2011 OPERATIONAL REVIEW & PLANS FOR 2012

Annual Report to the Technical Advisory Board

Metropolitan Mosquito Control District

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 2012

Carol Le Doux	Anoka County
Matt Look	Anoka County
Robyn West	Anoka County
James Ische	Carver County
Tom Workman	Carver County
Thomas Egan	Dakota County
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Liz Workman	Dakota County
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Jeff Johnson	Hennepin County
Randy Johnson	Hennepin County
Tony Bennett	Ramsey County
Jan Parker	Ramsey County
Janice Rettman	Ramsey County
Dave Menden	Scott County
Tom Wolf	Scott County
Gary Kriesel	Washington Co.
Lisa Weik	Washington Co.

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.

Technical Advisory Board Members 2011-2012

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Metropolitan Mosquito Control District Contributing Staff

Jim Stark	Executive Director
Stephen Manweiler	Director of Operations/Tech. Serv.
Sandy Brogren	Entomologist
Diann Crane	Asst. 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

MINNESOTA
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DEPARTMENT OF HEALTH

Protecting, maintaining and improving the health of all Minnesotans

April 10, 2012

Commissioner Janice Rettman, Chair
Metropolitan Mosquito Control Commission
2099 University Avenue West
St. Paul, MN 55104

Dear Commissioner Rettman:

The Technical Advisory Board (TAB) met on February 14, 2012 to review and discuss MMCD operations in 2011 and plans for 2012. Since the Board's formation in 1981, the member representatives have met at least once per year to provide independent review of field control programs and to enhance inter-agency cooperation.

After an excellent interchange of questions and information between the TAB and MMCD staff, the TAB approved the following resolutions.

1. That the TAB establish a subcommittee to continue literature review on nontarget impacts of spinosad on aquatic invertebrates, and report back to the TAB by e-mail within 2 months.

2. That until there are good indications that spinosad applications will not have an impact on nontarget invertebrates, the TAB recommends MMCD limit applications to small-scale testing and not move to operational use.

3. That the TAB supports MMCD's commitment to involvement in the Climate Change Adaptation Working Group.

Sincerely,

Dave Neitzel

Dave Neitzel
Chair, Technical Advisory Board
David F. Neitzel, MS
Epidemiologist
Foodborne, Vectorborne, and Zoonotic Disease Unit
Acute Disease Investigation and Control Section
Infectious Disease Epidemiology, Prevention, and Control Division
PO Box 64975
Saint Paul, Minnesota 55164-0975
651-201-5414
Fax: 651-201-5743

General Information: 651-201-5000 • Toll-free: 888-345-0823 • TTY: 651-201-5797 • www.health.state.mn.us
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APPENDICES

Executive Summary

The Metropolitan Mosquito Control District (MMCD) strives to provide cost-effective service in an environmentally sound manner. This report presents MMCD staff efforts to accomplish that goal during 2011 through mosquito, black fly and tick surveillance, disease monitoring, mosquito and black fly control, new product testing, data management, and public information.

For 2011, MMCD's expense budget was reduced 3% from $18.6 million in 2010 to $17.9 million. This reduction was accomplished by actions such as shifting control material strategies and freezing wages, as well as many smaller cuts and changes. However, dry conditions such as those in 2008 and 2009 had resulted in some accumulated surplus, part of which has been used to address infrastructure needs or fund extra control in very wet years. For 2012, the Metropolitan Mosquito Control Commission decided to use additional portions of the surplus to minimize the tax impact on metro citizens and has directed staff to identify ways to reduce expenditures further while maintaining service levels. Thus, MMCD’s income from the property tax levy for 2012 will remain the same as the past two years, at $16.7 million (approximately $13.35 on a $250,000 home), the operating budget for expenses will decrease by an additional 2.54% to $17.4 million and the difference between income and expense will be made up by the surplus. The 2012 budget document is currently available at www.mmcd.org/pdf/BudgetBrief20129.pdf.

Surveillance

The 2011 season was characterized by a cool, wet spring followed by a hot summer. While overall 2011 precipitation was above normal, very little rainfall occurred past mid-August. Near drought conditions persisted through late summer and autumn.

Seven large broods occurred District-wide in 2011. Three small to medium-size broods occurred in parts of the District. The two most notable large summer broods occurred in May and July. A storm during the weekend of May 21-23 brought tornadoes through north Minneapolis and 2-4 inches of rain in some areas. The largest brood of the season resulted from a District-wide storm on July 16 with 4-5 inches of rain. This brood coincided with extremely high temperatures and dewpoints, including the highest dewpoint ever measured at the Twin Cities station (MSP). July had temperature records for the warmest overnight minimum temperatures with some nights that never dipped below 80°F. These unusual conditions accelerated larval development and shortened brood length to five days.

Levels of the West Nile virus (WNV) vector, *Culex tarsalis*, were low to moderate; however, MMCD tracked unusually high numbers of *Culiseta melanura,* the primary eastern equine encephalitis vector, throughout the District. *Aedes japonicus* continued to expand its range and increase in numbers throughout the District in 2011. District monitoring for other exotics continued to be a high priority.

The District continued to sample the distribution of ticks in the metro area as part of its mandate to provide information and education on prevention of Lyme disease. While 2011 data have not yet been fully analyzed, preliminary indications are that *Ixodes scapularis* continued to become more widespread in the District.

Disease

Mosquito-borne disease activity continued to be low in 2011 compared to previous years. There were no La Crosse encephalitis cases in the District, but there were two WNV cases in Minnesota, both in District residents. In addition, there was little WNV activity detected in mosquitoes or birds.

As part of its disease prevention efforts, MMCD has worked with city crews to survey and treat underground BMPs since 2005. In 2011, municipalities continued to volunteer their staff to assist with material applications as part of this cooperative mosquito control plan for underground habitats.

A new tick-borne disease (*Ehrlichia muris*-like) unique to Minnesota and Wisconsin was described in 2011 in the New England Journal of Medicine. Minnesota recorded its first fatality from the rare tick-borne Powassan virus. Statewide, the all-time high Lyme disease and human granulocytic anaplasmosis (HGA) case records were set in 2010 (Lyme 1,293; HGA 720), surpassing the previous Lyme and HGA records from 2007 (1,239 and 322, respectively). Case data for 2011 is not yet available from the Minnesota Department of Health.

Control

Since 2005, MMCD has worked to expand the area within the District to which we provide larvicide services through strategies designed to stretch each dollar of funding. Cost-effective strategies will help MMCD minimize the impact of budget limitations on service delivery.

Due to the large size 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 in 2011 some shifts were made in treatment thresholds and control materials used in different situations to reduce cost. However, wet conditions early in the year rapidly consumed most of the budget for helicopters and materials and the decision was made to ask the Commission for access to reserve funds (as in 2002 and 2010). However, with the dry conditions after mid-August, reserve funds were not needed. Overall in 2011, there were fewer acres of larvicides applied to wetlands than in 2010, and fewer acres of adulticides applied throughout the District.

For black fly control, 39 liquid *Bti* treatments were used to control large river-breeding black fly larvae in 2011. The amount of *Bti* used in 2011 was 890 gallons above the yearly average of 2,888 gallons used on the large rivers between 1997 and 2010, primarily because the flows on the Rum, Mississippi, Minnesota, and Crow rivers were above average throughout the 2011 treatment season. Liquid *Bti* treatment effectiveness was excellent. Average 2011 post-treatment black fly mortality on the large rivers was 98%.

In 2012, MMCD will continue to review all aspects of its integrated mosquito management program while complying with any new regulatory requirements.

Product and Equipment Testing

Quality assurance processes focused on product evaluations, equipment, and waste reduction. All new products are certified prior to operational use. The District continued certification testing of four larvicides and one new adulticide. All four larvicides have been tested in different control situations in the past. Three larvicides were tested to control *Culex* in catch basins, two to control *Culex* in wetlands, and one to control the cattail mosquito, *Coquillettidia perturbans*. The adulticide was tested for use around cropland. These additional 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. In 2011, we evaluated alternatives and chose to move our field data entry to a web-based system accessible through smart phones, which is now under development.

Calls, e-mails, and other contacts from citizens are an important way for MMCD to identify areas of high service demand. This 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. Total requests for adult mosquito treatment were down slightly in 2011; however, there was an almost four-fold increase in the number of calls requesting breeding site checks. The bulk of calls concerning breeding sites came during the first weeks of the season as callers expressed concerns with spring wetlands filling with heavy snowpack runoff. Treatment requests for public and private events decreased slightly in 2011.

In 2011, staff continued an array of education efforts including school presentations and efforts to increase awareness of the interaction between stormwater management and mosquitoes and efforts to raise awareness of tick risks and services. Staff also hosted a regional conference for mosquito control professionals.

Chapter 1 Mosquito Surveillance

2011 Highlights

- Rainstorms produced seven major mosquito broods
- Cool, wet spring. Hot, dry summer
- Major mosquito peak occurred in August
- Identified 28,305 larval samples
- Reduced the number of sweep net collections
- Highest level of *Culiseta melanura* observed since implementing current surveillance network
- No *Aedes albopictus* detected
- Evaluated adult surveillance methods for ability to collect *Aedes japonicus*
- *Ae. japonicus* population continued to grow and spread, found in Chisago and Wright counties for the first time

2012 Plans

- Continue to evaluate effects of reducing number of Monday Night sweep net collections
- Continue search for presence of *Aedes cataphylla* and *Aedes melanimon*
- Continue to monitor and study *Ae. japonicus*
- Maintain surveillance for *Ae. albopictus* and remain aware of other potential invasive species
- Reevaluate surveillance options for *Cs. melanura*

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. About 45 of these species occur in the District, 20 of which are human-biting. Other species prefer to feed on birds, large mammals, reptiles, or amphibians. Additionally, 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 in order 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* (fourteen species) eggs to hatch in March and April and adults emerge in late April to early May. They 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. They 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.

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. Since its beginning, the District has operated a network of rain gauges from May to September.

In 2010, we evaluated the process of maintaining the rain gauge network. Most of our gauges are located at homes of employees, former employees, and citizens. Others are at city halls and parks. How frequently gauges are checked depends on the amount of rain, convenience of the location (if travel is required), and the sense of urgency to obtain the data. Historically, staff recorded rainfall amounts on paper, entered rain gauge data into an Excel spreadsheet, and sent paper copies to the State Climatology Office. Staff also used Nexrad, radar estimates of precipitation available from the National Weather Service and commercial web sites, to view rainfall amounts (in less time and with less expense than reading rain gauges).

In 2011, 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, fill gaps with observers in CoCoRaHS, and share data in a timely manner. Consequently, in 2011, the number of rain gauges we operated was reduced from 80 in 2010 to 60. The network was augmented with 86 CoCoRaHS gauges that are within the District boundaries, for a total of 146. These data were used for summaries in this document.

Average rainfall in the District from May 1 through September 30, 2011 was 20.61 inches – 1.18 inches above the 52-year District average of 19.43 inches (Table 1.1). Anoka and Ramsey counties had the most rainfall, which were 5 and 4 inches above their average, respectively. The southern counties (Carver, Dakota, and Scott) received below average rainfall.

Table 1.1 Average rainfall received in each county from May through September 2007-2011 and 52-year District average

Year	Anoka	Carver	Dakota	Hennepin	Ramsey	Scott	Wash.	District
2007	16.01	17.26	20.89	17.92	16.93	16.58	19.02	17.83
2008	15.19	16.90	15.03	13.55	12.60	14.08	14.15	14.15
2009	14.84	17.75	15.52	13.12	12.35	13.65	13.08	13.89
2010	23.29	23.47	29.03	22.92	24.99	26.63	24.65	24.66
2011	24.21	19.03	17.68	20.32	23.32	17.06	21.18	20.61
52-Year Avg	18.94	*20.26	19.83	19.53	19.74	19.35	20.02	19.43

*28-year average (Carver joined the District in 1982)

We experienced 10 rainfall events that were sufficient to produce broods of mosquitoes (Figure 1.1). The size of the brood is determined by the amount of area in the District affected by rainfall, the amount of rainfall received, and the amount of mosquito production that resulted. In 2011, seven large broods occurred District-wide and another three small-medium sized broods occurred in various parts of the District.

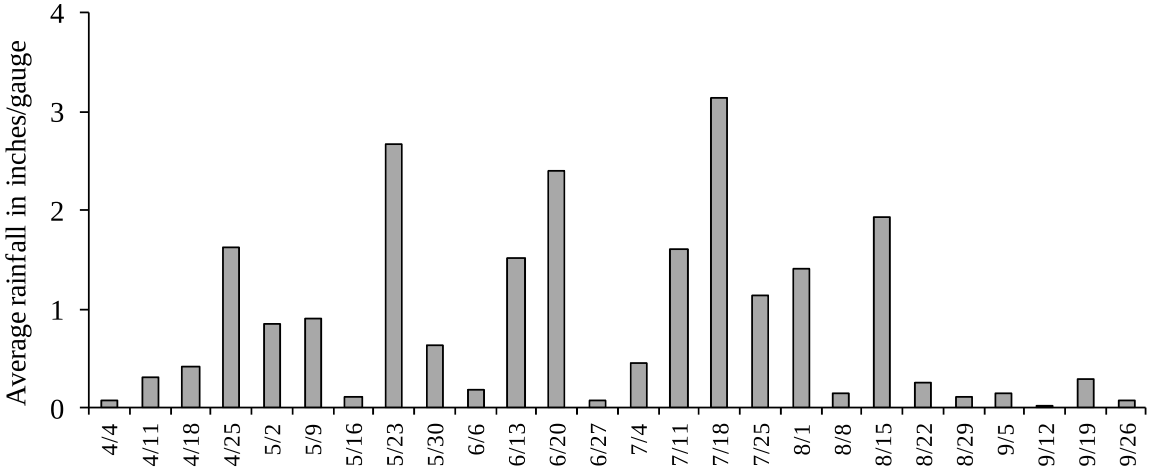


Figure 1.1 Average rainfall amounts per gauge per week (Saturday – Friday), 2011. Date labels represents the Monday of each week.

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 can influence how quickly larvae develop in sites. Figure 1.2 displays the monthly departures from normal for temperature and rainfall in 2011 (source: National Weather Service, Twin Cities Station). Snowfall this past winter ranked the fourth highest in history. The cool spring delayed the melting of all that snow, causing the spring mosquito season to start later and last longer than usual. Our first larval sample was taken on March 30.

The two most notable summer broods occurred in May and July. A storm during the weekend of May 21-23 brought tornadoes through north Minneapolis and 2-4 inches of rain in some areas. The largest brood of the season resulted from a District-wide storm on July 16 with 4-5 inches of rain. This brood coincided with extremely high temperatures and dewpoints, including the highest dewpoint ever measured at the Twin Cities station (MSP) of 82°F on July 19. July had temperature records for the warmest overnight minimum temperatures with some nights that never dipped below 80°F. These unusual conditions accelerated larval development and shortened the brood length to five days. Figure 1.3 depicts the geographic distribution and magnitude of weekly (Saturday-Friday) rainfall received in District gauges from April through September 2011.

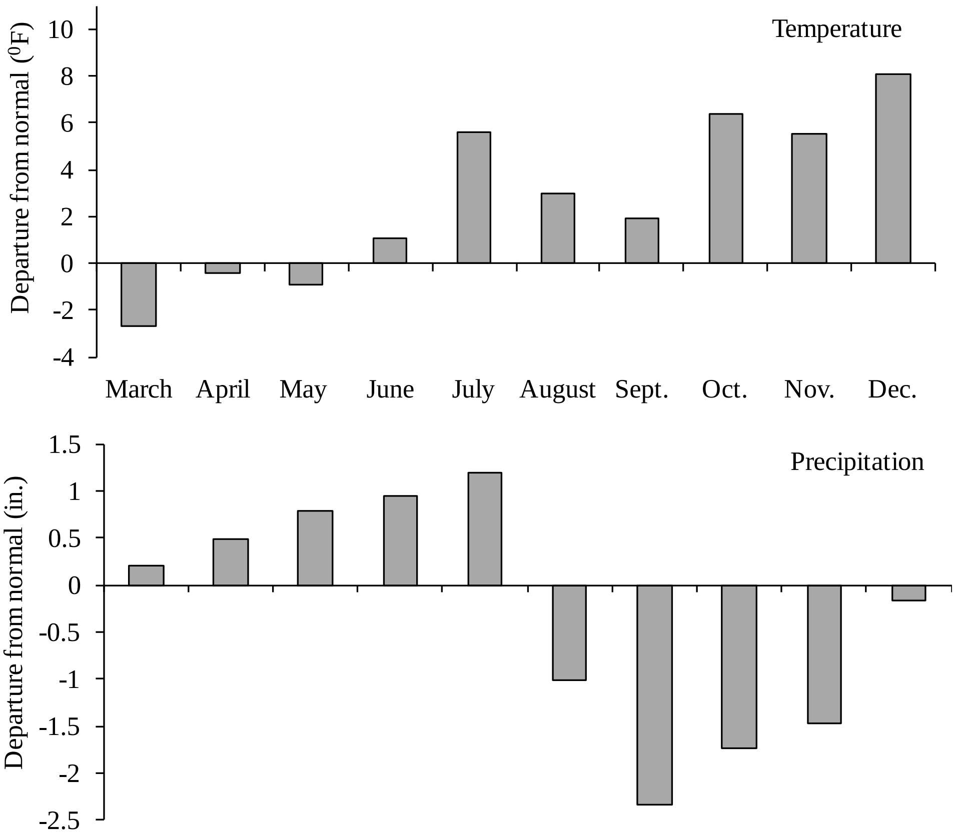


Figure 1.2 Monthly departures from normal for temperature and precipitation March-December, 2011 (source: National Weather Service, Twin Cities Station).

Larval Collections

Larval mosquito inspections are done to determine if targeted species are present at threshold levels or to obtain species history in breeding 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.

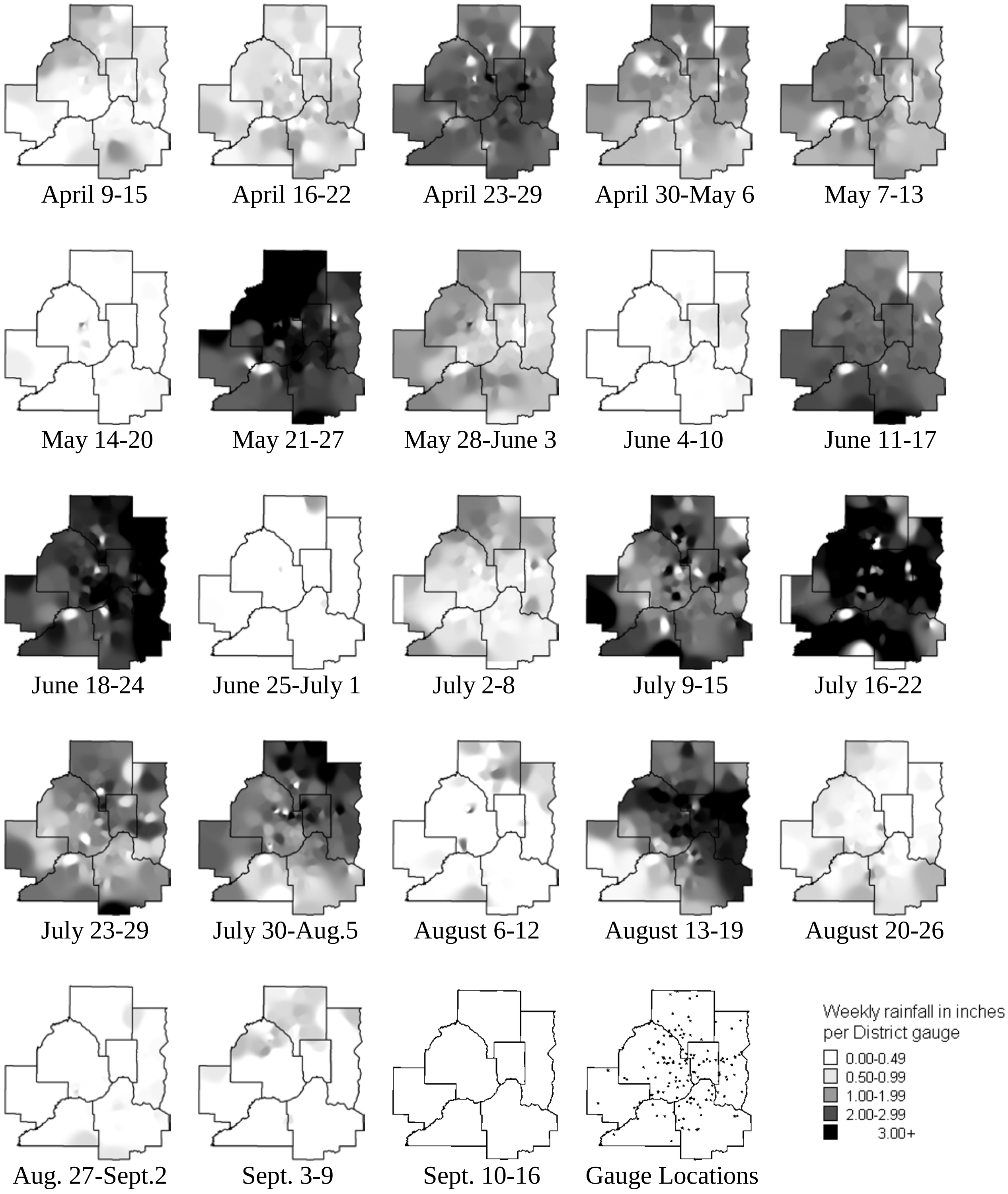


Figure 1.3 Weekly rainfall in inches per gauge, 2011. The number of gauges varied from 102-123. A map of the rain gauge locations is included. Inverse distance weighting was the algorithm used for shading of maps.

In 2011, lab staff identified 28,305 larval collections, the second highest ever collected, and 53% higher than average for the last 20 years (Fig. 1.4). 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.

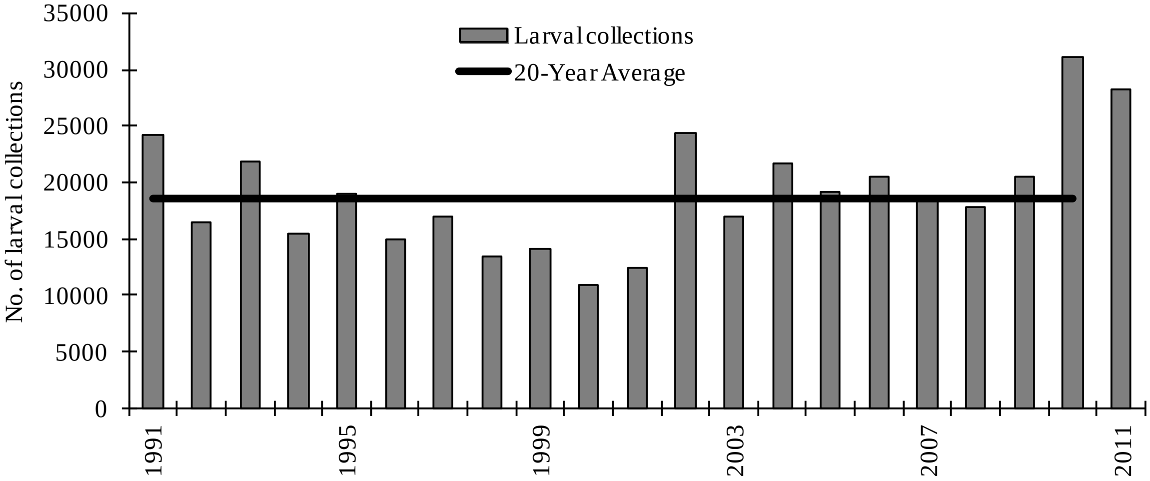


Figure 1.4 Yearly total larval collections, 1991-2011, and 20-year average.

Table 1.2 shows the results of the 16,042 samples identified to species, calculated as the percent of samples in which the species was present. A significant amount of sampling is done in catch basins, stormwater structures, and other man-made features (e.g., swimming pool, culvert, artificial pond); those results (shaded column) are displayed separately from the natural breeding area (i.e., wetlands and cattail marshes) results in Table 1.2.

The most frequently collected species from natural breeding areas was our usual winner, *Ae. vexans,* occurring in 35.4% of the samples (Table 1.2). For the second year in a row, the unusual second place winner was *Culiseta inornata*, which often inhabits the same sites as *Ae. vexans* and is typically a non-human biter. Third and fifth place were taken by the spring species *Ae. stimulans* and *Ae. excrucians*. *Culex territans,* which prefers cold-blooded hosts, ranked fourth. *Culex tarsalis,* a disease vector, occurred in only 1.0% of the 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 66.1% of the structure samples and *Cx. pipiens* in 16.4% (Table 1.2). *Aedes* species sometimes develop in stormwater structures and were identified in 13.5% of the larval samples. However, surveillance for *Culex* species often occurs after the *Aedes* have emerged from the sites. A detailed discussion of the larval *Culex* surveillance in structures can be found in Chapter 2: Vector-borne Disease.

Table 1.2 Percent of samples where larval species occurred in wetland collections by facility and District total, and the District total for structure samples, 2011; the total number of samples processed to species is in parentheses.

	Percent of samples where species occurred by facility							
Species	North (2,515)	East (3,983)	South Rosemount (2,216)	South Jordan (1,460)	West Plymouth (2,373)	West Maple Grove (1,428)	Wetland Total (13,975)	Structures Total (2,067)
Aedes abserratus	0.5	0.5	0.1	0.1	0.7	<	0.4	
aurifer	<	<					<	
canadensis	0.5	0.6	1.0	1.0	0.3	0.1	0.6	
*cataphylla**								
cinereus	13.5	8.3	6.4	5.0	8.5	8.8	8.7	<
communis								
dorsalis	0.2	0.2	0.2	0.3	0.2	1.3	0.3	
euedes								
excrucians	12.2	8.1	9.2	12.0	11.9	10.9	10.3	
fitchii	5.8	3.5	2.3	2.1	0.9	2.0	3.0	
flavescens		<				0.1	<	
hendersoni								
implicatus	0.4	0.5	0.1	0.3	0.4	0.2	0.3	
intrudens								
japonicus	<		<	0.1	<		<	1.8
nigromaculis	<		0.2	<	<	0.2	<	<
punctor	0.2	0.7	<	<	0.6	0.3	0.4	
riparius	0.8	0.6	0.1	1.0	2.9	2.1	1.2	
spencerii	0.2	0.5	0.2	0.5	<	1.0	0.4	
sticticus	3.7	0.6	1.0	0.6	0.5	0.9	1.2	
stimulans	14.2	14.1	18.8	29.1	23.8	21.8	18.9	
provocans	1.8	2.0	0.7	0.1	0.3	0.3	1.1	
triseriatus	0.2	<	<	0.1	0.2		<	1.5
trivittatus	0.8	2.4	3.4	1.0	1.5	0.3	1.8	<
vexans	45.7	42.9	31.4	19.2	27.8	32.1	35.4	13.5
Ae. species	25.7	25.4	27.7	17.1	26.5	25.6	25.2	3.1
Anopheles earlei		<			<		<	
punctipennis	0.4	0.9	0.2	0.3	0.3	0.4	0.5	0.6
quadrimaculatus		0.1	<	0.2		0.1	<	<
walkeri								
An. species	5.1	5.8	0.8	3.4	1.0	1.1	3.3	4.4
Culex pipiens	0.7	1.0	0.5	1.0	1.0	2.0	1.0	16.4
restuans	10.3	10.3	5.9	5.6	9.9	6.5	8.7	66.1
salinarius	<	<	<		<	<	<	<
tarsalis	2.1	0.6	0.5	1.2	0.5	1.7	1.0	3.2
territans	17.1	18.8	7.8	20.8	8.3	6.0	13.9	14.4
Cx. species	1.0	1.8	0.9	1.9	1.6	1.6	1.5	33.5
Cx. pipiens/restuans	0.2			0.2			<	
Culiseta inornata	23.7	19.1	29.8	20.5	23.3	22.4	22.8	7.1
melanura		<					<	
minnesotae	0.9	1.4	0.3	<	1.3	0.3	0.9	0.2
morsitans		<	<				<	
Cs. species	2.9	4.2	1.4	0.8	3.0	1.1	2.6	0.7
Ps. columbiae								<
Psorophora ferox		0.1	<				<	
horrida		<					<	
Ps. species	<	0.2	0.1		<		0.1	
Ur.sapphirina	2.6	2.2	1.1	4.5	0.4	1.1	1.9	0.7

< = percent of total is less than 0.1%

* 1st known occurrence in Minnesota was in 2008

Exciting events in the Technical Services Lab this season included identifying a larval specimen of *Psorophora columbiae*, a rare species in the District. There was an increase in the number of *Ae. japonicus* in floodwater sites and in catch basins—the typical larval habitat is containers, so it is unusual to collect them in other types of sites. More discussion of *Ae. japonicus* surveillance follows in the vector surveillance section of this chapter.

In 2008, larval *Aedes cataphylla*, were collected for the first time in Minnesota (Minnetonka). *Aedes cataphylla* is a very early spring species whose range is the western US and Canada, no further east than Colorado. Extensive larval sampling conducted in 2009-2011 in the area of the 2008 detection has been negative for *Ae. cataphylla*. A CO_2 trap operated near the location of the detection has also been negative for adult specimens. Whether this species is established in Minnesota or this detection is just an anomaly is still a mystery we will continue to investigate.

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. A vacuum aspirator captures mosquitoes resting in the understory of wooded areas in the daytime. Gravid traps are used to capture egg-laying *Culex* and *Aedes* spp. 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.

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. Sweeps were taken for 17 weeks and CO_2 traps operated for 21 weeks, starting one week earlier than 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. absеrratus/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 Net The District uses sweep net collections to monitor human annoyance during the peak mosquito activity period, which is 35-40 minutes after sunset for most mosquito species. The number of collectors varied from 65-106 per evening.

Staff took 1,539 collections containing 3,463 mosquitoes. In 2011, the average number of summer *Aedes* collected in the evening sweep net collections was higher than in the past four years, but still below the 10-year average (Table 1.3). Populations of *Cq. perturbans* were nearly double the averages of the last two highest years and were above the 10-year average. Weather conditions the past four years have been favorable for the production of spring *Aedes* mosquitoes (Fig. 1.5). In 2011, the number of spring *Aedes* increased from last year and was second highest of the last 10 years. *Culex tarsalis,* which are infrequently collected in sweep net samples, showed a slight decrease in 2011.

Table 1.3 Average number of mosquitoes collected per evening sweep net collection within the District, 2007-2011 and 10-year average, 2001-2010 (±SE)

Year	Summer *Aedes*	*Cq. perturbans*	Spring *Aedes*	*Cx. tarsalis*
2007	0.20	0.10	0.08	0.010
2008	0.50	0.20	0.57	0.003
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
10-yr Avg.	1.84 (±0.18)	0.29 (±0.02)	0.14 (±0.02)	0.010 (±0.008)

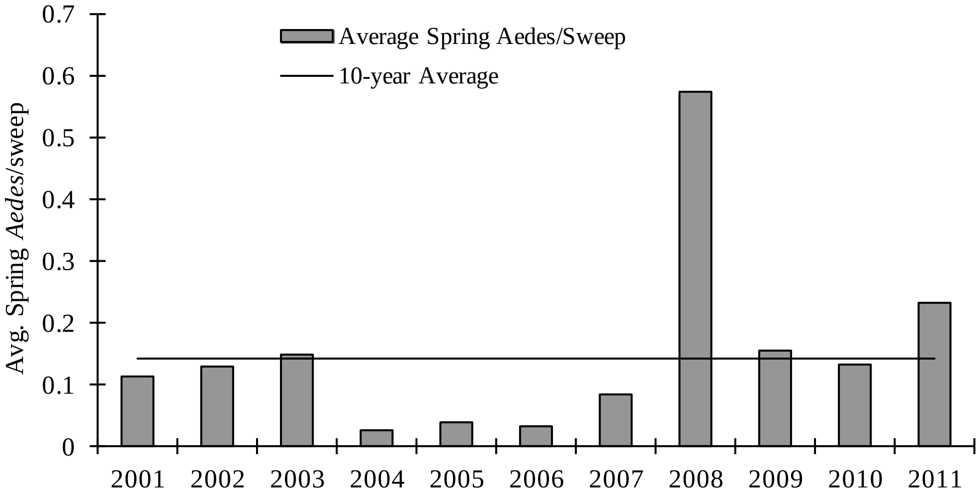


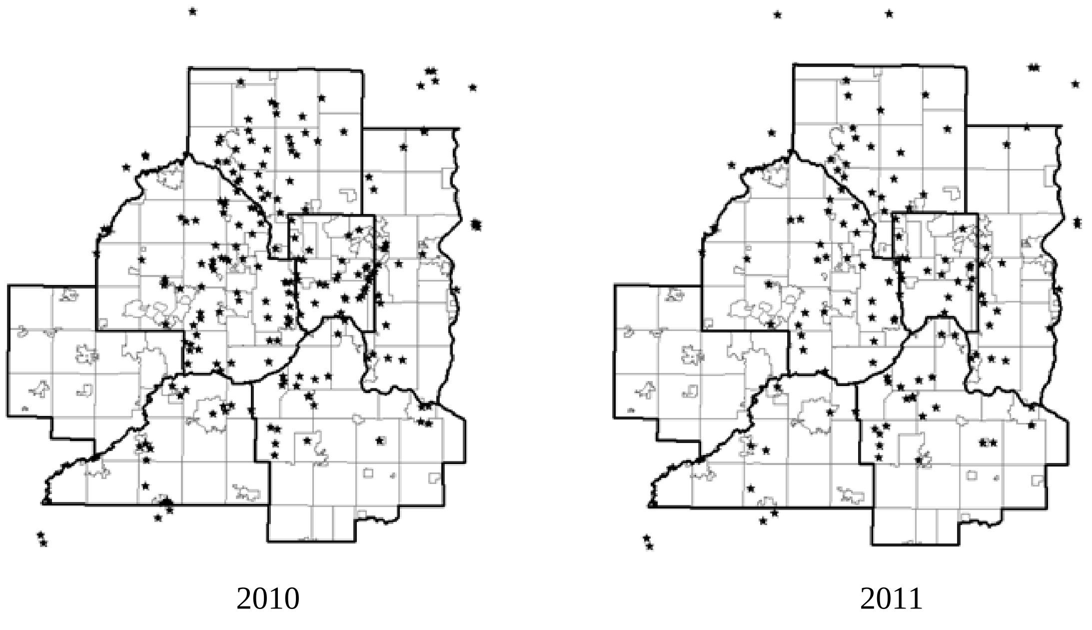
Figure 1.5 Average spring *Aedes* per sweep net 2001-2011 vs. 10-year average.

In 2010, staff were asked to contribute cost savings suggestions in anticipation of the need to reduce the District's budget for 2011. One suggestion was to eliminate or reduce the Monday night sweeps. Staff studied this issue and recommended the following: 1) to continue the sweeps but reduce the number of locations to 100-130, 2) remove clusters of sweep locations, 3) choose reliable, accurate sweepers, and 4) determine cost savings. We then evaluated whether the reduction of the number of sweeps affected the quality of the data.

The number of sweep locations was reduced from 204 in 2010 to 126 in 2011 (Table 1.4). The regular full-time (RFT) staff locations served as the base and seasonal staff locations were chosen to fill in gaps. The distribution of sweep locations in 2011 was similar to 2010 (Fig. 1.6). The reliability of the sweepers was measured by the percentage of missing collections (Table 1.5). The percentage of RFT missing sweeps remained the same in 2011 as 2010 and the seasonal staff missing sweep percentage was lower in 2011 than 2010. The results of a Chi^2 test (value=0.12) indicate that reducing the number of sweeps did not significantly affect the percent of missing collections in 2011. Staff are paid ½ hour to take the sweep collection at their home at night, which often results in overtime. The estimated cost savings of reducing the number of sweeps is $13,517 (Table 1.6), or 0.08% of the District budget. It appears that reducing the number of sweep collections can save money without affecting data quality. For 2012, we plan to continue with the reduced number of sweeps and analyze results.

Table 1.4 Number of sweep net locations and percent decrease 2010, 2011

Staff	2010	2011	% decrease
RFT	33	22	33
Seasonal	171	104	39
Total	204	126	38


2010

2011

Fig. 1.6 Locations of weekly sweep net locations, 2010 and 2011

Table 1.5 Percent of missing sweep net samples, 2010 and 2011

	2010			2011		
Staff	Sweeps possible	Sweeps missing	% missing	Sweeps possible	Sweeps missing	% missing
RFT	576	58	10.1	357	36	10.1
Seasonal	2631	284	10.8	1585	152	9.6
Total	3207	342	10.7	1942	188	9.7

Table 1.6 Estimated costs to conduct weekly sweep net collections, 2010 and 2011

	Overtime hours		Cost		
	2010	2011	2010	2011	Savings
RFT	1,173.0	703.0	$24,750	$14,833	
Seasonal	265.5	177.0	$10,800	$ 7,200	
Total	1,438.5	880.0	$35,550	$22,033	$13,517

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 2011, we operated 129 traps at 116 locations to allow maximum coverage of the District. At 13 locations, additional traps are placed ~25 ft above ground in the tree canopy to collect *Culex* spp., which are active where birds are resting. All *Culex* specimens collected from the elevated trap locations and 12 standard placement locations are tested for WNV; however, *Cx. tarsalis* from all locations are tested as well. Six 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. The total number of traps operated per night varied from 98-110. Figure 1.7 shows the CO_2 trap locations and their uses (i.e., general monitoring, virus testing, eastern equine encephalitis (EEE) vector monitoring).

A total of 2,200 trap collections taken contained 682,939 mosquitoes. Summer *Aedes* regained its normal position of being the predominant species collected in CO_2 traps, and was close to the 10-year average (Table 1.7). Fewer spring *Aedes* were captured than last year and were below the 10-year average. This is opposite of data collected with sweep nets (Table 1.3). *Coquillettidia perturbans* populations jumped to more than twice the 10-year average. *Culex tarsalis* numbers were below the 10-year average and are discussed later in the vector surveillance section of this chapter.

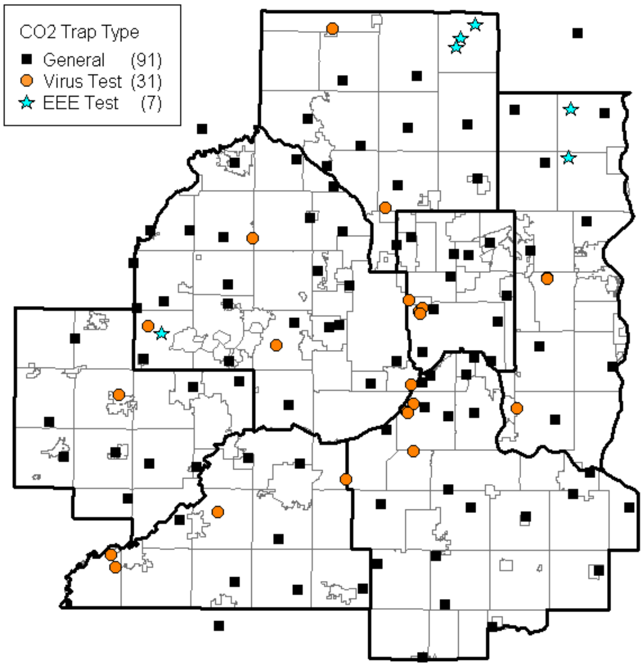
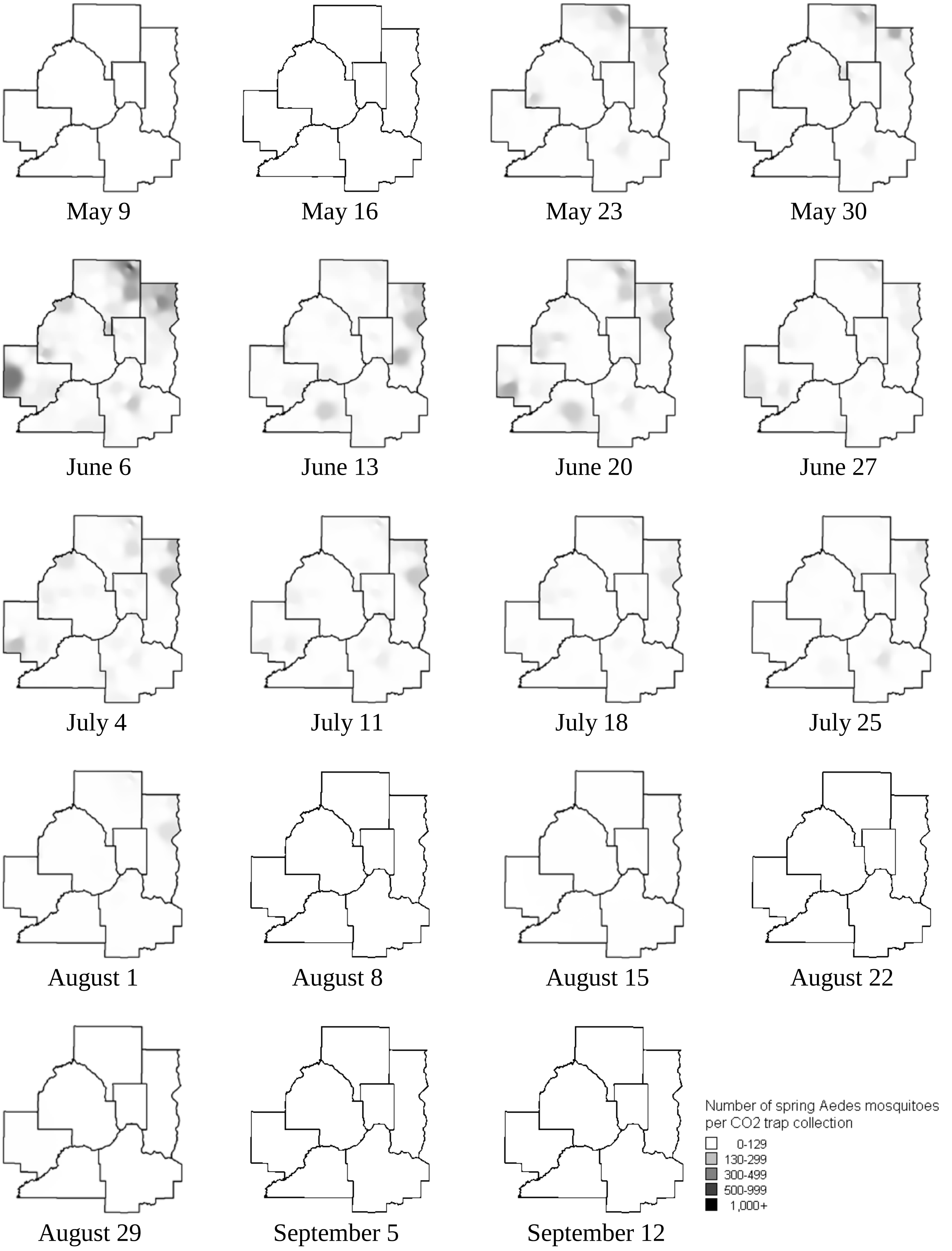


Figure 1.7 Locations of CO_2 traps used to monitor general mosquito populations and disease vectors (virus test and EEE test), 2011.

Table 1.7 Average numbers of mosquitoes collected in CO_2 traps within the District, 2007-2011 and 10-year average, (2001-2010) (±SE)

Year	Summer *Aedes*	*Cq. perturbans*	Spring *Aedes*	*Cx. tarsalis*
2007	43.7	31.9	10.2	5.2
2008	60.5	31.2	21.3	1.3
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
10-yr Avg.	211.3 (±53.2)	45.9 (±8.3)	11.8 (±3.0)	2.3 (±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 1.8, 1.9, and 1.10. The computer software extrapolates the data between collection points, so some dark areas are the result of one collection without another close by. The higher populations of spring *Aedes* were confined to the outer edges of the District (Figure 1.8). The trap collections of summer *Aedes* remained above threshold throughout the District in July and early August, with some locally high populations (Figure 1.9). *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 1.10).



May 9 May 16 May 23 May 30

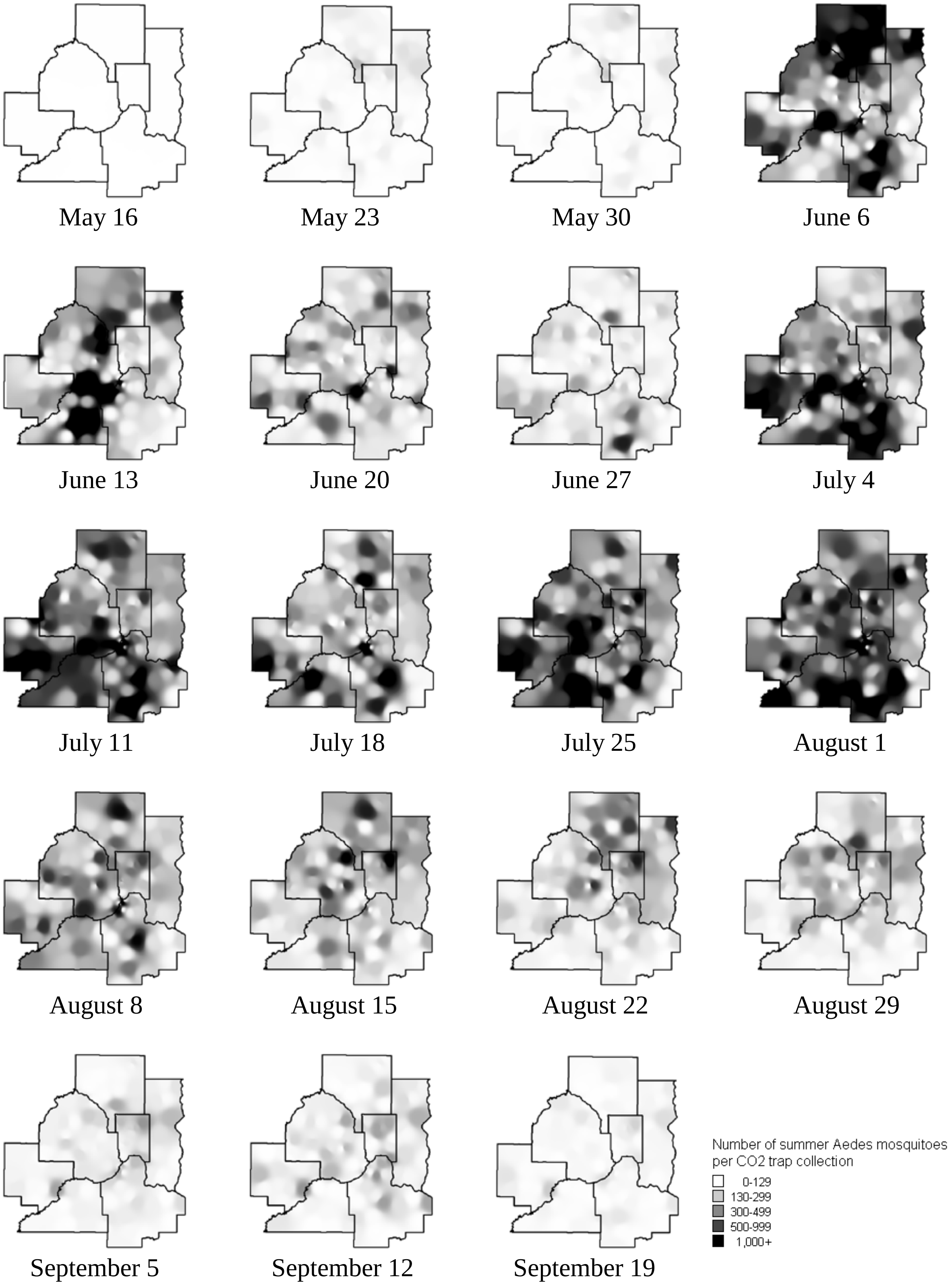
June 6 June 13 June 20 June 27

July 4 July 11 July 18 July 25

August 1 August 8 August 15 August 22

August 29 September 5 September 12

Figure 1.8 Number of spring *Aedes* in District low (5 ft) CO_2 trap collections, 2011. The number of traps operated per night varied from 98-110. Inverse distance weighting was the algorithm used for shading of maps.


May 16
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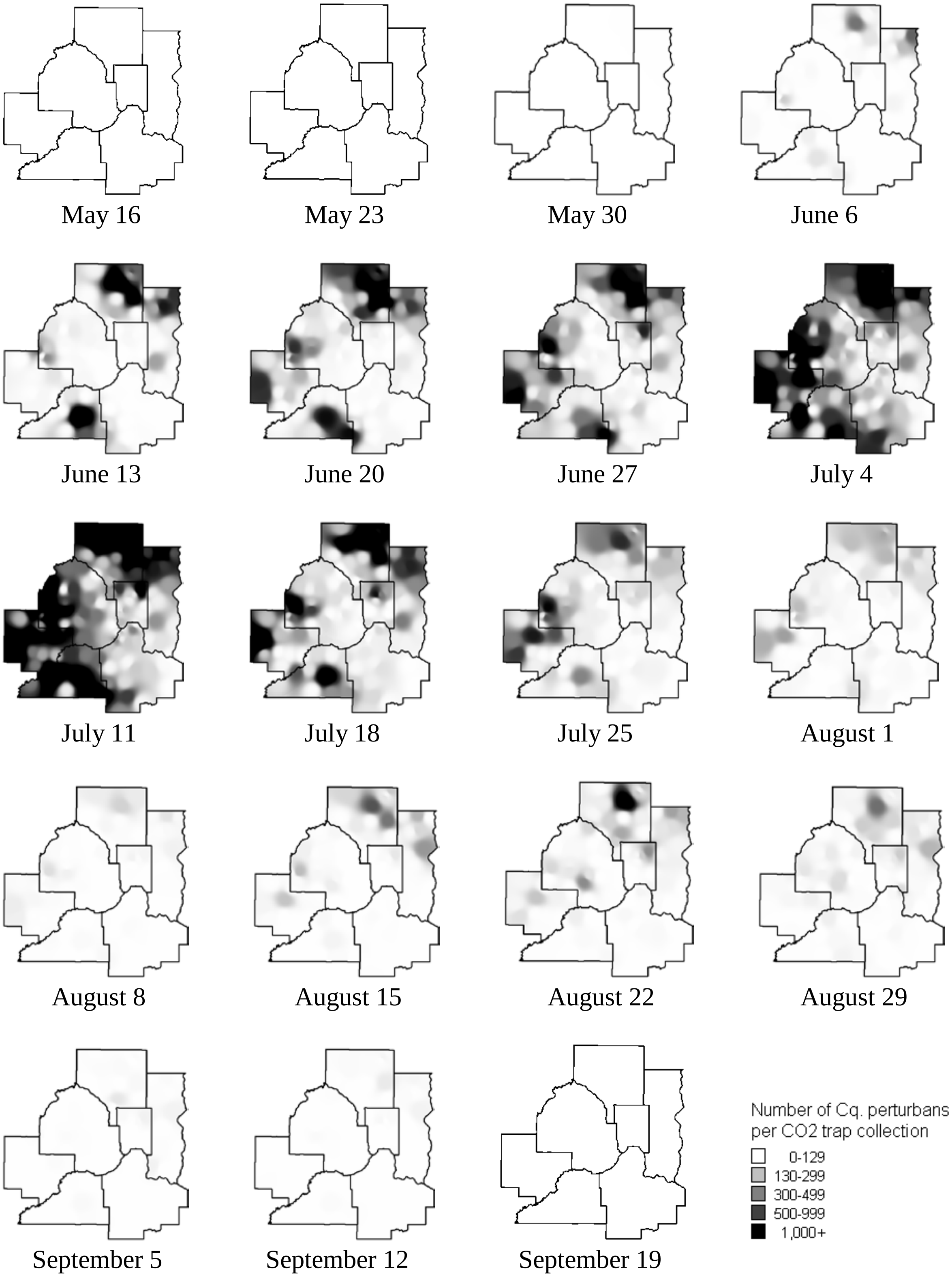
May 30
June 6
June 13
June 20
June 27
July 4
July 11
July 18
July 25
August 1
August 8
August 15
August 22
August 29
September 5
September 12
September 19

Figure 1.9 Number of summer *Aedes* in District low (5 ft) CO_2 trap collections, 2011. The number of traps operated per night varied from 98-110. Inverse distance weighting was the algorithm used for shading of maps.



May 16
May 23
May 30
June 6
June 13
June 20
June 27
July 4
July 11
July 18
July 25
August 1
August 8
August 15
August 22
August 29
September 5
September 12
September 19

Figure 1.10 Number of *Cq. perturbans* in District low (5 ft) CO_2 trap collections, 2011. The number of traps operated per night varied from 98-110. Inverse distance weighting was the algorithm used for shading of maps.

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 temperatures on sampling nights this season were all above the minimum (55°F) for mosquito activity (Fig. 1.11). Nights in July and August were very warm – in the 70s and 80s.

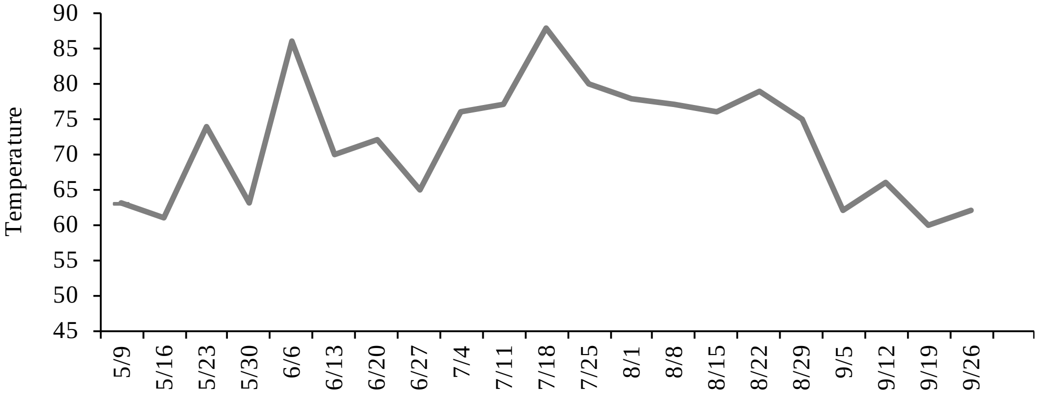


Figure 1.11 Temperature at 9:00 P.M. on Monday night surveillance dates.

Figure 1.12 shows the seasonal distribution of the three major groups of mosquitoes from mid-May through early September, detected by sweep netting. Collections detected the spring *Aedes* emergence May 23, populations peaked in early June and diminished by the end of July. Summer *Aedes* populations rose following the large broods in May and June and peaked the beginning of August as a result of the large July storm. Populations diminished but then were fueled by more rain events in August. *Coquillettidia perturbans* populations peaked the week of July 18 and continued to be collected through the last sampling date. The end date for the sweep net collections is earlier than the CO_2 traps due to the availability of seasonal staff to perform the sweep collections.

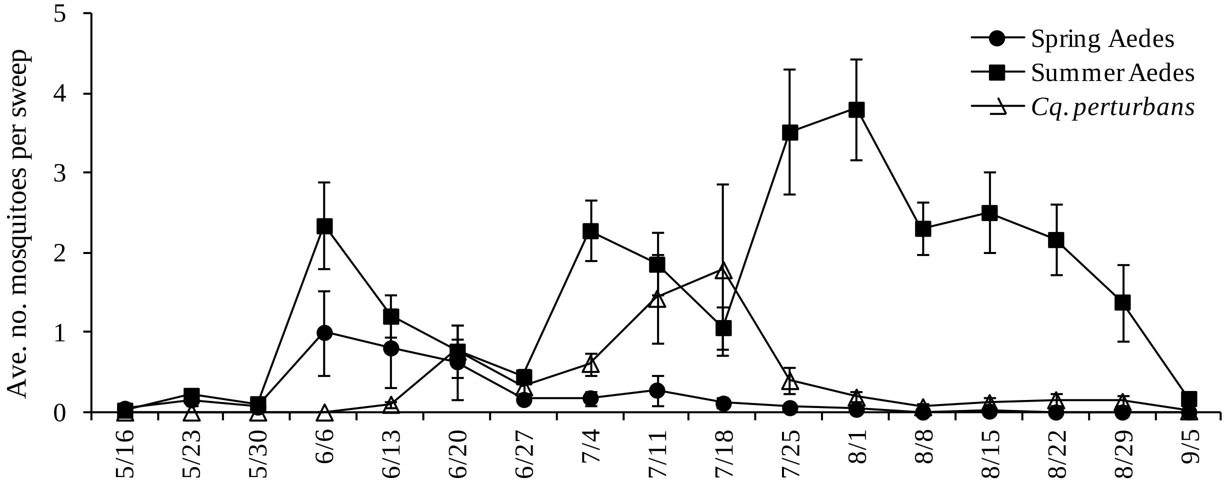


Figure 1.12 Average number of spring *Aedes*, summer *Aedes*, and *Cq. perturbans* per evening sweep net collection, 2011. Error bars equal ± 1 standard error of the mean.

CO_2 traps are placed at selected locations throughout the District to measure the abundance of mosquitoes. The traps detected the same pattern as the sweeps for spring and summer *Aedes* (Figure 1.13). The *Cq. perturbans* peak in the CO_2 traps was July 11. Typically, *Cq. perturbans* begin emergence in June, peak in early July, and die off by the beginning of August. In 2011, we detected a very unusual increase in populations in August and continued to collect specimens through the last collection date in September (Fig. 1.14 and Fig. 1.10).

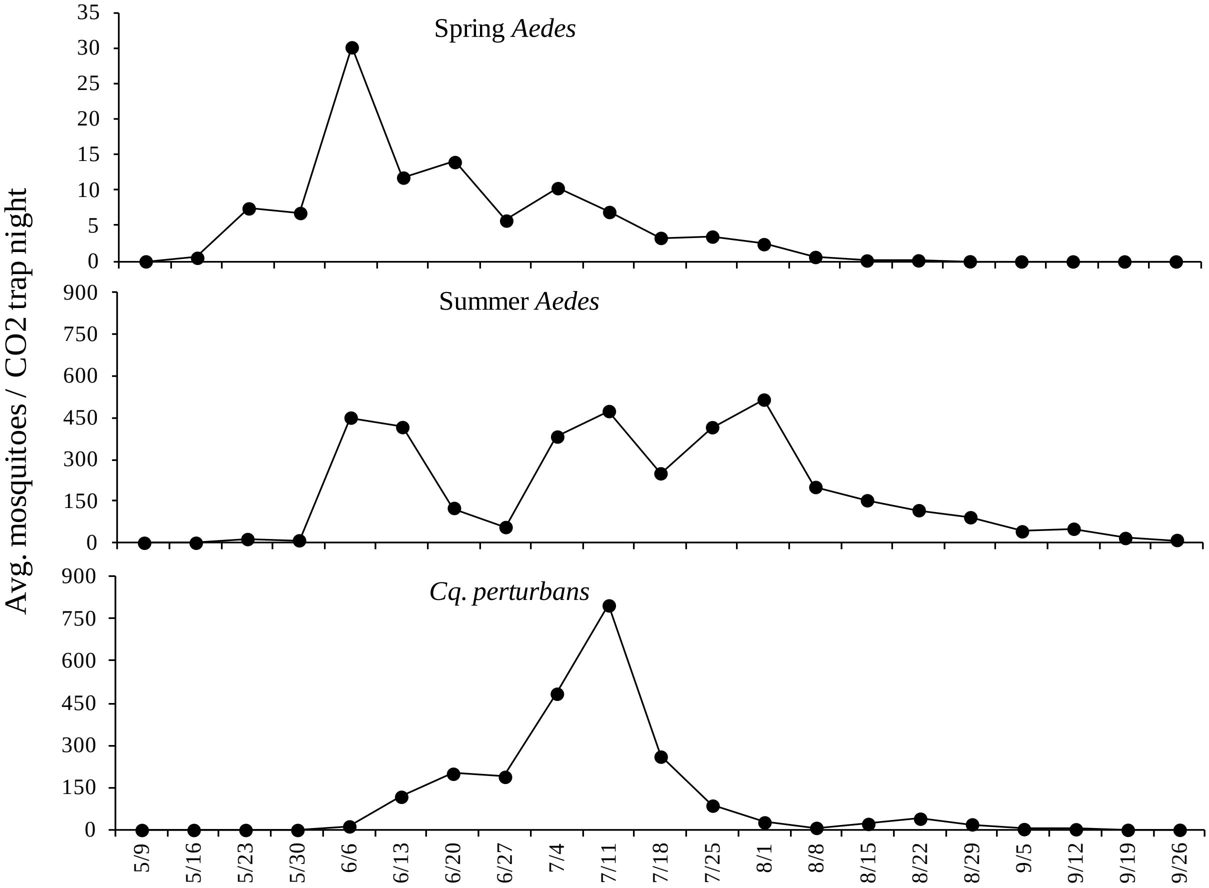


Figure 1.13 Average number of spring *Aedes*, summer *Aedes* and *Cq. perturbans* per CO_2 trap, 2011. Error bars equal ± 1 standard error of the mean.

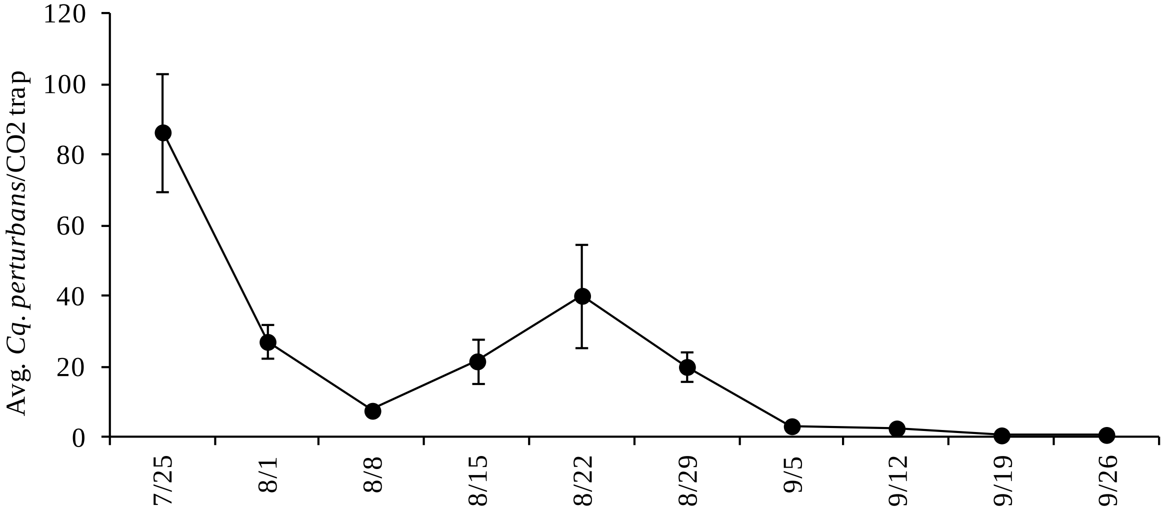


Fig. 1.14 Average number of *Cq. perturbans* per CO_2 trap in late July-September, 2011. Error bars equal ± 1 standard error of the mean.

New Jersey 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 traps and locations 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 Wildlife Refuge, trap AV at the Minnesota Zoo in Apple Valley, and trap MN in Minnetrista (Figure 1.15). Trapping occurs nightly for 20 weeks from May to 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 1965-2011 from those four traps is shown in Appendix B.

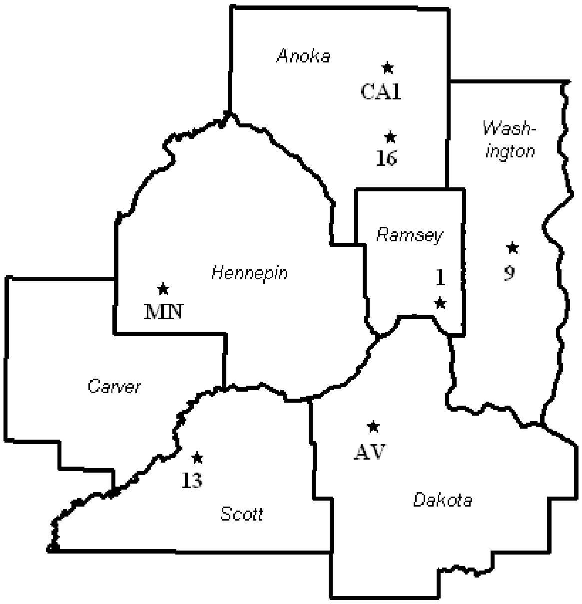


Figure 1.15 NJ light trap locations, 2011

The most numerous species collected in NJ traps was *Ae. vexans*, whose total was 61% of all female mosquitoes captured (Table 1.8). Two traps were responsible for collecting the majority of the *Ae. vexans* — Minnetrista and Carlos Avery. The Minnetrista trap also contributed more than half of the *Cq. perturbans*, our number two pest. The spring *Aedes* species combination of *Ae. abserratus* and *Ae. punctor* (*Ae. abs/punct*) came in fourth place. *Anopheles* species were unusually high this season with *An. walkeri* in third place, *An. punctipennis* in fifth, and *An. quadrimaculatus* in seventh. *Uranotaenia sapphirina* occurred in very high numbers as well, ranking sixth.

Table 1.8 Total number and frequency of occurrence for each species collected in NJ light traps, May 8 – September 24, 2011

	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	137	133	139	140	131	130	132	942	Total	Night
Ae. abserratus	0	1	0	6	236	0	16	259	0.21%	0.27
aurifer	0	0	0	0	0	0	0	0	0.00%	0.00
canadensis	0	0	8	0	12	0	0	20	0.02%	0.02
cinereus	8	7	4	18	323	3	78	441	0.35%	0.47
dorsalis	0	0	1	1	0	0	1	3	0.00%	0.00
excrucians	0	7	0	2	85	1	28	123	0.10%	0.13
fitchii	0	1	0	1	3	0	3	8	0.01%	0.01
flavescens	0	0	0	0	0	0	0	0	0.00%	0.00
implicatus	0	0	0	0	1	0	0	1	0.00%	0.00
japonicus	2	7	0	0	2	2	8	21	0.02%	0.02
nigromaculus	0	0	0	0	0	1	0	1	0.00%	0.00
punctor	0	1	1	1	156	1	4	164	0.13%	0.17
riparius	0	0	0	0	6	0	9	15	0.01%	0.02
spenceri	0	0	0	0	0	0	0	0	0.00%	0.00
sticticus	1	2	59	0	29	4	1	96	0.08%	0.10
stimulans	1	2	0	0	25	6	96	130	0.10%	0.14
provocans	0	1	0	0	9	0	0	10	0.01%	0.01
triseriatus	0	19	0	3	4	2	55	83	0.07%	0.09
trivittatus	15	300	113	1	11	40	13	493	0.39%	0.52
vexans	4,022	3,335	5,250	5,732	16,307	4,915	36,270	75,831	60.68%	80.50
abserratus/punctor	1	1	0	10	1,411	1	23	1,447	1.16%	1.54
Aedes species	96	64	37	47	283	105	1,370	2,002	1.60%	2.13
Spring *Aedes*	1	9	1	1	41	2	33	88	0.07%	0.09
Summer *Aedes*	0	0	6	1	0	0	1	8	0.01%	0.01
An. barberi	0	0	0	0	0	0	1	1	0.00%	0.00
earlei	0	0	0	0	0	0	0	0	0.00%	0.00
punctipennis	26	295	56	43	486	14	357	1,277	1.02%	1.36
quadrimaculatus	13	654	179	20	76	17	60	1,019	0.82%	1.08
walkeri	0	13	16	72	2,383	1	77	2,562	2.05%	2.72
An. species	9	107	33	6	200	10	37	402	0.32%	0.43
Cx. erraticus	0	0	0	0	0	0	0	0	0.00%	0.00
pipiens	0	0	0	0	0	0	0	0	0.00%	0.00
restuans	38	92	12	33	75	55	75	380	0.30%	0.40
salinarius	2	2	1	11	7	0	18	41	0.03%	0.04
tarsalis	6	5	16	10	10	4	14	65	0.05%	0.07
territans	12	182	8	85	65	27	167	546	0.44%	0.58
Cx. species	12	33	4	10	44	32	60	195	0.16%	0.21
Cx. pipiens/restuans	78	149	16	38	100	100	137	618	0.49%	0.66
Cs. inornata	44	29	14	73	66	41	730	997	0.80%	1.06
melanura	2	4	0	3	48	0	0	57	0.05%	0.06
minnesotae	24	6	10	237	119	8	60	464	0.37%	0.49
morsitans	5	1	0	5	18	0	1	30	0.02%	0.03
Cs. species	8	1	1	24	12	0	1	47	0.04%	0.05
Cq. perturbans	149	148	207	2,658	9,576	313	20,229	33,280	26.63%	35.33
Or. signifera	0	0	0	0	0	0	0	0	0.00%	0.00
Ps. ciliata	0	0	0	0	0	1	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	86	517	11	95	59	17	343	1,128	0.90%	1.20
Unidentifiable	14	9	1	7	57	10	508	606	0.48%	0.64
Female Total	4,675	6,004	6,065	9,254	32,345	5,733	60,884	124,960	100.00%	132.65
Male Total	2,267	3,702	1,641	2,608	4,924	722	4,599	20,463		
Grand Total	6,942	9,706	7,706	11,862	37,269	6,455	65,483	145,423		

The first collection of *Ae. japonicus* in a NJ light trap was in 2009 (Minnetrista). In 2011, *Ae. japonicus* were captured in five traps: St. Paul, Lake Elmo, Carlos Avery, Apple Valley, and Minnetrista. Also of note was the collection of a single *Ps. ciliata* in the AV trap.

The MN and CA1 traps collected by far the most mosquitoes with the MN trap collecting almost twice as many as the CA1 trap. Trap 16 in Lino Lakes ranked third. These traps are located in the northern counties where precipitation and mosquito production was greater.

Rare Detections *Anopheles quadrimaculatus* is notable because it is capable of transmitting malaria. Historically, it is rare in the District, but in recent years, it has occurred in traps more frequently than in the past. We compared total *An. quadrimaculatus* for the four NJ trap locations that have remained the same since 1965. Results showed that for the first eight years of the District's existence, the highest yearly total collected at these locations was 57 and no other year was greater than 27. For the next 34 years (1968-2002), they were only captured in four years. *Anopheles quadrimaculatus* started to reappear in 2003, with a large population occurring in 2007, declining the next two years, then reaching the highest amount ever in 2011(Fig. 1.16). About 75% of the *An. quadrimaculatus* in 2011 came from the Lake Elmo trap and about 20% from the Jordan trap (Table 1.8); 1% occurred at the St. Paul location, and 2% occurred in the Lino Lakes trap.

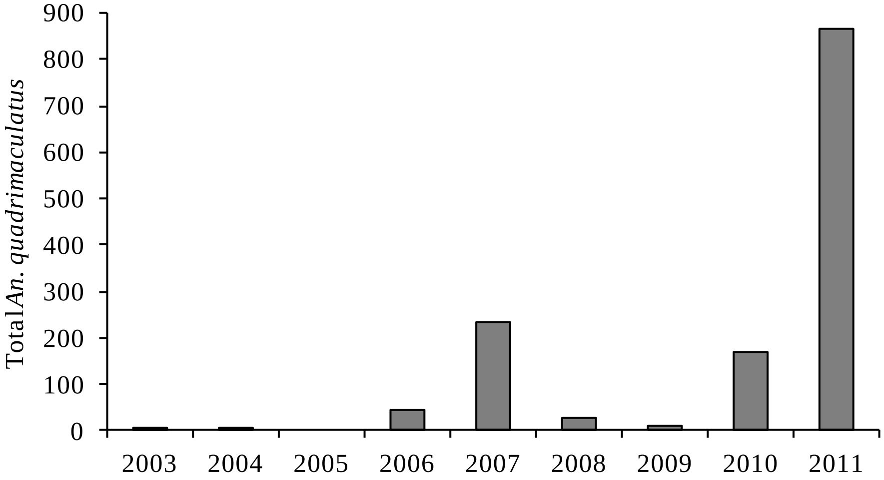


Figure 1.16 Yearly total *Anopheles quadrimaculatus* in four NJ light traps (traps 1, 9, 13, and 16) that have operated at the same location, 2003-2011.

In the last few years, there has been an increase in the number and variety of *Psorophora* species in our adult collections. In addition to the *Ps. ciliata* in the NJ trap, the rare species *Ps. columbiae*, formerly named *confinnis*, was collected in CO_2 traps in 2010 and 2011. Other rare species found this season that are not targeted for control are *Anopheles barberi* and *Orthopodomyia signifera*.

Lab staff were excited about a suspected first occurrence of *Aedes melanimon* in Minnesota! One specimen was collected in a CO_2 trap at the U of M St. Paul campus on July 6, but it is missing a key character to confirm its identification. The range for this species is western US, as far east as central North Dakota.

Targeted Vector Mosquito Surveillance

Aedes triseriatus Staff use a vacuum aspirator 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 30 and continued through mid-September. The peak rate of capture of 1.8 *Ae. triseriatus* per sample occurred during the week of June 27 (Figure 1.17). Following the early season population peak, mean rates of capture fell during each of the next three weeks. This was likely due to a combination of factors including, but not limited to, high mortality from extreme heat in mid-July and a natural dip in the adult population which often occurs immediately following a peak in adult numbers. When temperatures returned to normal in late July, the *Ae. triseriatus* population rebounded quickly. In August and September, we observed the general population decline that is typical of that time of year.

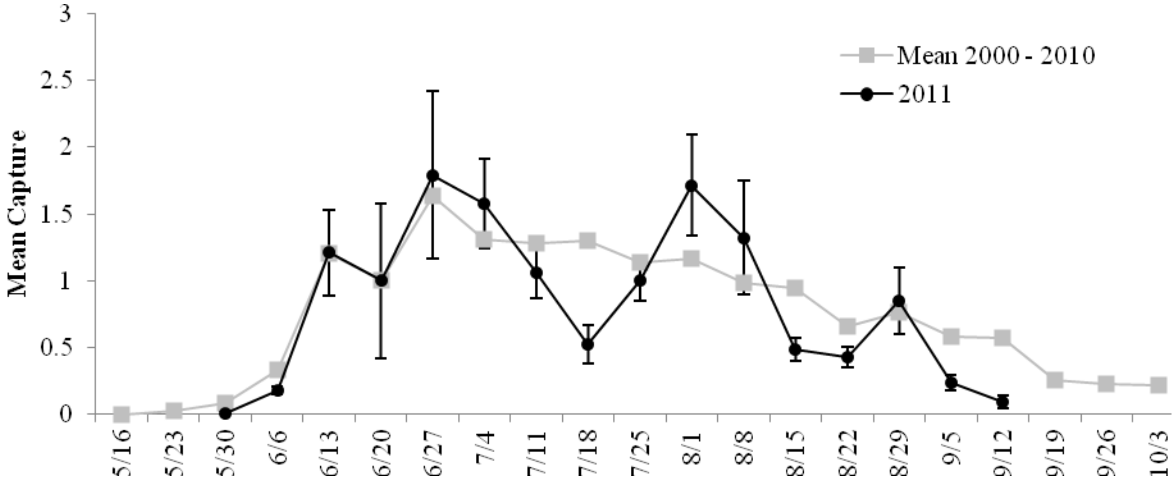


Figure 1.17 Mean number of *Ae. triseriatus* adults in aspirator samples plotted by week and compared to mean captures for the corresponding weeks of 2000-2010. Dates listed are the Monday of each week in 2011. Error bars equal ± 1 standard error of the mean.

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 are sometimes found 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. In a mark-recapture study, Howard et al. (1989) found the mean distance traveled to be 4 km (2.5 mi) from the release points. However, *Cs. melanura* were captured as far as 9.8 km (6.1 mi) from their release.

District staff monitored adult *Cs. melanura* at six locations using seven CO_2 traps: three sites in Anoka County, two sites in Washington County, and one site in Hennepin County (see Figure 1.7). *Culiseta melanura* have been collected from each location in the past. The Hennepin County location had two traps – one at ground level and one elevated 20 ft into the tree canopy, where many bird species roost at night.

In 2010, our surveillance detected a late season increase in the *Cs. melanura* population. The peak rate of capture in our CO_2 trap network occurred on September 20. Since the species overwinters in its larval stages, we anticipated an elevated population early in 2011. Surveillance early and throughout the 2011 season documented unusually high numbers of *Cs. melanura* in the District.

Culiseta melanura occurred at each location, including the Hennepin County elevated trap. A total of 697 *Cs. melanura* were collected in 79 of 142 trap placements, a rate 4.9 times greater than in 2010. The current network of CO_2 traps has been in use since 2005. Ten times in 2011, the weekly mean capture of *Cs. melanura* exceeded the network's previous high rate of capture which occurred in 2010. In fact, the mean rate of capture for the entire 2011 season exceeded the network's previous high weekly mean collection.

The first *Cs. melanura* adults were collected in CO_2 traps on May 23 (Figure 1.18) and the population of the first generation to emerge peaked around June 6. The population appeared to reach its peak in early August, although one trap collected an unusually high number of specimens that week (78). Still, the mean collection of 17.7 per CO_2 trap on August 1 is the highest ever recorded in the District. The late season population remained high as evidenced by CO_2 trap collections, as well as by other surveillance methods.

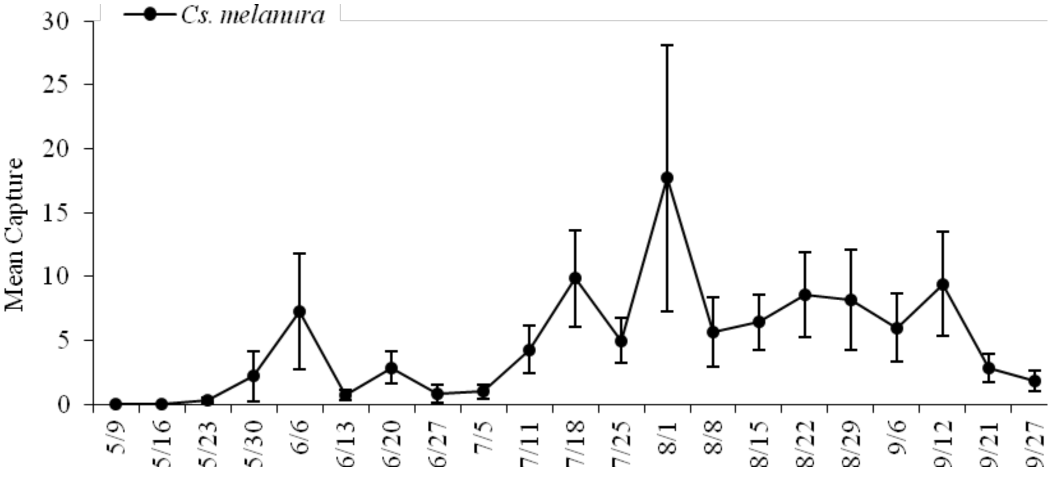


Figure 1.18 Mean number of *Cs. melanura* adults in CO_2 traps from selected sites. Dates listed are the Monday of each sampling week. Error bars equal ± 1 standard error of the mean.

Through a variety of surveillance methods, *Cs. melanura* were captured in all seven District counties (Figure 1.19), as well as in Chisago County in 2011. Aspirator samples contained *Cs. melanura* 125 times as did 92 CO_2 trap samples from 44 locations that are not part of the regular *Cs. melanura* network. Five gravid traps and four sweep samples also contained *Cs. melanura*.

Culiseta melanura develop in a narrow range of aquatic habitats in the District, and larvae are difficult to collect. In 2011, in an effort to confirm the presence of an overwintering population of the species, we conducted larval surveillance in several potential *Cs. melanura* habitats. *Culiseta melanura* larvae were collected in eight of 73 sites inspected.

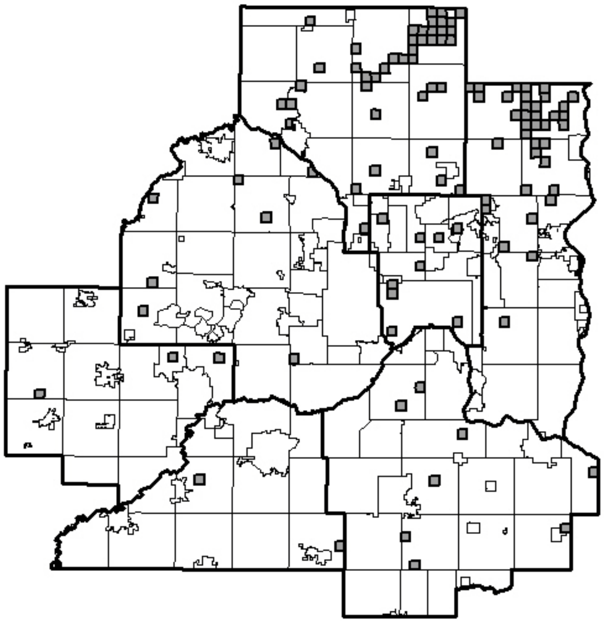
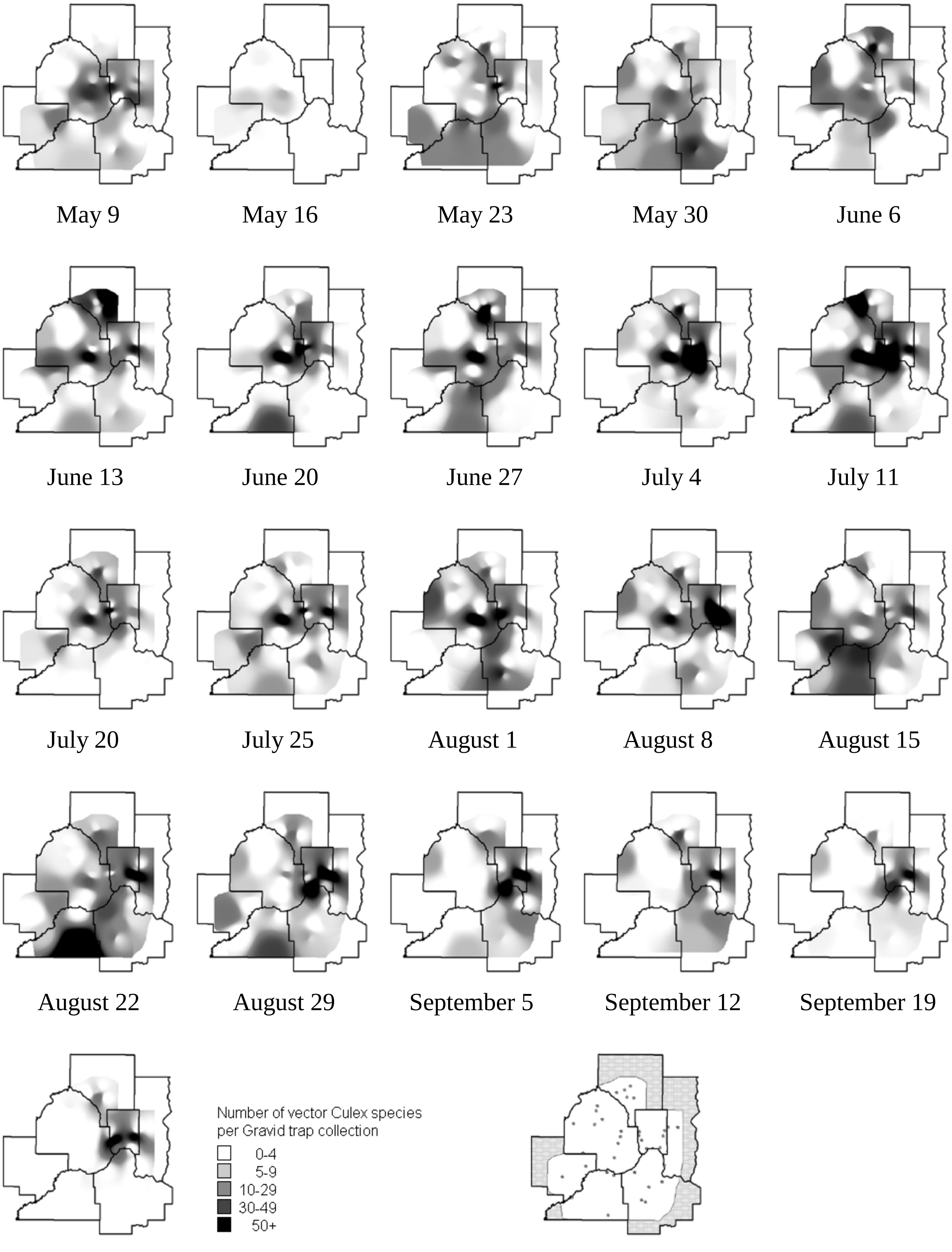


Figure 1.19 *Culiseta melanura* distribution in MMCD. Areas shaded in gray represent locations where *Cs. melanura* were collected in 2011.

***Culex* Surveillance** *Culex* species are important for the amplification and transmission of WNV and WEE virus in our area. The District uses CO_2 traps (129 locations) to monitor host-seeking *Culex* mosquitoes and gravid traps (36 locations) to monitor egg-laying *Culex* mosquitoes. Many *Culex* specimens collected in the network were tested for WNV and some were also tested for WEE. Concentrations of *Culex* in the District as detected through gravid trap monitoring are displayed in Figure 1.20.

Culex tarsalis is the most likely vector of WNV to humans in our area. *Culex tarsalis* specimens from Monday night CO_2 traps and gravid traps were tested for WNV in 2011 (see Chapter 2, Table 2.3). Capture rates for *Cx. tarsalis* in CO_2 traps were low to moderate during the 2011 season (Figure 1.21). For nine weeks from the beginning of July to the end of August, the mean rate of capture ranged between one and seven per CO_2 trap. The season peak of 6.8 *Cx. tarsalis* per CO_2 trap occurred on August 8. 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. *Culex restuans* were collected in low to moderate numbers in CO_2 traps in 2011 (Figure 1.22). The CO_2 trap capture peaked at 2.5 per trap on June 6, about one month earlier than in 2010. Gravid trap collections of *Cx. restuans* in 2011 were similar to observations in 2010 indicating that the population grew through mid-July. A falling population was observed during the later half of the season as is typical for the species.



May 9 | May 16 | May 23 | May 30 | June 6

June 13 | June 20 | June 27 | July 4 | July 11

July 20 | July 25 | August 1 | August 8 | August 15

August 22 | August 29 | September 5 | September 12 | September 19

September 26

Gravid Trap Locations

Figure 1.20 Number of *Culex* vector species in District gravid trap collections by week, 2011. Inverse distance weighting was used to generate shading of maps. A map of the gravid trap locations showing the area of District used to generate the weekly maps is also included.

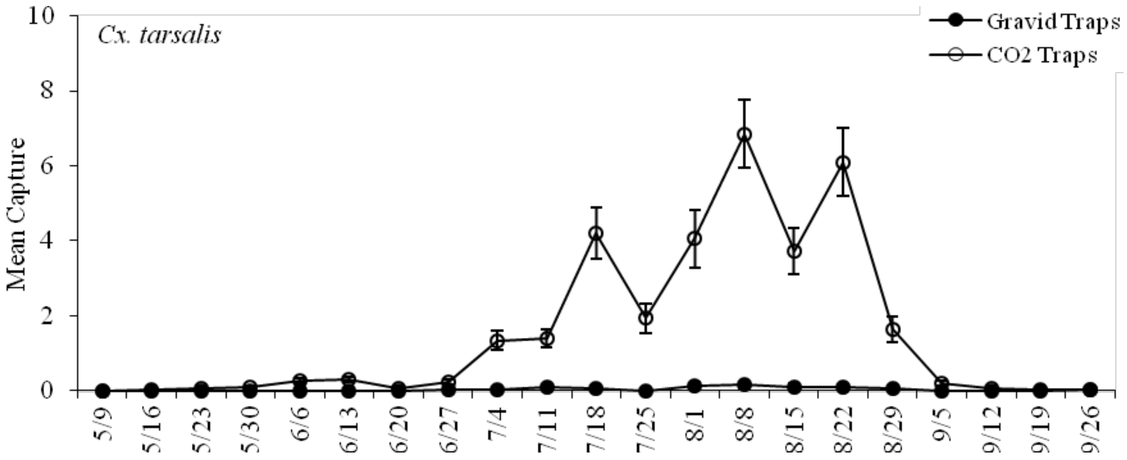


Figure 1.21 Average number of *Cx. tarsalis* in CO_2 traps and gravid traps, 2011. Dates listed are the Monday of each sampling week. Error bars equal ± 1 standard error of the mean.

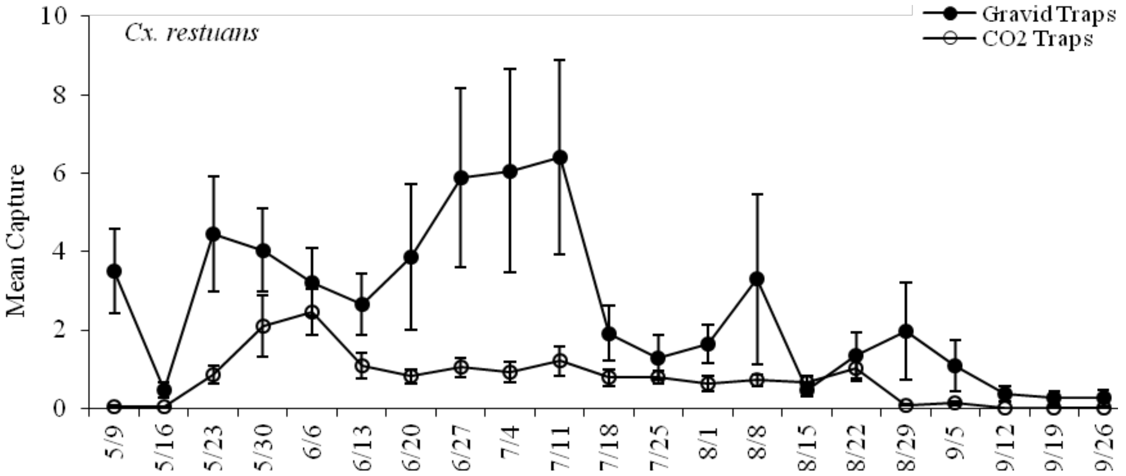


Figure 1.22 Average number of *Cx. restuans* in CO_2 traps and gravid traps, 2011. Dates listed are the Monday of each sampling week. Error bars equal ± 1 standard error of the mean.

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. Collections of *Cx. pipiens* were low in both CO_2 traps and gravid traps in 2011 (Figure 1.23). There were two weeks during the year when a few CO_2 traps captured extremely high numbers of *Cx. pipiens* by comparison to the rest of the network. During the week of July 18 one trap captured 96 while another caught 141 and during the week of August 29 one trap contained 563 *Cx. pipiens*.

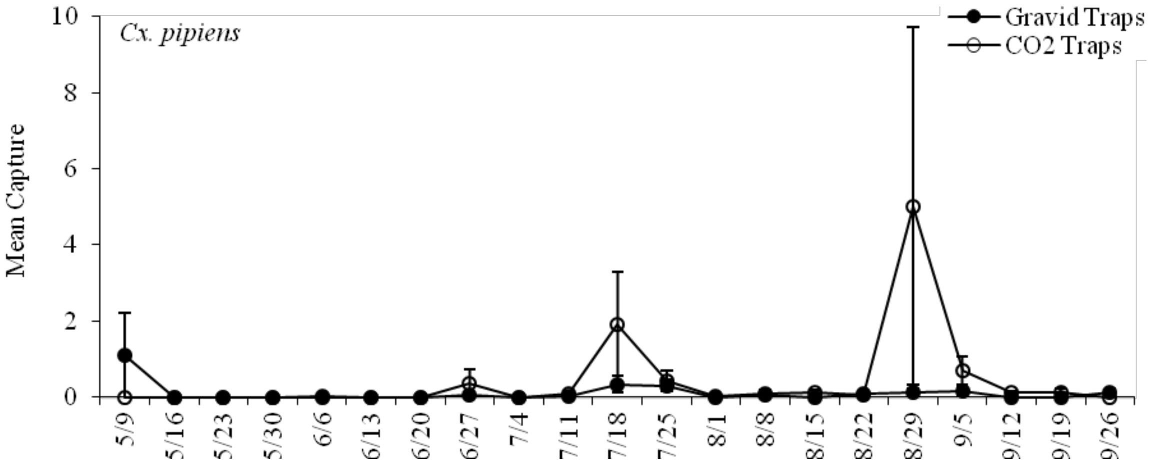


Figure 1.23 Average number of *Cx. pipiens* in CO_2 traps and gravid traps, 2011. Dates listed are the Monday of each sampling week. Error bars equal ± 1 standard error of the mean.

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 numbers of *Cx. pipiens/restuans* (Figure 1.24) and *Culex* species (Figure 1.25) captured in gravid traps fluctuated throughout the season with the two highest collections of both groups occurring during the weeks of July 11 and August 22. Few adults from CO_2 traps were grouped into the *Culex* species category as most could be identified to species or to the *Cx. pipiens/restuans* group. Captures of *Cx. pipiens/restuans* in CO_2 traps generally increased until the week of August 1 and then fell gradually over the remainder of the season.

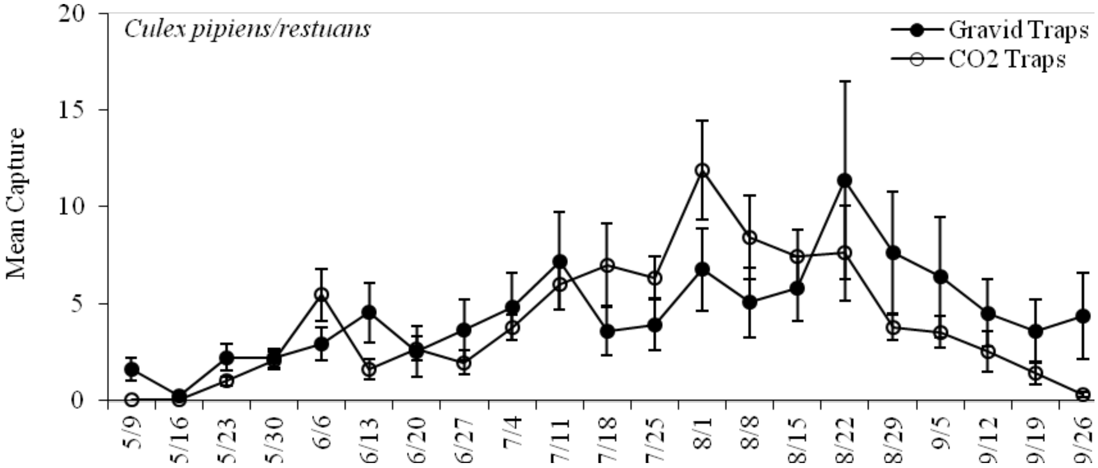


Figure 1.24 Average number of *Cx. pipiens/restuans* in CO_2 traps and gravid traps, 2011. Dates listed are the Monday of each sampling week. Error bars equal ± 1 standard error of the mean.

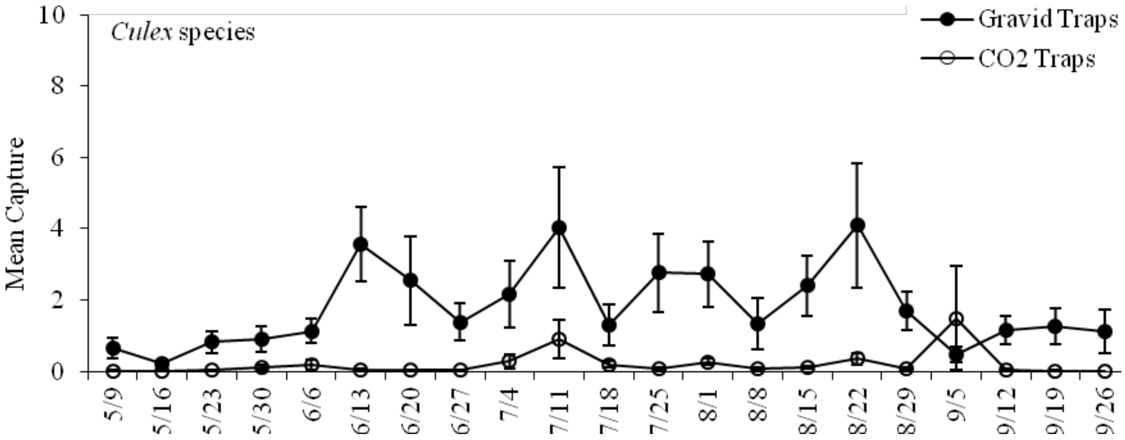


Figure 1.25 Average number of *Culex* species in CO_2 traps and gravid traps, 2011. Dates listed are the Monday of each sampling week. Error bars equal ± 1 standard error of the mean

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 both have adapted to use tires and other artificial containers as oviposition sites and larval habitat. This allows them to be transported over great distances. *Aedes albopictus*, first introduced in the United States in 1985, are established in many states to the south and east of Minnesota and are frequently introduced to the District in shipments of used tires and by other means. *Aedes japonicus* recently became established in Minnesota. They were first found in the District in 2007 and have been collected in increasing numbers since then.

Aedes albopictus *Aedes albopictus* were not collected here in 2011; however, we have detected them in the District during seven seasons (1991, 1996, 1999, 2005, 2006, 2007, and 2009). MMCD staff also collected them in Wright County in 1997. *Aedes albopictus* have not successfully overwintered here despite recurring introductions.

Aedes japonicus In 2010, we worked to integrate *Ae. japonicus* surveillance and control into the array of services provided by the District. We built upon that foundation in 2011 with control efforts focused on eliminating small container type larval habitats. Additional larval and adult control supported that work. We also evaluated several adult surveillance methods to better understand how each might support *Ae. japonicus* control.

Aedes japonicus larvae were found in 659 samples. Most were from containers (448) and tires (168). Larvae were found in other habitats as well, including: artificial or ornamental ponds (18), stormwater structures (9), catch basins (2), tree holes (4), wetlands (5), and unspecified habitats (5). Each year since *Ae. japonicus* arrived in the District, we have observed an increase in the frequency of larval collections, especially from containers and tires (Table 1.9).

Table 1.9 Percentage of samples from containers, tires, and tree holes that contained *Ae. japonicus* larvae, 2009 – 2011

Habitat type	2009	2010	2011
Containers	4.2%	23.5%	36.2%
Tires	2.9%	15.5%	21.3%
Tree holes	0	8.8%	9.3%

Aedes japonicus adults were identified in 229 samples. They were found in 134 aspirator samples, 32 CO_2 trap samples, 28 NJ trap samples, 24 gravid trap samples, and 11 two-minute sweep samples. Most of the samples contained only one *Ae. japonicus* adult; however, 61 samples contained more than one (Table 1.10).

Aedes japonicus were collected from 335 District sections in 2011 (Figure 1.26). The growth and spread of the *Ae. japonicus* population is highlighted when this is compared to the number of sections where they were found in previous seasons: one in 2007, 13 in 2008, 86 in 2009, and 271 in 2010. In addition to collecting *Ae. japonicus* from multiple locations in each of the seven District counties, MMCD also recorded the species for the first time from both Wright and Chisago counties in 2011.

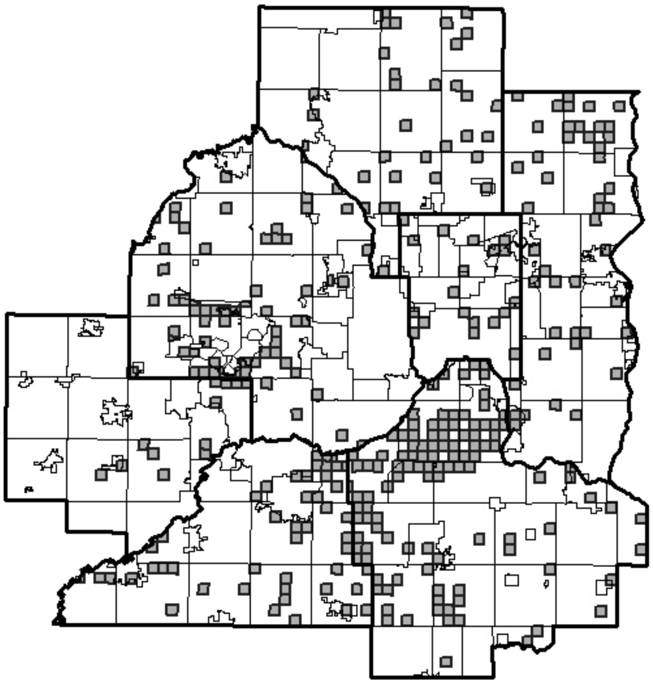


Figure 1.26 *Aedes japonicus* distribution in MMCD. Areas shaded in gray represent locations where *Ae. japonicus* were collected in 2011.

Table 1.10 *Aedes japonicus* adult collections by each surveillance method used in the District in 2011

Surveillance method	Total samples	No. with *Ae. japonicus*	No. with >1 *Ae. japonicus*	Maximum capture
Aspirator	2,821	134	44	7
CO_2 trap	2,611	32	2	2
NJ trap	937	28	6	3
Gravid trap	806	24	9	3
Two-minute sweep	3,606	11	0	1

***Aedes japonicus* Adult Surveillance Study** In 2011 we designed a field trial to compare *Ae. japonicus* captures by five collection methods. Each of the adult mosquito surveillance methods in regular use in 2010 successfully captured *Ae. japonicus*. We were interested in determining how each surveillance method could support our *Ae. japonicus* control efforts. The adult surveillance methods used by MMCD include CO_2 traps, gravid traps, NJ traps, aspirators, and two-minute sweeps. For the 2011 trial, we decided to exclude the NJ trap since some of the surveillance sites lacked access to electricity. We did, however, test two different baits in gravid traps: a hay infusion that is used in our weekly surveillance network and a tree leaf infusion.

We conducted the trials on seven properties that each held numerous larval habitats, mainly tires and water-holding containers, where we had previously collected *Ae. japonicus*. Significant portions of the properties were wooded and the surveillance occurred within the wooded portions of the properties.

Each property was divided into three surveillance zones labeled A, B and C. Equipment availability allowed us to run each trial over three consecutive days. For each trial, surveillance methods were randomly assigned to one of the three zones for the first day and rotated to a new zone on day two. The aspirator and sweep were subsequently rotated to a third zone on day three. The rotation plan for the CO_2 trap and the two gravid traps was to move from zone A to B, B to C and C to A. The aspirator and sweep moved from zone A to C, B to A and C to B (Figure 1.27). That way no two collection methods would occur in the same zones on consecutive days.

Beginning on July 27 and ending on September 9, we ran twelve trials resulting in 24 samples each from CO_2 traps, hay infusion baited gravid traps, and leaf infusion baited gravid traps; we also collected 36 samples each from aspirators and sweeps.

We successfully captured *Ae. japonicus* at least once by each surveillance method in the trial. However, it is clear that we were sampling relatively small populations of *Ae. japonicus*. During the entire investigation only 20 of 144 mosquito collections contained *Ae. japonicus* and we collected just 26 specimens. Still, we were able to demonstrate that the aspirator is significantly more likely to capture *Ae. japonicus* than any of the other surveillance methods. None of the other methods differed significantly from each other (Table 1.11). These results agree with observations from operational surveillance over the past three seasons (Table 1.12).

Wednesday Thursday Friday

Figure 1.27 Surveillance rotation plan for *Ae. japonicus* adult surveillance study.

Table 1.11 Chi-square analysis of adult mosquito surveillance methods used in the 2011 comparison

	All methods	Aspirator	CO_2 trap	Gravid hay	Gravid leaf	Sweep	All except aspirator
No. of collections	144	36	24	24	24	36	108
No. of collections with *Ae. japonicus*	20	12	3	3	1	1	8
% of collections with *Ae. japonicus*	13.9%	33.3%	12.5%	12.5%	4.2%	2.8%	7.4%
Chi-square	17.071	11.381	0.039	0.039	1.897	3.716	5.690
df	4	1	1	1	1	1	3
P-value	0.0019	0.0007	0.8440	0.8440	0.1684	0.0539	0.1277

Table 1.12 Ratio of samples containing *Ae. japonicus* in operational collections 2009-2011 and in the 2011 comparison of methods study

	2009	2010	2011	2011 Trial
Aspirator	0.41%	2.85%	4.75%	33.33%
CO_2 trap	0.00%	0.43%	1.23%	12.50%
Gravid (hay)	0.27%	1.88%	2.98%	12.50%
Gravid (leaf)	N/A	N/A	N/A	4.17%
New Jersey	0.21%	1.68%	2.99%	N/A
Sweep	0.00%	0.06%	0.31%	2.78%

It is apparent that *Ae. japonicus* can be collected through a variety of surveillance methods. Our experience is that, with trained staff, we are much more likely to find *Ae. japonicus* larvae than adults. Yet, our efforts now are moving beyond detection of the species in new areas toward management of an established population. Surveillance for adult mosquitoes is an important component of any such effort. In our case, detection of adults indicates that there are larval habitats in the area that we can locate and potentially eliminate. Collections of *Ae. japonicus* adults by every method will provide useful information to aid our control strategy. Showing that the aspirator is more likely to capture *Ae. japonicus* than other adult surveillance methods is encouraging.

The aspirator holds several advantages over other adult surveillance methods, some of which help explain its sensitivity. It is capable of collecting resting adults in all phases: recently emerged, host seeking, engorged and gravid. Most other methods attract mosquitoes in one phase. The aspirator collects equal proportions of males and females. Our standard aspirator sampling period is short, only five minutes, and the equipment is portable allowing one employee to survey many locations in one day. Most other methods are stationary and set over longer periods allowing for fewer samples per day. Finally, surveillance with an aspirator requires one trip to a site whereas traps placed overnight require two trips.

Plans for 2012

We will continue to evaluate the reduction of Monday night sweep collections and the locations of Monday night CO_2 traps.

Staff will continue to search for the species new to the District, *Ae. cataphylla* and *Ae. melanimon*.

In response to both increased collections of *Cs. melanura* over the past two seasons and nearby eastern equine encephalitis activity in 2011, we plan to re-evaluate our *Cs. melanura* surveillance strategies.

References Cited

Howard J.J., White D.J., and Muller S.L., 1989. Mark-recapture studies on the *Culiseta* vectors of eastern equine encephalitis virus. J. Med. Entomol. 26(3): 190-199.

Chapter 2 Vector-borne Disease

2011 Highlights

- No La Crosse encephalitis cases in the District in 2011 and only one in Minnesota
- WNV illness confirmed in 2 Minnesotans – both cases occurred in the District
- WNV detected in 5 District mosquito samples
- Made 235,412 catch basin treatments
- Collected and recycled 17,326 waste tires
- In 2011, Minnesota's first documented Powassan virus case fatality, of the strain transmitted by *Ixodes scapularis* (source MDH)
- New tick-borne disease (*Ehrlichia muris*-like), unique to Minnesota and Wisconsin, described (source New England Journal of Medicine)
- 2011 *I. scapularis* larval collections were very low but our nymphal collections were very high
- Average *I. scapularis* per mammal was 0.616 in 2011, comparable to our 2006 and 2008 averages
- *Amblyomma americanum* no reports MMCD; Shakopee, Lindstrom, Hennepin Co reports by MDH
- Signs posted in 25 dog parks to facilitate tick collections from the public
- 2011 not available, but new records set for Lyme disease and HGA cases in 2010 (source MDH)

Background

District staff provide a variety of disease surveillance and control services, as well as public education, to reduce the risk of mosquito-borne illnesses, as well as tick-borne illnesses such as Lyme disease and human granulocytic anaplasmosis (HGA). Past efforts have also included determining metro-area risk for infections of the mosquito-borne Jamestown Canyon virus, and the tick-borne illnesses of babesiosis, Rocky Mountain spotted fever, and Sin Nombre virus (a hantavirus).

Mosquito-borne Diseases La Crosse encephalitis (LAC) 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) or a history of LAC cases. MMCD targets these areas for intensive control efforts including public education, larval habitat removal (e.g., tires, tree holes, and artificial containers), and limited adult mosquito treatments. Additionally, routine surveillance and control activities are conducted at past LAC case sites. Surveillance for the invasive species *Ae. albopictus* (Asian tiger mosquito) and *Ae. japonicus* (Japanese rock pool mosquito) routinely occurs to detect infestations of these potential disease vectors.

The District collects and tests *Cx. tarsalis* to monitor western equine encephalitis (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 for West Nile virus (WNV), which 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.

2012 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
- Re-evaluate *Cs. melanura* surveillance and 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 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 eastern equine encephalitis (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.

Tick-borne Diseases 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, 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 useful as we can direct vector control and public education where needed.

Knowing the location and population levels of the vectors is only one part of the vector-borne disease cycle, however; 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.

MMCD is continuously exploring ways to improve its disease prevention programs. We would ultimately like to increase our ability to serve metro citizens given that in recent years we have more frequently received reports of rarely detected vector-borne illnesses (EEE, Powassan, Rocky Mountain spotted fever). Additionally, we are detecting invasive vector species (*Ae. albopictus*, *Ae. japonicus*, *Amblyomma americanum*) more often and our surveillance continues to show increases in population levels and geographic distribution of disease vectors (*Ae. japonicus*, *I. scapularis*).

2011 Mosquito-borne Disease Services

Breeding 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 exotic 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 2011, District staff recycled 17,326 tires that were collected from the field (Table 2.1). Since 1988, the District has recycled 551,798 tires. In addition, MMCD eliminated 3,250 containers and filled 219 tree holes in 2011. This reduction of breeding sources occurred while conducting a variety of mosquito, tick, and black fly surveillance and control activities, including the 2,581 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
2002	15,412	2,799	1,432	19,643
2003	14,654	1,542	518	16,714
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

La Crosse Encephalitis

La Crosse encephalitis is a viral illness that is transmitted in Minnesota by *Ae. triseriatus*. Two invasive mosquitoes, *Ae. 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 the La Crosse virus; 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 2011, there were 122 La Crosse illnesses documented in the United States.

***Aedes triseriatus* Surveillance and Control** *Aedes triseriatus* is a container inhabiting, floodwater mosquito whose preferred natural habitat is tree holes. MMCD staff sample wooded mosquito habitats by vacuum aspirator to monitor adult *Ae. triseriatus* populations and to direct adult and larval control efforts. Frequent rainfall in 2011 allowed for nearly continuous *Ae. triseriatus* larval development and adult emergence from May to August; however, *Ae. triseriatus* adult numbers may have been negatively impacted by high temperatures in July, (see Chapter 1, Figure 1.17).

In 2011, MMCD staff collected 2,563 aspirator samples to monitor *Ae. triseriatus* populations. The District's treatment threshold (≥ 2 adult *Ae. triseriatus*/aspirator collection) was met in 316 of these samples. Inspections of wooded areas and surrounding residential properties were provided as follow-up service when *Ae. triseriatus* adults were collected. Additionally, 162 adulticide applications to wooded areas were prompted by collections of *Ae. triseriatus* in aspirator samples.

Adult *Ae. triseriatus* were captured in 566 of 1,769 individual wooded areas sampled. This ratio, as well as the mean number of *Ae. triseriatus* captured per sample, was similar to the previous season's findings (Table 2.2).

Table 2.2 *Aedes triseriatus* aspirator surveillance data, 2000 – 2011

Year	Total areas surveyed	No. with *Ae. triseriatus*	Percent with *Ae. triseriatus*	Total samples collected	Mean 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

La Crosse Encephalitis in Minnesota There was one LAC case reported in Minnesota in 2011. It occurred in a resident of Houston County. This was the second consecutive year when the state's only confirmed LAC case occurred in Houston County and the sixth consecutive year with no LAC illnesses in the District. Since 1970, the District had an average of 2.2 LAC encephalitis cases per year (range 0 – 10, median 2). Since 1990, the mean is 1.4 cases per year (range 0 – 8, median 0).

While *Ae. triseriatus* is known as the primary vector of the La Crosse virus, less is understood of the role *Ae. japonicus* might play in the La Crosse cycle. *Aedes japonicus* is a competent vector of LAC in laboratory settings, but has not been implicated as a vector in nature. In 2011, MMCD submitted 129 pools of *Ae. japonicus* to MDH to be tested for the La Crosse virus as well as West Nile virus. Neither virus was detected from the *Ae. japonicus* samples.

Eastern Equine Encephalitis

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 only record of EEE in Minnesota was in 2001 when three horses were diagnosed with the illness, including one from Anoka County.

In 2011, the EEE virus was detected in 14 states. There were four human illnesses diagnosed: two in Massachusetts (one Missouri resident), one in New York, and one in Wisconsin. There were 65 veterinary reports of EEE illnesses in domestic animals, primarily horses, from 11 states. The worst of the EEE epizootics occurred in northern Wisconsin where 34 cases were confirmed in domestic animals. The nearest veterinary confirmations to the District were three cases in Dunn County, Wisconsin.

***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, as was the case in both 2010 and 2011.

Unusually high numbers of *Cs. melanura* were collected in the District in 2011 (see Chapter 1, page 22). Most were collected in Anoka and Washington counties; however, there were specimens from each of the seven District counties. We first learned of EEE activity in Wisconsin in early August, about the same time that we observed record numbers of *Cs. melanura* through our CO_2 trap network. At that time, we intensified our surveillance for *Cs. melanura* by increasing the number of aspirator collections near bog habitats. Over two-thirds of the season's 255 aspirator samples targeting *Cs. melanura* were collected in August and September. Ninety-four pools of *Cs. melanura* were submitted to MDH for EEE analysis, all results were negative.

On a few occasions, crews worked to reduce adult *Cs. melanura* populations in response to collections in aspirators and CO_2 traps. In August and September, adult control was done at 13 sites in response to 10 mosquito samples that contained *Cs. melanura*. Over the entire season, adult control was done in response to 23 collections that contained *Cs. melanura,* although, in some cases the presence of other species in the sample may have stimulated the control response. Given the recent EEE activity in our region, we are currently re-evaluating options for controlling *Cs. melanura*.

Western Equine Encephalitis

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. In 2011, 99 pools of *Cx. tarsalis* collected by the District were tested for WEE by MDH; all results were negative.

West Nile Virus

West Nile virus circulates among many mosquito and bird species. It was first detected in New York in 1998 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 West Nile virus transmission was documented in 47 states in 2011. There were no WNV findings in Alaska, Hawaii, or Maine. The U.S. Centers for Disease Control and Prevention received reports of 667 West Nile illnesses from 42 states and the District of Columbia. There were 42 fatalities attributed to WNV infections. California had the greatest number of cases with 154. Nationwide screening of blood donors detected WNV in 129 individuals from 24 states. Thirty-one of the 129 presumptively viremic blood donors eventually developed clinical illnesses and are also included in the confirmed cases reported to CDC. Additionally, West Nile illness was diagnosed in 115 domestic animals, mainly horses, from 29 states.

WNV in Minnesota MDH reported two WNV illnesses in Minnesota, both residents of Hennepin County, one of which was fatal. The earliest onset of a WNV illness in the state was August 20. There were no presumptively viremic blood donors reported in Minnesota. The only Minnesota veterinary report of a WNV infection was in a horse from Kandiyohi County.

West Nile in the District As stated above, there were two WNV illnesses reported in residents of Hennepin County. Both cases are believed to have been exposed locally. Since WNV arrived in the Minnesota, the District has experienced an average of 9.1 WNV illnesses each year (range 0 – 25, median 6). When cases with known exposure locations outside of the District are excluded, the mean is 6.5 cases per year (range 0 – 17, median 4).

Surveillance for WNV West Nile virus activity was low again in 2011. The earliest detection of WNV in the District was from an American crow collected on June 24. The first WNV positive mosquito sample was collected on August 16. Only four birds and five mosquito samples returned positive results for WNV.

Several mosquito species from 39 CO_2 traps (13 elevated into the tree canopy) and 36 gravid traps were processed for viral analysis each week. In addition, *Cx. tarsalis* collected in other Monday night CO_2 traps were processed for viral analysis. One pool of *Cx. tarsalis* from a gravid trap was also tested for WNV. MMCD tested 637 mosquito pools using Response Biomedical Corporation's RAMP® method. We also submitted 287 mosquito pools to MDH for WNV analysis by PCR. These samples consisted of *Cx. tarsalis*, *Cs. melanura,* and *Ae. japonicus*. Five mosquito samples were positive for WNV, all by the RAMP® method. Table 2.3 is a complete list of mosquitoes MMCD processed for viral analysis.

Table 2.3 Number of MMCD mosquito pools processed for viral analysis and minimum infection rate (MIR) by species, 2011

Species	Number of mosquitoes	Number of pools	WNV+ pools	MIR per 1000
Aedes japonicus	173	129	0	0
Aedes triseriatus	68	7	0	0
Culex pipiens	228	6	0	0
Culex restuans	881	36	0	0
Culex salinarius	11	2	0	0
Culex tarsalis	3,228	277	0	0
Culex species	3,378	162	1	0.30
Culex pipiens/restuans	4,273	211	4	0.94
Culiseta melanura	1,153	94	0	0
Total	13,393	924	5	0.37

MMCD conducted surveillance for WNV in wild birds with help from the public. Citizens reported dead birds to MMCD and some of those birds were selected for WNV analysis. Thirty-seven reports of dead birds were received by telephone, internet, or from employees in the field. RAMP® tests were done on ten birds. Four birds, all American crows, were positive for WNV. The dates and locations of collection for the positive birds were June 24 (Minneapolis), August 20 (Minneapolis), August 22 (Linwood), and September 7 (St. Paul).

Following the first pool of mosquitoes to return a WNV positive result, a mixed pool of 28 *Culex pipiens/restuans*, three weeks passed prior to the next positive result. Pools of 10 and 50 mixed *Cx. pipiens/restuans* collected on September 7 and September 8 were positive for WNV. The remaining two WNV positive mosquito pools were a sample of 25 mixed *Cx. pipiens/restuans* collected on September 20 and a sample of 19 mixed *Culex* species collected on September 28. All five of the WNV positive pools were collected in Ramsey County. Given the low level of WNV circulation early in the season, the late season peak rates of infection in mosquitoes were understandably low (Figure 2.1).

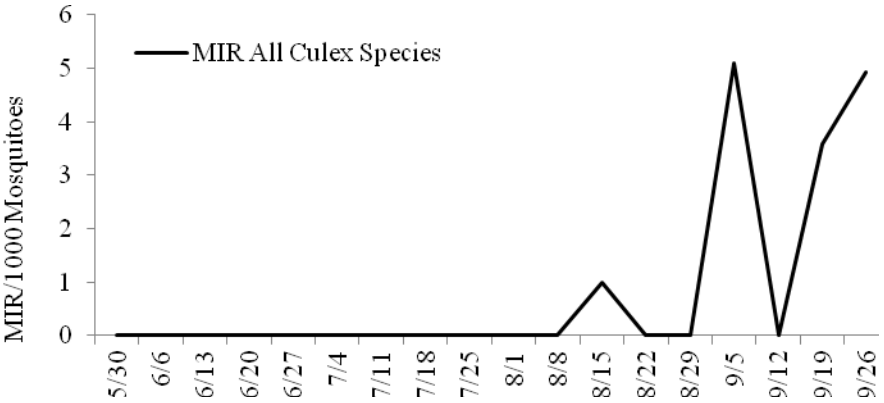


Figure 2.1 Weekly minimum WNV infection rates (MIR) for *Culex* samples, 2011. Dates listed are the Monday of each sampling week.

Larval *Culex* Surveillance and Control

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. In 2011, crews concentrated on surveying and applying larvicides to confirmed *Culex* habitats.

Staff made 15,021 inspections of 8,386 structures in 2011. Mosquito larvae were found in 2,168 of the 8,941 habitats that were wet on the date of inspection. Inspectors collected 1,567 larval samples from stormwater structures and other man-made habitats. West Nile virus vector *Culex* species were found in 76.6% of the samples (Table 2.4). *Culex restuans*, *Cx. salinarius*, and *Cx. tarsalis* were found at rates similar to 2010 observations, but *Cx. pipiens* were found less than half as frequently as in 2010.

Table 2.4 Frequency of *Culex* vector species collected from stormwater management structures and other man made habitats, 2010 and 2011

	Percent occurrence by year	
Species	2010 (N=2,020)	2011 (N=1,567)
Cx. pipiens	31.8	13.7
Cx. restuans	64.2	65.3
Cx. salinarius	0.0	0.1
Cx. tarsalis	4.5	3.8
Any *Culex* vector species	77.4	76.6

Larval Surveillance in Catch Basins Frequent rainfall in 2011 inhibited mosquito development in catch basins. Even though mosquitoes may often be found in catch basins during wet periods, many larvae are swept away by flushing rainfall before emerging as adults. Larval surveillance was conducted in catch basins from the first week in June through the second week in September, although no inspections occurred during the week of September 5 (Figure 2.3). Larvae were found during 493 of 904 catch basin inspections (54.5%) in 2011.

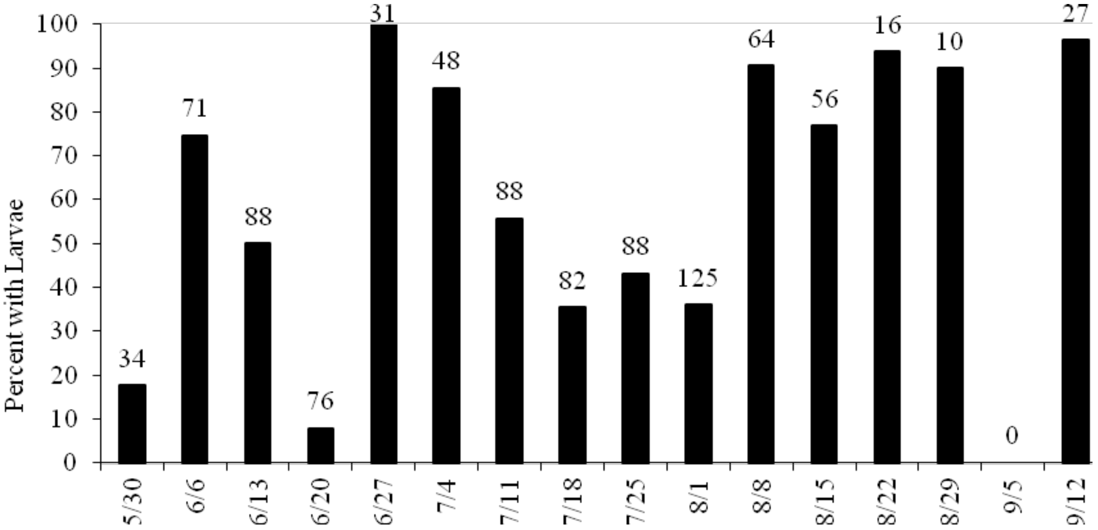


Figure 2.3 Ratios of catch basins inspected with mosquitoes present, 2011. Bars are labeled with the number of inspections occurring during the week.

Mosquito larvae were identified from 493 catch basin samples (Figure 2.4). *Culex pipiens* were found in 25.4% of catch basin larval samples. *Culex restuans* were found in 67.1% of samples. At least one *Culex* vector species was found in 97.8% of samples. As is common in our area, *Cx. restuans* were prominent throughout the summer and *Cx. pipiens* occurred in greater frequencies during the latter portion of the summer. Frequently, larval samples from catch basins contain first instar *Culex* species which are identified only to genus level in our lab. In 2011, 56.4% of samples included first instar *Culex* larvae. If a catch basin flushing rainfall event occurs in the days prior to sample collection the likelihood of collecting later larval instars decreases and most of the larvae encountered will be in the early stages of development. This was evident during the week of August 15 when few older larvae were collected; however, 39 of 43 samples contained first instar *Culex* larvae.

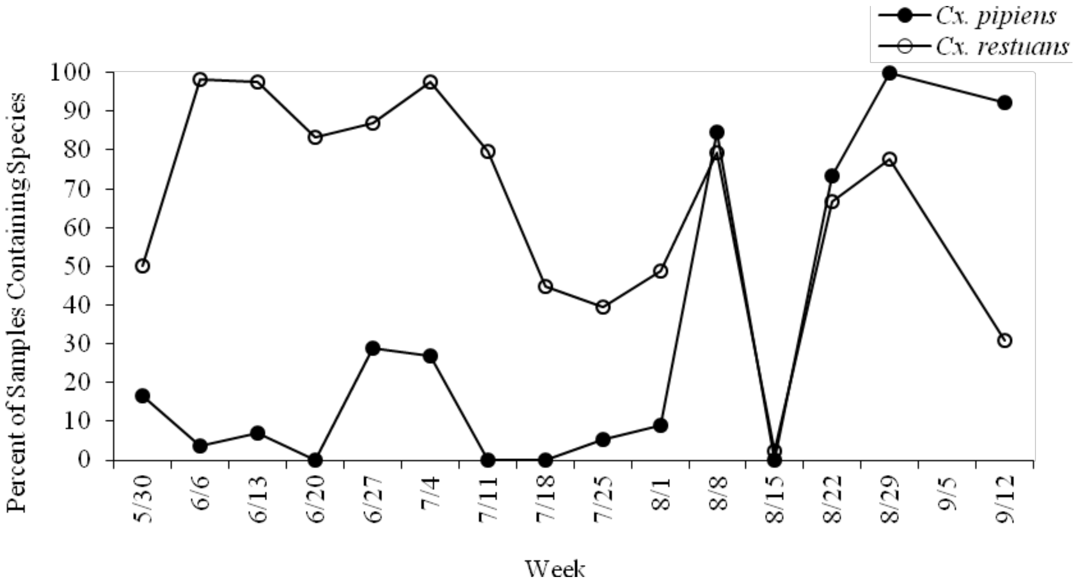


Figure 2.4 Percent occurrence of *Cx. pipiens* and *Cx. restuans* in catch basin larval samples by week, 2011.

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 2011, we continued the cooperative mosquito control plan for underground habitats. Eighteen 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 gal of water retained. Briquets were placed in 628 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; 628 structures were treated and a total of 738 briquets were applied, 2011

City	Structures treated	Briquets used	City	Structures treated	Briquets used
Arden Hills	6	6	Lino Lakes	10	10
Blaine	6	21	Maplewood	140	140
Bloomington	59	92	Mendota Heights	28	38
Brooklyn Park	4	15	New Brighton	5	8
Columbia Heights	7	10	New Hope	6	12
Crystal	5	14	Prior Lake	306	306
Eden Prairie	12	20	Roseville	11	14
Hastings	2	2	Savage	6	15
Lauderdale	13	13	Spring Lake Park	2	2

Plans for 2012 – Mosquito-borne Disease

With documented EEE activity in northern Wisconsin for the second time in 11 years and high *Cs. melanura* populations in the District over the past two seasons, it is necessary for MMCD to re-evaluate EEE risk. It is possible that the EEE observations in Wisconsin in 2011 and in Wisconsin, Minnesota, and Iowa in 2001 are signs that a new pattern of EEE risk is emerging in our part of the country. It is, therefore, important for MMCD to review options for EEE risk reduction through mosquito surveillance and control.

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.

2011 Tick-borne Disease Services

Ixodes scapularis Distribution

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 from them. Collections from the northeastern metropolitan area (primarily Anoka and Washington counties) have consistently detected *I. scapularis*. In 1998, *I. scapularis* was detected in Hennepin and Scott counties for the first time. 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 any wooded area in Dakota County. Results from this year's sampling are in progress and the 2011 report will be available on the District website (www.mmcd.org) in June. Following are some preliminary highlights.

Figure 2.5 shows the yearly total number of sites with *I. scapularis* (positive sites) from 1990-2011; also shown is the percentage of sites with *I. scapularis* north versus south of the Mississippi River. The overall positive site total for 2011 was 55, down from the all-time high of 70 in 2010, but comparable to the yearly positive site totals since 2000. For the first time since 2007, we did not collect at least one *I. scapularis* from all of the counties in the District – no *I. scapularis* were collected from Carver County. However, we again tabulated a new record positive site total from counties south of the Mississippi River. The total of 26 surpasses the previous record high of 24 in 2010. As has been typical in recent years, the majority of the Dakota County sites (11 of 15) were positive in 2011. The majority of the Scott County sites (6 of 8) were also positive again in 2011, and for the first time, the majority of Hennepin County sites (9 of 14) were positive as well, two of which were positive for the first time (both Hennepin County parks). The shift in recent years to increasing numbers of positive sites south of the river is evident (Figure 2.6).

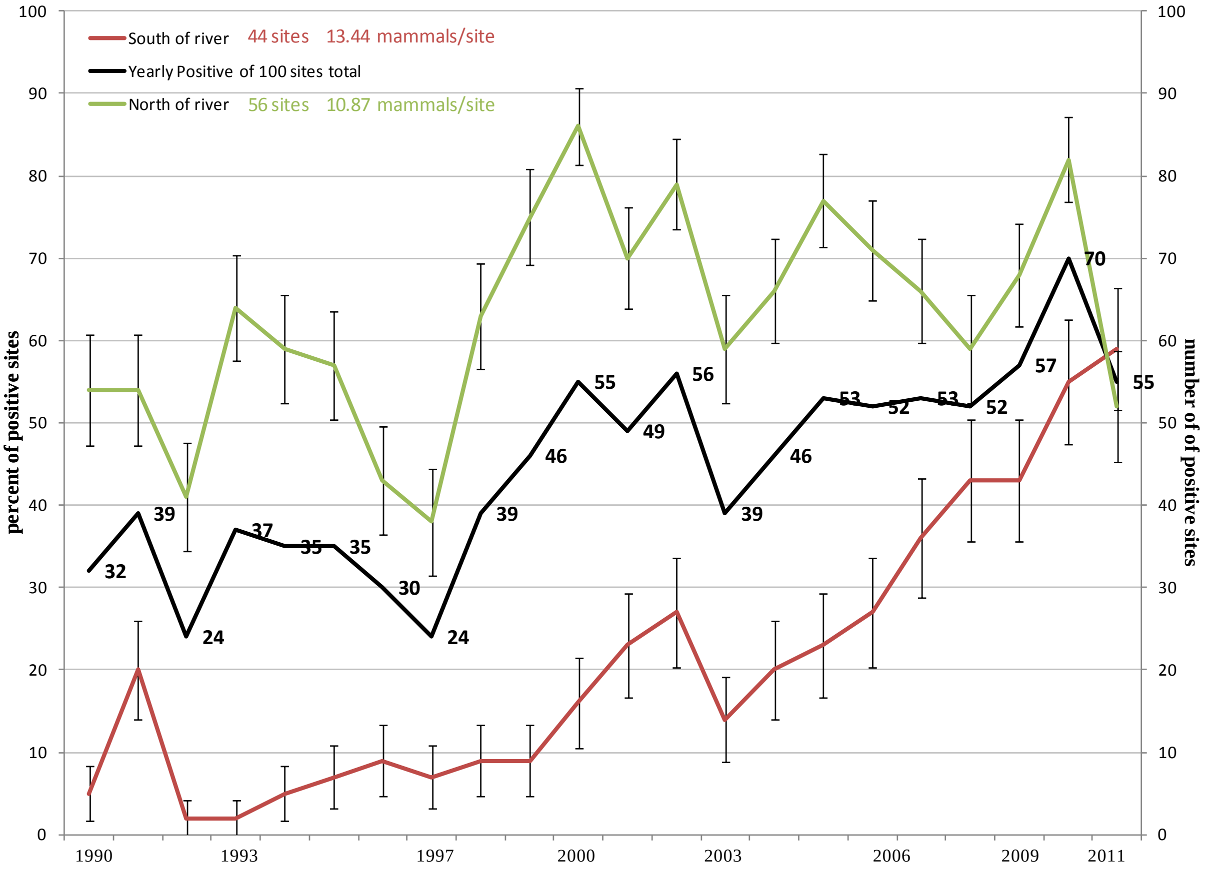
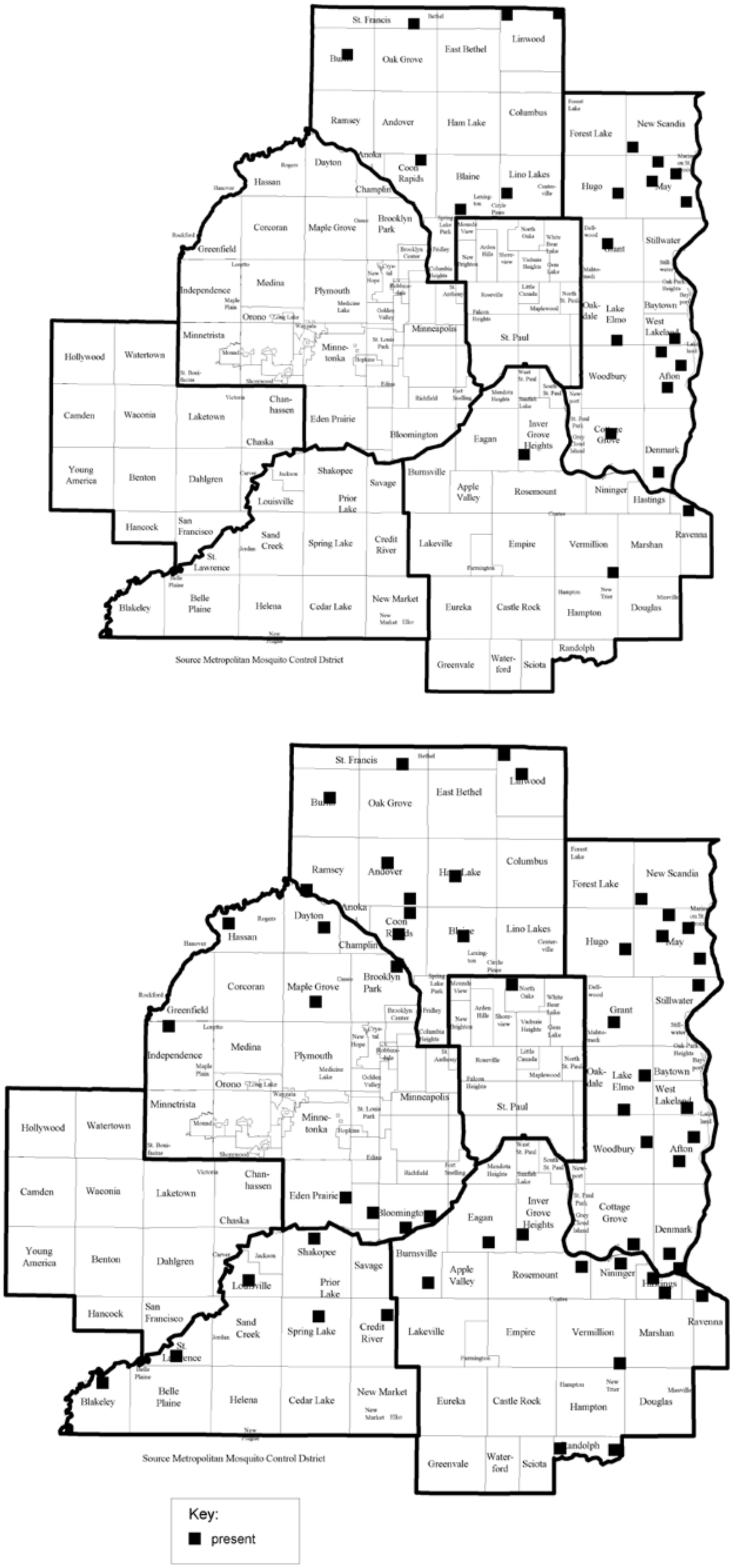


Figure 2.5 Yearly total sites positive (black line) and percentage of sites positive, north versus south of the Mississippi River: 1990-2011 and total sites positive. Error bars equal ±1 SE of a proportion.


1997

2011

Source Metropolitan Mosquito Control Dstrict

Figure 2.6 Geographic distribution of *Ixodes scapularis*, 1997 and 2011

Although the average number of *I. scapularis* per mammal (0.616) in 2011 is lower than averages in recent years (2000 – 2002, 2004, 2005, 2007, 2009 and 2010 were all ≥ 0.806), it is similar to averages in 2006 and 2008 (0.637 and 0.644, respectively) and remains higher than the averages from 1990-1999 (range 0.089 - 0.406). Similar to 2003, the 2011 average was negatively influenced by the low number of *I. scapularis* larvae collected; there was a four-fold drop in larvae collected between 2010 and 2011 and, in raw numbers, we collected the fewest number of larvae since 1997. The average was positively influenced, however, by the very high numbers of *I. scapularis* nymphs collected (205) which represents the second-highest nymph total since inception of the study. Additionally, larval and nymphal *I. scapularis* collection totals have never before been so comparable that they are roughly equal. Due to high nymph collections, *I. scapularis* still comprised 50% of the total tick collections, which is only the sixth time this has occurred, all since 2002 (Table 2.6).

Table 2.6 Yearly totals of mammals and ticks collected and the frequency of occurrence of tick species by life stage. The number of sites sampled was 250 in 1990, 270 in 1991, 200 in 1992, and 100 from 1993 on.

		Total	*Dermacentor variabilis*				*Ixodes scapularis*				Other	
	No.	ticks	larvae		nymphs		larvae		nymphs		species[b]	
Year	mammals	collected	%	(n)	%	(n)	%	(n)	%	n	%	(n)
1990 [a]	3651	9957	83	(8289)	10	(994)	6	(573)	1	(74)	0	(27)
1991	5566	8452	81	(6807)	13	(1094)	5	(441)	1	(73)	0	(37)
1992	2544	4130	79	(3259)	17	(703)	3	(114)	1	(34)	0	(20)
1993	1543	1785	64	(1136)	12	(221)	22	(388)	1	(21)	1	(19)
1994	1672	1514	53	(797)	11	(163)	31	(476)	4	(67)	1	(11)
1995	1406	1196	54	(650)	19	(232)	22	(258)	4	(48)	1	(8)
1996	791	724	64	(466)	20	(146)	11	(82)	3	(20)	1	(10)
1997	728	693	73	(506)	10	(66)	14	(96)	3	(22)	0	(3)
1998	1246	1389	56	(779)	7	(100)	32	(439)	5	(67)	0	(4)
1999	1627	1594	51	(820)	8	(128)	36	(570)	4	(64)	1	(12)
2000	1173	2207	47	(1030)	10	(228)	31	(688)	12	(257)	0	(4)
2001	897	1957	54	(1054)	8	(159)	36	(697)	2	(44)	0	(3)
2002	1236	2185	36	(797)	13	(280)	42	(922)	8	(177)	0	(9)
2003	1226	1293	52	(676)	11	(139)	26	(337)	11	(140)	0	(1)
2004	1152	1773	37	(653)	8	(136)	51	(901)	4	(75)	0	(8)
2005	965	1974	36	(708)	6	(120)	53	(1054)	4	(85)	0	(7)
2006	1241	1353	30	(411)	10	(140)	54	(733)	4	(58)	1	(11)
2007	849	1700	47	(807)	8	(136)	33	(566)	10	(178)	1	(13)
2008	702	1005	48	(485)	6	(61)	34	(340)	11	(112)	1	(7)
2009	941	1897	48	(916)	9	(170)	39	(747)	3	(61)	0	(3)
2010	1320	1553	21	(330)	7	(101)	65	(1009)	7	(107)	0	(6)
2011	756	938	40	(373)	10	(97)	28	(261)	22	(205)	0	(2)

[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

Lyme Disease and Human Granulocytic Anaplasmosis

The 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. Human granulocytic anaplasmosis (HGA) cases have also been on the rise. After averaging about 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. Statewide, the all-time high Lyme disease and HGA case records were set in 2010 (Lyme 1,293; HGA 720), surpassing the previous Lyme and HGA records from 2007 (1,239 and 322, respectively). Case data for 2011 is not yet available (as of March 27, 2012).

Additional Updates

First Minnesota Tick-borne Disease Death - Powassan Virus On June 29, 2011 MDH reported the first death from Powassan virus (POW) ever recorded in Minnesota, from a northern Minnesota resident thought to have been exposed near her home. POW is *I. scapularis*-transmitted, in as few as five minutes, although scientists are unsure of exactly when transmission occurs. The virus is similar to West Nile virus in that there is a variability in human susceptibility and not everyone will become sick if bitten by an infected tick. The overall case fatality rate in the US is 10% with some survivors suffering long-term neurological effects. Signs and symptoms typically begin to occur 1-5 weeks after an infected *I. scapularis* bite.

POW, which has been recognized since 1958, is most prevalent in the eastern US (approximately five cases per year), and, like EEE, was detected in Wisconsin for a long time prior to having been recorded from Minnesota. The first Minnesota-exposed POW case occurred in 2008. Since then, through June 2011 MDH has recorded eight POW cases with Minnesota exposure. So far all cases, except for an undetermined Anoka County resident case from 2011, have been determined to have been exposed in northern Minnesota counties but POW-positive ticks have been collected in northern and southern Minnesota and as close to the metro area as Pine County. POW will likely remain a rare disease but POW cases, as with tick-borne disease cases in general, are on the rise.

New Tick-borne Disease—*Ehrlichia muris*-like This disease, reported in the August 4, 2011 edition of the New England Journal of Medicine, is caused by an as yet unnamed bacterium. The bacterium had been found in Minnesota deer ticks several years ago but its impact to human health had remained unknown. As the same antibiotic (typically doxycycline) is used to treat this disease as well as Lyme disease, HGA, and human monocytic ehrlichioisis human cases prior to now had been likely tabulated as the more traditionally endemic tick-borne diseases of Minnesota. So far these bacteria have only been found in Minnesota and Wisconsin so they are unique to our area. This bacterium apparently causes less severe symptoms than does the more common human granulocytic anaplasmosis. So far 25 cases have been reported from both Minnesota and Wisconsin.

***Amblyomma americanum* (Lone Star Tick) Found Again in the Metro (by MDH)**
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 and this species was first collected by MMCD in 1991 via a road kill examination of a white-tailed deer (*Odocoileus virginianus*). For the first time in a number of years, *Amblyomma* was submitted to MDH and MMCD by the public in 2009 (Minneapolis and Circle Pines). This trend continued in 2010, with *Amblyomma* submitted to MMCD from Eagan, Mound, and the Orono/Lake Minnetonka areas of the metro. All 2009 and 2010 records were of single ticks. MMCD did not receive any *Amblyomma* in 2011. The MDH, however, had adult ticks submitted from Shakopee on April 28 and from Lindstrom on June 7. There was also a report from Hennepin County on June 22 (unconfirmed, tick not submitted). In the first instance, the resident from Shakopee had been home for three weeks prior to the collection after spending three months in the southern US. Possible collection locations for the Hennepin County *Amblyomma* were Golden Valley, Richfield, Bloomington, or Minneapolis.

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 to collect more unusual tick data (species and atypical locations for ticks). As in 2010, we posted signs in the spring at approximately 21 parks and an additional four signs were in active dog walking areas, including at Stubbs Bay Park, Luce Line Trail Entrance. Staff retrieved signs at all parks in fall 2011. We have also worked on expanding our sign placements into additional metro locations.

Outreach / New Strategies

The overall scope of tick-borne disease education activities and services were maintained in 2011 using previously described methods and tools, although we did expand our outreach efforts by creating fact sheets, graphics, and implementing new strategies for tick-borne disease risk reduction.

- Fact sheets
    - tick testing basics versus tick identifications (on website)
    - two fact sheets (*Ehrlichia muris*-like and Powassan basics) for use at our booth at the MN State Fair
    - dog specific sheet (on website)
- Graphics
    - deer tick life cycle, Minnesota-based (on website)
    - result maps, available and posted on our website sooner than in previous years
- Strategies for tick-borne disease risk reduction
    - actively contacted metro park personnel to offer assistance in tick-borne disease awareness and training
    - tick-borne disease given a higher presence at our fair booths
    - increased the number of notifications of *I. scapularis* activity and results, both to the media and on our website
    - expanded signage across the metro and sent out permission requests for the posting of signs in additional areas
    - made contacts with several dog rescue groups
        - Result: The Great Pyrenees Club of America (national) and Northstar Great Pyrenees Rescue of Minnesota requested canine specific tick-borne disease

information from MMCD. Each club distributed the information to their members in late September.

Evaluating *I. scapularis* Activity for Possible Media Alert On November 10, 2011, the North, Plymouth, Rosemount, and Jordan facilities performed drags (i.e., a 1 m^2 white canvas cloth is dragged along the ground and any attached ticks are removed) to evaluate the need for a media alert in response to an ongoing perception of higher *I. scapularis* questing levels in fall, 2011 compared to past years. Zero ticks were found on November 10, possibly due to very cold temperatures (39°F for a high) compared to the warmer than average temperatures that had been occurring throughout the fall; however, Jordan facility staff had found an adult *I. scapularis* female just the day previous, November 9 (high 50°F), while performing non-tick related field work. We decided not to alert the media at the time as our results seemed to indicate lower than expected metro tick activity, and to try to ensure we had made a good decision we continued to communicate tick questing observations amongst staff until tick activity appeared to fade for the year.

2012 Plans for Tick-borne Services

Metro Surveillance

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

Tick Identification Services/Outreach

We plan to maintain our tick-borne disease education activities and services (including tick identifications and homeowner consultations) using previously described methods and tools. Since our *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.

Outreach Expansion

Posting Signs We will continue to post at dog parks and plan to continue our expansion 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.

Develop Process for Public Notifications of Tick Activity Periods We are currently refining our process and developing new ideas to inform the public of high tick activity periods in real time. We also want to maximize the impact of tick messaging on MMCD's new social media (Facebook, Twitter) accounts.

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 for this tick in our surveillance and to track collections submitted to us by the public. Both MMCD and MDH plan to maintain our current notification process to the other agency upon identifying an *A. americanum* or other new or unusual tick species.

Chapter 3 Mosquito Control

2011 Highlights

- 50,846 fewer acres worth of larvicides were applied to wetlands in 2011 than in 2010
- Aerial cattail mosquito treatments consumed significantly more larvicides in 2011 (23,291 acres) than in 2010 (15,677 acres)
- A cumulative total of 235,111 catch basin treatments were made in three rounds to control vectors of WNV
- 4,251 fewer acres worth of adulticides were applied in 2011 than in 2010

2012 Plans

- Continue to test larvicides and strategies to reduce the amount of time and personnel required for effective season-long control of mosquitoes in many kinds of habitats
- Begin to incorporate Natular™ G30™ and MetaLarv™ S-PT into our spring *Aedes* and *Aedes vexans* prehatch treatment programs
- Work closely with MnPCA to obtain and fulfill the requirements of a NPDES permit
- Continue to increase vector surveillance and control in response to the observed geographic expansion of *Ae. japonicus* within the District

Background

The mosquito control program targets the principal summer pest mosquito *Ae. vexans*, several species of spring *Aedes*, the cattail mosquito *Cq. perturbans*, and several disease vectors including: *Ae. triseriatus*, *Cx. tarsalis*, *Cx. pipiens*, *Cx. restuans*, and *Cx. salinarius*. *Aedes japonicus* arrived on the scene in 2007 and has also increased control needs.

Due to the large size of the metropolitan region (~ 2,600 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 (out of ~70,000 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 acres of wetlands. Small sites are three acres or less and field crews treat them by hand (ground sites). Large sites are treated by helicopter (air sites) only after certain 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).

An insect growth regulator (Altosid® or methoprene) and a soil bacterium (*Bacillus thuringiensis israelensis* or *Bti*) are the primary larval control materials; other materials (e.g., *B. sphaericus*, spinosad) are being evaluated as well. Staff applies materials to sites immediately after it rains or to dry ground using pre-hatch materials (e.g., methoprene products). Adult control augments the larval control program when necessary.

The District uses priority zones to focus service in areas where it will benefit the highest number of citizens (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 resources allow.

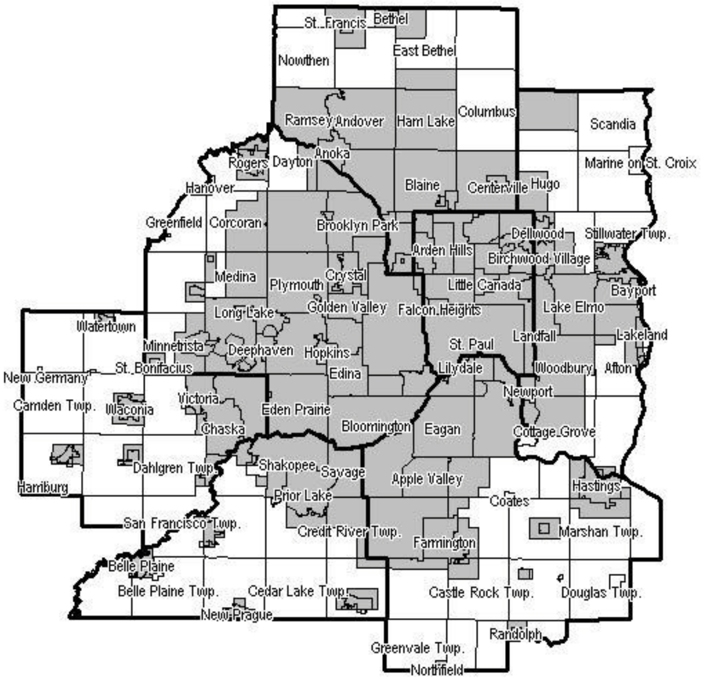


Figure 3.1 Priority Zones 1 (shaded) and 2 (white), with District county and city/township boundaries, 2011.

To supplement the larval control program, adulticide applications are performed after sampling detects mosquito populations meeting threshold levels (especially disease vectors), primarily in high use park and recreation areas, for public events, or in response to citizen mosquito annoyance reports.

Three synthetic pyrethroids are used: resmethrin, permethrin, and sumithrin. Sumithrin and two formulations of natural pyrethrins, Pyrenone® and Pyrocide®, are 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 (2003-2011). Pesticide labels are located in Appendix F.

2011 Mosquito Control

Larval Mosquito Control

Thresholds Treatments are only done where larvae are present, as measured by taking 10 dips with a standard 4-inch diameter dipper, or, for prehatch, where there is a history of larvae present. For helicopter 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. Spring *Aedes*, which tend to be long-lived, aggressive biters, have lower thresholds. In 2011, we increased the spring *Aedes* larval thresholds (from 0.1 to 0.5/dip in P1 and 0.5 to 1/dip in P2) to conserve resources. After mid-May, when most larvae found are floodwater summer species, thresholds are increased to 2/dip in P1 and 5/dip in P2. The threshold for "*Culex*4" (*Cx. restuans*, *Cx. pipiens*, *Cx. salinarius*, *Cx. tarsalis*) was increased from 1/dip to 2/dip in all priority zones at any time of the season. If *Aedes* and *Culex* are both present in a site and neither meet threshold, the site can be treated if the combined count meets the 2/dip (P1) or 5/dip (P2) threshold.

Season Overview The 2011 season was notable for its long, cold spring followed by frequent above average precipitation through early August (Chapter 1, Figure 1.1). Large parts of the District received 4-5 inches of rain on July 16 followed by five days of the highest heat indices on record. Precipitation decreased significantly by mid-August. September was one of the driest on record.

Spring *Aedes* larvae began hatching in the early snowmelt in mid-March, and the first larvicide treatments were started in late March, three weeks later than in 2010. Rain in May through mid-August triggered hatch of seven large and three small-medium broods of *Ae. vexans*, and led to multiple large-scale aerial *Bti* or Altosid® pellet treatments (Figure 3.2). A typical season has four large broods.

Total larval control material use in 2011 was high but significantly lower than 2010 (Table 3.1, Figure 3.3). In addition to the rainfall pattern, several operational factors contributed to the service levels provided by the District in 2011:

- The 2011 control materials budget was reduced from 2010 levels as part of an overall operating budget reduction.
- We increased the larval treatment thresholds for spring *Aedes* and *Culex* in P1 and P2. We treated 55,060 acres with *Bti* for spring *Aedes*—a savings of 14,276 acres if we had treated all sites that met the former threshold (69,336 acres). The increase in *Culex* threshold resulted in minimal savings due to overlap with floodwater threshold.
- We reduced the amount of Altosid® pellets planned for *Ae. vexans* prehatch by 4,000 acres from 2010 levels (14,410 acres applied in 2010) to about 10,000 acres, and treated with *Bti* instead as needed based on actual rains and hatch. The acreage of sites with significant cattail mosquito production was much higher (~68%) in 2011 than in 2010 which prompted us to shift an additional 5,900 acres worth of Altosid® pellets away from *Ae. vexans* prehatch into cattail treatments (both air and ground) which resulted in about 4,510 acres worth of Altosid® pellets for aerial *Ae. vexans* prehatch treatments.

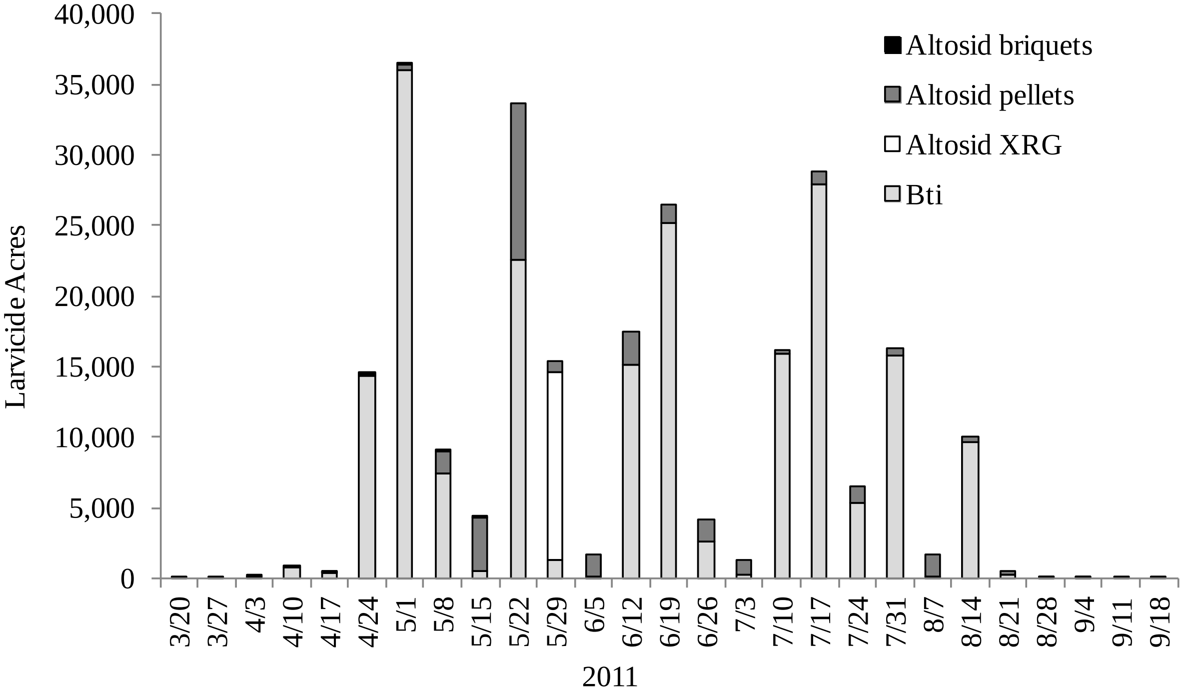


Figure 3.2 Acres of larvicide and adulticide treatments each week (March-September 2011). Date represents start date of week.

Table 3.1 Comparison of larval control material usage in wetlands (including stormwater structures other than catch basins) and in stormwater catch basins for 2010 and 2011 (research tests not included)

	2010		2011	
Material	Amount used	Area treated	Amount used	Area treated
Wetlands				
Altosid® briquets	268.53 cases	174 acres	286.64 cases	205 acres
Altosid® pellets	122,015.15 lb	36,516 acres	99,947.02 lb	30,749 acres
Altosid® XR-G	99,240.00 lb	9,924 acres	133,360.00 lb	13,336 acres
VectoBac® G	2,003,869.60 lb	250,478 acres	1,615,714.75 lb	201,957 acres
Larvicide subtotals		297,092 acres		246,246 acres
Catch basins				
Altosid® pellets	1,842.39 lb	227,611 CB[1]	1,841.33 lb	234,033 CB
Natular™ XRT	0.00 cases	0 CB	4.90 cases	1,078 CB
CB subtotals		227,611 CB		235,111 CB

[1] CB=catch basin treatments

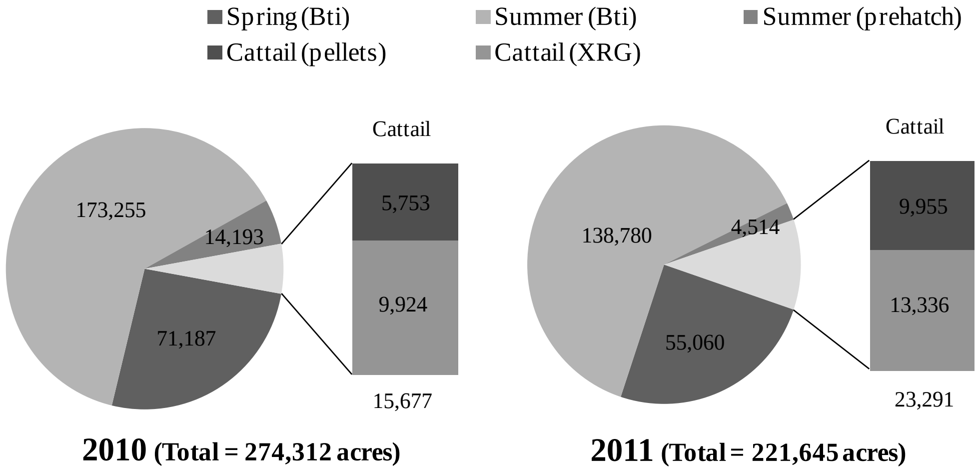


Figure 3.3 Total acres of aerial larvicide treatments (area treated may be smaller because many sites are treated more than once) in 2010 and 2011.

By late July, the budget for helicopters and materials was almost 90% expended and the decision was made to ask the Commission for access to reserve funds (previously requested in 2002 and 2010). The cessation of rainfall after mid-August prevented additional large *Ae. vexans* broods; consequently, we did not use any reserve funds.

A primary limiting factor for treatments continues to be budgetary. The District is actively looking at ways to reduce cost while maintaining treatment capacity, for example, by testing new materials or formulations. We continued to study how to reduce the amount of time and personnel required for effective season-long control of mosquitoes in many kinds of sites. In 2011, we focused on testing larvicides designed to control multiple broods of vector and annoyance mosquitoes when applied to dry sites or early in the season (see Chapter 5).

In 2011, we continued expanding large-scale treatments of Altosid® XR-G sand to control *Cq. perturbans*. Over 7,614 additional cattail acres were treated aerially in 2011 than in 2010 (Altosid® XR-G sand treatments increased by 3,412 acres) (Table 3.1, Figure 3.3). The per acre material cost of XR-G sand is lower than Altosid® pellets, meaning that funds formerly used for pellets can purchase enough material to treat about 25% more acres with XR-G sand (Figure 3.3). Additionally, we treated 444 acres of cattail sites with VectoLex® (*B. sphaericus*) in September to evaluate the minimum dosage required to consistently control the cattail mosquito. Emergence cages will be placed in these sites in June – August 2012. The goal is to provide more time for aerial cattail treatments by adding a late summer window to our current spring treatment program.

The control pattern of 2011 also provides interesting data related to the effectiveness of the larvicide program. Despite increasing the spring *Aedes* larval threshold, we did not observe a significant increase in adult spring *Aedes* (Figure 1.5, Table 1.3). We did observe more consistent levels of adult *Ae. vexans* in CO_2 trap counts peaking above threshold beginning in mid-June and more consistently from mid-July through August (Figures 1.13, 3.4). Customer calls in 2011 (4,232) were higher than in 2010 (3,092).

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 3.1).

Surveillance detected *Ae. japonicus* in 334 sections within all District counties in 2011; *Ae. japonicus* was found in 271 sections in 2010 and 86 sections in 2009 (Figure 1.23). 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 artificial container larval habitat, plus treatment of other habitat as needed.

We continued to work with Minnesota Pollution Control Agency (MnPCA) to satisfy the requirements of our NPDES permit. We verified that our control programs meet the needs of integrated control as defined by the NPDES permit and that our data records satisfy MnPCA needs. We completed our Pesticide Discharge Management Plan (PDMP) by the October 31, 2011 deadline. Treatments made through April 2012 will be covered by our permit. We will be ready to submit our Notice of Intent (NOI) and pay permit fees ($1,240 plus $345 per year) as soon as MnPCA's web-based submission system is ready (planned April 2012).

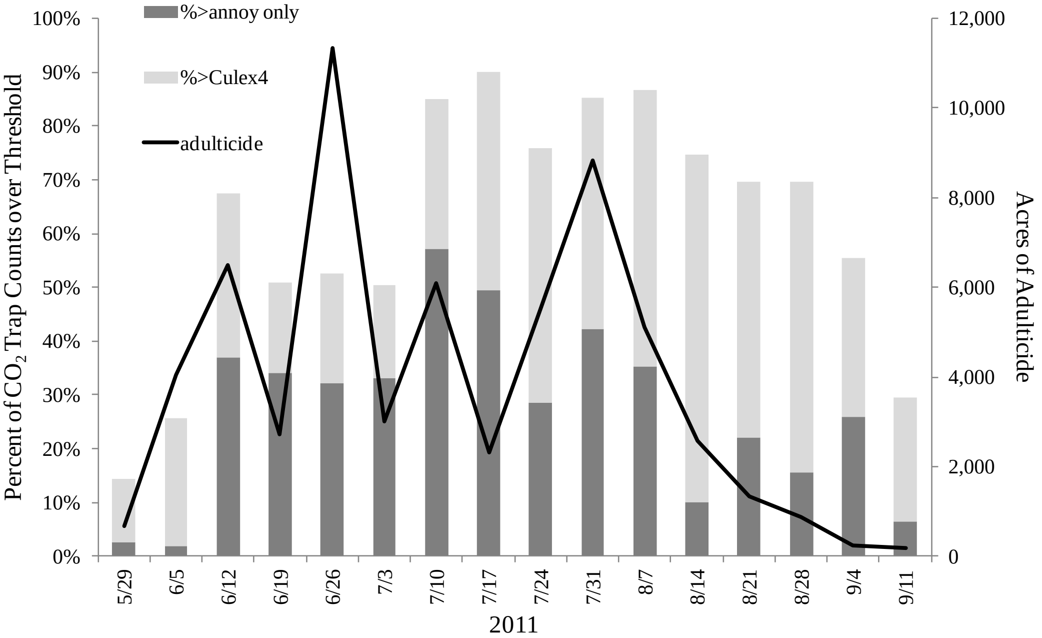


Figure 3.4 Percent of Monday CO_2 trap locations with counts over threshold (date is start of week), showing subtotals by annoyance or *Culex* vector thresholds, with acres of adulticides applied, 2011.

Adult Mosquito Control

Thresholds Adult mosquito control operations are considered when mosquito levels meet or rise above established thresholds of 2 mosquitoes in a 2-minute sweep or 2-minute slap count or 130 mosquitoes in an overnight CO_2 trap. In 2004, we established treatment thresholds specific to the *Culex*4 species: *Cx. restuans*, *Cx. pipiens*, *Cx. salinarius*, and *Cx. tarsalis*. The thresholds are 1 of any of these *Culex* species in a 2-minute sweep, 5 in an overnight CO_2 trap, 5 in a 2-day gravid trap, and 1 *Cx. tarsalis* in a vacuum aspirator sample. Adulticide treatments were also considered when 2 or more *Ae. triseriatus* were captured in a vacuum aspirator sample. One *Ae. japonicus* captured using any adult surveillance method was the threshold established in 2009. We may modify this threshold as we learn more about the impacts of *Ae. japonicus*' expansion in the District.

Season Overview In 2011, adult mosquito levels rose in mid-June before peaking in late June and again between mid-July and mid-August (Figure 1.13); at those times counts over threshold were fairly widespread (Figure 3.4 and map Figure 1.9). MMCD applied 4,251 fewer acres-worth of adulticides than in 2010 (Table 3.2) (Appendix E). Figure 3.4 shows weekly adulticide acres treated (line). The peaks in late June and late July reflect a response to both widespread *Ae. vexans* and *Cq. perturbans* emergence and elevated numbers of *Culex* vectors. The number of traps over the vector threshold remained high for much of the summer (compare with Figures 1.21-1.25). In response to budget limitations, we worked to minimize overtime. However, evening adulticiding is difficult to schedule effectively without using overtime, and this plus low levels of virus activity was related to a reduction in late-season work.

In 2011, staff continued to improve linkages of adulticide treatments with surveillance that includes identified mosquito samples (compared to landing rates only). In 2011, 96% of ULV treatments were associated with identified samples, up from 89% in 2010, 65% in 2009, and 33% in 2008. In 2011, 89% of permethrin (barrier) treatments were linked to identified samples, up from 85% in 2010, 69% in 2009, and 38% in 2008.

In 2011, 23% of ULV treatments were in direct response to above-threshold vector detections; the remaining 77% were in response to annoyance thresholds. Similarly, 31% of barrier treatments were in direct response to above-threshold vector detections; the remaining 69% were in response to annoyance thresholds.

Table 3.2 Comparison of adult control material usage in 2010 and 2011.

	2010		2011	
Material	Gallons used	Acres treated	Gallons used	Acres treated
Permethrin	1,723.66	8,826	1,467.89	7,544
Resmethrin	330.78	27,794	301.69	24,605
Sumithrin*	498.01	26,429	643.86	29,208
Pyrocide*	0.00	0	0.00	0
Pyrenone*	30.00	2,560	0.00	0
Total		65,608		61,357

* Products labeled for use in agricultural areas

2012 Plans for Mosquito Control Services

Integrated Mosquito Management Program

In 2012, 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.

Larval Control

Priority Zone Boundary Evaluation Priority Zone 1 boundaries will be reevaluated based on the 2010 census population information.

Cattail Mosquitoes In 2012, control of *Cq. perturbans* will use a strategy similar to that employed in 2011. MMCD will focus control activities on the most productive cattail marshes near human population centers. Altosid® briquet applications will begin in February-March 2012 to frozen sites (e.g., floating bogs, deep-water cattail sites, remotely located sites). Beginning in late May, staff will treat with Altosid® XR-G sand at 10 lb/acre applied by helicopter. Ground sites will be treated with Altosid® pellets at a rate of 4 lb/acre. More acres will be treated with Altosid® XR-G sand and fewer with Altosid® pellets to decrease per-acre treatment costs. Staff will continue evaluating the success of late summer VectoLex® applications.

Floodwater Mosquitoes The primary control material will again be *Bti* corn cob granules. Budgeted larvicide needs in 2012—mainly *Bti* - VectoBac® G, Altosid® pellets, Altosid® XRG sand, Natular™ G30, and MetaLarv™ S-PT (tested in 2010 and 2011 as VBC-60215)—are expected to be similar to the five-year average larvicide usage (211,953 acres). 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), Natular™ G30, or *Bti* corncob granules. During a wide-scale mosquito brood, breeding 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 new larval treatment thresholds established in 2011.

Staff annually review ground site histories to identify those sites that produce mosquitoes most often which helps us to better prioritize which sites to inspect before treatment, which sites to pre-treat with Altosid® products before flooding and egg hatch, and which sites to not 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 breeding sites that impact the most citizens (based upon 2010 census data).

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 have tentatively planned to complete a first round of pellet treatments by June 25 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 as we determine which larvicides effectively control vector larvae in these structures (see Chapter 5).

Intensive surveillance for *Ae. japonicus* will continue in 2012 to determine abundance and common larval habitats and refine larval and adult 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 2012 are similar to 2011 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* spread. We plan to continue testing additional ULV adulticides (see Chapter 5) to prepare for the disappearance of Scourge® (resmethrin); Bayer, the manufacturer, has withdrawn its re-registration. We are making sure that all employees that may apply adulticides have passed applicator certification testing, in preparation for a shift in label status of permethrin to Restricted Use (certified applicators only).

Our primary barrier treatment adulticide (Permethrin 57-OS Concentrate) is undergoing re-registration with the Environmental Protection Agency (EPA) and this last phase of review may be completed by mid-2012. This product, along with many other pyrethroid products undergoing re-registration, will become a restricted use pesticide. MMCD has established new procedures to have all our applicators properly trained and licensed to use this product in 2012.

Chapter 4 Black Fly Control

2011 Highlights

- Larval mortality following *Bti* treatment on the large rivers averaged 98%
- Completed non-target monitoring report for samples collected on the Mississippi River in 2009
- Monitored adult populations weekly using overhead net sweeps and CO_2 traps
- Higher than normal flow on rivers and streams due to runoff from heavy winter snowpack and frequent rain events through mid-August
- Increased numbers of *S. johannseni* and *S. meridionale* adults in Scott and Carver counties

2012 Plans

- Threshold for treatment will be the same as previous years
- Monitor adult populations by the overhead net sweep and CO_2 trap methods
- Increase larval surveillance in Scott and Carver counties
- Process non-target monitoring samples collected in 2011

Background

The goal of the black fly program is to reduce pest populations of adult black flies within the MMCD to tolerable levels. Black flies develop in rivers and streams in clean flowing water. Larval populations are monitored at more than 150 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 reaches the treatment threshold.

The small stream 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 Fig. 4.1.

2011 Program

Small Stream Program – *Simulium venustum* Control

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

In April and early May, 157 potential *S. venustum* breeding sites were sampled 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 54 sites on 15 streams met the threshold and were treated once with VectoBac® 12AS formulation of *Bti* (Table 4.1). Although fewer stream sites met threshold, the high volume of flow required more total control material in 2011 (39.8 gal) than in 2010 (34.8 gal).

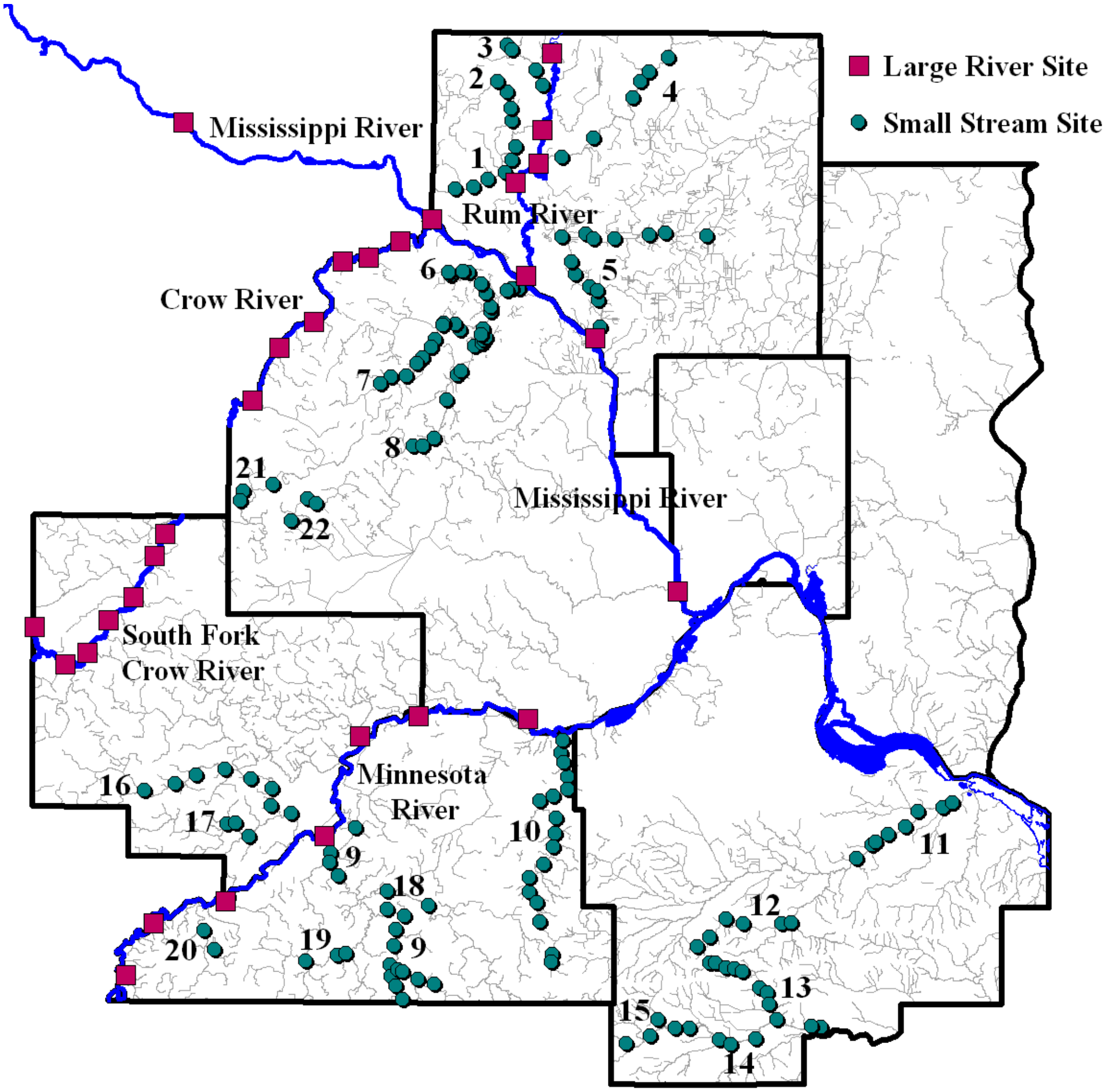


Figure 4.1 Large river and small stream black fly larval monitoring/treatment locations, 2011. Note: the large river site located outside the District on the Mississippi River is for monitoring only. The numbers on the map refer to the small stream names listed below:

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. Branch
20=Robert
21=Pioneer
22=Painter

Table 4.1 Summary of *Bti* treatments for black fly control by the MMCD in 2010 and 2011

	2010			2011		
Water body	No. treatment sites	No. treatments	Gallons of *Bti* used	No. treatment sites	No. treatments	Gallons of *Bti* used
Small Stream Total	79	79	34.8	54	54	38.9
Large River						
Mississippi	2	7	605.4	2	8	1,273.0
Crow	0	0	0.0	2	3	140.0
South Fork Crow	5	7	74.9	5	6	136.6
Minnesota	6	15	1,707.8	6	11	2,067.6
Rum	5	27	207.4	3	11	161.0
Large River Total	18	56	2,595.5	18	39	3,778.2
Grand Total	97	135	2,630.3	72	93	3,817.1

Large River Program

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

The black fly larval population was monitored weekly between May and early September using artificial substrates at the 28 sites permitted by the Minnesota Department of Natural Resources (MnDNR) on the Rum, Mississippi, Crow, South Fork Crow, and Minnesota rivers. A total of 465 samples were collected to determine if the treatment threshold was met. The treatment thresholds were the same as those used since 1990. Thirty-nine *Bti* treatments totaling 3,778.2 gallons of VectoBac® 12AS were used to control large river-breeding black fly larvae in 2011 (Table 4.1). The amount of *Bti* used in 2011 was 890 gallons above the yearly average of 2,888 gallons used on the large rivers between 1997 and 2010, primarily because the flows on the Rum, Mississippi, Minnesota, and Crow rivers were above average throughout the 2011 treatment season.

Bti treatment effectiveness was excellent in 2011. 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, 97% on the Minnesota River, 95% on the Rum River, 99% on the Crow River, and 99% on the South Fork Crow River. Overall, the average post-treatment mortality on the large rivers in 2011 was 98%.

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 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 2011 was 1.96 (Table 4.2). The average number of adult black flies captured per net sweep sample from 1984 to 1986, when no large river *Bti* treatments were done, was 14.8. 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 3.6. 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 in 1996 is 1.5 (1996-2011).

The most abundant black fly collected in the overhead net-sweep samples in 2011 was *S. luggeri*, comprising 67% of the total captured. The overall average number of *S. luggeri* captured per net-sweep sample in 2011 was 1.31 (Table 4.2). *Simulium luggeri* was most abundant in Anoka County in 2011, as it has been since the program began. The average number of *S. luggeri* captured in Anoka County was 8.5 in 2011. The average number of *S. luggeri* captured in the other counties in the MMCD (Carver, Dakota, Hennepin, Ramsey, Scott and Washington) was less than 0.3 per sample. The higher number of *S. luggeri* captured in Anoka County compared to other counties in the MMCD 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 2011 was *S. meridionale*, comprising 23% of the overall number of black flies captured in net-sweep monitoring samples. The overall average number of *S. meridionale* captured per sample was 0.45, which is the highest number observed since 1993. In 2011, *S. meridionale* was most abundant in Carver and Scott counties where the average per net-sweep was 1.6 and 0.61. The reason for the increase in *S. meridionale* in 2011 may be due to the higher than normal flows in the South Fork Crow, Crow, and Minnesota rivers throughout the late spring and summer months in 2010 and 2011, which is the primary habitat for larval *S. meridionale* within the District. In June, a treatment for *S. meridionale* on the Minnesota River was not done because of flooding even though the treatment threshold was met. On several other occasions treatment thresholds were not met on these rivers, despite observations of high larval populations, due to the ineffectiveness of the artificial substrate samplers during extremely high water conditions.

Table 4.2 Annual mean number of black fly adults captured in over-head sweep 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[1]	All species[3]	*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[2]	1.60	1.54	0.05	0.00
1989	6.16	5.52	0.29	0.18
1990	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	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

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

[2] 1988 was a severe drought year and limited black fly production occurred.

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

Black Fly Specific CO_2 Trap Collections Adult black fly populations were also monitored in 2011 between mid-May and mid-June with CO_2 traps at four sites in Scott County, four sites in Anoka County, and five sites in Carver County. The sites in Anoka and Scott counties have been monitored with CO_2 traps since 1998; monitoring in the Carver County expansion area began in 2004. Black flies captured in the CO_2 traps are preserved in ethyl alcohol to facilitate species-level identification.

Results of CO_2 trap collections from Anoka, Scott, and Carver counties are in Table 4.3. The most abundant black fly species captured in the CO_2 traps were *S. venustum*, *S. johannseni*, and *S. meridionale*. The higher numbers of *S. meridionale* and *S. johannseni* in Scott and Carver counties are due to the fact that the primary larval habitat of both species is in the Crow, South Fork Crow and Minnesota rivers. The large increase in the number captured in 2011 was likely due to favorable habitat conditions that occurred in these rivers throughout the breeding season from the higher than normal flows. In fact, a CO_2 trap collection on May 24 in New Germany (Carver County) had a record-breaking 140,000+ black flies.

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

County	Year	*Simulium venustum*	*Simulium johannseni*	*Simulium meridionale*
Anoka	1998	15.34	2.42	0.08
	1999	1.53	0.26	0.30
	2000	4.83	0.08	0.35
	2001	6.22	0.37	0.29
	2002	4.77	0.26	1.09
	2003	18.29	1.35	2.61
	2004	0.89	5.11	14.09
	2005	2.31	0.03	1.23
	2006	22.80	0.75	0.75
	2007	37.62	0.20	0.51
	2008	13.84	0.13	0.68
	2009	18.32	0.34	0.70
	2010	21.75	0.03	0.05
	2011	8.90	2.61	0.93
Scott	1998	3.16	1.08	2.56
	1999	6.58	5.50	35.35
	2000	0.51	1.71	11.17
	2001	8.30	4.70	611.27
	2002	0.62	0.41	53.82
	2003	1.76	12.93	109.57
	2004	2.25	0.17	0.65
	2005	3.40	3.50	23.25
	2006	3.38	38.07	10.50
	2007	35.59	32.50	172.48
	2008	228.93	20.18	75.03
	2009	238.16	22.80	98.77
	2010	44.60	6.18	256.90
	2011	60.64	280.64	311.55
Carver	2004	0.25	32.93	327.29
	2005	0.84	99.04	188.02
	2006	1.82	98.75	107.53
	2007	75.67	112.77	388.64
	2008	169.63	95.63	359.02
	2009	425.00	35.92	820.25
	2010	77.00	219.38	271.08
	2011	48.30	4,584.72	268.28

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 2011. 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.

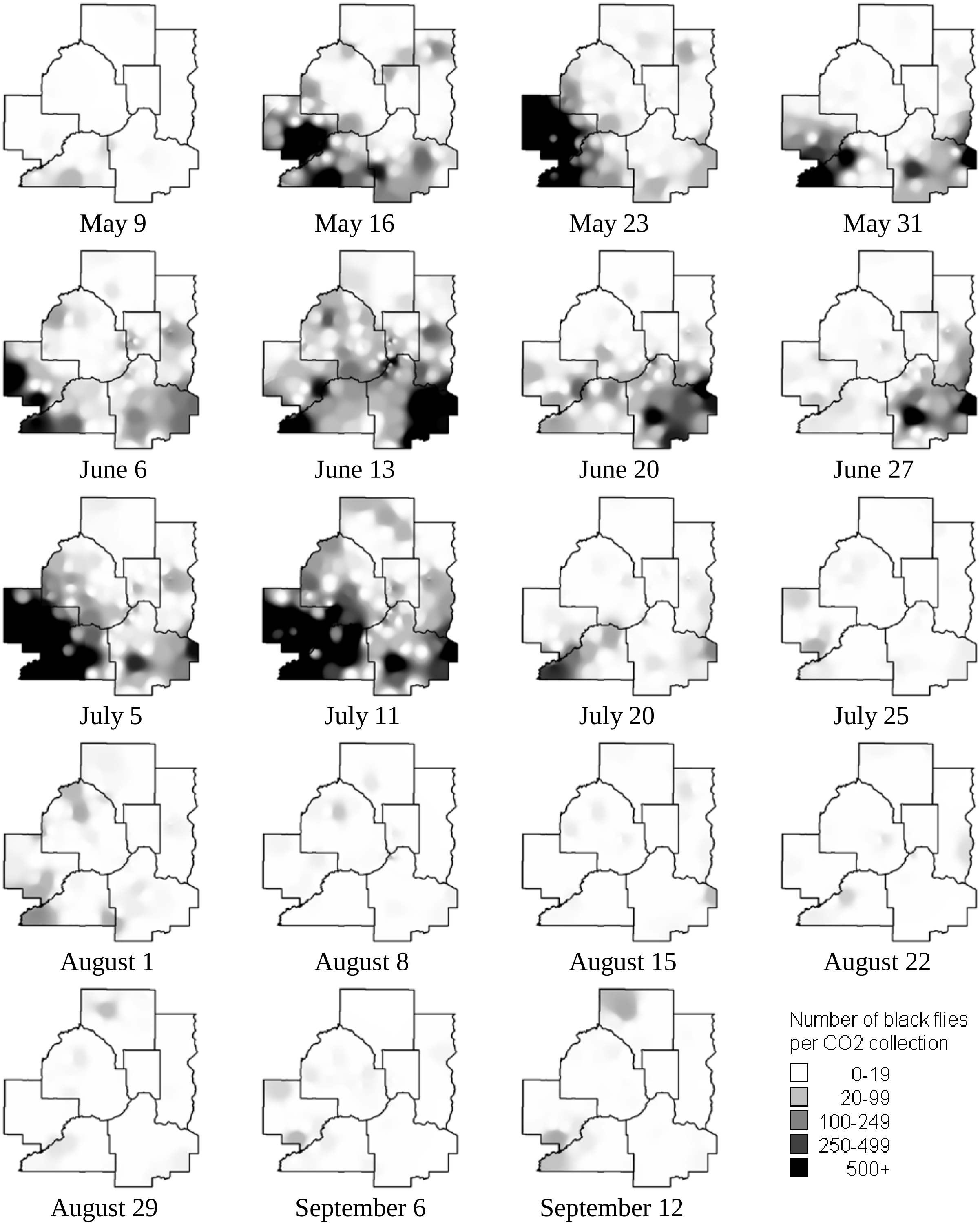
The areas in dark gray and black represent the highest numbers collected, ranging from 250 to more than 500 per trap. The highest number of black flies was observed in May, June, and July in parts of Scott, Carver, and Dakota counties (Figure 4.2). The results in Scott and Carver counties are similar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

Non-target Monitoring

The District conducts biennial monitoring of the non-target invertebrate population in the Mississippi River as part of the permit requirements set by the MnDNR. This monitoring began in 1995. The study was designed to provide a long-term assessment of the invertebrate community in *Bti*-treated reaches of the Mississippi River. Results from monitoring data collected and analyzed through 2009 indicate that there have been no large-scale changes in macroinvertebrate community in the *Bti*-treated reaches of the Mississippi River. Monitoring sampling was repeated as scheduled on the Mississippi River in 2011. Sample processing and enumeration will be completed in early 2013 with and a report due in spring 2013. Monitoring sampling will be repeated in 2013.

2012 Plans

2012 marks the 28th year of black fly control in the District. Our goal in 2012 is 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 2012 black fly control permit application request will be submitted to the MnDNR in January. Sorting, identification, and enumeration of the non-target monitoring samples collected in 2011 is on-going and scheduled for completion in early 2013. Data will be analyzed and a report submitted to the MnDNR in the spring 2013. Non-target monitoring sampling will be repeated on the Mississippi River in 2013. Increased larval surveillance will continue in those areas of Carver and Scott counties that had elevated adult black fly populations in 2010 and 2011. Program development will continue to emphasize improving future program effectiveness, surveillance, and efficiency.



May 9
May 16
May 23
May 31
June 6
June 13
June 20
June 27
July 5
July 11
July 20
July 25
August 1
August 8
August 15
August 22
August 29
September 6
September 12

Figure 4.2 Number of black flies collected in mosquito surveillance District low (5 ft) and elevated (25 ft) CO_2 traps, 2011. The number of traps operated per night varied from 106-122. Inverse distance weighting was the algorithm used for shading of maps.

Chapter 5 Product & Equipment Tests

2011 Highlights

- VectoBac™ G *Bti* achieved the same high level of control of *Ae. vexans* in air sites as in previous years
- Natular™ G30 (spinosad) controlled spring *Aedes* and *Ae. vexans* in air sites for four weeks
- MetaLarv™ S-PT (methoprene) (formerly VBC-60215) controlled at least one *Ae. vexans* brood in air sites
- Permethrin (barrier) controlled mosquitoes including *Ae. triseriatus* and WNV vectors for up to one week in woodlots

2012 Plans

- Continue testing control materials in catch basins with the goal of decreasing the number of treatments per season while maintaining efficacy
- Test Natular™ G30 in spring and summer in wetlands to determine the minimum effective dosage
- Test MetaLarv™ S-PT in summer in wetlands to determine the minimum effective dosage
- Continue late summer cattail treatments of VectoLex® CG (*Bs*) to determine the minimum effective dosage
- Test Natular™ G30 and MetaLarv™ S-PT against the cattail mosquito
- 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 its operations.

2011 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 four larvicides and one new adulticide. All four larvicides have been tested in different control situations in the past. Three larvicides were tested to control *Culex* breeding in catch basins, two to control *Culex* developing in wetlands, and one to control the cattail mosquito, *Cq. perturbans*. The adulticide was tested for use in croplands. These additional materials will provide MMCD with more tools to use in our operations.

Control Material Acceptance Testing

Altosid® Briquets and Pellets Warehouse staff collected random Altosid® product samples from shipments received from Wellmark International for methoprene content analysis. MMCD contracts an independent testing laboratory, Legend Technical Services, to complete the active ingredient (AI) analysis. Zoecon Corporation, Dallas, Texas, provided the testing methodologies. The laboratory protocols used were CAP No. 311, “Procedures for the Analysis of S-Methoprene in Briquets and Premix” and CAP No. 313, “Procedure for the Analysis of S-Methoprene in Sand Formulations”. All 2011 samples were within acceptable values of the label claim of percent methoprene (Table 5.1).

Table 5.1 Methoprene content of Altosid® (methoprene) briquets, pellets, and sand

Methoprene Product	No. Samples Analyzed	Methoprene Content: Label Claim	Methoprene Content: Analysis Average	SE
XR-Briquet	12	2.10%	2.15%	0.0149
Pellets	18	4.25%	4.21%	0.0235
XR-G Sand	25	1.50%	1.42%	0.0261

Adult Mosquito Control Products MMCD requests certificates of AI analysis from the manufacturers to verify product AI levels at the time of manufacture. MMCD 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. Technical Services is building a database on warehoused adult control materials to assist in inventory management and purchasing decisions. In 2011, MMCD did not purchase a large volume of adulticides and used products remaining in inventory. Our product storage data shows there is negligible breakdown of active ingredients after one season. Therefore, MMCD did not re-analyze products in inventory and saved expenses of analysis. Voucher samples of all 2011 adulticides were collected and stored for reference. One stored product, MGK Pyrocide, was evaluated for AI content to assure quality after being warehoused for several years. Results of this analysis (Table 5.2) showed that all products were within acceptable values of the label claim of active ingredients.

Table 5.2 Active ingredient content of 2011 adulticides

Product	No. Samples Analyzed	% AI Content: Label Claim	% AI Content
MGK Pyrocide 25-5	1	5.00%	4.99%
MGK Pyrocide 2.5% Mix	1	2.50%	2.48%

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 2011. Efficacy calculated using pre- and post-treatment larval counts from randomly selected sites was similar in 2010 and 2011 (Table 5.3).

Table 5.3 Efficacy of aerial VectoBac® G applications in 2010 and 2011 (SE=standard error)

Year	n	Mean % mortality	SE
2010	724	91.2	0.9%
2011	531	93.2	0.9%

New Control Material Evaluations

The District, as part of its Continuous Quality Improvement philosophy, desires to continually improve its control methods. Much testing has focused upon controlling potential vectors of WNV since its arrival to Minnesota in 2002. Testing in 2011 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.

Spring *Aedes* Treatments of Clarke Natular™ G30 in Air Sites The primary goals of control material tests in 2011 was to find a longer lasting material to decrease the number of times per season staff need to treat breeding sites in April and May to control multiple broods of various spring *Aedes* mosquitoes. Few larvicides effectively control spring *Aedes* larvae because of low water temperatures. VectoBac® G (*Bti*) works well, but lasts only 24-48 hours. Many sites require multiple VectoBac® G treatments in April and May. Natular™ G30, a promising alternative, contains a biological active called spinosad that is isolated from the soil bacterium *Saccharopolyspora spinosa*. Organic growers have used spinosad for over 10 years (WHO 2008), and in 2009, mosquito larvicides containing spinosad became commercially available.

Tests completed in 2010 demonstrated that Natular™ G30 treatments (10 lb/acre) could control spring *Aedes* in small ground sites for at least seven weeks. We chose to repeat these tests using aerial applications of two dosages, 10 lb/acre as tested in 2010 and 5 lb/acre to investigate minimum effective dosages.

We selected 20 small air sites (between ~3 to 40 acres per site) with histories of consistent high levels of spring *Aedes*. Six were treated with Natular™ G30 (5 lb/acre), seven with Natular™ G30 (10 lb/acre), and seven remained untreated. All sites were dipped before any were treated. Natular™ G30 was applied aerially on April 18, 2011. All sites were dipped each week thereafter through May 26, 2011.

Before treatment, larval abundance was similar in sites treated with Natular™ G30 and sites designated as untreated controls. Control in sites treated with Natular™ G30 (10 lb/acre) was high for four weeks after treatment compared to untreated sites. Control in sites treated with 5 lb/acre was very high the first two weeks after treatment and slightly lower, but still good, three and four weeks after treatment (Figure 5.1). Weekly cumulative rainfall was highest the first and fifth weeks after treatment. All sites remained wet during the entire test. We conclude that both dosages of Natular™ G30 were effective for four weeks after treatment. The higher dosage seemed to be effective longer than four weeks.

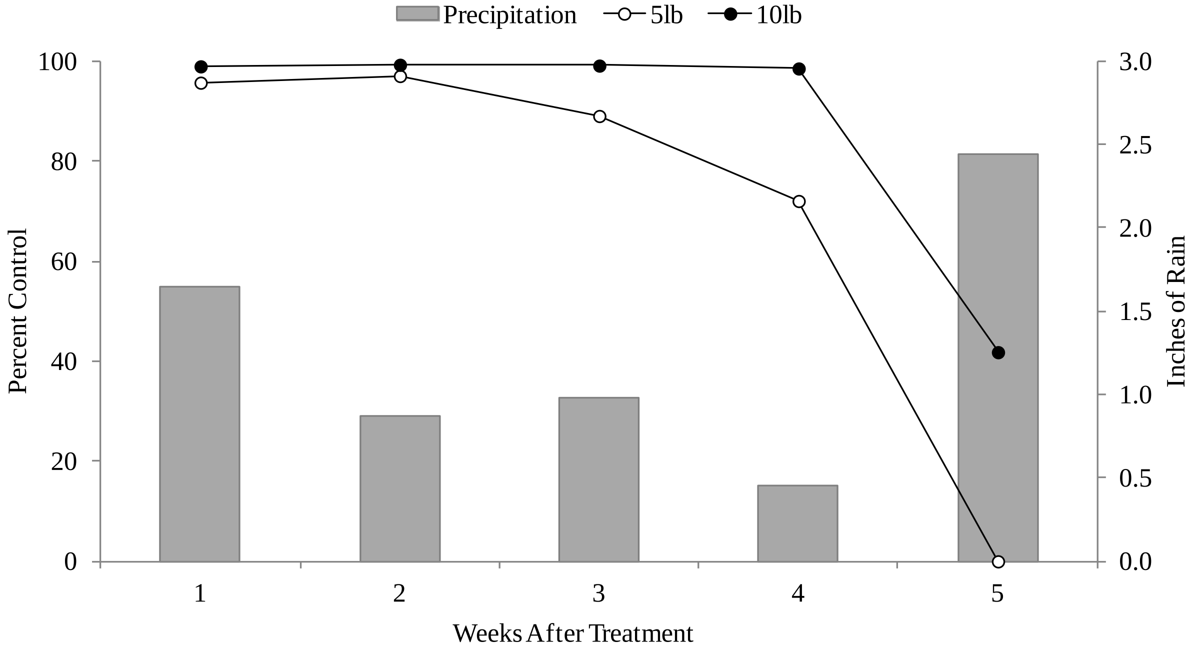


Figure 5.1 Control of spring *Aedes* in air sites treated with two dosages of Natular™ G30 on April 18, 2011 (dip counts in treated sites compared to control sites). Bars indicate weekly cumulative rainfall though the day sites were dipped.

Summer Treatments of Clarke Natular™ G30 in Air Sites Tests completed in 2008 and 2009 demonstrated that Natular™ G30 can control the first brood of floodwater mosquitoes (i.e., egg hatch induced by rainfall) in ground sites treated either before the rain or after larvae were present. In 2008 and 2009, Natular™ G30-treated sites did not reflood after they dried up, thereby preventing us from evaluating effectiveness against subsequent mosquito broods. Tests in 2010 demonstrated that a single application of Natular™ G30 (10 lb/acre) could effectively control two broods of *Ae. vexans* separated by complete drying of the sites.

In 2011, we completed two tests using aerial applications of two dosages of Natular™ G30, 10 lb/acre as tested in 2008-2010 and 5 lb/acre to investigate minimum effective dosages. The first test included nine sites treated with Natular™ G30 (10 lb/acre) and five sites with Natular™ G30 (5 lb/acre) on May 18, 2011. All sites were dipped before treatment and weekly after treatment. Efficacy was evaluated by comparing dip counts with operational dip counts from air site inspections. Frequent precipitation kept most sites wet throughout the first test.

Both dosages were effective for four weeks (Figure 5.2). The lower dosage (5 lb/acre) became ineffective after four weeks following heavy precipitation (2.28 inches) that week. The higher dosage (10 lb/acre) still was effective the fifth week after treatment.

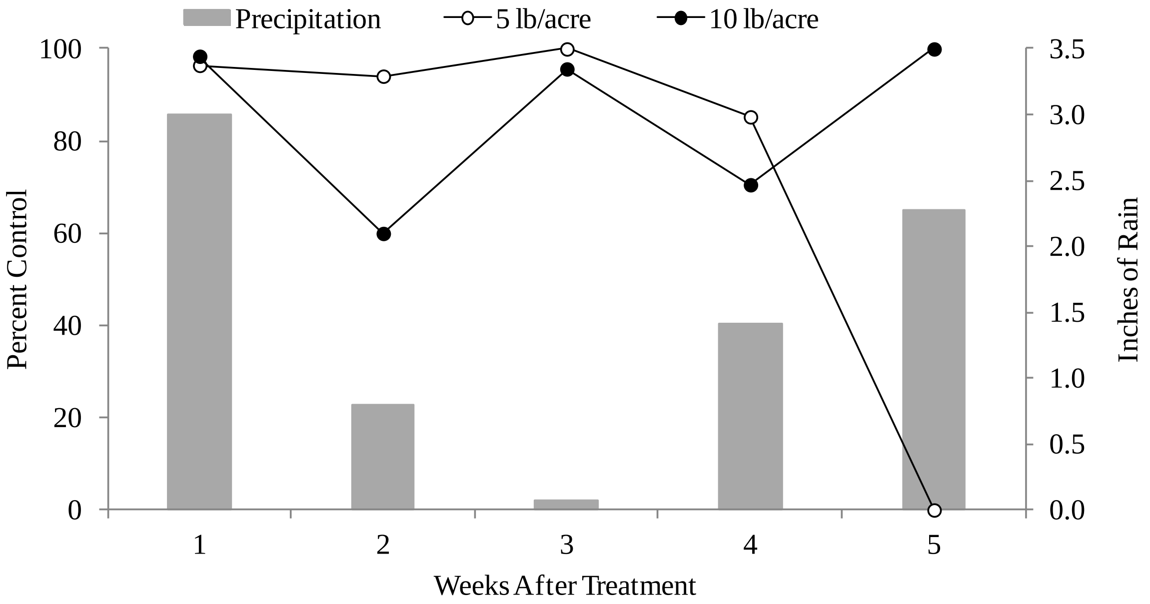


Figure 5.2 Control of *Ae. vexans* in air sites treated with two dosages of Natular™ G30 on May 18, 2011 (dip counts in treated sites compared to control sites). Bars indicate weekly cumulative rainfall though the day sites were dipped.

The second test included nine sites treated with Natular™ G30 (10 lb/acre) on June 28, 2011. Clumps in the Natular™ G30 that had to be crushed before treatment prevented inclusion of the lower dosage (5 lb/acre). Efficacy was evaluated by comparing dip counts with operational dip counts from air site inspections. Frequent precipitation kept most sites wet throughout the first test.

The second test confirmed that Natular™ G30 (10 lb/acre) can effectively control *Ae. vexans* for four weeks (Figure 5.3). Control decreased during the third week when very heavy precipitation (3.79 inches) occurred but rebounded the fourth week when precipitation (1.06 inches) was lower (Figure 5.3).

Clumping of Natular™ G30 was not present in material applied in April but occurred in material from the same production lot in May and, especially, June. We have worked closely with Clarke to determine the cause to prevent clumping in the future.

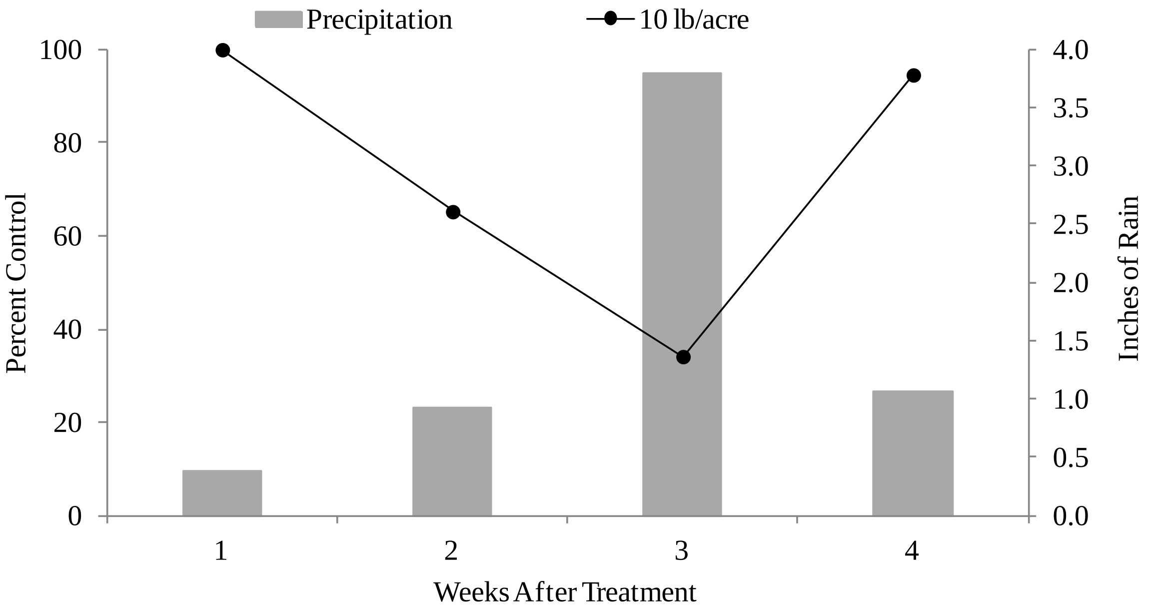


Figure 5.3 Control of *Ae. vexans* in air sites treated with Natular™ G30 on June 28, 2011 (dip counts in treated sites compared to control sites). Bars indicate weekly cumulative rainfall though the day sites were dipped.

MetaLarv™ In 2010, MMCD tested an experimental larvicide designated as VBC-60215 in small ground sites. Results were promising enough to conduct larger scale aerial tests in 2011. VBC-60215 received its EPA registration and label in late 2011. The product now is designated MetaLarv™ S-PT. The active ingredient is S-methoprene (the same active ingredient as in Altosid® products).

We selected eight small air sites (between 3 to 8 acres per site). All eight were treated with MetaLarv™ S-PT on May 18, 2011, four sites with 2.5 lb/acre and four with 4 lb/acre. Bioassays were collected from treated and nearby untreated similar sites when pupae were present. Control of the first *Ae. vexans* brood after treatment was excellent in sites treated with 4 lb/acre (Figure 5.4). Two sites treated with 2.5 lb/acre yielded enough pupae for bioassays during the first *Ae. vexans* brood; one indicated excellent control and the other low control (although still higher than the upper 95% confidence interval for untreated bioassays) (Figure 5.4).

Additional precipitation between 21 and 35 days after treatment stimulated a second *Ae. vexans* brood. Bioassays collected from sites treated with both dosages 36-41 days after treatment indicated much lower effectiveness (Figure 5.4). The MetaLarv™ S-PT label indicates that the product has a four week field life. This test seems to verify that.

Overall efficacy, judging from mean emergence inhibition values, does not look good (Table 5.4). However, efficacy against the first brood was excellent, especially for the 4 lb/acre rate, and all bioassays collected from treated sites throughout the test were significantly higher than the 95% confidence interval of bioassays from untreated sites suggesting significant control throughout the test (Table 5.4, Figure 5.4). These results, combined with good efficacy of the

4 lb/acre rate in 2010 tests, justify additional tests of MetaLarv™ S-PT at 4 lb/acre in 2012. We also plan to test 3 lb/acre to better determine the minimum effective dosage.

Table 5.4 Bioassay results (emergence inhibition=EI) of samples collected in MetaLarv™ S-PT treated sites compared to the upper 95% CL for untreated control bioassays*

Treatment dosage	bioassays (n)	Corrected EI Mean (±SE)	bioassays >95% CL (%)	Days After Treatment Mean (±SE)(min-max)
2.5 lb/acre	3	52.10% (±25.18%)	3 (100%)	23.3 (±8.33) (15-40)
4.0 lb/acre	4	67.41% (±12.72%)	4 (100%)	27.8 (±6.34) (15-41)

* Untreated Control: mean EI=2.10% (SE=0.88%)(n=5); upper 95% CL=7.56%

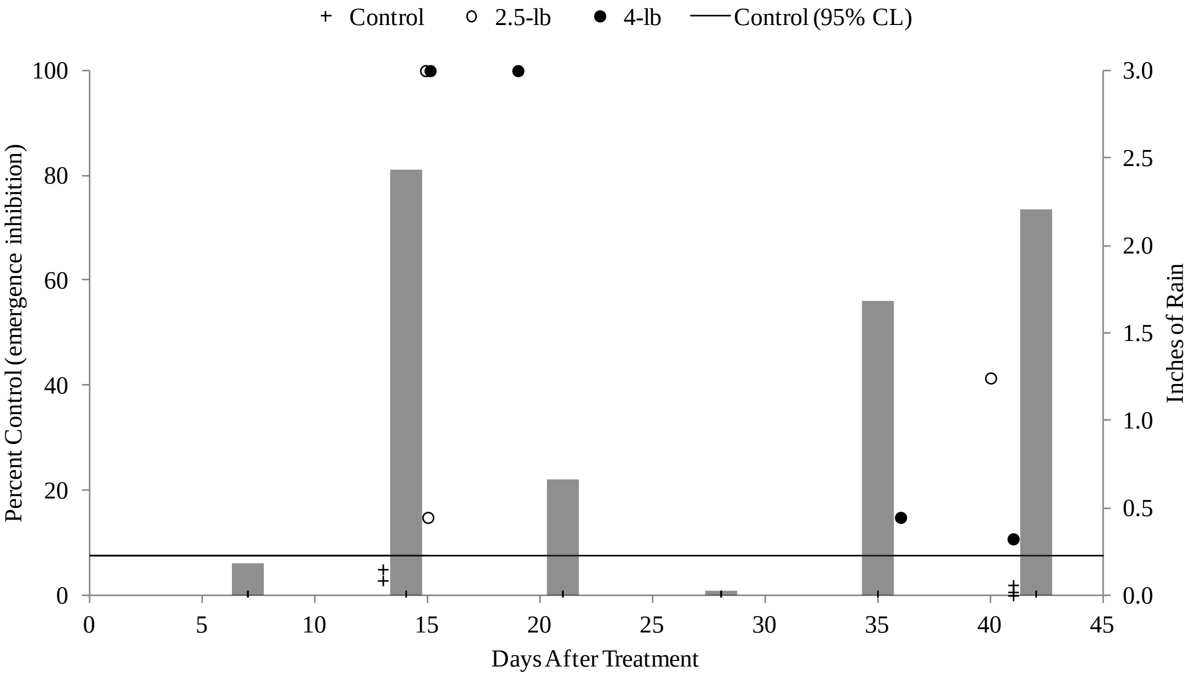


Figure 5.4 Bioassay results (emergence inhibition) of samples collected in untreated and MetaLarv™ S-PT treated sites. Emergence inhibition values from MetaLarv™ S-PT treated sites were corrected for untreated control mortality. Bars indicate weekly cumulative rainfall. MetaLarv™ S-PT was applied on May 18, 2011.

VectoLex CG® for *Cq. 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 operations treat for this single brood mosquito beginning in February/March in a small number of hard to reach ground sites using Altosid briquets, and during a ten-day window in late May using Altosid pellets and Altosid XR-G sand. Because cattail control applications often coincide with treatments of other floodwater species, a fall application period may lessen the demand of limited resources during this extremely active floodwater treatment period. To that end, we are evaluating whether a fall application of

VectoLex® CG (*B. sphaericus* 30-day granules) can provide good control for the subsequent season's cattail mosquitoes.

VectoLex CG® (20 lb/acre) applied in September 2008 to seven cattail marshes in Anoka and Washington counties while water temperatures were approximately 50°F achieved 95.7% control of *Cq. perturbans* throughout the June-August emergence period (see 2009 Operational Review for details). We also received 1,600 lb of VectoLex® granules in August 2010 to continue these tests, and in September 2010, we treated 15 sites with VectoLex® granules, eight sites with 10 lb/acre and seven with 20 lb/acre. At the beginning of June 2011, emergence cages (five per site) were placed in VectoLex CG® treated and untreated sites (four sites per treatment group) to evaluate the efficacy of the fall 2010 application. Adult mosquitoes were collected from each cage twice per week through August 2, 2011.

Emergence in sites treated with both dosages was significantly lower than in untreated sites (Table 5.5). Control was consistently high in sites treated with 20 lb/acre (99.1%; 0.39 mosquitoes per cage compared to 43.25 in untreated cages). Control also was very good in sites treated with 10 lb/acre (86.9%; 5.65 mosquitoes per cage compared to 43.25 in untreated cages). Control in sites treated with both dosages was consistently high until adult *Cq. perturbans* emerged the first week of July in one of four sites treated with 10 lb/acre (Figure 5.5). These results suggest that 10 lb/acre is near the minimum effective dosage.

In September 2011, we treated 440 acres with three dosages (10 lb/acre, 15 lb/acre, 20 lb/acre) of VectoLex CG® to more accurately determine the minimum effective dosage. We plan to place emergence cages in June through July 2012.

Table 5.5 Percent of cages in VectoLex CG® treated and untreated sites from which *Cq. perturbans* emerged, June – July 2011

Treatment	Total cages	Cages with *Cq. perturbans*	Cages with no *Cq. perturbans*	Percent with *Cq. perturbans*	Fisher Exact p-value*
Control	20	20	0	100	
20 lb/acre	20	9	11	45	0.000073
10 lb/acre	20	8	12	40	0.000023

* Untreated control compared to VectoLex CG®

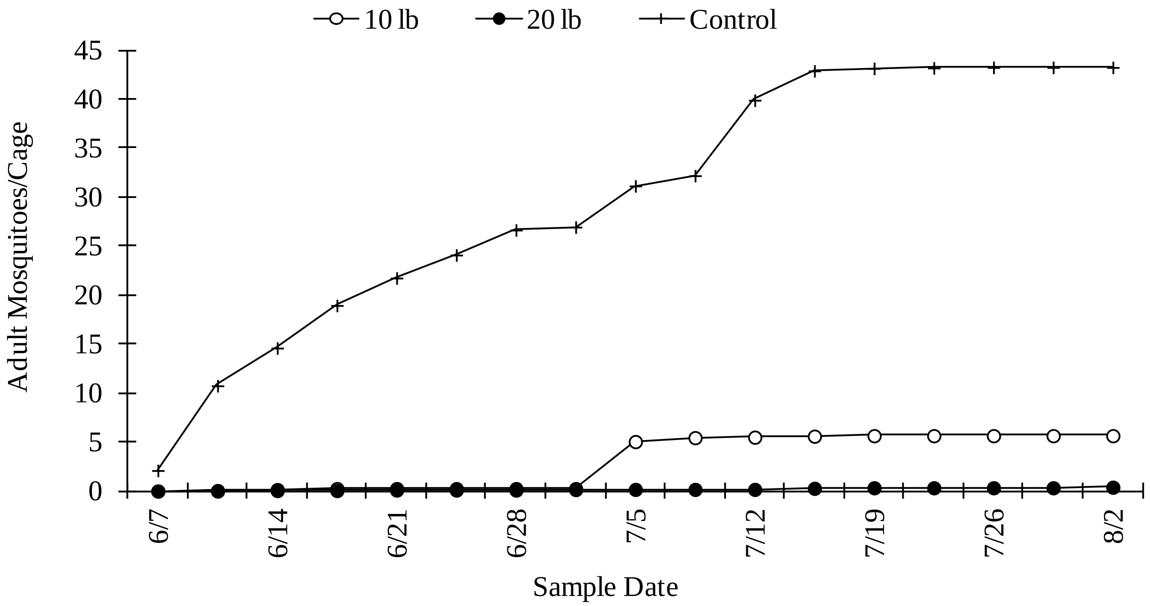


Figure 5.5 Mean cumulative emergence of *Cq. perturbans* in cages in VectoLex CG® treated (10 lb/acre, 20 lb/acre) and untreated sites, June – July 2011.

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 two permethrin tests in 2011. All tests were conducted in woodlots where operational permethrin treatments could potentially be made and all tests included untreated woodlots. 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). Both tests included CO_2 trap data. One test also included vacuum aspirator data. The goal of both tests was to better evaluate the duration and consistency of control achieved by barrier treatments and to include vector-specific efficacy evaluations.

Two attempted tests of permethrin and Onslaught® did not return useable data because of trap malfunctions and weather issues. Two tests that included only permethrin successfully provided useable data.

Permethrin effectively controlled all species of mosquitoes for up to seven days in both successful tests (Table 5.6, 5.7). For the first time, we located woodlots with a history of *Ae. triseriatus* detections where we were able to successfully test permethrin efficacy against this vector. Permethrin controlled *Ae. triseriatus* for up to seven days (Table 5.6).

Sufficient WNV vectors (*Culex*4=*Cx. tarsalis*, *Cx. restuans*, *Cx. pipiens*, and *Cx. salinarius*) were captured during the second test to estimate WNV vector-specific efficacy. Effectiveness against vectors lasted up to seven days (Table 5.7). These results are the same as results of previous vector-specific evaluations (tests in 2008) (see 2008 Operational Review for details).

In eight previous tests (two in 2006, one in 2007, three in 2008, two in 2010), permethrin achieved high levels of control 24-48 hours after treatment. Effective control (≥80%) persisted for seven days in two of the five tests that were sampled seven days after treatment; control was lower in the other three tests (27%, 57%, and 22%). Onslaught® effectively controlled mosquitoes for seven days in the 2007 test; it was not included in other tests until 2010 in which it was as effective as permethrin. Enough WNV vectors were captured in two tests in 2008 and two tests in 2010 to evaluate efficacy. Permethrin effectively controlled WNV vectors for at least 24 hours in all four of these tests (see 2006, 2007, 2008 and 2010 Operational Reviews for details).

Table 5.6 First permethrin barrier treatment efficacy in 2011: One woodlot per treatment, two traps per woodlot. Efficacy percent calculated using Mulla's formula[*]

		All mosquito species		*Aedes triseriatus***	
July 13- 20	Collection	CO$_2$ trap catch[§]	Efficacy	Aspirator catch[§]	Efficacy
Permethrin	Pre-treat	646 (±121)	---	2.0 (±2.0)	---
	Post-treat	344 (±112)	44%	0.0 (±0.0)	100%
	Post-24 h	164 (±47)	77%	0.0 (±0.0)	---
	Post-7 day	58 (±32)	65%	0.0 (±0.0)	100%
Untreated control	Pre-treat	1,510 (±134)	---	1.5 (±1.5)	---
	Post-treat	1,429 (±89)	---	0.5 (±0.5)	---
	Post-24 h	1,687 (±103)	---	0.0 (±0.0)	---
	Post-7 day	391 (±41)	---	3.5 (±0.5)	---

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

[**] Abundance evaluated using vacuum aspirator samples.

§ Mean (±SE), n=2 (CO$_2$ traps or vacuum aspirator samples)

Table 5.7 Second permethrin barrier treatment efficacy in 2011: one woodlot per treatment, two traps per woodlot. Efficacy percent calculated using Mulla's formula[*]

		All mosquito species		*Culex*4	
July 26- Aug 3	Collection	CO_2 trap catch[§]	Efficacy	CO_2 trap catch[§]	Efficacy
Permethrin	Pre-treat	412.0 **	---	11.0 **	---
	Post-treat	34.5 (±9.5)	99%	1.0 (±1.0)	96%
	Post-24 h	17.5 (±8.5)	98%	0.0 (±0.0)	100%
	Post-7 day	22.0 (±8.0)	98%	0.5 (±0.5)	97%
Untreated control	Pre-treat	84.0 **	---	4.0 **	---
	Post-treat	490.0 (±135.0)	---	8.5 (±6.5)	---
	Post-24 h	144.0 (±23.0)	---	1.5 (±1.5)	---
	Post-7 day	272.5 (±3.5)	---	6.5 (±0.5)	---

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

[**] Only one CO_2 trap placed the first night

§ Mean (±SE), n=2

Zenivex® (ULV) compared to Anvil® Zenivex® is a new formulation of the pyrethroid etofenprox. Like Anvil® (sumithrin), Zenivex® is a softer adulticide, both because of its pyrethroid active and the lack of PBO in the formulation. We tested Zenivex® to increase the number of ULV adulticides we have available since Bayer has withdrawn the re-registration of Scourge® and it soon will no longer be available.

We tested Zenivex® in campgrounds in Anoka County. Efficacy was evaluated using Mulla's equation that compares mean mosquito captures from treated and untreated sites on the first night of trapping (pre-treatment counts) with mean mosquito captures the second and third nights of trapping (post-treatment counts). Three CO_2 traps were placed three consecutive nights in each untreated control and treated site. Test materials were applied at sundown on the second night of trapping; CO_2 traps were placed 30 minutes after the treatments were completed at both treated locations and the untreated control location. CO_2 traps were placed at sundown the first and third trapping nights.

Adult mosquitoes (all species) and WNV vectors were effectively controlled by Zenivex® and Anvil® immediately after treatment (Table 5.8). No samples were available to evaluate Zenivex® efficacy 24 hours after treatment. Efficacy appeared to wane 24 hours after treatment in the one identifiable Anvil® sample.

Table 5.8 ULV Zenivex® compared to Anvil®, 2011; Mulla's formula incorporates untreated control trap counts to correct for changes in the treated traps that are not due to the treatment

		All mosquito species		*Culex*4	
Test 1 June 22-24	Collection	CO_2 trap catch*	Efficacy	CO_2 trap catch*	Efficacy
Zenivex®	Pre-treat	1,540.7 (±498.0)	---	1.0 (±0.0)	---
	Post-treat	232.3 (±114.1)	96%	0.0 (±0.0)	100%
	Post-24 h	N/A (n=0)	N/A	N/A (n=0)	N/A
Untreated control	Pre-treat	429.7 (±37.3)	---	22.7 (±11.3)	---
	Post-treat	1,624.0 (±320.9)	---	112.7 (±91.9)	---
	Post-24 h	925.0 (±323.0)	---	21.0 (±21.0)	---
Anvil®	Pre-treat	887.7 (±343.9)	---	27.7 (±19.3)	---
	Post-treat	80.0 (±22.4)	98%	1.3 (±0.9)	99%
	Post-24 hr	1,276.0 (n=1)	33%	0.0 (n=1)	100%

* Mean (±SE), n=3 (unless indicated otherwise)

Equipment Evaluations

Helicopter Swath Analysis and Calibration Procedures for Larvicides Technical Services and field staff conducted eight aerial calibration sessions for dry, granular materials during the 2011 season. These computerized calibrations directly calculate application rates and swath patterns for each pass so each helicopter's dispersal characteristics are optimized. These sessions were held at the municipal airport in LeSueur, MN. Staff completed calibrations for nine different operational and experimental control materials. In total, eight helicopters were calibrated and each helicopter was configured to apply an average of three different control materials.

Improved Helicopter Swath Analysis Procedures Technical Services implemented new procedures which utilized two technicians to independently weigh product samples for the analyst. This procedure increased the number of swaths that could be evaluated per hour. We gained approximately 20% in our processing efficiency.

Update of Granular Deposition Software Technical Services worked with manufacturer's programmers to upgrade their swath characterization software, which had been based mainly on agricultural applications. MMCD uses application rates that are much lower than most agricultural rates so staff worked to increase the sensitivity of the analysis program to these low treatment rates. The software upgrade improved the clarity and effectiveness of MMCD's swath analysis.

Droplet Analysis of Ground-based Spray Equipment During March 2011, Technical Services and the East Region staff used our 20 ft x 40 ft indoor spray booth to evaluate our adulticide application equipment. This self-contained booth collects the adulticide spray particles, which minimizes their release into the air following the calibration process, thus limiting any environmental effects. Technical Service staff optimized 48 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. MMCD staff demonstrated this portable spray booth technology at North Central Mosquito Control Association annual meeting to help other agencies improve their operations.

Optimizing Efficiencies and Waste Reduction

Improvement of Warehouse Functions In 2011, a new tandem axle truck was purchased for the Oakdale warehouse. This large flatbed truck increased the weight capacity of our warehouse transfers by almost 50%. This capacity increase was necessary as MMCD incorporates more sand-based or composite materials into our operations. Warehouse staff will be able to reduce the amount of miles, fuel, staff time and related expenses by decreasing the overall number of trips to our ten inventory storage locations. Staff will be able to better support field operations and increase warehouse efficiency.

Recycling of 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 the related pesticide contamination of ground and water. MDA used Consolidated Container Company, Minneapolis, MN, for disposal services of their plastic pesticide container-recycling program in 2011.

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 directly to the recycling facility in quantities of $\geq$ 400 jugs. This system allowed each facility to free up storage space in a timely manner.

MMCD staff collected 5,557 jugs for this recycling program. The control materials that use plastic 2.5 gal containers are sumithrin (125 jugs), *Bti* liquid (764 jugs), Altosid® pellets (4,658 jugs), and other materials (10 jugs).

MMCD also purchases adulticides in 55-gal drums and refills the 5-gal steel cans of the same-labeled material thereby reducing the need for new packaging as well as 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-gal drums were brought to a local company to be refurbished and reused.

Recycling of Pesticide Pallets In 2011, MMCD operations produced 1,009 empty hardwood pallets used in the transportation of VectoBac® G brand *Bti* granules. Technical Services worked with the vendor, Valent BioSciences, to re-use these heavy-duty pallets. After new product deliveries, MMCD periodically returns truckloads of empty pallets to Valent. In doing so, MMCD reduces the need for new pallets, reduces the overall cost of production, and maintains lower control material cost for the District.

MMCD is working with manufacturers to use reusable pallets and bulk totes to reduce waste streams. We are reviewing packaging options and shipping containers made from recyclable materials. It is our goal to evaluate some prototypes in 2012.

Plans for 2012

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 2012, we plan to test VectoLex CG® (late summer treatments) against the cattail mosquito to determine minimum effective dosages. We also plan initial tests of Natular™ G30 and MetaLarv™ S-PT against the cattail mosquito to explore control potential. We plan to expand spring and summertime tests of Natular™ G30 in wetlands to determine minimum effective dosages. We also plan to repeat tests of adulticides, emphasizing vector (*Culex*4, *Ae. triseriatus*, others) control and effectiveness of barrier treatments.

References

Mulla's Formula:

$$\text{Percent Efficacy} = 100 - \left(100 \times \left(\frac{\text{Cntl Pr e}}{\text{Trt Pr e}}\right) \times \left(\frac{\text{TrtPost}}{\text{CntlPost}}\right)\right)$$

CntlPre = Mean pretreatment count of untreated control
TrtPre = Mean pretreatment count of treated group
CntlPost = Mean post treatment count of untreated control
TrtPost = Mean post treatment count of treated group

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.

World Health Organization Specifications and Evaluations for Public Health Pesticides Spinosad (2008). www.who.int/entity/whopes/quality/Spinosad_eval_only_March_2008.pdf

Chapter 6 Supporting Work

2011 Highlights

- Switched to smartphones and started transition to new data system
- Finished transferring Restricted Access maps and data to new functionality in Customer Call Tracking system
- Completed field map updates using 2010 high-resolution aerial photography
- Continued education efforts on stormwater and mosquitoes
- Requests to check larval habitats increased almost four-fold in 2011 compared to 2010
- Presented "Mosquito Mania" curriculum to 5,323 students in 53 schools

2012 Plans

- Continue upgrade of data systems
- Modify "Mosquito Mania" curriculum for use with "Smartboard" technology

2011 Projects

Data and Mapping Systems

In 2011 we took several major steps to move MMCD's data systems to new hardware and software that allow centralized data management and access from any web-enabled device.

Our current electronic field and lab data entry system, "DataGate", handles inspection, treatment, sample, and physical inventory data and provides daily updates for the public web map site. Palm OS-based personal digital assistants (PDAs) have been used since 2003 to record data and upload to network databases when field staff return to their base. DataGate was built by staff over the past 13 years, and we are now having problems keeping the program running on new PCs. Additionally, the Palm PDAs for mobile data entry are becoming hard to find and expensive.

Staff examined alternatives for several years, hoping to find a reasonably priced web-based mobile system. Our goal was to enable development of web-based data entry tools to replace both our PC and PDA systems, reduce hardware cost by eliminating additional data-entry devices, and reduce software development and maintenance cost by having to support fewer platforms.

After testing a number of tablet and smart phone devices, and shopping for data access plans, we were able to find a combination of smart phone and data plan that allows us to use phones for data entry at no additional hardware or data connection cost than our previous voice-only phone system.

In early September, the District switched cell phone providers and replaced 229 phones with smart phones. The new phone system gives users voice communication, GPS location, e-mail, texting and internet access, and will allow real-time access to sample/treatment data, all in a single device. It reduces our investment in hardware by eliminating PDAs while improving communications and data entry systems well into the future.

As a first step toward a new web-based data system accessible through mobile phones, MMCD worked with Houston Engineering Inc. (HEI) to develop a prototype of one data entry form to test during the fall cattail mosquito site inspections. At first entries were made in both PDAs and phones, but by the end of the season the new cattail web form was capable of handling all entries and PDAs were no longer needed for this form in most areas.

We chose to use web-based software rather than a phone-based app in order to reduce development and maintenance costs by having only one system to maintain for both desktop and mobile access. HEI developed the application using the Open Source tools jQuery Mobile, as well as html5, css, javascript and PHP. Additional revisions are underway that allow data entry to be done on the phone even when there is no web connection, and synch to the central database when connection is restored.

The cattail entry form tested is one of about 13 data entry forms, and we are developing specifications and have begun work to replace the other forms and reports, starting with Vehicle Mileage. We expect that some data entry will still be done on PDAs in 2012 during the transition, with the switch completed by the end of 2012.

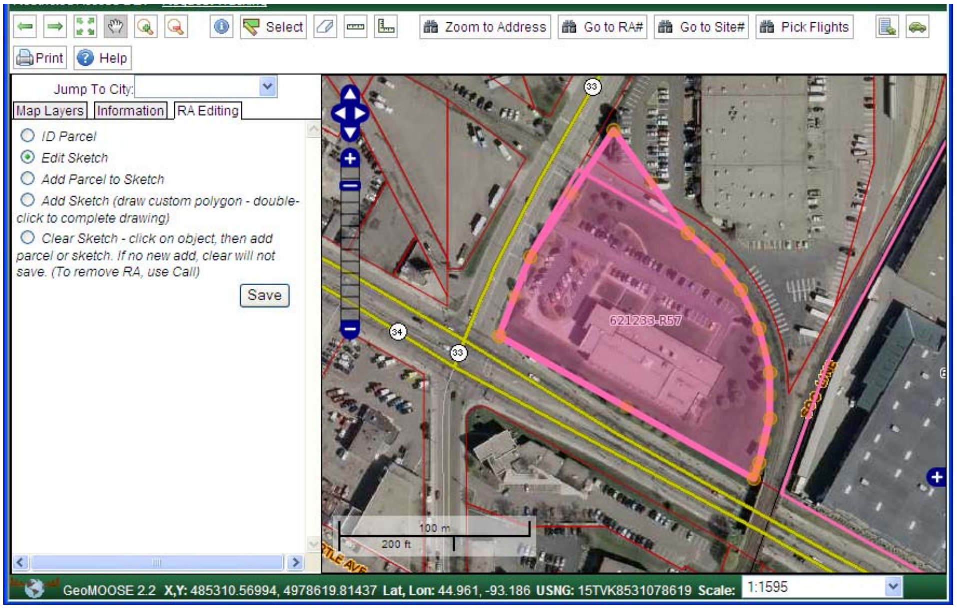
The use of smart phones opens opportunities for data management but also presents risks. We have updated our Electronic Communication guidelines and IT staff members have been working on maintaining security of MMCD's systems given the connectivity provided by the phones.

Integrating Customer Call System and Restricted Access Maps

MMCD uses a web-based customer call management system developed by HEI which allows rapid call entry and access and also supports interactive mapping of locations based on street address, intersection, or place name. In addition to tracking the many calls we receive requesting mosquito control treatments, the call system also tracks calls from households or organizations which have asked for notification before entry on their property, or asked for limited or no treatments, known as "Restricted Access" or RA calls.

Keeping track of the properties affected by RA calls and the types of restrictions requested, and getting that information quickly, is important for all fieldwork. In the past the RA property mapping has been done in our desktop mapping system, MapInfo, at each field office, and data automatically assembled nightly. However it has been challenging to keep these maps coordinated with the call history for each property.

At the end of 2010, staff began a review of MMCD's RA systems and worked with HEI to develop a new web-based RA mapping system integrated with the Call System. The system was implemented early in 2011 and existing RA records transferred into the Call System. With the new system, a caller's address can be used to select a parcel boundary directly in the web map, and the boundary can be edited as needed (Figure 6.1) and saved in the database with the household and call history information. Map objects from the Call System are available immediately as web-based WMS-format layers that can be used in desktop or web mapping applications. They are also downloaded nightly to MMCDs servers for more extensive use in desktop mapping. This is MMCD’s first web application using on-line polygon editing for map updates.



Jump To City:

○ *ID Parcel*
● *Edit Sketch*
○ *Add Parcel to Sketch*
○ *Add Sketch (draw custom polygon - double-click to complete drawing)*
○ *Clear Sketch - click on object, then add parcel or sketch. If no new add, clear will not save. (To remove RA, use Call)*

GeoMOOSE 2.2 **X,Y:** 485310.56994, 4978619.81437 **Lat, Lon:** 44.961, -93.186 **USNG:** 15TVK8531078619 **Scale:** 1:1595

Figure 6.1 Call System extension for Restricted Access (RA) maps. RA boundaries can be copied from county parcel layers and edited as needed, using an on-line map interface. This figure shows edit nodes on the RA object.

Before the transfer there were 2,281 recorded RA locations mapped, of which 550 were owned by organizations (US F&W, MnDNR, Three Rivers Parks, Minneapolis Parks, and others). In the course of transferring, a few individual records were found to be no longer valid and were dropped, and information on some others was updated. About 56 new requests in 2011 were added directly through the Call System. Staff is currently checking the transfer to ensure accuracy and see if any changes need to be made in the system for 2012.

Public and Internal Web Map Sites

MMCD continues to make wetland locations and multi-year larval treatment history available for the entire District 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). In 2011, the public web map access page on MMCD’s site received 3,116 visits (similar to 2010 and 2009 but down from 4,623 in 2008).

The internal MMCD-only version of the site includes greater detail and tools to query data, and supports helicopter track analysis using data uploaded from the AgNav systems in the helicopters. Functionality will be expanded as the map interface is integrated with the new web-based data entry systems described above.

Wetland and Stormwater Mapping

The high-quality spring 2010 aerial photography flown by a coalition of MnGeo, MnDNR, Metropolitan Council, several metropolitan counties and MMCD (leaf-off, 1 ft resolution) was used to update MMCD's field maps of larval and adult mosquito habitats. MnGeo provides these photos as a web service, which saves users like MMCD from the expense of storing and indexing this large amount of photos.

MMCD's updated maps of approximately 70,000 wet areas that serve as potential larval mosquito habitat was again made available for download through the MetroGIS "DataFinder" web service.

In addition to wetlands, MMCD staff members map locations of many stormwater structures, such as street catchbasins, 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 22,000 structures are now mapped, in addition to catchbasins.

A regional effort to standardize mapping of stormwater structures among cities, watershed districts, MnDOT, and other agencies, led by the Minnesota Pollution Control Agency (MPCA), produced a pilot project with Ramsey Washington Metro Watershed District and MetroGIS. Results of this project were reviewed in early 2011 and showed that the standard could be helpful for sharing data but there were still many challenges. The standard continues to be under consideration but little additional progress was made in 2011. MMCD staff have participated on this group. The final report is available at http://www.metrogis.org/documents/reports/SDSSDE_PilotProject2010_final.pdf

A District staff member serves on the Technical Advisory Committee of the National Wetlands Inventory (NWI) update project, funded by Legislative-Citizen Commission on Minnesota Resources (LCCMR). This project recently updated the NWI for an area including the metro, using the 2010 aerial photography. MMCD wetland areas were provided to be used as ancillary data for this effort, and we will be comparing the NWI results with our maps.

MMCD staff continue to participate in MetroGIS, and in 2011 assisted with various projects providing benefit to metro governments, including work on developing standardized Address Points (useful for the geocoder in the Customer Call system and web maps), development of a new communications strategy, and participation in a workshop on mapping and emergency response (see http://www.co.dakota.mn.us/Departments/GIS/Newsletter/Winter2012_GIS101_TwinCitiesGECCo.htm)

Impact of State Shutdown

MnGeo provides an online aerial photo service that MMCD staff depends on for field maps and our public web map. MnGeo also provides an online address lookup (geocoder) service that is central to our Customer Call System. On June 30, the day before the state shutdown, the aerial photo service was declared critical, so we narrowly missed a difficult situation. The geocoder, however, was shutdown and staff worked with the Metropolitan Council and local nonprofit SharedGeo to set up alternatives. SharedGeo also set up an alternative aerial photo service, as the State's was not supported during the shutdown if technical problems arose. This incident encouraged staff in many local agencies to consider ways to address the need for redundant services for emergencies.

Stormwater Management, Wetland Design, Climate, and Mosquitoes

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

- Staff participated in the MN Water Resources Conference (civil engineers, city & watershed district staff, U of M researchers) and presented a poster titled "Rain Gauge Network Data Online."
- The "Stormwater and Mosquitoes" page on the MMCD web site received 690 visits in 2011, down from 1,031 in 2010. (see Resources – Stormwater Management, http://www.mmcd.org/storm.html)
    - The fact sheet on rain barrels recorded 592 downloads, about the same as the past two years.
    - The Rain Gardens poster (produced for the 2009 Water Resources Conference) recorded 145 downloads, up from 121 in 2010 (after 280 downloads in Nov-Dec 2009).
    - The "Mosquitoes and Wetlands" slide show had 30 visits, down from 47 in 2010.
    - The site includes a link to the section on mosquitoes in the MPCA Stormwater Manual (http://www.pca.state.mn.us/index.php/water/water-types-and-programs/stormwater/stormwater-management/stormwater-management.html).

Published research continues to show the potential for mosquito production from stormwater structures, for example: "Discovery of Vector Mosquitoes (Diptera: Culicidae) in Installed Above- and Belowground Stormwater Treatment Systems, San Diego County, California" by M. E. Metzger, J. E. Harbison, and R. Hu, J. Med. Entomol. 48(6): 1136-1144 (2011); DOI: http://dx.doi.org/10.1603/ME11063

MMCD continued active participation in the Minnesota Climate Change Adaptation Working Group, comprising the State Climatologist, staff from the U of MN, federal, state, and local governments, private and nonprofit sector and other interested individuals. The group focuses on sharing information on climate predictions and temperature and water-related changes, and shares insights and potential challenges member's agencies face. In 2011, the group sponsored a series of lectures and is working on expanding web resources for sharing information. Basic information on the group is available at climate.umn.edu/adapt/ and a social network site is available at mnclimateadaptation.ning.com. MMCD staff drew on information made available through the Working Group to prepare a talk on "Adapting to Climate Change: Issues for Mosquito Control" for the North Central Mosquito Control Association annual meeting in April 2011.

Nontarget Studies

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) assembled by MMCD, are available on the MMCD web site, mostly as PDF files. Download totals for 2006-2011 are given in Table 6.1. A large portion of the 2011 downloads occurred in 1-day spikes, for example, 521 on 1/12/2011.

Table 6.1 Larvicide nontarget impact study report downloads from www.mmcd.org, 2006-2011

Report content		2006	2007	2008	2009	2010	2011
SPRP Final Report, 1996		89	289	313	499	703	3,445
Long-term study brief overview		72	125	58	58	116	258
Results summary (1991-1998) with graphs		119	213	223	190	269	408
Balcer et al. 1999 Report	text	104	190	73	47	116	180
	figures	66	122	23	25	58	36
	tables	61	119	37	48	77	58
	appx. – cores	48	130	26	31	59	68
	appx. – substrates	41	107	27	26	71	56
Dose Report		62	131	92	116	120	165

The frog malformation study done by C. M. Johnson et al. (NRRI Technical Report # NRRI/TR-2001/01) showed 88 downloads in 2011, up from 72 downloads in 2010, 12 downloads in 2009.

Permits and Treatment Plans

National Pollutant Discharge Permit Issues Starting October 31, 2011, a Clean Water Act - National Pollutant Discharge Elimination System (NPDES) permit will be required for most applications of mosquito control pesticides to water. The earlier effective date of April 1, 2011 was delayed by court action to provide more time for agencies to prepare (including state agencies that are responsible for managing the NPDES permitting process).

The MPCA has outlined procedures for Pesticide NPDES Permits on their web page 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. As required, MMCD prepared a Pesticide Discharge Management Plan (PDMP) that describes 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. We will also submit a Notice of Intent (NOI) to the Minnesota Pollution Control Agency (MPCA) before April 1, 2012 using the electronic submission system being developed by MPCA. MMCD staff will continue to work with MPCA to fulfill the permit requirements. We also stand ready to serve as a resource to smaller regional mosquito control operations through the regional mosquito control association as they work to understand and comply with the permit requirements.

US Fish & Wildlife Service – Mosquitoes and Refuges MMCD continues to work with US Fish & Wildlife Service (FWS) to conduct mosquito surveillance on and near local FWS lands. Activities on the Minnesota Valley National Wildlife Refuge are done according to the stipulations of a Special Use Permit issued by the Refuge Manager. Emergency Response Procedures and Pesticide Use Proposals for the larvicide, *Bacillus sphaericus* (VectoLex®), and 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”.

The FWS regional leadership organized a meeting in January 2012 with MMCD and MDH staff and other mosquito-borne disease experts to discuss the biology of these diseases and implications for prevention and control. In 2012, we plan to work with refuge staff and MDH to update strategies for vector surveillance, methods to evaluate vector-borne disease risk, and mitigation of disease risk. We also plan to identify experts with whom to consult regarding risk mitigation on federal lands, and develop an arrangement for regular communication of findings and concerns.

Public Communication

Calls Requesting Service Calls requesting treatment began early in the season (May 16), when mosquito populations were low (Figure 6.2). By early June, the volume of calls increased, as did the mosquito population. Calls requesting treatment closely tracked a late season drop in precipitation and subsequent drop in mosquito numbers. 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 (Table 6.2). Total requests for adult mosquito treatment were down slightly in 2011; however, there was an almost four-fold increase in the number of calls requesting breeding site checks. The bulk of calls concerning breeding sites came during the first weeks of the season as callers expressed concerns with spring wetlands filling with heavy snowpack runoff. Calls requesting treatment for public and private events also decreased slightly in 2011.

As MMCD staff continued to track the rapid spread of the exotic species *Ae. japonicus* in 2011, public interaction with District staff intensified as monitoring and surveillance increased. This direct interaction, in addition to increased media scrutiny of our prevention and control measures, has led to increased calls from citizens requesting tire pick-up and recycling.

Yearly comparisons of specific types of citizen calls (Table 6.2) shows a significant increase in calls requesting checks of possible breeding sites. Significant late snowmelt and lots of standing water in early May had many callers asking if MMCD could check possible breeding sites. There were significant declines in the number of calls requesting adult mosquito treatment from 2002 to 2007, continuing a downward trend from a high of 3,602 treatment request calls recorded during 2003 when mosquito numbers were high. Treatment requests increased in 2008 to 1,375, then decreased again in 2009 to 594 (April through September). Total calls requesting treatment were up sharply again in 2010 and held steady in 2011. Calls requesting treatment for public and private events increased significantly in 2009 but were down in 2010 and again in 2011. In 2011, there were only a handful of requests to pick up dead birds for WNV due to continued low WNV activity.

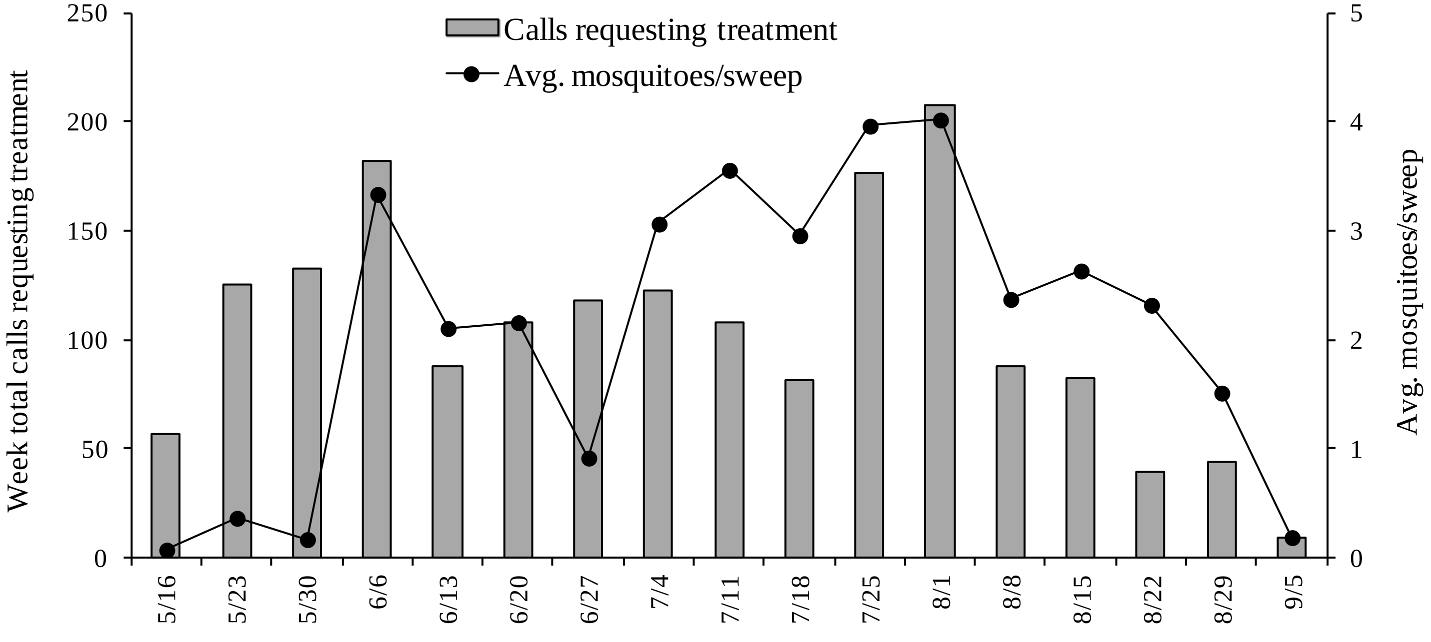


Figure 6.2 Calls requesting treatment of adults, and sweep net counts, by week, 2011.

Table 6.2 Yearly comparisons of citizen calls tallied by service request from 2002 to 2011*

	Number of Calls/Year									
Caller Concern	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Check a breeding site	1,307	1,516	984	633	610	393	220	197	164	626
Request adult treatment	3,062	2,714	2,506	1,094	854	867	1,375	594	1,384	1,291
Public event, request treatment	171	132	135	100	72	60	109	250	78	68
Request tire removal	321	236	255	242	170	208	257	253	335	316
Request or confirm limited or no treatment	**190	60	38	36	**171	49	66	61	55	56

* Includes email requests for service

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

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Notification of Control The District continues to post daily adulticide information on its web site (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 as they become available.

Social Media As part of an ongoing effort to notify residents when and where treatment is to take place, MMCD has launched a Facebook page and Twitter account. Sign up to receive MMCD Tweets (@metromosquito). People can also "friend" Metropolitan Mosquito Control District on Facebook.

MMCD currently uses the service "GovDelivery" to manage its advance notification of District residents of adult mosquito treatments. In 2012, GovDelivery will continue to manage MMCD's direct treatment notification email lists. MMCD will work with GovDelivery to make efficient use of social media to reach people who are interested in advance notification of District treatment activities.

Curriculum in Schools MMCD continued to deliver "Mosquito Mania," a 3-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 5,323 students in 53 schools during 2011. We will continue to monitor changes in middle-school learning standards and make the adjustments necessary to keep the curriculum relevant and useful.

Professional Association Support

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

- Jim Stark is continuing in the elected position of Regional Director for the North Central AMCA region, and serves on the AMCA Board of Directors.
- Diann Crane continues to provide editorial assistance with the AMCA Annual Meeting Program.

North American Black Fly Association John Walz served as President and Program Chair for this group again in 2011 and is developing their association web site. The 2012 annual meeting is in Venus, Florida in February.

North Central Mosquito Control Association Mark Smith serves 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. Many MMCD staff members were involved in planning the 2011 annual meeting, which we hosted at our North facility in Andover, MN. Mark was Moderator for the program and gave the Treasurer's Report and Update from the Board. The 2012 annual meeting is in Aberdeen, SD.

Scientific Publications, Presentations and Posters

MMCD staff attends a variety of scientific meetings throughout the year. Following is a list of papers and posters presented during 2011 and talks that are planned in 2012. Also included are publications that have MMCD staff as authors or co-authors.

2011 Publications

Johnson R. C., C. Kodner, J. Jarnefeld, D.K. Eck, and Y. Xu. 2011. Agents of human anaplasmosis and Lyme disease at Camp Ripley, Minnesota. *Vector-Borne and Zoonotic Diseases* 11:12 p.

2011 Presentations & Posters

Brogren, S. 2011. Mosquitoes on the move. Presentation: North Central Mosquito Control Association Annual Meeting, Andover, MN.

Fischer, B. and N. Read. 2011. Managing aerial GPS tracks with an enterprise web-based GIS application. Presentation: American Mosquito Control Association Annual Meeting, Anaheim, CA.

Jarnefeld, J. 2011. MMCD tick surveillance. Presentation: North Central Mosquito Control Association Annual Meeting, Andover, MN.

Johnson, K. and S. Manweiler. 2011. A comparison of adult surveillance methods for *Aedes japonicus*. Poster: Annual Meeting of the Society for Vector Ecologists, Flagstaff, AZ.

Johnson, K. 2011. *Aedes japonicus* in the North Central Region. Presentation: North Central Mosquito Control Association Annual Meeting, Andover, MN.

Johnson, K. 2011. Mosquito-borne disease prevention at MMCD. Presentation and panel discussion: North Central Mosquito Control Association Annual Meeting, Andover, MN.

LaMere, C. and J. Walz. 2011. Long-term non-target monitoring for larval black fly control operations in the Mississippi River. Poster: North Central Branch Entomological Society of America Annual Meeting, Minneapolis, MN.

McLean, M. 2011. Mosquito biology and the rise of an exotic species in Minnesota. Presentation: Minnesota Pesticide Applicator Recertification Workshop, October 21, Alexandria, MN.

Read, N., S. Brogren and J. Jarnefeld. 2011. Rain gauge network data online. Presentation: MN GIS/LIS Annual Conference, St. Cloud, MN & Poster: MN Water Resources Conference, St. Paul, MN.

Read, N. 2011. Adapting to climate change: Issues for mosquito control. Presentation: North Central Mosquito Control Association Annual Meeting, Andover, MN.

Smith, M. 2011. Budget issues – A review of your program can lead to cost savings and efficient operations. Presentation: American Mosquito Control Association Annual Meeting, Anaheim, CA.

Smith, M. 2011. Adulticide applications – review of cold fogging and barrier treatments. Presentation: North Central Mosquito Control Association Annual Meeting, Andover, MN.

Smith, M. 2011. Adulticiding equipment – importance of proper droplet size. Presentation: North Central Mosquito Control Association Annual Meeting, Andover, MN.

Stark, J. 2011. Distribution of *Aedes japonicus* in Minnesota. Presentation: Michigan Mosquito Control Association Annual Meeting, Grand Rapids, MI.

Stark, J., S. Manweiler, and K. Johnson. 2011. One Natular XRT® treatment controls WNV vectors in Minnesota catch basins all season (June-September). Presentation: American Mosquito Control Association Annual Meeting in Anaheim, CA.

Walz J. and D. Clark. 2011. National Pollutant Discharge Elimination System (NPDES): Permit application guidelines for black fly control. Presentation: North American Black Fly Association Annual Meeting, Athens, GA.

2012 Presentations & Posters

Manweiler, S. 2012. Evaluating effectiveness of barrier adulticide treatments in Minnesota. Presentation: Michigan Mosquito Control Association Annual Meeting, Troy, MI.

Smith, M. 2012. Helicopter crash: Emergency response and crisis management. Presentation: American Mosquito Control Association Annual Meeting in Austin, TX.

APPENDICES

APPENDIX A Mosquito Biology

There are 51 species of mosquitoes in Minnesota. Thirty-nine species are found within the MMCD. 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 flood water 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. It breeds in tree holes and artificial containers, especially discarded tires. The 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 artificial containers, and feeding shifts from birds to horses or humans. MMCD monitors this species using NJ 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 breed in permanent and semipermanent sites and *Cx. pipiens* and *Cx. restuans* breed in storm sewers and catch basins as well.

Culiseta melanura *Culiseta melanura* is the enzootic vector of eastern equine encephalitis (EEE). Its preferred breeding sites are spruce tamarack bogs. Adults do not fly far from their breeding sources. A sampling strategy including both larvae and adults is currently being developed.

Floodwater Mosquitoes

Spring Snowmelt *Aedes* Spring snowmelt mosquitoes are the earliest mosquitoes to hatch in the spring. They breed in woodland pools, bogs, and marshes that are flooded with snow melt water. There is only one generation per year and overwintering is in the egg stage. Adult females live throughout the summer and can take up to four blood meals. These mosquitoes do not fly very far from their breeding 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 species hatch in late April and early May. Floodwater mosquitoes lay their eggs at the margins of grassy depressions, marshes, and along river flood plains. There are multiple generations per year resulting from rainfalls greater than one inch. Overwintering is in the egg stage. Adult females live about three weeks. 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 breeds in cattail marshes and is called the cattail mosquito. A unique characteristic of this mosquito is that the larvae can obtain oxygen by attaching its specialized siphon to the roots of cattails and other aquatic plants. They overwinter in this manner. This species has one generation per year with adults beginning to emerge in late June and their peak emergence around the first week of July. They are very aggressive biters, even indoors, and will fly up to five miles from the breeding site. Peak biting activity is at dusk and dawn. Eggs are laid in rafts on the surface of the water. Surveillance of adults is best achieved with CO_2 traps.

Permanent Water Species

Larvae of other mosquito species not previously mentioned develop in permanent and semipermanent 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. The District targets four *Culex* species and one *Culiseta* species for surveillance and/or control.

Exotic or Rare Species

Aedes albopictus This exotic species is called the Asian tiger mosquito. It breeds in tree holes and containers. This mosquito is a very efficient vector of several diseases, including La Crosse encephalitis. *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 has established itself 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 of the species. 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 is an exotic species that was first detected in Minnesota in 2007. In 2008, we determined they are established in the District and southeast Minnesota. Larvae are found in a wide variety of natural and artificial containers, including rock holes and used tires. Preferred sites usually are shaded and contain water rich in organic matter. The transport of eggs, larvae, and pupae 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.

Aedes cataphylla The first occurrence of this mosquito was detected in 2008. It is a very early spring species whose range is western US and Canada, no further east than Colorado.

It is not considered a vector, but is an aggressive pest in Canada. More surveillance is needed to determine if this species is established in Minnesota.

***Psorophora* species** Species of this genus develop in floodwater areas, are human-biting, and not known as a vector for any disease. The larvae are predacious, especially on mosquito larvae and are also cannibalistic. They are considered rare in the District, but have recently been collected more often than in the past. The adult *Psorophora ciliata* is the largest mosquito found in the District.

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

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*	rare
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, localized
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*	rare
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*			601.	Not a mosquito or broken bottle		
Black Flies							
91.	*Simulium*	*luggeri*	summer, treated	96.	Other Simuliidae		
92.		*meridionale*	summer, treated	97.	Unidentifiable Simuliidae		
93.		*johansenni*	spring, treated				
94.		*vittatum*	summer, non-treated				
95.		*venustum*	spring, treated				

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

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 Mosquito Species Collected per Night in Four New Jersey Light Traps and Average Yearly Rainfall - 1965-2011

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	23.60
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

APPENDIX C Description of Control Materials

The following is an explanation of the control materials currently in use by MMCD. The specific names of products used in 2011 are given. The generic products will not change in 2012, although the specific formulator may change.

Altosid® (Methoprene) XR Extended Residual Briquet 150-day Central Life Sciences

Altosid® briquets are typically applied to mosquito breeding sites which 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.

Cattail mosquito (*Coquillettidia perturbans*) breeding 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.

Altosid® (Methoprene) Pellets Central Life Sciences

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.

Altosid® (Methoprene) SR-20 Liquid Central Life Sciences

Altosid® liquid is mixed with water and applied in the spring to mosquito breeding sites containing spring *Aedes* mosquito larvae. Typical applications are to woodland pools. Sites that are greater than three acres in size are treated by the helicopter at a rate of twenty milliliters of concentrate per acre. The dilution is adjusted to achieve the best coverage of the site. Altosid® liquid treatments are ideally completed by June 1 of each season.

Altosid® (Methoprene) XR-G Sand Central Life Sciences

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.

MetaLarv™ S-PT (Methoprene) Granules Valent Biosciences

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.

VectoBac® G [*Bacillus thuringiensis israelensis* (*Bti*)] Corn Cob Valent Biosciences

Bti corncob may be applied in all types of mosquito breeding. *Bti* can be effectively applied during the first three instars of the mosquito breeding 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, *Bti* is applied to pockety sites with cyclone seeders or power backpacks.

VectoBac® 12AS [*Bacillus thuringiensis israelensis* (*Bti*)] Liquid Valent Biosciences

Bti liquid is applied directly to small streams and large rivers to control black fly larvae. Treatments are applied 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. *Bti* is applied at pre-determined sites, usually at bridge crossings applied from the bridge, or by boat.

VectoLex® CG [*Bacillus sphaericus* (*Bs*)] Valent Biosciences

Bs corn cob may be experimentally applied in all types of *Culex* mosquito breeding. *Bs* can be effectively applied during the first three instars of the mosquito breeding cycle. Typical experimental 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, *Bs* is applied to pockety sites with cyclone seeders or power backpacks at rates of 8 lb per acre. This product is also being evaluated as a control material for catch basin applications.

VectoMax® CG [*Bti*/*Bacillus sphaericus* (*Bs*)] Corn Cob Valent Biosciences

Bti/Bs corn cob may be experimentally applied in all types of *Culex* mosquito breeding. It combines the rapid kill of *Bti* and the residual activity of *Bs*. Typical experimental applications are by helicopter in sites which are greater than three acres in size at a rate of 8 lb per acre. In sites less than three acres, *Bs* is applied to pockety sites with cyclone seeders or power back packs at rates of 8 lb per acre. This product is also being evaluated as a control material for catch basins and other small storm water management structures.

Natular™ (Spinosad) G30, XRT Clarke

Natular™ is a new formulation of spinosad, a biological toxin extracted from the soil bacterium *Saccharopolyspora spinosa* being developed for larval mosquito control. Spinosad has been used by organic growers for over 10 years. Natular™ is formulated as long release tablets (XRT) and granules (G30) and can be applied to dry and wet sites. This product is also being evaluated as a control material for catch basins, other small storm water management structures, and small ground sites.

Agnique® Mono-Molecular Film (MMF) Granules — Cognis Corporation

Agnique granules are applied directly to small mosquito breeding sites to control pupae. Experimental treatments are applied when mosquito larvae are no longer actively feeding or affected by other larvicides. Application rates are 10 lb per acre. Agnique® is applied by hand to the surface of the water creating a thin self-spreading film layer and applications lowers the surface tension of the water's surface. This loss of surface tension does not allow the pupae to easily access the water's surface and breathe without significant effort. Therefore, pupae will eventually drown and control is obtained.

Permethrin 57% OS — Clarke

Permethrin 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 light trap collections) indicates nuisance populations of mosquitoes, when employee conducted landing rate collections document high numbers of mosquitoes, or when a large number of citizen complaints of mosquito annoyance are received from an area. In the case of citizen complaints, MMCD staff evaluates mosquito levels 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 District mixes permethrin with soybean and food grade mineral oil and applies it to wooded areas with a power backpack mister at a rate of 25 oz of mixed material per acre (0.0977 lb active ingredient (AI) per acre).

Onslaught® Microencapsulated Insecticide (Esfenvalerate) — MGK, McLaughlin Gormley King

Esfenvalerate 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. Esfenvalerate is a non-restricted use compound. The District mixes Onslaught (esfenvalerate) with water and applies it to wooded areas with a power backpack mister at a rate of 25 oz of mixed material per acre (0.0919 lb AI per acre).

Scourge® 4+12 (Resmethrin) — Bayer

Resmethrin is used by the District to treat adult mosquitoes in known areas of concentration or nuisance. Resmethrin 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. Resmethrin is applied at a rate of 1.5 oz of mixed material per acre (0.0035 lb AI per acre). Resmethrin is a restricted used compound and is applied only by Minnesota Department of Agriculture licensed applicators.

Anvil® 2+2 (Sumithrin) Clarke

Sumithrin is used by the District to treat adult mosquitoes in known areas of concentration or nuisance. Sumithrin 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. Sumithrin 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). Sumithrin is a non-restricted use compound.

Pyrenone® 25-5 (Natural Pyrethrin) Bayer

Pyrenone is used by the District to treat adult mosquitoes in known areas of concentration or nuisance where crop restrictions prevent treatments with resmethrin or sumithrin. Pyrenone 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 enables 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. Pyrenone is applied at a rate of 1.5 oz of mixed material per acre (0.00172 lb AI per acre). Pyrenone is a non-restricted used compound.

Pyrocide® 7396 (5+25) (Natural Pyrethrin) MGK, McLaughlin Gormley King

Pyrocide is used by the District to treat adult mosquitoes in known areas of concentration or nuisance where crop restrictions prevent treatments with resmethrin or sumithrin. Pyrocide 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 enables 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. Pyrocide is applied at a rate of 1.5 oz of mixed material per acre (0.00217 lb AI per acre). Pyrocide is a non-restricted used compound.

Zenivex® E20 (Etofenprox) Central Life Sciences

Etofenprox is used 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 2011 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
Altosand	Methoprene	0.05	5 lb	0.0025	10
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
VectoMax® CG	*Bti/Bs*	7.20	8 lb	0.5760	7-28
			0.0077 lb* (3.5 g)	0.00055*	7-28
Permethrin 57%OS [c]	Permethrin	5.70	25 fl oz	0.0977	5
Scourge® [d]	Resmethrin	4.14	1.5 fl oz	0.0035	<1
Anvil® [e]	Sumithrin	2.00	3.0 fl oz	0.0035	<1
			1.5 fl oz	0.00175	<1
Pyrenone® [f]	Pyrethrins	2.00	1.5 fl oz	0.00172	<1
Pyrocide® [g]	Pyrethrins	2.50	1.5 fl oz	0.00217	<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] 0.30 lb AI per 128 fl oz (1 gal)

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

[f] 0.147 lb AI per 128 fl oz (1 gal) (product diluted 1:1.5 before application, undiluted product contains 0.367 lb AI per 128 fl oz)

[g] 0.185 lb AI per 128 fl oz (1 gal) (product diluted 1:1 before application, undiluted product contains 0.37 lb AI per 128 fl oz)

* 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 for 2003-2011; the actual geographic area treated is smaller because some sites are treated more than once

Control Material	2003	2004	2005	2006	2007	2008	2009	2010	2011
Altosid® XR Briquet 150-day	323	398	635	352	290	294	225	174	205
Altosid® Sand-Products	0.5	0	0	0	1,776	6,579	8,320	9,924	13,336
Altosid® SR-20 liquid	33	0	0	0	0	0	0	0	0
Altosid® Pellets 30-day	18,458	19,139	29,965	31,827	36,818	35,780	35,161	36,516	30,749
Altosid® Pellets Catch Basins	135,978	148,023	145,386	167,797	161,876	195,973	219,045	227,611	234,033
Natular™ XRT Catch Basins	0	0	0	0	0	0	0	0	1,078
Altosid® XR Briquet Catch Basins	0	0	0	5,210	6,438	40	0	0	0
VectoLex® CG granules	0	0	810	540	27	6	0	0	0
VectoMax® CG granules	0	0	0	0	0	182	5	0	0
Bti Corn Cob granules	113,198	166,299	176,947	160,780	118,128	122,251	151,801	250,478	201,957
Bti Liquid Black Fly (gallons used)	3,408	2,813	3,230	1,035	1,348	2,063	2,181	2,595	3,817
Permethrin Adulticide	6,411	8,292	7,982	5,114	3,897	8,272	4,754	8,826	7,544
Resmethrin Adulticide	68,057	71,847	40,343	29,876	24,102	64,142	12,179	27,794	24,605
Sumithrin Adulticide	14,447	15,508	25,067	5,350	5,608	35,734	7,796	26,429	29,208
Pyrenone® Adulticide	0	0	0	0	0	2,214	943	2,560	0
Pyrocide® Adulticide	0	0	0	0	0	299	0	0	0

Appendix G Technical Advisory Board Meeting Notes February 14, 2012

TAB members present:
Robert Koch, MN Dept. of Agriculture
David Neitzel, MN Department of Health, Chair
Gary Montz, MN Department of Natural Resources
Sarma Straumanis, MN Department of Transportation
Steven Hennes, MN Pollution Control Agency
Rick Bennett, US Environmental Protection Agency (remote)
Vicky Sherry, US Fish and Wildlife Service
Susan Palchick, Hennepin County Public Health
Roger Moon, University of Minnesota
Karen Oberhauser, University of Minnesota
Larry Gillette, Three Rivers Park District
Robert Sherman, Independent Statistician

MMCD staff in attendance: Jim Stark, Nancy Read, Diann Crane, Kirk Johnson, Mike McLean, Janet Jarnefeld, Carey LaMere, Sandy Brogren, Stephen Manweiler, John Walz

Guests: Jeanne Holler, Deputy Refuge Manager, MN Valley Wildlife Refuge
Hannah Friedlander, MDH (Council of State and Territorial Epidemiologists Fellow working on vector-borne disease issues)

(Initials in the notes below designate discussion participants)

Welcome and call to order

Chair Dave Neitzel called the meeting to order at 12:30 p.m. All present introduced themselves. Dave then introduced MMCD Executive Director, Jim Stark.

2011 Review and Budget

MMCD Executive Director Jim Stark welcomed TAB members and discussed MMCD's history, taxing authority, and its current budget situation. Between 2009 and 2010, MMCD reduced its levy by 5% but continued expenditures using accumulated reserves. Since 2010, the levy has remained flat and we are working to reduce expenditures as we spend down our reserves. In 2011 and 2012, we have reduced the expenditures budget and you will see that reflected in other presentations.

NPDES Permit Requirement (National Pollutant Discharge Elimination System)

Jim gave an update on the situation with the Clean Water Act and its extension to pesticide applications including mosquito control, as a result of 2009 court actions. EPA has been developing permit processes, and MN has been developing local procedures for a general permit. We expect this will be set up by the April 30, 2012 deadline for submitting a Notice of Intent.
SP - One permit will cover the District as a whole? JS – Yes.
KO – will the management plan be on the website or accessible to us? JS – we could do that. SM – mostly the plan lists who is responsible for making what decisions and where records are stored, would help someone doing an investigation, not really our treatment procedures.

Jim continued that there is legislation currently in the US Congress that would make this permitting unnecessary, will keep you posted.

Vector-Borne Disease

MMCD Vector Ecologist Kirk Johnson presented information on eastern equine encephalitis (EEE) and its vectors, including *Culiseta melanura*. EEE has higher rate of infection to neuroinvasive disease, and nearly 70% mortality rate, so it is rare but serious. This virus also affects horses. In 2011 there was a cluster of cases in horses in Wisconsin, and reflects a general increase in reported virus cases in northern areas of the US and adjoining areas in Canada. In 2011, we saw high numbers of the vector *Cs. melanura* after seeing some increase in the fall of 2010 and having high water levels over the winter. We had 94 sample pools tested for EEE and did not find any positive. Larval surveillance is challenging because of their use of small hidden pools in roots of trees in bogs. Adult surveillance in CO_2 traps showed the highest mean counts since 2002, the most recent year when horse cases occurred in nearby areas of Wisconsin. Additionally, there has been wildlife research done by MnDNR that suggests there is EEE virus exposure in moose and wolves in northern MN in 2007-2010. Kirk summarized MMCD's considerations for EEE risk reduction, including larval and/or adult control for *Cs. melanura* and bridge vectors, public education, and collaborative work with other agencies, and asked for TAB feedback.

DN – you have records of *Cs. melanura* in southern parts of district, not bogs, ideas of how they are getting there? KJ – flight range does not seem to be enough to get there, they must be using some other habitat, looking at exploring that further, have not found larvae incidentally in other habitats, might look more at upturned tree root-holes. DN – would be hard to do larval control, too hard to find? Control of bridge vectors might be the best approach; you are already working on those.
SP – collaborate with others (e.g. wild life health programs). … explore vector-borne issues – "One Health" – vaccinate
RM – reservoir is birds? Can you be more specific? KJ – don't have that info
RM – what do other agencies do? KJ – most are coastal floodplains, do control in large marshes. Michigan has similar habitat, has had difficulty with control.
KO – doesn't seem that the proportion of mosquito samples infected are increasing? KJ – we haven't collected any EEE positive mosquitoes. We are at fringe of prime habitat.
KO – the risk doesn't seem to be too great –last time it occurred was 11 years ago.

Janet Jarnefeld introduced the top news regarding ticks in the area, which is primarily new human disease, and asked Dave Neitzel to give the group an update on that. Dave discussed Powassan virus, with 11 cases throughout the state including 1 mortality. Ticks are showing 3-4% infection rate in central and southeastern Minnesota. The other new disease is human ehrlichiosis (*Ehrlichia muris*-like), new to North America, most closely matches an Asian group. There were 18 Minnesota cases reported. MDH has been working with Mayo Clinic on testing and distribution; they have done national testing and only found this bacterium in western WI and in eastern MN. The vector is *Ixodes scapularis*.

Mosquito Surveillance Methods Review

MMCD Entomologist Sandy Brogren discussed changes in the District's surveillance, focusing on changes made in the Monday night sweep collections. The number of sweep locations was reduced from 204 to 136, and the choice of locations was done to reduce clustering and give a preference to the most reliable participants, while maintaining spatial coverage of the region. Cost savings were estimated at $13,000. The value of the sweeps as a method is that it shows vector species actually attracted to humans. For example, we did get *Cs. melanura* in some sweeps this year. Sweeps also correlate well with customer calls regarding annoyance. In comparing the sweeps and CO_2 traps, counts tend to increase in sweep counts a week before CO_2 counts increase. We plan to continue to do sweeps, and want to stress their value to staff.

RK – is there a threshold? How are data used? SB – there is a threshold, usually done as a daytime sweep immediately before treatment. RK – if you keep reducing number of sweeps, do you get to the point where they are no longer useful? SM – there's more on this in the next talk. RM – comparing locations in 2010, 2011, you still have lots of clustering, consider looking at spatial stats to see where you could cut? SB – depends on staff homes, limited. Have CO_2 traps that fill in many of those parts. KO – could do some modeling to see what close sweeps could be dropped. RS – there's high variability in these, probably need many at one point. RM – use semivariogram.

Control Threshold Changes

Stephen Manweiler, Operations/Technical Services director, presented information on a change in spring *Aedes* larval thresholds done in 2011. In 2010, we used a large portion of our control budget on spring *Aedes*, and so as part of budget reductions we decided to try increasing the threshold. This resulted in a savings of about $285,000 relative to using the previous threshold, based on 2011 sample counts. The average count of spring *Aedes* in sweep counts increased, but was still at levels we consider tolerable.

Stephen continued with a response to a previous resolution from the TAB to examine possible effect of increasing the adulticide threshold from 2 to 5 per two minutes. This was done by looking at recorded sweep net samples associated with MMCD's adulticide treatments. Raising the threshold would have eliminated about 20 to 25% of treatments with ULV fog or barrier sprays. This would have resulted in about $34,000 in cost savings. In considering this, however, we have concerns that this would reduce our ability to respond to citizen calls, especially in areas where larval control is not a practical option. The 2 mosquitoes per two minutes is based on human annoyance research, not sure there would be a justification for a higher number. Also, note that the percent over 5 per two minutes varied by time of year, but not consistently between 2010 and 2011.

RM – what does it cost to apply the materials? Savings would be greater than just material costs. SM – our entire adulticide budget is only $100,000 for material. In the Audit report there is an estimate of labor for adulticide. KJ – note that for customer response, you still need to go to the location and do the sampling. JS – labor savings is also limited because you still have the people employed.

RM – how much of your budget is spent in doing control vs. gathering the information needed to direct control? I don't have a sense of that. SM – could be 40% surveillance for larval control. LG – regarding calls, if people compared what it's like in District vs outside, wouldn't complain. No question that larval control has more impact on budget than adulticides, but might still be worth considering for reducing nontarget risks. SM – it's still a small amount of acres. What the nontarget data really suggests is putting as much resource into larval control as we can. LK –

most of your complaints are about *Ae. vexans*, they tend to have a short life, by the time you get out there, would they disappear anyway, how much has treatment contributed? Combination of tolerance levels, nontarget effects, and short life, I'm skeptical of the value of this, although I know it can be very effective at reducing mosquitoes at the time. SM – hard to predict how long the mosquitoes will be around. LK – are there some people that complain many times? Or a new spot every time? SM – somewhere in between, we typically look for clusters of complaints and prioritize those locations. We also focus on places where other surveillance indicates high populations.
RM – I need to challenge your statement that *Ae. vexans* disappear rapidly, look at page 16, not that synchronized. KO – I agree though that people tend to have expectations for very low mosquito counts, would help re PR if you could say that the threshold is preventing environmental impacts, protecting other insects including some that potentially eat mosquitoes. SM – People tend to expect us to provide service and reduce mosquito numbers. We can explain why we have thresholds and what we're trying to do. KO – they also need to understand which mosquitoes have health impacts re: disease carrying and most are *Ae. vexans* and don't carry disease. SM – most citizens seem to be most concerned about biting.
LK – thank you for doing this exercise, even if we don't agree on what we'd like to do as a result.

Break 1:55-2:05 p.m.

New Control Materials

MMCD Director of Operations/Technical Services Stephen Manweiler summarized the criteria MMCD uses for selecting new larval control materials. MMCD uses a 3-step certification strategy, starting with small-scale tests, and moving up to tests on larger areas to determine effective dosages, and finally large-scale tests with efficacy verification. He focused on two materials: MetaLarv (methoprene pellets) and Natular (spinosad). MetaLarv is similar to our current Altosid pellets but from a different vendor. The material has a different shape that we hope will make it possible to do aerial treatments with lower doses which are not mechanically feasible with the current Altosid pellet design. Efficacy tests (bioassays) showed good control for the first few weeks but not significant control after 4 weeks. For 2012 we plan to test additional sites, especially spring *Aedes*, and both 3 and 4 lb doses.

SP – Given the material's shape and irregularities, how consistent is calibration? SM – It has been shown to be consistent. Swath analysis showed variation of +/- ½ lb per acre

Natular has as its active ingredient spinosad, a fermentation product of *Saccharopolyspora spinosa*, called spinosyn, which has 2 forms. It has a unique mode of action, has shown no cross-resistance, and is used to control pests in over 200 agricultural crops.

KO – what are target spp in ag? SM – A wide array, including primarily Lepidoptera (e.g., coddling moths) and some fruit maggots. KO – Is it toxic to all insects? SM – yes on contact, key is a formulation that exposes it to target insects and not nontargets.

The World Health Organization (WHO) sponsored many lab and field tests against mosquitoes, showed effective control. The WHO Programme on Chemical Safety concludes that use as a mosquito larvicide poses no untoward threat to human health or environment. Clarke began formulation development in 2002.

MMCD has tested Natular tablets in catch basins for several years and saw loss of efficacy after large rainfalls in 2 out of 3 years. That, in combination with the price set for this material, led us to conclude that this material was not something that we would continue to consider. There were also some concerns about flushing into the Mississippi near locations where there were endangered mussel species; Clarke declined to do additional nontarget testing related to that.

We have also been testing Natular granules in small wetland sites and structures such as culverts. This resulted in very good control, even 37-41 days after treatment. The 10/lb per acre rate does not give a cost advantage, so we are currently testing lower doses. Would particularly like to use this in spring conditions, found that 10lb controlled for 4 weeks, 5lb good for at least 20 d. We have also seen good control in culverts [dose?]. Conclusions – 5 lb/acre is cost-effective in several situations. For 2012 we are looking at further tests of aerial applications.

Stephen then presented some of the existing data on nontarget testing, ranging from quail and minnows to *Daphnia* and oysters, and compared that with mosquito toxicity. Concentration of spinosad in water from Natular products is estimated at 0.015-0.025 ppm. Note that Natular G30 is labeled for use in salt marshes adjoining oyster beds despite Eastern Oyster sensitivity because there is a 12x estimated margin of safety relative to the acute toxic hazard. Stephen recommended that a small group look into this issue further.

BS – in tests you've been limited by water, control level? You could inundate sites if you wanted.
Discussion tabled.

Climate Change and Mosquito Control

MMCD Technical Coordinator Nancy Read gave a presentation on predicted changes in climate for our area, based on information gathered from the MN Climate Change Adaptation Working Group (see http://climate.umn.edu/adapt/), of which she has been an active member. The most likely impacts of change on mosquito control activities are an extension of the season in both spring and fall, and we have already had to extend sampling activity and address needs for earlier and later control. An extended season could also enhance development of disease vectors and disease organisms. An increase in extreme precipitation events can also present challenges, especially in combination with higher summer temperatures, such as we experienced in an event in 2011, where the window of opportunity for applying *Bti* after a rainfall is shortened because of faster larval development. The predicted changes emphasize the need to develop ways to manage resources and budget when dealing with large fluctuations in conditions.

BS – how are you monitoring for changes? NR – we have been noting changes in the frequency of collection of some species. Some of the spring species may be decreasing.

Discussion and Resolutions

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

GM – Noted that it was good to see spinosad nontarget data, but he continues to be concerned about mollusks in some of the sites the District treats. For example, cattail sites may have extensive fauna, and woodland pools have some mollusks and key larger crustaceans that are used heavily by other species. Some summer sites are probably not as much an issue. The oyster studies examined acute toxicity, but we should really look at chronic, and note that chronic toxicity was much lower for *Daphnia*. With efficacy at 4 weeks in some of these habitats, he would really like to see some further nontarget studies in these habitats. It seems like it might have higher toxicity than methoprene and *Bti*. He would be reluctant to see MMCD moving toward more operational use in these habitats before nontarget impacts are studied.
KO – Said she had the same concerns, and didn't see other insects in data in slides that were presented SM – there is a lot of data suggesting that topical sensitivity high, as-applied sensitivity is lower. Toxicity in chironomids is closer to that in mosquitoes. There is a lot of data available. KO – would like to add insects to concerns about crustaceans and mollusks.
RM – Proposes that some TAB members meet in the next month to review the literature and propose some studies for this summer.
SM – I would like to know more about what organisms should be included. When we were looking at doing something with river organisms I looked at testing protocols for those and shared, Clarke declined to fund. If we can come up with a pragmatic way to do some of these, Clarke may fund some.
RM – I wasn't thinking about characterizing exposure, I was thinking of testing toxicity – if the toxicity isn't there, don't worry about exposure.
GM – most info I found on nontarget for Natular is for terrestrial organisms, didn't see much on aquatic. Earlier there were concerns about oysters and mollusks, also honeybees, but approach there was to use the material when these non-targets are not around, The material was ok after it dried. I would like to get aquatics info; it might be ok to use in some areas and not others.
SM – would like to know why EPA felt it was ok, would like to get at the information they used. Sometimes companies are reluctant to release information.

MOTION: That the TAB establish a subcommittee to continue literature review on nontarget impacts of spinosad on aquatic invertebrates, and report back to the TAB by e-mail within 2 months. Made by RM, second by BS

Discussion – DN – who would be available and interested? GM, SH, KO, BK
Motion Carried, no opposition.

MOTION: That until there are good indications that spinosad applications will not have an impact on nontarget invertebrates, the TAB recommends MMCD limit applications to small-scale testing and not move to operational use. Made by KO, second by GM

Discussion – RM – probably will not be unambiguous results of review. GM – if information shows that there is a lack of data, it would be prudent to hold off on moving to operational use until that information is available. SM – which nontargets would be the main concern, and what kind of testing, acute? Chronic? RM – how close are you to going operational? SM – a year or two. BS – in our experience, nontarget studies can go on forever, need to look at this and identify major problems and what needs to be resolved. DN – may also depend on whether you think it

will work operationally, may affect habitats and organisms of concern. RK – concern re “any impacts?”
Motion Carried, 1 vote against (BS, concern re wording of motion)

LG – Years ago, I remember MMCD staff saying that in dry years they would use some of the money saved on larvicide treatments to provide additional adult treatments. I didn’t think this was very wise, because mosquito populations were generally low at this time. Would this be a possible operating procedure if the summer of 2012 was dry?
JS – No. When I became Director, MMCD established that we are primarily a larval control program, and we’re still committed to that principle. This year may have some savings because of cattail habitats drying down.

RM – commend staff for taking TAB recommendations seriously, including evaluating surveillance and economizing on control materials.

KO - appreciated having MMCD’s involvement in the Climate Change working group, including Nancy Read’s contributions to leadership of the group.

MOTION: That the TAB supports MMCD’s commitment to involvement in the Climate Change Adaptation Working Group. Made by KO, second by RM
Motion Carried, no opposition.
JS expressed his appreciation to staff and TAB
Meeting adjourned 3:35 p.m.

Next chair will be representative from Mn Dept. of Ag. (Robert Koch)

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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