatment	Total cages	No. positive cages	% positive cages	MCE§ (% control)	Fisher Exact p-value*
Control	15	11	73.3	39.8 (N/A)	N/A
MetaLarv	30	8	26.7	4.8 (88%)	0.003276

* Untreated control compared to MetaLarv S-PT.

§ MCE, mean cumulative emergence per cage

Adulticide Tests

Beginning in 2008, research focused upon evaluating how effectively barrier and ULV (cold fogging) treatments controlled mosquitoes, especially West Nile virus vectors. This research is partially in response to recommendations by the Technical Advisory Board that MMCD demonstrate vector-specific efficacy, especially for barrier permethrin treatments that pose the greatest potential risk to non-target organisms in treated areas.

Permethrin and Onslaught® Barrier We completed three barrier tests in 2013. All tests were conducted in woodlots where operational permethrin treatments could potentially be made and all tests included untreated woodlots. All tests included CO_2 trap data. CO_2 traps (two of each per woodlot) were placed 24 hours before treatment, 30 minutes after treatment, 24 hours after treatment, and one week after treatment. Efficacy was evaluated using Mulla's equation (a correction that accounts for natural changes in the untreated control site, as well as the treatment site). The goal of all tests was to better evaluate the duration and consistency of control achieved by barrier treatments and to include vector-specific efficacy evaluations.

Three tests were completed concurrently from July 9-16 in three triplets of woodlots in Washington County that had a history of *Ae. triseriatus* or *Ae. japonicus* captures in an attempt to collect vector-specific efficacy data. Permethrin controlled all mosquitoes within 24 hours of treatment in Test 1 and Test 2. Control was detected sooner after treatment in Test 1 (a few hours) than in Test 2 (24 hours). Efficacy lasted one week in both of those tests (Table 5.5). Onslaught also was effective in both tests where permethrin controlled adult mosquitoes. Neither permethrin nor Onslaught was effective in the Test 3 (Table 5.5).

Sufficient *Culex* vectors were captured in all three tests to evaluate effectiveness. Both permethrin and Onslaught effectively suppressed vectors in Test 2, 24 hours and one week after treatment. Neither product was effective against *Culex* vectors in the other tests (Table 5.5). None of the tests yielded enough *Ae. triseriatus* or *Ae. japonicus* to evaluate effectiveness.

We are unable to determine the causes of inconsistent control but we believe that mosquitoes moving into the test sites from adjacent areas could in some cases nullify control achieved by these limited area barrier treatments. Wide area treatment could potentially achieve more consistent control. Many factors including variable vegetation, streets, buildings, etc., render wide area barrier treatment impractical. Combining limited area barrier treatments with wider area ULV treatments might achieve more consistent control.

Between 2006 and 2013, we completed 18 barrier tests that included permethrin. Permethrin effectively controlled adult mosquitoes within 24 hours after treatment in most tests (Table 5.6). Permethrin also effectively controlled vector mosquitoes within 24 hours after treatment in most tests where enough vectors were captured to evaluate efficacy. One week after treatment permethrin effectively controlled adult mosquitoes in only about half of those tests (Table 5.6). (see 2006, 2007, 2008, 2010 and 2011 Operational Reviews for details).

We completed eight barrier tests that included Onslaught between 2007 and 2013. The proportion of tests in which Onslaught was able to effectively control adult mosquitoes was similar to permethrin. Onslaught is able to control *Culex* vectors within 24 hours after treatment with control persisting up to one week. Insufficient data are available to evaluate effectiveness against *Ae. triseriatus* (Table 5.6) (see 2006, 2007, 2008, 2010, 2011 and 2012 Operational Reviews for details).

In the future, we plan to continue barrier adulticide tests. Our goal is to collect as much vector-specific data (includes *Culex*, *Ae. triseriatus*, *Ae. japonicus*) as possible. We plan to explore causes of inconsistent efficacy, especially more than 24 hours after treatment, perhaps by comparing efficacy in smaller and larger scale treatments (different sized treatment areas).

Table 5.5 Barrier treatment efficacy: Three concurrent tests in 2013 (7/9 – 7/16): Efficacy percent calculated using Mulla's formula[*]

		All mosquito species		*Culex* 4**	
Test 1	Collection	CO$_2$ trap catch[§]	Efficacy	CO$_2$ trap catch[§]	Efficacy
Permethrin	Pre-treat	102 (±73)	---	1.5 (±1.5)	---
	Post-treat	156 (±121)	67%	3.0 (±1.0)	0%
	Post-24 h	217 (±88)	68%	2.5 (±1.5)	0%
	Post-7 day	51 (±25)	81%	0.0 (±0.0)	100%
Onslaught	Pre-treat	452 (±164)	---	15.0 (±1.0)	---
	Post-treat	208 (±50)	90%	7.0 (±1.0)	7%
	Post-24 h	184 (±26)	94%	5.5 (±1.5)	27%
	Post-7 day	70 (±16)	94%	4.5 (±4.5)	40%
Untreated control	Pre-treat	41 (±31)	---	1.0 (±1.0)	---
	Post-treat	188 (±8)	---	0.5 (±0.5)	---
	Post-24 h	276 (±28)	---	0.5 (±0.5)	---
	Post-7 day	110 (±38)	---	5.0 (±0.5)	---
Test 2					
Permethrin	Pre-treat	1,372 (±496)	---	15.5 (±8.5)	---
	Post-treat	439 (±278)	0%	1.0 (±0.0)	0%
	Post-24 h	754 (±25)	81%	0.5 (±0.5)	99%
	Post-7 day	1,335 (±661)	65%	4.0 (±4.0)	36%
Onslaught	Pre-treat	1,002 (±154)	---	24.5 (±2.5)	---
	Post-treat	408 (±90)	0%	4.0 (±1.0)	0%
	Post-24 h	565 (±177)	81%	7.5 (±0.5)	87%
	Post-7 day	246 (±68)	91%	0.0 (±0.0)	100%
Untreated control	Pre-treat	198 (±96)	---	21.0 (±4.0)	---
	Post-treat	20 (±4)	---	0.0 (±0.0)	---
	Post-24 h	578 (±183)	---	50.5 (±28.5)	---
	Post-7 day	555 (±377)	---	8.5 (±7.5)	---
Test 3					
Permethrin	Pre-treat	762 (±149)	---	17.5 (±8.5)	---
	Post-treat	211 (±8)	20%	3.0 (±1.0)	49%
	Post-24 h	128 (±78)	15%	2.0 (±1.0)	83%
	Post-7 day	163 (±22)	0%	0.5 (±0.5)	0%
Onslaught	Pre-treat	236 (±146)	---	6.5 (±0.5)	---
	Post-treat	83 (±57)	0%	2.5 (±2.5)	0%
	Post-24 h	101 (±90)	0%	2.0 (±1.0)	54%
	Post-7 day	34 (±4)	0%	0.0 (±0.0)	0%
Untreated control	Pre-treat	189 (±102)	---	1.5 (±0.5)	---
	Post-treat	66 (±42)	---	0.5 (±0.5)	---
	Post-24 h	37 (±37)	---	1.0 (±1.0)	---
	Post-7 day	14 (±14)	---	0.0 (±0.0)	---

[*] Mulla's formula incorporates untreated control trap counts to correct for changes in the treated traps that are not due to the treatment

[**] *Culex*4=*Cx. tarsalis*, *Cx. restuans*, *Cx. pipiens*, and *Cx. salinarius*

§ Mean (±SE), n=2 (CO$_2$ traps)

Table 5.6 Permethrin and Onslaught barrier tests with high efficacy (>80% control using Mulla's equation). Tests occurred from 2006-2013 for permethrin and 2007-2013 for Onslaught

		No. tests with high efficacy (% tests with high efficacy)	
Material used and number of tests*	Target mosquitoes	24-48 hours after treatment	7 days after treatment
Permethrin (2006-2013)			
18	All species	16 (89%)	7 (39%)
9	*Culex* (WNV)	7 (78%)	4 (44%)
2	*Ae. triseriatus* (LAC)	2 (100%)	1 (50%)
Onslaught (2007-2013)			
8	All species	5 (63%)	3 (38%)
4	*Culex* (WNV)	3 (75%)	2 (50%)
1	*Ae. triseriatus* (LAC)	0 (0%)	0 (0%)

* Number of tests in which sufficient mosquitoes of a particular species group were captured to evaluate efficacy.

Zenivex® (ULV) Compared to Scourge® Zenivex is a new formulation of the pyrethroid etofenprox. Zenivex is a softer adulticide, both because of its pyrethroid active ingredient and the lack of PBO in the formulation. We are testing Zenivex to increase the number of ULV adulticides we have available. Tests in 2010 and 2011 showed good control immediately following treatment (see 2010 and 2011 Operational Reviews for details). In 2012, we attempted to test Zenivex in campgrounds in Anoka County. Weather (thunderstorms) and trap failures precluded the completion of any tests. We were able to successfully test Zenivex in 2013. Both Zenivex and Scourge effectively controlled adult mosquitoes 30 minutes and 24 hours after treatment (Table 5.7). Zenivex effectively controlled *Culex* vectors 30 minutes and 24 hours after treatment; insufficient vectors were captured in the site treated with Scourge to evaluate vector-specific efficacy (Table 5.7).

Table 5.7 Mean trap catch (mean ± SE) and efficacy of ULV Zenivex compared to Scourge. The test period was July 16-18, 2013. *Culex*4 includes *Cx. pipiens*, *Cx. restuans*, *Cx. salinarius*, and *Cx tarsalis*.

		All mosquito species		*Culex*4	
Treatment	Collection	Mean trap catch§	Efficacy*	Mean trap catch§	Efficacy*
Zenivex	Pre-treat	1,390.3 ± 870.0	---	22.7 ± 22.7	---
	Post-treat	86.0 ± 17.2	96%	0.3 ± 0.3	99%
	Post-24 h	866.3 ± 39.4	85%	0.3 ± 0.3	100%
Scourge	Pre-treat	251.0 ± 114.7	---	0.0 ± 0.0	---
	Post-treat	46.3 ± 26.6	88%	0.7 ± 0.7	---
	Post-24 hr	413.0 ± 132.8	61%	5.3 ± 2.0	---
Untreated control	Pre-treat	328.3 ± 58.0	---	4.0 ± 4.0	---
	Post-treat	489.7 ± 208.2	---	4.0 ± 4.0	---
	Post-24 h	1,377.3 ± 215.8	---	22.3 ± 13.3	---

§ n=3 CO_2 traps per campground site per sampling period

* Mulla's formula incorporates untreated control trap counts to correct for changes in the treated traps that are not due to the treatment

Equipment Evaluations

Helicopter Swath Analysis and Calibration Procedures for Larvicides Technical Services and field staff conducted four aerial calibration sessions for dry, granular materials during the 2013 season. These computerized calibrations directly calculate application rates and swath patterns for each pass so each helicopter's dispersal characteristics are optimized. Sessions were held at the municipal airport in LeSueur, MN. Staff completed calibrations for 10 different operational and experimental control materials. In total, eight helicopters were calibrated and each helicopter was configured to apply an average of four different control materials.

Droplet Analysis of Ground-based Spray Equipment During October 2013, Technical Services and the East Region staff used our 20 ft x 40 ft indoor spray booth to evaluate adulticide application equipment. This self-contained booth collects the adulticide spray droplets, which minimizes their release into the air following the calibration process, thus limiting any environmental effects. Technical Service staff optimized 52 ultra-low-volume (ULV) insecticide generators (truck-mounted, ATV-mounted, or handheld) using the KLD Model DC-III portable droplet analyzer. Staff uses this analyzer to fine-tune equipment to produce an ideal droplet spectrum of 8-20 microns. Adjusting the ULV sprayers to produce a more uniform droplet range maximizes efficacy by creating droplets of the correct size to impinge upon flying mosquitoes. In addition, more uniform swaths allow staff to better predict ULV application patterns and swath coverage throughout the District.

Permethrin Backpack Droplet Evaluations Technical Services conducted backpack droplet spectrum evaluations of our barrier spray units. These evaluations were completed due to a recent EPA label change during the product re-registration process. The droplet size requirement was significantly increased to reduce the risk of product drifting off the targeted site. The new label requires a droplet size of 150-300 microns.

Technical Services used the DC-III analyzer and hot wire probe to measure droplet size. This analyzer was designed to measure ULV droplets but some questions have arisen in the industry on the accuracy of this equipment on measuring larger oil-based droplets.

The District has 114 Stihl backpacks used for permethrin barrier treatments and random sampling has shown they produce a consistent droplet size of 35-45 microns at full throttle. Technical Services is working towards a modification of the current equipment to create the required droplet size. A new prototype wand has been designed and evaluated using our analyzer. To confirm that the DC-III is accurately determining the correct droplet spectrum, a backpack was sent to Lee County Mosquito Control District in Florida to be evaluated by the Insitec Laser Measurement System. This laser measurement device more precisely evaluates the droplet spectrum and will be used to confirm the results of our measurement system. Technical Services will continue to develop a modification that meets the droplet size requirement for our Stihl backpacks.

Electric Backpack (Pioneer ULV Generator) Evaluation Staff evaluated a battery-operated electric backpack as an alternative to the traditional gas engine units. This backpack does not directly burn fossil fuels or produce exhaust emissions making it a good fit for MMCD’s sustainability initiatives and governmental air quality recommendations. The backpack’s droplet spectrum produced a spray that met the required droplet size. When the backpack was used operationally, the battery life was insufficient for all-day use. MMCD provided the manufacturer with a written evaluation and will review the pack again if suggested improvements are incorporated into future units.

Optimizing Efficiencies and Waste Reduction

Evaluation of Transportation Options for Control Materials Over the past two seasons, the District has reviewed methods for transporting pallets of control materials to helicopter landing sites. Large flatbed trucks have been the operational standard but these vehicles are expensive, can require additional licensing, and are not used extensively in the off-season. Facilities are reviewing a less expensive combination of a one-ton pickup truck and flatbed trailer. This equipment combination has more operational versatility, fewer restrictions, and can significantly reduce overall costs. Staff will continue to evaluate this helicopter support system to determine its best effective use.

Recycling Pesticide Containers MMCD continued to use the Minnesota Department of Agriculture’s (MDA) pesticide container recycling program. This project focuses on properly disposing of agricultural pesticide waste containers, thereby protecting the environment from related pesticide contamination of ground and water.

Field offices collected their empty, triple-rinsed plastic containers at their facility and packaged them in large plastic bags for recycling. Each facility delivered their empty jugs to our

Rosemount warehouse for pickup by the MDA contractor, Consolidated Container. MMCD prearranged two semi-trailer pickups during the treatment season and staff assisted the contractor with loading of the recycled packaging materials. MMCD also assists other small regional users to properly recycle their pesticide containers in conjunction with these collections.

MMCD staff collected 4,099 jugs for this recycling program. The control materials that use plastic 2.5 gallon containers are sumithrin (340 jugs), *Bti* liquid (1,551 jugs), Altosid pellets (2,197 jugs), and other materials (11 jugs).

The District started purchasing Permethrin 57% OS concentrate in returnable drums. The manufacturer arranged to pick up the empty containers for reuse. In addition, these drums do not have to be triple-rinsed and thus, reduces the District's overall generation of waste products.

MMCD also purchases products in 55-gallon drums and refills the 5-gallon steel cans of the same-labeled material thereby reducing the need for new packaging, thus lowering the amount of packaging waste generated by the District. In addition, the warehouse triple-rinsed and recycled numerous plastic drums and steel containers this past season. These 30- or 55-gallon drums were brought to a local company to be refurbished and reused.

Recycling Pesticide Pallets In 2013, MMCD produced over 950 empty hardwood pallets used in control material transportation. Technical Services worked with our vendors to uniquely mark their company's pallets and arrange for their return to the manufacturer for re-use. In doing so, MMCD reduces the need for the production of new pallets and helps to maintain lower control material costs for the District.

Bulk Packaging of Control Materials In 2013, MMCD continued the development of reusable packaging containers. The focus is to reduce the packaging waste of the various high use materials. MMCD can produce over 40,000 empty bags in an average year. MMCD would like to eliminate a significant portion of these bags by using a large pallet-sized tote that could be adaptable to our field operations. In 2013, MMCD received a prototype from one manufacturer to evaluate and provide feedback. Staff will conduct a pilot project in 2014 to test the feasibility of using these larger containers in helicopter and ground operations.

Hazardous Waste Collection In 2013, MMCD worked with the MDA to provide two regional sites for hazardous waste collection. The MDA provides a day each year that the public can properly dispose of any small quantity of hazardous waste free of charge. The District's Andover and Jordan facilities were used as collection points and MDA staff managed the safe handling of these materials. MMCD will continue to support this important public service to protect the environment.

2014 Plans – Product and Equipment Testing

Quality assurance processes will continue to be incorporated into the everyday operations of the regional process teams. Technical Services will continue to support field operations to improve their ability to complete their responsibilities most effectively. A primary goal will be to continue to assure the collection of quality information for all evaluations so decisions are based upon good data. We will continue to improve our calibration techniques to optimize all of our mosquito control equipment.

In 2014, we plan to continue tests of Natular G30 and Natular G against the cattail mosquito to explore control potential. We plan to test Natular G and to repeat tests of MetaLarv S-PT against spring *Aedes* to evaluate the effectiveness of both products as a spring pre-hatch larvicide. Non-target sampling will be included in the Natular G tests against spring *Aedes*. We also will repeat tests of adulticides, emphasizing vector (*Culex*, *Ae. triseriatus*, *Ae. japonicus,* and others) control and effectiveness of barrier treatments.

References Cited

Mir S. Mulla, R. Lee Norland, Dean M. Fanara, Husam A. Darwazeh and Donald W. McKean. 1971. Control of chironomid midges in recreational lakes. J. Econ. Ent. 64(1): 300-307.

Mulla's Formula: $$\text{Percent Efficacy} = 100 - \left(100 \times \left(\frac{\text{Cntl Pre}}{\text{Trt Pre}}\right) \times \left(\frac{\text{TrtPost}}{\text{CntlPost}}\right)\right)$$

CntlPre = Mean pretreatment count of untreated control

CntlPost = Mean post treatment count of untreated control

TrtPre = Mean pretreatment count of treated group

TrtPost = Mean post treatment count of treated group

Chapter 6 Supporting Work

2013 Highlights

- ❖ Continued development of web-based system for field data entry
- ❖ Updated Degree-Day study to compare spring conditions
- ❖ Worked with TAB subgroup to examine nontarget concerns for spinosad products
- ❖ Formed a steering group and began to quantify the District's sustainability efforts
- ❖ Expanded the use of Facebook as a way to keep in touch with District friends and former employees

2014 Plans

- ❖ Continue upgrade of data systems
- ❖ Continue to expand use of social media to communicate with citizens and current and former District staff
- ❖ Continue with sustainability efforts

2013 Projects

Data System Transition

Maps and data are an essential framework for managing work at MMCD. As seen throughout this report, we keep records of all larval and adult site inspections, samples, and treatments, container inspection and removal, and treatment check-backs and bioassays, as well as control material physical inventory and truck mileage.

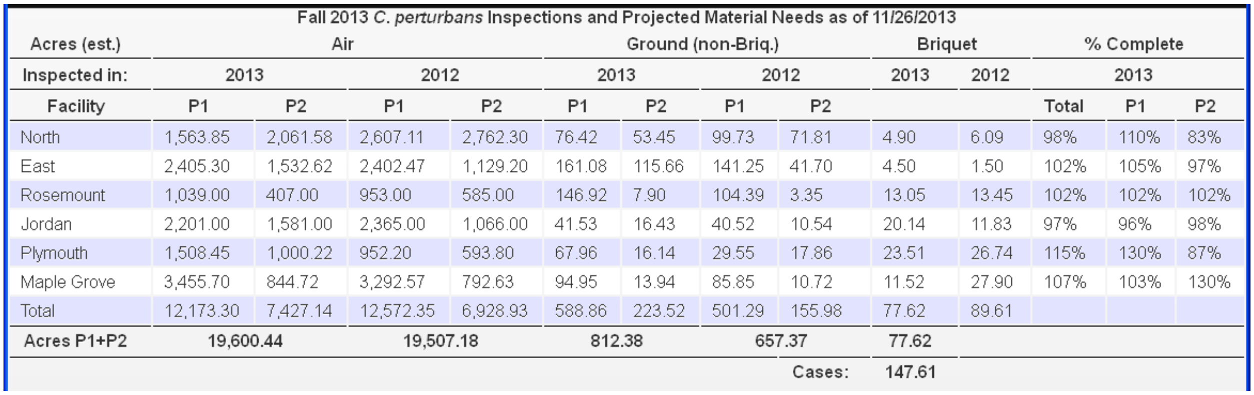
We are continuing our transition from a PDA / local database system to a web-based system that takes advantage of current mobile technology and provides faster access to a unified view available on any connected device.

In 2013 we moved the new central database to a cloud server (Rackspace) which should provide reliable access with relatively low cost. We also developed backup plans and systems for various failure modes, and have a continuous replication of the main server on another server run by our contractor, Houston Engineering Inc. (HEI).

In the process of moving to the new server we upgraded all the open source software the system is built on, and fixed issues that arose from the upgrades. We are also using more functionality from the "wq" software project, originally developed for handling citizen water quality monitoring data (see wq.io project home page, developed by S. Andrew Shepard).

Inventory managers at each headquarters used the system for physical inventory data entry. Central reports on inventory updated automatically from facility entries and could be viewed at any time by any staff.

Data entry for larval cattail mosquito (*Cq. perturbans*) inspections was done through phones or PCs with the new web data site system, as has been true the last two years. Entry forms used in previous years were revised for new processes and materials in use for cattail treatment planning. Reports were also expanded, including a whole-District summary that updates directly from real-time data (Fig. 6.1).



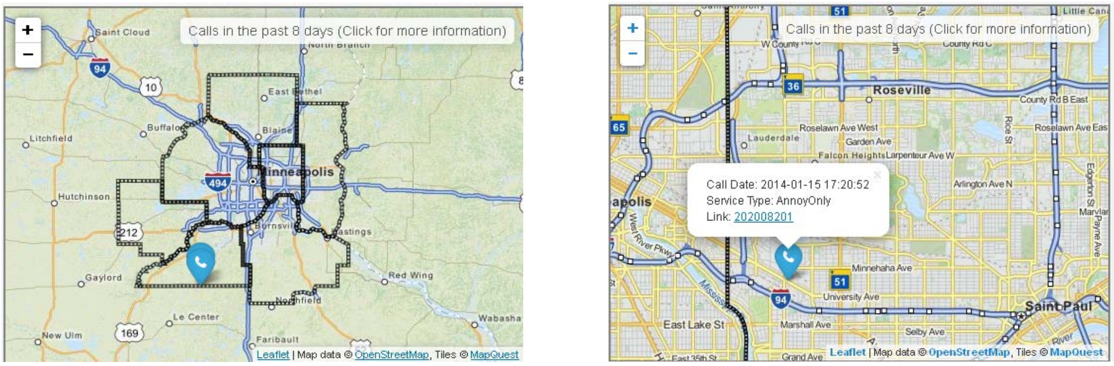
Fall 2013 *C. perturbans* Inspections and Projected Material Needs as of 11/26/2013

Acres (est.)	Air				Ground (non-Briq.)				Briquet		% Complete		
Inspected in:	2013		2012		2013		2012		2013	2012	2013		
Facility	P1	P2	P1	P2	P1	P2	P1	P2			Total	P1	P2
North	1,563.85	2,061.58	2,607.11	2,762.30	76.42	53.45	99.73	71.81	4.90	6.09	98%	110%	83%
East	2,405.30	1,532.62	2,402.47	1,129.20	161.08	115.66	141.25	41.70	4.50	1.50	102%	105%	97%
Rosemount	1,039.00	407.00	953.00	585.00	146.92	7.90	104.39	3.35	13.05	13.45	102%	102%	102%
Jordan	2,201.00	1,581.00	2,365.00	1,066.00	41.53	16.43	40.52	10.54	20.14	11.83	97%	96%	98%
Plymouth	1,508.45	1,000.22	952.20	593.80	67.96	16.14	29.55	17.86	23.51	26.74	115%	130%	87%
Maple Grove	3,455.70	844.72	3,292.57	792.63	94.95	13.94	85.85	10.72	11.52	27.90	107%	103%	130%
Total	12,173.30	7,427.14	12,572.35	6,928.93	588.86	223.52	501.29	155.98	77.62	89.61			
Acres P1+P2	19,600.44		19,507.18		812.38		657.37		77.62				
								Cases:	147.61				

Figure 6.1 Example of a data report that updates from real-time data entries at data.mmcd.org

The front “dashboard” page of the new web application was updated with interactive maps of 24-hr total rainfall (NWS adjusted NEXRAD) and current radar that allow users to zoom in to see estimated rain amounts in areas where they are working. An interactive map was also added on the Calls page that shows calls from the last eight days with easy drill-down access to call details (Fig. 6.2).

A. B.



Call Date: 2014-01-15 17:20:52
Service Type: AnnoyOnly
Link: 202008201

Figure 6.2 Interactive map of call locations on data.mmcd.org. Map A is the general map; the telephone handset icon pinpoints the location of the call. Clicking the icon displays further information (map B).

The custom application for upload and view of helicopter tracks was worked on extensively in 2013. It has been improved and expanded to use the helicopter GPS tracks from the AgNav guidance systems to automate most record-keeping for aerial treatments. We are working with Scott’s Helicopter Service to revise the flight review and sign-off process to take advantage of the potential from this automation.

In 2014, we plan to continue development of the larval inspection and treatment sections of the data entry system (beyond cattail and aerial treatment), including daily material use calculations and integration of lab entry of sample identifications. We hope to start development of new entry and reporting systems for adult sampling and treatment, and records of container inspections, as time and resources allow. We will need to continue to run part of the data recording in the old PDA and local database system until all of these systems are complete.

Mapping

Wetland Mapping MMCD staff members updated maps of the approximately 70,000 wet areas that serve as potential larval mosquito habitat. No new aerial photography has been made publicly available since the spring 2012 set from USGS/NGA, so we have purchased some access to Bing photography to help with outer areas with new developments. We are currently working to get access to photography flown in 2013 by Washington and Hennepin counties but have encountered some technical and policy challenges to its distribution.

In addition to wetlands, MMCD staff members map locations of many stormwater structures, such as street catch basins, large culverts or separators, and pond water level regulators, which provide larval habitat for species such as *Culex* vectors of West Nile virus and for *Ae. japonicus.* Over 24,000 structures are now mapped, in addition to 280,000 catch basins.

A District staff member continues to serve on the Technical Advisory Committee of the National Wetlands Inventory (NWI) update project, funded by Legislative-Citizen Commission on Minnesota Resources (LCCMR). The metro-area update to the NWI (using 2010 aerial photography, elevation and soils data, and ancillary data including MMCD’s wet areas) was released in early 2013, and was provided to MMCD staff members for review and comparison with our current maps.

Public Web Map MMCD continues to make wetland locations and multi-year larval treatment history available through a public web map available at www.mmcd.org. Larval treatment records are automatically updated daily. The site was developed by HEI and uses the MetroGIS Geocoder, basemap information from MetroGIS (Metropolitan Council), and aerial photos from MnGeo (Minnesota Geospatial Information Office).

GIS Community MMCD staff continue to participate in MetroGIS, and participated in planning the Free and Open Source for Geospatial – North America (FOSS4G-NA) conference hosted in Minneapolis in May 2013.

Climate Trends – Spring Degree Day Study

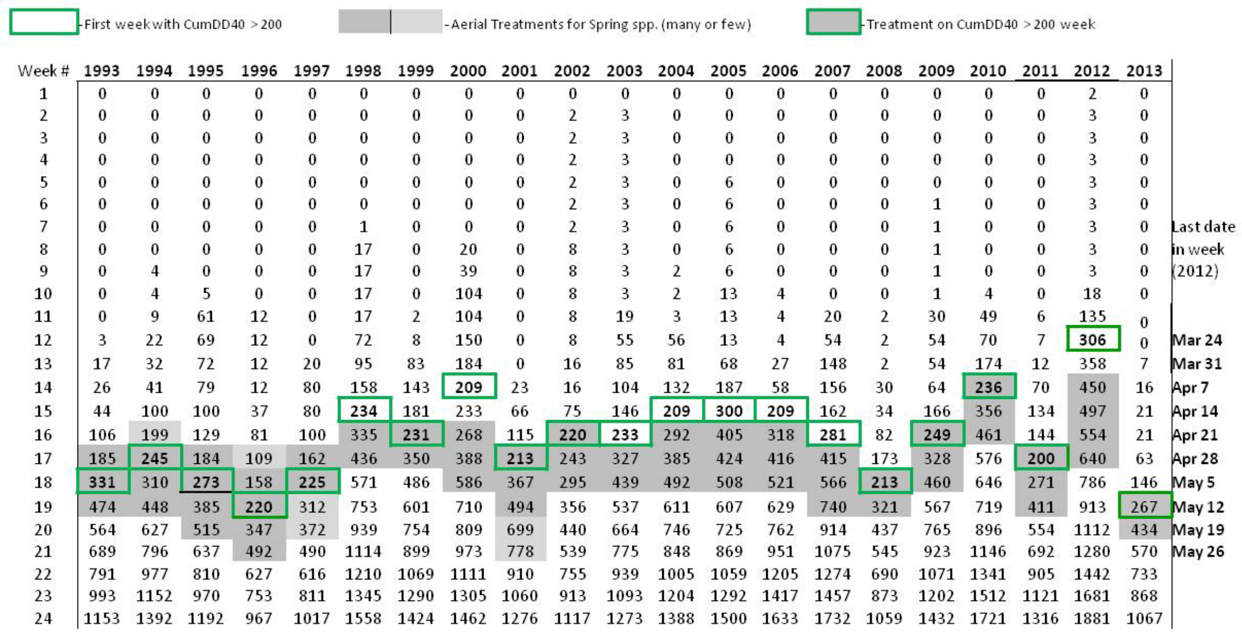
In 2012, the unusually early spring prompted MMCD staff to examine trends in spring temperatures and their effect on control activities (see 2012-2013 TAB Report). That analysis was repeated in 2013 and shows the stark contrast in spring conditions.

Degree-day (DD) accumulations were compared with aerial treatments for spring *Aedes*. The DD model used daily maximum and minimum air temperature (MSP airport) to compute a daily average. The difference between the average and the chosen base temperature of 40 °F (no larval growth per day) gave the ‘heat units’ accumulated each day for that base (DD $_{base}$). These were then summed from an assumed start date of January 1.

$$\text{SumDD}_{\text{to\_date, base}} = \sum_{(\text{start\_date, to\_date})} (T_{avg} - \text{baseT}) \quad \text{where } T_{avg} = [(T_{max}+T_{min})/2]$$

Figure 6.3 shows the cumulative sum of DD $_{40F}$ from Jan 1 by week of the year (value at end of week), for each year from 1993-2013. Week numbers were based on standard CDC weeks (week starts on Sunday, week 1 = first week with four or more days, modified so that all dates after Jan. 1 were in week 1 or higher, not in previous year’s week 52).

The week totals with an outlined box mark the first week with ≥ 200 DD. This number was chosen empirically from these data as an apparent indicator of when spring *Aedes* larvae have sufficiently developed to warrant aerial treatment. The year 2013 had one of the latest dates for (DD $_{40F}$ from Jan 1) >200 in the last 20 years.



☐ - First week with CumDD40 > 200

▨ - Aerial Treatments for Spring spp. (many or few)

▨ - Treatment on CumDD40 > 200 week

Week #	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	
2	0	0	0	0	0	0	0	0	0	2	3	0	0	0	0	0	0	0	0	3	0	
3	0	0	0	0	0	0	0	0	0	2	3	0	0	0	0	0	0	0	0	3	0	
4	0	0	0	0	0	0	0	0	0	2	3	0	0	0	0	0	0	0	0	3	0	
5	0	0	0	0	0	0	0	0	0	2	3	0	6	0	0	0	0	0	0	3	0	
6	0	0	0	0	0	0	0	0	0	2	3	0	6	0	0	0	1	0	0	3	0	
7	0	0	0	0	0	1	0	0	0	2	3	0	6	0	0	0	1	0	0	3	0	Last date
8	0	0	0	0	0	17	0	20	0	8	3	0	6	0	0	0	1	0	0	3	0	in week
9	0	4	0	0	0	17	0	39	0	8	3	2	6	0	0	0	1	0	0	3	0	(2012)
10	0	4	5	0	0	17	0	104	0	8	3	2	13	4	0	0	1	4	0	18	0	
11	0	9	61	12	0	17	2	104	0	8	19	3	13	4	20	2	30	49	6	135	0	
12	3	22	69	12	0	72	8	150	0	8	55	56	13	4	54	2	54	70	7	**306**	0	Mar 24
13	17	32	72	12	20	95	83	184	0	16	85	81	68	27	148	2	54	174	12	358	7	Mar 31
14	26	41	79	12	80	158	143	**209**	23	16	104	132	187	58	156	30	64	**236**	70	450	16	Apr 7
15	44	100	100	37	80	**234**	181	233	66	75	146	**209**	**300**	**209**	162	34	166	356	134	497	21	Apr 14
16	106	199	129	81	100	335	**231**	268	115	**220**	**233**	292	405	318	**281**	82	**249**	461	144	554	21	Apr 21
17	185	**245**	184	109	162	436	350	388	**213**	243	327	385	424	416	415	173	328	576	**200**	640	63	Apr 28
18	**331**	310	**273**	158	**225**	571	486	586	367	295	439	492	508	521	566	**213**	460	646	271	786	146	May 5
19	474	448	385	**220**	312	753	601	710	494	356	537	611	607	629	740	321	567	719	411	913	267	May 12
20	564	627	515	347	372	939	754	809	699	440	664	746	725	762	914	437	765	896	554	1112	434	May 19
21	689	796	637	492	490	1114	899	973	778	539	775	848	869	951	1075	545	923	1146	692	1280	570	May 26
22	791	977	810	627	616	1210	1069	1111	910	755	939	1005	1059	1205	1274	690	1071	1341	905	1442	733	
23	993	1152	970	753	811	1345	1290	1305	1060	913	1093	1204	1292	1417	1457	873	1202	1512	1121	1681	868	
24	1153	1392	1192	967	1017	1558	1424	1462	1276	1117	1273	1388	1500	1633	1732	1059	1432	1721	1316	1881	1067	

Figure 6.3 Cumulative Degree Days (base 40 °F, 4.4 °C) from January 1, MSP Airport.

Gray boxes in Fig. 6.3 indicate in which weeks helicopter treatments for spring *Aedes* were done each year. In addition to being timed to match mosquito abundance, aerial treatments are not started until a sufficient number of sites are over threshold, seasonal inspectors are hired, and helicopters are calibrated. In 2012, we considered hiring staff early, but determined we had enough time to complete control before the spring *Aedes* larvae developed completely. In 2013, we delayed hiring, and still had some days where snowfall inhibited larval sampling.

We are continuing to examine multi-year trends in biology and their implications for control techniques and budget. We also continue to participate in the Minnesota Climate Adaptation Partnership (formerly known as the Minnesota Climate Change Adaptation Working Group) to keep up with work done in other agencies, and presented at their fall conference on Climate Adaptation.

Stormwater Management, Wetland Design, and Mosquitoes

MMCD staff works to maintain awareness of mosquito issues within the stormwater design and regulatory community. For example:

- Staff participated in the MN Water Resources Conference (civil engineers, city & watershed district staff, U of M researchers) and presented a poster titled "Reflections on 10 Years of West Nile Virus Vector Mosquitoes in Stormwater Structures."
- The "Stormwater and Mosquitoes" page on the MMCD web site has typically received almost 1,000 hits per year (see Resources – Stormwater Management, now at http://www.mmcd.org/resources/storm-water-management/). This page includes a fact sheet on rain barrels, Rain Gardens poster (produced for the 2009 Water Resources Conference), and "Mosquitoes and Wetlands" slide show.
- The Minnesota Pollution Control Agency (MPCA) Stormwater Manual has been updated to a web-based format, and the information it contains regarding mosquito prevention can be found at http://stormwater.pca.state.mn.us/index.php/Mosquito_control_and_stormwater_management We plan to work with MPCA to make new references available.

Evaluating Nontarget Risks

Spinosad (Natular) Nontarget Risk Information MMCD and TAB members continued to review information available regarding nontarget risk assessment for Natular G30, an extended release (30 day) formulation of the biological control material spinosad (see Appendix C, and discussion in 2012-2013 TAB report). MMCD is using Natular G30 for control in summer *Aedes* sites. It provides both a tool in possible resistance management (the mode of action is different from *Bti* or methoprene), and a chance to diversify our larvicide supply chain. Natular has been registered by the U.S. EPA as a "Reduced Risk Pesticide" and is OMRI Listed® (Organic Materials Review Institute).

TAB members had expressed special concern about nontarget risks if Natular G30 was to be used in vernal pools for the control of spring *Aedes*. As requested by the TAB at their February 2013 meeting, the chair of the TAB sent a letter to Clarke regarding nontarget studies on Natular, asking for support and additional data to address the TAB's concerns about chronic toxicity.

Karen Larsen from Clarke sent their response in July, which focused on two things: 1) estimates of exposure based on both models and measurements, and 2) recent research on *Daphnia* (the most sensitive organism tested and most relevant to Minnesota freshwater vernal pools).

Expected "Peak Environmental Concentration" (PEC), if a control material was immediately released, would be a simple calculation from application rate per unit area, % AI, and water depth. For a 5 lb/acre dose (as is used by MMCD) this amounts to 0.0934 mg/l for a water depth of 15 cm (MMCD staff calculation). However, in the G30 formulation this amount is not released immediately but is spread over 30 days. The amount in the water at a given time is based on how quickly the material is released and how quickly it degrades. Clarke's PEC estimate based on release and degradation rates for 15 cm deep water was 0.0045 mg/l (4.5 µg/l (ppb)). The degradation rate (half-life of 1-2 days) has been verified in field studies (Duchet et al. 2008), and is primarily from photolysis.

Daphnia spp. are known to be sensitive to spinosad. Duchet et al. (2008) evaluated potential impacts of treatment with agricultural spinosad (immediate release) on *Daphnia* in 125 L microcosms in a shallow temporary marsh. They reported "applications of 17 and 33 µg/liter had lethal effects on *D. pulex*, lasting the duration of the study [21 d]. At 8 µg/liter, the population of *Daphnia* was reduced initially, but beginning after day 7 recovered to levels comparable to that of the control…" Their data also showed spinosad levels at day 7 in the 8 µg/liter dose pools had degraded to the limit of detection, 0.2 µg/liter, while levels in the higher dose pools were about 1 µg/liter. Other data presented in the Clarke letter indicate a 48-hr static test EC50 of 1.48 mg/l, but a 21-day chronic flow through study NOEC (no observed effect concentration) of 0.62 µg/liter. Additional information in Duchet et al. (2010) was used to illustrate the observed impact of spinosad in *Daphnia* in both laboratory and field (microcosm) conditions.

The letter included comparative toxicological data to support the conclusion that *Daphnia* is the most sensitive aquatic organism, using EPA's risk ratio method to compare expected spinosad exposure to sensitivity levels. An RQ (= PEC/NOEC) of less than or equal to 1 is considered acceptable for prolonged exposure. Species such as oysters, grass shrimp, and mysid shrimp had RQ values < 0.1. Only *Daphnia* had an RQ over 0.5. Clarke concluded that the results of existing studies and EPA risk ratios indicate a low risk of non-target impact at a population level, especially to aquatic species that are less sensitive to spinosad than *Daphnia*.

At the TAB's request Clarke searched for information on fairy shrimp, amphipods, sphaeriid clams, and gastropods, and found no published or unpublished information. Most of these groups are not common test organisms. Clarke asserted that "available information on appropriate surrogate invertebrate organisms, and the fate and transport of spinosad in the aquatic environment is sufficient to assess the effects of longer term exposures in the sites and at the rates proposed by the District." They also stated that they continue to evaluate data to refine models of exposure, and will make that available through publications and presentations.

At the 2013 TAB meeting, a subgroup was chosen to draft plans for nontarget impact studies of Natular G30 in vernal pools, and choose organisms for study. The subgroup reviewed the information provided from Clarke. One subgroup member proposed conducting microcosm studies similar to protocols employed in Duchet et al. (2010) in sites where early season mosquitoes (spring *Aedes*) develop. During its February 14, 2013 meeting, the TAB recommended that a qualified third party conduct all non-target research. Given the current tight budgetary situation, approval of necessary funding by the MMCC is unlikely. Any non-target research funded by the MMCC would need to be simple and clear enough to provide a definitive answer within one season for a small amount of funding. No further protocol design has been completed.

References

Duchet C, M. Larroque, T. Caquet, E. Franquet, C. Lagneau, and L. Lagadic. 2008. Effects of spinosad and *Bacillus thuringiensis israelensis* on a natural population of *Daphnia pulex* in field microcosms. Chemosphere: 74(1):70-7.

Duchet C, M.A. Coutellec, E. Franquet, C. Lagneau, and L. Lagadic. 2010. Population-level effects of spinosad and *Bacillus thuringiensis israelensis* in *Daphnia pulex* and *Daphnia magna*: comparison of laboratory and field microcosm exposure conditions. Ecotoxicology: 19(7):1224-37.

Previous Larvicide Nontarget Studies Earlier publications and reports on Wright County Long-term Study and other studies on *Bti* and methoprene done under the direction of the Scientific Peer Review Panel (SPRP) continue to be available on the MMCD web site, mostly as PDF files. The new address is http://www.mmcd.org/non-target-studies-bti/ Download totals for 2013 are unavailable due to MMCD's move to new web site software; in 2012 the SPRP Final Report had shown over 5,000 downloads (see TAB report 2012-2013).

Permits and Treatment Plans

National Pollutant Discharge Elimination System Permit A Clean Water Act - National Pollutant Discharge Elimination System (NPDES) permit is currently required for most applications of mosquito control pesticides to water. The MPCA procedures for Pesticide NPDES Permits, effective April 30, 2012, are described at http://www.pca.state.mn.us/index.php/water/water-permits-and-rules/water-permits-and-forms/pesticide-npdes-permit/pesticide-npdes-permit-program.html.

In 2012 MMCD prepared a Pesticide Discharge Management Plan (PDMP) describing contact people, target pests and data sources, thresholds and management, and steps to be taken to respond to various types of incidents included in the NPDES permit. Staff submitted a Notice of Intent (NOI) to the MPCA and paid permit fees ($1,240 plus $345 per year) in April 2012, which was renewed in 2013.

A comprehensive treatment listing was prepared for the MPCA in fulfillment of the permit requirements and submitted in early 2013. The listing included site-specific treatment history and a geospatial file of treatment locations. This is the same information that MMCD makes available for public view on MMCD's web site.

US Fish & Wildlife Service – Mosquitoes and Refuges MMCD works with the US Fish & Wildlife Service (FWS) regarding mosquito surveillance on and near FWS lands within the District. If rainfall, river levels, or other nearby surveillance indicates a need for sampling, work in the Minnesota Valley National Wildlife Refuge is conducted following the stipulations of a Special Use Permit updated annually by the Refuge Manager. "Emergency Response Procedures" and "Pesticide Use Proposals" for the larvicide *Bacillus sphaericus* (VectoLex) and the adulticide sumithrin (Anvil) prepared in 2009 by FWS staff allow treatment of disease vectors if "a mosquito-borne disease human health emergency exists in vicinity of the Refuge" (agreed on by MDH, FWS, and MMCD) and such treatment "is found to be appropriate".

In 2013, MMCD continued to conduct larval and adult surveillance within and near lands managed by FWS in accordance with our sampling permit. Larval mosquito inspections were conducted in the Soberg WPA (waterfowl production area) in May after heavy rainfall events. Larval abundance was fairly low, and no WNV vector larvae were detected at that time. Adult surveillance with CO_2 traps near the Blackdog area of MnNWR recovered large numbers of *Ae. vexans* and relatively few adult WNV vectors. MMCD staff report these surveillance findings annually to FWS.

Public Communication

Notification of Control The District continues to post daily adulticide information on its website (www.mmcd.org) and on its "Bite Line" (651-643-8383), a pre-recorded telephone message interested citizens can call to hear the latest information on scheduled treatments. Aerial larvicide treatment schedules are also posted on the web site and on the "Bite Line" as they become available. Information on how to access daily treatment information is regularly posted on Facebook and Twitter.

Calls Requesting Service As is usually the case, calls requesting treatment closely tracked overall mosquito numbers as measured by Monday night sweep net counts of human biting mosquitoes (Figure 6.4). Calls requesting treatment began in earnest in early June when mosquito populations began to increase and peaked just after the July 4 holiday. By late July, treatment requests dropped dramatically and stayed low for the remainder of the season. People planning outdoor activities, such as picnics, outdoor weddings, and graduation open houses continue to be responsible for many early season calls, as they anticipate the number of mosquitoes with which they may have to contend.

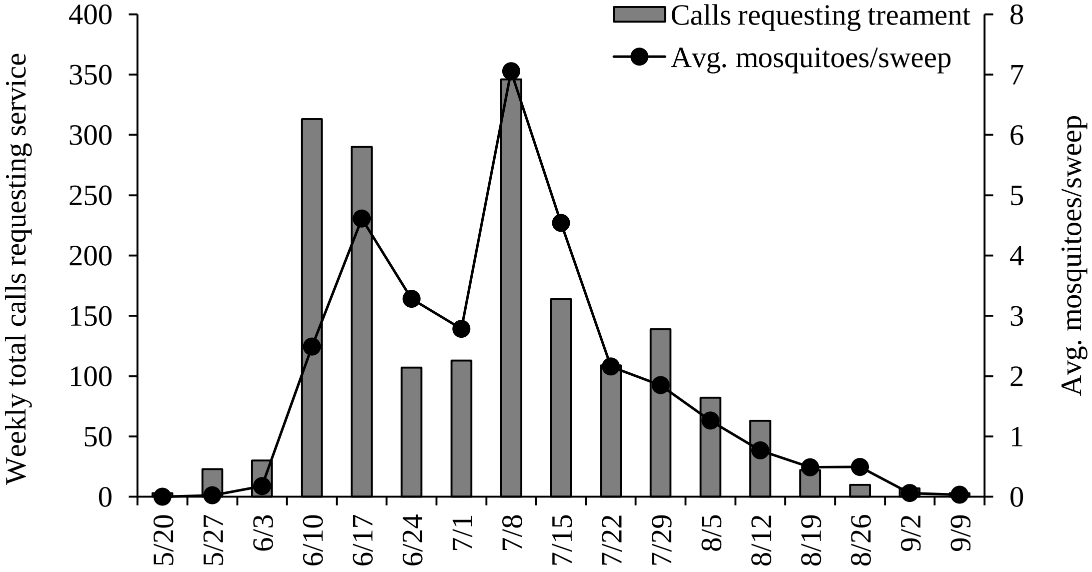


Figure 6.4 Calls requesting treatment of adults, and sweep net counts, by week, 2013.

Total requests for adult mosquito treatment dipped slightly in 2013 (Table 6.1). Calls, requesting larval site checks were also down from 2012 levels. Calls requesting treatment for public events also held steady in 2013. Calls requesting tire removal, however, dipped significantly in 2013 from a historic high in 2012. Late-season emphasis on mosquito-borne disease prevention, as public awareness of West Nile virus and La Crosse encephalitis risk increases, continues to drive requests to pick up and dispose of used tires.

Table 6.1 Yearly comparisons of citizen calls tallied by service request from 2003 to 2013*

	Number of calls/year										
Caller concern	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Check a larval site	1,516	984	633	610	393	220	197	164	626	539	450
Request adult treatment	2,714	2,506	1,094	854	867	1,375	594	1,384	1,291	1,413	1,329
Public event, request treatment	132	135	100	72	60	109	250	78	68	61	61
Request tire removal	236	255	242	170	208	257	253	335	316	419	351
Request or confirm limited or no treatment	60	38	36	**171	49	66	61	55	56	54	88

* Includes email requests for service

** Years where confirmation postcards sent to confirm restricted access property status

Curriculum in Schools MMCD continued to deliver “Mosquito Mania,” a three-day curriculum for upper elementary and middle school students. This curriculum was introduced to metro-area schools during the 2005-2006 school year. “Mosquito Mania” builds on MMCD’s relationship with schools by offering a standards-based approach to the subject of mosquitoes and their relationship to the environment. Main Office and regional facility staff made presentations to 5,820 students in 48 schools during 2013. We continue to monitor changes in middle-school learning standards and make the adjustments necessary to keep the curriculum relevant and useful.

Social Media As part of an ongoing effort to notify residents when and where treatment is to take place, MMCD continues to build a presence on Facebook and Twitter. Sign up to receive MMCD tweets (@metromosquito). People can also “friend” Metropolitan Mosquito Control District on Facebook. MMCD currently has 184 Twitter followers (up from 149 a year ago), and 199 “Likes” on Facebook (up from 84 Likes in 2012).

MMCD currently uses the service “GovDelivery” to give advance notification to District residents of adult mosquito treatments. In 2013, GovDelivery will continue to manage MMCD’s direct treatment notification email lists. MMCD will continue to work with GovDelivery to make efficient use of social media to reach people who are interested in finding out more about District treatment activities.

Sustainability Initiative

Ongoing impacts from decreasing natural resources and climate change have served to deepen MMCD's longstanding commitment to sustainability and social responsibility. In 2013, MMCD established a formal sustainability strategy, and formed a steering committee to assist in guiding staff's efforts. We identified key opportunity areas and created small work groups to establish specific quantifiable sustainability goals in each of these areas:

- reducing energy usage
- reducing waste
- identifying and using renewable resources
- social responsibility/health and wellness

To kick off this effort, MMCD assembled all staff in January 2013 to discuss our sustainability initiatives. At the meeting, members of our focus area small groups outlined their activities. Invited speakers from the private and public sector (Lyell Clarke, President and CEO of Clarke Mosquito Control and Cathy Moeger, MPCA) described their experiences implementing sustainable business practices. Group members discussed current District practices such as recycling efforts, using energy-saving lights, using E85 in District vehicles, etc. Staff identified a need to ensure that all District employees, including inspectors, approach their jobs with sustainability as part of their mindset going forward. Staff also agreed that sustainability initiatives adopted by the District must include specific, measurable objectives that are positive, forward-looking, and strengthen the District over the long term. A guiding document for the District that can be updated each year can be found at www.mmcd.org/resources/technical-reports/

Professional Association Support

American Mosquito Control Association MMCD staff members continued to provide support for the national association in a variety of ways.

- Jim Stark completed his term as a Regional Director for the North Central region on the AMCA Board of Directors as of the February 2013 AMCA meeting.
- Diann Crane continues to provide editorial assistance with the AMCA Annual Meeting Program, and is being honored for that work with an award at the 2014 AMCA Meeting in Seattle.

North American Black Fly Association John Walz served as President and Program Chair for this group again in 2013 and maintains the association's web site, http://www.nabfa-blackfly.org.

North Central Mosquito Control Association Mark Smith and Sandy Brogren serve on the Board of Directors of this regional association focused on education, communication, and promoting interaction between various regional organizations and individuals in Minnesota, North Dakota, South Dakota, Wisconsin, Iowa, and the Central Provinces of Canada. Mark and other MMCD staff members planned the 2013 annual meeting, hosted at our North facility in Andover, MN, April 11 and 12. The 2014 annual meeting will take place in Fargo, ND.

Scientific Presentations, Posters, and Publications

MMCD staff attends a variety of scientific meetings throughout the year. Following is a list of papers and posters presented during 2013 and talks that are planned in 2014. Also included are publications that have MMCD staff as authors or co-authors.

2013 Publications

No published papers.

2013 Presentations & Posters

Brogren, S. 2013. The new millennium: Changing climate, changing mosquito fauna. Presentation North Central Mosquito Control Association Annual Meeting in Andover, MN.

Brogren, S., D. Crane, and C. LaMere. 2013. What's causing the population explosion of *Culex erraticus* and *Anopheles quadrimaculatus* in Minnesota? Poster: American Mosquito Control Association Annual Meeting in Atlantic City, NJ.

Crane, D., S. Brogren, and C. LaMere. 2013. Minnesota mosquito fauna: intriguing changes in a half century of sampling. Presentation: Michigan Mosquito Control Association Annual Meeting in Bay City, MI.

Grant, S. 2013. Framework for excellence: mission, vision, values. Presentation: Michigan Mosquito Control Association Annual Meeting in Bay City, MI.

Herrmann, M. 2013. Framework for excellence: mission, vision, values. Presentation: American Mosquito Control Association Annual Meeting in Atlantic City, NJ.

Johnson, K. 2013. Mosquito-borne disease in MMCD: 2012 review/2013 preparations. Presentation North Central Mosquito Control Association Annual Meeting in Andover, MN.

Johnson, K., Brogren S. and LaMere C. 2013. Reflections on 10 years of West Nile virus vector mosquitoes in stormwater structures. Poster: Minnesota Water Resources Conference in St. Paul, MN

LaMere, C. and J. Walz. 2013. Long-term nontarget monitoring for larval black fly control operations in the Mississippi River. Poster: North American Black Fly Association Annual Meeting in Athens, GA.

McLean, M. 2013. Mosquito control crisis communication: expecting the best, planning for the worst. Presentation: Minnesota Pesticide Applicator Recertification Workshop. November, 2013 in St. Cloud, MN.

Read, N. and B. Fischer. 2013. Moving up to an enterprise open source geospatial platform. Presentation: Free and Open Source Software for Geospatial North America Conference (FOSS4G-NA) in St. Paul, MN.

Read, N. 2013. Wetland maps and mosquitoes: translating geospatial data into on-the-ground practice. Presentation: Society of Wetland Scientists Annual Meeting in Duluth, MN.

Read, N. 2013. Enterprise open source mobile web app in the cloud – making buzzwords a reality for mosquito control. Presentation: Minnesota Geographic Information Systems / Land Information Systems (MN GIS/LIS) Annual Conference in Rochester, MN.

Read, N. 2013. Adapting to changing climate: issues for mosquito control. Presentation: MN Climate Adaptation Partnership's one-day conference "Preparing Minnesota for Climate Change: A Conference on Climate Adaptation" in St. Paul, MN.

Smith, M. 2013. A reduction in your budget can improve your program's operational effectiveness and efficiency. Presentation: American Mosquito Control Association Annual Meeting in Atlantic City, NJ.

Smith, M. 2013. Focus on leadership to improve your mosquito control operations. Presentation: North Central Mosquito Control Association Annual Meeting in Andover, MN.

Stark, J. 2013. Sustainability: MMCD's efforts to reduce waste and save energy. Presentation: American Mosquito Control Association Annual Meeting in Atlantic City, NJ.

2014 Presentations & Posters

Crane, D., S. Brogren, K. Johnson, and C. LaMere. 2014. West Nile virus in Minnesota: Program adaptations over 10-plus years. Poster: American Mosquito Control Association Annual Meeting in Seattle, WA.

Griemann, L. 2014. Fleet vehicle management and sustainability. Presentation: American Mosquito Control Association Annual Meeting in Seattle, WA.

Johnson, K. 2014. Mosquito surveillance and control in MMCD catch basins. Presentation: Michigan Mosquito Control Association Annual Meeting in Lansing, MI.

Manweiler, S. and Mark Smith. 2014. Potential long-term budget impacts due to climate change. Presentation: Michigan Mosquito Control Association Annual Meeting in Lansing, MI.

Read, N. and B. Fischer. 2014. Enterprise mobile web app in the cloud – making buzzwords a reality. Presentation: American Mosquito Control Association Annual Meeting in Seattle, WA.

Smith, M. and S. Manweiler. 2014. Strategies for managing your control material budget under variable climatic conditions. Presentation: American Mosquito Control Association Annual Meeting in Seattle, WA.

APPENDICES

Appendix A Mosquito and Black Fly Biology and Species List

Appendix B Average Number of Common Mosquito Species Collected per Night in Four New Jersey Light Traps 1965-2013

Appendix C Description of Control Materials

Appendix D 2013 Control Materials: Percent Active Ingredient (AI), AI Identity, Per Acre Dosage, AI Applied Per Acre and Field Life

Appendix E Acres Treated with Control Materials Used by MMCD for Mosquito and Black Fly Control for 2004-2013

Appendix F Graphs of Larvicide, Adulticide, and ULV Fog Treatment Acres, 1984-2013

Appendix G Control Material Labels

Appendix H Technical Advisory Board Meeting Notes, February 13, 2014

APPENDIX A Mosquito and Black Fly Biology and Species List

Mosquito Biology

There are 51 species of mosquitoes in Minnesota. Forty-five species occur within the District. Species can be grouped according to their habits and habitat preferences. For example, the District uses the following categories when describing the various species: disease vectors, spring snow melt species, summer floodwater species, permanent water species, and the cattail mosquito.

Disease Vectors

Aedes triseriatus Also known as the eastern treehole mosquito, *Ae. triseriatus*, is the vector of La Crosse encephalitis (LAC). Natural oviposition sites are tree holes; however, adult females will also oviposit in water-holding containers, especially discarded tires. Adults are found in wooded or shaded areas and stay within ¼ to ½ miles from where they emerged. They are not aggressive biters and are not attracted to light. Vacuum aspirators are best for collecting this species.

Culex tarsalis *Culex tarsalis* is the vector of western equine encephalitis (WEE) and a vector of West Nile virus (WNV). In late summer, egg laying spreads to temporary pools and water-holding containers, and feeding shifts from birds to horses or humans. MMCD monitors this species using New Jersey light traps and CO_2 traps.

Other *Culex* Three additional species of *Culex* (*Cx. pipiens, Cx. restuans,* and *Cx. salinarius*) are vectors of WNV. All three use permanent and semi-permanent sites for larval habitat, and *Cx. pipiens* and *Cx. restuans* use storm sewers and catch basins as well. These three *Culex* vector species plus *Cx. tarsalis* are referred to as the *Culex*4.

Culex erraticus *Culex erraticus* normally a southern mosquito, has been increasing in our area over the past decade. In 2012 (a very warm spring and summer period), there were very high levels of adult *Cx. erraticus* in the District, and larvae were found for the first time since 1961 in permanent water sites with no emergent vegetation and edges with willow. *Culex erraticus* is a potential vector of eastern equine encephalitis (EEE).

Culiseta melanura *Culiseta melanura* is the enzootic vector of EEE. Its preferred larval habitat is spruce tamarack bogs, and adults do not fly far from these locations. A sampling strategy developed for both larvae and adults targets habitat in northeastern areas of the District, primarily in Anoka and Washington counties. Several CO_2 trap locations are specific for obtaining *Cs. melanura*; adult females collected from those sites are then tested for EEE.

Floodwater Mosquitoes

Spring *Aedes* Spring *Aedes* mosquito (12 species) eggs inundated with snowmelt runoff hatch from March through May; they are the earliest mosquitoes to hatch in the spring. Larvae develop in woodland pools, bogs, and marshes that are flooded with snowmelt water. There is only one generation per year and overwintering is in the egg stage. Adult females live throughout the summer, can take up to four blood meals, and lay multiple egg batches. There is only one generation per year as the eggs require freezing conditions prior to egg hatch. These mosquitoes stay near their oviposition sites, so localized hot spots of biting can occur both day and night. Our most common spring species are *Ae. absserratus,* *Ae. punctor*, *Ae. excrucians,* and *Ae. stimulans*. Adults are not attracted to light, so human (sweep nets) or CO_2-baited trapping is recommended.

Summer Floodwater *Aedes* Eggs of summer floodwater *Aedes* (15 species) can hatch beginning in late April and early May. These mosquitoes lay their eggs at the margins of grassy depressions, marshes, and along river flood plains; floodwater from heavy rains (greater than 1 inch) stimulate the eggs to hatch. Overwintering is in the egg stage. Adult females live about three weeks and can lay multiple batches of eggs, which can hatch during the current summer after flooding, resulting in multiple generations per year. Most species can fly great distances and are highly attracted to light. Peak biting activity is as at dusk. The floodwater mosquito, *Ae. vexans* is our most numerous pest. Other summer species are *Ae. canadensis*, *Ae. cinereus*, *Ae. sticticus,* and *Ae. trivittatus*. New Jersey light traps, CO_2-baited traps, and human-baited sweep net collections are effective methods for adult surveillance of these species.

Cattail Mosquito

Coquillettidia perturbans This summer species is called the “cattail mosquito” because it uses cattail marshes for larval habitat. Larvae of this unique mosquito obtain oxygen by attaching its specialized siphon to the roots of cattails and other aquatic plants; it overwinters this way. There is only a single generation per year, and adults begin to emerge in late June and peak around the first week of July. They are very aggressive biters, even indoors, and can disperse up to five miles from their larval habitat. Peak biting activity is at dusk and dawn. Eggs are laid in rafts on the surface of the water. Adult surveillance is best achieved with CO_2 traps and sweep net samples.

Permanent Water Species

Other mosquito species not previously mentioned develop in permanent and semi-permanent sites. These mosquitoes comprise the remaining *Anopheles*, *Culex*, and *Culiseta* species. These mosquitoes are multi-brooded and lay their eggs in rafts on the surface of the water. The adults prefer to feed on birds or livestock but will bite humans. The adults overwinter in places like caves, hollow logs, stumps or buildings. As previously mentioned, the District targets disease vectors (the *Culex*4 species and *Cs. melanura*) for surveillance and/or control.

Exotic or Rare Species

Aedes albopictus This exotic species is called the Asian tiger mosquito. It oviposits in tree holes and containers. This mosquito is a very efficient vector of several diseases, including LAC. *Aedes albopictus* has been found in Minnesota, but it is not known to overwinter here. It was brought into the country in recycled tires from Asia and is established in areas as far north as Chicago. An individual female will lay her eggs a few at a time in several containers, which may contribute to rapid local spread. This mosquito has transmitted dengue fever in southern areas of the United States. Females feed predominantly on mammals but will also feed on birds.

Aedes japonicus This non-native species was first detected in Minnesota in 2007. By 2008, they were established in the District and southeast Minnesota. Larvae are found in a wide variety of natural and artificial habitats (containers), including rock holes and used tires. Preferred sites usually are shaded and contain organic-rich water. Eggs, larvae, and pupae transported in used tires may be an important mechanism for introducing the species into previously uninfested areas. Eggs are resistant to desiccation and can survive several weeks or months under dry conditions. Overwintering is in the egg stage.

***Psorophora* species** Larvae of this genus develop in floodwater areas, are human-biting, and not known to vector any disease. Four species occur in the District; although considered rare or uncommon, they have been detected more frequently since the mid-2000s. The adult *Psorophora ciliata* is the largest mosquito found in the District, and its larvae are predacious and even cannibalistic.

Black Fly Biology

Life Cycle Females lay eggs directly onto the water or on leaves of aquatic plants and objects in rivers, streams, and other running water. Once they hatch, the larvae attach themselves to stones, grass, branches, leaves, and other objects submerged under the water. In Minnesota, black flies develop in large rivers (e.g. Mississippi, Minnesota, Crow, and Rum) as well as small streams. Most larval black flies develop under water for 10 days to several weeks depending on water temperature. Larvae eat by filtering food from the running water with specially adapted mouthparts that resemble grass rakes. They grow to about 1/4 inch when fully developed; after about a week as pupae, they emerge as adults riding a bubble of air to the surface.

Female black flies generally ambush their victims from tree-top perches near the edge of an open area and are active during the day; peak activity is in the morning and early evening. Females live from one to three weeks, depending on species and weather conditions. They survive best in cool, wet weather. Studies done by MMCD show that the majority of black flies in the region lay only one egg batch.

Targeted Species (taken from Adler, P. et al, 2004)
Simulium venustum develops in smaller streams. It has one generation in the spring (April through early June), and is univoltine (one egg batch per year). Eggs overwinter and larvae begin hatching in April. Females can travel an average of 5.5-8 miles (maximum=22 miles) from their natal waterways. *Simulium venustum* is one of the most common black flies and probably one of the major biting pests of humans in North America.

Simulium johannseni develops primarily in the Crow and South Fork Crow rivers. It has one generation in the spring (April through May). Larvae develop in large, turbid, meandering streams and rivers with beds of sand and silt. Female adults feed on both birds and mammals

Simulium meridionale develops in the Minnesota, Crow, and South Fork Crow rivers and is multivoltine with three to six generations (May- July). Adult females feed on both birds and mammals. Females will travel at least 18 miles from their natal sites and have been collected at heights up to 4,900 ft above ground (0.932 miles).

Simulium luggeri develops primarily in the Mississippi and Rum rivers and has five to six generations a year. Eggs overwinter with larvae and pupae present from May to October. Three to five overlapping generations are produced annually. Host-seeking females can travel at least 26 miles from their natal waters and perhaps more than 185 miles with the aid of favorable winds. Hosts include humans, dogs, horses, pigs, elk, cattle, sheep, and probably moose.

Adler, Peter H., Douglas C. Currie, and D. Monty Wood. 2004. *The Black Flies (Simuliidae) of North America*. Cornell University Press.

Species Code and Significance/Occurrence of the Mosquitoes and Black Flies in MMCD

Code	Genus	species	Significance/ Occurrence	Code	Genus	species	Significance/ Occurrence
Mosquitoes							
1.	*Aedes*	*abserratus*	common, spring	27.	*Anopheles*	*barberi*	rare, tree hole
2.		*atropalpus*	rare, summer	28.		*earlei*	common
3.		*aurifer*	rare, spring	29.		*punctipennis*	common
4.		*euedes*	rare, spring	30.		*quadrimaculatus*	common
5.		*campestris*	rare, spring	31.		*walkeri*	common
6.		*canadensis*	common, spring	311.	*An.* unidentifiable		
7.		*cinereus*	common, spring-summer				
8.		*communis*	rare, spring	32.	*Culex*	*erraticus*	rare
9.		*diantaeus*	rare, spring	33.		*pipiens*	common
10.		*dorsalis*	common, spring-summer	34.		*restuans*	common
11.		*excrucians*	common, spring	35.		*salinarius*	uncommon
12.		*fitchii*	common, spring	36.		*tarsalis*	common
13.		*flavescens*	uncommon, spring	37.		*territans*	common
14.		*implicatus*	uncommon, spring	371.	*Cx.* unidentifiable		
15.		*intrudens*	rare, spring	372.	*Cx.*	*pipiens/restuans*	common
16.		*nigromaculis*	uncommon, summer				
17.		*pionips*	rare, spring	38.	*Culiseta*	*inornata*	common
18.		*punctor*	common, spring	39.		*melanura*	uncommon, local
19.		*riparius*	common, spring	40.		*minnesotae*	common
20.		*spencerii*	uncommon, spring	41.		*morsitans*	uncommon
21.		*sticticus*	common, spring-summer	411.	*Cs.* unidentifiable		
22.		*stimulans*	common, spring	42.	*Coquillettidia*	*perturbans*	common
23.		*provocans*	common, early spring	43.	*Orthopodomyia*	*signifera*	rare
24.		*triseriatus*	common, summer, LAC vector	44.	*Psorophora*	*ciliata*	rare
25.		*trivittatus*	common, summer	45.		*columbiae*	rare
26.		*vexans*	common, #1 summer species	46.		*ferox*	uncommon
50.		*hendersoni*	uncommon, summer	47.		*horrida*	uncommon
51.		*albopictus*	rare, exotic, Asian tiger mosquito	471.	*Ps.* unidentifiable		
52.		*japonicus*	summer, Asian rock pool mosq.				
53.		*cataphylla**		48.	*Uranotaenia*	*sapphirina*	common, summer
118.		*abserratus/punctor*	inseparable when rubbed	49.	*Wyeomyia*	*smithii*	rare
261.	*Ae.* unidentifiable			491.	Males		
262.	Spring *Aedes*			501.	Unidentifiable		
264.	Summer *Aedes*						
Black Flies							
91.	*Simulium*	*luggeri*	treated, summer	96.	Other Simuliidae		
92.		*meridionale*	treated, summer	97.	Unidentifiable Simuliidae		
93.		*johansenni*	treated, spring				
94.		*vittatum*	non-treated, summer				
95.		*venustum*	treated, spring				

* Two *Aedes cataphylla* larvae were collected in April, 2008 in Minnetonka, MN

Genus Abbreviations for mosquitoes

Aedes=Ae.
Anopheles=An.
Culex=Cx.
Culiseta=Cs.
Coquillettidia=Cq.
Orthopodomyia=Or.
Psorophora=Ps.
Uranotaenia=Ur.
Wyeomyia=Wy.

APPENDIX B Average Number of Common Mosquitoes Collected/Night in Four NJ Light Traps and Average Yearly Rainfall, 1965-2013

Year	Spring *Aedes*	*Aedes cinereus*	*Aedes sticticus*	*Aedes trivittatus*	*Aedes vexans*	*Culex tarsalis*	*Cq. perturbans*	All species	Avg. Rainfall
1965	0.10	0.22	0.06	0.01	107.54	8.76	1.28	135.69	27.97
1966	0.16	0.06	0.00	0.01	17.26	0.45	1.99	22.72	14.41
1967	0.31	0.27	0.25	0.03	85.44	0.96	4.93	95.5	15.60
1968	0.21	0.71	0.04	0.19	250.29	2.62	3.52	273.20	22.62
1969	0.15	0.23	0.01	0.03	20.39	0.57	3.57	30.12	9.75
1970	0.20	0.57	0.03	0.33	156.45	0.97	3.07	179.71	17.55
1971	0.87	0.42	0.12	0.11	90.45	0.50	2.25	104.65	17.82
1972	1.05	1.79	0.19	0.07	343.99	0.47	14.45	371.16	18.06
1973	0.97	0.68	0.03	0.04	150.19	0.57	22.69	189.19	17.95
1974	0.37	0.36	0.10	0.03	29.88	0.26	5.62	38.75	14.32
1975	0.28	0.63	0.44	0.17	40.10	6.94	4.93	60.64	21.47
1976	0.24	0.04	0.01	0.00	1.69	0.25	4.24	9.34	9.48
1977	0.14	0.07	0.00	0.02	21.75	5.98	7.42	34.07	20.90
1978	0.84	0.77	0.17	0.11	72.41	4.12	0.75	97.20	24.93
1979	0.29	0.21	0.03	0.48	27.60	0.29	2.12	35.44	19.98
1980	0.03	0.19	0.05	0.79	74.94	0.93	16.88	96.78	19.92
1981	0.05	0.14	0.13	0.69	76.93	1.50	4.45	87.60	19.08
1982	0.10	0.08	0.02	0.03	19.95	0.23	3.16	25.91	15.59
1983	0.15	0.08	0.02	0.04	45.01	0.67	3.44	53.39	20.31
1984	0.08	0.09	0.15	0.36	74.68	2.97	22.60	110.26	21.45
1985	0.07	0.00	0.02	0.01	21.02	0.33	4.96	28.72	20.73
1986	0.35	0.22	0.11	0.04	30.80	1.55	2.42	40.76	23.39
1987	0.00	0.09	0.01	0.17	29.91	1.18	1.52	37.43	19.48
1988	0.01	0.09	0.00	0.00	12.02	0.84	0.18	15.31	12.31
1989	0.05	0.35	0.01	0.26	13.13	1.60	0.17	21.99	16.64
1990	0.30	3.39	0.22	0.08	119.52	4.97	0.08	147.69	23.95
1991	0.11	0.56	0.15	0.26	82.99	1.17	0.45	101.33	26.88
1992	0.04	0.04	0.03	0.13	50.30	0.62	16.31	74.56	19.10
1993	0.03	0.24	0.10	1.15	50.09	0.96	10.90	72.19	27.84
1994	0.02	0.14	0.03	0.08	23.01	0.05	15.19	40.92	17.72
1995	0.04	0.28	0.02	0.29	63.16	0.42	6.79	77.71	21.00
1996	0.12	0.10	0.01	0.04	14.28	0.05	12.06	28.81	13.27
1997	0.09	0.64	0.14	0.63	39.06	0.14	2.03	45.35	21.33
1998	0.03	0.14	0.16	1.23	78.42	0.10	6.13	91.29	19.43
1999	0.01	0.28	0.09	0.11	28.24	0.06	1.74	33.03	22.41
2000	0.01	0.07	0.00	0.22	24.09	0.15	1.36	29.50	17.79
2001	0.05	0.41	0.32	0.10	20.97	0.27	1.01	26.26	17.73
2002	0.05	0.22	0.07	2.53	57.87	0.35	0.75	65.82	29.13
2003	0.04	0.15	0.43	2.00	33.80	0.13	1.59	40.51	16.79
2004	0.02	0.33	0.22	0.63	24.94	0.16	0.99	28.91	21.65
2005	0.05	0.11	0.17	0.42	22.27	0.17	0.57	25.82	22.82
2006	0.05	0.08	0.14	0.01	6.73	0.08	1.85	10.04	18.65
2007	0.22	0.27	0.01	0.01	8.64	0.26	0.94	13.20	17.83
2008	0.38	0.32	0.17	0.01	8.17	0.10	2.01	12.93	14.15
2009	0.10	0.07	0.00	0.02	3.48	0.04	0.23	4.85	13.89
2010	0.07	0.08	0.06	0.17	16.18	0.23	0.36	26.13	24.66
2011	0.10	0.07	0.11	0.78	33.40	0.07	5.76	47.36	20.61
2012	0.04	0.03	0.15	0.21	21.10	0.04	4.01	30.39	17.53
2013	0.37	0.49	0.15	0.81	26.95	0.12	1.80	35.08	17.77

APPENDIX C Description of Control Materials

The following is an explanation of the control materials currently used by MMCD. The specific names of products used in 2013 are given. The generic products will not change in 2014, although the specific formulator may change.

Insect Growth Regulators

Methoprene 150-day briquets Central Life Sciences
Altosid® XR Extended Residual Briquet EPA # 2724-421

Altosid briquets are typically applied to mosquito oviposition sites that are three acres or less. Briquets are applied to the lowest part of the site on a grid pattern of 14-16 ft apart at 220 briquets per acre. Sites that may flood and then dry up (Types 1 & 2) are treated completely. Sites that are somewhat permanent (Types 3, 4, 5) are treated with briquets to the perimeter of the site in the grassy areas. Pockety ground sites (i.e., sites without a dish type bottom) may not be treated with briquets due to spotty control achieved in the uneven drawdown of the site.

Coquillettidia perturbans sites are treated at 330 briquets per acre in rooted sites or 440 briquets per acre in floating cattail stands. Applications are made in the winter and early spring.

Methoprene pellets Central Life Sciences
Altosid® Pellets EPA# 2724-448

Altosid pellets consist of methoprene formulated in a pellet shape. Altosid pellets are designed to provide up to 30 days control but trials have indicated control up to 40 days. Applications will be made to ground sites (less than three acres in size) at a rate of 2.5 lb per acre for *Aedes* control and 4-5 lb per acre for *Cq. perturbans* control. Applications will also be done by helicopter in sites that are greater than three acres in size at the same rate as ground sites, primarily for *Cq. perturbans* control.

Methoprene sand Central Life Sciences
Altosid® XR-G EPA# 2724-451

Altosid XR-G sand consists of methoprene formulated in a sand-sized granule designed to provide up to 20 days control. Applications for control of *Cq. perturbans* are being evaluated at 10 lb per acre.

Methoprene granules Valent Biosciences
MetaLarv® S-PT EPA# 73049-475

MetaLarv S-PT consists of methoprene formulated in a sand-sized granule designed to provide up to 28 days control. Applications for control of *Cq. perturbans* and *Aedes* mosquitoes are being evaluated at 3 and 4 lb per acre.

Bacterial Larvicides

***Bacillus thuringiensis israelensis* (*Bti*) corn cob**	Valent Biosciences
VectoBac® G	EPA#73049-10

VectoBac corn cob may be applied in all types of larval habitat. The material is most effective during the first three instars of the larval life cycle. Typical applications are by helicopter in sites that are greater than three acres in size at a rate of 5-10 lb per acre. In sites less than three acres, the material is applied to pockety sites with cyclone seeders or power backpacks.

***Bacillus thuringiensis israelensis* (*Bti*) liquid**	Valent Biosciences
VectoBac® 12AS	EPA# 73049-38

VectoBac liquid is applied directly to small streams and large rivers to control black fly larvae. Treatments are done when standard Mylar sampling devices collect threshold levels of black fly larvae. Maximum dosage rates are not to exceed 25 ppm of product as stipulated by the MnDNR. The material is applied at pre-determined sites, usually at bridge crossings applied from the bridge, or by boat.

Bacillus sphaericus (Bs)	Valent Biosciences
VectoLex® CG	EPA# 73049-20

VectoLex CG may be applied in all types of larval *Culex* habitat. The material is most effective during the first three instars of the larval life cycle. Typical applications are by helicopter in sites that are greater than three acres in size at a rate of 8 lb per acre. In sites less than three acres, VectoLex is applied to pockety sites with cyclone seeders or power back packs at rates of 8 lb per acre. This material may also be applied to cattail sites to control *Cq. perturbans*. A rate of 15 lb per acre is applied both aerially and by ground to cattail sites in early to mid-September to control emergence the following June-July.

Natular® (spinosad)	Clarke
Natular® G30	EPA# 8329-83

Natular is a new formulation of spinosad, a biological toxin extracted from the soil bacterium *Saccharopolyspora spinosad,* that was developed for larval mosquito control. Spinosad has been used by organic growers for over 10 years. Natular is formulated as long release granules (G30) and can be applied to dry or wet sites.

Pyrethroid Adulticides

Permethrin	Clarke
Permethrin 57% OS	EPA# 8329-44

Permethrin 57% OS is used by the District to treat adult mosquitoes in known daytime resting or harborage areas. Harborage areas are defined as wooded areas with good ground cover to provide a shaded, moist area for mosquitoes to rest during the daylight hours.

Adult control is initiated when MMCD surveillance (sweep net and CO_2 trap collections) indicates nuisance populations of mosquitoes, when employee conducted landing rate collections document high numbers of mosquitoes, or when a large number of citizens complain of mosquito annoyance from a given area. In the case of citizen complaints, MMCD staff conducts mosquito surveillance to determine if treatment is warranted. MMCD also treats functions open to the public and public owned park and recreation areas upon request and at no charge if the event is not-for-profit.

The material is diluted with soybean and food grade mineral oil (1:10) and is applied to wooded areas with a power backpack mister at a rate of 25 oz of mixed material per acre (0.0977 lb AI per acre).

Esfenvalerate and Prallethrin MGK, McLaughlin Gormley King
Onslaught® FastCap Microencapsulated Insecticide EPA# 1021-1815

Onslaught (esfenvalerate, prallethrin, and the synergist PBO) is used by the District to treat adult mosquitoes in known daytime resting or harborage areas. Onslaught, a non-restricted use compound, is diluted with water (1:50) and applied to wooded areas with a power backpack mister at a rate of 25 oz of mixed material per acre (0.0026 lb AI per acre [0.0021 esfenvalerate and 0.0005 prallethrin]).

Resmethrin Bayer
Scourge® 4+12 EPA# 432-716

Scourge (resmethrin and the synergist PBO) is used by the District to treat adult mosquitoes in known areas of concentration or nuisance. Scourge is applied from truck or all-terrain-vehicle mounted ULV machines that produce a fog that contacts mosquitoes when they are flying. Fogging may also be done with hand-held cold fog machines that enable the applications in smaller areas than can be reached by truck. Cold fogging is done either in the early morning or at dusk when mosquitoes become more active. The material is applied at a rate of 1.5 oz of mixed material per acre (0.0035 lb AI per acre). Scourge is a restricted used compound and is applied only by Minnesota Department of Agriculture licensed applicators.

Sumithrin Clarke
Anvil® 2+2 EPA# 1021-1687-8329

Anvil (sumithrin and the synergist PBO) is used by the District to treat adult mosquitoes in known areas of concentration or nuisance. Anvil is applied from truck or all-terrain-vehicle mounted ULV machines that produce a fog that contacts mosquitoes when they are flying. Fogging may also be done with hand held cold fog machines that enable applications in smaller areas than can be reached by truck. Cold fogging is done either in the early morning or at dusk when mosquitoes become more active. The material is applied at a rates 1.5 and 3.0 oz of mixed material per acre (0.00175 and 0.0035 lb AI per acre). Anvil is a non-restricted use compound.

Etofenprox Central Life Sciences
Zenivex® E20 EPA# 2724-791

Zenivex (a non-ester pyrethroid) is being evaluated by the District to treat adult mosquitoes in known areas of concentration or nuisance. Etofenprox is applied from truck or all-terrain-vehicle mounted ULV machines that produce a fog that contacts mosquitoes when they are flying. Fogging may also be done with hand-held cold fog machines that enable applications in smaller areas than can be reached by truck. Cold fogging is done either in the early morning or at dusk when mosquitoes become more active. Etofenprox is applied at a rate of 1.0 oz of mixed material per acre (0.00175 lb AI per acre). Etofenprox is a non-restricted use compound.

APPENDIX D 2013 Control Materials: Active Ingredient (AI) Identity, Percent AI, Per Acre Dosage, AI Applied Per Acre and Field Life

Material	AI	Percent AI	Per acre dosage	AI per acre (lbs)	Field life (days)
Altosid® briquets [a]	Methoprene	2.10	220	0.4481	150
			330	0.6722	150
			440	0.8963	150
			1*	0.0020*	150
Altosid® pellets	Methoprene	4.25	2.5 lb	0.1063	30
			4 lb	0.1700	30
			0.0077 lb* (3.5 g)	0.0003*	30
Altosid® SR-20 [b]	Methoprene	20.00	20 ml	0.0091	10
Altosid® XR-G	Methoprene	1.50	10 lb	0.1500	20
MetaLarv™ S-PT	Methoprene	4.25	2.5 lb	0.1063	30
			3 lb	0.1275	30
			4 lb	0.1700	30
Natular™ G30	Spinosad	2.50	5 lb	0.1250	30
VectoBac® G	*Bti*	0.20	5 lb	0.0100	1
			8 lb	0.0160	1
VectoLex® CG	*Bs*	7.50	8 lb	0.6000	7-28
			0.0077 lb* (3.5 g)	0.0006*	7-28
Permethrin 57%OS [c]	Permethrin	5.70	25 fl oz	0.0977	5
Onslaught FastCap® [d]	Esfenvalerate Prallethrin	6.40 1.60	25 fl oz	0.0021 0.0005	5
Scourge® [e]	Resmethrin	4.14	1.5 fl oz	0.0035	<1
Anvil® [f]	Sumithrin	2.00	3.0 fl oz	0.0035	<1

[a] 44 g per briquet total weight (220 briquets=21.34 lb total weight)

[b] 1.72 lb AI per 128 fl oz (1 gal); 0.45 lb AI per 1000 ml (1 liter)

[c] 0.50 lb AI per 128 fl oz (1 gal) (product diluted 1:10 before application, undiluted product contains 5.0 lb AI per 128 fl oz)

[d] 0.0135 lb AI per 128 fl oz (1 gal) (product diluted 1:50 before application, undiluted product contains 0.675 lb AI per 128 fl oz)

[e] 0.30 lb AI per 128 fl oz (1 gal)

[f] 0.15 lb AI per 128 fl oz (1 gal)

* Catch basin treatments—dosage is the amount of product per catch basin.

APPENDIX E Acres Treated with Control Materials Used by MMCD for Mosquito and Black Fly Control, 2005-2013. The actual geographic area treated is smaller because some sites are treated more than once

Control Material	2005	2006	2007	2008	2009	2010	2011	2012	2013
Larvicides									
Altosid® XR Briquet 150-day	635	352	290	294	225	174	205	165	189
Altosid® XRG	0	0	1,776	6,579	8,320	9,924	13,336	23,436	6,948
Altosid® Pellets 30-day	29,965	31,827	36,818	35,780	35,161	36,516	30,749	13,172	15,813
Altosid® Pellets catch basins	145,386	167,797	161,876	195,973	219,045	227,611	234,033	226,934	246,300
MetaLarv™ S-PT	0	0	0	0	0	0	0	2,750	14,063
Natular™ G30	0	0	0	0	0	0	0	9,524	15,000
Altosid® XR Briquet catch basins	0	5,210	6,438	40	0	0	0	458	375
VectoLex® CG granules	810	540	27	6	0	0	0	0	2,330
VectoMax® CG granules	0	0	0	182	5	0	0	0	0
VectoBac G *Bti* corn cob granules	176,947	160,780	118,128	122,251	151,801	250,478	201,957	207,827	150,280
VectoBac 12 AS *Bti* liquid (gal used) Black fly control	3,230	1,035	1,348	2,063	2,181	2,595	3,817	3,097	3,878
Adulticides									
Permethrin 57% OS Permethrin	7,982	5,114	3,897	8,272	4,754	8,826	7,544	8,578	9,020
Scourge 4+12 Resmethrin/PBO	40,343	29,876	24,102	64,142	12,179	27,794	24,605	8,078	37,204
Anvil 2 + 2 Sumithrin/PBO	25,067	5,350	5,608	35,734	7,796	26,429	29,208	27,486	36,000
Pyrenone® Adulticide	0	0	0	2,214	943	2,560	0	0	0
Pyrocide® Adulticide	0	0	0	299	0	0	0	0	0

APPENDIX F Graphs of Larvicide, Adulticide, and ULV Fog Treatment Acres, 1984-2013

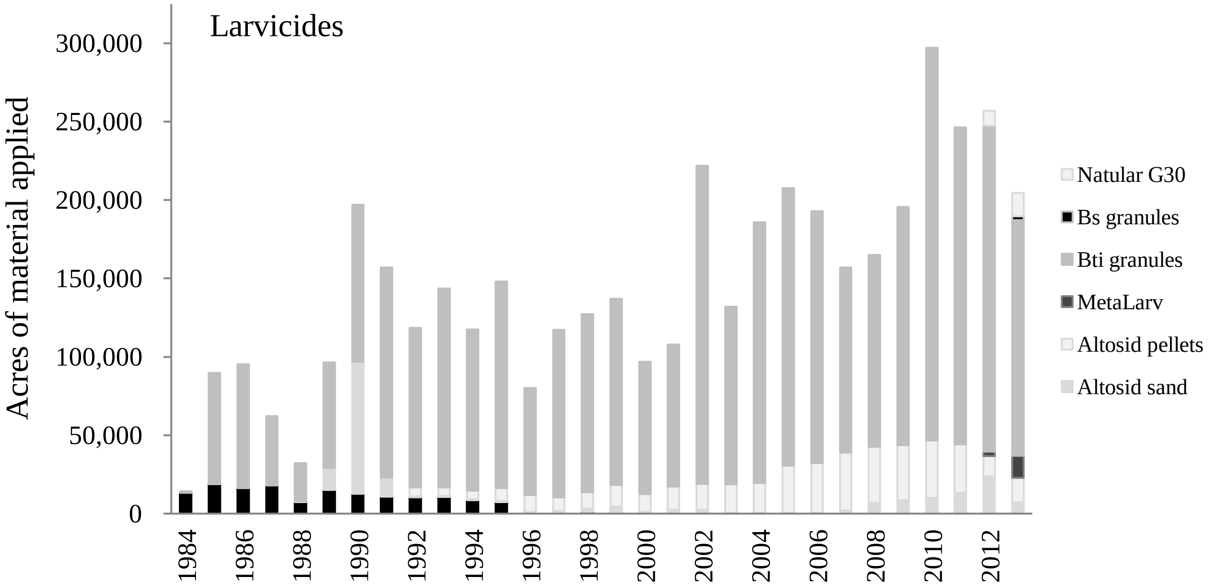


Figure F.1 Summary of total acres of larvicide treatments applied per year since 1984. For materials that are applied to the same site more than once per year, actual geographic acreage treated is less than that shown.

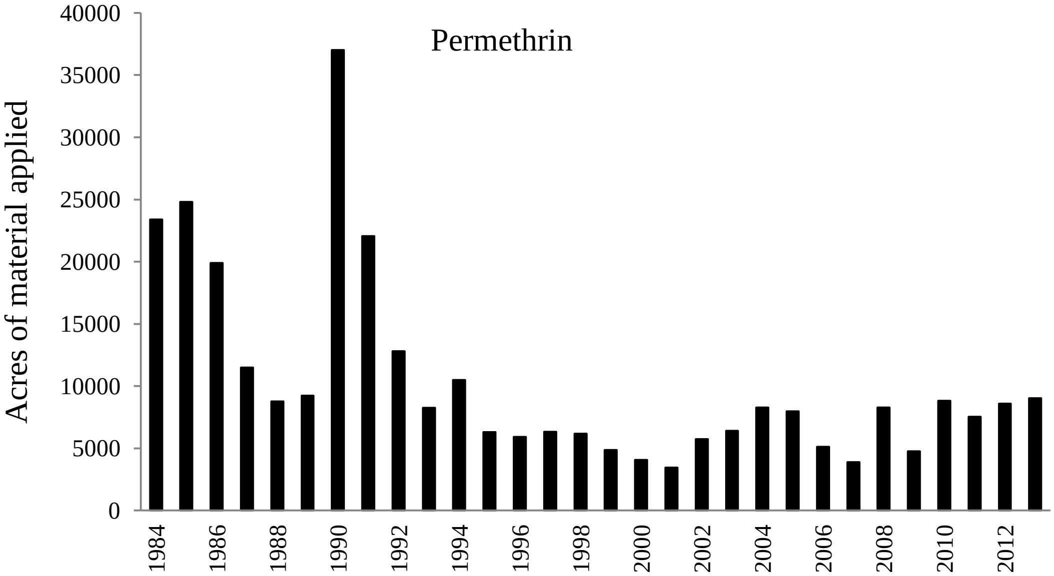


Figure F.2 Summary of total acres of permethrin treatments applied per year since 1984. This material may be applied to the same site more than once per year, so actual geographic acreage treated is less than that shown.

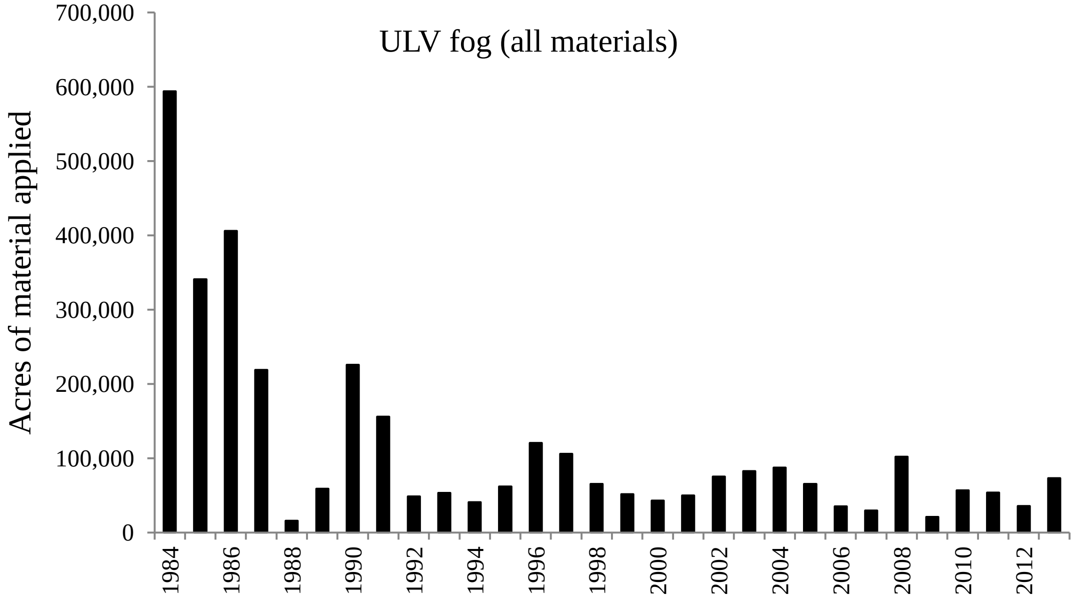


Figure F.3 Summary of total acres of ULV fog treatments applied per year since 1984. These materials may be applied to the same site more than once per year, so actual geographic acreage treated is less than that shown.

APPENDIX G Control Material Labels

Altosid® XR Extended Residual Briquets (EPA# 2724-421)

Altosid® Pellets (EPA# 2724-448)

Altosid® XR-G Sand (EPA# 2724-451)

MetaLarv® S-PT (EPA# 73049-475)

VectoBac® 12AS (EPA# 73049-38)

VectoBac® G (EPA# 73049-10)

VectoLex® CG (EPA# 73049-20)

Natular™ G30 (EPA# 8329-83)

Permethrin 57% OS (EPA# 8329-44)

Onslaught® FastCap (EPA# 1021-1815)

Scourge® 4+12 (EPA# 432-716)

Anvil® 2+2 ULV (EPA# 1021-167-8329)

Zenivex® E20 (EPA# 2724-791)

Appendix H MMCD Technical Advisory Board Meeting Notes

February 13, 2014

TAB members present:

David Neitzel, MN Department of Health
Mark Abrahamson, MN Dept. of Agriculture
Robert Sherman, Independent Statistician
Vicky Sherry, US Fish and Wildlife Service
Susan Palchick, Hennepin County Public Health
Roger Moon, University of Minnesota
Sarma Straumanis, MN Department of Transportation
John Moriarty, Three Rivers Park District
Karen Oberhauser, University of Minnesota
Don Baumgartner, US EPA (remote link)
Steve Hennes, MN Pollution Control Agency

Absent:

Gary Montz, MN Dept. of Natural Resources (gave comments to staff)

MMCD Staff in Attendance: Bill Caesar, Stephen Manweiler, Nancy Read, Sandy Brogren, Diann Crane, Kirk Johnson, Mike McLean, Janet Jarnefeld, Carey LaMere, John Walz, Mark Smith, Scott Helling-Christy

Guests: Julie Ray (MDH), Jenna Bjork (MDH), Elizabeth Schiffman (MDH), Meg Duhr Schultz (USFWS)

(Initials in the notes below designate discussion participants)

Welcome and Call to Order

Chair Mark Abrahamson called the meeting to order at 12:30 p.m. All present introduced themselves. Mark then introduced MMCD Interim Executive Director, Bill Caesar.

2013-2014 Budget Review, Sustainability

MMCD Interim Executive Director **Bill Caesar** expressed MMCD's appreciation for the TAB members' time. He thanked Diann Crane for her work on the TAB report document, and noted her meritorious service award at AMCA for similar work. Bill mentioned the search for a new Executive Director and welcomed applications.

In 2013 the early season had high expenditures, but with the dry, late summer we came out under budget. That has allowed MMCD to keep the levy flat for another year while increasing expenses for some items including control materials and wage increases.

Mike McLean presented an overview of MMCD's sustainability efforts, including our participation in the Interagency Pollution Prevention Advisory Team (IPPAT). MMCD has done a District-wide review, summarizing efforts to reduce our waste stream, reduce electrical and fuel use, exploring options for renewable energy, and looking for opportunities to promote social responsibility and wellness in the organization and communities we serve.

2013 Season Overview

Sandy Brogren presented a report on 2013 weather conditions and mosquito populations. The spring started unusually cold and wet. The season then quickly transitioned to warm, and then dry, ending in drought conditions. Mosquito sampling started later than normal, and the start date of treatments was one of the latest in the past 25 years. She described the patterns of activity seen in CO_2 trap results for the various species, and the probable forecasts for 2014.

RM – how much of spring *Aedes* is coming from just snow melt vs. pools replenished by rainfall? SB – we are finding them in more than just woodland snowmelt sites, may be using rainfall-fed sites.

Stephen Manweiler discussed the helicopter crash and its affect on overall treatment effectiveness. We were able to use our emergency incident plan and found the helicopter fairly quickly. This is the first such incident since 1968. Following the crash, we voluntarily suspended treatments for six days. This had an effect on the amount of treatments we could make, during a time when there was rainfall and new mosquito larvae. Once we resumed treatments, we raised the threshold and reduced dose to try to get the most effective treatment we could in a short time. Treatments with pre-hatch materials were also delayed. Stephen showed a map of areas that were treated and those where larvae were too old to treat. The CO_2 traps showed a large increase, particularly in Zone 1, after the time when we were unable to treat.
KO – can you compare the Zone 1(P1)/and Zone 2 (P2) difference with other years?
SM – we have some other data showing adult numbers going down after larval treatments
DB – did MMCD do any investigation of the crash? SM – what we could. DB – who did you notify? SM – FAA, emergency responders, provided MSDS, MN Dept of Ag.
SP – what is typical difference between P1 and P2? SM – 50% SP – but even though you did some treatments in P1, the in/out was equal?
KO – multiple variables, because you decreased dose and increased threshold as well.
SP – especially a problem with lower dose and later instars. RS - You could do a multivariate analysis – there was a decrease in area treated due to threshold and instar age, a decrease in the rate of application
RM – look at P1 vs. P2 for the rest of the season after 7/8, see if difference held up after the threshold and dosages returned to normal levels.

Kirk Johnson discussed seasonality and disease cases, starting with West Nile virus. Mosquito tests showed higher *Cx. tarsalis* WNV positive than in recent years. He pointed out how the mosquito infection rate increased during warm weather, and compared that with mosquito populations and onset of illness dates. Note that infected mosquitoes were still active in early October, and are probably overwintering now.

For La Crosse encephalitis, there were several cases, and the numbers of *Ae. triseriatus* reached their highest collection rate since the late 1990s, but did decrease during a period of very high temperatures. There were no EEE cases in MN, and populations of the primary vector, *Cs melanura*, were low, probably related to low winter water levels in their bog habitats. Rainfall in 2013 brought water levels up again, but they are continuing to decrease. Wildlife management agencies also reported wolf and moose samples that were positive for antibodies for EEE, showing exposure at some time.

Tick surveillance showed the lowest total ticks collected in many years.
DN – note incubation for onset of illness for WNV is 4-6 days.
JM – EEE has been found in wolves? Has it been found in dogs, other canids? KJ – found in horses, doesn't usually cause symptoms in dogs but if you tested they might have antibodies.
RM – you have measures of mosquitoes of all ages, not just viremic. Could you multiply MIR and mosquito count to estimate number of viremic mosquitoes? KJ – MIR is coming from more than CO_2 traps. RM – should work anyway.
DB – do you have stats on Lyme disease in MN? DN – we have data, note different life stage in mice than infects humans, highest human cases different years.
DB – how useful is tick surveillance? DN – great for showing the spread of the ticks over area, not really designed to show human risk JJ – sampling designed for presence/ absence.
DB – is the District doing control? JJ – mandated to do control, but do not have a cost-effective method at this time, doing mostly public education. DB – methods? JJ – small mammal traps.
Julie – you provide tick id? How many submissions? JJ – about 30. RM – many come to UM as well. DN – plus to MDH.

John Walz discussed the Black Fly Control Program, and gave an overview. Small stream treatments occurred at the latest date in the history of the program. Large river treatments had to deal with very high water in mid-year, with widespread flooding, so we had to stop both treatments and nontarget monitoring for a few weeks. Adult sampling showed a pronounced peak after the period of no treatment. The nontarget monitoring report from 2011 is available, shows no effects.
KO – what macroinvertebrates are you targeting? JW – whatever lands on multiplates, mostly caddisflies. KO – compared? JW – Monticello untreated.
RM – map of CO_2 counts, why are there gobs in some areas? JW – with more frequent, widespread treatments we could eliminate, they are probably coming in from outside the border.
BS – it would be nice to get permission to try to expand outside the borders.
[At this time Don Baumgartner had to leave the meeting.]

Break 1:50-2:05 p.m.

Subgroup Reports – Bird Surveillance

Kirk Johnson presented results of last year's TAB subgroup that evaluated MMCD's use of passive bird surveillance (public reports of dead birds) in managing West Nile virus. As presented last year, this bird surveillance provides useful additional information about the location and timing of virus activity. Recently, however, we have seen a drop-off in public reports, and have recognized the expense of staff and lab time that can take away from other activity. We also suspect that the local crow population has developed some herd immunity. At last year's TAB meeting, a subgroup volunteered to review the bird surveillance, and met by teleconference on March 7, 2013. The recommendations (see attached) were to increase public awareness, do testing until first positive, and compile data from both MDH and MMCD for analysis. We were hoping to have some students volunteer to run some epidemiological analysis, but had no volunteers.

In 2013, surveillance showed that the first WNV bird report was about the same time as the increase in mosquito infection rate, and very close to the increase in reported birds.

We increased public information notifications through Twitter (links to local media) and Facebook. Plan for 2014 is to collect and test birds until first positive, and after that, just record reports, not collect. We also want to increase contact with traditional media as well as social, and add an interactive web map of dead bird reports. We will also work with field staff to refine our response process on WNV.
KO – curious about why stop testing? KJ – once virus detected, have good history that virus is circulating. KO – but many reported not positive? KJ – only one was tested before the one positive. KO – so you wouldn't have infection rate? KJ – correct.
JM – so first dead crow is first indicator of virus in system? KJ – testing helps show it's not something else. JM – DNR has a crow season from August-March; you could get a subsample of blood samples to test, would be a way to get antibody rate.
RM –Reluctant to draw conclusions from one year's data. Consider putting a bounty on crows? This is a passive system, not that valuable. SP – but birds must die of natural causes.

Subgroup Reports – Natular Nontarget Data

Nancy Read presented a brief background on MMCD's testing and use of the control material Natular (active ingredient spinsosad), and on efforts by staff, TAB members, and the manufacturer, Clarke, to assemble useful information and address concerns about possible nontarget effects (as in TAB Report, Chapter 6). She discussed the importance of cost and efficacy as well as nontarget effects, and said that the District is planning to test another spinsosad formulation, Natular G, which is only active up to 7 days (compared with the 30 day controlled release profile of G30) and is less expensive.

Roger Moon described the TAB subgroup's proposal for using local studies to check a broader range of species than has currently appeared in the literature, and led discussion of what the TAB might recommend for next steps.

JM – Are *Daphnia* more sensitive than fairy shrimp; what says this is the best indicator? Or was it just the lab rat? SH – hard to generalize. RM – looked at IRAC's mode of action, neurotoxins, very different from *Bti* and methoprene.
KO – why no insects on list of species tested? NR, RM – standard EPA suite.
RM – would like to know what doses need to be used to control mosquitoes? Start with target (e.g. mosquito) testing. Encourage the District to live up to its mission statement for environmental responsibility, do preliminary nontarget testing simultaneously with efficacy testing (maybe skip a year of black fly multiplates and do this instead?)
SH – what is the new formulation you are looking at? SM – G is a corncob-based formulation, less expensive. JM – would this be a once per year treatment? SM – yes (in spring sites).
RM – would like to consider doing field assessment of nontargets along with efficacy, double blind study, ok if MMCD handle samples. Which sites? SM – vernal pools. We have good evidence that spinosad works against spring mosquitoes, so that would be more useful. We might do some basic testing in cattail to see if it works on those mosquitoes.
KO – what sites were treated with spinosad in 2013? SM – only summer sites. KO – but quite a few acres, surprising.
RM – my understanding is that vernal pools are also more important for migrating waterfowl?
SM – in summer sites, G30 can control multiple broods of mosquitoes. In spring sites, at 5 lbs/ac, control with G30 lasts for three weeks.

BS – compared with Altosid, similar duration of control? What is the advantage of Natular? SM – potentially different mode of action – resistance management, note also the price of Altosid has come down since Natular came on the market. BS – but we would not have to use Natular? SP – another tool in the toolbox.
MDS – explain more about controlled release? How can it last four weeks with a half-life of 1 day? SM – described release.
VS – list of spp, why were midges dropped? Because of vernal pools? RM – yes, included *Hyalella azteca* (scuds) because of value as bird food.

RM – do we trust District to do nontarget work in house?
** TAB voted yes by show of hands.
RM – asks TAB subgroup to come back with experimental designs for 2014.
KO – seems like this is valuable data for more than just the District.
SM – I can justify research costs if it allows us to use a cost effective material.

NR – would like to bring up issue of possibly dropping multiplates for a year and doing this instead, would TAB like to reiterate that?
RM – Could we make the case that some portion of MMCD's budget be routinely dedicated to nontarget assessment? SM – some commissioners would just want to accept the EPA tests, some might be more interested if linked with duck success?
BS – are there any 3rd parties interested in contributing to support research? Or outer counties to help with expanded black fly control?

General Discussion and Resolutions

Chair Mark Abrahamson opened the floor for discussion and suggestions for resolutions to be brought before the MMCD Commission.

KO – concerned about increased use of adulticides in last few years, Appendix E. Also appreciated summary of adulticide efficacy tests pp 70-71. Concerned about the generalist impact of adulticides. SM – uptick in 2013 in part from helicopter crash and increase in disease vectors, July peak. JM – widespread across the District? SM – yes. KO – fog treatment up, a lot more. SM – commission wants us to provide service to citizens, sometimes adulticiding is the only thing we can do. KO – but you realize the potential nontarget effects. SM – we focus on larval control, use adulticides when that is not sufficient. [Note: In pre-meeting discussion with staff Gary Montz had also raised concerns that adulticide use in 2013 being higher than the year before, would prefer to see 2014 target levels lower.]

MDS – are you looking at outreach for preventing introductions of other species? For example from tire shipments. SM – we conduct surveillance around areas with tire shipments and work with owners to try to keep tires dry. There are similar problems with keeping out other invasive species. MA – DNR is working to get people to clean boots, tools between locations. JM – also for mowers and other workers. KJ – a major communication message for us is to try to get public to manage tires and containers on their own property. It's difficult to totally prevent introductions. MDS – seems like more of a regulatory problem. JJ – both education and motivation, people need to not only know the right thing, but also to do it. TAB members suggested MMCD could put something on the DNR website as well.

Discussion returned to the subgroup reports, and the following resolutions were enacted.

Motion – In keeping with the District's mission statement to be environmentally sensitive, that the MMCD study Natular nontarget effects in the context of any efficacy studies. These studies may be done by in-house staff, in consultation with the TAB subcommittee.
Motion JM, 2nd KO. Passed unanimously.
Discussion – any and all formulations or habitats, also double-blind study format

Motion – In keeping with the District's mission statement to be environmentally sensitive, that MMCD should investigate designating a portion of their funds annually to assessing and preventing nontarget impacts of control materials.
Motion by DN, second JM. Passed unanimously.

Motion – That the TAB commends MMCD for its sustainability initiative and encourages it to maintain efforts in reducing waste and energy use.
Motion by BS, second SH. Passed unanimously.

Additional discussion:
KO – want to make sure when people call MMCD for treatment they know that adulticides will kill all insects. RM – but at this dose it does not kill all insects. SH – kills other sensitive insects; the toxicology is there but the dose isn't, the material kills all insects with similar sensitivities and dose. BS – not all the other insects are of concern? KO – but would like to educate people about environmental impacts of the program.
BS – we've been looking at this for a long time, would need wordsmithing. SP – need to separate this issue from the nontarget resolution.

Meeting adjourned 3:58 p.m.

Next chair will be the representative from MN Dept. of Transportation (Sarma Straumanis).

EDITORIAL STAFF & CONTRIBUTORS

Diann Crane, M.S., Assistant Entomologist
Carey LaMere, Laboratory Technician

The following people wrote or reviewed major portions of this document:
Sandra Brogren, Janet Jarnefeld, Kirk Johnson, Carey LaMere,
Stephen Manweiler, Mike McLean, Nancy Read, Ken Simmons,
Mark Smith, and *John Walz*

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