Metropolitan Mosquito Control District

2017 Operational Review & Plans for 2018

Annual Report to the Technical Advisory Board

60th Anniversary
1958-2018

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 2018

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Jim Kordiak	Anoka County
Robyn West	Anoka County
James Ische	Carver County
Tom Workman	Carver County
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Gary Kriesel	Washington Co.
Fran Miron	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.

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Robert Sherman	Independent Statistician
Vicki Sherry	US Fish & Wildlife Service
Sarma Straumanis	Mn Dept. of Transportation
Christine Wicks	Mn Dept. of Agriculture

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Diann Crane	Assistant Entomologist
Janet Jarnefeld	Technical Services/Tick
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Commissioner Tom Wolf, Chair
Metropolitan Mosquito Control Commission
2099 University Avenue West
St. Paul, MN 55104

Dear Commissioner Wolf,

The Technical Advisory Board (TAB) met on February 21, 2018 to review and discuss MMCD operations in 2017 and plans for 2018. 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. The TAB supports the MMCD's review of raising the threshold for spring *Aedes*, with consideration for targeting areas where these mosquitoes are most likely to affect human populations.

2. The TAB thanks MMCD's Entomologist, Sandy Brogren, for her many years of work building up the lab and surveillance systems to a level recognized as one of the best in the country and reaffirms the importance of this work to generate an understanding of mosquito biology essential to managing an effective, efficient, and environmentally sound mosquito control program.

3. The TAB supports the program presented in the 2017 Operational Review and 2018 Plan and acknowledges the efforts of the MMCD staff on its presentation.

4. The TAB commends MMCD for its efforts to improve the cost efficiency of its programs while continuing to protect public health through vector control and considering long-term environmental effects of its programs.

5. The TAB recommends MMCD review current developments regarding CRISPR-Cas9 and gene drive techniques being used in the control of mosquitoes and ticks.

Sincerely,

Roger D. Moon

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Chair, Technical Advisory Board
Emeritus Professor of Entomology, University of Minnesota

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Table of Contents

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Executive Summary

The Metropolitan Mosquito Control District (MMCD or the District) strives to provide cost-effective service in an environmentally sound manner. This report presents MMCD staff efforts to accomplish that goal during 2017 through mosquito, black fly and tick surveillance, disease monitoring, mosquito and black fly control, new product testing, data management, and public information. It also presents plans for 2018 as we continue to provide an integrated mosquito management program for the benefit of metro area citizens.

Surveillance

Rainfall is a key factor for understanding floodwater mosquito populations and planning control efforts. There were 12 summer rainfall events sufficient to produce summer *Aedes* broods. Five large broods and 7 small to medium sized broods occurred from May – September. Rainfall for the weeks of April 30 through September 30, 2017 was 22.27 inches, which is 2.59 inches above the 58-year District average of 19.68 inches. The dry, warm winter resulted in low numbers of spring *Aedes* adults, the lowest since 2000.The two largest rain events occurred in May and August; the rest of the rain events were scattered throughout the season. There were only two weeks with above average levels of *Aedes* mosquitoes. *Coquillettidia perturbans* was the most numerous species and had the highest captures in the 17-year history of Monday night surveillance.

The District continued monitoring the distribution of ticks in the metro area. The average number of *I. scapularis* collected per mammal was 1.21, lower than the average of 1.68 (a record high) in 2016. The number of sites positive for *I. scapularis* was 69, down from the record high of 82 out of 100 sites monitored in 2016.

Adult black fly populations were the second lowest recorded since the black fly program began in 1984 averaging 0.24 black flies per overhead sweep sample.

Disease

District staff provides a variety of disease surveillance and control services, as well as public education, to reduce the risk of mosquito-borne illnesses such as La Crosse encephalitis (LAC), western equine encephalitis (WEE), eastern equine encephalitis (EEE), West Nile (WNV) encephalitis, as well as tick-borne illnesses such as Lyme disease and human anaplasmosis (HA). In 2017, the Minnesota Department of Health reported eight cases of WNV in District residents. MMCD tested 708 mosquito pools using the RAMP® method, 55 of which were positive for WNV. A warm period from May 13 through May 16 may have initiated the WNV season in 2017. A second warm period lasting the first two weeks of June also facilitated early season WNV amplification as well as vector mosquito development. Surveillance for the virus in mosquitoes began during the week of June 5 and the virus was detected in three samples that week. Detections of the virus occurred each week of the season except the final week of surveillance. There was one case of LAC diagnosed in a non-District resident. Eliminating water-holding containers that provide larval habitat for many vector species is an effective strategy for preventing mosquito-borne illnesses, and in 2017 staff collected and recycled 14,304 tires. 2017 also saw 17 cases of Jamestown Canyon illnesses in Minnesota with four occurring in District residents.

Control

MMCD's program focuses on control of mosquitoes while they are in the larval stage, and uses the insect growth regulator methoprene, the bacteria *Bacillus thuringiensis* var. *israelensis* (*Bti*) and *B. sphaericus*, and the bacterial product spinosad. Larvicide treatments in 2017 (195,031 acres) were lower than the record set in 2016 (305,969 acres). A cumulative total of 253,260 catch basin treatments were made in three rounds to control WNV vectors. Adulticide treatments in 2017 (41,908 acres) were much lower than 2016 levels when 82,583 acres were treated in response to widespread *Ae. vexans* emergence, higher numbers of customer calls, and increasing numbers of *Culex* (WNV vectors).

To control black flies in the metro area, MMCD treated 14 small streams sites with *Bti* when the *Simulium venustum* larval population met the treatment threshold. MMCD also made 63 large rivers treatments with *Bti* when the larval population of the target species met the treatment threshold.

Product and Equipment Testing

Evaluation of products, equipment, and processes is an important part of our program. Tests of the methoprene formulation MetaLarv S-PT achieved an average of 81.9% inhibition of spring *Aedes* emergence, and we are evaluating whether to expand its use in that time of year. Tests of the effectiveness of our fall cattail mosquito larval control treatments with VectoLex® FG showed that emergence of adult *Cq. perturbans* was much lower in treated vs. untreated sites (over 91% control). Preliminary tests of VectoPrime® FG, a new formulation that contains both *Bti* and methoprene, found floodwater *Aedes* larval and pupal abundance reduced by 86%. A large-scale test of MGK Sumilarv® 0.5 G, containing the insect growth regulator pyriproxyfen, found it could be effective at controlling mosquito larvae in catch basins over an entire season. Examination of adult mosquito numbers in the core populated area ("P1") vs outer areas suggested that expense reductions that reduced outer area treatments did not affect adult cattail and spring mosquito numbers for most residents as much as changing weather conditions did. Tests of a natural pyrethrin formulation that meets USDA Organic standards (Merus®) showed that it decreased adult mosquito abundance immediately after treatment.

Data Management and Public Information

We continued improving MMCD's custom web-based data management system with additions to "Mobile Map," rainfall, and other tools to help all staff use data to answer field operations questions. The public web map on www.mmcd.org was also updated to make it easier for citizens to access information on treatments.

Sustainability efforts continued to expand and become an integral part of MMCD operations. For example, organics separation at the St. Paul Main Office contributed to a 45.2% reduction in trash.

Requests for adult mosquito treatment decreased in 2017 compared to the record high in 2016. The number of requests reached its peak early in the season and then declined, similar to the adult mosquito counts. Calls requesting site checks for larval mosquitoes continued to increase in 2017 compared to previous years.

Chapter 1 *Mosquito Surveillance*

2017 Highlights

- Rainstorms produced five major mosquito broods
- Warm, dry, late spring; only two weeks with above average *Aedes* mosquitoes
- *Coquillettidia perturbans* was most numerous species, highest in 17-year history
- Major summer *Aedes* mosquito peak occurred in mid-May
- Identified 18,896 larval samples
- Collected 13 *Culex erraticus* adults in 10 trap locations
- *Aedes albopictus* larvae found at tire recycling facility in Savage

2018 Plans

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

Background

The Metropolitan Mosquito Control District (MMCD or the District) conducts larval and adult mosquito surveillance to determine levels of mosquitoes present, measure annoyance, and to detect the presence of disease vector species. A variety of surveillance strategies are used because 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.

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

The District focuses on four major groups of human-biting mosquito species: spring *Aedes*, summer *Aedes*, *Coquillettidia perturbans*, and disease vectors. Snowmelt induces spring *Aedes* (15 species) eggs to hatch in March and April and adults emerge in late April to early May. These species have one generation each season; however, adults can live for three months and lay multiple egg batches. Summer *Aedes* (five species) begin hatching in early May in response to rainfall and warmer temperatures. Adults can lay multiple egg batches throughout the summer and can live up to two weeks. *Coquillettidia perturbans* (cattail mosquito) develops in cattail marshes. There is one emergence, which begins in early June, peaking around July 4. Disease vectors include *Aedes triseriatus*, *Culiseta melanura*, and *Culex* mosquitoes (*Cx. pipiens*, *Cx. restuans*, *Cx. salinarius*, and *Cx. tarsalis*). 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.

2017 Surveillance

Precipitation

Rainfall is a key factor for understanding floodwater mosquito populations and planning control efforts. For over 50 years MMCD has used a network of rain gauges, read daily by staff or volunteers, to measure rainfall. These data were shared with the Minnesota State Climatologist's office for analysis, typically at the end of each month. Our rain gauge data is entered directly into the Community Collaborative Rain, Hail, and Snow (CoCoRaHS) system to make the measurements available more quickly for each other, the National Weather Service (NWS), and the public. This system has limitations because of the sparse gauge network in some areas of the District.

The NWS River Forecast Centers (RFC) create a 4x4 km grid of precipitation estimates based on a combination of Nexrad radar, satellite, and ground rain gauge measures (including MMCD's gauges submitted through CoCoRaHS). Although it is not perfect, this dataset is one of the best sources of timely, high resolution precipitation information available.

Since 1959, average seasonal rainfall in the District is calculated from May through September. The rainfall for the weeks of April 30 through September 30, 2017 was 22.27 inches, which is 2.59 inches above the 58-year District average of 19.68 inches. Historical rain data from District and CoCoRaHS gauges were used to calculate the averages. April rainfall amounts are included in the graph to indicate their possible influences on adult mosquito emergence in May. The two largest rain events occurred in May and August (Figure 1.1); the rest of the rain events were scattered throughout the season.

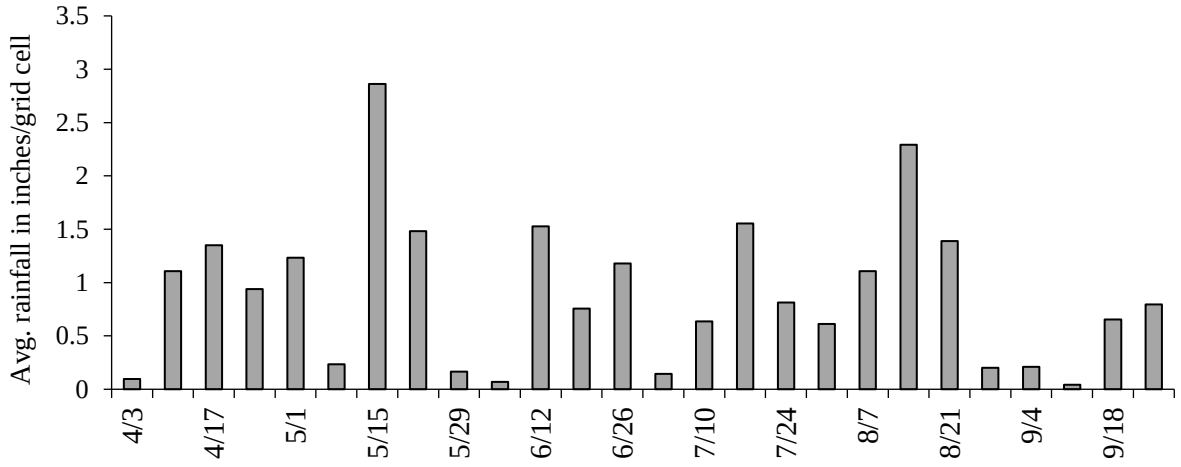


Figure 1.1 Weekly rainfall amounts per gauge, 2017 (CoCoRaHS data, Sunday – Saturday). Dates represent the Monday of each week.

Typically, spring *Aedes* mosquito 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 and precipitation amounts influence how quickly larvae develop in sites. The winter of 2016-2017

was warm, with very little snow, thus, less snowmelt to induce hatching of larval spring *Aedes* mosquitoes. Minnesota had a total of 32 inches of snow from November-April, most of which fell in December (15.8 inches). February was very warm, 10.4 °F above normal, and precipitation was slightly below normal (Figure 1.2). The first larval sample of the year was taken on March 8.

April had warm temperatures and above normal precipitation (Figure 1.2) that fueled the brood of spring *Aedes* and also summer *Aedes* to hatch. On May 6, we switched from our spring *Aedes* control threshold (see Chapter 4, Table 4.1, p. 44) to our summer *Aedes* threshold, just in time for the largest rain event of the season on May 15-17.

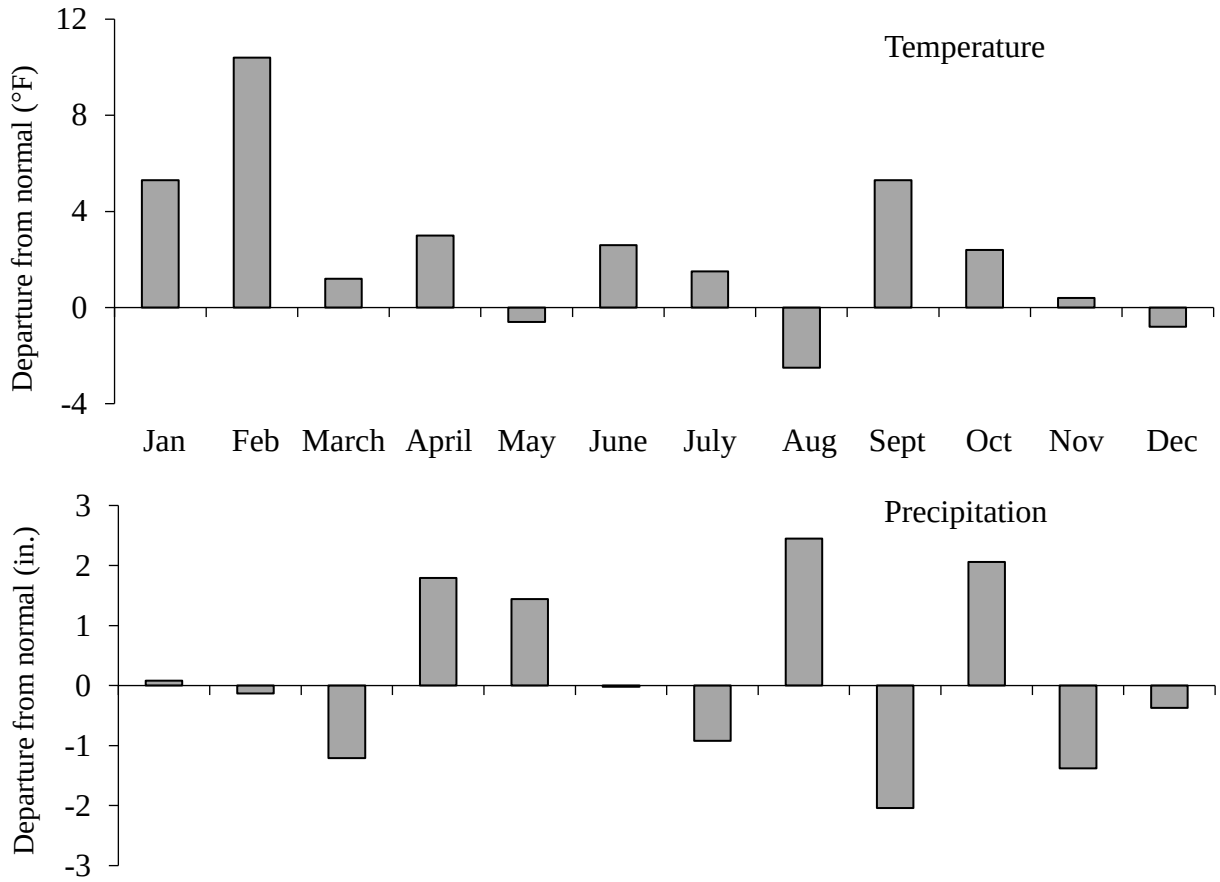


Figure 1.2 Monthly departures from normal for temperature and precipitation January-December, 2017 (source: National Weather Service, Twin Cities Station).

There were 12 summer rainfall events sufficient to produce summer *Aedes* broods. Five large broods and 7 small to medium sized broods occurred from May - September; the amount of area affected by rainfall, the amount of rainfall received, and the resultant amount of mosquito production determines brood size. Figure 1.3 depicts the geographic distribution and magnitude of weekly rainfall received in the District from April through September 2017. Since some weeks had multiple rain events, the cumulative weekly rainfall does not identify individual rain events.

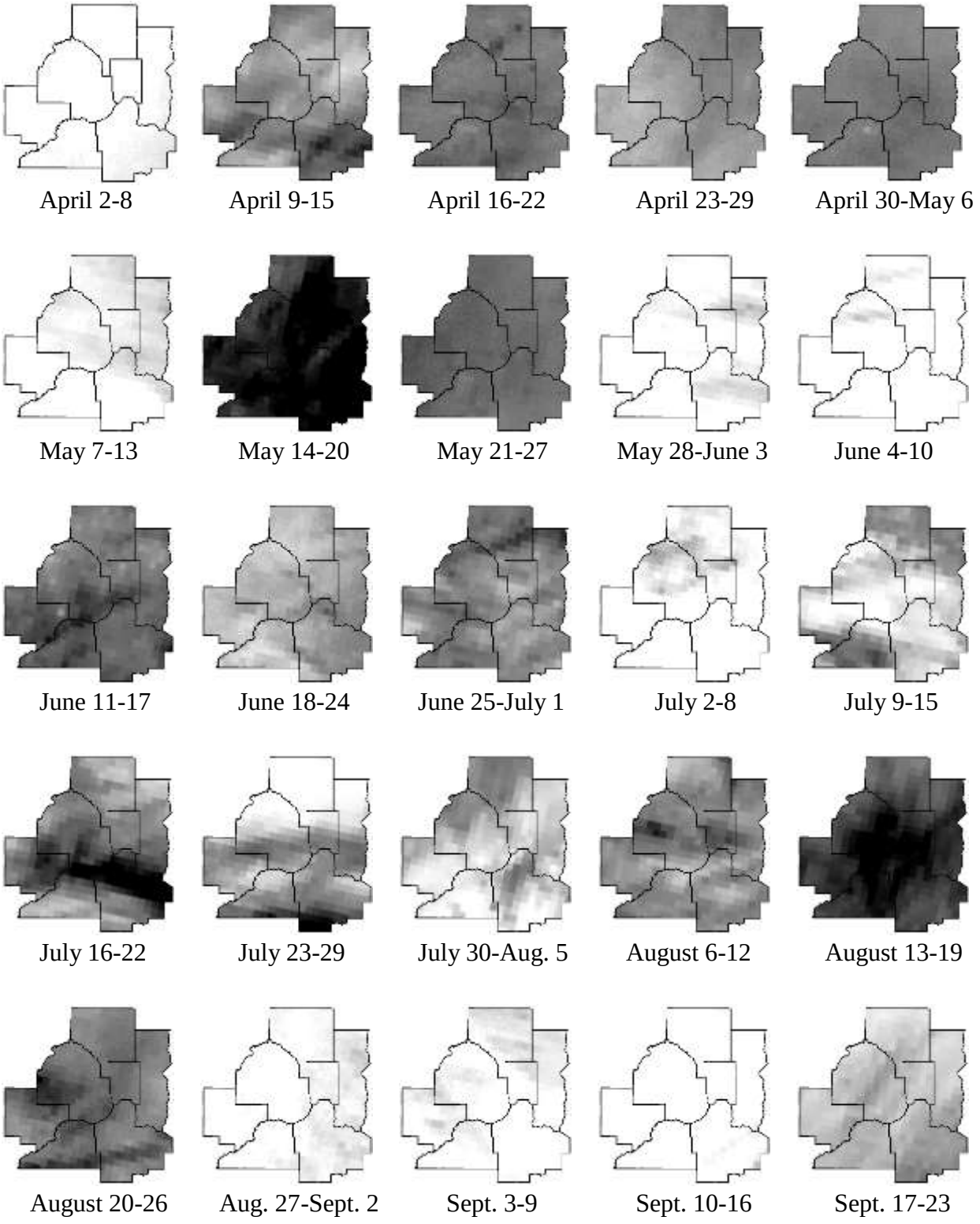


Figure 1.3 Weekly rainfall in inches, 2017. RFC-corrected data using 406 4x4 km grid cells. Inverse distance weighting was the algorithm used for shading of maps.

Larval Collections

Larval mosquito inspections are done to determine if targeted species are present at threshold levels or to obtain species history in development sites. A variety of habitats is inspected to monitor the diverse fauna. Habitats include wetlands for *Aedes* and *Culex*, catch basins and stormwater structures for *Cx. pipiens* and *Cx. restuans*, cattail marshes for *Cq. perturbans*, tamarack bogs for *Cs. melanura*, and containers, tires, and tree holes for *Ae. triseriatus*, *Ae. japonicus*, and *Ae. albopictus*. The majority of larval collections are taken from floodwater sites using a standard four-inch dipper. The average number of larvae collected in a minimum of 10 dips is recorded as the number of larvae per dip. Larvae are placed in sample vials and sent to the Entomology Lab for species identification.

To accelerate the identification of samples from sites to be treated by helicopter, larvae are identified to genus only, except for *Culex* larvae, which are identified to species to differentiate vectors. Staff process lower priority samples as time permits and those are identified to species. In 2017, lab staff identified 18,896 larval samples, the lowest amount in the last eight years (Figure 1.4).

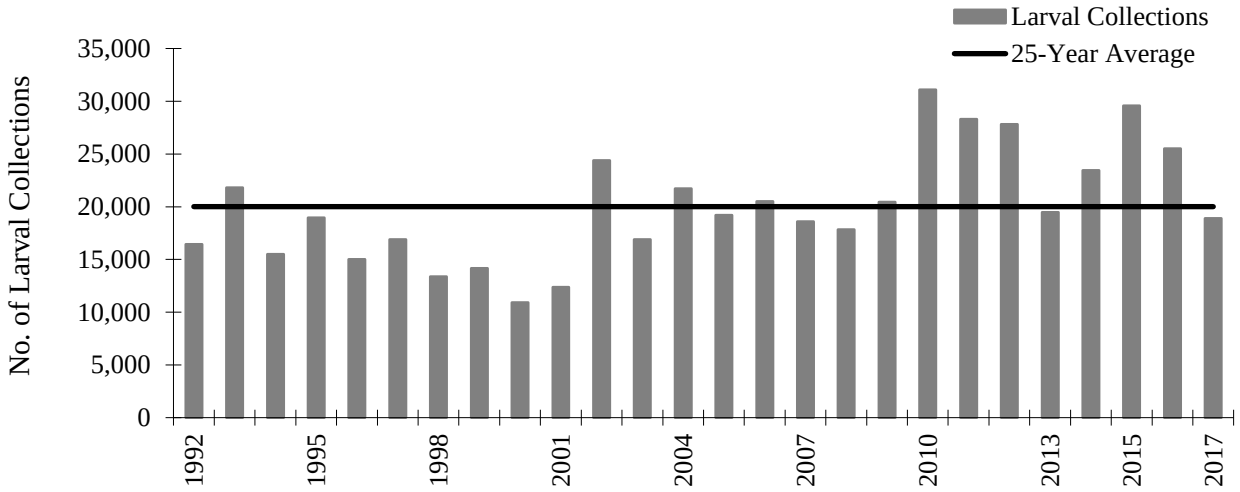


Figure 1.4 Yearly total larval collections, 1992-2017, and 25-year average.

The results of 10,159 samples identified to species, calculated as the percent of samples in which the species was present, is shown in Table 1.1. Most larval sampling takes place in natural wetlands but a significant amount of sampling is done in catch basins, stormwater structures, and other man-made features (e.g., swimming pools, culverts, artificial ponds). Those results are displayed separately (shaded column) from the natural wetlands results in Table 1.1. *Culex* mosquitoes are by far the most common species found in man-made features.

Aedes vexans is the most common species collected from natural development areas, occurring in 51.9% of the samples. The next three in the top five are nonhuman-biting species: *Culex territans* (15.5%), *Culiseta inornata* (13.0%), and *Cx. restuans* (8.4%), a West Nile virus (WNV) vector. *Aedes cinereus* (8.3%), a spring and summer species, was number five. Each genus of mosquitoes has a category that is mostly first instar stage larvae that are unidentifiable to species.

Table 1.1 Percent of samples where larval species occurred in wetland collections by facility and District total, and the District total for structure samples, 2017; the total number of samples processed to species is in parentheses. A percent of total less than 0.1 is indicated by <.

	Percent of samples where species occurred by facility							
Species	North (1,591)	East (2,113)	South Rosemount (2,697)	South Jordan (1,149)	West Plymouth (434)	West Maple Grove (772)	Wetland Total (8,756)	Structures Total (1,403)
Aedes abserratus	0.5	0.4	<				0.2	
aurifer	<						<	
canadensis	<	0.4	0.7	0.5	0.5		0.4	
cinereus	14.2	10.5	2.2	7.8	14.5	8.8	8.3	0.1
communis								
dorsalis			<	<	0.5	0.3	<	<
excrucians	1.8	1.6	0.3	0.6	1.8	1.8	1.1	
fitchii	0.3	0.5	<	<		0.4	0.3	
flavescens								
hendersoni								0.2
implicatus	0.1	<		<	0.7	0.1	0.1	
intrudens								
japonicus	0.8	0.2	0.2	<	0.2	0.3	0.3	14.1
nigromaculis								
punctor	0.1	0.6				0.1	0.2	
riparius	<	0.2	<	<	0.5	0.3	0.1	
spencerii								
sticticus	1.6	0.3	0.5	0.7	0.7	0.4	0.7	
stimulans	1.8	2.3	1.1	2.4	2.1	2.3	1.9	
provocans	0.2	0.2				0.3	0.1	
triseriatus	<	<					<	3.3
trivittatus	2.2	2.3	10.0	6.2	1.8	1.6	5.1	0.3
vexans	61.1	30.3	60.0	63.7	52.5	45.7	51.9	7.6
Ae. species	39.0	29.8	36.9	28.5	36.9	42.4	34.9	5.8
Anopheles earlei								
punctipennis	1.1	1.0	0.5	0.3	1.2	0.1	0.7	0.8
quadrimaculatus	1.2	0.9	<	0.3	0.2	0.3	0.5	0.1
walkeri			<				<	
An. species	3.1	3.8	1.1	1.0	1.4	1.4	2.2	2.3
Culex erraticus								
pipiens	4.7	3.7	3.1	2.3	6.7	5.7	3.9	50.6
restuans	8.2	8.4	9.2	7.7	11.3	6.3	8.5	70.2
salinarius	<	<					<	0.2
tarsalis	1.8	0.9	0.5	1.7	1.4	2.8	1.3	1.9
territans	14.8	31.3	8.9	11.0	5.8	8.0	15.5	8.5
Cx. species	3.5	2.7	2.2	3.9	2.3	2.8	2.9	46.0
Culiseta inornata	6.6	13.1	10.6	15.1	25.8	23.8	13.0	3.9
melanura	<						<	
minnesotae	1.1	3.5	0.6	0.8	1.4	0.6	1.4	<
morsitans		0.1	<				<	
Cs. species	2.9	10.6	1.3	1.6	3.0	1.9	4.0	<
Or. signifera								
Ps. ciliata								
columbiae								
ferox	0.2	<	0.3	0.2			0.2	
horrida								
Ps. species	0.4	0.3	0.8		0.2	0.1	0.4	
Ur. sapphirina	0.7	0.9	0.1	0.2		0.5	0.5	

Adult Mosquito Collections

As stated earlier, the District employs a variety of surveillance strategies to target different behaviors of adult mosquitoes. Sweep nets are used to survey the mosquitoes attracted to a human host. We use carbon dioxide-baited (CO_2) traps with small lights to monitor host-seeking, phototactic species. New Jersey (NJ) light traps monitor only phototactic mosquitoes. Large hand-held aspirators are used to capture mosquitoes resting in the understory of wooded areas in the daytime. Gravid traps with liquid bait are used to attract and capture egg-laying *Culex* and *Aedes* species and ovitraps are used to collect eggs of container-inhabiting vector species (i.e., *Ae. triseriatus, Ae. japonicus, Ae. albopictus*). The information obtained from sampling is used to direct control activities and to monitor vector populations and disease activity—specimens collected are tested for disease. Treatment thresholds are discussed in Chapter 4: Mosquito Control (p. 47).

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 two-minute sweep net collections and/or set overnight CO_2 traps in their yards every Monday night from May - September. To achieve a District-wide distribution of CO_2 traps, other locations such as parks or wood lots are chosen for surveillance as well. Figure 1.5 shows the sweep net and CO_2 trap locations and their uses [i.e., general monitoring, virus testing, eastern equine encephalitis (EEE) vector monitoring]. Sweep net collections and CO_2 traps were operated once weekly for 20 weeks, May 8-September 18.

Most of the mosquitoes collected are identified to species, but in some cases, species are grouped together to expedite sample processing. *Aedes* mosquitoes are grouped by their seasonal occurrence (spring, summer). Others are grouped because species-level separation is very difficult (e.g., *Ae. abserratus/punctor, Cx. pipiens/restuans*). Generally, the most abundant species captured in sweep nets and CO_2 traps are the summer *Aedes*, *Cq. perturbans*, and spring *Aedes*. *Culex tarsalis*, unlike the other *Culex* species that prefer birds as hosts, is also attracted to mammals; it is important in the transmission of WNV to humans and is best captured in CO_2 traps.

Sweep Nets CO_2 Traps

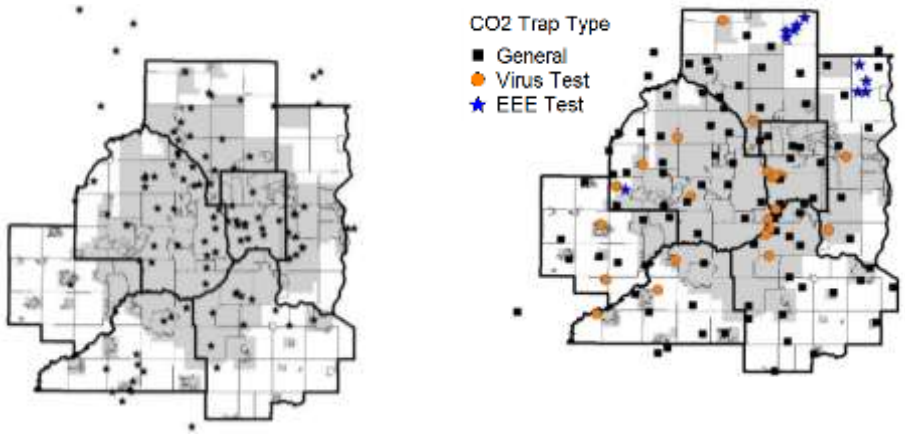


Figure 1.5 Locations of weekly sweep net and CO_2 trap locations used to monitor general mosquito populations and disease vectors (virus test and EEE test), 2017.

Sweep Net The District uses sweep net collections to monitor mosquito annoyance to humans during the peak mosquito activity period, which is 35-40 minutes after sunset for most mosquito species. The number of collectors varied from 32-77 per evening.

In 2017, staff took 1,146 collections containing 1,567 mosquitoes. The average number of summer *Aedes* collected in the evening sweep net collections in 2017 was the lowest since 2009 (0.21/sweep), and well below the 17-year average (Table 1.2).

Populations of *Cq. perturbans* were higher than the last four years and above the 17-yr average. The dry, warm winter resulted in low numbers of spring *Aedes* adults, the lowest since 2000 (0.01/sweep). *Culex tarsalis,* which are infrequently collected in sweep net samples, were the lowest in sweep history.

Table 1.2 Average number of mosquitoes collected per evening sweep net collection within the District, 2013-2017 and 17-year average, 2000-2016 (± 1 SE).

Year	Summer *Aedes*	*Cq. perturbans*	Spring *Aedes*	*Cx. tarsalis*
2013	1.87	0.12	0.03	0.005
2014	2.33	0.12	0.20	0.008
2015	1.27	0.29	0.05	0.006
2016	1.55	0.37	0.03	0.005
2017	0.79	0.49	0.01	0.001
17-yr Avg.	1.84 (±0.08)	0.33 (±0.01)	0.12 (±0.01)	0.009 (±0.0004)

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 2017, we placed 136 traps at 123 locations to allow maximum coverage of the District (Figure 1.5). The "General" trap type locations are used to monitor non-vector mosquitoes. There are thirteen locations with low traps (~5 ft above ground) paired with elevated traps placed in the tree canopy (~25 ft above ground) to collect *Culex* species, which are active where birds are resting. All *Culex* specimens collected from 45 traps are tested for WNV (Figure 1.5, "Virus Test" trap type). Additionally, *Cx. tarsalis* from all locations are tested. Eleven trap locations in the network have historically captured *Cs. melanura* and are used to monitor this vector's populations and to obtain specimens for EEE testing (Figure 1.5, "EEE Test" trap type).

A total of 2,207 trap collections taken contained 644,633 mosquitoes in 2017. The total number of traps operated per night varied from 105-115. Historically, *Ae. vexans* is the number one pest captured in the CO_2 traps, but *Cq. perturbans* was the most numerous species in 2017, the highest captures in the 17-year history of Monday night surveillance! This may be due to high yearly rainfall amounts replenishing the cattail habitats the last three years and also our cost-

saving decision to not treat priority zone 2 (Figure 4.1, page 43) cattail sites in 2017. Populations of *Ae. vexans* were lower than three of the last four years and lower than the 17-year average (Table 1.3). Captures of spring *Aedes* increased in 2017 but remained well below the long-term average. *Culex tarsalis* numbers were very low, well below average, and are discussed later in the vector surveillance section of this chapter.

Table 1.3 Average numbers of mosquitoes collected in CO_2 traps within the District, 2013-2017 and 17-year average, 2000-2016 (± 1 SE).

Year	Summer *Aedes*	*Cq. perturbans*	Spring *Aedes*	*Cx. tarsalis*
2013	303.6	22.5	5.7	2.4
2014	255.4	22.4	7.9	1.9
2015	115.7	37.4	1.7	1.0
2016	207.6	51.0	1.3	1.4
2017	134.8	140.8	2.5	0.6
17-yr Avg.	213.5 (±31.8)	47.7 (±6.6)	8.3 (±2.1)	2.0 (±0.3)

Geographic Distribution The weekly District geographic distributions of the three major groups of nuisance mosquitoes (i.e., spring *Aedes*, summer *Aedes*, and *Cq. perturbans*) collected in CO_2 traps are displayed in Figures 1.6, 1.7, and 1.8. The computer software interpolates the data between collection points, so some dark areas are the result of one collection without another close by. What little populations of spring *Aedes* we had were confined to a few locations on the outer edges of the District or in localized areas (Figure 1.6). Summer *Aedes* were collected at above threshold levels (≥130 mosquitoes/trap night) in some scattered locations throughout the season, but June had the highest District-wide populations of the season (Figure 1.7). The one generation of *Cq. perturbans* occurred in record-breaking numbers in their usual hot spots in the northern District borders and in untreated priority zone 2 areas in the District (Figure 1.8).

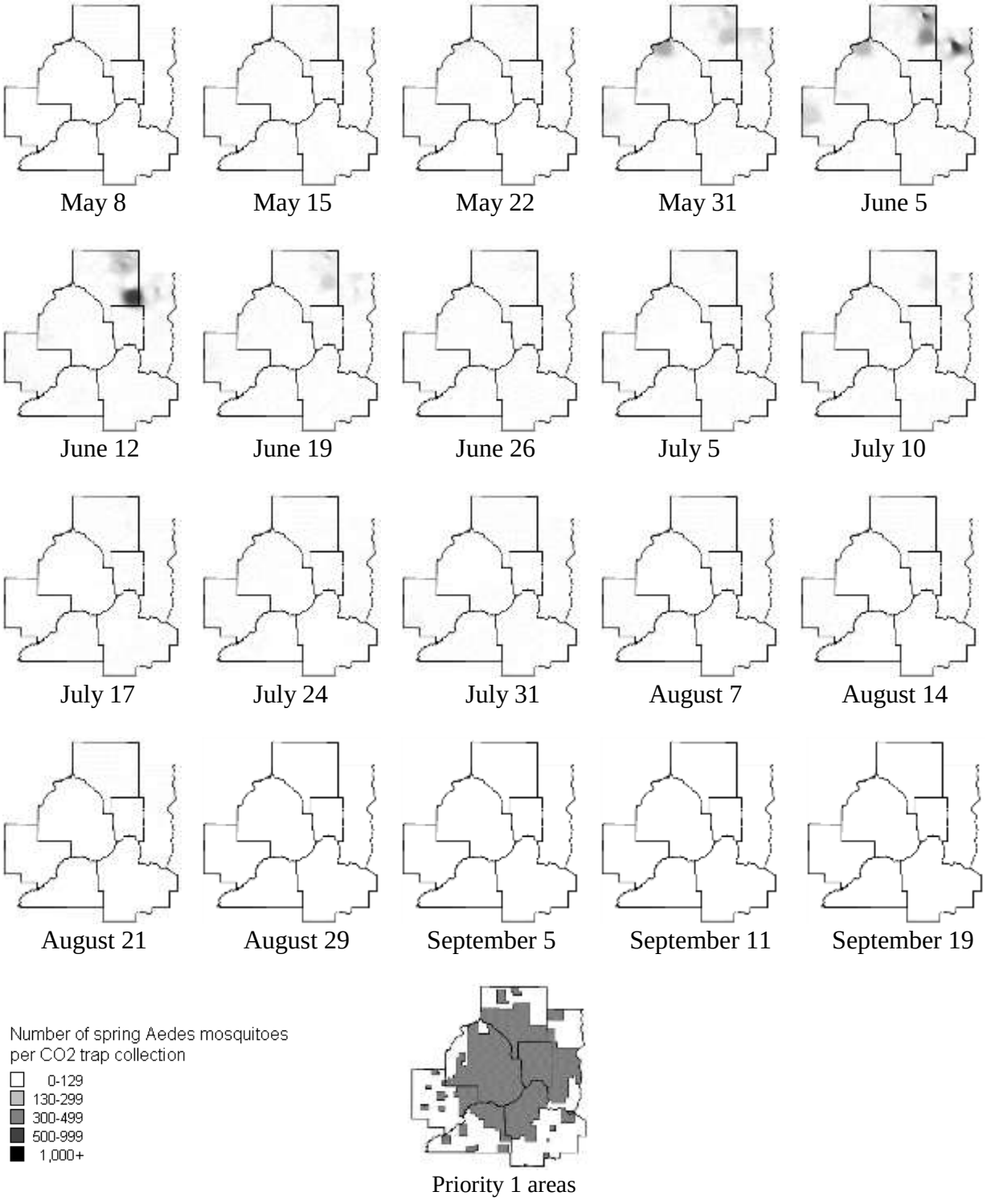


Figure 1.6 Number of spring *Aedes* in District low (5 ft) CO_2 trap collections, 2017. The number of traps operated per night varied from 105-115. Inverse distance weighting was the algorithm used for shading of maps. Treatment threshold is >130 mosquitoes/trap night. Priority 1 area map for reference.

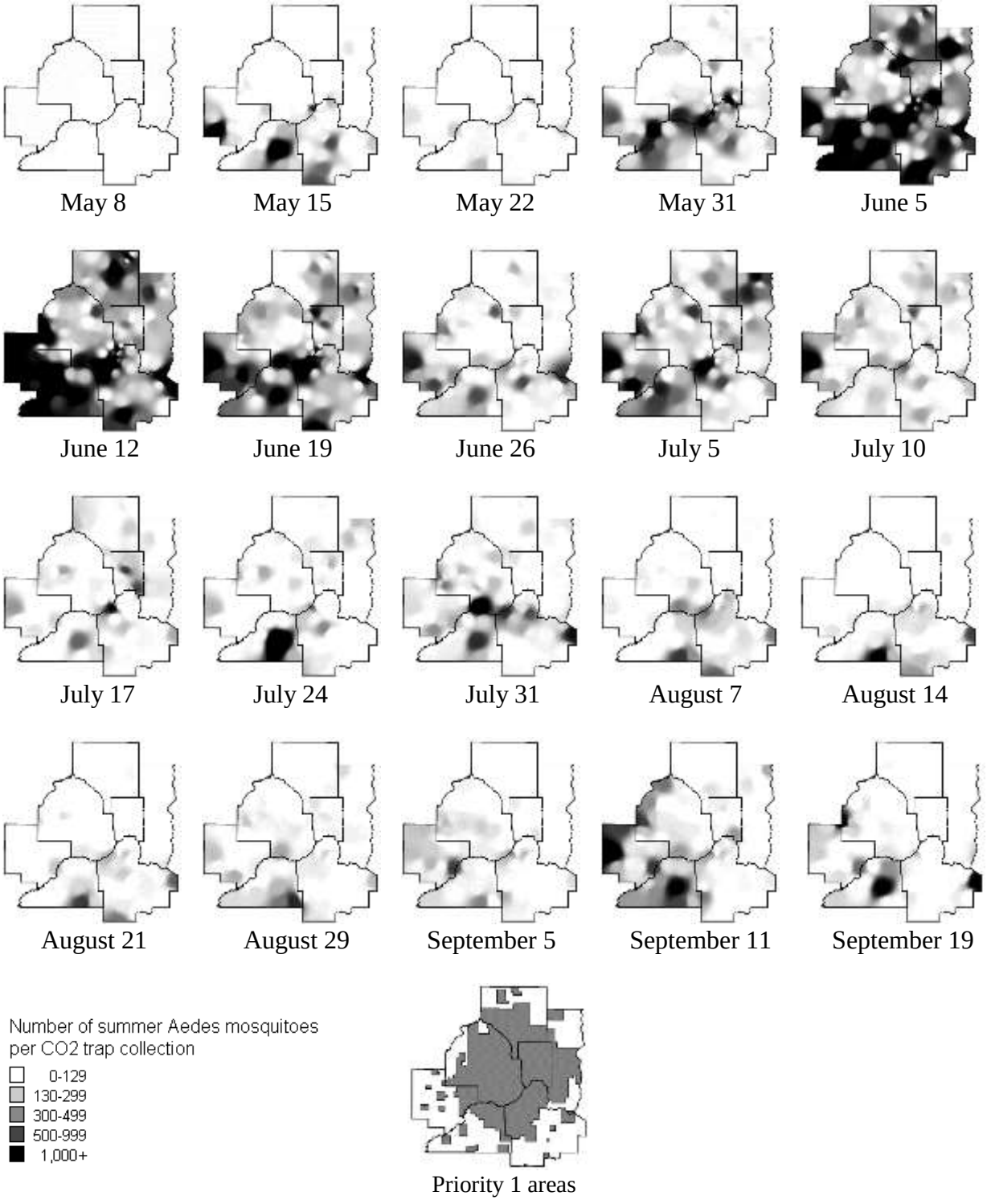


Figure 1.7 Number of summer *Aedes* in District low (5 ft) CO_2 trap collections, 2017. The number of traps operated per night varied from 105-115. Inverse distance weighting was the algorithm used for shading of maps. Treatment threshold is >130 mosquitoes/trap night. Priority 1 area map for reference.

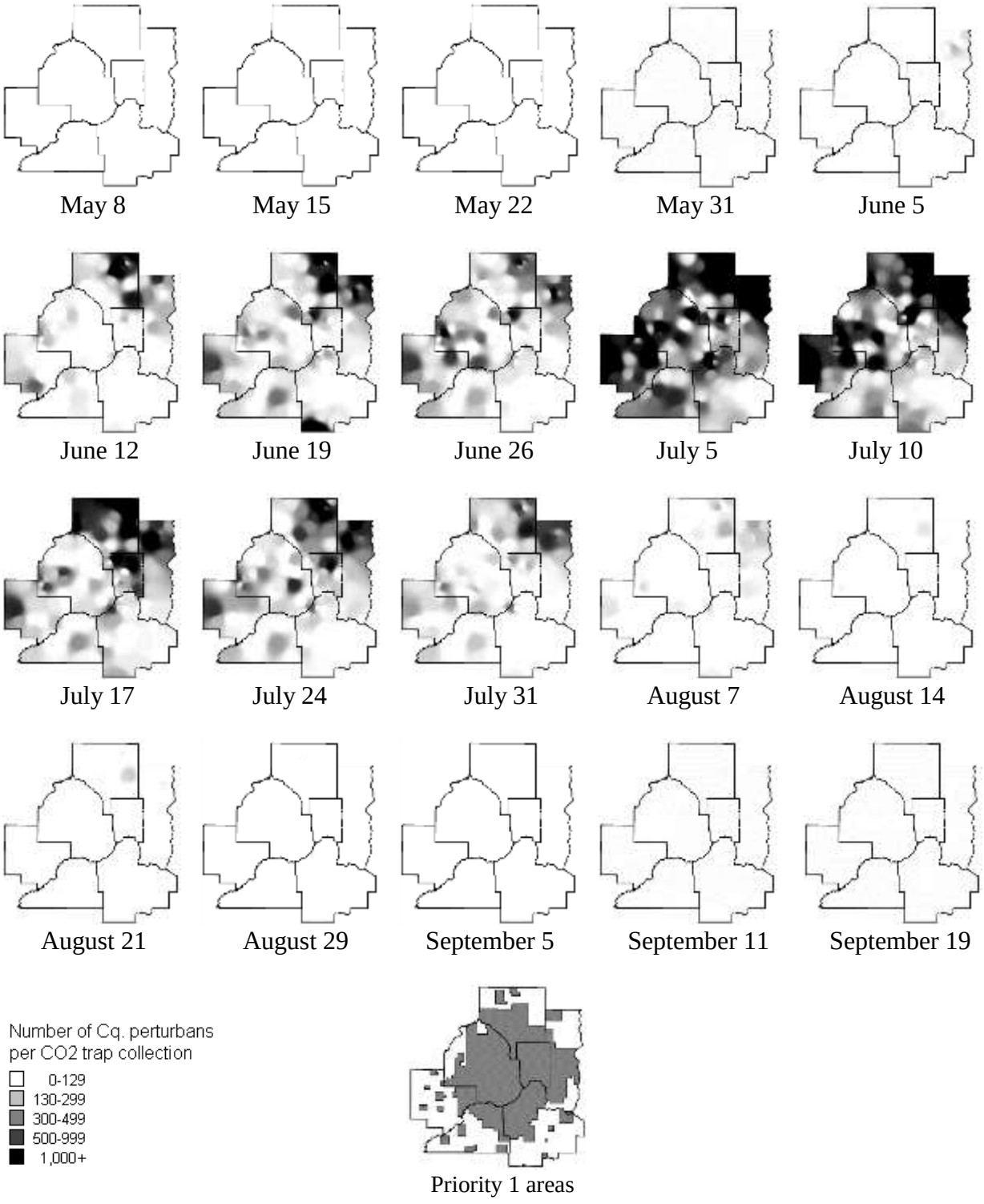


Figure 1.8 Number of *Cq. perturbans* in District low (5 ft) CO_2 trap collections, 2017. The number of traps operated per night varied from 105-115. Inverse distance weighting was the algorithm used for shading of maps. Treatment threshold is >130 mosquitoes/trap night. Priority 1 area map for reference.

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 below 55 °F inhibit mosquito flight activity. If rain or cold temperatures are forecasted on sampling night, surveillance is postponed until the next night. Figure 1.9 depicts the actual temperature at 9 p.m. on the scheduled sampling night. In 2017, sampling with CO_2 traps and sweep nets started May 8. Four nights were postponed and only three cool nights with upper 50s during the season may have affected mosquito activity.

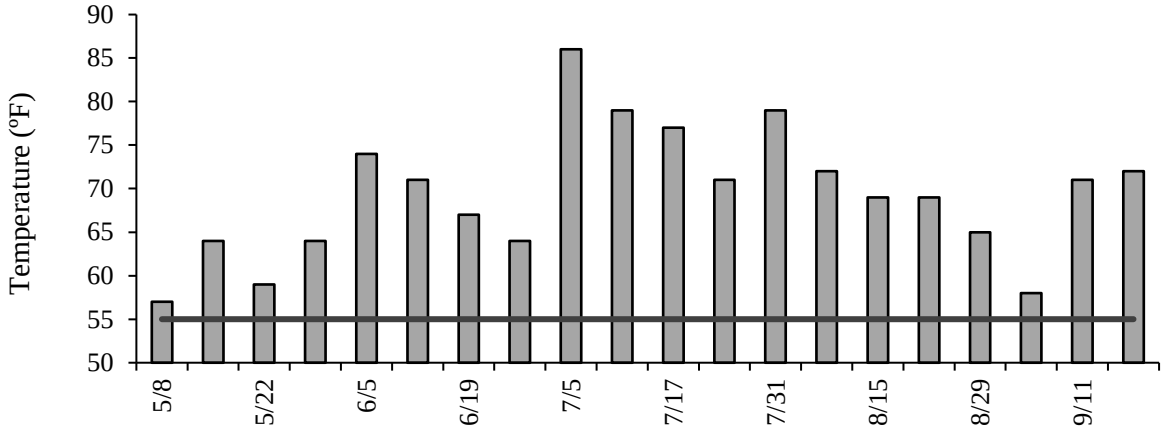


Figure 1.9 Temperature at 9:00 PM on actual dates of Monday night surveillance, 2017 (source: National Weather Service, Twin Cities Station). The black horizonal line indicates the mosquito flight threshold, 55 °F.

Figure 1.10 shows the seasonal distribution of the three major groups of mosquitoes from early May through mid-September, detected by sweep netting and CO_2 traps. The peak activity dates for the three major mosquito groups matched for the sweeps and CO_2 traps. The spring *Aedes* peaked on June 5 at levels below the 17-year average and diminished by the end of July (Figure 1.10).

The captures of summer *Aedes* in sweeps were below average all summer. High numbers of summer *Aedes* detected by CO_2 traps on June 5 and June 12 were the only above average occurrences. Mosquitoes continued to be below or at average levels until sampling ended in September.

The peak for the one generation of *Cq. perturbans* occurred on July 3, its typical time, but not its typical amount. Captures started close to average in June and remained above average into August; these were the highest levels in District history!

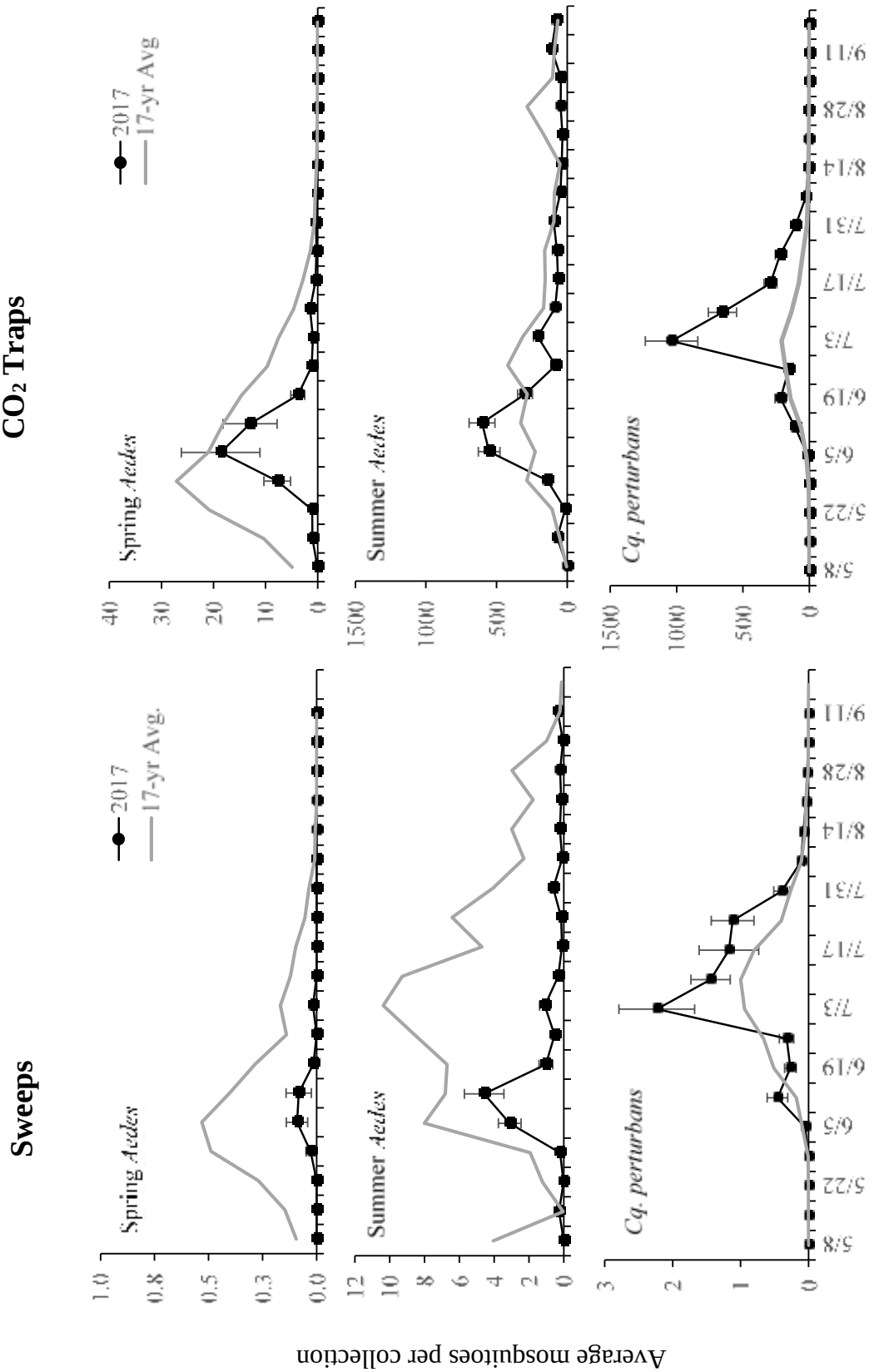


Figure 1.10 Average number of spring *Aedes*, summer *Aedes* and *Cq. perturbans* per sweep net and CO_2 trap, 2017 vs. 17-year average. Dates are the Mondays of each week. Sweep net sampling ended the week of September 11, CO_2 traps ended the week of September 18. Error bars equal +_1 standard error of the mean.

Coquillettidia perturbans, the cattail mosquito, is usually our second-most numerous species and has one generation per year. Adults lay their eggs in cattail marshes in July and August, the eggs hatch, larvae overwinter in the marsh, and adults emerge the following June-July. Adult populations are influenced by rainfall amounts from the previous year. Higher *Cq. perturbans* captures in CO_2 traps occurred (2003, 2006, 2011, and 2012) following years with higher than normal rainfall amounts (Figure 1.11). However, high rainfall in 2014 did not result in significantly higher *Cq. perturbans* populations in 2015. Drought conditions existed in the fall through winter of 2012-2014. Despite the heavy summer rains in 2014, water levels remained low in cattail marshes, reducing mosquito production in 2015. High rain amounts in 2015 and 2016, especially in the fall, helped marshes rebound from the drought and increase mosquito production in 2017. We hypothesized that the record-breaking amount and late summer timing of the rain in 2016 could be an indication of increased *Cq. perturbans* in 2017.

Analysis by Dr. Roger Moon (University of MN) in 2016 showed the change in average *Cq. perturbans* levels from a given year to the next was related to the number of adults and average weekly total rainfall in the starting year. The predicted catch rate in 2017 was 91.4 *Cq. perturbans* per CO_2 trap, but the actual rate was 140.8, the highest in CO_2 surveillance history! (Figure 1.11). The predicted amount of *Cq. perturbans* per CO_2 trap in 2018 is 65.

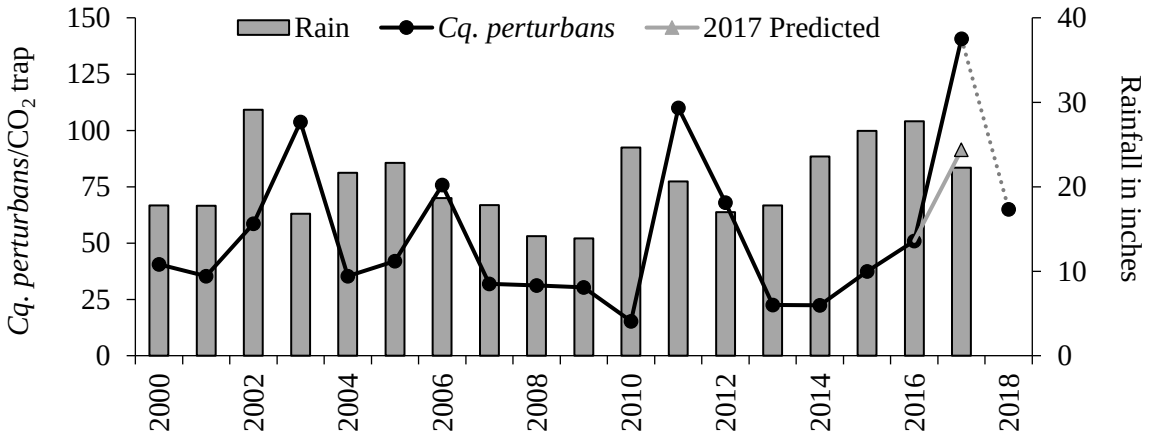


Figure 1.11 Average number of *Coquillettidia perturbans* in CO_2 traps and average seasonal rainfall per gauge, 2000-2017. The gray line shows the predicted amount for 2017; the dotted line indicates the predicted amount in 2018.

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

The number of locations and traps has fluctuated since then. In 2015, the location for Trap 1 in St. Paul became unavailable and no alternate was found. A new St. Paul location was established in 2016 at the State Fairgrounds (SF), 13 miles from the former trap 1 site. The trap at the Minnesota Zoo in Apple Valley (AV) was moved one half mile to a new location within the zoo. The remaining five traps were in the following locations: trap 9 in Lake Elmo, trap 13 in Jordan, trap 16 in Lino Lakes, trap CA1 in the Carlos Avery State Wildlife Management Area, and trap MN in Minnetrista (Figure 1.13).

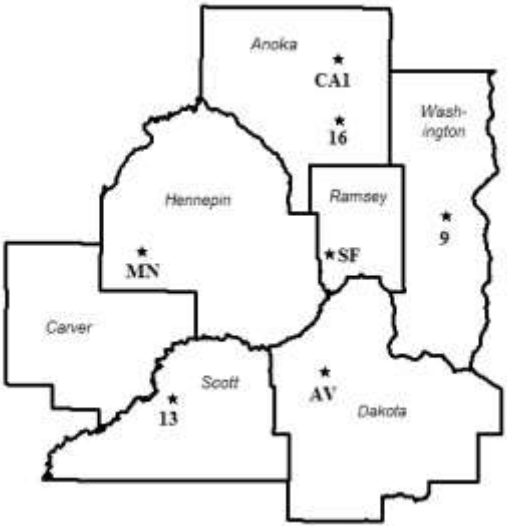


Figure 1.13 NJ light trap locations, 2017.

Trapping occurs nightly for 20 weeks from May through September and staff identify all adult female mosquitoes to species. Traps 9, 13, and 16 have operated from 1965-2017. A comparison of the major species collected from those three traps is shown in Appendix B.

The most numerous species collected was *Ae. vexans* whose total was 54% of all female mosquitoes captured (Table 1.4). The Minnetrista trap contributed 74% of all *Ae. vexans* captured. *Coquillettidia perturbans* ranked second and comprised 39% of the females captured. The Carlos Avery and Minnetrista traps, placed within many acres of untreatable cattail habitat, contributed 47% and 45% of the overall *Cq. perturbans* collected. The hard to distinguish spring *Aedes* species combo of *Ae. abserratus* and *Ae. punctor* was in third place. Nearly all of these species (99.5%) were collected in the Carlos Avery trap. The West Nile virus vector, *Cx. restuans,* was quite abundant this year in fourth place. The SF location contributed 77% of the *Cx. restuans* and almost all of the *Cx. pipiens* collected in 2017. *Anopheles quadrimaculatus* populations have increased the past few years and won fifth place with 0.69%. *Aedes cinereus*, which occurs in the spring and summer and is usually in the top five, came in sixth place again this year at 0.59% of the female total.

The first collection of *Ae. japonicus* in a NJ light trap was in 2009 (Minnetrista). Since then, *Ae. japonicus* has increased in frequency of occurrence and has been found at all of the NJ trap locations except Jordan. In 2017, a record total number (244) was collected from three *Ae. japonicus*-positive NJ trap locations: Minnetrista (98%), and 2% in the remaining two traps.

Table 1.4 Total numbers and frequency of occurrence for each species collected in New Jersey light traps, May 6 - September 22, 2017.

	Trap Code, Location, and Number of Collections							Summary Statistics		
Species	SF State Fair 130	9 Lake Elmo 134	13 Jordan 140	16 Lino Lakes 131	CA1 Carlos Avery 138	AV Apple Valley 127	MN Minnetrista 135	Total Collected 935	% Female Total	Avg per Night
Ae. abserratus	0	0	0	0	345	0	7	352	0.27%	0.38
atropalpus	0	0	0	0	0	0	0	0	0.00%	0.00
aurifer	0	0	0	0	4	0	0	4	0.00%	0.00
canadensis	0	0	0	0	0	0	0	0	0.00%	0.00
cinereus	3	2	7	23	353	1	381	770	0.59%	0.82
dorsalis	0	0	0	0	0	0	0	0	0.00%	0.00
excrucians	0	1	0	0	0	0	2	3	0.00%	0.00
fitchii	0	0	0	0	0	0	0	0	0.00%	0.00
hendersoni	0	0	0	0	0	0	0	0	0.00%	0.00
implicatus	0	0	0	0	0	0	0	0	0.00%	0.00
japonicus	0	3	0	2	0	0	239	244	0.19%	0.26
nigromaculus	0	0	0	0	0	0	0	0	0.00%	0.00
punctor	0	0	0	0	196	0	3	199	0.15%	0.21
riparius	0	0	0	0	3	0	35	38	0.03%	0.04
spencerii	0	0	0	0	0	0	0	0	0.00%	0.00
sticticus	0	5	30	2	341	3	1	382	0.29%	0.41
stimulans	0	0	0	0	0	0	0	0	0.00%	0.00
provocans	0	0	0	0	0	0	0	0	0.00%	0.00
triseriatus	1	8	1	0	2	0	25	37	0.03%	0.04
trivittatus	0	39	29	1	27	7	52	155	0.12%	0.17
vexans	334	1,188	2,719	6,507	6,821	1,069	52,364	71,002	54.23%	75.94
abserratus/punctor	0	0	0	3	1,460	0	54	1,517	1.16%	1.62
Aedes species	1	7	15	14	56	16	479	588	0.45%	0.63
Spring *Aedes*	0	0	0	0	9	0	22	31	0.02%	0.03
Summer *Aedes*	2	0	2	0	0	4	10	18	0.01%	0.02
An. barberi	0	0	0	0	0	0	2	2	0.00%	0.00
earlei	0	0	0	0	0	0	0	0	0.00%	0.00
punctipennis	3	25	10	9	80	4	166	297	0.23%	0.32
quadrimaculatus	4	217	64	143	214	12	249	903	0.69%	0.97
walkeri	0	3	7	3	566	0	9	588	0.45%	0.63
An. species	0	19	3	10	83	1	31	147	0.11%	0.16
Cx. erraticus	0	0	0	0	0	0	1	1	0.00%	0.00
pipiens	160	6	1	5	3	1	23	199	0.15%	0.21
restuans	776	36	5	40	32	52	71	1,012	0.77%	1.08
salinarius	2	0	0	0	0	0	8	10	0.01%	0.01
tarsalis	47	3	2	16	6	0	12	86	0.07%	0.09
territans	44	6	0	16	18	3	150	237	0.18%	0.25
Cx. species	39	6	0	1	4	18	36	104	0.08%	0.11
Cx. pipiens/restuans	219	20	2	37	37	77	107	499	0.38%	0.53
Cs. inornata	9	4	5	8	18	3	58	105	0.08%	0.11
melanura	1	0	0	4	6	0	0	11	0.01%	0.01
minnesotae	26	0	2	26	50	0	12	116	0.09%	0.12
morsitans	22	2	1	10	14	0	6	55	0.04%	0.06
Cs. species	0	1	0	3	9	0	2	15	0.01%	0.02
Cq. perturbans	255	376	196	3,323	23,669	38	22,937	50,794	38.79%	54.33
Or. signifera	0	0	0	0	0	0	1	1	0.00%	0.00
Ps. ferox	0	0	0	0	0	0	0	0	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	8	10	2	5	3	1	36	65	0.05%	0.07
Unidentifiable	3	14	9	7	57	3	253	346	0.26%	0.37
Female Total	1,959	2,001	3,112	10,218	34,486	1,313	77,844	130,933	100.00%	140.04
Male Total	837	950	2,555	1,892	8,017	413	24,383	39,047		
Grand Total	2,796	2,951	5,667	12,110	42,503	1,726	102,227	169,980		

Rare Detections *Culex erraticus* is rare in the District. It is a southern species with its northernmost distribution extending from the East Coast to Ohio, Indiana, Illinois, and parts of Iowa, Minnesota, and South Dakota (Darsie and Ward, 2005). Barr (1958) reported that the University of Minnesota insect collection had 45 specimens from two light trapping efforts in Wabasha, MN in 1939 and 1941. Larvae were detected in District sampling in 1961 and the first adults were detected in NJ light traps in 1988. Since that time low, sporadic numbers of adults have been detected until 2012 when 649 were collected in District CO_2 traps (Figure 1.14). Fifteen adults were also collected in NJ light traps (9), sweep nets (1), and gravid traps (5) that year. During 2012, larvae were collected from six sites in Scott and Washington counties for the first time since the one Washington County sample in 1961, the only other occurrence in District history. No larval samples have since been collected. In 2013, we were surprised to collect adults in low numbers. Very few have been collected since 2012 – yearly total collected range from three to 21 during 2013-2017. Their name is truly descriptive of their occurrence.

The reason for the 2012 peak remains a mystery. One possibility is that this southern species, was able to thrive in the very warm, dry conditions that prevailed in 2012. Temperatures in March that year were very much above average, and April-September were also warmer than normal. Additionally, with the exception of May and July, precipitation was below normal. A review of mosquito surveillance records at Iowa State University (https://mosquito.ent.iastate.edu/browse_species2.php?spcID=373) beginning in 1969 show 2007 as the first occurrence of *Cx. erraticus* in Iowa (77 specimens taken). High levels were also detected in 2010 (108), 2011 (72), 2015 (251), 2016 (176), and 2017 (over 50). Interestingly, the very high populations we detected in 2012 did not occur in Iowa at the same time. Because *Cx. erraticus* is usually very rare, it has not been targeted for control. It is, however, a competent vector of eastern equine encephalitis and a suspected maintenance vector of West Nile virus, so it is still a concern.

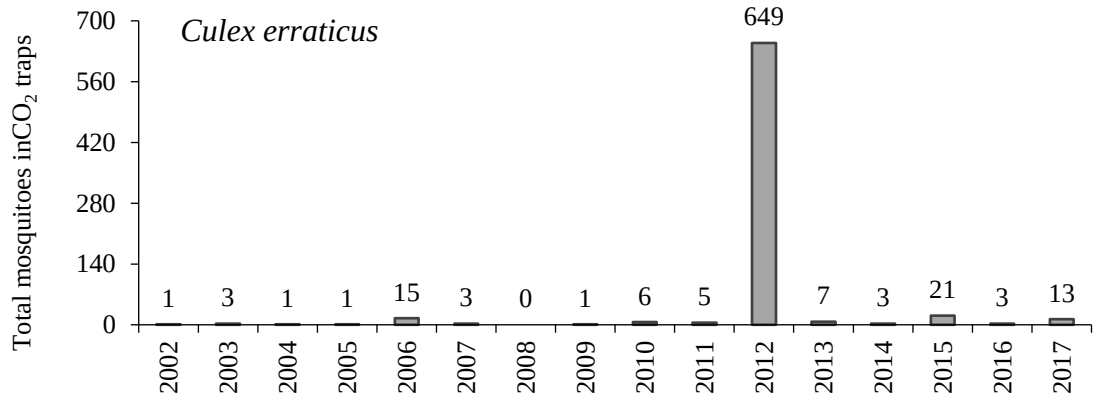


Figure 1.14 Total yearly *Culex erraticus* in all CO_2 traps, 2002-2017.

References cited

Darsie, R.F. and R.A. Ward. 2005. *Identification and Geographical Distribution of the Mosquitoes of North America, North of Mexico.* University of Florida Press, Gainesville, FL., 363 pp.

Barr, A.R. 1958. *The Mosquitoes of Minnesota (Diptera: Culicidae: Culicinae*). Univ. of Minn. Agr. Exp. Sta. Tech. Bull. 228, 154 pp.

Anopheles quadrimaculatus is notable because it is a WNV maintenance vector and capable of transmitting dog heartworm and malaria. Historically, it is rare in the District, but in recent years, it has occurred in traps throughout the District more frequently than in the past (Figure 1.15).

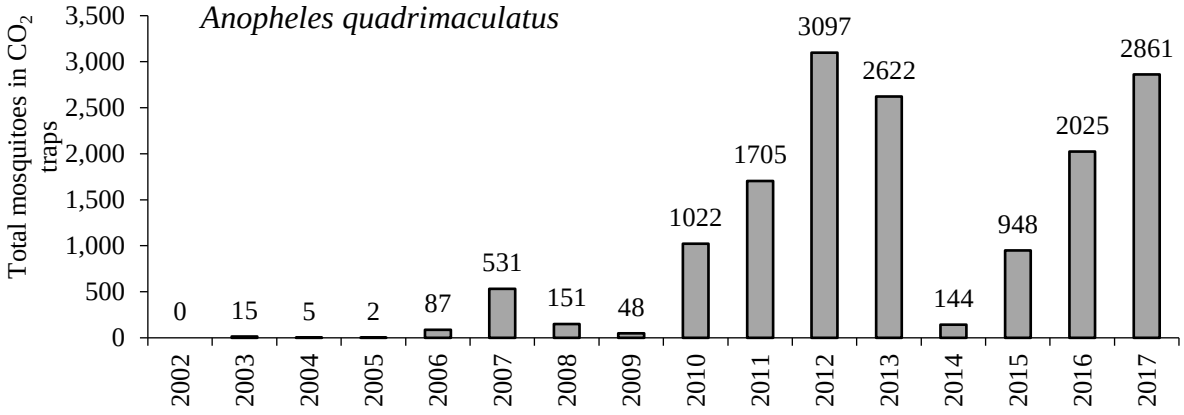


Figure 1.15 Total yearly *An. quadrimaculatus* in all CO_2 traps, 2002-2017.

Since 2002, *An. quadrimaculatus* has appeared with sporadic frequency, reaching high amounts in 2012 and 2013, low again in 2014, and increasing again in the last three years. The averages per CO_2 trap and sweep net are low (Table 1.4), but can be locally abundant. The sweep net captures are proof that *An. quadrimaculatus* are attracted to humans.

Table 1.4 Yearly average of *An. quadrimaculatus* per CO_2 trap and sweep net collection, 2002-2017.

Year	Avg./CO_2 trap	Avg./sweep	Year	Avg./CO_2 trap	Avg./sweep
2002	0.000	0.000	2010	0.398	0.017
2003	0.009	0.000	2011	0.671	0.014
2004	0.002	0.000	2012	1.132	0.059
2005	0.001	0.000	2013	1.069	0.043
2006	0.040	0.005	2014	0.063	0.004
2007	0.205	0.006	2015	0.402	0.023
2008	0.064	0.001	2016	0.807	0.016
2009	0.019	0.000	2017	1.107	0.025

Psorophora species are human-biting floodwater mosquitoes that are rare in the District. Detections in NJ traps have occurred in several years since 1959, but with fewer than five mosquitoes per year. However, two species have increased in Monday night CO_2 traps over the years: *Ps. ferox* and *Ps. horrida* (Figure 1.16). Specimens that are missing the taxonomic characters needed for identification to species are recorded as *Ps.* species. Although *Ps. ferox* captures have increased in the last two years, they compose only 0.35% of the mosquito total in 2017.

Several viruses have been isolated from the mosquito, but it is generally not thought to play a major role in pathogen transmission to humans. In other parts of the country, *Psorophora* is

known to frequently and voraciously bite people, but only nine *Psorophora* were identified in 17 years of Monday night sweep net collections. Since southeastern Minnesota is on the northern edge of their North American ranges, it appears the *Ps. ferox* and *Ps. horrida* are expanding northward into the District. Hopefully, their low populations do not increase to the frequent and voracious biting level.

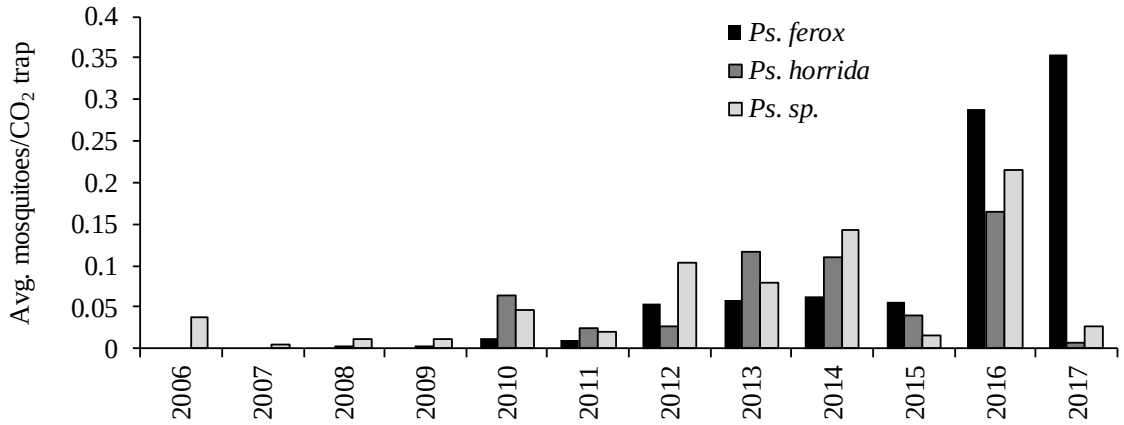


Figure 1.16 Average yearly *Ps. ferox*, *Ps. horrida* and *Ps.* species, 2006-2017.

Targeted Vector Mosquito Surveillance

Aedes triseriatus Staff use a mechanical aspirator (pictured at left) to sample the understory for resting mosquitoes in the daytime. This method is used primarily for *Ae. triseriatus*, the La Crosse encephalitis (LAC) vector, which can be difficult to capture by other methods. The aspirator is also used to collect *Ae. japonicus* and *Ae. albopictus*, two invasive mosquito vectors. Sampling began during the week of May 22 and continued through the week of September 18.

The first collection of *Ae. triseriatus* occurred during the week of June 5 (Figure 1.17). The rate of capture in aspirators increased through the week of June 19, when we observed the season peak at 2.5 *Ae. triseriatus* per sample. For the remainder of the season, the rate of capture remained near or below the average for corresponding weeks for the past 17 seasons.

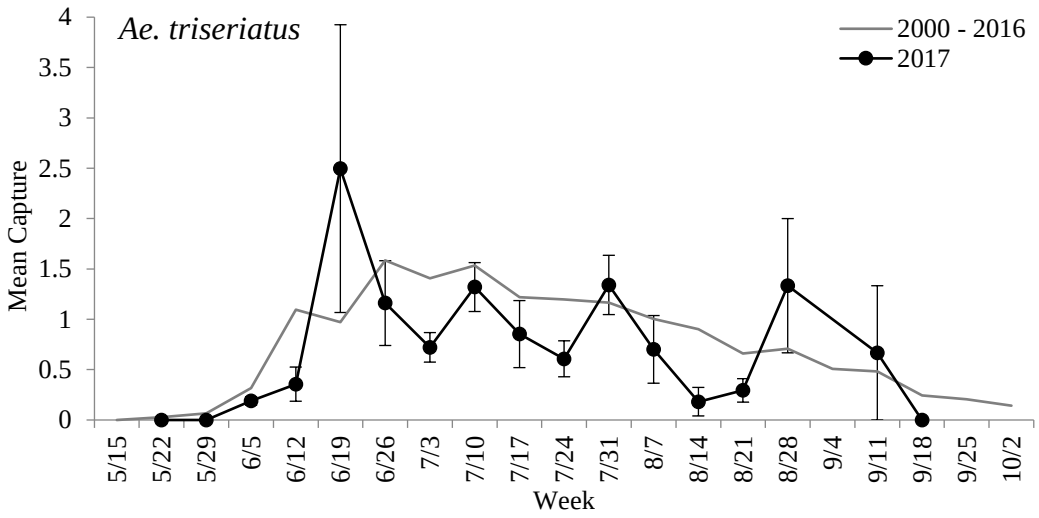


Figure 1.17 Mean number of *Ae. triseriatus* adults in 2017 aspirator samples plotted by week compared to mean captures for the corresponding weeks of 2000-2016. Dates listed are Monday of each week. There were no samples during the week of Sept. 4. Error bars equal ± 1 standard error of the mean.

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

District staff monitored adult *Cs. melanura* at 10 locations (Figure 1.5, p. 7) using 11 CO_2 traps. Five sites are in Anoka County, four sites are in Washington County, and one site is in Hennepin County. *Culiseta melanura* have been collected from each location in the past. Two traps are placed at the Hennepin County location – one at ground level and one elevated 25 feet into the tree canopy, where many bird species roost at night. The first *Cs. melanura* adults were collected in CO_2 traps on May 29 (Figure 1.18). The population remained low throughout the season with a maximum capture of 3.7 per trap on July 17. Despite the low rates of capture at the above described locations, the *Cs. melanura* adult population was more widespread in 2017 than is typical. The species was collected in numerous locations including several long-term surveillance sites where *Cs. melanura* had not been collected previously.

Staff collected 195 *Cs. melanura* in 122 aspirator samples from wooded areas near bog habitats. The first aspirator collections of *Cs. melanura* occurred during the week of June 5. Thereafter, aspirator samples targeting the species were collected during only six of the next 15 weeks. The peak rate of capture was 9.6 *Cs. melanura* per sample during the week of August 21.

Culiseta melanura develop primarily in bog habitats in the District and they can be difficult to locate. In 2017, 17 sites were surveyed for *Cs. melanura*. Larval samples were collected from 12 sites and *Cs. melanura* larvae were found in five sites.

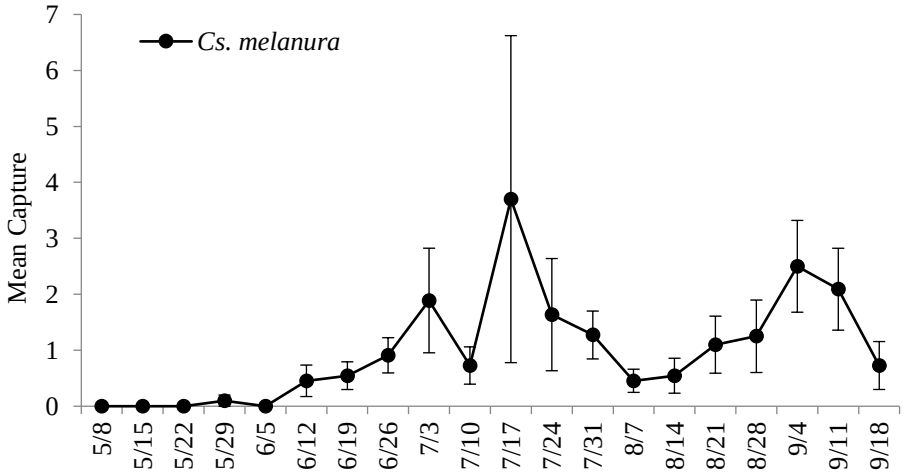


Figure 1.18 Mean number of *Cs. melanura* adults in CO_2 traps from selected sites, 2017. Dates listed are the Monday of each sampling week. Error bars equal ± 1 standard error of the mean.

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

Culex tarsalis is the most likely vector of WNV for human exposures in our area and as such, they are routinely tested for WNV (see Chapter 2, Table 2.3). Collections of *Cx. tarsalis* in CO_2 traps were consistently low in 2017. The weekly mean capture peaked at 2.9 per sample during the week of July 3 (Figure 1.19). Surveillance indicated that the *Cx. tarsalis* population crashed in early August; few were collected by any method in August or September. As is typical, few *Cx. tarsalis* were captured by gravid trap during the entire season.

Culex restuans is another important vector of WNV in Minnesota. The species is largely responsible for the early season amplification of the virus and for season-long maintenance of the WNV cycle, as well. Low numbers of *Cx. restuans* were collected in CO_2 traps in 2017 (Figure 1.19). The CO_2 trap captures peaked on July 24 at 1.9 per trap. Gravid trap collections of *Cx. restuans* were low for most of the season. The peak rate of capture occurred earlier than is typical during the week of May 15 at 17.2 per trap.

Culex pipiens are important WNV vectors 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 in early to mid-summer and peak late in the summer when temperatures are typically warmer. In 2017, the rate of capture in both CO_2 traps and gravid traps increased gradually through June and both traps collected considerably more *Cx. pipiens* in the mid and late summer months (Figure 1.19). The rate of capture peaked at 7.6 per gravid trap during the week of July 31 and at 2.2 per CO_2 trap during the week of August 21.

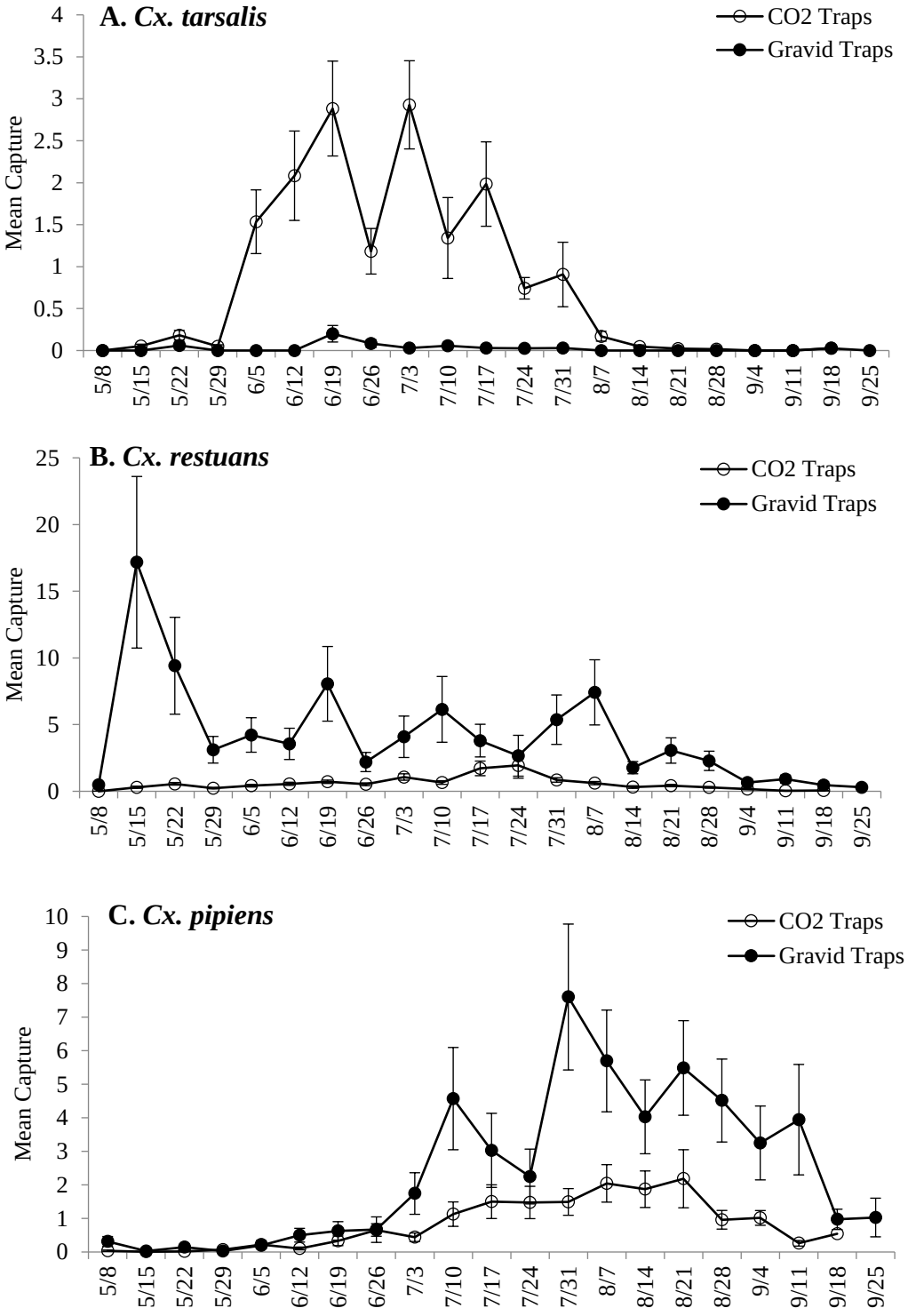


Figure 1.19 Average number of *Cx. tarsalis* (A), *Cx. restuans* (B), and *Cx. pipiens* (C) in CO_2 traps and gravid traps, 2017. Dates are the Monday of each sampling week. Error bars equal ± 1 standard error of the mean.

When *Cx. pipiens* and *Cx. restuans* are difficult to distinguish from each other, they are grouped together and identified as *Cx. pipiens/restuans* (Figure 1.20); when only a genus level identification can be made, they are classified as *Culex* species (Figure 1.20). Both groups usually consist 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.

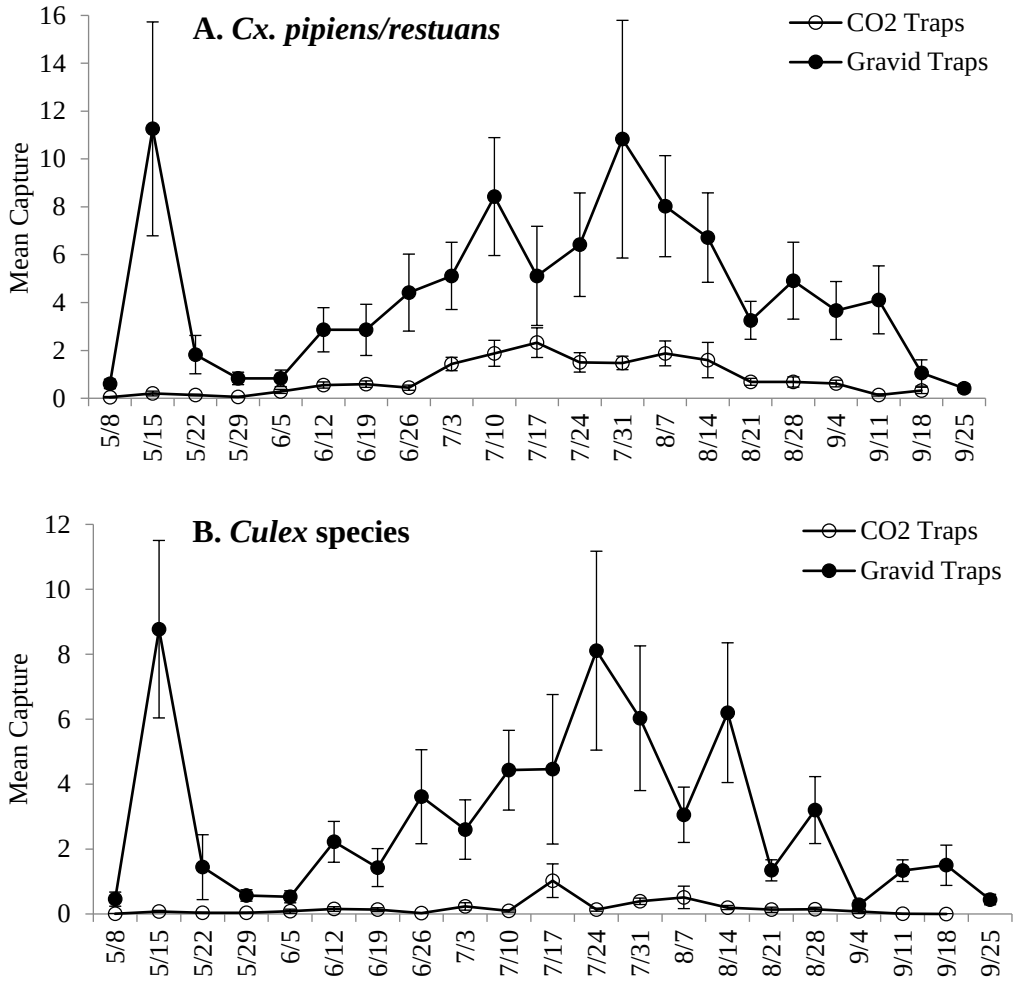


Figure 1.20 Average number of *Cx. pipiens/restuans* (A) and *Culex* species (B)in CO_2 traps and gravid traps, 2017. Dates are the Monday of each sampling week. Error bars equal ± 1 standard error of the mean.

Exotic Species Each season, MMCD conducts surveillance for exotic or introduced mosquito species. There are also opportunities to collect unexpected species through a variety of surveillance techniques used to monitor local mosquito species. MMCD laboratory technicians are trained to recognize exotic species in their adult and larval forms so that the mosquitoes can be spotted in any of the tens of thousands of samples processed each year. The two exotic, invasive species most likely to be found here are *Ae. albopictus* and *Ae. japonicus*. Both are native to Asia and have adapted to use artificial larval habitats such as tires and other containers

and are easily transported as eggs or larvae. *Aedes albopictus*, first collected in the US in 1985, are established in many states south and east of Minnesota and are occasionally introduced to the District in shipments of used tires or by transport of other water-holding containers. *Aedes japonicus* were first collected in the eastern United States in 1998 and were first found in the District in 2007.

Aedes albopictus *Aedes albopictus* were collected in 11 samples in 2017. All of the samples were collected from a tire recycling facility or adjacent properties in Scott County. Specimens were reared from eight ovitrap samples; three were collected on August 1, three were collected on August 11, and two were collected on September 13. Three samples contained adult *Ae. albopictus*: two gravid traps collected on August 2 and September 20 and one aspirator sample collected on September 22.

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

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

Aedes japonicus larvae were found in 794 samples. Most were from containers (418) and tires (151). Larvae were found in other habitats as well, including: stormwater structures/artificial ponds (123), catch basins (73), wetlands (27), and tree holes (2). The frequency of *Ae. japonicus* occurrence in larval samples from containers and tires has generally increased each year since their arrival in the District with one exception (2013); the species is found less commonly in tree holes (Table 1.5).

Table 1.5 Percentage of samples from containers, tires, and tree holes containing *Ae. japonicus* larvae, 2009 – 2017.

	Percent in habitat types		
Year	Containers	Tires	Tree holes
2009	4.2	2.9	0.0
2010	23.5	15.5	8.8
2011	36.2	21.3	9.3
2012	39.4	26.7	4.7
2013	35.7	21.2	1.8
2014	39.2	26.3	2.0
2015	44.2	36.0	4.8
2016	47.9	42.7	4.5
2017	58.0	42.7	7.7

Aedes japonicus adults were identified in 508 samples. They were found in 265 aspirator samples, 116 gravid trap samples, 69 CO_2 trap samples, 21 NJ trap samples, and 37 two-minute sweep samples. *Aedes japonicus* were also hatched from 77 of 89 ovitrap samples collected in 2017.

2018 Plans – Surveillance

Surveillance will continue as in past years with possible adjustments to monitor disease vectors in the District. We will evaluate sweep net, CO_2, and gravid trap locations to ensure adequate distribution and that target species are collected.

We plan on adding three BG Sentinel 2 traps (Figure 1.21) to our surveillance network in 2018. The BG Sentinel 2 trap is commonly used to capture host-seeking *Ae. albopictus*, a cohort of the population that is not highly attracted to other traps. The trap uses a chemical lure of ammonia, lactic acid, and caproic acid to enhance collections of target species. Traps will be placed near high-risk sites for *Ae. albopictus* introduction.

Figure 1.21 BG Sentinel 2 trap.

Chapter 2 Mosquito-borne Disease

2017 Highlights

- There was one La Crosse encephalitis case in Minnesota
- Jamestown Canyon virus caused 17 illnesses in Minnesota with four in District residents
- WNV illnesses were confirmed in 27 Minnesotans, eight occurred in District residents
- WNV detected in 55 District mosquito samples
- Collected and recycled 14,304 tires

2018 Plans

- Continue to provide surveillance and control for La Crosse encephalitis prevention
- Create materials to educate the public on Jamestown Canyon virus
- Continue catch basin larvicide treatments to manage WNV vectors
- Communicate disease prevention strategies to other local governments
- Continue surveillance for WNV and other mosquito-borne viruses
- Continue to monitor for *Ae. albopictus* and other exotic species
- Continue *Cs. melanura* surveillance and evaluate control options for EEE prevention

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 such as La Crosse encephalitis (LAC), western equine encephalitis (WEE), eastern equine encephalitis (EEE), Jamestown Canyon illness (JCV), and West Nile (WNV) encephalitis.

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

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

The District collects and tests *Culex tarsalis* to monitor WNV and WEE activity. The species is a bridge vector for both viruses, meaning it bridges the gap between infected birds and humans and other mammals. Western equine encephalitis can cause severe illness in horses and humans. The last WEE outbreak in Minnesota occurred in 1983. The first occurrence of EEE in Minnesota was in 2001. Since then, MMCD has conducted surveillance for *Culiseta melanura*, which

maintains the virus in birds. A "bridge vector" such as *Coquillettidia perturbans* can acquire the virus from a bird and pass it to a human in a subsequent feeding.

Jamestown Canyon virus is native to North America. It is transmitted by mosquitoes and amplified by deer. Infections occasionally cause human illnesses. Documentation of JCV illness has been on the rise in Minnesota and Wisconsin. We are working to better understand the JCV cycle so that we are prepared to provide the best risk prevention service that we can.

The District uses a variety of surveillance methods to measure mosquito vector populations and to detect mosquito-borne pathogens. Results are used to direct mosquito control services and to enhance public education efforts so that the risks of contracting mosquito-borne illnesses are significantly reduced.

2017 Mosquito-borne Disease Services

Source Reduction

Water-holding containers such as tires, buckets, tarps, and even plastic toys provide developmental habitat for many mosquito species including *Ae. triseriatus*, *Ae. albopictus*, *Ae. japonicus*, *Cx. restuans*, and *Cx. pipiens*. Eliminating these container habitats is an effective strategy for preventing mosquito-borne illnesses. In 2017, District staff recycled 14,304 tires that were collected from the field (Table 2.1). Since 1988, the District has recycled 669,060 tires. In addition, MMCD eliminated 1,809 containers and filled 298 tree holes. This reduction of larval habitats occurred while conducting a variety of mosquito, tick, and black fly surveillance and control activities, including 1,543 property inspections by MMCD staff.

Table 2.1 Number of tire, container, and tree hole habitats eliminated during each of the past 12 seasons.

Year	Tires	Containers	Tree holes	Total
2006	10,513	2,059	228	12,800
2007	14,449	1,267	107	15,823
2008	16,229	1,615	93	17,937
2009	39,934	8,088	529	48,551*
2010	23,445	5,880	275	29,600
2011	17,326	3,250	219	20,795
2012	21,493	3,908	577	25,978
2013	17,812	2,410	386	20,608
2014	21,109	3,297	478	24,884
2015	24,127	2,595	268	26,990
2016	18,417	1,690	261	20,368
2017	14,304	1,809	298	16,411

*Intensified property inspections in response to introduction of *Ae. japonicus*

La Crosse Encephalitis (LAC)

La Crosse encephalitis is a viral illness that is transmitted in Minnesota by *Ae. triseriatus*. *Aedes albopictus* and *Ae. japonicus* are also capable of transmitting the La Crosse virus (LACV). Small mammals such as chipmunks and squirrels are the vertebrate hosts of LACV; they amplify the virus through the summer months. The virus can also pass transovarially from one generation of mosquitoes to the next. Most cases of LAC encephalitis are diagnosed in children under the age of 16. In 2017, there were 37 LAC illnesses documented in the United States.

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

The first adult *Ae. triseriatus* were collected during the week of June 5, 2017; two weeks later than is typical. See Chapter 1, Fig. 1.17 for results of aspirator surveillance for *Ae. triseriatus*.

In 2017, MMCD staff collected 1,334 aspirator samples to monitor *Ae. triseriatus* populations. Inspections of wooded areas and surrounding residential properties to eliminate larval habitat were provided as follow-up service when *Ae. triseriatus* adults were collected. The District's adulticide treatment threshold (≥ 2 adult *Ae. triseriatus* per aspirator collection) was met or exceeded by 190 aspirator samples. Adulticides were applied to wooded areas in 76 of those cases. Adult *Ae. triseriatus* were captured in 361 of 1,173 wooded areas sampled. The mean *Ae. triseriatus* capture was higher than the previous two seasons (Table 2.2).

Table 2.2 *Aedes triseriatus* aspirator surveillance data, 2000 – 2017.

Year	Total areas surveyed	No. with *Ae. triseriatus*	Percent with *Ae. triseriatus*	Total samples collected	Mean *Ae. triseriatus* per sample
2000	1,037	575	55.4	1,912	1.94
2001	1,222	567	46.4	2,155	1.32
2002	1,343	573	42.7	2,058	1.70
2003	1,558	470	30.2	2,676	1.20
2004	1,850	786	42.5	3,101	1.34
2005	1,993	700	35.1	2,617	0.84
2006	1,849	518	28.0	2,680	0.78
2007	1,767	402	22.8	2,345	0.42
2008	1,685	495	29.4	2,429	0.64
2009	2,258	532	24.0	3,125	0.56
2010	1,698	570	33.6	2,213	0.89
2011	1,769	566	32.0	2,563	0.83
2012	2,381	911	38.3	3,175	1.10
2013	2,359	928	39.3	2,905	1.22
2014	2,131	953	44.7	2,543	1.45
2015	1,272	403	31.7	1,631	0.72
2016	1,268	393	31.0	1,590	0.75
2017	1,173	361	30.8	1,334	0.98

La Crosse Encephalitis in Minnesota There was one LAC case reported in Minnesota in 2017. It occurred in a resident of Wright County in an area with previous LAC cases. Since 1970, the District has had an average of 2.1 LAC cases per year (range 0 – 10, median 2). Since 1990, the mean is 1.4 cases per year (range 0 – 8, median 1).

While *Ae. triseriatus* is known as the primary vector of LAC, the role *Ae. japonicus* might play in the LAC cycle is less understood. *Aedes japonicus* is a competent vector of LAC virus in laboratory settings. In 2017, MMCD submitted 58 pools of *Ae. japonicus* to MDH to be tested for LAC virus as well as WNV. All samples were negative for LAC and WNV.

Eastern Equine Encephalitis (EEE)

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

In 2017, detections of the EEE virus were reported to CDC by 19 states. There was one human illness reported in Florida. There were reports of EEE activity in 18 other states primarily through veterinary reports and mosquito testing. There were several reports of EEE illness in Wisconsin horses.

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

The *Cs. melanura* population remained low in 2017 with a season total of only 220 adult females collected in 209 CO_2 trap settings from designated surveillance locations (see Chapter 1, Figure 1.5). Oddly, *Cs. melanura* were widely distributed about the District with several collections in locations where they had been previously undetected. Twenty-six pools containing 216 *Cs. melanura* were submitted to MDH for EEE and WNV analysis. All samples were negative for EEE and WNV.

Western Equine Encephalitis (WEE)

Western equine encephalitis circulates among mosquitoes and birds in Minnesota. Occasionally, the virus causes illness in horses and less frequently in people. *Culex tarsalis* is the species most likely to transmit the virus to people and horses. In both 2004 and 2005, the virus was detected in *Cx. tarsalis* specimens collected in southern Minnesota. The virus has not been detected in Minnesota since then. *Culex tarsalis* collections remained low throughout the 2017 season, peaking at only 2.9 per CO_2 trap during the week of July 3 (see Ch 1, Fig. 1.19).

Jamestown Canyon Virus (JCV)

Jamestown Canyon virus is native to North America and circulates among mosquitoes and deer species. The virus has been detected in many mosquito species although the role of each in transmission of JCV is not well defined. Several spring snowmelt *Aedes* species are likely responsible for maintenance of the JCV cycle and for incidental human infections. In rare cases, humans suffer moderate to severe illness in response to JCV infections.

MDH confirmed 17 JCV illnesses in Minnesota in 2017. Four cases were diagnosed in residents of the District. Two were in residents of Hennepin County, one was in a Dakota County resident and one in a Ramsey County resident. Both Minnesota and Wisconsin, with 45 JCV cases, reported record high numbers of illnesses in 2017.

West Nile Virus (WNV)

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

WNV in the United States West Nile virus transmission was documented in 47 states in 2017. Alaska, Hawaii and Maine were the exceptions. The U.S. Centers for Disease Control and Prevention received reports of 1,984 West Nile illnesses from 47 states and the District of Columbia. There were 121 fatalities attributed to WNV infections. California had the greatest number of cases with 505. Adjusted for population, the highest rates of infection were in South Dakota and North Dakota. Nationwide screening of blood donors detected WNV in 236 individuals from 35 states.

WNV in Minnesota MDH reported 27 WNV illnesses in Minnesota residents from 17 counties. There was one WNV fatality in Minnesota in 2017. There were 19 presumptively viremic blood donors reported from 17 Minnesota counties. Additionally, there were three veterinary reports of WNV illness; two in horses from two Minnesota counties and one in a harbor seal from a zoo in the state. Two wild bird from two counties and 55 mosquito samples from six counties also returned positive results for WNV.

West Nile in the District There were eight WNV illnesses reported in residents of the District, three in Hennepin County, two in Anoka County, two in Ramsey County and one in Dakota County. Since WNV arrived in Minnesota, the District has experienced an average of 9.8 WNV illnesses each year (range 0 – 25, median 8). When cases with suspected exposure locations outside of the District are excluded, the mean is 7.6 cases per year (range 0 – 17, median 6).

Surveillance for WNV A warm period of four days from May 13 through May 16 may have initiated the WNV season in 2017. A second warm period lasting the first two weeks of

June also facilitated early season WNV amplification as well as vector mosquito development. Surveillance for the virus in mosquitoes began during the week of June 5 and the virus was detected in three samples that week. Detections of the virus occurred each week of the season except the final week of surveillance.

Several mosquito species from 45 CO_2 traps (13 elevated into the tree canopy) and 36 gravid traps were processed for viral analysis each week. In addition, we processed *Cx. tarsalis* collected by any of the CO_2 traps in our Monday night network for viral analysis. MMCD tested 708 mosquito pools using the RAMP® method, 55 of which were positive for WNV. We also submitted 105 mosquito pools to MDH for WNV analysis by PCR. Table 2.3 is a complete list of mosquitoes MMCD processed for WNV analysis.

Table 2.3 Number of MMCD mosquito pools tested for West Nile virus and minimum infection rate (MIR) by species, 2017.

Species	Number of mosquitoes	Number of pools	WNV+ pools	MIR per 1,000
Aedes japonicus	562	61	0	0.00
Aedes triseriatus	160	20	0	0.00
Culex pipiens	1,486	68	6	4.04
Culex restuans	1,101	51	4	3.63
Culex tarsalis	1,532	138	4	2.61
Culex species	4,895	235	22	4.49
Culex pipiens/restuans	3,749	214	19	5.07
Culiseta melanura	216	26	0	0.00
Total	13,701	813	55	4.01

The first WNV positive results of 2017 were obtained during the initial week of testing. Two samples of *Cx. tarsalis* from CO_2 traps in Burnsville and St. Lawrence Township collected on June 6 and a mixed sample of *Cx. pipiens* and *Cx. restuans* from a gravid trap in Blaine collected on June 7 were positive for the virus. Four of the season's 55 WNV positive mosquito pools were from collections of *Cx. tarsalis*, the remaining 51 were *Cx. pipiens*, *Cx. restuans*, mixed pools of *Cx. pipiens* and *Cx. restuans*, or pools identified as *Culex* species.

Thirty-one of the 55 WNV positive mosquito samples were collected in Ramsey County. Six WNV positive samples were collected in Anoka County, six in Dakota County, eight in Hennepin County, two in Scott County, and two in Washington County. Forty-seven of the 55 WNV positive samples were collected by gravid traps; eight were collected by CO_2 traps.

The 2017 WNV infection rate in *Culex* species was highest during the first week of testing at 8.02/1,000 mosquitoes tested. The infection rate then dropped to levels more consistent with the time of year for the next several weeks, peaking again during the week of August 21 at 7.19/1,000 mosquitoes tested (Figure 2.1).

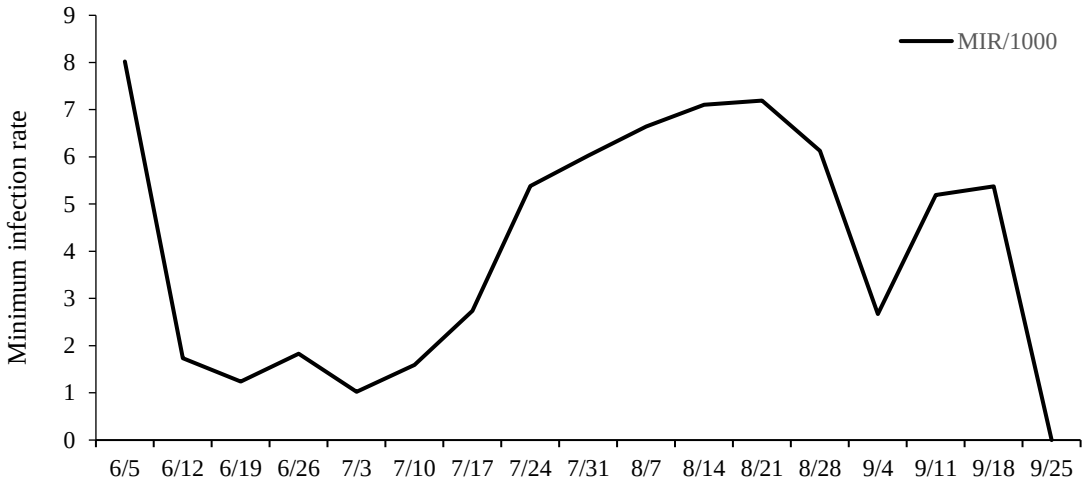


Figure 2.1 Weekly minimum WNV infection rates (MIR) per 1,000 *Culex* specimens tested in 2017. Dates listed are the Monday of each sampling week.

The District modified its bird surveillance plan in 2013 for more efficient use of reported information. We determined that we would stop collecting birds after the first WNV positive result. The single bird tested by MMCD in 2017 was positive for WNV by RAMP® test. It was an American crow collected on June 27 in Cedar Lake Township in Scott County. MMCD received 106 reports of dead birds by telephone, internet, or from employees in the field. Five of the reports were of dead blue jays, 82 were American crows. All other reports were of non-corvids.

Larval *Culex* Surveillance

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

Stormwater Management Structures and Other Constructed 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.

Inspectors collected 627 larval samples from stormwater structures and other constructed habitats. *Culex* vectors were found in 74.6 percent of the samples in 2017 (Table 2.4). *Culex pipiens* were found more frequently and *Cx. restuans* were found less frequently than in any of the previous four seasons.

Table 2.4 Frequency of *Culex* vector species in samples collected from stormwater management structures and other constructed habitats 2013 – 2017.

	Yearly percent occurrence				
Species	2013 (N=877)	2014 (N=814)	2015 (N=701)	2016 (N=625)	2017 (N=627)
Cx. pipiens	29.8	15.6	24.4	27.4	39.7
Cx. restuans	66.0	64.6	71.0	75.4	60.0
Cx. salinarius	0.5	0.6	0.4	0.0	0.5
Cx. tarsalis	3.9	5.4	2.4	3.5	3.2
Any *Culex* vector spp.	78.6	74.1	81.6	90.1	74.6

Mosquito Control in Underground Stormwater Structures Many stormwater management systems include large underground chambers to trap sediments and other pollutants. There are several designs in use that vary in dimension and name, but collectively they are often referred to as BMPs from *Best Management Practices for Stormwater* under the U.S. Environmental Protection Agency's National Pollution Discharge Elimination System (NPDES). MMCD has worked with city crews to survey and treat underground BMPs since 2005.

In 2017, 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 gallons of water retained. Briquets were placed in 865 underground habitats.

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

Table 2.5 Cities that assisted in treating underground stormwater habitats in 2017; 865 structures were treated with a total of 1,146 briquets.

City	Structures treated	Briquets used	City	Structures treated	Briquets used
Blaine	6	21	Mendota Heights	16	16
Bloomington	98	115	Minneapolis	170	170
Brooklyn Park	4	15	New Hope	35	36
Columbia Heights	10	14	Plymouth	150	335
Crystal	15	31	Prior Lake	56	56
Eden Prairie	12	20	Richfield	13	25
Little Canada	3	3	Roseville	27	29
Lino Lakes	10	10	Savage	18	28
Maplewood	220	220	Spring Lake Park	2	2

Larval Surveillance in Catch Basins Catch basin larval surveillance began the week of May 23 and ended the week of September 26 (Figure 2.2). Despite frequent rainfall throughout the summer, larvae were found during 698 of 963 catch basin inspections (72.5%) in 2017.

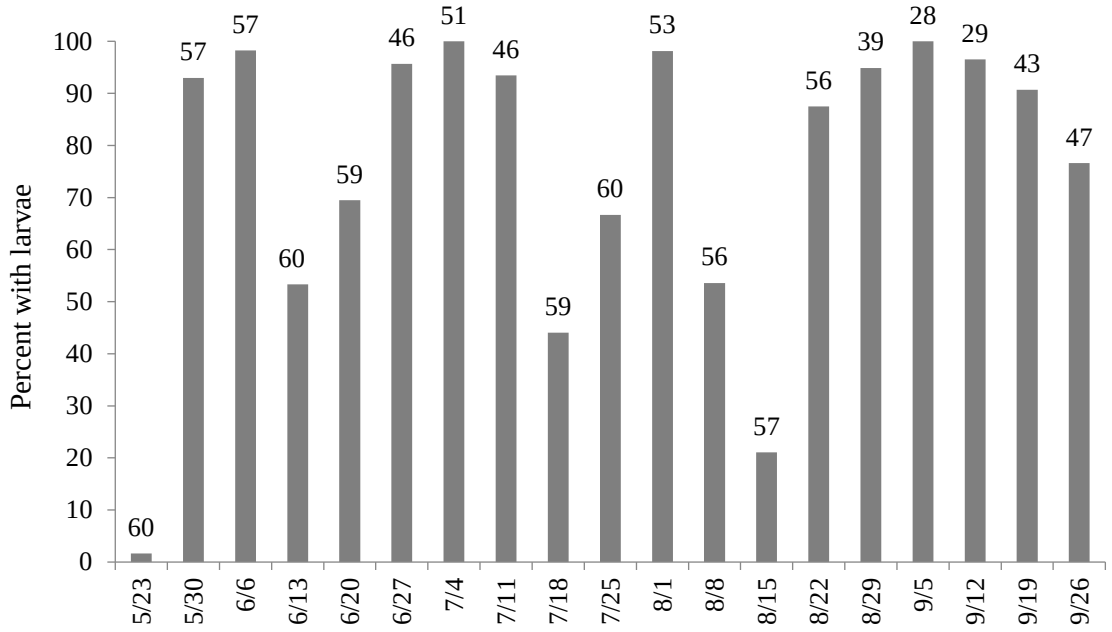


Figure 2.2 Percent of catch basins inspected with mosquitoes present in 2017. Bars are labeled with the number of inspections occurring during the week.

Mosquito larvae were identified from 697 catch basin samples. *Culex restuans* were found in 79.8% of catch basin larval samples (Figure 2.3). *Culex pipiens* were found in 64.1% of samples. At least one *Culex* vector species was found in 98.0% of samples. *Culex restuans* were common in catch basins throughout the season. *Culex pipiens* were present in catch basins during each week of surveillance and they were identified in over half of the samples from the week of July 4 until the end of surveillance.

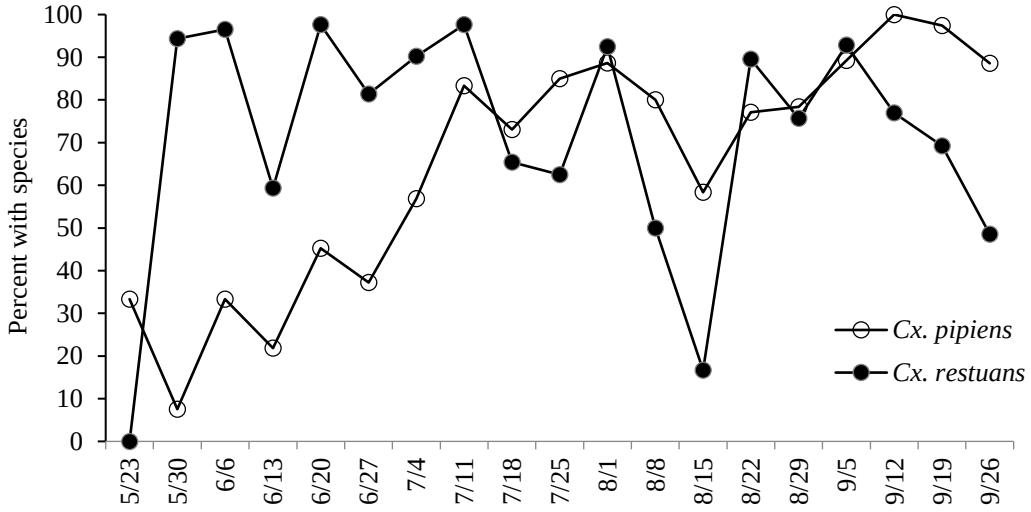


Figure 2.3 Occurrence of *Cx. pipiens* and *Cx. restuans* in catch basin larval samples by week.

2018 Plans – Mosquito-borne Disease

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

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

MMCD will continue to conduct surveillance for LAC, WNV, JC, and EEE vectors and for other mosquito-borne viruses in coordination with MDH and others involved in mosquito-borne disease 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 and the region.

Chapter 3 Tick-borne Disease

2017 Highlights

- Number of sites positive for *I. scapularis* was 69, down from the record high of 82 of 100 set last year
- Average *I. scapularis* per mammal was 1.21, also lower than 2016
- *Amblyomma americanum* 0 reports MMCD, 5 reports MDH - 1 each in Hennepin and Washington counties and three additional reports from outside of the District
- 2017 tick-borne cases not available, but in 2016 Lyme cases totaled 1,305 (23.78 cases per 100,000, source MDH)
- Anaplasmosis cases in 2016 totaled 733 (13.4 cases per 100,000, source MDH)

2018 Plans

- Continue *I. scapularis* surveillance at 100 sampling locations
- Continue with tick-borne disease education, tick identifications, and homeowner consultations
- Continue to update the Tick Risk Meter and provide updates on Facebook
- Continue to post signs at dog parks and expand to additional locations
- Continue to track collections of *A. americanum* or other new or unusual tick species
- Continue a collaborative study testing *I. scapularis* nymphs for tick-borne disease exposure

Background

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 disease effort.

MMCD initiated tick surveillance to determine the range and abundance of the black-legged tick (*Ixodes scapularis*, also known as the deer tick), the prominent vector in our area. 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.

Infected *I. scapularis* primarily transmit two important diseases in our area. Lyme disease, a bacterial infection caused by the bacterium *Borrelia burgdorferi*, and human anaplasmosis (HA), which is caused by the bacterium *Anaplasma phagocytophilum*. Other rare diseases transmitted by deer ticks include babesiosis and Powassan virus.

The Metropolitan Mosquito Control District's Lyme Disease Program identifies and monitors the distribution of deer ticks within the seven-county Twin Cities metropolitan area, ranks the deer tick activity throughout the season, and provides education in preventing tick-borne illness for District residents. Additionally, MMCD has 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 that 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).

2017 Tick-borne Disease Services

Lyme Disease and Human Anaplasmosis

Our tick surveillance began to detect increases in the metro *I. scapularis* population in 1998, with obvious expansion beginning in 2000. Since then, we have documented record-setting collection seasons on an ongoing basis. In parallel, but with a two-year lag (since 2000), the MDH has been documenting ongoing record-setting human tick-borne disease case totals. Pre-2000, the highest Lyme disease case total was 302 but since 2000 the Lyme disease totals have ranged from 463 to 1,431 cases, and now typically average >1,000 per year. Human anaplasmosis cases have also been on the rise. After averaging roughly 15 cases per year through 1999, the total HA case numbers ranged from 78 to 186 from 2000-2006 then increased into the range of the 300s. The all-time high, statewide Lyme disease case record (1,431) was set in 2013. The all-time high HA record of 782 was set in 2011. There were 1,305 Lyme disease and 733 HA cases in 2016. Case totals from 2017 are not yet available.

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* since 1990, and in 1998 *I. scapularis* was detected in Hennepin and Scott counties for the first time. We collected at least one *I. scapularis* from all seven counties that comprise our service area for the first time in 2007. Since then, we have detected *I. scapularis* with greater frequency and they appear to be prevalent now in many wooded areas south of the Mississippi River. The 2017 Lyme Tick Distribution Study report will be available on our website in June (www.mmcd.org/resources/technical-reports). Following are some 2017 highlights.

The average number of *I. scapularis* collected per mammal (1.209) in 2017 is high but lower than our record high of 1.679 that had just been set in 2016. However, it is comparable to the averages we have come to expect since 2000. As shown in Table 3.1, in 13 of the last 17 years averages have all been $\geq$ .806.

As has occurred in all years since 2007 except 2011, we collected at least one *I. scapularis* from all seven counties. From 2000 – 2009 our yearly positive site totals were typically in the 50s. The first time we had a site total of 70 or more was in 2010, then through 2014 our totals were either in the 50s or 70s. The first time we tabulated a site total of 80 or more was in 2015 when we had 81 positive sites, and our record high of 82 positive sites was set in 2016. We tabulated 69 positive sites in 2017. Maps are included in our yearly Lyme tick distribution study.

Table 3.1 Yearly totals of the number of mammals trapped and ticks collected (by tick species and life stage), and the average number of *I. scapularis* per mammal, 1990-2017. The number of sites sampled was 250 in 1990, 270 in 1991, 200 in 1992, and 100 from 1993 to present.

			Dermacentor variabilis		*Ixodes scapularis*			
Year	No. mammals	Total ticks collected	No. larvae	No. nymphs	No. larvae	No. nymphs	No. other species[b]	Ave. *I. scap* / mammal
1990 [a]	3651	9957	8289	994	573	74	27	0.18
1991	5566	8452	6807	1094	441	73	37	0.09
1992	2544	4130	3259	703	114	34	20	0.06
1993	1543	1785	1136	221	388	21	19	0.27
1994	1672	1514	797	163	476	67	11	0.33
1995	1406	1196	650	232	258	48	8	0.22
1996	791	724	466	146	82	20	10	0.13
1997	728	693	506	66	96	22	3	0.16
1998	1246	1389	779	100	439	67	4	0.41
1999	1627	1594	820	128	570	64	12	0.39
2000	1173	2207	1030	228	688	257	4	0.81
2001	897	1957	1054	159	697	44	3	0.83
2002	1236	2185	797	280	922	177	9	0.89
2003	1226	1293	676	139	337	140	1	0.38
2004	1152	1773	653	136	901	75	8	0.85
2005	965	1974	708	120	1054	85	7	1.18
2006	1241	1353	411	140	733	58	11	0.59
2007	849	1700	807	136	566	178	13	0.88
2008	702	1005	485	61	340	112	7	0.64
2009	941	1897	916	170	747	61	3	0.86
2010	1320	1553	330	101	1009	107	6	0.85
2011	756	938	373	97	261	205	2	0.62
2012	1537	2223	547	211	1321	139	5	0.95
2013	596	370	88	42	147	92	1	0.40
2014	1396	2427	580	149	1620	74	4	1.21
2015	1195	2217	390	91	1442	291	3	1.45
2016	1374	3038	576	153	2055	252	2	1.68
2017	1079	1609	243	45	1101	204	6	1.21

[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

Tick-borne Disease Prevention Services

Identification Services and Outreach The overall scope of tick-borne disease education activities and services were maintained in 2017 including tick identifications and homeowner consultations, updating our Tick Risk Meter on our website and MMCD's Facebook page, and

providing tick-borne disease information at the Minnesota State Fair and the county fairs in the metropolitan area.

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. Signs have been posted in approximately 21 parks with additional signs posted in active dog walking areas. We have also worked on expanding placements into additional metro locations.

Distributing Materials to Targeted Areas Brochures, tick cards, and/or posters were dropped off at roughly 270 locations (city halls, libraries, schools, child care centers, retail establishments, vet clinics, parks) across the metro as well as distributed at fair booths and city events, with many more mailed upon request.

Additional Updates – 2017

***Amblyomma americanum* (Lone Star Tick) Found in the Metro** *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 U.S., but the range of *A. americanum* is known to be moving northward. *Amblyomma americanum* 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*). However, in 2009, for the first time in a number of years, the public submitted *A. americanum* to both the MDH and MMCD (Minneapolis and Circle Pines). This trend has continued since, with *A. americanum* submitted to MMCD and/or the MDH from a variety of metro and other locations. As part of the tick submission process, each agency makes queries regarding travel history, excluding ticks that may have been picked up elsewhere. In 2017, the MMCD did not receive any reports but the MDH received one report each from Hennepin and Washington counties as well as three additional reports from outside MMCD's service boundaries. Including these 2017 submissions, we have totaled 24 adults and one nymph since 2009.

2018 Plans for Tick-borne Services

Surveillance and Disease Prevention Services The metro-based *I. scapularis* distribution study that began in 1990 is planned to continue unchanged. We will continue our tick-borne disease education activities and services including tick identifications and homeowner consultations, website updates of our Tick Risk Meter, and occasional use of social media. Since our *I. scapularis* collections and the MDH's human tick-borne disease case totals remain elevated, we will continue to stock local parks and other locations with tick cards, brochures and/or posters and signs. 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. We will continue to post at dog parks and other appropriate locations. As in past years, signs will be posted in the spring and removed in late fall after *I. scapularis* activity ceases for the year.

***Amblyomma americanum* and Other New or Unusual Ticks** 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 turned in by the public as part of our tick identification service. Both MMCD and MDH plan to maintain our current notification process of contacting the other agency upon identifying an *A. americanum* or other new or unusual tick species.

Collaborative Study: Testing Nymphal Deer Ticks (ongoing) In 2015, MMCD provided *I. scapularis* nymphs to PhD student Steve Bennett (University of Minnesota - St Paul campus) to be tested for exposure to several tick-borne disease agents. Nymphs from 1990 through 2014 are being tested and any changes over time will be documented.

Chapter 4 Mosquito Control

2017 Highlights

- Larvicide treatments in 2017 (195,061 acres) were lower than the record set in 2016 (305,969 acres)
- 30,039 acres worth of potential larval treatments were not applied to reduce expenditures
- A cumulative total of 253,139 catch basin treatments were made in three rounds to control vectors of WNV
- Adulticide treatments in 2017 (41,908 acres) were much lower than in 2016 (82,583 acres)

2018 Plans

- Apply two Natular® G30 treatments six weeks apart to replace former summer prehatch treatments made four weeks apart
- Add 3,000 acres worth of treatments in late May to control larval *Cq. perturbans*
- Maintain September VectoLex® CG treatments as part of our cattail mosquito control program
- Continue with successful cost-cutting changes: no larviciding in P2, except part of 3,000 acres of treatments to control larval *Cq. perturbans*
- Work closely with MPCA to fulfill the requirements of a NPDES permit

Background

The mosquito control program targets the principal summer pest mosquito *Aedes vexans*, several species of spring *Aedes*, the cattail mosquito *Cq. perturbans*, and several known disease vectors (*Ae. triseriatus, Culex tarsalis, Cx. pipiens, Cx. restuans, Cx. salinarius*) and *Aedes japonicus,* another potential vector species.

Due to the large size of the metropolitan region (2,975 square miles), larval control was considered the most cost-effective control strategy in 1958 and remains so today. Consequently, larval control is the focus of the control program and the most prolific mosquito habitats (over 79,000 potential sites) are scrutinized for all target mosquito species.

Larval habitats are diverse. They vary from very small, temporary pools that fill after a rainfall to large wetland acreages. Small sites (ground sites) are three acres or less, which field crews treat by hand if larvae are present. Large sites (air sites) are treated by helicopter only after certain criteria are met: larvae occur in sufficient numbers (threshold), larvae are of a certain age (1-4 instar), and larvae are the target species (human biting or disease vector).

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

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

Four synthetic pyrethroids were used in 2017: resmethrin, permethrin, sumithrin and etofenprox. Resmethrin will not be used after 2017 because it no longer is available. Sumithrin (Anvil®) and etofenprox (Zenivex®) can be used in agricultural areas. Local (barrier) treatments are applied to foliage where adult mosquitoes rest (mosquito harborage). Ultralow volume (ULV) treatments employ a fog of very small droplets that contact mosquitoes where they are active. Barrier treatments are effective for up to seven days. ULV treatments kill mosquitoes and dissipate within hours. 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 (2009-2017). Insecticide labels are located in Appendix F.

The District uses priority zones to focus service in areas where the highest numbers of citizens benefit (Figure 4.1). Priority zone 1 (P1) contains the majority of the population of the Twin Cities metropolitan area and has boundaries similar to the Metropolitan Urban Service Area (MUSA, Metropolitan Council). Priority zone 2 (P2) includes sparsely populated and rural parts of the District. We consider small towns or population centers in rural areas as satellite communities and they receive services similar to P1. Citizens in P1 receive full larval and adult vector and nuisance mosquito control. In P2, the District focuses on vector control and provides additional larval and adult control services as appropriate and as resources allow.

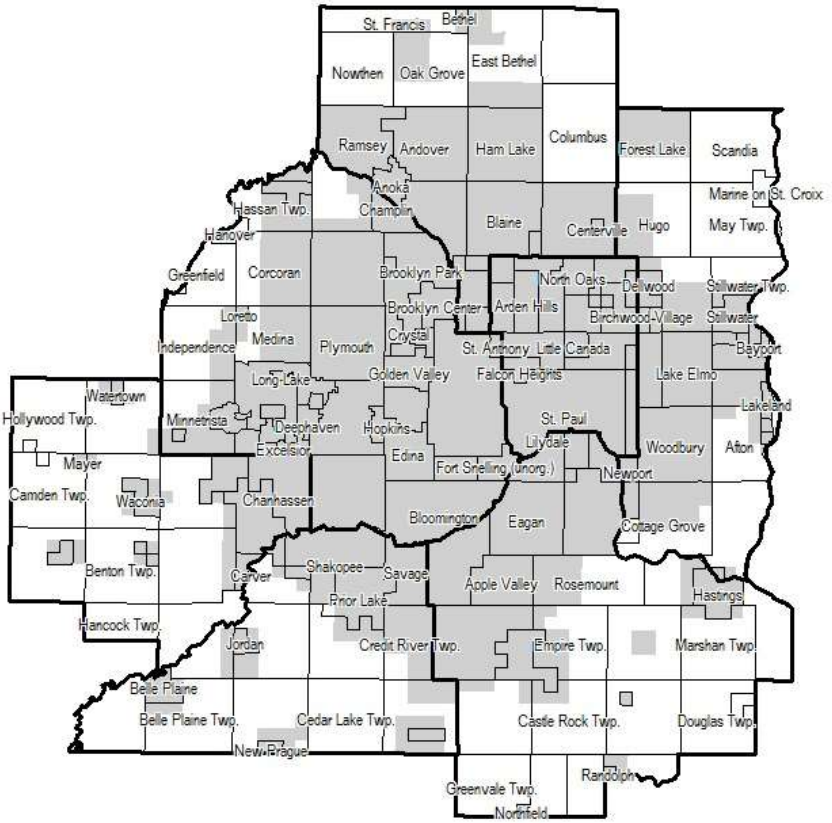


Figure 4.1 Priority zones 1 (shaded-P1) and 2 (white-P2), with District county and city/township boundaries, 2017.

2017 Mosquito Control

Larval Mosquito Control

Thresholds *Bti* treatments in large sites treated by helicopter (i.e., "air sites") are only done when larval numbers meet treatment thresholds, as measured by taking 10 dips with a standard 4-inch diameter dipper. P1 and P2 areas have different thresholds to help focus limited time and materials on productive sites near human population centers (Table 4.1). Spring *Aedes*, which tend to be long-lived, aggressive biters, have a lower threshold. After mid-May, when most larvae found are summer floodwater species, thresholds are increased. 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 threshold.

Table 4.1 Larval thresholds (average number of larvae per ten dips) in priority zone (P1 and P2) by species group.

	Priority zone	
Species group	P1	P2
Spring *Aedes*	0.5	1.0
Summer*	2.0	5.0
*Culex*4**	2.0	2.0

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

Culex* 4 = *Cx. restuans, Cx. pipiens, Cx. salinarius, Cx. tarsalis

Treatments with materials formulated for application prior to flooding and egg hatch ("prehatch materials") are applied to sites with a history of larvae present. The first "prehatch" treatments were applied in mid-May with a second in mid-June. Methoprene larvicides (MetaLarv S-PT, Altosid pellets) were applied in late May and very early June to control the cattail mosquito.

Temporary Program Changes in Response to Budget Resource Limitations From the beginning of 2014 through the end of 2016 (three record high service demand years), the District spent $5,891,103 more than funding received. The $5,891,103 came from reserves. At the end of 2016, reserves were $2,164,002 below the recommended minimum to support District cash flow. The levy was increased 1% in 2016 and 3% in 2017 to bring funding (monetary resources) and desired service levels (expenditures) closer in balance.

In early 2017, we evaluated options to reduce expenses by approximately $1.2 million but with the least impact on service for the majority of District residents. We chose five to implement:

1. Focus all larval control on P1 and minimize larval control expenses in P2 (affecting primarily spring *Aedes* treatments with *Bti* and cattail treatments with methoprene products, other P2 treatments had already been reduced in recent years).
2. Increase use of partial/perimeter treatment (*Bti*) of air sites to focus treatment on areas with the most larvae. This increases the amount of dipping required per air site.
3. Reduce use of aerial pre-hatch treatments (30-day control) and re-allocate resources to ground pre-hatch or air *Bti* treatments, aiming for a net treatment cost reduction of 22%. This requires staff to dip air sites after each rain, and thus could reduce the total number

of air sites treated. (Pre-hatch is less expensive only if there are three or more rain events in a 30-day period.)

4. Reduce seasonal inspector labor costs by delaying April inspector hires until May.
5. Reduce overtime during the treatment season.

In addition, after treating we chose to stay at a 5 lb/acre rate for *Bti* treatments after June 13 instead of increasing to 8 lb/acre later in the season. No other control strategies (including adult control) were changed.

We estimate the three expenditure reduction steps involving larval control resulted in a reduction in larval treatments of 30,039 acres (Table 4.2). While significant, these temporary reductions did not represent a major larval control strategy change. As in previous years, the majority of larval control was conducted in P1. The District continued to provide some services to all citizens in the entire service area. Evaluation of the effect of these changes on adult mosquito numbers is given in Chapter 6 – Product and Equipment Tests.

Table 4.2 Treatment reductions in 2017.

Control operation	Acres not Treated	Percent Change (from 2016)	Savings
Bti treatments	7,721	-3.3	$128,706
Cattail treatments all larvicides	7,946	-20.8	$524,761
Partial/perimeter site treatments (*Bti*)	9,586	-4.1	$172,138
Pre-hatch treatment all larvicides	4,786	-21.9	$291,044

Comprises $1,116,649 out of total savings of $1,339,628 achieved in 2017.

Season Overview Staff detected the first spring *Aedes* larvae on March 8, three days earlier than in 2016. Aerial *Bti* treatments began on May 3, eight days later than in 2016 (see Chapter 7). The mosquito species composition switched to primarily *Ae. vexans* (summer floodwater) in early May, and on May 6 and thereafter the summer larval threshold was used.

Precipitation in 2017 was relatively low in March, April, June, and July. Precipitation was higher in May and especially August with more precipitation in the southern parts of the District. Aerial *Bti* treatments targeted one large brood of spring *Aedes* and five large and seven small-medium broods of *Ae. vexans* (typical season has four large broods). Aerial prehatch treatments were applied in mid-May and mid-June. The majority of aerial treatments to control the cattail mosquito using MetaLarv S-PT and Altosid pellets were applied the last ten days of May (Figure 4.2).

Overall, we applied 195,061 acres worth of larval control in 2017 which is significantly less than 2016 and closer to values in years with more typical precipitation patterns (2011 and 2013)

(Table 4.3). 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 4.3).

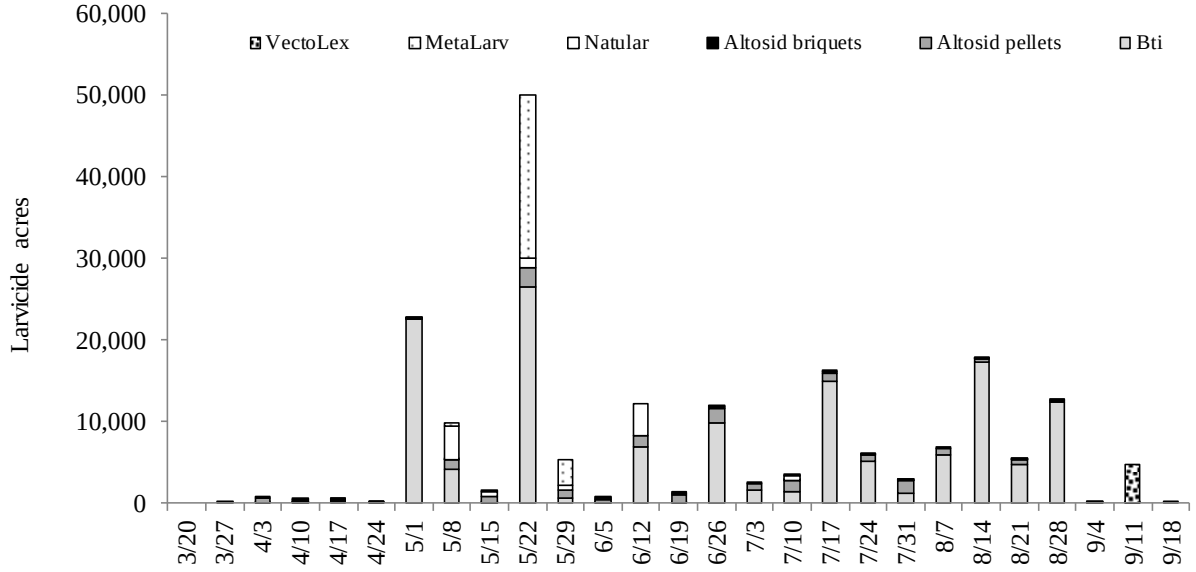


Figure 4.2 Acres treated with larvicide and each week (March-September 2017). Date represents start date of week.

Table 4.3 Comparison of larval control material usage in wetlands (including stormwater structures other than catch basins) and in stormwater catch basins for 2016 and 2017 (research tests not included).

	2016		2017	
Habitat and material used	Amount used	Acres treated	Amount used	Acres treated
Wetlands and structures				
Altosid briquets (cases)	244.41	168	234.19	166
Altosid pellets (lb)	57,529.86	19,173	50,038.01	17,939
MetaLarv S-PT (lb)	99,895.94	33,409	68,972.07	23,740
Natular G30 (lb)	75,197.66	13,023	63,999.47	12,271
VectoLex FG (lb)	95,520.02	6,076	71,925.00	4,773
VectoBac G (lb)	1,629,507.64	234,120	888,294.62	136,173
Total wetland and structures		305,969		195,061
Catch basins	Amount used	CB treatments	Amount used	CB treatments
Altosid briquets (cases)	2.04	448	2.02	445
Altosid pellets (lb)	1,914.63	240,806	1,989.20	252,694
Total catch basin treatments		241,254		253,139

We continued to work with Minnesota Pollution Control Agency (MPCA) to make sure MMCD's larval control program satisfies the requirements of our National Pollution Discharge Elimination System (NPDES) permit, including submission of annual reports with site-specific larval surveillance and treatment records (see Chapter 7 – Supplemental Work).

Adult Mosquito Control

Thresholds Adult mosquito control operations are considered when mosquito levels rise above established thresholds for nuisance (*Aedes* spp. and *Cq. perturbans*) and vector species (Table 4.4). Staff conducted a study in the early 1990s that measured people's perception of annoyance while simultaneously sampling the mosquito population (Read et.al., 1994). Results of this study are the basis of MMCD's nuisance mosquito thresholds. The lower thresholds for vector species are designed to interrupt the vector/virus transmission cycle. The sampling method used is targeted to specific mosquito species.

Table 4.4 Thresholds levels by sampling method for important nuisance and vector species detected in MMCD surveillance. *Aedes* spp. and *Cq. perturbans* are considered nuisance mosquitoes; all other species listed are disease vectors.

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

*2-minute slap count may be used
**Aspirator threshold only for *Cx. tarsalis*
****Culex*4 = *Cx. restuans*, *Cx. pipiens*, *Cx. salinarius*, *Cx. tarsalis***

Season Overview In 2017, adult mosquito levels rose in mid-June and remained higher through July; at those times, counts over threshold were fairly widespread (Figure 4.3). In 2017, MMCD applied 40,892 fewer acres worth of adulticides than in 2016 when adult mosquito levels remained elevated well into September (Table 4.5, Appendix E). Figure 4.3 shows weekly adulticide acres treated (line). The peak in early June depicts a response to widespread *Ae. vexans* emergence and increasing numbers of *Culex* (WNV vectors). The peak at the end of June continuing into the second week of July was mostly in response to the annual *Cq. perturbans* emergence. A greater proportion of adulticide treatments later in the summer targeted vector mosquitoes. Customer calls related to mosquito annoyance peaked in June (1,358) and were much lower in May (268), July (351), August (166), and September (83). In 2016, annoyance calls were high from June into August, a much longer period than in 2017.

Table 4.5 Comparison of adult control material usage in 2016 and 2017.

	2016		2017	
Material	Gallons used	Acres treated	Gallons used	Acres treated
Permethrin	1,405.04	8,128	894.73	5,038
Resmethrin	279.59	23,072	24.29	2,090
Sumithrin*	437.06	16,399	299.58	11,683
Etofenprox*	261.66	34,984	205.99	23,097
Total		82,583		41,908

* Products labeled for use in agricultural areas

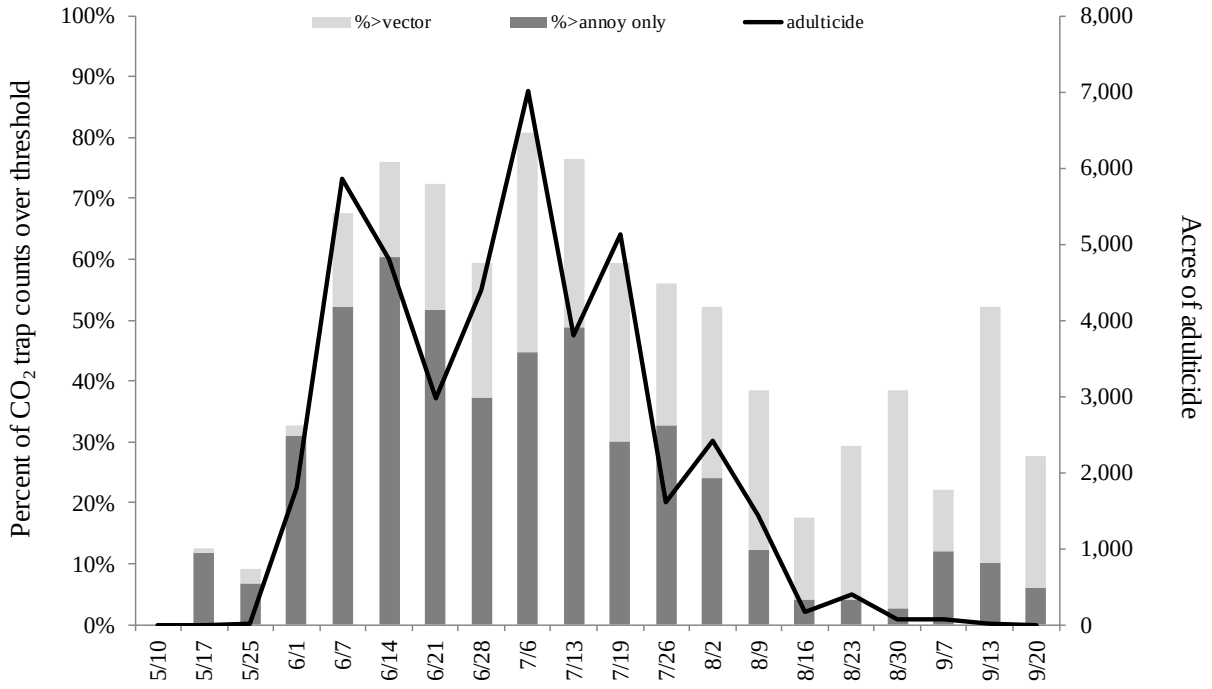


Figure 4.3 Percent of Monday CO_2 trap locations with counts over threshold compared with acres of adulticides applied in 2017 (solid line). Dark bars indicate the percentage of traps meeting annoyance mosquito thresholds and lighter bars represent the percentage of traps meeting the vector thresholds (*Culex*4, *Ae. triseriatus*, *Ae. japonicus*, *Cs. melanura*) on each sampling date. Date is day of CO_2 trap placement.

References

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

2018 Plans for Mosquito Control Services

Integrated Mosquito Management Program

In 2018, 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 7. Our control materials budget in 2018 will be increased slightly compared to 2017.

Larval Control

Temporary Measures to Decrease Expenditures In 2018, we plan to maintain the five expenditure reduction steps with revisions to pre-hatch and cattail treatment strategies. Because of an overall increase of the cattail mosquito observed by adult surveillance District-wide in 2017, we plan to make available more resources for cattail mosquito control in 2018 by replacing three prehatch treatments made four weeks apart with two aerial Natular G30 (prehatch) treatments (5 lb/acre) six weeks apart. This will make available resources to treat about 3,000 additional acres to control the cattail mosquito with no net larval control cost increase. Aerial Natular G30 treatments have provided effective control of *Ae. vexans* for at least four significant rain events (See 2013 Operational Review and Plans for 2014 for details). More than four significant rain events during a six-week period between mid-May and mid-August has happened only twice in recent years, during 2013 and 2015.

Cattail Mosquitoes In 2018, control of *Cq. perturbans* (cattail mosquitoes) will use a strategy similar to that employed in 2017 except that about 3,000 more acres will be treated with larvicides (Altosid pellets and MetaLarv S-PT). MMCD will focus control activities on the most productive cattail marshes near human population centers. Altosid briquet applications will start in early March to frozen sites (e.g., floating bogs, deep water cattail sites, remotely located sites). Largely because of control material prices, a greater proportion of acres will be treated with Altosid pellets and MetaLarv S-PT to minimize per-acre treatment costs. Beginning in late May, staff will apply MetaLarv S-PT (3 lb/acre) and Altosid pellets (4 lb/acre) aerially. Ground sites will be treated with Altosid pellets (4 lb/acre) and MetaLarv S-PT (3 lb/acre). Staff will maintain (compared to 2017) late summer VectoLex CG applications (15 lb/acre), based upon site inspections completed between mid-August and mid-September.

Floodwater Mosquitoes The primary control material will again be *Bti* corn cob granules. Larvicide needs in 2018, mainly *Bti* (VectoBac G), Altosid pellets, Natular G30, and MetaLarv S-PT, are expected to be similar to the five-year average larvicide usage (269,312 acres). We plan to treat sites to control spring *Aedes* with *Bti* at 8 lb/acre and decrease the *Bti* dosage to 5 lb/acre when we switch to the summer *Aedes* threshold. As in previous years, to minimize shortfalls, control material use may be more strictly apportioned during the second half of the season, depending upon the amount of the season remaining and control material supplies. Regardless of annoyance levels, MMCD will maintain sufficient resources to protect the public from potential disease risk.

Staff will treat ground sites with methoprene products (Altosid pellets, Altosid briquets, MetaLarv S-PT), Natular G30 or *Bti* corncob granules. During a wide-scale mosquito brood,

sites in highly populated areas will receive treatments first. The District will then expand treatments into less populated areas where treatment thresholds are higher. We will continue with the larval treatment thresholds used in 2017 (Table 4.1).

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

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

Ground and aerial larvicide treatments of wetlands have been increased to control *Culex*. Catch basin treatments control *Cx. restuans* and *Cx. pipiens* in urban areas. Most catch basins will be treated with Altosid pellets. Catch basins selected for treatment include those found holding water, those that potentially could hold water based on their design, and those for which we have insufficient information to determine whether they will hold water. Treatments could begin as early as the end of May and no later than the third week of June. We tentatively plan to complete a first round of pellet treatments by June 25 with subsequent Altosid pellet treatments every 30 days.

Adult Mosquito Control

Staff will continue to review MMCD's adulticide program to ensure effective resource use and minimize possible non-target effects. Adulticide requirements in 2017 are expected to be similar to the five-year average adulticide usage (72,810 acres). 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.

Additional plans are:

- to use Anvil (sumithrin) and Zenivex (etofenprox) as needed to respond to elevated levels of adult mosquitoes as needed;
- to use Anvil and Zenivex as needed to control WNV vectors in agricultural areas because current labels now allow applications in these areas;
- to evaluate possible adulticide use in response to *Ae. japonicus* and *Cs. melanura*;
- to ensure all employees who may apply adulticides have passed applicator certification testing for both restricted and non-restricted use products.

Chapter 5 Black Fly Control

2017 Highlights

- Treated 14 small streams sites with *Bti* when the *Simulium venustum* larval population met the treatment threshold; a total of 19.5 gallons of *Bti* was used
- Made 63 *Bti* treatments on the large rivers when the larval population of the three target species met the treatment threshold; a total of 3,620.6 gallons of *Bti* was used for these treatments
- Monitored adult populations using overhead net sweeps and CO_2 traps; the average black fly/overhead sweep was 0.24, the second lowest number since the black fly program started in 1984
- Completed report for Mississippi River non-target monitoring samples collected in 2015
- Collected Mississippi River non-target invertebrate monitoring samples

2018 Plans

- Monitor larval black fly populations in small streams and large rivers and apply *Bti* when treatment thresholds are met
- Monitor adult populations by the overhead net sweep and CO_2 trap methods
- Process Mississippi River non-target monitoring samples collected in 2017

Background

The goal of the black fly control program is to reduce pest populations of adult black flies within the MMCD to tolerable levels. Black flies develop in clean flowing rivers and streams. Larval populations are monitored at 169 small stream and 28 large river sites using standardized sampling techniques during the spring and summer. Liquid *Bti* is applied to sites when the target species reach treatment thresholds in accordance with MMCD's permit from the Minnesota Department of Natural Resources (MnDNR).

The small stream treatment program began in 1984. The large river program began with experimental treatments and non-target impact studies in 1987. A full-scale large river treatment program did not go into effect until 1996. The large river treatment program was expanded in 2005 to include the South Fork Crow River in Carver County. Large river and small stream monitoring and treatment locations are shown in Figure 5.1.

2017 Program

Small Stream Program: *Simulium venustum* Control

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

In April, 206 larval monitoring samples were collected from the small streams within the MMCD 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 14 sites on seven streams met the threshold and were treated once with VectoBac® 12AS *Bti*. A total of 19.5 gallons of VectoBac was used for the treatments (Table 5.1). In comparison, the average amount of *Bti* used to treat the small stream sites annually during 1996-2016 was 27.3 gallons.

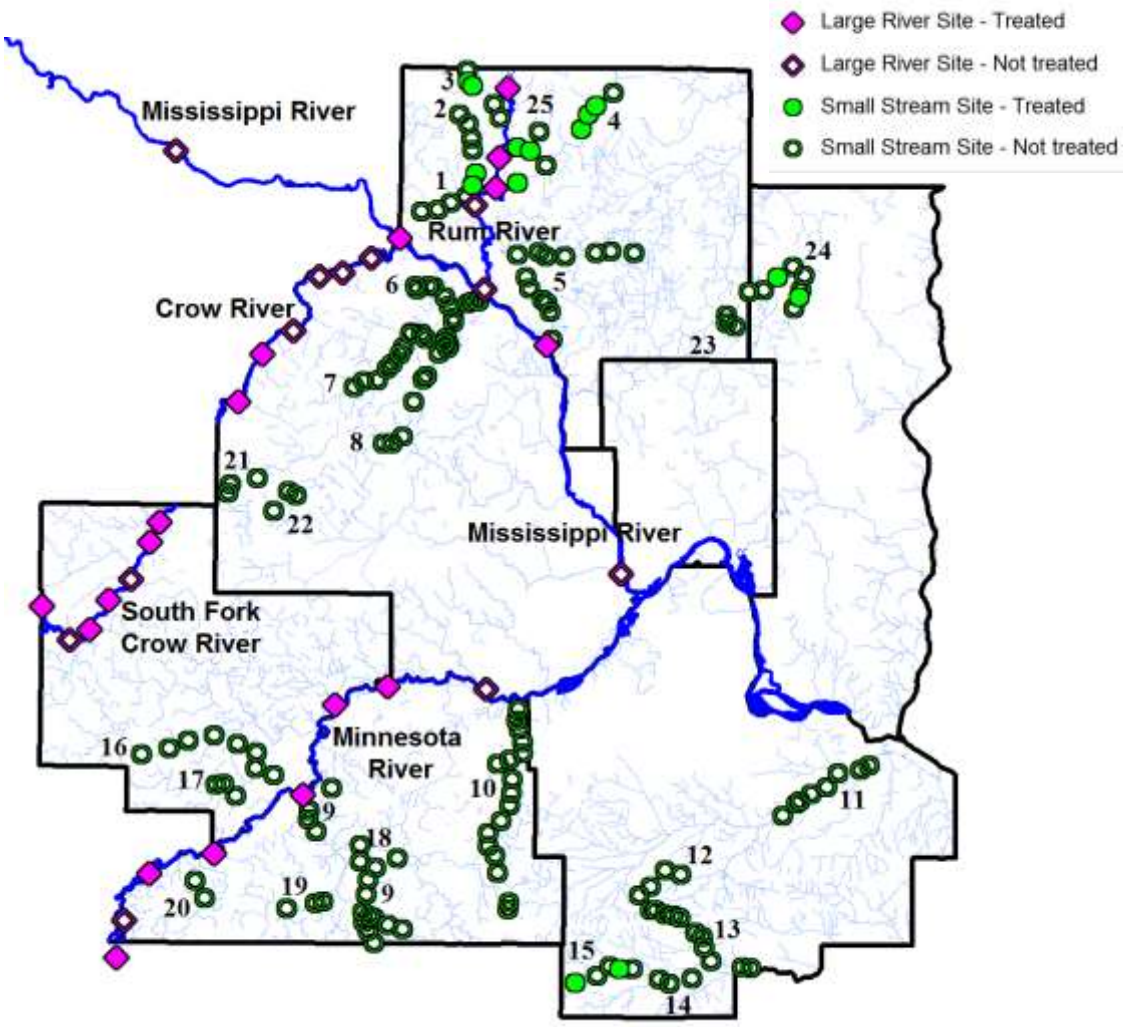


Figure 5.1 Large river and small stream black fly larval monitoring and treatment locations, 2017.

Note: the large river site located outside the District on the Mississippi River is for monitoring only. Since 1991, more than 450 of the more than 600 original small stream treatment sites were eliminated from the annual small stream sampling program due to the increased treatment threshold as well as our findings from years of sampling that some sites did not produce any, or very few, *S. venustum*. Periodically historical sites that were eliminated from the permit are sampled to confirm if larval populations are present or absent. Requests are made to add new sites if larval monitoring confirms elevated *S. venustum* populations. The numbers on the map refer to the small stream names listed below:

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

Table 5.1 Summary of *Bti* treatments for black fly control by the MMCD, 2017 vs. long-term average.

	2017			Long-Term Average[1]		
Water body	# sites treated	Total # treatments	Gal. of *Bti* used	# sites treated	Total # treatments	Gal. of *Bti* used
Small Stream	14	14	19.5	48.1	48.1	27.3
Large River						
Mississippi	2	5	435.0	2.1	11.1	1,192.5
Crow	2	7	135.0	2.2	5.2	92.5
South Fork Crow	5	11	137.5	5.4	12.2	103.9
Minnesota	6	19	2,727.9	6.0	16.6	1,650.8
Rum	3	21	185.2	3.5	20.2	142.4
Large River Totals	18	63	3,620.6	19.2	65.3	3,182.1

[1] The Mississippi, Crow, Minnesota and Rum averages are from 1996 - 2016. The South Fork Crow is from 2005 - 2016.

Large River Program

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

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

A total of 526 larval monitoring samples were collected in 2017. The treatment threshold was met in 63 of these samples at 18 of the permitted sites and the associated sites were treated with a total of 3,620.6 gallons of VectoBac 12AS *Bti* (Table 5.1). In comparison, the average amount of *Bti* used in the large river treatments annually between 1996 and 2016 was 3,182.1 gallons with an average of 65.3 treatments.

The efficacy of the VectoBac 12AS treatments is measured by determining larval mortality 250 m downstream from the *Bti* application point. In 2017, the average larval mortality of the treatments was 99% on the Minnesota River, 96% on the Rum River, 96% on the Crow River, 96% on the South Fork Crow River and 100% on the Mississippi River.

Adult Population Sampling

Daytime Sweep Net Collections The adult black fly population was monitored at 53 standard stations (Figure 5.2) using the District's black fly over-head net sweep technique that was established in 1984. Samples were taken once weekly from early May to mid-September, generally between 8:00 AM and 10:00 AM. The average number of all species of adult black flies captured in 2017 was 0.24 (± 0.93 SD). In comparison, the average of all species captured in net sweeps from 1996, when operational treatments began, through 2016 was 1.35 (± 0.80 SD) (Table 5.2). Between 1984 and 1986 when no *Bti* treatments were done on the large rivers, the average number of all species of adults captured in the net sweeps was 14.80 (± 3.04 SD).

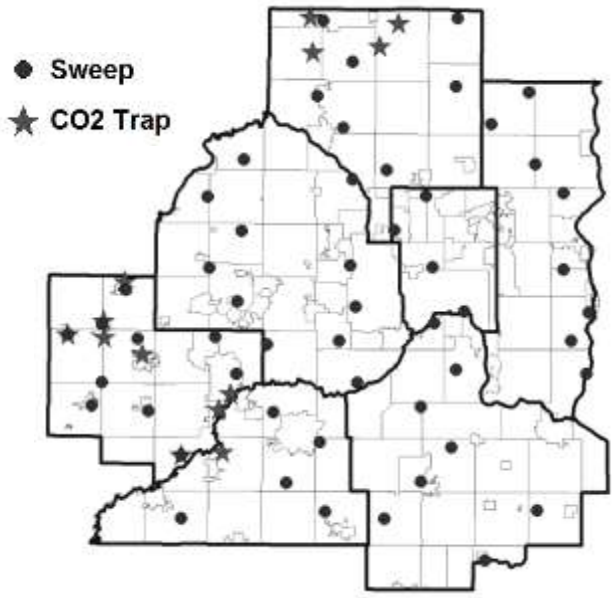


Figure 5.2 Adult black fly sweep and CO_2 trap sampling locations, 2017.

The most abundant black fly collected in the overhead net-sweep samples in 2017 was *S. luggeri*, comprising 41.7% of the total captured with an average of 0.10 (± 0.61 SD) per sample. The second most abundant black fly species captured was *S. meridionale*, comprising 31.2% of the total captured with an average of 0.08 (± 0.52 SD) per sample.

Among the seven MMCD counties, Anoka County had the highest average number (0.68) of all black fly species captured in net sweep samples in 2017. *Simulium luggeri* was the most abundant black fly captured in Anoka County with an average of 0.50 per sample. The best *S. luggeri* larval habitat in the MMCD is located on reaches of the Mississippi and Rum rivers in Anoka County.

Table 5.2 Mean number of black fly adults captured in over-head net sweeps taken at standard sampling locations between mid-May and mid-September; samples were taken once weekly beginning in 2004 and twice weekly in previous years.

Large river *Bti* treatment status[1,2,3,4]	Time Period	Mean ± SD			
		All species[5]	*Simulium luggeri*	*Simulium johannseni*	*Simulium meridionale*
No treatments	1984-1986	14.80 ± 3.04	13.11 ± 3.45	0.24 ± 0.39	1.25 ± 0.55
Experimental treatments	1987-1995	3.63 ± 2.00	3.16 ± 2.05	0.10 ± 0.12	0.29 ± 0.40
Operational treatments	1996-2016	1.35 ± 0.80	1.07 ± 0.77	0.01 ± 0.01	0.15 ± 0.12
	2017	0.24 ± 0.92	0.10 ± 0.61	0.01 ± 0.16	0.08 ± 0.52

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

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

[3]1996 was the first year of operational treatments (treatment of all MnDNR-permitted sites) on the large rivers.

[4]Expanded operational treatments began in 2005 when permits where received from the MnDNR for treatments on the So. Fork Crow River.

[5]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 monitored from mid-May to mid-June in 2017 with CO_2 traps at four stations each in Scott and Anoka counties, and five stations in Carver County (Figure 5.2). The adult black population at these stations has been monitored with CO_2 traps since 2004 when larval treatments began on the South Fork Crow River. Black flies captured in these CO_2 traps are preserved in alcohol to facilitate species identification.

A total of 27,463 adult black flies were collected in the CO_2 traps in 2017. *Simulium meridionale* was the most abundant species, comprising 78% of the total black flies captured. Overall, 21,443 *S. meridionale* were collected in the traps, of which 19,405 were collected in the five Carver County traps. The mean number of *S. meridionale* captured in the Carver Country traps was 298.54 (± 782.76 SD), whereas the mean number captured in the Scott County traps was 38.94 (± 119.75 SD) and 1.00 (± 4.57 SD) in the Anoka County traps (Table 5.3).

Simulium johannseni was the second most abundant species captured in the CO_2 traps in 2017 with a total of 5,291, comprising 19% of total black flies. The largest number of *S. johannseni* was captured in Carver County with an average of 71.08 (± 224.84 SD) per trap; in Scott County the average number captured was of 6.86 (± 16.61 SD) and in Anoka County the average per trap was 6.17 (± 15.81 SD) (Table 5.3).

Simulium venustum was the third most abundant species collected in the CO_2 traps with a total of 609 captured, comprising 2% of total black flies. The largest number of *S. venustum* was captured in Anoka County with an average of 7.48 (± 13.52 SD) per trap; in Scott County the

average number captured was of 2.56 (± 9.24 SD) and in Carver County the average per trap was 1.42 (± 13.52 SD) (Table 5.3).

Table 5.3 Mean number of adult *S. venustum*, *S. johannseni*, and *S. meridionale* captured in CO_2 traps set twice weekly between May and mid-June in Anoka, Scott, and Carver counties, 2004-2017.

	S. venustum			*S. johannseni*			*S. meridionale*		
Year	Anoka	Scott	Carver[1]	Anoka	Scott	Carver[1]	Anoka	Scott	Carver[1]
2004	0.89	2.25	0.25	5.11	0.17	32.93	14.09	0.65	327.29
2005	2.31	3.40	0.84	0.03	3.50	99.04	1.23	23.25	188.02
2006	22.80	3.38	1.82	0.75	38.07	98.75	0.75	10.50	107.53
2007	37.62	35.59	75.67	0.20	32.50	112.77	0.51	172.48	388.64
2008	13.84	228.93	169.63	0.13	20.18	95.63	0.68	75.03	359.02
2009	18.32	238.16	425.00	0.34	22.80	35.92	0.70	98.77	820.25
2010	21.75	44.60	77.00	0.03	6.18	219.38	0.05	256.90	271.08
2011	8.90	60.64	48.30	2.61	280.64	4,584.72	0.93	311.55	268.28
2012	2.89	5.45	0.40	0.95	81.73	154.13	0.41	242.55	100.53
2013	14.61	3.09	1.44	1.18	4.88	14.03	0.00	111.45	322.43
2014	13.64	16.82	8.68	3.36	12.36	702.82	1.32	12.64	193.57
2015	9.83	1.14	0.43	0.37	35.17	12.43	0.17	23.31	161.30
2016	1.70	0.72	0.02	1.50	2.89	35.41	0.86	64.33	501.85
2017	7.48	2.56	1.42	6.17	6.86	71.08	1.00	38.94	298.54
SD	±13.52	± 9.24	±13.52	±15.81	±16.61	±224.84	±4.57	±119.75	±782.76
	n=4	n=4	n=5	n=4	n=4	n=5	n=4	n=4	n=5

Monday Night CO_2 Trap Collections Black flies captured in District-wide weekly CO_2 trap collections were counted and identified to family level in 2017. 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 5.3. 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 and early June in parts of Carver, Hennepin, and Dakota counties (Figure 5.3).

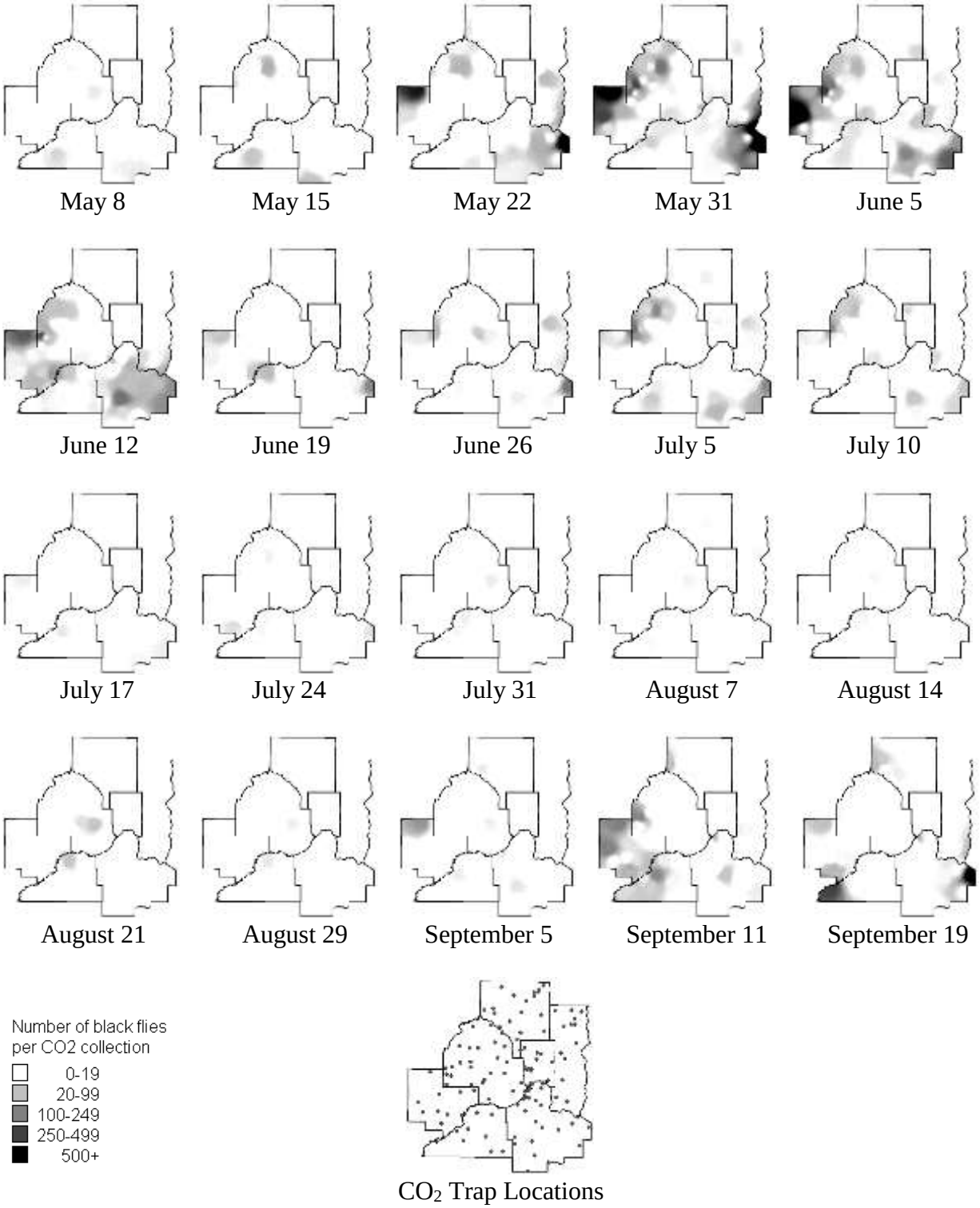


Figure 5.3 Number of black flies collected in mosquito surveillance District low (5 ft) and elevated (25 ft) CO_2 traps, 2017. The number of traps operated per night varied from 114-128. Inverse distance weighting was the algorithm used for shading of maps.

Non-target Monitoring

The District has conducted biennial monitoring of the non-target macroinvertebrate population in the Mississippi River as part of its MnDNR permit requirements since 1995. The monitoring program is a long-term assessment of the macroinvertebrate community in *Bti*-treated reaches of the Mississippi River within the MMCD. A report of the results from monitoring samples collected in 2015 was submitted to the MnDNR in March. The results were consistent with those from the previous years and indicated that there have been no large-scale changes in the macroinvertebrate community in the *Bti*-treated reaches of the Mississippi River within the MMCD since monitoring began in 1995.

In an effort to improve efficiency and reduce workload, a concurrent study was proposed in 2017 to compare the standard 14 plate sampler to a reduced 7 plate sampler. The standard 14 plate samples and additional 7 plate samples were collected from the Mississippi River in 2017. A report will be submitted to the MnDNR comparing results from the 7 vs 14 plate samplers at the same stations and sample months prior to the start of the 2019 sampling season. If results between the 7 and 14 plate samplers are comparable, the MMCD will propose using 7 plate samplers starting in 2019 (with no other changes to the current sampling protocols, stations or months sampled). A report is scheduled for completion by the spring of 2019.

2018 Plans – Black Fly Program

2018 will be the 34th year of black fly control in the District. The primary goal in 2018 will be to continue to effectively monitor and control black flies in the large rivers and small streams. The larval population monitoring program and thresholds for treatment with *Bti* will continue as in previous years. Field crews will continue to use the bulk control materials containers as part of the broader sustainability efforts of the District. The 2018 black fly control permit application will be submitted to the MnDNR in February. Samples collected for the non-target invertebrate monitoring program on the Mississippi River in 2017 will be processed. Program development will continue to emphasize improvement in effectiveness, surveillance, and efficiency.

Chapter 6 Product & Equipment Tests

2017 Highlights

- Both 8- and 5-lb/acre dosages of VectoBac® G *Bti* achieved good control of *Ae. vexans* in air sites
- MetaLarv® S-PT effectively controlled spring *Aedes* for four weeks
- VectoLex® FG effectively controlled cattail mosquitoes in both rooted and floating sites
- VectoPrime® FG effectively controlled third and fourth instar *Ae. vexans*, *Cx. tarsalis*, and *Cs. inornata* in ground sites
- Sumilarv® 0.5 G effectively controlled mosquito larvae in catch basins for the entire season (June – September)
- Merus® and Anvil® (ULV) both controlled mosquitoes effectively when mosquitoes were very abundant before treatment

2018 Plans

- Repeat tests of VectoPrime® FG against summer *Aedes* to evaluate its effectiveness against fourth instar larvae
- Evaluate efficacy of Natular® G during six weeks following treatment to verify control for at least four rain events
- Complete Natular® G (9 lb/acre) test in rooted vs floating cattail sites for possible *Cq. perturbans* control
- Continue tests of adulticides in different situations emphasizing control of vectors and effectiveness of barrier treatments

Background

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

2017 Projects

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

Control Material Acceptance Testing

Larval Mosquito Control Products Warehouse staff collected random product samples from shipments received from manufacturers for active ingredient (AI) content analysis. MMCD contracts an independent testing laboratory, Legend Technical Services, to complete the AI analysis. Manufacturers provide the testing methodologies. The laboratory protocols used were CAP No. 311, "Procedures for the Analysis of S-Methoprene in Briquets and Premix", CAP No. 313, "Procedure for the Analysis of S-Methoprene in Sand Formulations", VBC Analytical Method: VBC-M07-001.1 Analytical Method for the Determination of (S)-Methoprene by High Performance Liquid Chromatography and Clarke Analytical Test Method SP-003 Revision #2

"HPLC Determination of Spinosad Content in Natular G30 Granules." The manufacturer's certificates of analysis at the time of manufacture for samples of all control materials shipped to MMCD in 2017 were all within acceptable limits. Due to the significant cost of independent laboratory evaluation, 2016-2018 product samples have been submitted to the independent laboratory to lower our overall expenditures. MMCD will use these results to study the ability to carryover products over multiple years.

Adult Mosquito Control Products MMCD requests certificates of AI analysis from the manufacturers to verify product AI levels at the time of manufacture. MMCD has incorporated AI analysis as part of a product evaluation procedure and will submit randomly selected samples of adulticide control materials to an independent laboratory for AI level verification. This process will assure that all adulticides (purchased, formulated, and/or stored) meet the necessary quality standards. In 2016 and 2017, MMCD sampled but did not analyze adulticide products and saved voucher samples for reference.

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 2017. Aerial *Bti* treatments began May 3 (five days later than in 2016). We applied 8 lb/acre to control spring *Aedes* and switched to the 5 lb/acre rate beginning on June 13 to control *Ae. vexans*. We used the 5 lb/acre rate for the remainder of the season to conserve budgetary resources. In 2017, aerial *Bti* treatments achieved an average of 84.5% control (Table 6.1), comparable to 86.0% control in 2016, 83.7% control in 2015, and 90.4% control in 2014. Effectiveness of both rates was remarkably uniform throughout the 2017 season. Percent mortality was calculated by comparing pre- and post-treatment dip counts.

Table 6.1 Efficacy of aerial VectoBac G applications (8 lb and 5 lb/acre) during different time periods of the 2017 mosquito season. (n = number of sites dipped)

Time period	Dosage rate	n	Mean mortality	±SE*
May 3 – June 1	8 lb/acre	258	84.1%	2.1%
June 13 – Sept 1	5 lb/acre	397	84.7%	1.8%
May 3 – Sept 1	All rates	655	84.5%	1.3%

*SE= standard error

Temporary *Bti* and Cattail Control Reductions Cattail larvicide treatments in P2 that were applied in 2016 largely were not applied in 2017 as part of a strategy to reduce expenditures (see Chapter 4 for details). In 2017, larval surveillance detected more sites containing cattail mosquito larvae in P1 than could be treated with available resources. Three years (2014-2016) of high precipitation flooded many acres of cattail sites. Adult mosquito surveillance documented a large increase in adult cattail mosquitoes throughout the District in 2017 (see Chapter 1 for details). We compared adult cattail mosquito abundance in groups of CO_2 traps in P1 (cattail larvicide treatments maintained in 2016 and 2017) and P2 (fewer cattail larvicide treatments completed in 2016, largely curtailed in 2017) in Washington and Hennepin counties (Figure 6.1).

Abundance in traps located in Linwood Township (no cattail mosquito control in 2016 and 2017) served as a reference (Figure 6.1).

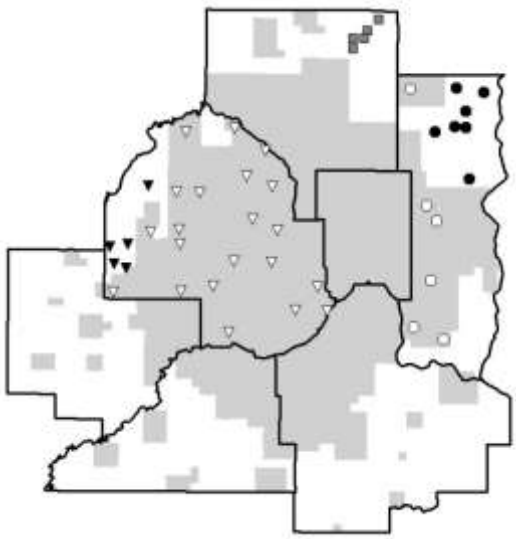


Figure 6.1 Location of CO_2 traps in Hennepin County (P1 white triangles, P2 black triangles), Washington County (P1 white circles, P2 black circles), and Linwood Township (gray squares). P1 is shaded light gray.

Adult *Cq. perturbans* abundance as measured by CO_2 trap captures in 2016 and 2017 documented a large increase in 2017 throughout the District (Table 6.2). In both 2016 and 2017, abundance was lower in P1 than in P2 in Hennepin and Washington counties (Table 6.2) suggesting that larval control is decreasing adult *Cq. perturbans* abundance in P1.

Table 6.2 Adult *Cq. perturbans* abundance (nightly CO_2 trap captures) in 2016 and 2017 in five groups of CO_2 traps [mean (± 1 SE)]; n=number of CO_2 traps.

	Hennepin Co.		Washington Co.		Linwood Twp.
Year	P1 (n=21)	P2 (n=5)	P1 (n=6)	P2 (n=7)	P2 (n=5)
2016	19.3 (±4.6)	42.0 (±15.4)	30.6 (±11.4)	161.13 (±26.8)	325.1 (±67.5)
2017	57.8 (±12.7)	158.7 (±57.1)	123.5 (±81.9)	424.8 (±76.7)	750.2 (±164.1)
%Δ17/16	199.7%	278.2%	304.2%	163.6%	130.7%

The relative change in adult *Cq. perturbans* abundance (2017 compared to 2016) was very similar in P1 and P2 of the District suggesting that environment (high precipitation in 2014, 2015 and 2016) resulted in similar relative increases of *Cq. perturbans* abundance in 2017 throughout the observation area (%Δ in Table 6.2). The environmental impact seems to have been much stronger than potential effects of minimal larval control in P2 in 2017. In both 2016 and 2017 a much larger proportion of cattail breeding acreage in P1 was treated with larvicide compared to P2. When environmental conditions support high larval *Cq. perturbans* abundance, a greater

proportion of breeding acreage probably will require larval control to more significantly decrease adult *Cq. perturbans* abundance.

Abundance of spring *Aedes* in CO_2 traps District-wide was well below the 17-year average in both 2016 and 2017 (see Table 1.3). The five groups of CO_2 traps used to compare *Cq. perturbans* abundance also can be used to compare spring *Aedes* abundance relative to treatments in 2016 and 2017. Hennepin P1 and Washington P1 are areas where aerial *Bti* treatments targeting spring *Aedes* were completed in 2016 and 2017. Aerial *Bti* treatments were completed in Hennepin P2 in 2016; these treatments were not made in 2017. No significant aerial *Bti* treatments targeting spring *Aedes* were completed in 2016 and 2017 in Washington P2 and in Linwood Township.

Low and variable numbers of adult spring *Aedes* were captured by CO_2 traps which made estimating percent change challenging (%Δ in Table 6.3). Spring *Aedes* abundance in 2017 was equal to or lower than 2016 in Hennepin County (P1 and P2) and Washington P1 (Table 6.3). Spring *Aedes* abundance in 2017 in Washington P2 and Linwood Township was higher than in 2016 (Table 6.3). The lack of spring *Aedes* increase in Hennepin P2 in 2017 suggests that factors other than aerial *Bti* treatments contributed to the spring *Aedes* increase observed in Washington P2 and north of Linwood Township.

Table 6.3 Adult spring *Aedes* abundance (nightly CO_2 trap captures) in 2016 and 2017 in five groups of CO_2 traps [mean (± 1 SE)]; n=number of CO_2 traps.

	Hennepin Co.		Washington Co.		Linwood Twp.
	P1	P2	P1	P2	P2
Year	(n=21)	(n=5)	(n=6)	(n=7)	(n=5)
2016	0.8 (±0.5)	3.7 (±1.8)	0.9 (±0.3)	2.6 (±0.9)	6.1 (±0.6)
2017	1.0 (±0.8)	1.5 (±0.8)	0.4 (±0.2)	8.5 (±5.5)	17.6 (±4.9)
%Δ17/16	20%	-55%	-56%	227%	188%

New Control Material Evaluations

The District, as part of its Continuous Quality Improvement philosophy, strives to continually improve its control methods. Testing in 2017 was designed to evaluate how different segments of mosquito control programs can be modified to deliver more mosquito control services to a greater part of the District area using existing resources. Much testing has focused upon controlling multiple mosquito species including potential vectors of WNV.

Larval Control

MetaLarv and spring *Aedes* In 2017, sufficient precipitation occurred in April and May to evaluate how effectively MetaLarv® S-PT (2.5 lb/acre) can control spring *Aedes*. Fifty-three ground sites were treated with MetaLarv S-PT between April 12 and May 11 in five areas throughout the District. Thirty-three pupal bioassays were collected from these treated sites

between two and thirty-two days after treatment. Twelve pupal bioassays were collected from twelve untreated sites near the treated sites. Mortality (inhibition of adult mosquito emergence) in bioassays from untreated sites averaged 22.9% which is slightly higher than control mortality results from tests in spring *Aedes* sites completed in 2013 (average 8.9% inhibition of adult mosquito emergence, n=11, 95% confidence limits: 2.1% to 24.3%) (see 2013 Operational Review and Plans for 2014 for details).

Larval samples from untreated and treated sites both contained various mosquito species including *Aedes* (first instar), *Ae. vexans*, *Ae. cinereus*, *Ae. sticticus*, *Ae. stimulans*, *Cs. inornata*, and *Cx. territans*. One sample contained *Anopheles punctipennis*.

Pupal bioassays were used to evaluate effectiveness from MetaLarv S-PT treated sites. Adult emergence inhibition (EI) is calculated by dividing the number of pupae that did not successfully emerge (# adults minus initial number of pupae) by the initial number of pupae. EI results for bioassays from MetaLarv S-PT treated sites are corrected for emergence in untreated sites (background mortality) using an Abbotts type correction.

Emergence Inhibition (EI) = adults/pupae

Corrected EI = 1 – ((1/pupae) * (adults/untreated emergence))

pupae = initial number of pupae in the bioassay sample
adults = number of adult mosquitoes that emerge successfully
untreated emergence = proportion of pupae from untreated sites from which adults emerge

Following correction for untreated emergence, MetaLarv S-PT achieved an average of 81.9% inhibition of spring *Aedes* emergence (Table 6.4). Emergence inhibition observed in 25 of 33 bioassays from MetaLarv S-PT treated sites was greater than the upper 95% confidence limit (70.5%) for emergence inhibition in bioassays from untreated sites; these 25 bioassay results (pupal emergence inhibition) were significantly greater than background (untreated) mortality. All bioassays collected sooner than twelve days after treatment with MetaLarv S-PT and the majority of bioassays collected between 12 and 32 days after treatment were greater than the 95% untreated confidence limit strongly suggesting that MetaLarv S-PT is effective for at least four weeks after treatment (Figure 6.2).

Table 6.4 Bioassay results (pupal emergence inhibition=EI) of samples collected in MetaLarv S-PT treated sites compared to the upper 95% CL for untreated control bioassays*.

Treatment	Bioassays (n)	Corrected EI mean (±SE)	Bioassays >95% CL (%)	Days after treatment mean (±SE) (min-max)
MetaLarv S-PT	33	81.9% (±5.3%)	25 (76%)	18.4 (±1.8) (2-32)

*Untreated Control: mean EI=22.9% (SE=6.23%) (n=12); upper 95% CL=70.5%; SE= standard error

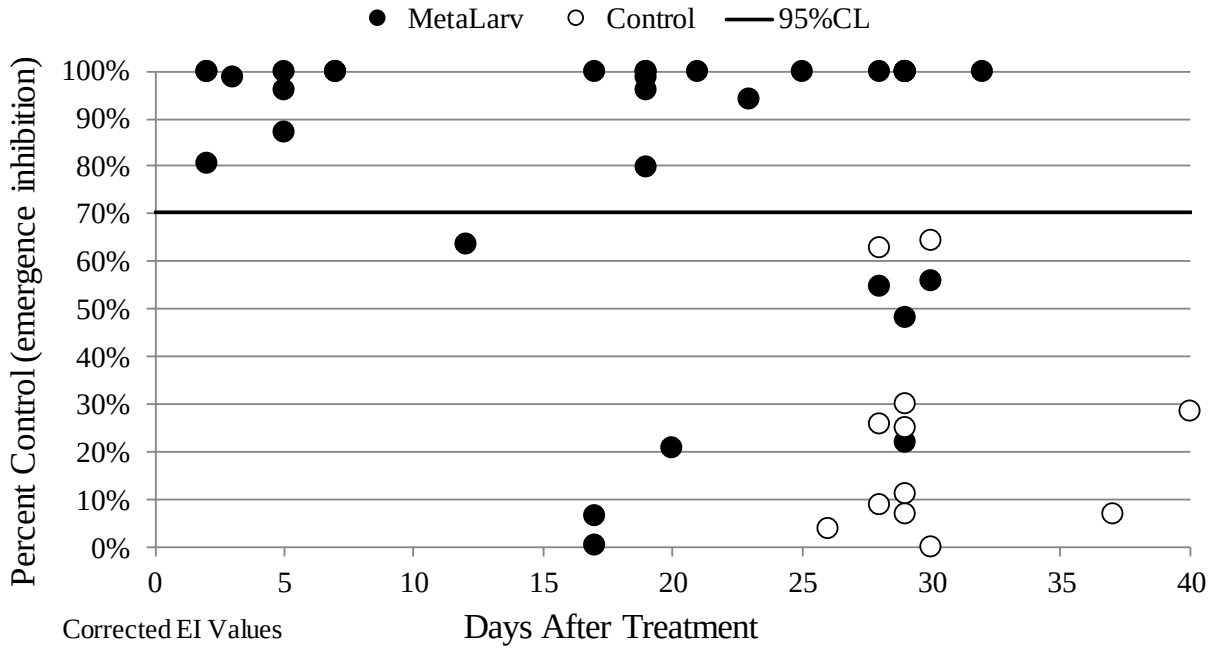


Figure 6.2 Bioassay results (emergence inhibition) of samples collected in untreated (control) and MetaLarv S-PT treated sites. Emergence inhibition values from MetaLarv S-PT treated sites were corrected for untreated control mortality. Days after treatment values for control bioassays were determined by comparing the bioassay date to the first MetaLarv S-PT treatment date (April 12). 95% confidence limits (CL) of control pupal mortality calculated using a t-distribution (df=11, t (0.05) = 2.20).

VectoLex and *Cq. perturbans* *Coquillettidia perturbans* is an abundant pest that lays its eggs in mid- to late summer and overwinters as larvae attached to aquatic vegetation, primarily cattail roots. Our current control strategy includes large-scale ground and aerial treatments for this single brood mosquito in late May, just prior to its emergence. We also treat a smaller number of sites in mid-September with VectoLex® FG to control mosquitoes that would otherwise emerge in June and July of the next year. Tests of VectoLex FG conducted between 2009 and 2011 demonstrated consistent high effectiveness at dosages of 15 and 20 lb/acre (see 2009, 2010 and 2011 Operational Reviews for details). These tests were conducted primarily in rooted cattail sites leading staff to question effectiveness in floating sites.

To compare effectiveness in rooted and floating sites, we treated four rooted and four floating cattail sites with VectoLex FG (15 lb/acre) on September 14, 2016. On June 5, 2017 we placed five emergence cages into each of the eight sites treated with VectoLex FG and each of five nearby untreated sites. All adult mosquitoes in each emergence cage were collected twice each week beginning on June 8 through July 27, 2017.

Emergence of adult *Cq. perturbans* (in terms of mean adult emergence per cage) from both floating and rooted sites treated with VectoLex FG was much lower throughout the sampling period (Rooted sites: 1.8 per cage, SE=0.57, Floating sites: 1.6 per cage, SE=1.14) than emergence from untreated sites (20.6 per cage, SE=9.53) (Figures 6.3, 6.4). This translates to 91.3% control in rooted and 92.2% control in floating sites strongly suggesting that VectoLex

FG is equally effective in both rooted and floating sites. We interpret these results to indicate that VectoLex FG controls *Cq. perturbans* equally in rooted and floating sites.

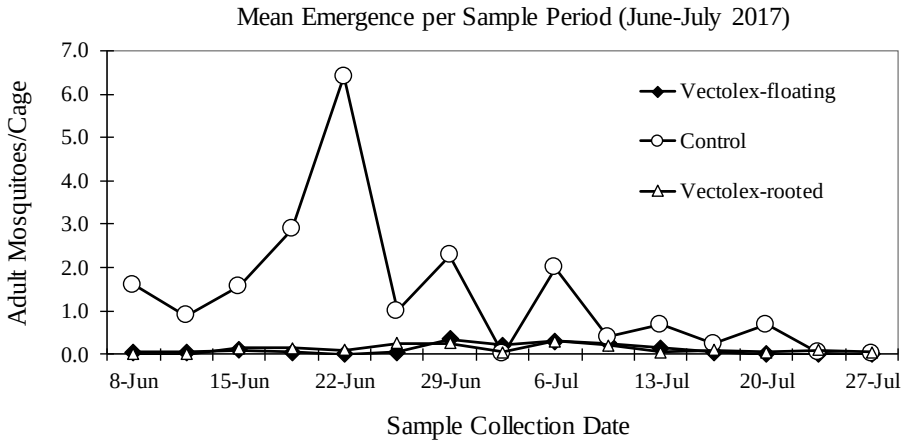


Figure 6.3 Mean emergence of *Cq. perturbans* per sample period in cages in rooted and floating sites treated with VectoLex FG and untreated sites. Emergence cages were placed on June 5 and sampling occurred from June 8 – July 27, 2017.

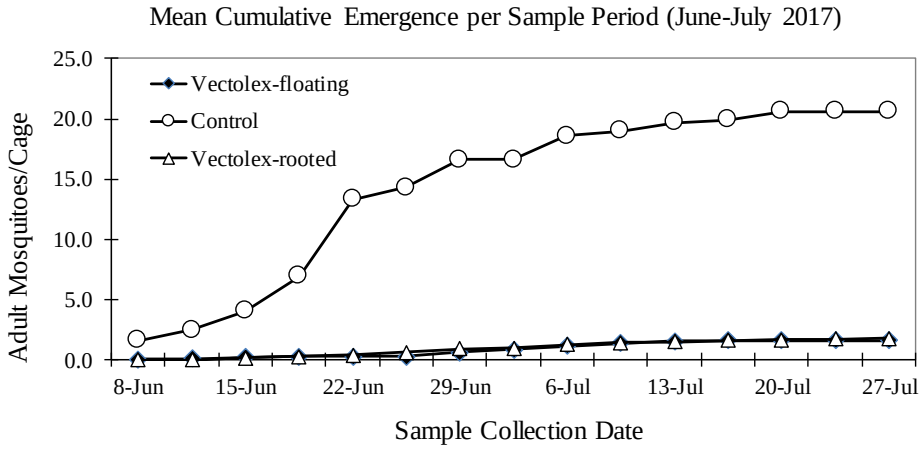


Figure 6.4 Mean cumulative emergence of *Cq. perturbans* per sample period in cages in rooted and floating sites treated with VectoLex FG and untreated sites. Emergence cages were placed on June 5 and sampling occurred from June 8 – July 27, 2017.

Valent VectoPrime® FG and Fourth Instar Larvae VectoPrime® FG is a new corn cob formulation that contains both *Bti* and methoprene. It is designed to more effectively control later fourth instar mosquito larvae that have stopped feeding and therefore become less susceptible to *Bti*. According to Valent Biosciences, the manufacturer of VectoPrime FG, this product is designed to work by disrupting metamorphosis and thereby kill mosquito pupae. We conducted a preliminary test of VectoPrime FG to evaluate control of larvae including later fourth instar larvae. The *Bti* controls younger larvae when they also are present.

Between May 15 and June 21, we treated nine small ground sites with VectoPrime FG at 4 lb/acre. Larval dips were collected from all nine sites immediately before treatment. All nine

sites were inspected again 24 hours after treatment; larvae were collected if present. We visited all nine sites again during the week after treatment but were unable to collect enough pupae for bioassay. Preliminary efficacy results are based upon comparing pre- and post-treatment larval dips.

Pre-treatment larval samples contained *Ae. vexans, Cx. tarsalis*, and *Cs. inornata*. Larvae (third and fourth instars) and pupae were collected before treatment. Twenty-four hours after treatment larval and pupal abundance was reduced by an average of 86.1% (Table 6.5). All three species and developmental stages captured before treatment also were captured after treatment. These results suggest that VectoPrime FG is able to control larvae including older larvae that are difficult to control with *Bti* alone. These results justify conducting larger scale tests.

Table 6.5 Pre- and Post-treatment dip counts from VectoPrime FG treated sites.

Treatment	(n)	Pre-Treatment mean (±SE)	Post-Treatment mean (±SE)	% Control mean (±SE)
VectoPrime® FG	9	3.2 (±0.8)	0.8 (±0.5)	86.1 (±7.2)

SE= standard error

Sumilarv® 0.5 G in Catch Basins Sumilarv® 0.5 G is a granule which contains pyriproxyfen, an insect growth regulator which affects development at the fourth instar to early pupal stage, resulting in pupal mortality and prevention of adult emergence. Originally developed by Sumitomo Chemical Co. Ltd., it has been tested and used in other parts of the world since 1996 for control of mosquito larvae especially in containers or polluted waters (http://sumivector.com/larvicides/sumilarv). The active ingredient, pyriproxyfen, is approved by the World Health Organization (WHO) for treatment of potable water (WHO/SDE/WSH/03.04/113). Minnesota-based MGK® (McLaughlin Gormley King Company), a subsidiary of Sumitomo, is working on obtaining EPA registration for formulations designed for extended control of mosquito larvae (primarily West Nile virus vectors) in catch basins. MMCD is interested in testing different active ingredients to increase the number of tools available for mosquito control, especially formulations that might work in catch basins longer than four weeks. Previous tests of an earlier MGK formulation had looked promising (MMCD Operational Review 2009). In 2017 we worked with MGK on one of several tests designed to provide dosage and field effectiveness duration information that EPA can use to approve a final label.

We tested four dosages of Sumilarv 0.5 G in catch basins to evaluate minimum effective dose, duration and degree of effectiveness. Effectiveness was evaluated using pupal bioassays. Larval mosquito samples were collected and identified. Adult mosquitoes that successfully emerged from pupae collected for bioassay also were identified.

Four groups of ten catch basins were treated with one of four Sumilarv 0.5 G dosages (75 g, 100 g, 125 g, and 150 g per catch basin) on May 25. Ten catch basins were treated with Altosid pellets (3.5 g per catch basin) on June 14, July 17, and August 21. Ten untreated catch basins were monitored in the same manner as treated catch basins. All catch basins were located in St. Paul. Catch basins from each treatment group were inspected each week by MMCD staff, weather and workload permitting, from the week of larvicide application through September until the temperature dropped enough to inhibit oviposition by mosquitoes in catch basins. Pupae

for bioassays were collected when pupae (preferably at least 50 per catch basin) were found during inspections.

All four dosages of Sumilarv 0.5 G achieved very high levels of control throughout the June-September evaluation (Figure 6.5, Table 6.6), levels comparable to that achieved by Altosid pellets for four weeks. Daily rainfall equal or greater than 0.5 and 1.0 inch did not eliminate effectiveness (Figure 6.5).

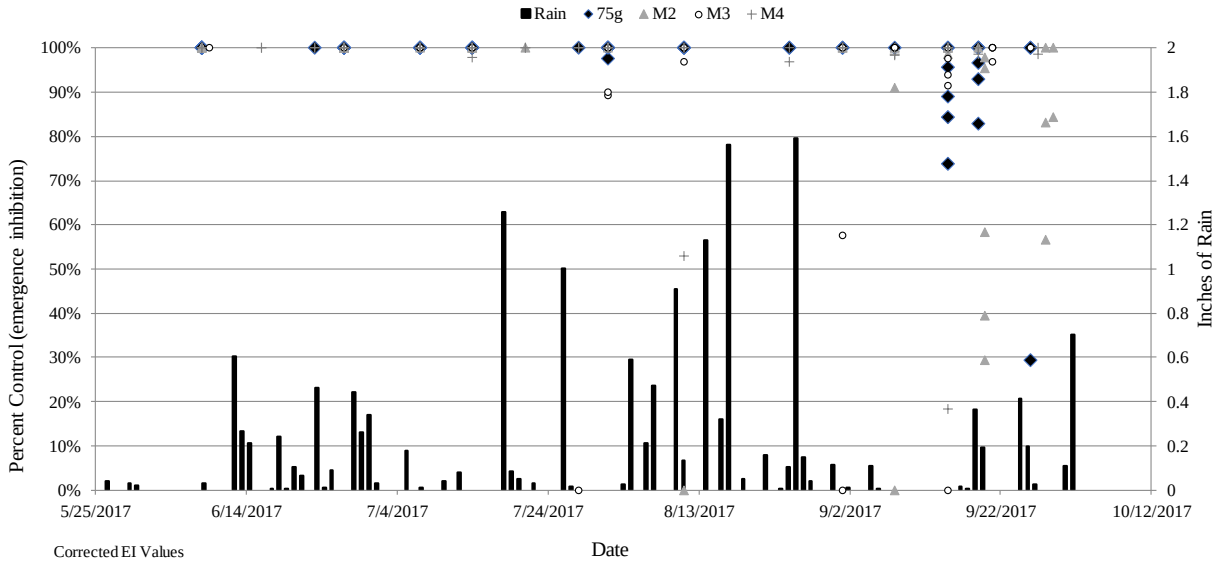


Figure 6.5 Bioassay results (emergence inhibition) of samples collected in untreated (control) and Sumilarv 0.5 G treated catch basins (75g, 100g, 125g, 150g). Emergence inhibition values from Sumilarv 0.5 G treated catch basins were corrected for untreated control mortality. Days after treatment values for control bioassays were determined by comparing the bioassay date to the Sumilarv 0.5 G treatment date (May 25).

Table 6.6 Bioassay results (pupal emergence inhibition=EI) of samples collected in Sumilarv 0.5 G treated catch basins (75g, 100g, 125g, 150g) compared to Altosid® pellet treated catch basins (all EI values corrected for untreated control emergence*).

Treatment	Bioassays (n)	Corrected EI mean (±SE)	Days after treatment** mean (±SE)(min-max)
Sumilarv 0.5 G (75g)	55	97.1% (±1.42%)	69.2 (±5.23) (14-124)
Sumilarv 0.5 G (100g)	39	88.1% (±4.30%)	79.4 (±6.61) (14-127)
Sumilarv 0.5 G (125g)	38	89.8% (±4.48%)	86.9 (±4.96) (15-124)
Sumilarv 0.5 G (150g)	56	97.5% (±1.67%)	67.1 (±4.61) (14-125)
Altosid pellet (3.5g)	41	83.3% (±4.02%)	19.4 (±10.13) (2-38)

* Untreated Control: emergence=70.8% (SE=3.52%) (n=67); SE= standard error; **days after treatment when pupae were collected; Sumilarv 0.5 G treatments May 25; Altosid pellet treatments June 14, July 17, August 21

All four dosages achieved 100% control during the first 32 days after treatment (Figure 6.6). Efficacy did decline slightly during subsequent 32-day periods although, based upon overlap of error bars (±1SE), differences did not appear to be statistically significant (Figure 6.6). No

decreases related to dosages, rainfall or time after treatment were apparent. Mortality (EI) achieved by all four Sumilarv 0.5 G dosages was significantly greater than mortality observed in the untreated control throughout the 128-day post-treatment evaluation period based upon non-overlap of error bars (±1SE) (Figure 6.6). The low EI value of 50% for the 100g dosage during the third 32-day period (65-96 days) apparently is the result of only two bioassays being collected during this period, one with 100% control and the other with zero % control (Figure 6.6).

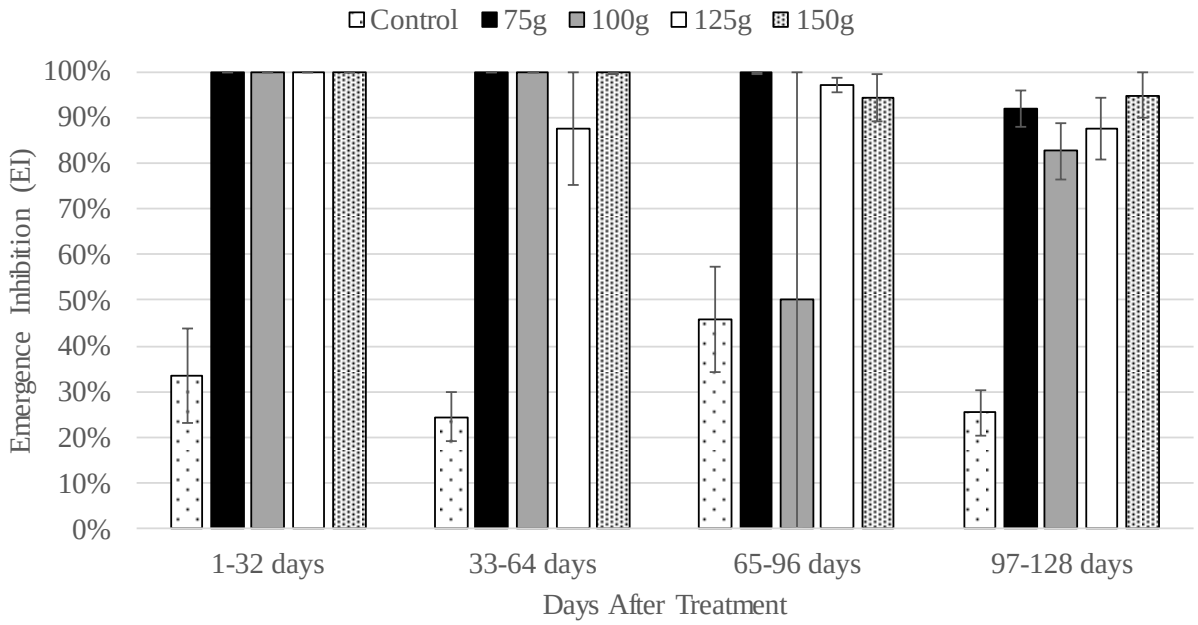


Figure 6.6 Bioassay results (emergence inhibition) of samples collected in untreated (control) and Sumilarv 0.5 G treated catch basins (75g, 100g, 125g, 150g) during four 32-day periods after treatment. Emergence inhibition values from Sumilarv 0.5 G treated catch basins were corrected for untreated control mortality. Days after treatment values for control bioassays were determined by comparing the bioassay date to the Sumilarv 0.5 G treatment date (May 25). Error bars equal ±1SE.

The majority of mosquito larvae collected from untreated and treated catch basins were *Cx. restuans* and *Cx. pipiens* (Table 6.7). Likewise, the majority of adult mosquitoes that successfully emerged in bioassays collected from untreated and treated catch basins were *Cx. restuans* and *Cx. pipiens* (Table 6.8). Larval *Ae. japonicus* were collected in all treatment groups. Adult *Ae. japonicus* emerged only in pupal bioassays collected from untreated catch basins (Table 6.8). We conclude from these results that both Sumilarv 0.5 G and Altosid pellets effectively control mosquitoes developing in catch basins, the majority of which are the West Nile virus vectors *Cx. restuans* and *Cx. pipiens*. Both products also effectively control the less common *Ae. japonicus* developing in catch basins.

Table 6.7 Most common mosquito species (% of samples) in larval samples collected from Sumilarv 0.5 G treated catch basins (75 g, 100 g, 125 g, 150 g), Altosid® pellet treated and untreated catch basins.

Treatment	*Cx. restuans*	*Cx. pipiens*	*Ae. japonicus*	*Ae. vexans*
Untreated Control	89.7%	82.4%	33.8%	0.0%
Sumilarv 0.5 G (75 g)	89.1%	85.5%	21.8%	0.0%
Sumilarv 0.5 G (100 g)	69.2%	71.8%	5.1%	2.6%
Sumilarv 0.5 G (125 g)	86.8%	89.5%	2.6%	0.0%
Sumilarv 0.5 G (150 g)	85.7%	85.7%	3.6%	0.0%
Altosid pellet (3.5 g)	87.8%	78.0%	4.9%	2.4%

Table 6.8 Most common mosquito species (% of pupal bioassays from which adults successfully emerged) collected from Sumilarv 0.5 G treated catch basins (75 g, 100 g, 125 g, 150 g), Altosid pellet treated and untreated catch basins.

Treatment	*Cx. restuans*	*Cx. pipiens*	*Ae. japonicus*	*Ae. vexans*
Untreated Control	85.9%	75.0%	4.7%	0.0%
Sumilarv 0.5 G (75 g)	11.1%	88.9%	0.0%	0.0%
Sumilarv 0.5 G (100 g)	16.7%	100.0%	0.0%	0.0%
Sumilarv 0.5 G (125 g)	27.3%	100.0%	0.0%	0.0%
Sumilarv 0.5 G (150 g)	0.0%	100.0%	0.0%	0.0%
Altosid pellet (3.5 g)	41.7%	75.0%	0.0%	0.0%

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 As in previous years, we attempted to conduct tests in woodlots where operational permethrin treatments could potentially be made and all tests included untreated woodlots. All tests included CO_2 trap data. CO_2 traps (two of each per woodlot) were placed 24 hours before treatment, 30 minutes after treatment, 24 hours after treatment, and one week after treatment. Efficacy was evaluated using Mulla's equation (a correction that accounts for natural changes in the untreated control site, as well as the treatment site). The goal of all tests was to better evaluate the duration and consistency of control achieved by barrier treatments and to include vector-specific efficacy evaluations. We were not able to

complete any tests in 2017 because we could not collect threshold amounts of adult mosquitoes in pre-treatment CO_2 trap sampling in a sufficient number of woodlots.

Merus™ (ULV) Compared to Anvil® Merus™ is the first and only adulticide listed with the Organic Materials Review Institute (OMRI), for wide-area mosquito control in and around organic gardens and farms and meets the USDA's Natural Organic Program (NOP) standards for use on organic crops. Its active ingredient, pyrethrin, is a botanical insecticide. The product contains no chemical synergist. It is OMRI and NOP listed for use in environmentally sensitive areas.

We tested Merus and Anvil in campgrounds in Anoka County. Rum River Central Park in Ramsey was treated with Merus, Lake George Regional Park in Oak Grove was treated with Anvil® (for comparison with an operational material), and Ajawah Campground in Linwood Township was the untreated (control) site. 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) were effectively controlled by Merus and Anvil immediately after treatment. Insufficient vectors were captured to evaluate efficacy. Efficacy appeared to wane 24 hours after treatment in both treated campgrounds (Table 6.9). Adult mosquitoes were very abundant before treatment. Both products significantly decreased adult mosquito abundance quickly after treatment with mosquitoes already moving in from surrounding areas within 24 hours after treatment. These results are very similar to a comparable test conducted in August 2016 (see 2016 Operational Review for details).

Table 6.9 ULV Merus compared to Anvil 2017 (July 11-13).

		All mosquito species	
	Collection	Average CO_2 trap catch§	Efficacy*
Merus	Pre-treat	600.0 (±00.0)	---
	Post-treat	144.0 (±78.2)	80%
	Post-24 h	613.7 (±101.2)	12%
Untreated control	Pre-treat	844.5 (±751.5)	---
	Post-treat	1,024.0 (±514.2)	---
	Post-24 h	977.7 (±274.6)	---
Anvil	Pre-treat	1,495.3 (±858.8)	---
	Post-treat	25.3 (±15.1)	99%
	Post-24 hr	217.7 (±127.2)	87%

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

§Mean (±SE), n=3 CO_2 traps per campground site per sampling period

Equipment Evaluations

Helicopter Swath Analysis and Calibration Procedures for Larvicides Technical Services and field staff conducted five aerial calibration sessions for dry, granular materials during the 2017 season. These computerized calibrations directly calculate application rates and swath patterns for each pass so each helicopter's dispersal characteristics are optimized. Sessions were held at the municipal airport in Le Sueur, MN and Benson Airport in White Bear Lake, MN. Staff completed calibrations for eight different operational and experimental control materials. In total, eight helicopters were calibrated and each helicopter was configured to apply an average of four different control materials.

In 2017, MMCD's 24 ft helicopter calibration trailer (mobile workstation) was used to conduct swath characterizations. The trailer includes two sample weighing stations, an analysis station, product and equipment storage, aircraft communications, a weather station, and a power generator. The trailer continues to be modified to improve its efficiency as a workstation. This trailer can be towed to any location and be set up for operations in a short period of time. This innovation was demonstrated at the North Central Mosquito Control Association annual meeting in April, 2017. Three vendors and manufacturers participated in our swath characterization sessions and MMCD is assisting in product development by testing the aerial application characteristics of various matrixes used in mosquito control products. In addition, we are currently assisting the development of a similar mobile aircraft calibration trailer for the University of Illinois Extension Service.

Malvern Laser: Droplet Analysis of Ground-Based Spray Equipment
In 2015, Technical Services purchased a Malvern Instruments Spraytec laser diffraction system to evaluate our adult mosquito equipment (backpacks, handheld, ATV-mounted and truck-mounted sprayers).

Much of the work done in 2017 focused on evaluating backpack sprayers. MMCD staff worked to modify all models of our gasoline backpacks to produce droplets in the 150-300 micron range. MMCD purchased two electric Pioneer backpacks to evaluate a more environmentally friendly unit. The electric backpacks did not produce the droplet spectrum that the manufacturer stated in their literature. Staff explored various modifications to these units but did not find an applicable solution for 2017. Staff will continue to investigate means to utilize renewable energy in our applications and lower emissions in our equipment.

All District backpacks used for barrier treatments were set up to produce the proper droplet spectrum and were in compliance with the label requirements.

ULV Droplet Evaluations Technical Services continued the spray equipment workgroup to evaluate truck-mounted, UTV-mounted, backpack and handheld ULV generators. Technical Services and MMCD staff use our 20 ft x 40 ft indoor spray booth to evaluate adulticide application equipment. Using the Malvern laser, staff continued to improve sampling procedures and techniques to sample the multiple types of spray equipment. MMCD evaluated the spray characteristics of all of our ULV equipment and optimized each spray system with its respective control material. All equipment was set up according to label parameters and approved for use.

Optimizing Efficiencies and Waste Reduction

Evaluation of Transportation Options for Control Materials The District has continued to move towards more versatile options to transport materials to helicopter landing sites. A combination of one-ton pickups and flatbed trailers is now being used in most facilities to transport pallets of *Bti* to landing sites. The truck-trailer combination has more operational flexibility and is less expensive than large flatbed trucks. The pickups are used regularly in other field functions when not involved in helicopter operations.

Flatbed trucks are now being converted to transport more bulk residual materials. Bulk tote use for pre-hatch larvicides is increasing as the District moves towards more sustainable packaging options. The truck's larger weight capacity, equipment storage space, and bed height work well for the new helicopter loading processes.

Recycling Insecticide Containers MMCD continued to use the Minnesota Department of Agriculture's (MDA) insecticide container recycling program. The Ag Container Recycling Council (ACRC) program focuses on properly disposing of agricultural insecticide waste containers, thereby protecting the environment from related insecticide contamination of ground and water.

Field offices collected their empty, triple-rinsed plastic containers at their facility and packaged them in large plastic bags for recycling. Each facility delivered their empty jugs to the Rosemount warehouse for pickup by the MDA contractor, Consolidated Container. MMCD arranged two semi-trailer pickups during the treatment season and staff assisted the contractor with loading of the recycled packaging materials. MMCD also assisted other small regional users to properly recycle their insecticide containers in conjunction with these collections. MMCD staff collected 2,998 jugs for this recycling program. The control materials that use plastic 2.5-gallon containers are Anvil 2-2 (122 jugs), Zenivex E4 RTU (85 jugs), *Bti* liquid (823 jugs), Altosid pellets (1,370 jugs), and other materials (7 jugs). The purchase of a portion of the Altosid pellets and *Bti* liquid in bulk totes significantly reduced the number of jugs generated in 2017.

The District purchases Permethrin 57% OS concentrate in returnable drums. The manufacturer arranged to pick up the empty containers for reuse. In addition, these drums do not have to be triple-rinsed and thus reduces the District's overall generation of waste products. MMCD triple-rinsed and recycled numerous plastic drums and steel containers this past season. These 5- or 55-gallon drums were brought to a local company to be recycled or refurbished and reused.

The District purchased mineral oil in 275-gallon bulk containers. Staff was able to reduce the overall number of 55-gallon drums purchased by 10 drums. These returnable containers do not have to be triple-rinsed and thus, reduces the District's overall generation of waste products.

Recycling Insecticide Pallets In 2017, MMCD produced over 667 empty hardwood pallets used in control material transport. Our warehouse staff worked with our vendors to arrange for their return to the manufacturer for re-use. In doing so, MMCD reduced the need for the production of new pallets and helped to maintain lower control material costs for the District.

We are working with Valent BioSciences to explore using the recycled materials of our empty *Bti* bags to make plastic pallets. These reusable pallets would eventually replace the need for wood pallets and be more environmentally sustainable.

Bulk Packaging of Control Materials MMCD continued incorporating reusable packaging containers into our operations. The focus is to reduce the packaging waste of the various high use materials. MMCD can produce over 40,000 empty bags in an average year. We would like to eliminate a significant portion of these insecticide bags that cannot be recycled. Staff is attempting to keep these bags out of landfills, and instead directing them to garbage burner facilities where some public benefit of the generated waste can be realized.

The District continues to expand use of refillable totes in the helicopter loading operations. MMCD is working with three manufacturers to ship bulk larvicides in reusable pallet sized totes. In 2017, Clarke shipped all of our Natular G30 granules (75,200 lb) in 47 totes and reduced our packaging use by 1,880 bags. Central Life Sciences shipped a portion of Altosid pellets (22,000 lb) in 11 totes and reduced the packaging by 1,000 jugs. Valent BioSciences shipped a portion of MetaLarv granules (2,000 lb) in two totes which reduced packaging by 50 bags. Valent also sent a portion of VectoBac 12-AS liquid (1,528 gallons) in bulk totes and reduced the packaging by 634 jugs. Staff was able to spend less time dealing with waste and the District eliminated 3,564 containers from entering the waste stream. MMCD is attempting to reduce the amount of time and effort spent handling packaging after the product is used, allowing staff to focus more time on our primary missions.

Return of Packaging Waste In 2017, Valent BioSciences agreed to take back all of the waste packaging of their products. Due to the quantity (888,134 lb) and high bulk density of their products, Valent packaging is a significant portion of the waste produced annually by the District. This waste included product bags, pallets, boxes, and stretch wrap. All waste was packaged on specialized pallets and the manufacturer picked up these pallets periodically at our facility locations. Valent is working to recycle these multi-layered insecticide bags and thus, keep them out of landfills. MMCD greatly reduced their waste disposal services and estimates 9,945 lb was eliminated from our waste stream.

Hazardous Waste Collection In 2017, MMCD worked with the MDA to provide two regional sites for hazardous waste collection. The MDA provides a day each year that the public can properly dispose of any small quantity of hazardous waste free of charge. The District's Andover and Jordan facilities were used as collection points and MDA staff managed the safe

handling of these materials. MMCD will continue to support this important public service to protect the environment.

2018 Plans – Product and Equipment Testing

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

In 2018, we plan to repeat tests of VectoPrime FG against summer *Aedes* to evaluate its effectiveness against fourth instar larvae.

We plan to evaluate effectiveness of ground and aerial Natular G30 treatments completed six weeks apart as part of our *Ae. vexans* larval control program to verify effectiveness.

We plan to place emergence cages in rooted and floating cattail sites treated on October 4, 2017 with Natular G (9 lb/acre) at the beginning of June 2018.

We plan to continue tests of adulticides in different situations emphasizing control of vectors and effectiveness of barrier treatments.

Chapter 7 Supporting Work

2017 Highlights

- Improved web-based "Mobile Map" and other tools for data entry and access to data
- Updated public web site map and site search on to improve usability
- Added rainfall data storage and display that can be easily used in data analysis
- Organics separation at the St. Paul Main Office contributed to a 45.2% reduction in trash
- Citizen calls decreased but remained above 10-yr average

2018 Plans

- Add new real-time aerial treatment tracking display
- Expand data tools for managing aerial treatment preparation and monitoring
- Rewrite larval data entry to integrate more easily with web forms
- Expand sustainability efforts from initiatives to a sustainability culture

2017 Projects

Data Systems

As MMCD's custom web-based data system ("Webster") matures, we are expanding tools for data access and analysis, and for maintaining data quality.

All field staff can access Webster through MMCD smart phones, or through any device connected to the web. Staff use it daily to track truck mileage, larval and adult inspections and treatments, and material inventory. We have added "Reference Documents" so they can have easy access to safety information on a phone.

In 2017, we improved material inventory tracking processes and reports, both to help with field work and in preparation for providing support for a new accounting system. We expect to continue work on that in 2018.

We have an integrated "Mobile Map" (Figure 7.1) that allows field staff to search for a wetland or harborage site and get driving directions, and find helicopter landing sites, water-holding structures, and traps. We added a "Flag Point" tool for marking locations of eagle's nests, bees, new sites, and other items of interest. Users can then transfer that info to our regular desktop GIS maps.

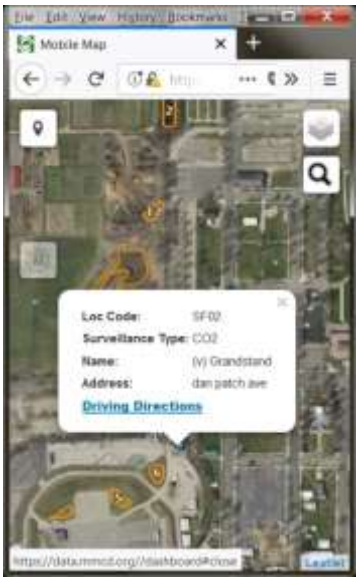


Figure 7.1 Mobile Map.

We improved Webster's "Search" and "Report" tools used by full-time staff. This included easier ways to connect species results with other

information used to plan control activities. We also access the database directly using custom SQL (structured query language) queries and expanded training on their use.

In early 2017 we set up a way to download and store precipitation data from the National Weather Service - River Forecast Center (NWA-RFC). These 4x4 km grids (Hydrologic Rainfall Analysis Project, HRAP) are based on both Nexrad radar and ground rain gauge measures. This 10-year data set can be used with our inspection and treatment histories to help analyze past work, and we continue to work on ways to use this to predict future needs. It also provides a quick visual reference for events during the year or compared with previous years (Figure 7.2).

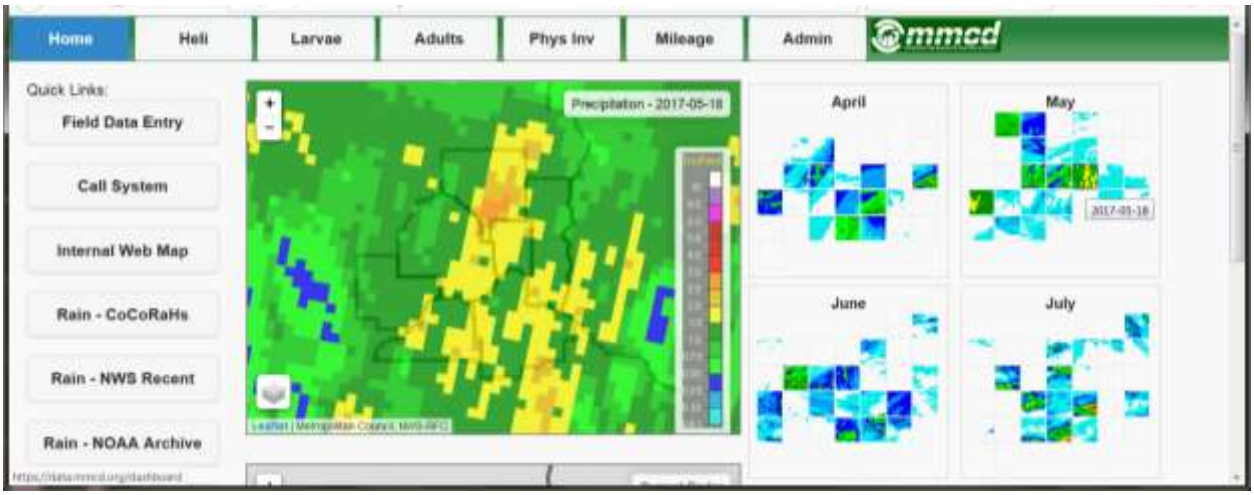


Figure 7.2 Rainfall history from NWS-RFC available to MMCD staff in Webster.

We continued to work with Houston Engineering, Inc. as our main consultant for building the Webster interface and supporting environment. Most of the data underlying this Annual Report is collected through Webster. Projects planned for 2018 include working with the helicopter contractor to implement some form of real-time tracking.

Mapping

Wetland Mapping MMCD's field staff regularly updates our maps of about 80,000 wet areas that can serve as mosquito larval habitat. In 2017, we continued to use aerial photos collected in 2016 by the Metropolitan Council and MnGeo, the state Geospatial Information Office, and augmented that information with field visits and reference to publicly available photography. We are working with metro-area county offices to obtain access to more recent photos as they become available.

We also map locations of stormwater structures such as street catch basins, large culverts or separators, and pond water level regulators, when these provide larval habitat for species such as *Culex* vectors of West Nile virus and for *Ae. japonicus.* Over 25,900 structures are now mapped, in addition to 286,000 catch basins.

Public Web Map Our public access map on www.mmcd.org was updated to a simpler, more user-friendly interface (Figure 7.3). This map lets people see wetland inspection and treatment activity in real time, as well as access history back to 2006. It uses a basemap and geocoder service from Metropolitan Council and aerial photos from MnGeo. This site is currently the only public-viewable part of our Webster online data environment developed by Houston Engineering Inc. Plans for 2018 include expanding the data available and making more of the public web site data update automatically from Webster.

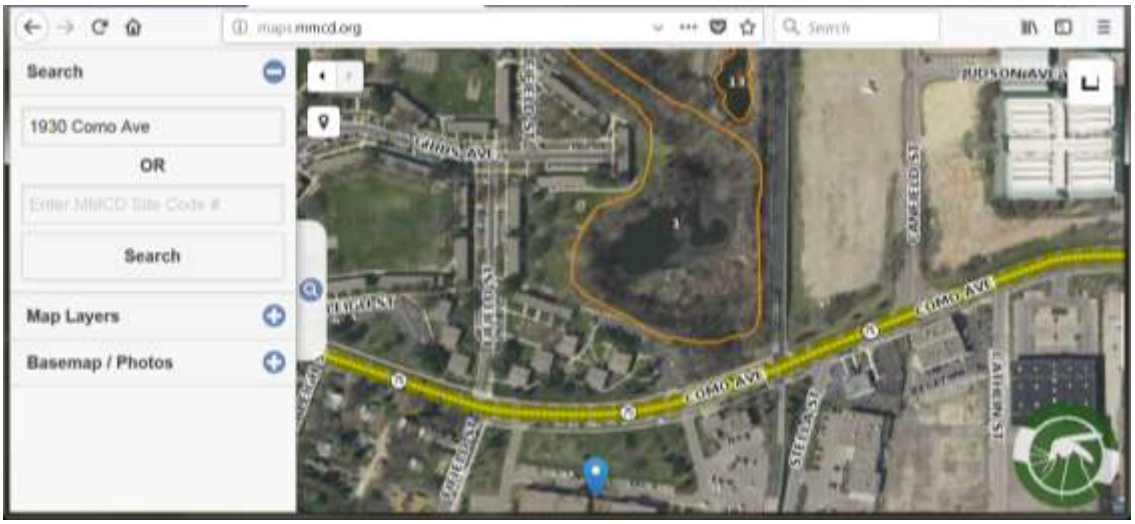


Figure 7.3 MMCD public web site map for accessing wetland information.

GIS Community MMCD staff attended meetings regarding National Wetland Inventory and Great Lakes Restoration Initiative work on wetland inventory and remote sensing, and continue to participate in MetroGIS.

Climate Trends – Spring Degree Day Study

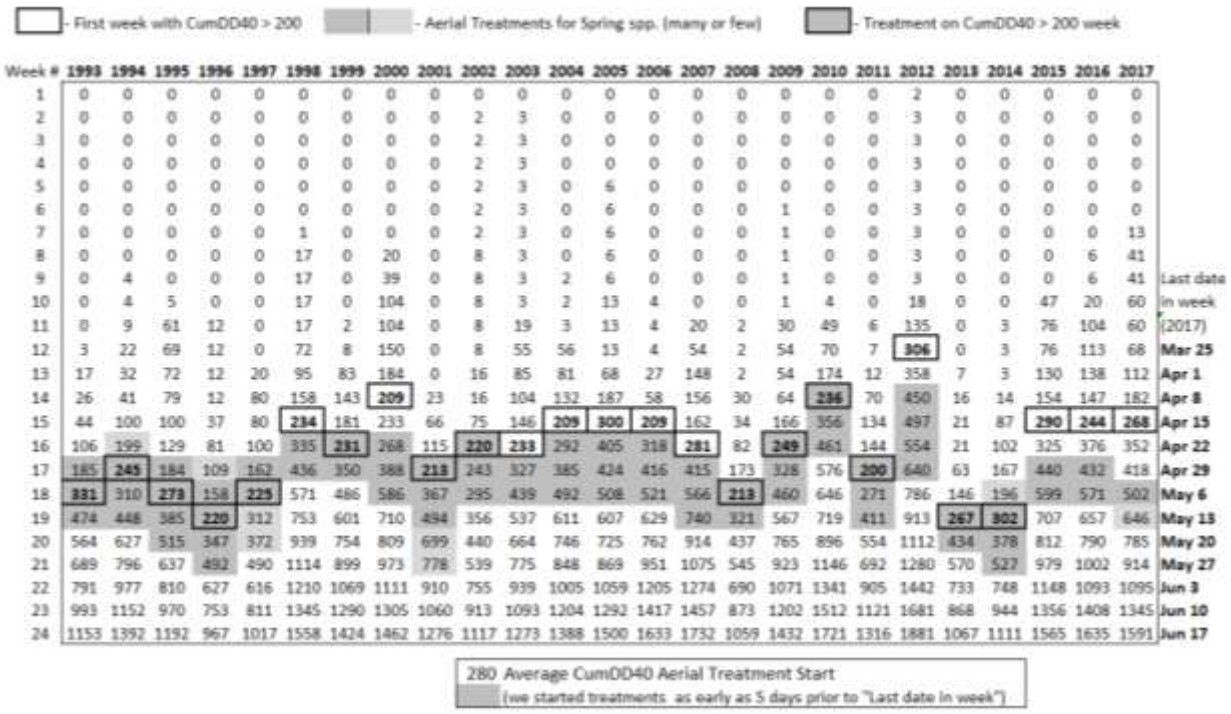
Spring temperatures described using degree-day (DD) accumulations continue to be a useful estimator for control activities. The DD model uses daily maximum and minimum air temperature (MSP airport) to compute a daily average. The difference between the average and the chosen base temperature of 40 °F (no larval growth per day) gives the 'heat units' accumulated each day for that base (DD_{base}). These are then summed from an assumed start date of January 1.

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

Figure 7.4 shows the cumulative sum of DD_{40F} from Jan 1 by week of the year (DD value at end of week), for each year from 1996-2017. Week numbers were based on standard CDC weeks (week starts on Sunday, week 1 = first week with four or more days, modified so that all dates after Jan. 1 were in week 1 or higher). The outlined box each year marks the first week with ≥

200 DD, a number (chosen empirically from these data) approximating when spring *Aedes* larvae have sufficiently developed to warrant aerial treatment.

In 2017, the DD_{40F} total went over 200 by the end of week 15 (April 16), a fairly typical date compared with the last 20 years. However, there was very little snowmelt, so significant spring *Aedes* hatch was unlikely until after precipitation events near the end of April and on May 1 (see Chapter 1). Aerial treatments for spring *Aedes* (gray boxes) began May 2 and were completed by May 12.



Week #	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	
2	0	0	0	0	0	0	0	0	0	2	3	0	0	0	0	0	0	0	0	3	0	0	0	0	0	
3	0	0	0	0	0	0	0	0	0	2	3	0	0	0	0	0	0	0	0	3	0	0	0	0	0	
4	0	0	0	0	0	0	0	0	0	2	3	0	0	0	0	0	0	0	0	3	0	0	0	0	0	
5	0	0	0	0	0	0	0	0	0	2	3	0	6	0	0	0	0	0	0	3	0	0	0	0	0	
6	0	0	0	0	0	0	0	0	0	2	3	0	6	0	0	0	1	0	0	3	0	0	0	0	0	
7	0	0	0	0	0	1	0	0	0	2	3	0	6	0	0	0	1	0	0	3	0	0	0	0	13	
8	0	0	0	0	0	17	0	20	0	8	3	0	6	0	0	0	1	0	0	3	0	0	0	6	41	
9	0	4	0	0	0	17	0	39	0	8	3	2	6	0	0	0	1	0	0	3	0	0	0	6	41	Last date
10	0	4	5	0	0	17	0	104	0	8	3	2	13	4	0	0	1	4	0	18	0	0	47	20	60	in week
11	0	9	61	12	0	17	2	104	0	8	19	3	13	4	20	2	30	49	6	135	0	3	76	104	60	(2017)
12	3	22	69	12	0	72	8	150	0	8	55	56	13	4	54	2	54	70	7	**306**	0	3	76	113	68	**Mar 25**
13	17	32	72	12	20	95	83	184	0	16	85	81	68	27	148	2	54	174	12	358	7	3	130	138	112	**Apr 1**
14	26	41	79	12	80	158	143	**209**	23	16	104	132	187	58	156	30	64	**236**	70	450	16	14	154	147	182	**Apr 8**
15	44	100	100	37	80	**284**	181	233	66	75	146	**209**	**300**	**209**	162	34	166	356	134	497	21	87	**290**	**244**	**268**	**Apr 15**
16	106	199	129	81	100	335	**281**	268	115	**220**	**233**	292	405	318	**281**	82	**249**	461	144	554	21	102	325	376	352	**Apr 22**
17	185	**245**	184	109	162	436	350	388	**213**	243	327	385	424	416	415	173	328	576	**200**	640	63	167	440	432	418	**Apr 29**
18	**331**	310	**273**	158	**225**	571	486	586	367	295	439	492	508	521	566	**213**	460	646	271	786	146	196	599	571	502	**May 6**
19	474	448	385	**220**	312	753	601	710	494	356	537	611	607	629	740	321	567	719	411	913	**267**	**302**	707	657	646	**May 13**
20	564	627	515	347	372	939	754	809	699	440	664	746	725	762	914	437	765	896	554	1112	434	378	812	790	785	**May 20**
21	689	796	637	492	490	1114	899	973	778	539	775	848	869	951	1075	545	923	1146	692	1280	570	527	979	1002	914	**May 27**
22	791	977	810	627	616	1210	1069	1111	910	755	939	1005	1059	1205	1274	690	1071	1341	905	1442	733	748	1148	1093	1095	**Jun 3**
23	993	1152	970	753	811	1345	1290	1305	1060	913	1093	1204	1292	1417	1457	873	1202	1512	1121	1681	868	944	1356	1408	1345	**Jun 10**
24	1153	1392	1192	967	1017	1558	1424	1462	1276	1117	1273	1388	1500	1633	1732	1059	1432	1721	1316	1881	1067	1111	1565	1635	1591	**Jun 17**

Figure 7.4 Cumulative Degree Days (base 40 °F, 4.4 °C) from January 1, MSP Airport.

Aerial treatments are not started until a sufficient number of sites are over threshold, seasonal inspectors are hired and helicopters calibrated. By holding off on treatment until the first rain, we try to control both snow-melt spring *Aedes* and any early floodwater *Aedes* hatch.

Evaluating Nontarget Risks

Spinosad (Natular) Nontarget Risk Information In recent years, MMCD and TAB members worked on evaluating nontarget risk for Natular products, which use the biological control material spinosad (see Appendix C). Natular is registered by the U.S. EPA as a "Reduced Risk Pesticide" and is OMRI Listed® (Organic Materials Review Institute). MMCD uses Natular G30, an extended release (30 day) formulation, as an option for larval control in summer *Aedes* sites, as it has both a different mode of action and different manufacturer than *Bti* or methoprene. We are also testing Natular G, which has a shorter active period (up to 7 days) and lower cost.

Studies done under the direction of the TAB by District staff in 2014 and 2015 did not identify any large-scale nontarget impacts of Natular G on physid snails, sphaeriids (fingernail clams), and branchipods (fairy shrimp) in spring ephemeral ponds, or on amphipods (scuds) or isopods in cattail marshes, respectively. Based on the TAB's recommendations and MMCD's projected use plans, no further studies were conducted in 2017.

Previous Larvicide Nontarget Work Earlier publications and reports on Wright County Long-term Study and other studies on *Bti* and methoprene done under the direction of the Scientific Peer Review Panel (SPRP) continue to be available on the MMCD web site, mostly as PDF files. The address is http://www.mmcd.org/non-target-studies-bti/.

Pollinators and Mosquito Control The status of pollinator populations (e.g. honeybees, native bees, butterflies, flies, etc.) continues to be a public concern, and MMCD has continued efforts to minimize negative effects on pollinators, including the rusty patched bumble bee (*Bombus affinis*) which was listed by the U.S. Fish and Wildlife Service as an endangered species under the Endangered Species Act effective March 21, 2017. Our biological controls for mosquito larvae pose no risk to bees. For controlling adult mosquitoes, the pyrethroids we use as fog or barrier spray on vegetation, when used according to label, are relatively low risk for bees. However, knowing where and when bees are active can reduce the chance of exposure and decrease risk further.

Since 2015, beekeepers who want to be eligible for compensation for losses due to pesticide exposure must register their hives through "beeCheck", a FieldWatch system (https://www.mda.state.mn.us/beekillcompensation). The hive locations can be seen on Drift Watch (mn.driftwatch.org/map) or by logging in as a FieldWatch registered applicator. We have been transferring these hive locations into our internal database/mapping system, and are continuing to explore methods to keep hive information up-to-date and easy to access for field staff, given that hives may be moved frequently for different forage conditions.

Permits and Treatment Plans

National Pollutant Discharge Elimination System Permit A Clean Water Act - National Pollutant Discharge Elimination System (NPDES) permit is required for most applications of mosquito control insecticides to water, and MPCA procedures for Pesticide NPDES Permits are described at http://www.pca.state.mn.us/index.php/water/water-permits-and-rules/water-permits-and-forms/pesticide-npdes-permit/pesticide-npdes-permit-program.html. The checklist for mosquito control permits is given at http://www.pca.state.mn.us/index.php/view-document.html?gid=15671

MMCD's Pesticide Discharge Management Plan (PDMP) describes contact people, target pests and data sources, thresholds and management, and steps to be taken to respond to various types of incidents. This plan has been renewed annually since 2012, along with submitting our Notice of Intent and fees every 5 years (most recently in 2016).

Comprehensive treatment listings have been prepared for the MPCA in fulfillment of the permit requirements and submitted annually. The listings included site-specific treatment history and a geospatial file of treatment locations. This is the same information that MMCD makes available for public view on MMCD's web site.

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

On May 5, 2017 MMCD requested permission to survey wetlands within the Soberg Waterfowl Production Area (WPA). The request was granted later that day. On May 11, MMCD staff surveyed ten wetlands within the Soberg WPA. Mosquito larvae were found in seven wetlands and collected from six of the sites. The species collected included *Ae. vexans*, *Ae. sticticus*, and *Cs. inornata*. The Minnesota River remained within its banks inside the MVNWR during the entire mosquito season. Due to heavy demands on staff time throughout the mosquito season and low populations of vector mosquitoes in the area, MMCD did not request permission to survey wetlands in MVNWR for mosquito larvae in 2017.

Adult mosquito surveillance indicated initial emergence of the *Ae. vexans* population occurred shortly before the May 16 sampling date. *Aedes vexans* collections were highest in June and early July. For the eight CO_2 traps near the MVNWR collections of *Ae. vexans* were greatest within one mile of the refuge.

Collections of *Cx. pipiens* and/or *Cx. restuans* were relatively low (avg. 3.5 or less per trap night) at locations near MVNWR in 2017. *Culex pipiens* and *Cx. restuans* serve as the enzootic or maintenance vectors of West Nile virus (WNV). Birds that move between the refuge and the surrounding area can be infected with WNV on or off the refuge then carry the virus to other areas and subsequently infect other mosquitoes on or near the refuge.

Culex tarsalis collections were generally low (avg. 1.4 or less per trap night) for most of the season near MVNWR at all but one location. Trap H291 in Eden Prairie collected moderate numbers of *Cx. tarsalis* over a three-week period in June and July (11 to 27 per trap night).

Mosquitoes collected from traps near MVNWR were tested for WNV from the beginning of June through the end of September. There were two WNV positive samples from the area in 2017 from trap locations DSR2 in Burnsville on June 6 and DSR7 in Eagan on July 6.

Public Communication

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

Calls Requesting Service The most frequent type of call from the public continues to be requests for larval or adult mosquito treatment. In 2017, the number of these calls peaked in mid-June, concurrent with a surge in mosquito abundance fairly early in the season. Calls and mosquito abundance both dropped off dramatically in mid-July and stayed low through Labor Day weekend (Figure 7.5).

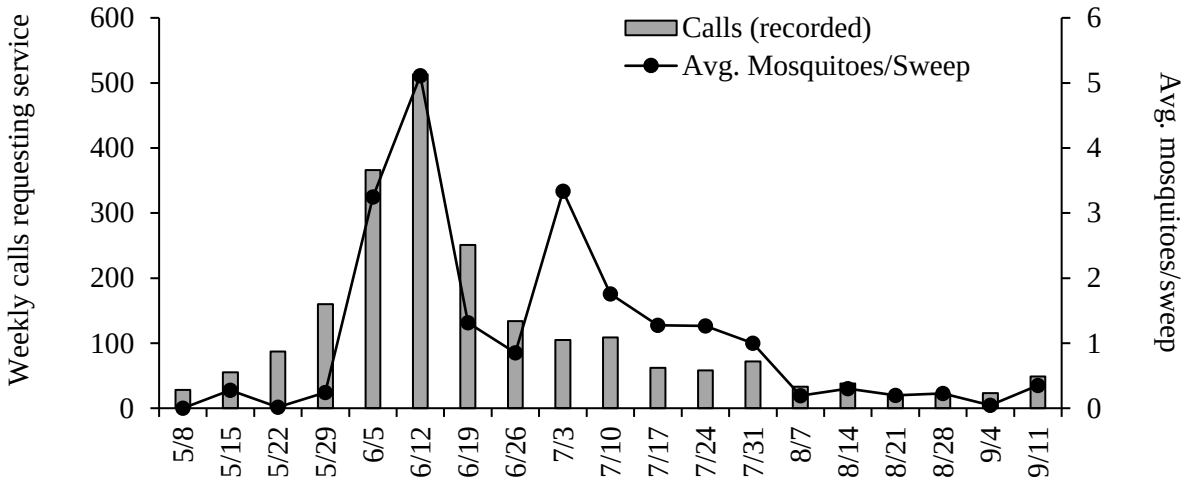


Figure 7.5 Calls requesting service, and sweep net counts, by week, 2017.

Requests specifically asking for adult mosquito treatment decreased in 2017 compared to 2016 to more typical levels (Table 7.1). Calls requesting site checks for larval mosquitoes remained high in 2017. Although mosquito-borne Zika virus transmission does not occur in Minnesota, the specter of Zika virus and its associated effects continued in mosquito-related news nationally and to some extent, locally, and helped raise public awareness of mosquito issues.

The total calls for request or confirmation of limited or no treatment appears higher than in earlier years because since 2014 we have used this part of our Call System to record all bee hive locations we become aware of through Driftwatch or independent reports.

Table 7.1 Yearly citizen call totals (including e-mails) by service request type, 2007-2017.

	Number of calls by year										
Service request	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Check a larval site	393	220	197	164	626	539	609	1,068	447	886	1,158
Request adult treatment	867	1,375	594	1,384	1,291	1,413	1,825	2,454	1,633	2,499	1,169
Public event, request treatment	60	109	250	78	68	61	70	93	91	106	102
Request tire removal	208	257	253	335	316	419	351	434	371	378	366
Request or confirm limited or no treatment	49	66	61	55	56	54	[a]151	[b]150	147	163	130
Total calls											

[a] Historic restriction "calls" moved into new system
[b] Bee hive locations added into call system to track restrictions

Curriculum in Schools Main Office and regional facility staff made presentations to 4,830 students in 47 schools during 2017. MMCD continued to deliver "Mosquito Mania," a three-day curriculum for upper elementary and middle school students. This curriculum was introduced to metro-area schools during the 2005-2006 school-year. "Mosquito Mania" builds on MMCD's relationship with schools by offering a standards-based approach to the subject of mosquitoes and their relationship to the environment. We continue to monitor changes in middle-school learning standards and make the adjustments necessary to keep the curriculum relevant and useful. Nearly one quarter of students reached by MMCD's school presentations visited learning stations set up as part of multi-school field days where a variety of public agencies gave short, science-based presentations throughout the day.

Social Media As part of an ongoing effort to notify residents when and where treatment is to take place, MMCD continues to build a presence on Facebook and Twitter. Anyone can sign up to receive MMCD tweets (@metromosquito). People can also "friend" Metropolitan Mosquito Control District on Facebook. MMCD currently has 420 Twitter followers, up from 360 Twitter followers at the end of 2016, and 685 "Total Page Likes" on Facebook, up from 594 in 2016.

MMCD currently uses the service "GovDelivery" to give advance notification to District residents of adult mosquito treatments. In 2017, GovDelivery managed MMCD's direct treatment notification email lists. MMCD also works with GovDelivery to make efficient use of social media to reach people who are interested in finding out more about District treatment activities. GovDelivery is also used to distribute press releases and make announcements about job openings. Our GovDelivery subscriptions continue to experience robust growth. 2017 ended with 4,879 distinct subscribers to our GovDelivery email lists. This is up from 4,129 in 2016, 3,177 in 2015, and 2,503 in 2014.

Sustainability Initiative

In 2013, MMCD's Sustainability Steering group was assembled to set up a framework for incorporating sustainability principles into the organization. Since then the group evolved into a standing team and workgroups have implemented many new measures to enhance sustainability initiatives in the areas described below.

In 2017, we also felt that we needed to go farther. Sustainability is larger than saving energy or recycling. Sustainability really becomes a way of life, a way of doing business, a way of delivering services to our community to keep it healthy in the long term. The group explored growing from sustainability initiatives to a sustainability culture, and for 2018 is planning ways to harness/engage employee passion, and focus on the District vision to be the best mosquito control District in the world including long-term sustainable operations.

Reduce Energy Usage In 2017, we conducted a small-scale study to estimate desktop computer use patterns and potential savings from shutting down vs. sleep mode when not in use. We found that using a full shut-down vs. sleep mode dropped power consumption per week by about half (a savings of 4.6 kilowatt hours per week for two-monitor computers). We will be looking at estimates for other models and possibilities for District-wide savings.

We continue to review our vehicle fleet and ways to minimize fuel usage while maximizing work done per mile driven. We had planned to update our fleet with more small trucks but found limited availability within our budget limitations. In 2018, we plan to look at how we can use other vehicle models, and options beyond the MN State Contract. We are also continuing to use teleconferencing for meetings or webinars for training when possible.

Reduce Waste We worked to reduce our waste stream through more effective recycling practices, through increasing organics composting, and by adopting reusable bulk control material containers. Organics separation at the St. Paul Main Office contributed to a 45.2% reduction in trash between 2016 and 2017. One of our insecticide manufacturers agreed to collect empty control material bags and is working with a recycler to develop a method to reuse the raw materials. We returned over 42,000 bags which saved about 19,320 pounds of trash from entering our waste stream.

Renewable Energy We continued to explore renewable energy such as solar and wind generation to determine when and how such sources could provide cost-effective replacements for current fossil fuel derived energy. In 2017, we reviewed projects such as community solar gardens that could be an option for MMCD.

Social Responsibility and Wellness This area includes how we give back to and take care of our community. In 2017, we held our 4th annual shoe drive, donated record amounts to our summer food shelf drive, and continued other donation programs. Two facilities updated their landscaping with major prairie plantings. Plans for 2018 include expanding vegetable gardens, and looking for new ways to enhance the health and wellbeing of our employees.

Professional Association Support

American Mosquito Control Association MMCD staff members continued to provide support for the national association, most notably Diann Crane's 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 2017 and Carey LaMere maintains the association's web site, http://www.nabfa-blackfly.org.

North Central Mosquito Control Association Mark Smith and Sandy Brogren serve on the Board of Directors of this regional association focused on education, communication, and promoting interaction between various regional organizations and individuals in Minnesota, North Dakota, South Dakota, Wisconsin, Iowa, and the Central Provinces of Canada. MMCD hosted the 2017 meeting at Bunker Hills Regional Park, Andover, MN, which included speakers from throughout the region. The meeting qualified attendees for pesticide applicator re-certification for MN and ND. The 2018 meeting is planned for Winnipeg. Visit their website to learn more http://north-central-mosquito.org/WPSite/.

Scientific Presentations, Posters, and Publications

MMCD staff attends a variety of scientific meetings throughout the year. Following is a list of papers and posters presented during 2017 and talks that are planned in 2018. In 2017, there were no publications that had MMCD staff as authors or co-authors.

2017 Presentations & Posters

Johnson, K. 2017. Strategies for surveillance and control of *Culiseta melanura* and secondary vectors of eastern equine encephalitis by the Metropolitan Mosquito Control District. Presentation: American Mosquito Control Association Meeting in San Diego, CA.

Grant, S. 2017. MMCD Black Fly Control Program update. Presentation: North American Black Fly Association Meeting in Harrisburg, PA.

Manweiler, S. 2017. Informing the public: How MADs are prepared to protect them from new and unknown vector-borne threats like Zika. Presentation: Michigan Mosquito Control Association Annual Meeting in Port Huron, MI.

Manweiler, S. 2017. WNV vector control in catch basins in Minnesota. Presentation: American Mosquito Control Association Meeting in San Diego, CA.

Read, N. 2017. Deluge, display, decision: automating rain data. Minnesota GIS/LIS Consortium Annual Meeting in Bemidji, MN.

Smith, M. 2017. Incorporating bulk larvicide containers to improve the efficiency of mosquito control operations. Presentation: American Mosquito Control Association Meeting in San Diego, CA.

Smith, M. 2017. Partners in sustainability. Presentation: North Central Mosquito Control Association in Andover, MN.

Soukup, A. 2017. Aerial perimeter treatments. Presentation: American Mosquito Control Association Meeting in San Diego, CA.

2018 Presentations & Posters

Johnson, K. 2018. Efficacy trials of Sumilarv 0.5G in St. Paul, Minnesota catch basins. Presentation: Michigan Mosquito Control Association Annual Meeting in Lansing, MI.

Manweiler, S. 2018. Controlling *Coquillettidia perturbans* in rooted and floating cattail sites with VectoLex FG. Presentation: Michigan Mosquito Control Association Annual Meeting in Lansing, MI.

Smith, M. 2018. Capturing innovative ideas – How the Metropolitan Mosquito Control District is striving to improve. Presentation: American Mosquito Control Association Meeting in Kansas City, MO.

APPENDICES

APPENDIX A Mosquito and Black Fly Biology and Species List

Mosquito Biology

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

Disease Vectors

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

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

Aedes japonicus This non-native species was first detected in Minnesota in 2007. By 2008, they were established in the District and southeast Minnesota. Larvae are found in a wide variety of natural and artificial habitats (containers), including rock holes and used tires. Preferred sites usually are shaded and contain organic-rich water. Eggs are resistant to desiccation and can survive several weeks or months under dry conditions. Overwintering is in the egg stage. Wild-caught specimens have tested positive for the LAC (Harris, C., et al, 2015. Emerging Infectious Diseases 21:4), thus, it is another potential vector of LAC in Minnesota.

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

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

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

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

Floodwater Mosquitoes

Spring *Aedes* Spring *Aedes* mosquito (15 species in the District) eggs inundated with snowmelt runoff hatch from March through May; they are the earliest mosquitoes to hatch in the spring. Larvae develop in woodland pools, bogs, and marshes that are flooded with snowmelt water. There is only one generation per year and overwintering is in the egg stage. Adult females live throughout the summer, can take up to four blood meals, and lay multiple egg batches. These mosquitoes stay near their oviposition sites, so localized hot spots of biting can occur both day and night. Our most common spring species are *Ae. abserratus, Ae. punctor, Ae. excrucians,* and *Ae. stimulans.* Adults are not attracted to light, so human- (sweep net) or CO_2-baited trapping is recommended.

Summer Floodwater *Aedes* Eggs of summer floodwater *Aedes* (5 species) can hatch beginning in late April and early May. These mosquitoes lay their eggs at the margins of grassy depressions, marshes, and along river flood plains; floodwater from heavy rains (greater than one inch) stimulate the eggs to hatch. Overwintering is in the egg stage. Adult females live about three weeks and can lay multiple batches of eggs, which can hatch during the current summer after flooding, resulting in multiple generations per year. Most species can fly great distances and are highly attracted to light. Peak biting activity is as at dusk. The floodwater mosquito, *Ae. vexans,* is our most numerous pest. Other common 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.

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

Cattail Mosquito

Coquillettidia perturbans This summer species is called the "cattail mosquito" because it uses cattail marshes for larval habitat. Eggs are laid in rafts on the surface of the water and will hatch in the same season. Larvae of this unique mosquito obtain oxygen by attaching its

specialized siphon to the roots of cattails and other aquatic plants; early instar larvae overwinter this way. There is only a single generation per year, and adults begin to emerge in late June and peak around the first week of July. They are very aggressive biters, even indoors, and can disperse up to five miles from their larval habitat. Peak biting activity is at dusk and dawn. Adult surveillance is best achieved with CO_2 traps and sweep net samples.

Permanent Water Species

Other mosquito species not previously mentioned develop in permanent and semi-permanent sites. These mosquitoes comprise the remaining *Anopheles*, *Culex*, and *Culiseta* species. These mosquitoes are multi-brooded and lay their eggs in rafts on the surface of the water. Adults prefer to feed on birds or livestock but will bite humans. They overwinter in places like caves, hollow logs, stumps or buildings.

Black Fly Biology

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

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

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

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

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

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

Reference Cited

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

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

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

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

Genus Abbreviations for mosquitoes

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

APPENDIX B Average Number of Common Mosquitoes Collected per Night in Four Long-term NJ Light Trap Locations and Average Yearly Rainfall, 1965-2017. Trap 1, Trap 9, Trap 13, and Trap 16 have run yearly since 1965. Trap 1 was discontinued in 2015.

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

Continued on next page

Year	Spring *Aedes*	*Aedes cinereus*	*Aedes sticticus*	*Aedes trivittatus*	*Aedes vexans*	*Culex tarsalis*	*Cq. perturbans*	All species	Avg. Rainfall
2006	0.05	0.08	0.14	0.01	6.73	0.08	1.85	10.04	18.65
2007	0.22	0.27	0.01	0.01	8.64	0.26	0.94	13.20	17.83
2008	0.38	0.32	0.17	0.01	8.17	0.10	2.01	12.93	14.15
2009	0.10	0.07	0.00	0.02	3.48	0.04	0.23	4.85	13.89
2010	0.07	0.08	0.06	0.17	16.18	0.23	0.36	26.13	24.66
2011	0.10	0.07	0.11	0.78	33.40	0.07	5.76	47.36	20.61
2012	0.04	0.03	0.15	0.21	21.10	0.04	4.01	30.39	17.53
2013	0.37	0.49	0.15	0.81	26.95	0.12	1.80	35.08	17.77
2014	0.12	0.32	0.19	0.44	32.42	0.20	2.18	41.72	23.60
2015*	0.02	0.26	0.01	0.46	27.73	0.06	3.77	36.00	24.02
2016	0.01	0.03	0.01	1.65	24.53	0.06	4.80	33.44	30.61
2017	0.01	0.08	0.09	0.17	25.71	0.05	9.62	37.85	22.27

*Trap 1 discontinued in 2015 due to operator retirement; averages after 2014 are from three traps used since 1965: Trap 9, Trap 13, and Trap 16.

APPENDIX C Description of Control Materials Used by MMCD in 2017

The following is an explanation of the control materials currently used by MMCD. The specific names of products used in 2017 are given. The generic products will not change in 2018, although the specific formulator may change.

Insect Growth Regulators

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

Altosid briquets are typically applied to mosquito oviposition sites that are three acres or less. Briquets are applied to the lowest part of the site on a grid pattern of 14-16 ft apart at 220 briquets per acre. Sites that may flood and then dry up are treated completely. Sites that are somewhat permanent are treated with briquets to the perimeter of the site in the grassy areas. Pockety ground sites (i.e., sites without a dish type bottom) may not be treated with briquets due to spotty control achieved in the uneven drawdown of the site. *Coquillettidia perturbans* sites are treated at 330 briquets per acre in rooted sites or 440 briquets per acre in floating cattail stands. Applications are made in the winter and early spring.

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

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

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

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

Bacterial Larvicides

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

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

***Bacillus thuringiensis israelensis* (Bti) liquid** Valent Biosciences

VectoBac® 12AS EPA# 73049-38

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

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

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

***Bacillus thuringiensis israelensis* (Bti) & methoprene granules** Valent BioSciences
VectoPrime® FG EPA# 73049-501

VectoPrime is a new corncob formulation containing methoprene and *Bti*. VectoPrime corn cob may be applied in all types of larval habitat. The duplex material controls existing larvae with *Bti* and has a seven-day residual control duration with methoprene. This residual control activity allows staff to work in other areas if additional rains immediately reflooded the site. Another possible advantage is that it may be effective to control late fourth instar larvae. These larvae slow their feeding activity as they get ready to pupate and therefore are less susceptible to *Bti*. According to the manufacturer, the reintroduction of juvenile hormone stimulates new feeding activity in later fourth instars causing them to ingest more *Bti*. Additionally, the methoprene can disrupt metamorphosis and thereby kill mosquito pupae. This material can be applied at 4 lb per acre (0.2428 lb/acre *Bti* and 0.0040 lb/acre methoprene). In evaluations, the material is applied to pockety sites with cyclone seeders or power backpacks.

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

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

Natular® (spinosad) Clarke
Natular® G EPA# 8329-80

Natular is a new formulation of spinosad, a biological toxin extracted from the soil bacterium *Saccharopolyspora spinosa,* that was developed for larval mosquito control. Spinosad has been used by organic growers for over 10 years. Natular G is formulated on corn cob as a short release granule designed for application (3.5 – 9 lb/acre) to wet sites.

Pyrethrin Adulticides

Natural Pyrethrin Clarke
Merus™ 2.0 Mosquito Adulticide EPA# 8329-94

Merus is the first and only adulticide listed with the Organic Materials Review Institute (OMRI), for wide-area mosquito control in and around organic gardens and farms and meets the USDA's Natural Organic Program (NOP) standards for use on organic crops. Its active ingredient, pyrethrin, is a botanical insecticide. The product contains no chemical synergist. It is OMRI and NOP listed for use in environmentally sensitive areas.

Merus is used by the District to treat adult mosquitoes in known areas of concentration or nuisance where crop restrictions (organic growers) prevent treatments with resmethrin or sumithrin. Merus 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. Merus is applied at a rate of 1.5 oz per acre (0.0048 lb AI per acre). Merus is a non-restricted use compound.

Natural Pyrethrin MGK, McLaughlin Gormley King
Pyrocide® Mosquito Adulticiding Concentrate 7369 EPA#1021-1569

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 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. 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 use compound.

Pyrethroid Adulticides

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

Onslaught (esfenvalerate, prallethrin, and the synergist PBO) is used by the District to treat adult mosquitoes in known daytime resting or harborage areas. Onslaught, a non-restricted use

compound, is diluted with water (1:50) and applied to wooded areas with a power backpack mister at a rate of 25 oz of mixed material per acre (0.0026 lb AI per acre [0.0021 esfenvalerate and 0.0005 prallethrin]).

Etofenprox Central Life Sciences
Zenivex® E4 Mosquito Adulticide EPA# 2724-807

Zenivex is used by the District to treat adult mosquitoes in known areas of concentration or nuisance. Zenivex 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. Zenivex is applied at a rate of 1.0 oz of mixed material per acre (0.0023 lb AI per acre). Zenivex is a non-restricted use compound.

Permethrin Clarke
Permethrin 57% OS EPA# 8329-44

Permethrin 57% OS is used by the District to treat adult mosquitoes in known daytime resting or harborage areas. Harborage areas are defined as wooded areas with good ground cover to provide a shaded, moist area for mosquitoes to rest during the daylight hours. Adult control is initiated when MMCD surveillance (sweep net and CO_2 trap collections) indicates nuisance populations of mosquitoes, when employee conducted landing rate collections document high numbers of mosquitoes, or when a large number of citizens complain of mosquito annoyance from a given area. In the case of citizen complaints, MMCD staff conducts mosquito surveillance to determine if treatment is warranted. MMCD also treats functions open to the public and public owned park and recreation areas upon request and at no charge if the event is not-for-profit. The material is diluted with soybean and food grade mineral oil (1:10) and is applied to wooded areas with a power backpack mister at a rate of 25 oz of mixed material per acre (0.0977 lb AI per acre).

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

Scourge (resmethrin and the synergist PBO) is used by the District to treat adult mosquitoes in known areas of concentration or nuisance. Scourge is applied from truck or all-terrain-vehicle mounted ULV machines that produce a fog that contacts mosquitoes when they are flying. Fogging may also be done with hand-held cold fog machines that enable the applications in smaller areas than can be reached by truck. Cold fogging is done either in the early morning or at dusk when mosquitoes become more active. The material is applied at a rate of 1.5 oz of mixed material per acre (0.0035 lb AI per acre). Scourge is a restricted used compound and is applied only by Minnesota Department of Agriculture-licensed applicators. This material has been phased out as the product label was not renewed with the EPA. The cost of the re-registration process and required testing made the product economically unviable for the limited mosquito control market.

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

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

APPENDIX D 2017 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 (lb)	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
MetaLarv® S-PT	Methoprene	4.25	2.5 lb	0.1063	30
			3 lb	0.1275	30
			4 lb	0.1700	30
Natular® G30	Spinosad	2.50	5 lb	0.1250	30
Natular® G**	Spinosad	0.50	5 lb	0.0250	7
			9 lb	0.0450	7
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
VectoPrime® FG**	*Bti* and methoprene	6.07 *Bti* 0.10 methoprene	4 lb	0.2428 *Bti* 0.0040 methoprene	7 single flood
Permethrin 57%OS [b]	Permethrin	5.70	25 fl oz	0.0977	5
Onslaught FastCap® [c]**	Esfenvalerate Prallethrin	6.40 1.60	25 fl oz	0.0021 0.0005	5
Scourge® [d]	Resmethrin	4.14	1.5 fl oz	0.0035	<1
Zenivex® E4 [e]	Etofenprox	4.00	1.0 fl oz	0.0023	<1
Anvil® [f]	Sumithrin	2.00	3.0 fl oz	0.0035	<1
Pyrocide® [g]	Pyrethrins	2.50	1.5 fl oz	0.00217	<1
Merus™ [h]**	Pyrethrins	5.00	1.5 fl oz	0.0048	<1

[a] 44 g per briquet total weight (220 briquets=21.34 lb total weight)
[b] 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)
[c] 0.0135 lb AI per 128 fl oz (1 gal) (product diluted 1:50 before application, undiluted product contains 0.675 lb AI per 128 fl oz)
[d] 0.30 lb AI per 128 fl oz (1 gal) [e] 0.30 lb AI per 128 fl oz (1 gal) [f] 0.15 lb AI per 128 fl oz (1 gal)
[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)
[h] 0.4096 lb AI per 128 fl oz (1 gal)
* Catch basin treatments—dosage is the amount of product per catch basin.
** Experimental

APPENDIX E Acres Treated with Control Materials Used by MMCD for Mosquito and Black Fly Control, 2009-2017.The actual geographic area treated is smaller because some sites are treated more than once

Control Material	2009	2010	2011	2012	2013	2014	2015	2016	2017
Larvicides									
Altosid® XR Briquet 150-day	225	174	205	165	189	193	186	168	166
Altosid® XRG	8,320	9,924	13,336	23,436	6,948	52	0	0	0
Altosid® Pellets 30-day	35,161	36,516	30,749	13,172	15,813	26,179	31,494	19,173	17,939
Altosid® Pellets catch basins (count)	219,045	227,611	234,033	226,934	246,300	239,829	248,599	240,806	252,694
MetaLarv™ S-PT	0	0	0	2,750	14,063	18,073	21,126	33,409	23,740
Natular™ G30	0	0	0	9,524	15,000	14,950	8,840	13,023	12,271
Altosid® XR Briquet catch basins (count)	0	0	0	458	375	437	450	448	445
VectoLex® FG granules	0	0	0	0	2,330	3,064	3,777	6,076	4,773
VectoMax® CG granules	5	0	0	0	0	0	0	0	0
VectoBac® G *Bti* corn cob granules	151,801	250,478	201,957	207,827	150,280	255,916	258,148	234,120	136,173
VectoBac® 12 AS *Bti* liquid (gal used) Black fly control	2,181	2,630	3,817	3,097	3,878	4,349	4,351	3,112	3,621
Adulticides									
Permethrin 57% OS Permethrin	4,754	8,826	7,544	8,578	9,020	8,887	6,093	8,128	5,038
Scourge® 4+12 Resmethrin/PBO	12,179	27,794	24,605	8,078	37,204	44,890	19,767	23,072	2,090
Anvil® 2 + 2 Sumithrin/PBO	7,796	26,429	29,208	27,486	36,000	31,381	27,183	16,399	11,683
Pyrenone® Adulticide	943	2,560	0	0	0	0	0	0	0
Pyrocide® Adulticide	0	0	0	0	0	5,338	3,605	0	0
Zenivex® Etofenprox	0	0	0	0	0	0	10,380	34,984	23,097

APPENDIX F Graphs of Larvicide, Adulticide, and ULV Fog Treatment Acres, 1984-2017

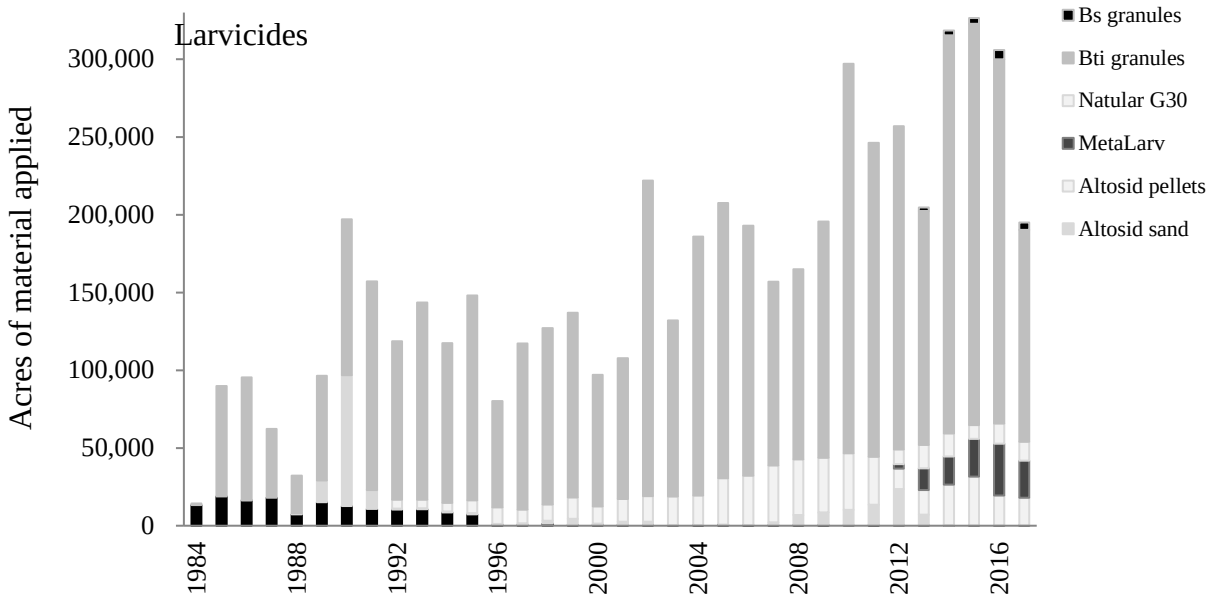


Figure F.1 Summary of total acres of larvicide treatments applied per year since 1984. For materials that are applied to the same site more than once per year, actual geographic acreage treated is less than that shown.

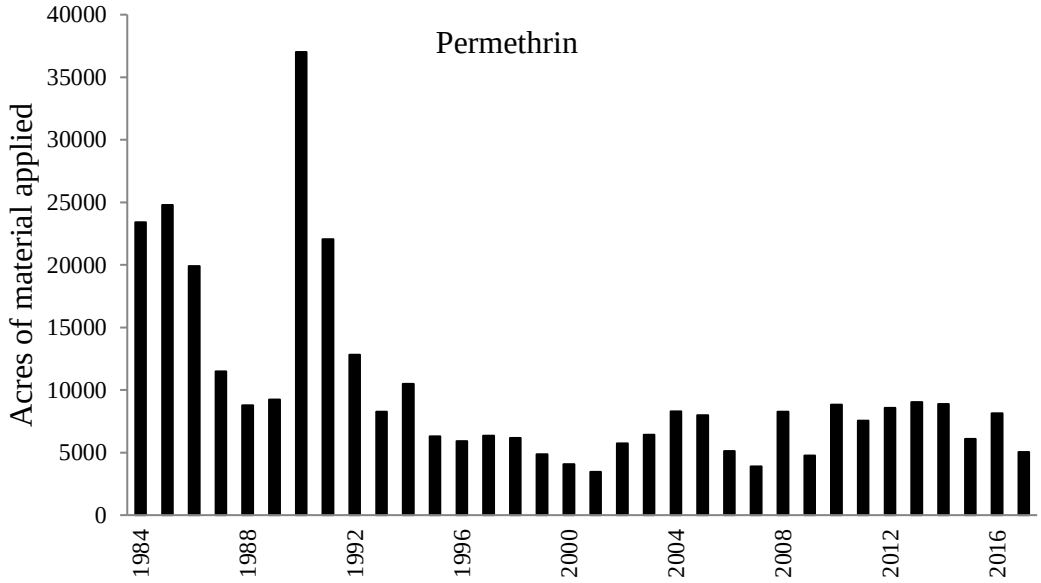


Figure F.2 Summary of total acres of permethrin treatments applied per year since 1984. This material may be applied to the same site more than once per year, so actual geographic acreage treated is less than that shown.

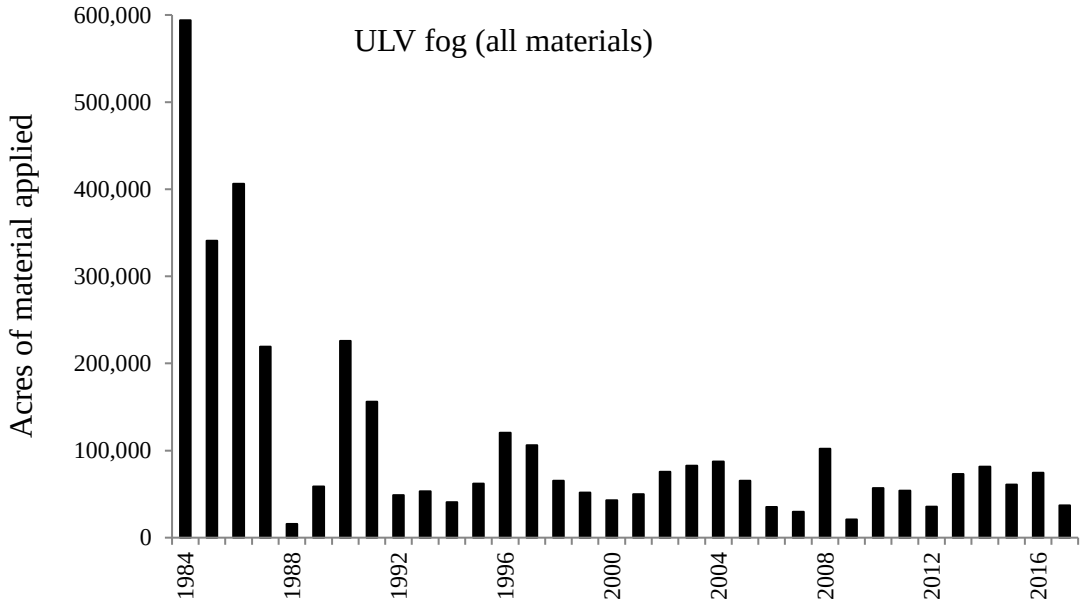


Figure F.3 Summary of total acres of ULV fog treatments applied per year since 1984. These materials may be applied to the same site more than once per year, so actual geographic acreage treated is less than that shown.

APPENDIX G Control Material Labels

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

Altosid® Pellets (EPA# 2724-448)

MetaLarv® S-PT (EPA# 73049-475)

VectoBac® 12AS (EPA# 73049-38)

VectoBac® G (EPA# 73049-10)

VectoLex® CG (EPA# 73049-20)

VectoPrime® FG (EPA# 73049-501)

Natular™ G (EPA# 8329-80)

Natular™ G30 (EPA# 8329-83)

Permethrin 57% OS (EPA# 8329-44)

Pyrocide® Mosquito Adulticiding Concentrate 7369 (EPA#1021-1569)

Onslaught® FastCap (EPA# 1021-1815)

Scourge® 4+12 (EPA# 432-716)

Anvil® 2+2 ULV (EPA# 1021-167-8329)

Zenivex® E4 RTU (EPA# 2724-807)

Merus™ 2.0 RTU (EPA# 8329-94)

A SUSTAINED RELEASE PRODUCT TO PREVENT ADULT MOSQUITO EMERGENCE
(INCLUDING THOSE WHICH MAY TRANSMIT WEST NILE VIRUS)

SPECIMEN LABEL

ACTIVE INGREDIENT:

(S)-Methoprene (CAS #65733-16-6)] (Dry Weight Basis):	2.1%
OTHER INGREDIENTS:	97.9%
Total	100.0%

EPA Reg. No. 2724-421
EPA Est. No. 2724-TX-1

KEEP OUT OF REACH OF CHILDREN
CAUTION
SEE ADDITIONAL PRECAUTIONARY STATEMENTS

INTRODUCTION

ALTOSID® XR BRIQUETS are designed to release effective levels of (S)-Methoprene insect growth regulator over a period up to 150 days in mosquito breeding sites. Release of (S)-Methoprene insect growth regulator occurs by dissolution of the briquet. Soft mud and loose sediment can cover the briquets and inhibit normal dispersion of the active ingredient. The product may not be effective in those situations where the briquet can be removed from the site by flushing action.

ALTOSID® XR BRIQUETS prevent the emergence of adult mosquitoes including: *Anopheles, Culex, Culiseta, Coquillettidia,* and *Mansonia* spp., as well as those of the floodwater mosquito complex (*Aedes, Ochlerotatus,* and *Psorophora* spp.) from treated water. Treated larvae continue to develop normally to the pupal stage where they die.

NOTE: (S)-Methoprene insect growth regulator has no effect on mosquitoes which have reached the pupal or adult stage prior to treatment.

PRECAUTIONARY STATEMENTS
HAZARDS TO HUMANS AND DOMESTIC ANIMALS - CAUTION

Causes moderate eye irritation. Harmful if absorbed through skin. Avoid contact with skin, eyes, or clothing. Wash thoroughly with soap and water after handling.

FIRST AID

Call a poison control center or doctor for treatment advice.

If in eyes	• Hold eye open and rinse slowly and gently with water for 15-20 minutes. • Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye.
If on skin or clothing	• Take off contaminated clothing. • Rinse skin immediately with plenty of water for 15-20 minutes.

Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-800-248-7763 for emergency medical treatment information.

ENVIRONMENTAL HAZARDS

Do not contaminate water when disposing of unused product.

DIRECTIONS FOR USE

It is a violation of Federal Law to use this product in a manner inconsistent with its labeling.

APPLICATION TIME

Place **ALTOSID® XR BRIQUETS** at or before the beginning of the mosquito season. Apply **ALTOSID® XR BRIQUETS** prior to flooding when sites are dry, or on snow and ice in breeding sites prior to spring thaw. Under normal conditions, one application will last the entire mosquito season, or up to 150 days, whichever is shorter. Alternate wetting and drying will not reduce their effectiveness.

APPLICATION RATES

***Aedes, Ochlerotatus, and Psorophora* spp.:** For control in non-(or low-) flow shallow depressions (≤ 2 feet in depth), treat on the basis of surface area, placing one **ALTOSID® XR BRIQUET** per 200 ft². Place briquets in the lowest areas of mosquito breeding sites to maintain continuous control as the site alternately floods and dries up.

***Culex, Culiseta* and *Anopheles* spp.:** Place one **ALTOSID® XR BRIQUET** per 100 ft².

Coquillettidia and *Mansonia* spp.: For application to cattail marshes and water hyacinth beds. For control of these mosquitoes, place one **ALTOSID® XR BRIQUET** per 100 ft².

***Culex* sp. in storm water drainage areas, sewers, and catch basins:** For catch basins, place one **ALTOSID® XR BRIQUET** into each basin. In cases of large catch basins, follow the chart below to determine the number of briquets to use. For storm water drainage areas, place one briquet per 100 ft² of surface area up to two ft deep. In areas that are deeper than two feet, use one additional briquet per two feet of water depth.

Water flow pressure increases the potential dissolution of the briquet. Conduct regular inspections (visual or biological) in areas of water flow to determine if the briquet is still present. Adjust the retreatment interval based on the results of an inspection.

ALTOSID® XR BRIQUETS Application Chart

Number of Briquets	Catch Basin Size (Gallons)	Surface Area/ Water Depth (ft)
1	0 – 1500	0 – 2
2	1500 – 3000	2 – 4
3	3000 – 4500	4 – 6
4	4500 – 6000	6 – 8

APPLICATION SITES

ALTOSID® XR BRIQUETS are designed to control mosquitoes in treated areas. Examples of application sites are: storm drains, catch basins, roadside ditches, fish ponds, ornamental ponds and fountains, other artificial water-holding containers, animal watering troughs, cesspools and septic tanks, waste treatment and settling ponds, flooded crypts, transformer vaults, abandoned swimming pools, tires, construction and other manmade depressions, cattail marshes, water hyacinth beds, vegetation-choked phosphate pits, pastures, meadows, rice fields, freshwater swamps and marshes, salt and tidal marshes, treeholes, woodland pools, floodplains, and dredging spoil sites. For application sites connected by a water system, i.e., storm drains or catch basins, treat all of the water-holding sites in the system to maximize the efficiency of the treatment program.

STORAGE AND DISPOSAL

Do not contaminate water, food, or feed by storage or disposal.

STORAGE: Store in a cool place. Do not reuse empty container.

PESTICIDE DISPOSAL: Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility.

CONTAINER DISPOSAL: Nonrefillable container. Do not reuse or refill this container. Completely empty bag into application equipment. Then offer for recycling, if available, or dispose of empty container in a sanitary landfill or by incineration, or if allowed by state and local authorities, by burning. If burned, stay out of smoke.

WARRANTY AND CONDITIONS OF SALE

Seller makes no warranty, expressed or implied, concerning the use and handling of this product other than indicated on the label. To the extent permitted by law, Buyer assumes all risks of use and handling of this material when such use and handling are contrary to label instructions.

For information, or in case of an emergency, call 1-800-248-7763.

www.altosid.com

Wellmark International
1501 East Woodfield Road 200W
Schaumburg, Illinois 60173

ZOËCON. Professional Products

300507286

May, 2010
Schaumburg, IL

A GRANULAR PRODUCT TO PREVENT ADULT MOSQUITO EMERGENCE *(INCLUDING THOSE WHICH MAY TRANSMIT WEST NILE VIRUS)*

SPECIMEN LABEL

ACTIVE INGREDIENT:
(S)-Methoprene (CAS #65733-16-6) 4.25%
OTHER INGREDIENTS: 95.75%
Total 100.00%

EPA Reg No. 2724-448 EPA Est. No. 39578-TX-1

KEEP OUT OF REACH OF CHILDREN
CAUTION

PRECAUTIONARY STATEMENTS
HAZARDS TO HUMANS AND DOMESTIC ANIMALS
CAUTION

Causes moderate eye irritation. Harmful if absorbed through skin. Avoid contact with skin, eyes, or clothing. Wash thoroughly with soap and water after handling.

FIRST AID	
Call a poison control center or doctor for treatment advice.	
If in eyes	• Hold eye open and rinse slowly and gently with water for 15-20 minutes. • Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye.
If on skin or clothing	• Take off contaminated clothing. • Rinse skin immediately with plenty of water for 15-20 minutes.
Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-800-248-7763 for emergency medical treatment information.	

ENVIRONMENTAL HAZARDS

Do not contaminate water when disposing of rinsate or equipment washwaters.

DIRECTIONS FOR USE

It is a violation of Federal Law to use this product in a manner inconsistent with its labeling.

INTRODUCTION

ZOËCON® ALTOSID® Pellets (ALTOSID® Pellets) release **ALTOSID®** Insect Growth Regulator as they erode. **ALTOSID® Pellets** prevent the emergence of adult standing water mosquitoes, including *Anopheles, Culex, Culiseta, Coquillettidia,* and *Mansonia* spp., as well as adults of the floodwater mosquitoes such as *Aedes, Ochlerotatus,* and *Psorophora* spp. from treated sites.

GENERAL DIRECTIONS

ALTOSID® Pellets release effective levels of **ALTOSID®** Insect Growth Regulator for up to 30 days under typical environmental conditions. Continue treatment through the last brood of the season. Treated larvae continue to develop normally to the pupal stage where they die. **NOTE:** This insect growth regulator has no effect on mosquitoes which have reached the pupal or adult stage prior to treatment.

APPLICATION SITES AND RATES

Use lower application rates when water is shallow, vegetation and/or pollution are minimal, and insect populations are low. Use higher rates when water is deep (>2 ft), vegetation, pollution, and/or organic debris or water flow are high, and insect populations are high. In instances of high organic debris and water flow, residual activity may be diminished.

MOSQUITO HABITAT	RATE (LB/ACRE)
Floodwater sites	
Pastures, meadows, rice fields, freshwater swamps and marshes, salt and tidal marshes, cattail marshes, woodland pools, flood-plains, tires, other artificial water-holding containers	2.5–5
Dredging spoil sites, waste treatment and settling ponds, ditches and other manmade depressions	5–10
Permanent water sites	
Ornamental ponds and fountains, fish ponds, cattail marshes, water hyacinth beds, flooded crypts, transformer vaults, abandoned swimming pools, construction and other manmade depressions, treeholes, other artificial water-holding containers	2.5–5
Storm drains, catch basins, roadside ditches, cesspools, septic tanks, waste settling ponds, vegetation-choked phosphate pits	5–10

APPLICATION METHODS

Mosquitoes: Apply **ALTOSID® Pellets** up to 15 days prior to flooding, or at any stage of larval development after flooding or in permanent water sites. Fixed wing aircraft or helicopters equipped with granular spreaders capable of applying rates from 2.5 to 10 lb/acre may be used to apply **ALTOSID® Pellets**. The pellets may also be applied using ground equipment which will achieve good, even coverage at the above rates. Apply **ALTOSID® Pellets** to artificial containers such as tires and catch basins, etc.

STORAGE AND DISPOSAL

Do not contaminate water, food, or feed by storage or disposal. Store closed containers of **ALTOSID® Pellets** in a cool, dry place.

PESTICIDE DISPOSAL

Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility.

CONTAINER HANDLING

Nonrefillable container. Do not reuse or refill this container. Triple rinse (or equivalent). Then offer for recycling, if available, or puncture and dispose of in a sanitary landfill, or by incineration, or if allowed by state and local authorities, by burning. If burned, stay out of smoke.

WARRANTY AND CONDITIONS OF SALE

Seller makes no warranty, expressed or implied, concerning the use and handling of this product other than indicated on the label. Buyer assumes all risks of use and handling of this material when such use and handling are contrary to label instructions.

For information or in case of an emergency, call **1-800-248-7763**.

www.altosid.com

Wellmark International
1501 East Woodfield Road 200W
Schaumburg, Illinois 60173

ZOECON. Professional Products

300506948

Made in the U.S.A.

May, 2010
Schaumburg, IL

MetaLarv™ S-PT

MOSQUITO GROWTH REGULATOR

PELLET

ACTIVE INGREDIENT:
(S)-Methoprene (CAS # 65733-16-6) 4.25%
OTHER INGREDIENTS 95.75%
TOTAL 100.00%

EPA Reg. No. 73049-475
EPA Est. No. 33762-IA-001 List No. 05765

INDEX:

KEEP OUT OF REACH OF CHILDREN
CAUTION

1.0

FIRST AID	
If in eyes	• Hold eye open and rinse slowly and gently with water for 15-20 minutes. • Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. • Call a poison control center for treatment advice.
If on skin or clothing	• Take off contaminated clothing. • Rinse skin immediately with plenty of water for 15-20 minutes. • Call a poison control center or doctor for treatment advice.
HOT LINE NUMBER	
Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact (PROSAR service) 1-877-315-9819 (24 hours) for emergency medical treatment and/or transport emergency information. For all other information, call Valent BioSciences 1-800-323-9597.	

2.0 PRECAUTIONARY STATEMENTS

2.1 Hazards To Humans and Domestic Animals

CAUTION

Causes moderate eye irritation. Harmful if absorbed through skin. Avoid contact with eyes, skin, or clothing. Wash thoroughly with soap and water after handling and before eating, drinking, chewing gum, using tobacco, or using the toilet. Remove and wash contaminated clothing before reuse.

2.2 Environmental Hazards

Do not contaminate water when cleaning equipment or disposing of equipment washwaters or rinsate.

3.0 DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

Introduction

MetaLarv S-PT is formulated to release S-Methoprene insect growth regulator for up to 42 days. MetaLarv S-PT prevents the emergence of *Aedes*, *Ochlerotatus*, and *Psorophora* spp., (adult floodwater mosquitoes) and *Anopheles*, *Culex*, *Culiseta*, *Coquillettidia*, and *Mansonia* spp (adult standing water mosquitoes).

NOTE: MetaLarv S-PT prevents development of mosquito larvae into adults. MetaLarv S-PT has no effect on mosquitoes that have reached the pupal or adult stage prior to treatment.

4.0 APPLICATION DIRECTIONS

Apply MetaLarv S-PT to mosquito breeding sites at any time during the mosquito season. One application will control adult emergence for up to 42 days. Continue treatment through the last brood of the season. Treated larvae continue to develop normally to the pupal stage where they die.

Apply MetaLarv S-PT to breeding sites that will be intentionally flooded and to sites that will naturally flood, up to 28 days prior to flooding. Periods of greater than 28 days between application and flooding will provide shorter residual control and will need reapplication based on local program threshold requirements.

Apply the pellets evenly over the entire habitat that is flooded and/or expected to be flooded to maintain continuous control as the site alternately floods and dries. Alternate wetting and drying will not reduce pellet effectiveness.

MetaLarv S-PT can be applied to areas that contain fish, other aquatic life, and plants. MetaLarv S-PT can be applied to areas used by or in contact with humans, pets, horses, livestock, birds, or wildlife.

4.1 Application Sites And Rates

Use lower application rates when water is shallow, vegetation and/or pollution are minimal, and mosquito populations are low. Use higher rates when water is deep (>2 ft), vegetation, pollution, and/or organic debris or water flow are high, and mosquito populations are high. Application of MetaLarv S-PT to sites subject to high organic pollution and water flow or exchange will diminish the product's effectiveness.

Use Sites	Rate Range (lbs/acre)
Floodwater sites	
Pastures, meadows, freshwater swamps and marshes, salt and tidal marshes, cattail marshes, woodland pools, flood-plains, grassy swales, bogs, tires, and artificial water-holding containers.	2.5-5
Dredge spoil sites, waste treatment and settling ponds, ditches, natural and manmade hollows or sinkhole (that retain water).	5-10
Permanent water sites	
Ornamental ponds and fountains, fish ponds, cattail marshes, water hyacinth beds, flooded crypts, transformer vaults, abandoned swimming pools, treeholes, manmade craters and pits, and artificial and natural water-holding containers.	2.5-5
Storm drains, catch basins, roadside ditches, cesspools, septic tanks, waste settling ponds, vegetation-choked phosphate pits.	5-10

CONTINUED

MetaLarv S-PT should be broadcast applied as a dry product. Applications can be made using fixed wing aircraft, helicopter, boat, tractor mounted spreader, handheld or backpack spreader. Fixed wing aircraft or helicopters equipped with granular spreaders capable of applying rates from 2.5-10 lb/acre may be used to apply MetaLarv S-PT. The pellets may also be applied using ground equipment that will achieve good, even coverage at rates from 2.5-10 lb/acre.

5.0 STORAGE AND DISPOSAL

Do not contaminate water, food or feed by storage or disposal. Do not contaminate water when disposing of equipment washwaters.

Pesticide Storage: Store any unused product in original container. Ensure that container is tightly closed then store in a cool, dry place.

Pesticide Disposal: Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility.

Container Handling: Nonrefillable container. Do not reuse or refill this container. Offer for recycling, if available. Completely empty bag into application equipment. Then dispose of empty bag in a sanitary landfill or by incineration, or, if allowed by State and local authorities, by burning. If burned, stay out of smoke.

6.0 WARRANTY STATEMENT

To the extent consistent with applicable law, seller makes no warranty, express or implied, of merchantability, fitness or otherwise concerning use of this product other than as indicated on the label. To the extent consistent with applicable law, user assumes all risks of use, storage or handling not in strict accordance with accompanying directions.

MetaLarv is a trademark of Valent BioSciences Corporation.

VALENT BIOSCIENCES CORPORATION
870 TECHNOLOGY WAY
LIBERTYVILLE, IL 60048 USA
PH: 800-323-9697

VectoBac® 12AS

BIOLOGICAL LARVICIDE

AQUEOUS SUSPENSION

Active Ingredient:

Bacillus thuringiensis, subsp. *israelensis*, strain AM 65-52, fermentation solids and solubles	11.61%
Other Ingredients	88.39%
Total	100.00%

Potency: 1200 International Toxic Units (ITU) per mg
(Equivalent to 4.84 billion ITU per gallon, 1.279 billion ITU per liter)

There is no direct relationship between intended activity (potency) and the Percent Active Ingredient by Weight.

EPA Reg. No. 73049-38
EPA Est. No. 33762-IA-001 List No. 05605

INDEX:

KEEP OUT OF REACH OF CHILDREN
CAUTION

1.0 FIRST AID

If in eyes	• Hold eye open and rinse slowly and gently with water for 15-20 minutes. • Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. • Call a poison control center or doctor for treatment advice.
If on skin or clothing	• Take off contaminated clothing. • Rinse skin immediately with plenty of water for 15-20 minutes. • Call a poison control center or doctor for treatment advice.

HOT LINE NUMBER

Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-877-315-9819 (24 hours) for emergency medical treatment and/or transport emergency information. For all other information, call 1-800-323-9597.

2.0 PRECAUTIONARY STATEMENTS

2.1 HAZARD TO HUMANS (AND DOMESTIC ANIMALS)

CAUTION

Harmful if absorbed through skin. Causes moderate eye irritation. Avoid contact with skin, eyes, or clothing. Wash thoroughly with soap and water after handling. Remove contaminated clothing and wash contaminated clothing before reuse.

Mixer/loaders and applicators not in enclosed cabs or aircraft must wear a dust/mist filtering respirator meeting NIOSH standards of at least N-95, R-95, or P-95. Repeated exposure to high concentrations of microbial proteins can cause allergic sensitization.

2.2 Physical and Chemical Hazards

Diluted or undiluted VectoBac 12AS can cause corrosion if left in prolonged contact with aluminum spray system components. Rinse spray system with plenty of clean water after use. Care should be taken to prevent contact with aluminum aircraft surfaces, structural components and control systems. In case of contact, rinse thoroughly with plenty of water. Inspect aluminum aircraft components regularly for signs of corrosion.

3.0 DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling. Do not apply directly to finished drinking water reservoirs or drinking water receptacles when water is intended for human consumption.

Do not apply when weather conditions favor drift from treated areas. Do not apply to metallic painted objects, such as automobiles, as spotting may occur. If spray is deposited on metallic painted surfaces, wash immediately with soap and water to avoid spotting.

Avoiding spray drift at the application site is the responsibility of the applicator. The interaction of many equipment- and weather-related factors determine the potential for spray drift. The applicator and the treatment coordinator are responsible for considering all these factors when making decisions.

3.1 Chemigation

Do not apply this product through any type of irrigation system unless labeling on chemigation is followed.

4.0 STORAGE AND DISPOSAL

Do not contaminate water, food, or feed by storage or disposal.

STORAGE: Store in a cool, [less than 86° F (30° C)], dry place.

PESTICIDE DISPOSAL: Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility.

CONTAINER DISPOSAL: Nonrefillable container. Do not reuse or refill this container. Triple rinse container (or equivalent) promptly after emptying. Triple rinse as follows: Empty the remaining contents into application equipment or a mix tank and drain for 10 seconds after the flow begins to drip. Fill the container 1/4 full with water and recap. Shake for 10 seconds. Pour rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Drain for 10 seconds after the flow begins to drip. Repeat this procedure two more times. Once cleaned, some agricultural plastic pesticide containers can be taken to a container collection site or picked up for recycling or puncture and dispose of in a sanitary landfill, or by incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke. Do not reuse container.

CONTINUED

5.0 APPLICATION DIRECTIONS

Do not apply when wind speed favors drift beyond the area of treatment.

Mosquito Habitat	Suggested Rate Range*
(Such as the following examples): Irrigation ditches, roadside ditches, flood water, standing ponds, woodland pools, snow melt pools, pastures, catch basins, storm water retention areas, tidal water, salt marshes and rice fields.	0.25 - 2 pts/acres
In addition, standing water containing mosquito larvae, in fields growing crops such as: Alfalfa, almonds, asparagus, corn, cotton, dates, grapes, peaches and walnuts, may be treated at the recommended rates.	
When applying this product to standing water containing mosquito larvae in fields growing crops, do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application.	
Polluted water (such as sewage lagoons, animal waste lagoons).	1 - 2 pts/acre

*Use higher rate range in polluted water and when late 3rd and early 4th instar larvae predominate, mosquito populations are high, water is heavily polluted, and/or algae are abundant.

Blackflies Habitat	Suggested Rate Range
Streams	
Stream water† (=ppm) for 1 minute exposure time	0.5 - 25 mg/liter
Stream water† (=ppm) for 10 minutes exposure time	0.05 - 2.5 mg/liter

†Use higher rate range when stream contains high concentration of organic materials, algae, or dense aquatic vegetation.

†Discharge is a principal factor determining carry of Bti. Use higher rate or increase volume by water dilution in low discharge rivers or streams under low volume (drought) conditions.

6.0 NUISANCE FLIES

For control of nuisance flies (*Psychoda* spp., *Chironomus* spp.) in sewage treatment facilities utilizing trickling filter systems.

APPLICATION DIRECTIONS

Nuisance Fly Habitat	Suggested Rate Range*
Trickling filter system of wastewater treatment plants	10 - 20 mg/liter a.(0.833-1.67 ml) per liter of wastewater feed to the filter per 30 minutes

* Use high rate for control of *Chironomus* spp. Apply undiluted with pre-calibrated pump or other device into the wastewater feeding into the filters for a period of 30 minutes. Repeat applications as needed after 2-4 weeks. Control of *Chironomus* spp. may take up to 2 weeks.

7.0 NUISANCE AQUATIC MIDGES

For control of *Chironomine* midges (*Chironominae: Chironomini*) inhabiting shallow, manmade and natural lakes or ponds.

APPLICATION DIRECTIONS

Nuisance Midge Habitat	Suggested Rate Range*
Shallow Lakes and Ponds per sewage oxidation ponds (less than acre 6 feet deep)	1 gallon (3,785.5 ml) per acre

* Apply diluted with water in total volume of 5 gallons/acre by pouring or spraying over the surface to be treated with pre-calibrated device. Repeat application as needed after 2-4 weeks. Control of *Chironomine* midges may take up to 2 weeks.

8.0 GROUND AND AERIAL APPLICATION

VectoBac 12AS may be applied in conventional ground or aerial application equipment with quantities of water sufficient to provide uniform coverage of the target area. The amount of water will depend on weather, spray equipment, and mosquito habitat characteristics. Do not mix more VectoBac 12AS than can be used in a 72-hour period.

For most ground spraying, apply in 5-100 gallons of water per acre using hand-pump, airblast, mist blower, etc., spray equipment.

For aerial application, VectoBac 12AS may be applied either undiluted or diluted with water. For undiluted applications, apply 0.25 to 2.0 pt/acre of VectoBac 12AS through fixed wing or helicopter aircraft equipped with either conventional boom and nozzle systems or rotary atomizers.

For diluted application, fill the mix tank or plane hopper with the desired quantity of water. Start the mechanical or hydraulic agitation to provide moderate circulation before adding the VectoBac 12AS. VectoBac 12AS suspends readily in water and will stay suspended over normal application periods. Brief recirculation may be necessary if the spray mixture has sat for several hours or longer. AVOID CONTINUOUS AGITATION OF THE SPRAY MIXTURE DURING SPRAYING.

Rinse and flush spray equipment thoroughly following each use.

For blackfly aerial applications, VectoBac 12AS can be applied undiluted via fixed wing or helicopter aircraft equipped with either conventional boom and nozzle systems or open pipes. Rate of application will be determined by the stream discharge and the required amount of VectoBac 12AS necessary to maintain a 0.5 - 25 ppm concentration in the stream water. VectoBac 12AS can also be applied diluted with similar spray equipment. Do not mix more VectoBac 12AS than can be used in a 72-hour period.

9.0 SMALL QUANTITY DILUTION RATES

Gallons Spray Solution/Acre
(Ounces Needed per Gallon of Spray)

VectoBac 12AS
Rate in Pints

Per Acre	10 Gal/A	25 Gal/A	50 Gal/A
0.25 (4 oz)	0.4	0.16	0.08
0.5 (8 oz)	0.8	0.32	0.16
1.0 (16 oz)	1.6	0.64	0.32
2.0 (32 oz)	3.2	1.28	0.64

CONTINUED

10.0 CHEMIGATION

Apply this product through flood (basin) irrigation systems. Do not apply this product through any other type of irrigation system.

Crop injury, lack of effectiveness, or illegal pesticide residues in the crop can result from nonuniform distribution of treated water.

If you have any questions about calibration, you should contact State Extension Service Specialists, equipment manufacturers or other experts.

A person knowledgeable of this chemigation system and responsible for its operation, or under the supervision of the responsible person, shall shut the system down and make necessary adjustments should the need arise.

10.1 RICE-FLOOD (BASIN) CHEMIGATION

Systems using a gravity flow pesticide dispensing system must meter the pesticide into the water at the head of the field and downstream of a hydraulic discontinuity such as a drop structure or weir box to decrease potential for water source contamination from backflow if water flow stops.

VectoBac 12AS is metered or dripped into rice floodwater at application stations positioned at the point of introduction (levee cut) of water into each rice field or pan. Two to three pints of VectoBac 12AS are diluted in water to a final volume of 5 gallons. The diluted solution is contained in a 5 gallon container and metered or dispersed into the irrigation water using a constant flow device at the rate of 80 ml per minute. Introduction of the solution should begin when 1/3 to 1/2 of the pan or field is covered with floodwater. Delivery of the solution should continue for a period of approximately 4-1/2 hours. Floodwater depth should not exceed 10-12 inches to prevent excessive dilution of VectoBac 12AS which could result in reduced larval kill.

Agitation is not required during the period in which the VectoBac 12AS solution is being dispersed.

Application of VectoBac 12AS into rice floodwater is not permitted using a pressurized water and pesticide injection system.

11.0 NOTICE TO USER

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VectoBac is a registered trademark of Valent BioSciences Corporation.

VALENT BIOSCIENCES CORPORATION
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VectoBac® G

BIOLOGICAL LARVICIDE

GRANULE

ACTIVE INGREDIENT:

Bacillus thuringiensis, subspecies *israelensis*, strain AM 65-52, fermentation solids, spores, and insecticidal toxins	2.80%
OTHER INGREDIENTS	97.20%
TOTAL	100.00%

Potency: 200 International Toxic Units (ITU) per mg
(Equivalent to 0.091 billion potency: ITU per pound)

The percent active ingredient does not indicate product performance and potency measurements are not Federally standardized.

EPA Reg. No. 73049-10
EPA Est. No. 33762-IA-001 List No. 05108

INDEX:

KEEP OUT OF REACH OF CHILDREN
CAUTION

1.0

FIRST AID	
If in Eyes	• Hold eyes open and rinse slowly and gently with water for 15-20 minutes. • Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eyes. • Call a poison control center or doctor for treatment advice.
HOT LINE NUMBER	
Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-877-315-9819 (24 hours) for emergency medical treatment and/or transport emergency information. For all other information, call 1-800-323-9597.	

2.0 PRECAUTIONARY STATEMENTS

2.1 HAZARD TO HUMANS (AND DOMESTIC ANIMALS)

CAUTION

Causes moderate eye irritation. Avoid contact with eyes or clothing. Wash thoroughly with soap and water after handling.

Mixers/loaders and applicators not in enclosed cabs or aircraft must wear a dust/mist respirator meeting NIOSH standards of at least N-95, R-95 or P-95. Repeated exposure to high concentrations of microbial proteins can cause allergic sensitization.

2.2 ENVIRONMENTAL HAZARDS

Do not contaminate water when cleaning equipment or disposing of equipment washwaters. Do not apply directly to treated, finished drinking water reservoirs or drinking water receptacles when the water is intended for human consumption.

3.0 DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

4.0 APPLICATION DIRECTIONS

VectoBac G is an insecticide for use against mosquito larvae.

Mosquitoes Habitat (Such as the following examples):	Suggested Range Rate*
Irrigation ditches, roadside ditches, flood water, standing ponds, livestock watering ponds and troughs, woodland pools, snow melt pools, pastures, catch basins, storm water retention areas, tidal water, salt marshes and rice fields	2.5 - 10 lbs. / acre

In addition, standing water containing mosquito larvae, in fields growing crops such as alfalfa, almonds, asparagus, corn, cotton, dates, grapes, peaches, sugar cane and walnuts may be treated at the recommended rates.

* Use 10-20 lbs. / acre when late 3rd and early 4th instar larvae predominate, mosquito populations are high, water is heavily polluted (sewage lagoons, animal waste lagoons), and/or algae are abundant.

Apply uniformly by aerial or ground conventional equipment.

Avoiding spray drift at the application site is the responsibility of the applicator. The interaction of many equipment and weather related factors determine the potential for spray drift. The applicator and the treatment coordinator are responsible for considering all of these factors when making decisions.

A 7 to 14 day interval between applications should be employed.

5.0 STORAGE AND DISPOSAL

Do not contaminate potable water, food or feed by storage or disposal.

Storage: Store in a cool [59-86°F (15-30°C)], dry place.

Pesticide Disposal: Completely empty bag into application equipment. Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility.

Container Disposal: Nonrefillable container. Do not reuse or refill this container. Once cleaned, some agricultural plastic pesticide containers can be taken to a container collection site or picked up for recycling. To find the nearest site, contact your chemical dealer or manufacturer, or contact Ag Container Recycling Council at 202-861-3144 or www.acrecycle.org. If recycling is not available dispose of in a sanitary landfill, or by incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

6.0 NOTICE TO USER

Seller makes no warranty, express or implied, of merchantability, fitness or otherwise concerning the use of this product other than as indicated on the label. User assumes all risks of use, storage or handling not in strict accordance with accompanying directions.

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VALENT BIOSCIENCES CORPORATION
870 TECHNOLOGY WAY
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Biological Larvicide

VectoLex® CG

Granules

ACTIVE INGREDIENT:
Bacillus sphaericus Serotype H5a5b, strain 2362 Technical Powder (670 BsITU/mg) 7.5%
OTHER INGREDIENTS 92.5%
TOTAL 100.0%

Potency: This product contains 50 BsITU/mg or 0.023 Billion BsITU/lb.

The percent active ingredient does not indicate product performance and potency measurements are not federally standardized.

EPA Reg. No.73049-20
EPA Est. No. 33762-IA-001 List No. 05722

INDEX:

KEEP OUT OF REACH OF CHILDREN
CAUTION

1.0

FIRST AID	
If in eyes	• Hold eye open and rinse slowly and gently with water for 15-20 minutes. • Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. • Call a poison control center for treatment advice.
If on skin or clothing	• Take off contaminated clothing. • Rinse skin immediately with plenty of water for 15-20 minutes. • Call a poison control center or doctor for treatment advice.
HOT LINE NUMBER	
Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-877-315-9819 (24 hours) for emergency medical treatment and/or transport emergency information. For all other information, call 1-800-323-9597.	

2.0 PRECAUTIONARY STATEMENTS

2.1 Hazards To Humans and Domestic Animals

CAUTION

Harmful if absorbed through the skin. Causes moderate eye irritation. Avoid contact with skin, eyes or clothing. Wash thoroughly with soap and water after handling.

Mixers/loaders and applicators not in enclosed cabs or aircraft, must wear a dust/mist filtering respirator meeting NIOSH standards of at least N-95, R-95, or P-95. Repeated exposure to high concentrations of microbial proteins can cause allergic sensitizations.

2.2 Environmental Hazards

Do not contaminate water when disposing of equipment washwaters or rinsate. Do not apply directly to treated, finished drinking water reservoirs or drinking water receptacles when the water is intended for human consumption.

3.0 DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

4.0 STORAGE AND DISPOSAL

Do not contaminate water, food or feed by storage or disposal. Do not contaminate water when disposing of equipment washwaters.

Pesticide Storage: Store in a cool, dry place.

Pesticide Disposal: Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility.

Container Disposal: Nonrefillable container. Do not reuse or refill this container. Offer for recycling, if available. Completely empty bag into application equipment. Then dispose of empty bag in a sanitary landfill or by incineration, or, if allowed by State and local authorities, by burning. If burned, stay out of smoke.

5.0 APPLICATION DIRECTIONS

MOSQUITO CONTROL

VectoLex CG is a selective microbial insecticide for use against mosquito larvae in a variety of habitats. VectoLex CG can be applied to areas that contain fish, other aquatic life, and plants. VectoLex CG can be applied to areas used by or in contact with humans, pets, horses, livestock, birds, or wildlife.

I. For control of mosquito larvae species* in the following non-crop sites:

Habitat	Rate Range
Wastewater: Sewage effluent, sewage lagoons, oxidation ponds, septic ditches, animal waste lagoons, impounded wastewater associated with fruit and vegetable processing.	5-20 lbs/acre**
Storm Waters/Drainage Systems: Storm sewers, catch basins, drainage ditches, retention, detention and seepage ponds.	5-20 lbs/acre**
Marine/Coastal Areas: Salt marshes, mangroves, estuaries.	5-20 lbs/acre**
Water Bodies: Natural and manmade aquatic sites such as lakes, ponds, rivers, canals, streams and livestock watering ponds and troughs.	5-20 lbs/acre**
Dormant Rice Fields: Impounded water in dormant rice fields. (For application only during the interval between harvest and preparation of the field for the next cropping cycle.)	5-20 lbs/acre**
Waste Tires: Tires stockpiled in dumps, landfills, recycling plants, and other similar sites.	20-80 lbs/acre(1)

(1) 0.5-2 lbs/1000 sq. ft.

CONTINUED

II. For the control of mosquito larvae species* in agricultural/ crop sites where mosquito breeding occurs:

Habitats:	Rate Range
Rice, pastures/hay fields, orchards, citrus groves, irrigated crops.	5-20 lbs/acre**

Apply uniformly by aerial or conventional ground equipment. Reapply as needed after 1 to 4 weeks.

* Mosquito species effectively controlled by VectoLex CG:

Culex spp.	
Aedes vexans	
Ochlerotatus melanimon	*(Aedes melanimon)*
Ochlerotatus stimulans	*(Aedes stimulans)*
Ochlerotatus nigromaculis	*(Aedes nigromaculis)*
Psorophora columbiae	
Psorophora ferox	
Ochlerotatus triseriatus	*(Aedes triseriatus)*
Ochlerotatus sollicitans	*(Aedes sollicitans)*
Anopheles quadrimaculatus	
Coquillettida perturbans	

**Use higher rates (10 to 20 lbs/acre) in areas where extended residual control is necessary, or in habitats having deep water or dense surface cover.

Avoiding spray drift at the application site is the responsibility of the applicator. The interaction of many equipment and weather related factors determine the potential for spray drift. The applicator and the treatment coordinator are responsible for considering all these factors when making desicions.

6.0 NOTICE TO USER

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VALENT BIOSCIENCES CORPORATION
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VectoPrime® FG

BIOLOGICAL LARVICIDE

FINE GRANULE

MADE WITH BioFuse™ TECHNOLOGY

ACTIVE INGREDIENT:

Bacillus thuringiensis, subsp. *israelensis*, strain AM 65-52 fermentation solids, spores, and insecticidal toxins	6.07%
(S)-methoprene	0.10%
OTHER INGREDIENTS	93.83%
TOTAL	100.00%

Potency: 400 International Toxic Units (ITU) per mg or 0.182 billion ITU per pound

The percent active ingredient does not indicate product performance and potency measurements are not federally standardized.

EPA Reg. No.73049-501
EPA Est. No. 33762-IA-001 List No. 05725

INDEX:

KEEP OUT OF REACH OF CHILDREN
CAUTION

1.0 FIRST AID

If in eyes	• Hold eyes open and rinse slowly and gently with water for 15-20 minutes. • Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eyes. • Call a poison control center or doctor for treatment advice.

HOT LINE NUMBER

Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-877-315-9819 (24 hours) for emergency medical treatment and/or transport emergency information. For all other information, call 1-800-323-9597.

2.0 PRECAUTIONARY STATEMENTS

2.1 Hazards To Humans and Domestic Animals

CAUTION

Causes moderate eye irritation. Avoid contact with eyes or clothing. Wash thoroughly with soap and water after handling and before eating, drinking, chewing gum, using tobacco or using the toilet. Mixers/loaders and applicators not in enclosed cabs or aircraft must wear a dust/mist respirator meeting NIOSH standards of at least N-95, R-95, or P-95. Repeated exposure to high concentrations of microbial proteins can cause allergic sensitization.

2.2 Environmental Hazards

Do not contaminate water when cleaning equipment or disposing of equipment washwaters. Do not apply directly to treated, finished drinking water reservoirs or drinking water receptacles when the water is intended for human consumption.

3.0 DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

For use only by federal, state, tribal or local government officials responsible for public health or vector control, or by persons certified in the appropriate category or otherwise authorized by the state or tribal lead pesticide regulatory agency to perform mosquito control applications, or by persons under their direct supervision.

IN CALIFORNIA: This product is to be applied by County Health Department, State Department of Health Services, Mosquito and Vector Control or Mosquito Abatement District personnel, or persons under contract to these entities only.

4.0 APPLICATION DIRECTIONS

VectoPrime® FG Biological Larvicide is an insecticide for use against mosquito larvae.

Mosquito Habitats	Application Rate Range*
(Such as the following examples):	
Irrigation ditches, roadside ditches, flood water, standing ponds, livestock watering ponds and troughs, woodland pools, snow melt pools, pastures, catch basins, storm water retention areas, tidal water, salt marshes and rice fields	1.25 - 20.0 lbs/acre*

In addition, standing water containing mosquito larvae, in fields growing crops such as (but not limited to) alfalfa, almonds, asparagus, corn, cotton, dates, grapes, peaches, sugar cane and walnuts may be treated at the recommended rates.

*** Post-flood Applications**

Use 1.25-4.0 lbs/acre against 1st-4th instar mosquito larvae. Use 4.0-10.0 lbs/acre when water is heavily polluted (e.g. sewage lagoons, animal waste lagoons), algae are abundant, and/or local experience suggests the need for higher rates. Re-treat as needed based on local conditions.

*** Pre-flood Applications**

VectoPrime FG can be applied prior to flooding of mosquito larval habitats. Use 10-20 lbs/acre when up to 7 days pre-flood capacity is needed. Use 20 lbs/acre when a 7-14 day pre-flood application is needed. Retreat as needed. Consult your local Valent BioSciences representative for further advice on pre-flood applications with VectoPrime FG.

CONTINUED

4.0 APPLICATION DIRECTIONS (Cont'd)

Apply uniformly by aerial or ground conventional equipment. Avoiding drift at the application site is the responsibility of the applicator. The interaction of many equipment and weather related factors determine the potential for drift. The applicator and the treatment coordinator are responsible for considering all of these factors when making decisions.

5.0 STORAGE AND DISPOSAL

Do not contaminate potable water, food or feed by storage or disposal.

Pesticide Storage: Store in a cool, dry place.

Pesticide Disposal: To avoid wastes, use all material in this container by application according to label directions. If wastes cannot be avoided, offer remaining product to a waste disposal facility or pesticide disposal program (often such programs are run by state or local governments or by industry).

Container Handling: Nonrefillable container. Do not reuse or refill this container. Completely empty bag into application equipment. Then offer for recycling if available or dispose of empty bag in a sanitary landfill or by incineration. Do not burn, unless allowed by State and local ordinances. If burned, stay out of smoke.

6.0 NOTICE TO USER

To the extent consistent with applicable law, seller makes no warranty, express or implied, of merchantability, fitness or otherwise concerning use of this product other than as indicated on the label. To the extent consistent with applicable law, user assumes all risks of use, storage or handling not in strict accordance with the accompanying directions.

VALENT BIOSCIENCES CORPORATION
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clarke

NATULAR™ G

Mosquito Larvicide Granule

To be used in governmental mosquito control programs, by professional pest control operators, or in other mosquito or midge control operations.

Active Ingredient:	
Spinosad (a mixture of Spinosyn A and Spinosyn D)	0.5%
Other Ingredients	99.5%
Total	100.0%

U.S. Patent No. 5,362,634 and 5,496,931
This product contains 0.2 lb of active ingredient spinosad per 40 lb bag

Group	5	INSECTICIDE

KEEP OUT OF REACH OF CHILDREN

CAUTION

Precautionary Statements

Hazards to Humans and Domestic Animals

Causes moderate eye irritation. Avoid contact with eyes or clothing. Wear protective eyewear. Remove and wash contaminated clothing before reuse. Wash thoroughly with soap and water after handling and before eating, drinking, chewing gum, or using tobacco.

FIRST AID	
If in eyes:	Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice.
Have the product container or label with you when calling a poison control center or doctor or going for treatment. You may also contact 1-800-214-7753 for emergency medical treatment information.	

Environmental Hazards

This product is toxic to aquatic invertebrates. Non-target aquatic invertebrates may be killed in water where this pesticide is used. Do not contaminate water when cleaning equipment or disposing of equipment washwaters. Do not apply when weather conditions favor drift from treated areas. Drift from treated areas may be hazardous to aquatic organisms in neighboring areas. Apply this product only as specified on the label.

Directions For Use

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

Read all Directions for Use carefully before applying.

General Information

Natular™ G is a product for killing mosquito and midge larvae. This product's active ingredient, spinosad, is biologically derived from the fermentation of *Saccharopolyspora spinosa*, a naturally occurring soil organism. Natular™ G may be applied with suitable ground or aerial application equipment.

General Use Precautions

Integrated Pest Management (IPM) Programs

Natular™ G is intended to kill mosquito and midge larvae. Mosquitoes are best controlled when an IPM program is followed. Larval control efforts should be managed through habitat mapping, active adult and larval surveillance, and integrated with other control strategies such as source reduction, public education programs, harborage or barrier adult mosquito control applications, and targeted adulticide applications.

Insecticide Resistance Management (IRM)

Natular™ G contains a Group 5 insecticide. Insect biotypes with acquired resistance to Group 5 insecticides may eventually dominate the insect population if appropriate resistance management strategies are not followed. Currently, only spinetoram and spinosad active ingredients are classified as Group 5 insecticides. Resistance to other insecticide groups is not likely to impact the effectiveness of this product. Spinosad may be used in rotation with all other labeled products in a comprehensive IRM program.

To minimize the potential for resistance development, the following practices are recommended:

- Base insecticide use on comprehensive IPM and IRM programs.
- Routinely evaluate applications for loss of effectiveness.
- Rotate with other labeled effective mosquito larvicides that have a different mode of action.
- In dormant rice fields, standing water within agricultural crop sites, and permanent marine and freshwater sites, do not make more than 20 applications per year.
- Use insecticides with a different mode of action (different insecticide group) on adult mosquitoes so that both larvae and adults are not exposed to products with the same mode of action.
- Contact your local extension specialist, technical advisor, and/or Clarke representative for insecticide resistance management and/or IPM recommendations for the specific site and resistant pest problems.
- For further information or to report suspected resistance, you may contact your local Clarke representative by calling 800-323-5727.

Spray Drift Management

Avoiding spray drift at the application site is the responsibility of the applicator. The interaction of many equipment and weather related factors determines the potential for spray drift. The applicator is responsible for considering all these factors when making decisions. Where states have more stringent regulations, they should be observed.

Application

Proper application techniques help ensure adequate coverage and correct dosage necessary to obtain optimum kill of mosquito and midge larvae. The following recommendations are provided for ground and aerial application of Natular™ G.

Ground Application

Use conventional ground application equipment and apply Natular™ G at the designated rate for the targeted site.

Spot Treatment

Apply Natular™ G as a spot treatment to areas where mosquitoes are breeding at rates appropriate for the treatment site habitat and conditions.

Aerial Application

Equipment used in the application of Natular™ G should be carefully calibrated before use and checked frequently during application to be sure it is working properly and delivering a uniform distribution pattern. Avoid overlaps that will increase Natular™ G dosage above recommended limits.

AL0305

Application Sites and Rates

The rates listed are typical for efficaciously killing mosquito and midge larvae in the listed habitat sites. Within this range, use lower rates when water is shallow, vegetation and/or pollution are minimal, and mosquito populations are low. Do not use less than labeled minimum rate. Natular™ G may be applied at rates up to 20 lb per acre in waters high in organic content (such as polluted water, sewage lagoons, animal waste lagoons, and waters with high concentrations of leaf litter or other organic debris), deep-water mosquito habitats or those with dense surface cover, and where monitoring indicates a lack of kill at typical rates. Do not re-apply within 7 days of the initial application unless monitoring indicates that larval populations have reestablished or weather conditions have rendered initial treatments ineffective. Do not apply to water intended for irrigation.

For killing mosquito larvae species in the following non-crop sites:

Non-Crop Site	Natular™ G lb/acre (lb ai/acre)
Temporary Standing Water: Woodland pools, snow pools, roadside ditches, retention ponds, freshwater dredge spoils, tire tracks and other natural or manmade depressions, rock holes, pot holes and similar areas subject to holding water **Other Freshwater Sites:** Natural and man-made aquatic sites, edges of lakes, ponds, canals, stream eddies, creek edges, detention ponds	3.5 - 6.5 (0.018 - 0.033)
Freshwater Swamps and Marshes: Mixed hardwood swamps, cattail marsh, common reed wetland, water hyacinth ponds, and similar freshwater areas with emergent vegetation **Marine/Coastal Areas:** Intertidal areas above the mean high water mark, mangroves, brackish water swamps and marshes, coastal impoundments and similar areas	9 (0.045)
Stormwater/Drainage Systems: Storm sewers, catch basins, drainage ditches, and similar areas **Wastewater:** Sewage effluent, sewers, sewage lagoons, cesspools, oxidation ponds, septic ditches and tanks, animal waste lagoons and settling ponds, livestock runoff lagoons, wastewater impoundments associated with fruit and vegetable processing, and similar areas	6.5 - 9 (0.033 - 0.045)
Dormant Rice Fields: Impounded water in dormant rice fields (for application only during the interval between harvest and preparation of the field for the next cropping cycle)	3.5 - 6.5 (0.018 - 0.033)
Natural and Artifical Containers: Tree holes, bromeliads, leaf axils, and other similar natural water holding containers, cemetery urns, bird baths, flower pots, rain barrels, buckets, single tires, tires stockpiled in dumps, landfills, recycling plants and other similar areas, abandoned swimming pools, ornamental ponds, flooded roof tops and similar water holding sites. Landfill containers, salvage yards, abandoned vehicles	3.5 - 9 (0.018 - 0.045)

Agricultural/Crop Sites Where Mosquito Breeding Occurs:

Apply Natular™ G at a rate of 3.5 to 9 lb per acre in standing water within agricultural/crop sites where mosquito breeding occurs: pastures/hay fields, rangelands, orchards, vineyards, and citrus groves. Do not apply to waters intended for irrigation.

STORAGE AND DISPOSAL

Do not contaminate water, food or feed by storage and disposal.

Pesticide Storage: Store in original container only. In case of leak or spill, contain material with absorbent materials and dispose as waste.

Pesticide Disposal: Wastes resulting from the use of this product must be disposed of on site according to label use directions or at an approved waste disposal facility.

Container Handling for Non-Refillable Bag: Nonrefillable container. Do not reuse or refill this container. Completely empty bag into application equipment. Offer for recycling, if available, or puncture and dispose of in a sanitary landfill or by incineration, or by other procedures allowed by state and local authorities.

Container Handling for Rigid Refillable Tote: Refillable container. Refill this container with granular spinosad pesticide formulation only. Do not reuse this container for any other purpose. Cleaning the container before final disposal is the responsibility of the person disposing of the container. Cleaning before refilling is the responsibility of the refiller. To clean the container before final disposal, empty the remaining contents from this container into application equipment. Use a sprayer with water to quickly and completely rinse the interior of the container. Ensure the top, bottom, and all sides are rinsed. A high pressure sprayer with a rinsing nozzle could provide a thorough rinse of the interior. Drain and collect rinsate from the container into a collection system for later disposal. Drain the container dry so no water remains. Return to point of sale. Then offer for recycling if available or reconditioning if appropriate or puncture and dispose of in a sanitary landfill or by incineration, or by other procedures allowed by State and local authorities.

Warranty: To the extent consistent with applicable law CLARKE MOSQUITO CONTROL PRODUCTS, INC. makes no warranty, express or implied, concerning the use of this product other than as indicated on the label. Buyer assumes all risk of use/handling of this material when use and/or handling is contrary to label instructions.

Natular™ is a Trademark of Clarke Mosquito Control Products, Inc.

Manufactured For:
CLARKE MOSQUITO CONTROL PRODUCTS, INC.
159 North Garden Avenue
Roselle, IL 60172,
U.S.A.

EPA Reg. No.: 8329-80 NET WEIGHT: _____

EPA Est. No.: 8329-IL-03 LOT: _____

AL0305

Natular ™ G30

To be used in governmental mosquito control programs, by professional pest control operators, or in other mosquito or midge control operations.

Active Ingredient (dry weight basis): spinosad (a mixture of spinosyn A and spinosyn D)*	2.5%
Other ingredients	97.5%
Total	100.00%

U.S. Patent No. 5,362,634 and 5,496,931

* A Naturalyte® Insect Control product

Natular G30 is a 2.5% extended release granule.

Group	5	INSECTICIDE

Keep Out of Reach of Children

CAUTION

Precautionary Statements

Hazards to Humans and Domestic Animals

Harmful if swallowed. Causes moderate eye irritation. Wash thoroughly with soap and water after handling and before eating, drinking, chewing gum, or using tobacco. Avoid contact with eyes or clothing. Wear protective eyewear (such as goggles, face shield, or safety glasses).

First Aid

If swallowed:	• Call a poison control center or doctor immediately for treatment advice. • Have person sip a glass of water if able to swallow. • Do not induce vomiting unless told to do so by a poison control center or doctor. • Do not give anything to an unconscious person.
If in eyes:	• Hold eye open and rinse slowly and gently with warm water for 15-20 minutes. • Remove contact lenses, if present, after the first 5 minutes, then continue rinsing. • Call a poison control center or doctor for treatment advice.

Have the product container or label with you when calling a poison control center or doctor or going for treatment. You may also contact 1-800-214-7753 for emergency medical treatment information.

Environmental Hazards

This product is toxic to aquatic organisms. Non-target aquatic invertebrates may be killed in waters where this pesticide is used. Do not contaminate water when cleaning equipment or disposing of equipment washwaters.

Directions for Use

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

Read all Directions for Use carefully before applying.

General Information

Natular G30 is a Naturalyte® product for killing mosquito and midge larvae. This product's active ingredient, spinosad, is biologically derived from the fermentation of Saccharopolyspora spinosa, a naturally occurring soil organism. Natular G30 releases effective levels of spinosad for up to 30 days under typical environmental conditions. Natular G30 may be applied with ground or aerial equipment.

General Use Precautions

Integrated Pest Management (IPM) Programs

Natular G30 is intended to kill mosquito and midge larvae. Mosquitoes are best controlled when an IPM program is followed. Larval control efforts should be managed through habitat mapping, active adult and larval surveillance, and integrated with other control strategies such as source reduction, public education programs, harborage or barrier adult mosquito control applications, and targeted adulticide applications.

Insecticide Resistance Management (IRM)

Natular G30 contains a Group 5 insecticide. Insect biotypes with acquired resistance to Group 5 insecticides may eventually dominate the insect population if appropriate resistance management strategies are not followed. Currently, only spinetoram and spinosad active ingredients are classified as Group 5 insecticides. Resistance to other insecticides is not likely to impact the effectiveness of this product. Spinosad may be used in rotation with all other labeled products in a comprehensive IRM program.

To minimize the potential for resistance development, the following practices are recommended:

- Base insecticide use on comprehensive IPM and IRM programs.
- Routinely evaluate applications for loss of effectiveness.
- Rotate with other labeled effective mosquito larvicides that have a different mode of action.
- In dormant rice fields, standing water within agricultural/crop sites, and permanent marine and freshwater sites, do not make more than 5 applications per year.
- Use insecticides with a different mode of action (different insecticide group) on adult mosquitoes so that both larvae and adults are not exposed to products with the same mode of action.
- Contact your local extension specialist, technical advisor, and/or Clarke representative for insecticide resistance management and/or IPM recommendations for the specific site and resistant pest problems.
- For further information or to report suspected resistance, you may contact your local Clarke representative by calling 800-323-5727.

Application

Proper application techniques help ensure adequate coverage and correct dosage necessary to obtain optimum kill of mosquito and midge larvae. Apply Natular G30 prior to flooding as a prehatch application to areas that breed mosquitoes, or at any stage of larval development after flooding in listed sites. Do not allow this product to drift onto neighboring crops or non-crop areas or use in a manner or at a time other than in accordance with label directions.

Ground Application

Use conventional ground application equipment that provides even coverage at labeled rates.

Aerial Application

Fixed wing aircraft or helicopters equipped with granular spreaders capable of applying rates from 5 to 20 lb per acre may be used to apply Natular G30. Aerial application equipment should be carefully calibrated before use to be sure it is working properly and delivering a uniform distribution pattern. Avoid overlaps that will increase the dosage of Natular G30 above labeled limits.

AL0152

Avoiding spray drift at the application site is the responsibility of the applicator. The interaction of many equipment and weather related factors determine the potential for spray drift. The applicator and the treatment coordinator are responsible for considering all these factors when making application decisions.

Application Sites and Rates

Apply Natular G30 at 5 to 20 lb per acre. Rates are equivalent to 5 to 20 g per 100 sq ft of water surface for efficacious kill of mosquito and midge larvae in the listed habitat sites. Within this range, use lower rates when water is shallow, vegetation and/or pollution are minimal, and mosquito populations are low. Do not use less than the labeled minimum rate. Use higher rates when water is deep, vegetation and/or pollution are high, and mosquito populations are high. Natular G30 may be applied at rates up to 20 lb per acre in waters high in organic content, deep-water mosquito habitats or those with dense surface cover, and where monitoring indicates a lack of kill at typical rates. Reapply after 30 days. More frequent applications may be made if monitoring indicates that larval populations have reestablished or weather conditions have rendered initial treatments ineffective.

Non-Crop Sites

Apply Natular G30 in the following non-crop sites to kill mosquito larvae species:

Temporary Standing Water: Woodland pools, snow pools, roadside ditches, retention ponds, freshwater dredge spoils, tire tracks and other natural or manmade depressions, rock holes, pot holes and similar areas subject to holding water.

Other Freshwater Sites: Natural and manmade aquatic sites; edges of lakes, ponds, canals, stream eddies, creek edges, and detention ponds.

Freshwater Swamps and Marshes: Mixed hardwood swamps, cattail marsh, common reed wetland, water hyacinth ponds, and similar freshwater areas with emergent vegetation.

Marine/Coastal Areas: Intertidal areas above the mean high water mark, mangroves, brackish water swamps and marshes, coastal impoundments and similar areas.

Stormwater/Drainage Systems: Storm sewers, catch basins, drainage ditches, and similar areas.

Wastewater: Sewage effluent, sewers, sewage lagoons, cesspools, oxidation ponds, septic ditches and tanks, animal waste lagoons and settling ponds, livestock runoff lagoons, wastewater impoundments associated with fruit and vegetable processing, and similar areas.

Dormant Rice Fields: Impounded water in dormant rice fields (for application only during the interval between harvest and preparation of the field for the next cropping cycle).

Natural and Artificial Containers: Tree holes, bromeliads, leaf axils, and other similar natural water holding containers; cemetery urns, bird baths, flower pots, rain barrels, buckets, single tires, tires stockpiled in dumps, landfills, recycling plants and other similar areas, abandoned swimming pools, ornamental ponds, flooded roof tops and similar water holding sites; landfill containers, salvage yards, abandoned vehicles.

Agricultural/Crop Sites Where Mosquito Breeding Occurs

Apply Natular G30 at the rate of 5 to 20 lb per acre in standing water within agricultural/crop sites where mosquito breeding occurs to kill mosquito larvae species: pastures/hay fields, rangeland, orchards, vineyards, and citrus groves. Do not apply to waters intended for irrigation.

STORAGE AND DISPOSAL

Do not contaminate water, food, or feed by storage and disposal.

Pesticide Storage: Store in a cool dry place in original container only.

Pesticide Disposal: Wastes resulting from the use of this product must be disposed of on site or at an approved waste disposal facility.

Container Handling: Nonrefillable container. Do not reuse or refill this container. Offer for recycling if available, or puncture and dispose of in a sanitary landfill, or by incineration, or by other procedures allowed by state and local authorities.

Warranty

To the extent consistent with applicable law, CLARKE MOSQUITO CONTROL PRODUCTS, INC. makes no warranty, express or implied, concerning the use of this product other than as indicated on the label. Buyer assumes all risk of use/handling of this material when use and/or handling is contrary to label instructions.

Naturalyte ® is a Trademark of Dow AgroSciences LLC

Natular™ is a Trademark of Clarke Mosquito Control Products, Inc.

Manufactured for
Clarke Mosquito Control Products, Inc.
159 North Garden Avenue
Roselle, IL 60172 U.S.A.

Made in the U.S.A. EPA Reg. No. 8329-83
EPA Est.8329-IL-03

Net Contents: 40 lbs / 18.14 kg
Lot/Batch No:

AL0152

RESTRICTED USE PESTICIDE

DUE TO TOXICITY TO FISH AND AQUATIC ORGANISMS

For retail sale to and use only by certified applicators or persons under their direct supervision and only for those uses covered by the certified applicator's certification.

clarke

PERMETHRIN 57% OS

A Synthetic Pyrethroid for Effective Control and Repellency of Adult Nuisance and Vector Mosquitoes, Gnats, Biting and Non-Biting Midges, Blackflies, Deer Flies and Other Biting Flies in Outdoor Residential and Recreational Areas

Active Ingredient:	
Permethrin (3-Phenoxyphenyl) methyl (+/-) cis, trans-3-(2,2 dichloroethenyl)-2,2-dimethyl-cyclopropane carboxylate	57.00%
Other Ingredients*	43.00%
TOTAL	100.00%

Contains 5 lb/gal Permethrin

*Contains petroleum distillates

Cis/trans isomers ratio: min. 35% (+) cis and max. 65% (+) trans.

KEEP OUT OF REACH OF CHILDREN

CAUTION

FIRST AID

Have product container or label with you when calling a poison control center or doctor, or going for treatment. For medical emergency information call the International Poison Control Center at 1-800-214-7756.

IF SWALLOWED:	Immediately call a poison control center or doctor. Do not induce vomiting unless told to do so by a poison control center or doctor. Do not give any liquid to the person. Do not give anything by mouth to an unconscious person.

Note to physicians: Contains petroleum distillate. Vomiting may cause aspiration pneumonia.

PRECAUTIONARY STATEMENTS

HAZARDS TO HUMANS AND DOMESTIC ANIMALS

CAUTION. Harmful if swallowed. Wash thoroughly with soap and water after handling and before eating, drinking, chewing gum, using tobacco or using the toilet.

Personal Protective Equipment (PPE). Mixers, loaders, applicators and other handlers must wear: Long-sleeve shirt and long pants, shoes plus socks, and chemical-resistant gloves made of any waterproof material. Mixers/loaders, persons cleaning equipment, and persons exposed to the concentrate must wear a chemical-resistant apron.

User Safety Requirements. Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables exist, use detergent and hot water. Keep and wash PPE separately from other laundry. Discard clothing and other absorbent materials that have been drenched or heavily contaminated with this product's concentrate. Do not reuse them.

User Safety Recommendations

Users should wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet. Users should remove clothing/PPE immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing. Users should remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

ENVIRONMENTAL HAZARDS

This product is extremely toxic to fish and aquatic organisms, including fish and invertebrates. Do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean high water mark. Do not apply when weather conditions favor drift from treated areas. Drift and runoff from treated areas may be hazardous to aquatic organisms in neighboring areas. Do not contaminate water when disposing of equipment wash waters. Under some conditions, it may also have a potential for transport into surface water runoff (primarily absorbed to suspended soil particles), for several months or more after application. These include poorly draining or wet soils with readily visible slopes toward adjacent surface waters, frequently flooded areas, and areas overlying extremely shallow groundwater, areas with in-field canals or ditches that drain to surface water, areas not separated from adjacent surface waters with vegetated filter strips, and areas over-lying tile drainage systems that drain to surface waters.

This pesticide is highly toxic to bees exposed to direct treatment on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds while bees are actively visiting the treatment areas.

Do not discharge effluent containing this product into lakes, streams, ponds, estuaries, oceans, or other waters unless in accordance with the requirements of the National Pollutant Discharge Elimination System (NPDES) permit and the permitting authority has been notified in writing prior to discharge. Do not discharge effluent containing this product to sewer systems without previously notifying the local sewage treatment plant authority. For guidance contact your State Water Board or Regional Office of the EPA.

PHYSICAL OR CHEMICAL HAZARDS

Do not use or store near heat or open flame.

DIRECTIONS FOR USE

It is a violation of Federal Law to use this product in a manner inconsistent with its labeling.

Precautions and Restrictions

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application.

Not for use in outdoor residential misting systems. Not for use in metered release systems.

Use in handheld thermal foggers is prohibited. Not for application by stationary fogger.

Do not make applications during rain. Apply when wind speed is greater than 1 mph.

Except when applying to building foundations, all outdoor applications to impervious surfaces such as sidewalks, driveways, patios, porches and structural surfaces (such as windows, doors, and eaves) are limited to spot and crack-and-crevice application only. When applying sprays to building foundations, apply spray to a maximum height of 3 feet.

Do not allow spray treatment to drift onto cropland, poultry ranges or potable water supplies. Do not use on crops used for food or forage.

Do not apply within 25 foot of aquatic habitats (such as, but not limited to, lakes, reservoirs, rivers, streams, marshes, natural ponds, estuaries, and commercial fish ponds).

Spray Drift Requirements

Only apply this product if the wind direction favors on-target deposition. Do not apply when the wind velocity exceeds 15 mph. Wind speed must be measured adjacent to the application site on the upwind side, immediately prior to application.

Do not make applications into temperature inversions. Inversions are characterized by stable air and increasing temperatures with height above the ground. Mist or fog may indicate the presence of an inversion in humid areas. The applicator may detect the presence of an inversion by producing smoke and observing a smoke layer near the ground surface.

ALB271

Use only Medium or coarser spray nozzles according to ASAE (S572) definition for standard nozzles, and that produce a droplet spectrum of 150-300 microns VMD. In conditions of low humidity and high temperatures, applicators should use a coarser droplet size.

General Information

PERMETHRIN 57% OS provides residual control of adult nuisance and vector mosquitoes and other listed pests on plant and other surfaces where these pests may rest (harbor) for up to 14 days in shaded areas. Secondary activity of a "barrier"-type application is through repellency.

PERMETHRIN 57% OS is approved for use as a residual barrier/harborage spray in vegetation and around structures in residential and recreational areas and other areas these insects occur. Typical harborage sites include brush, building foundations, bushes, climbing ivy, grasses, lawns, trees, turf, vegetative groundcover, windbreak vegetation and other such vegetative cover within or surrounding municipal and residential areas such as, but not limited to: athletic fields, campgrounds, collapsed structures (old building foundations, fences), junk yards, large tire piles, log piles, overgrown waste areas, parks, playgrounds, outdoor residential areas, school yards, scrap yards (including abandoned vehicles), wooded park trails, woodlands, woodlots, and woodpiles.

Application Directions

Apply product by ground application with a mist blower, power backpack, pressure sprayer, or ultra-low volume (ULV) cold aerosol generator. If a ULV sprayer is used, adjust pressure to deliver particles of 150-300 microns VMD.

PERMETHRIN 57% OS must be mixed with a non-phytotoxic oil mixture prior to application. The oil mixture is obtained by combining 1 part soybean oil to 2 parts mineral oil. Non-phytotoxic oils must be used to avoid plant damage within treated areas.

To kill or repel mosquitoes, midges, deer flies and other biting flies, mix with enough oil mixture so as to easily apply 0.1 pounds of Permethrin per acre. The following dilution and flow rate is calculated assuming a 2 MPH walking speed and a fifty (50) foot application swath. If a different dilution ratio or walking speed is used, adjust rate accordingly so as to achieve 0.1 pounds of Permethrin per acre.

Dilution			Finished Spray (Permethrin)		Application rate at 2 MPH walking speed		
PERMETHRIN 57% OS	Soybean Oil	Mineral Oil	%/ wt	Lb. ai./ gallon	Fl. oz./ Acre	Fl. oz./ Minute	Lb. ai./ Acre
1 Part	3 Parts	6 Parts	5.7 %	0.5	25	5.0	0.1

For optimum results, thoroughly spray vegetation. Do not spray to the point of runoff. For large recreational areas such as football fields, stadiums, racetracks, and public parks, spray the insecticide-oil mixture to all vegetative areas and groundcover and to surrounding harborage areas.

STORAGE & DISPOSAL

Do not contaminate water, food or feed by storage and disposal.

PESTICIDE STORAGE & SPILL PROCEDURES: Do not store at temperatures below 40 °F (4.5 °C). If the material has been exposed to temperatures below 40 °F, there may be precipitation. Check for crystallization. If evident, warm to 80 °F (26.5 °C) and thoroughly mix before using. DO NOT USE OPEN FLAME. Store upright at room temperature. Avoid exposure to extreme temperatures. In case of spill or leakage, soak up with an absorbent material such as sand, sawdust, earth, fuller's earth, etc. Dispose of with chemical waste.

PESTICIDE DISPOSAL: Wastes resulting from the use of this product may be disposed of at an approved waste disposal facility.

CONTAINER HANDLING: Refillable container. Refill this container with pesticide only. Do not reuse this container for any other purpose. Cleaning the container before final disposal is the responsibility of the person disposing of the container. Cleaning before refilling is the responsibility of the refiller. To clean the container before final disposal, empty the remaining contents from this container into application equipment or mix tank. Fill the container about 10 percent full with water. Agitate vigorously or recirculate water with the pump for 2 minutes. Pour or pump rinsate into rinsate collection system. Repeat this rinsing procedure two more times. Then offer for recycling if available or reconditioning if appropriate, or puncture and dispose of in a sanitary landfill, or by other procedures approved by state and local authorities.

FOR MORE INFORMATION CALL: 1-800-323-5727

NOTICE: To the extent consistent with applicable law, seller makes no warranty, expressed or implied, concerning the use of this product other than as indicated on the label. Buyer assumes all risk of use and/or handling of this material when use and/or handling is contrary to label instructions.

MANUFACTURED BY:
CLARKE MOSQUITO CONTROL PRODUCTS, INC.
159 NORTH GARDEN AVE.
ROSELLE, IL 60172
U.S.A.

EPA REG. NO. 8329-44
EPA EST. NO. 8329-IL-01

AVAILABLE CONTAINERS: (NET CONTENTS): 30 GAL
LOT NO. marked on container

AL0271

7396_1021-1569_0311

MGK® McLAUGHLIN GORMLEY KING COMPANY

PYROCIDE® Mosquito Adulticiding Concentrate for ULV Fogging 7396

8810 Tenth Avenue N. / Minneapolis, Minnesota 55427-4319 U.S.A. - Telephone (763) 544-0341

FOR USE ONLY BY FEDERAL, STATE, TRIBAL OR LOCAL GOVERNMENT OFFICALS RESPONSIBLE FOR PUBLIC HEALTH OR VECTOR CONTROL OR BY PERSONS CERTIFIED IN THE APPROPRIATE CATEGORY OR OTHERWISE AUTHORIZED BY THE STATE OR TRIBAL LEAD PESTICIDE REGULATORY AGENCY TO PERFORM ADULT MOSQUITO CONTROL APPLICATIONS, OR BY PERSONS UNDER THEIR DIRECT SUPERVISION.

ACTIVE INGREDIENTS:

Pyrethrins	5.00%
* Piperonyl butoxide, Technical	25.00%
** OTHER INGREDIENTS	70.00%
	100.00%

* Equivalent to 20.00% (butylcarbityl) (6-propylpiperonyl) ether and 5.00% related compounds

** Contains petroleum distillate

PYROCIDE® - Registered trademark of McLaughlin Gormley King Company

This product contains 0.475 lb/gal (56.85 g/L) Pyrethrins and 2.375 lb/gal (284 g/L) Piperonyl Butoxide

KEEP OUT OF REACH OF CHILDREN

CAUTION

FIRST AID

IF SWALLOWED:	▪ Immediately call a poison control center or doctor. ▪ Do not give any liquid to the person. ▪ Do not induce vomiting unless told to do so by a poison control center or a doctor. ▪ Do not give anything by mouth to an unconscious person.
IF IN EYES:	▪ Hold eye open and rinse slowly and gently with water for 15-20 minutes. ▪ Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eyes. ▪ Call a poison control center or doctor for treatment advice.
IF ON SKIN OR CLOTHING:	▪ Take off contaminated clothing. ▪ Rinse skin immediately with plenty of water for 15-20 minutes. ▪ Call a poison control center or doctor for treatment advice.
IF INHALED:	▪ Move person to fresh air. ▪ If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible. ▪ Call a poison control center or doctor for further treatment advice.
NOTE TO PHYSICIAN: This product contains petroleum distillate and may pose an aspiration pneumonia hazard.	
Have the product container or label with you when calling a poison control center or doctor, or going for treatment. For information regarding medical emergencies or pesticide incidents, call 1-888-740-8712.	

Net Contents _____

Manufactured by:
Mc LAUGHLIN GORMLEY KING COMPANY
8810 Tenth Avenue North
Minneapolis, MN 55427

EPA Reg. No. 1021-1569 EPA Est. No. 1021-MN-2

PRECAUTIONARY STATEMENTS

HAZARDS TO HUMANS AND DOMESTIC ANIMALS

CAUTION

Harmful if swallowed, inhaled, or absorbed through skin. Causes eye irritation. Avoid contact with skin, eyes, or clothing. Avoid breathing vapors or spray mist. Wash thoroughly with soap and water after handling. Remove contaminated clothing and wash before reuse.

ENVIRONMENTAL HAZARDS

This product is toxic to aquatic organisms, including fish and aquatic invertebrates. Runoff from treated areas or deposition of spray droplets into a body of water may be hazardous to fish and aquatic invertebrates. Before making the first application in a season, it is advisable to consult with the state or tribal agency with primary responsibility for pesticide regulation to determine if other regulatory requirements exist. Do not apply over bodies of water (lakes, rivers, permanent streams, natural ponds, commercial fish ponds, swamps, marshes or estuaries), except when necessary to target areas where adult mosquitoes are present, and weather conditions will facilitate movement of applied material away from the water in order to minimize incidental deposition into the water body. Do not contaminate bodies of water when disposing of equipment rinsate or wash waters.

BEE WARNING: This product is highly toxic to bees exposed to direct treatment on blooming crops or weeds. Do not apply this product to or allow it to drift onto blooming crops or weeds when bees are visiting the treatment area, except when applications are made to prevent or control a threat to public and/or animal health determined by a state, tribal or local health or vector control agency on the basis of documented evidence of disease causing agents in vector mosquitoes or the occurrence of mosquito-borne disease in animal or human populations, or if specifically approved by the state or tribe during a natural disaster recovery effort.

PHYSICAL OR CHEMICAL HAZARDS

Do not use or store near heat or open flame.

DIRECTIONS FOR USE

It is a violation of Federal Law to use this product in a manner inconsistent with its labeling.

This concentrate is formulated to be diluted with a suitable oil diluent, such as (but not restricted to) light mineral oil, deodorized kerosene or petroleum distillate, for use in cold fog aerosol generators.

This concentrate may be diluted or used as supplied for mosquito control programs involving residential, industrial, recreational and agricultural areas, swamps, marshes, overgrown waste areas, roadsides and pastures where adult mosquitos occur.

Use in agricultural areas should be in such a manner as to avoid residues in excess of established tolerances for pyrethrins and piperonyl butoxide on crops or commodities.

Best results are expected from application when the meteorological conditions favor an inversion of air temperatures in the area treated, and when the wind is not excessive. Repeated applications may be made as necessary to obtain the desired reduction in adult mosquitos.

Back pack application may require a greater rate of dilution than the dilution used for vehicle or aircraft mounted sprayers, in order to achieve the desired rate of application of active ingredients per acre.

EQUIPMENT CALIBRATION PARAMETERS

SPRAY PARTICLE SIZE AND DROPLET SPECTRA

Directions from the equipment manufacture or vendor, pesticide registrant or a test facility using laser-based measurement instrument must be used to adjust equipment to product acceptable droplet size spectra. Application equipment must be tested annually to confirm that pressure at the nozzle and nozzle flow rate(s) are properly calibrated.

If necessary, contact the distributor or manufacture of this product for undiluted spread factors or the manufacturer of diluting oils for a spread factor to use to determine droplet size with this product if applied undiluted or diluted.

Ground Equipment:

Specifically: Cold Aerosol ULV, Non-Thermal Spray, Mechanical Cold Aerosol, Turbine Spray, and Thermal Aerosol Fogging Equipment

Spray equipment must be adjusted so that the volume median diameter (VMD) is les than 30 microns (Dv 0.5 < 30um) and that 90% of the spray is contained in droplets smaller than 50 microns (Dv 0.9 <50 um).

Aerial Equipment:

Spray equipment must be adjusted so that the volume median diameter produced is less than 60 microns (Dv 0.5 < 60um) and that 90% of the spray is contained in droplets smaller than 80 microns (Dv 0.9 < 80).

The effects of flight speed and, for **non-rotary nozzles, nozzle angle on the droplet size spectrum must be considered.**

PROHIBITION ON AERIAL USE: Not for aerial application in Florida unless specifically authorized by the Bureau of Entomology, Florida Department of Agriculture and Consumer Services.

Do not apply more than 0.2 lbs of pyrethrin per acre/year (224.76 g/Ha/year) and 2.0 lbs of piperonyl butoxide per acre/year (2,267.5 g/Ha/year) in any treated area. Do not exceed 25 applications at 0.008 pounds of pyrethrins per acre in any given season.

Apply PYROCIDE® **Mosquito Adulticiding Concentrate for ULV Fogging 7396** diluted or undiluted at rates between 0.0018 pounds pyrethrins and no more than 0.008 pounds pyrethrins per acre in any given 24 hour period unless otherwise noted.

More frequent treatments may be made to prevent or control a threat to public and/or animal health determined by state, tribal, or local health or vector control agency on the basis of documented evidence of disease causing agents in vector mosquitoes or the occurrence of mosquito-borne disease in animal or human populations, or if specifically approved by the state or tribe during a natural disaster recovery effort.

STORAGE AND DISPOSAL

Do not contaminate water, food, or feed by storage and disposal.

PESTICIDE STORAGE: Store in a cool, dry place. Keep container closed. Post as a pesticide storage area. Always store pesticides in the original container. Store away from food, pet food, feed, seed, fertilizers, and veterinary supplies. Place liquid formulations on lower shelves and dry formulations above.

PESTICIDE DISPOSAL: To avoid wastes, use all material in this container by application according to label directions. If wastes cannot be avoided, offer remaining product to a waste disposal facility or pesticide disposal program (often such programs are run by state or local governments or by industry).

CONTAINER HANDLING[For Containers of 5 Gallons or Less]: Nonrefillable container. Do not reuse or refill this container. Triple rinse container (or equivalent) promptly after emptying. Triple rinse as follows: Empty the remaining contents into application equipment or a mix tank and drain for 10 seconds after the flow begins to drip. Fill the container ¼ full with water and recap. Shake for 10 seconds. Pour rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Drain for 10 seconds after the flow begins to drip. Repeat this procedure two more times. Then offer for recycling if available, or puncture and dispose of in a sanitary landfill or by incineration. Do not burn unless allowed by state and local ordinances.

CONTAINER HANDLING [For Containers Greater Than 5 Gallons]: Nonrefillable container. Do not reuse or refill this container. Triple rinse as follows: Empty the remaining contents into application equipment or a mix tank. Fill the container ¼ full with water. Replace and tighten closures. Tip container on its side and roll it back and forth, ensuring at least one complete revolution, for 30 seconds. Stand the container on its end and tip it back and forth several times. Turn the container over onto its other end and tip it back and forth several times. Empty the rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Repeat this procedure two more times.

Storage and Disposal for Refillable Rigid Containers with a capacity greater than 5 gallons]

STORAGE AND DISPOSAL

Do not contaminate water, food, or feed by storage and disposal.

STORAGE: Store in a cool, dry place. Keep container closed.

PESTICIDE DISPOSAL: To avoid wastes, use all material in this container by application according to label directions. If wastes cannot be avoided, offer remaining product to a waste disposal facility or pesticide disposal program (often such programs are run by state or local governments or by industry).

CONTAINER REUSE: Refillable container. Refill this container with pesticide only. Do not reuse this container for any other purpose. Cleaning the container before final disposal is the responsibility of the person disposing of the container. Cleaning before refilling is the responsibility of the refiller.

CONTAINER DISPOSAL: To clean the container before final disposal, empty the remaining contents from this container into application equipment or mix tank. Fill the container about 10 percent full with water. Agitate vigorously or recirculate water with the pump for 2 minutes. Pour or pump rinsate into application equipment or rinsate collection system. Repeat this rinsing procedure two more times. Offer for recycling if appropriate, or puncture and dispose of in a sanitary landfill, or by other procedures approved by state and local authorities.

Page 4 of 4
7396_1021-1569_0311

Onslaught FASTCAP

Spider & Scorpion Insecticide

Specimen Label

- **Fast-acting microencapsulated formula**
- **Combines fast kill and residual control**
- **Kills Ants, Spiders, Scorpions, Fleas, and other listed insects**

ACTIVE INGREDIENTS:	
Esfenvalerate	6.40%
Prallethrin	1.60%
Piperonyl butoxide	8.00%
OTHER INGREDIENTS*	84.00%
	100.00%

*Contains petroleum distillates

KEEP OUT OF REACH OF CHILDREN

CAUTION

See inside for first aid and precautionary statements.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

Remove pets and birds, cover fish aquariums before spraying.

For control of insects, indoors and outdoors, in food and non-food areas such as, but not limited to: homes, schools, warehouses, office buildings, apartment buildings, theatres, hotels, industrial buildings, motels, kennels, livestock housing, food processing plants, food service establishments, restaurants, supermarkets and grocery stores, transportation equipment, truck trailers, railroad cars, and food manufacturing and warehousing establishments. Also for use on backyards, lawns, trees, ornamental landscaping, recreational areas, parks and athletic fields.

INSECTS CONTROLLED:
Ants
Aphids
Asian Lady Beetles
Bed Bugs
Beetles
Boxelder Bugs
Brown Marmorated Stink Bugs
Carpet Beetles
Cockroaches
Crickets
Dog Ticks
Earwigs
Fire Ants
Firebrats
Fleas
Mealy Bugs
Midges
Millipedes
Mites
Pillbugs
Psocids
Scales
Silverfish
Spiders
Springtails
Swarming Termites
Ticks
Waterbug

STORED PRODUCT PESTS INCLUDING:
Angoumois Grain Moths
Ants
Cadelles
Cigarette Beetles
Confused Flour Beetles
Dark Mealworms
Dried Fruit Beetles
Drugstore Beetles
Flat Grain Beetles
Fruit Flies
Grain Mites
Grain Moths
Granary Weevils
Indian Meal Moths
Lesser Grain Borers
Maize Weevils
Meal Moth Larvae
Mediterranean Flour Moths
Merchant Grain Beetles
Red Flour Beetles
Rice Weevils
Rusty Grain Beetles
Saw-toothed Grain Beetles
Sloppers
Spider Beetles
Spider Mites
Square-necked Grain Beetles
Tobacco Moths
Yellow Mealworm

FLYING INSECTS INCLUDING:
Blow Flies
Chiggers
Clothes Moths
Crane Flies
Deer Flies
Face Flies
Fruit Flies
Fungus Gnats
Gnats
Horn Flies
Houseflies
Mosquitoes
Small Flying Moths
Whiteflies

BITING AND STINGING PESTS:
Bed Bugs
Bees
Biting Flies
Chiggers
Deer Flies
Deer Ticks
Dog Ticks
Fire Ants
Fleas
Gnats
Hornets
Lice
Mosquitoes
Scorpions
Spiders
Ticks
Wasps
Yellow Jackets

WOOD-DESTROYING PESTS INCLUDING:
Carpenter Ants
Carpenter Bees
Deathwatch Beetles
Furniture Beetles
Old House Borers
Powder Post Beetles
Round-headed House Borers
Swarming Termites

PLANT PESTS INCLUDING:
Alfalfa Caterpillars
American Plum Borers
Annual Bluegrass Weevils
Aphids
Apple Maggots
Armyworms
Artichoke Plum Moth
Bagworms
Balsam Woolly Adelgid
Beet Armyworms
Billbugs
Blueberry Spanworms
Brown Marmorated Stinkbug
Cherry Fruit Flies
Cherry Fruitworms
Chinch Bugs
Codling Moths
Cowpea Curculios
Cranberry Fruitworms
Cranberry Weevils
Cucumber Beetles
Cutworms
Diamondback Moths
Elm Leaf Beetles
European Pine Sawflies
Fall Webworms
Filbert Worms
Flea Beetles
Grasshoppers
Green Cloverworms
Green Fruitworms
Gypsy Moth Caterpillars
Hickory Shuckworms
Imported Cabbageworms
Japanese Beetles
Lace Bugs
Leaf Feeding Caterpillars
Leaf Miners
Leaf Rollers
Leaf Tiers
Leafhoppers
Lesser Appleworms
Lesser Peach Tree Borers
Loopers
Lygus Bugs
Mexican Bean Beetles
Mites
Mole Crickets
Navel Orangeworms
Northern Pine Weevils
Oriental Fruit Moths
Painted Lady Caterpillars
Pea Weevils
Peach Tree Borers
Peach Twig Borers
Pear Psylla
Pear Slugs
Pecan Leaf Phylloxera
Pecan Nut Casebearers
Pecan Spittlebugs
Pecan Stem Phylloxera
Pecan Weevils
Pepper Weevils
Periodical Cicadas
Pickleworms
Pillbugs
Pine Chafers
Pine Coreid Bugs
Plant Bugs
Plum Curculios
Red Pine Sawflies
Red-headed Pine Sawflies
Red-striped Fireworms
Rindworms
Salt Marsh Caterpillars
Sap Beetles
Scales
Sod Webworms
Sowbugs
Spiders
Spittlebugs
Stink Bugs
Tarnished Plant Bugs
Tent Caterpillars
Thrips
Tobacco Hornworms
Tufted Apple Bud Moths
Velvet Bean Caterpillars
Walnut Husk Flies
Western Bean Cutworms
Whiteflies

†Kills German Cockroaches for up to 12 months (1 year) on indoor, unsealed concrete and/or cement surfaces only.

GENERAL INFORMATION:

Do not apply this product in patient rooms or in any rooms while occupied by the elderly or infirm. Do not apply to classrooms while in use. Do not apply in institutions (including libraries, schools, sports facilities, etc.) in the immediate area where occupants are present. Do not apply as a space spray in residential sites.

Onslaught FastCap Spider & Scorpion Insecticide is a microencapsulated suspension concentrate containing the following pounds of active ingredient per gallon: Esfenvalerate (0.54 lbs.), Prallethrin (0. 135 lbs.), Piperonyl butoxide (0.675 lbs.).

Onslaught FastCap Spider & Scorpion Insecticide combines fast kill (action) and long residual activity against pests listed on this label when applied as surface or spot treatments, injected into wall voids, or as a crack and crevice spray in and around residential and commercial structures, as well as on turf and landscaping. Onslaught FastCap Spider & Scorpion Insecticide may be sprayed on any surface that will not be stained by water. DO NOT use this product as a fogger or apply it as a space spray. Injector application equipment that delivers low volume treatments may be used to make crack and crevice injections or spot and general surface treatments. DO NOT apply in electrical conduits, junction and switch boxes, motor housings, or other electrical equipment due to shock hazard from water-based spray.

Use only in areas described. Remove pets and cover fish aquariums and pets' food and water dishes before spraying. Keep all people (especially children) and pets out of areas being treated and restrict access to these areas until all surfaces are dry. DO NOT leave product where children or pets can come into contact with it. DO NOT allow spray to contact food or food-containing surfaces, feed, or water supplies. Thoroughly wash dishes and food handling utensils with soap and water if they become contaminated with this product. Food utensils such as teaspoons and measuring cups must not be used for food purposes after use with pesticides.

APPLICATION IN FOOD PROCESSING/HANDLING ESTABLISHMENTS:

Application is permitted within food and non-food areas of food service and handling establishments (places other than private residences) including, but not limited to: restaurants, meat processing plants, grocery stores, bakeries, food manufacturing and processing establishments, and food warehousing establishments. Do not treat establishments where livestock feed is present.

Food areas include areas for receiving, storing, packing, canning, bottling, wrapping, boxing, preparing, edible waste storage, and enclosed processing systems, mills, and dairies. Serving areas are places where prepared foods are served, such as dining rooms, but excluding areas where foods may be prepared or held. Non-food areas include garbage rooms, lavatories, floor drains (to sewers), entries and vestibules, offices, locker rooms, machine rooms, garages, mop closets, and storage after canning or bottling.

General Surface Applications: Do not apply Onslaught FastCap Spider & Scorpion Insecticide as a general surface application in food areas of the facility when the facility is in operation or food is exposed. Do not apply directly to food. Cover or remove all food and food processing equipment prior to application. After spraying in meat packing plants, bakeries, and other food processing plants, wash with an effective cleaning compound, and then rinse all equipment, benches, shelving, etc. where exposed food will be handled with potable water. Repeat applications as needed, but do not exceed more than one (1) application every fourteen (14) days.

Spot or crack & crevice applications:
Spot or crack and crevice applications may be made while facility is in operation, provided exposed food is covered or removed from the area being treated. Do not apply directly to food or food-handling surfaces. Repeat applications as needed, but do not exceed more than one (1) application every fourteen (14) days.

In the home, cover exposed food and do not allow spray to contact food surfaces. If spray does contact these surfaces, clean surfaces with soap and water.

MIXING INSTRUCTIONS:

Onslaught FastCap Spider & Scorpion Insecticide should be mixed with water and applied with hand pressurized or power operated sprayers. Agitate container of Onslaught FastCap Spider & Scorpion Insecticide before diluting by inverting it several times. Clean spray equipment before and after use. For dilution, add approximately half the required water to spray tank and then add the appropriate amount of Onslaught FastCap Spider & Scorpion Insecticide. Agitate, and slowly add the remaining water. Agitate spray thoroughly before using and also occasionally during use to ensure dispersion. If spray filter screens are used, they should be 50 mesh or larger. Use 0.5 fluid ounces (15 cc.) of Onslaught FastCap Spider & Scorpion Insecticide in 1 gallon of water for light infestations or as a maintenance control rate. Use 1.0 fluid ounce (30 cc.) per gallon of water for heavy infestations or as an initial clean out rate. Apply 2-second bursts of spray per square foot of area being treated. Avoid excessive application. Dampen surfaces but not to the point of saturation or run-off. Only dilute Onslaught FastCap Spider & Scorpion Insecticide with water.

Onslaught FastCap may be sprayed on any surface that will not be stained by water. If you are concerned about staining or are not sure if a surface is water safe, test the surface by spraying a small amount in an inconspicuous area before making a broad application.

The following chart indicates the percent of active ingredients that is in the sprayer tank after mixing Onslaught FastCap Spider & Scorpion Insecticide at either rate.

Dilution Rate In Water	0.5 fl. oz. per Gallon	1.0 fl. oz. per Gallon
	Final % concentration of Active Ingredients	Final % concentration of Active Ingredients
Esfenvalerate	0.025%	0.050%
Prallethrin	0.006%	0.012%
Piperonyl butoxide	0.031%	0.063%

Tank Mixing:
Onslaught FastCap Spider & Scorpion Insecticide may be tank mixed with an insect growth regulator such as NyGuard® IGR Concentrate or pyrethrum-containing products or any other currently registered pesticides unless expressly prohibited by the product label. The resulting tank mix may be applied in areas where these products are allowed to be sprayed. Do not tank mix Onslaught FastCap Spider & Scorpion Insecticide with products containing dichlorvos (DDVP).

INDOOR USE:

Application Rates for Indoor Structural Pests:

Pests	Dilution Rate In Water	Application Rate of Mixed Solution	Application Method(s)
Spiders and Other Listed Crawling Insects			Apply as a coarse, wet spray • Broadcast Surface Spray • Crack & Crevice Treatment • Spot Treatment • Injected into Wall Voids
Light Infestation	0.5 fl. oz. / Gallon (3.97 ml/L)	1 Gallon/1,000 sq. ft. (40 ml/m²)	
Heavy Infestation	1.0 fl. oz. / Gallon (7.9 2 ml/L)		
Flying Insects	0.5 fl. oz. / Gallon (3.97 ml/L)	1 Gallon/1,000 sq. ft. (40 ml/m²)	
Scorpions and Other Listed Stinging Insects	1.0 fl. oz. / Gallon (7.93 ml/L)	1 Gallon/1,000 sq. ft. (40 ml/m²)	
Ticks	0.5 fl. oz. / Gallon (3.97 ml/L)	1 Gallon/1,000 sq. ft. (40 ml/m²)	
Fleas, Lice & Bed Bugs	0.5 fl. oz. / Gallon (3.97 ml/L)	1 Gallon/1,000 sq. ft. (40 ml/m²)	Apply as noted above, with a fine particle spray.

Spiders, scorpions and other listed crawling insect pests indoors:
Apply as a course, wet spray to surfaces where these pests are normally found. Treat floors, baseboards, around doors and windows, in attics, crawl spaces, eaves, corners, closets, walls, utility pipes, storage areas, and all cracks and crevices. Treat underneath sinks, dishwashers, refrigerators, stoves, the underside of shelves, drawers, cabinets, areas behind pipes, and in all places where these insects shelter. Contact as many insects as possible with direct spray. Repeat applications as needed, but do not exceed more than one (1) application every seven (7) days.

For ant control indoors:
Apply to ant trails, around garbage receptacles, and near food sources. Also apply around doors and windows and wherever these pests may find entrance to the structure. Remove sources of food through basic hygiene practices whenever possible.

Flying insect pests indoors:
Treat insect resting areas such as walls and ceilings, screens, around windows, doors, and light fixtures, and other surfaces that attract flying insects. Initiate treatments at the beginning of fly season, and repeat treatments during periods of heavy infestation.

Stinging insect pests indoors:
Apply spray to nests late in the evening when stinging insects are at rest. Thoroughly spray nest, nest entrance, and surrounding areas where insects land or walk. Treat around doors and windows, in attics, crawl spaces, and possible harborage sites or points of entry.

For control of Brown Dog Ticks:
Thoroughly apply as a spot treatment to infested areas such as pet beds and resting areas, nearby cracks and crevices, along and behind baseboards, window and door frames, and localized areas of floor and floor coverings where these pests may be present. DO NOT SPRAY PETS WITH THIS PRODUCT. Treat dogs and cats with a product registered for use on animals.

For control of Fleas:
Thoroughly apply as a fine particle broadcast spray to infested rugs, carpets, and pet resting areas. Prior to treatment, aquariums and fish bowls should be covered, and pet animals should be removed from the area being treated. Do not permit humans or pets to contact treated surfaces until spray has dried. Old pet bedding should be removed and replaced with clean, fresh bedding after treatment. DO NOT SPRAY PETS WITH THIS PRODUCT. Treat dogs and cats with a product registered for use on animals.

To control Bed Bugs:
Thoroughly clean and vacuum mattresses, box springs, floors, and surfaces. Treat mattresses and box springs with an approved pesticide, such as a pyrethrin aerosol. Apply Onslaught FastCap Spider & Scorpion Insecticide as a spot treatment to potential harborage sites and migration paths, and cracks and crevices, around baseboards, floorboards, headboards, wall voids and walls.

For control of stored product pests:
Spray thoroughly around and into floor drains, non-food conveyors, benches, pipes, pallets, moist areas, storage racks, pieces of equipment, and other areas where stored product pests may be found. Tank-mix or sequential use of an insect growth regulator, such as NyGuard® IGR Concentrate, is recommended to break the insect reproduction cycle. Do not apply this spray to surfaces or utensils that may come in contact with food, since excessive residues in food may result.

To treat voids in equipment and structures:
To kill insects harboring in wall voids and other inaccessible spaces in equipment and structures, use injection equipment designed for deep void applications. Follow the injection equipment manufacturer's recommendations for proper set up and air pressures.

Place the applicator tip at or into the void space to be treated. For inaccessible voids, it may be necessary to drill an access hole(s). Inject product into the void space in short bursts, allowing air pressure to push insecticide deep into the space. Avoid applying to the point of runoff or drip. Ventilate area thoroughly before re-entry. Do not reapply more than every fourteen (14) days.

To kill the accessible stages of listed granary insects:
Use this concentrate to treat grain storage facilities, and other listed areas, for stored product pest control. For control of exposed adult and immature stages of stored product pests, apply to cracks, crevices, and other surfaces where the pests have been seen or have harborage. Treat areas where products are stored before filling with the product. Apply at the rates listed above, using one gallon of spray mix per 1000 square feet of surface area to be treated. Cleaning all areas prior to use will increase levels of control. Any foodstuffs infested with pests should be removed and destroyed. Do not apply when food-processing facility is in operation or foods are exposed. Do not apply this spray to surfaces or utensils that may come into contact with food.

Repeat application as needed, but do not exceed more than one application every fourteen (14) days.

USE IN AND AROUND LIVESTOCK HOUSING:
For use in and around unoccupied areas of livestock facilities, such as, but not limited to: barns, cow and calf pens & hutches, dairy barns & milk rooms, hog barns, horse barns, sheep barns, poultry houses, and rabbit hutches. Do not contaminate milk, food, or drinking water. Remove animals from area being treated. Cover feeders and waterers. Do not apply or allow insecticide to drift onto animals. Do not allow animals to enter treated areas until spray solution has dried.

Pests	Dilution Rate In Water	Application Method(s)
Crawling Insects including Litter Beetles	1 fl. oz. / Gallon (7.93 ml/L) **or** 1 fl. oz. in sufficient water to cover 1,000 sq. ft. (0.32 ml/m²)	Apply as a coarse, wet spray • General Surface Spray • Crack & Crevice Treatment • Spot Treatment • Injected into Wall Voids
Flying Insects	0.5 fl. oz. / Gallon (3.97 ml/L) **or** 0.5 fl. oz. in sufficient water to cover 1,000 sq. ft. (0.16 ml/m²)	

Crawling insect pests in livestock and poultry premises:
Apply as a general surface, spot treatment, and/or crack and crevice treatment. Apply to floors and vertical and overhead surfaces where crawling insects are or may be present. Treat stanchions, pipes, windows, doors, posts, cage framing, gates, under (but not in) feeders, and other areas where insects hide or congregate. To reduce immigration of insects, make a perimeter treatment around the outside of building foundations. Apply in a uniform band 1 – 3 feet (0.3 – 0.9 m) up the exterior foundation wall and 3 – 6 feet (0.3 – 1.8 m) out from the foundation.

Litter Beetle control in livestock and poultry premises:
To control Litter Beetles (Darkling, Hide, and Carrion Beetles), apply Onslaught FastCap Spider & Scorpion Insecticide to walls and floors at cleanout and before reintroduction of animals. Treat areas where beetles frequently occur, such as walls, supports, cages, cage framing, stalls, and around feeders. To reduce immigration of insects, make a perimeter treatment around the outside of building foundations. Apply in a uniform band 1 – 3 feet (0.3 – 0.9 m) up the exterior foundation wall and 3 – 6 feet (0.3 – 1.8 m) out from the foundation.

Flying insect pests in livestock and poultry premises:
For residual control of flying insects, treat insect resting areas such walls, ceilings, screens, around windows, doors, light fixtures, and other surfaces that attract flying insects. Initiate treatments at the beginning of fly season and repeat treatments during periods of heavy infestation. Tank-mix or sequential use of an insect growth regulator, such as NyGuard® IGR Concentrate, is recommended to break the insect reproduction cycle.

OUTDOOR USE:

Do not spray in or near fishponds or other bodies of water.

Do not water the treated area to the point of run-off.

Do not make applications during the rain.

Do not apply directly to sewers or drains, or any area like a gutter where drainage to sewers, storm drains, water bodies, or aquatic habitat can occur, except as directed by this label.

Not for use on plants being grown for sale or other commercial use. Not for use in nurseries, sod farms or golf courses.

All outdoor applications, if permitted elsewhere on this label must be limited to spot or crack-and-crevice treatments only, except for the following permitted uses, if allowed elsewhere on this label:

1. Applications to soil or vegetation, as listed on this label.
2. Applications to lawns, turf, and other vegetation, as listed on this label.
3. Applications to the side of a building, up to a maximum height of 3 feet above grade;
4. Application to underside of eaves, soffits, doors, or windows permanently protected from rainfall by a covering, overhang, awning, or other structure;
5. Applications around potential pest entry points into buildings, when limited to a surface band not to exceed one inch in width;
6. Applications made through the use of a coarse, low pressure spray to only those portions of surfaces that are directly above bare soil, lawn, turf, mulch or other vegetation, as listed on this label; and not over an impervious surface, drainage or other condition that could result in runoff into storm drains, drainage ditches, gutters, or surface waters in order to control occasional invaders or aggregating pests as listed on this label.

Outdoor applications for spiders, scorpions and other listed pests:

	Dilution Rate In Water	Application Method(s)
Treating Exterior Walls, Foundations and Structures	0.5 to 1 fl. oz. / Gallon (3.97 ml to 7.93 ml/L) **or** 0.5 to 1 fl. oz. in sufficient water to cover 1,000 sq. ft. (0.16 ml to 0.32 ml/m²)	Apply as a coarse, wet spray • Crack & Crevice Treatment • Spot Treatment
Treating Nests and Harborage Areas of Stinging Insects	1 fl. oz. / Gallon (7.93 ml/L) **or** 1 fl. oz. in sufficient water to cover 1,000 sq. ft. (0.32 ml/m²)	
To Control Swarming Termites and Wood Destroying Pests	1 fl. oz. / Gallon (7.93 ml/L) **or** 1 fl. oz. in sufficient water to cover 1,000 sq. ft. (0.32 ml/m²)	
Treating Ornamental Trees and Landscapes	0.1 to 1.0 fl. oz. / Gallon (0.793 ml to 7.93 ml/L) **or** 0.1 to 1.0 fl. oz. in sufficient water to cover 1,000 sq. ft. (0.032 ml to 0.32 ml/m²)	Apply as a course, wet spray • Broadcast Spray Treatment • Foliar Spray Treatment
Mosquito Breeding Sites	0.5 fl. oz. / Gallon (3.97 ml/L) **or** 0.5 fl. oz. in sufficient water to cover 1,000 sq. ft. (0.16 ml/m²)	
Treating Lawns and Turf	0.1 to 1 fl. oz. / Gallon (0.79ml to 7.93 ml/L) **or** 0.1 to 1 fl. oz. in sufficient water to cover 1,000 sq. ft. (0.032 ml to 0.32 ml/m²) **or** 4.3 to 43 fl. oz. per acre (127 ml to 1,271 ml/acre)	Apply as a course, wet spray • Broadcast Spray Treatment

Treating exterior walls, foundations and structures:
To control infestations of listed pests, treat exterior surfaces of buildings, walls, window frames, around garbage cans, eaves, cracks and crevices, porches, decks, gazebos, patios, carports, siding, garages, fence lines, and other areas where pests are active or may be hiding.

To help prevent insect infestation of buildings: Treat a 2 – 6 foot (0.6 – 1.8 m) band of soil or other substrate adjacent to buildings. Treat building foundation to a height of 2 – 3 feet (0.6- 0.9 m). Treat exterior walls, siding, eaves, cracks and crevices, and other areas where listed pests are active, and may find entrance into building.

Apply with sufficient water to adequately cover the area being treated, but do not allow dripping or run-off to occur. Alternate mixing directions are to use 2 to 4 fluid ounces of concentrate per 50 gallons of water.

Stinging insect control outdoors:
For stinging insects, apply spray solution to nests and harborage areas late in the evening when stinging insects are commonly at rest. Thoroughly spray nest, nest entrance, harborage sites, and surrounding areas where insects land or walk. For nests inside walls, inject sufficient spray to treat nest. Do not use in areas where an electrical shock hazard exists. For applications made when pests are active, applicator should wear protective equipment as required. Repeat application when there are signs of renewed insect activity.

For Yellow Jacket control, Onslaught FastCap Spider & Scorpion Insecticide can be mixed with baits in traps. Follow trap instructions for preparation of bait.

For control of Fire Ants, combine broadcast application with mound drenches to control foraging workers and newly mated fly-in queens. Apply Onslaught FastCap Spider & Scorpion Insecticide as a broadcast application at a rate of .8 fl. oz. of concentrate per 1,000 square feet (2.54 ml/m²). Treat mounds with a registered Fire Ant mound treatment.

Fleas and Ticks outdoors:
To control fleas and pet ticks, apply to kennels, runs, and other areas that pets have been present. For best outdoor control of ticks, apply spray to vegetation, brush, branches, and other areas near habitation where ticks may harbor or frequent. Treat the entire area and retreat as necessary to maintain control. Do not apply to pasture or cropland and do not allow animals and people to access to treated areas until the application has dried. DO NOT SPRAY PETS WITH THIS PRODUCT. Treat dogs and cats with a product registered for use on animals.

Insect control in ornamental trees and landscapes:
For residential and commercial trees, shrubs, ground covers, and bedding and foliage plants that will not be harvested for food, apply Onslaught FastCap Spider & Scorpion Insecticide in appropriate volumes of water to obtain thorough coverage. Apply as a full-coverage foliar spray, applying to the point of drip but not runoff. Treat active soil pests with an application to surrounding soil. Repeat treatments as necessary to achieve control, using higher application rates as pest pressure and foliage area increases. Repeat applications as necessary, but no more than once every seven (7) days. Certain plants may be sensitive to the final spray solution. A small-scale test is recommended to verify safety to ornamental plants. Spray and observe for one (1) week prior to application of an entire planting.

Insect control on lawns, turf grass, and turf:
For best results, lawn or turf grass should be mowed 1 – 2 days before spraying. Treat with spraying equipment or a hand sprayer. Use application volumes of up to 10 gallons per 1,000 square feet (400 ml/m2)to get uniform coverage when treating dense grass foliage. For low volume applications using less than 2 gallons of spray solution per 1,000 square feet (80ml/m2), immediate irrigation with at least 0.25 inches (0.635 cm) of water is recommended to improve effectiveness on sub-surface pests.

When hand spraying, spray using a slow, even sweeping motion, making sure to cover the entire lawn or turf grass area where pests are observed. Spray under ornamentals and trees. Repeat treatments may be necessary at 7 – 14-day intervals.

Rate range:
Use lower rate range for pests that are commonly exposed and will be contacted by spray solution at the time of application. For pests that will not be contacted by spray solution at the time of application, use the upper rate range. Use 1 fl. oz per 1,000 sq. ft (7.93 ml/L) when treating Mole Crickets and Chinch Bugs.

To kill Swarming Termites: OUTDOORS ONLY
Apply spray mix as a coarse, wetting spray when swarming termites are seen emerging from woodpiles, wooden fence posts, wooden structures, or from the ground. Swarming usually occurs in the spring or at other times when a termite colony becomes overcrowded and new reproductive termites with wings emerge and fly away to mate and establish new colonies. This treatment will control the sprayed termites and will not protect the structure from which the swarm is coming. Use only as a contact spray to kill emerging reproductive (winged) and worker termites emerging from infested wood. This treatment is not a substitute for a comprehensive termite control program.

To kill wood destroying pests: OUTDOORS ONLY
Apply spray mix as a coarse, wetting spray to exposed pests and to the damaged areas of wood, spraying into galleries or tunnels in the exposed wood. Also, spray around doors, window and door frames, and other areas where these pests may hide or enter the house. Spray into cracks and crevices and, if necessary, drill small holes and spray into inaccessible wooden structural voids where these pests are suspected.

Mosquito breeding sites:
Mosquito populations may be reduced by application of Onslaught FastCap Spider & Scorpion Insecticide to sites where mosquitoes rest, harbor, and breed. Apply spray solution into tall grass, shrubbery, and around backyards and lawns where these pests may hover or rest. Apply while air is still.

Not for wide area mosquito abatement using aerial or truck mounted cold aerosol ULV sprayers and thermal fogging devices.

FIRST AID

IF SWALLOWED:
- Call a poison control center or doctor immediately for treatment advice.
- Do not give any liquid to the person.
- Do not induce vomiting unless told to do so by a poison control center or a doctor.
- Do not give anything by mouth to an unconscious person.

IF IN EYES:
- Hold eye open and rinse slowly and gently with water for 15-20 minutes.
- Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eyes.
- Call a poison control center or doctor for treatment advice.

IF ON SKIN OR CLOTHING:
- Take off contaminated clothing.
- Rinse skin immediately with plenty of water for 15-20 minutes.
- Call a poison control center or doctor for treatment advice.

NOTE TO PHYSICIAN: Contains petroleum distillate. Vomiting may cause an aspiration pneumonia hazard.

Have the product container or label with you when calling a poison control center or doctor, or going for treatment. For information regarding medical emergencies or pesticide incidents, call 1-888-740-8712.

PRECAUTIONARY STATEMENTS
HAZARDS TO HUMANS AND DOMESTIC ANIMALS

CAUTION

Harmful if swallowed. Causes moderate eye irritation. Avoid contact with skin, eyes or clothing. Wear protective eyewear (goggles, face shield or safety glasses with side shields). Wash hands thoroughly with soap and water after handling and before eating, drinking, chewing gum, using tobacco or using the toilet.

ENVIRONMENTAL HAZARDS
This product is toxic to fish and other aquatic invertebrates. To protect the environment, do not allow pesticide to enter or run off into storm drains, drainage ditches, gutters or surface waters. Applying this product in calm weather when rain is not predicted for the next 24 hours will help to ensure that wind or rain does not blow or wash pesticide off the treatment area. Rinsing application equipment over the treated area will help avoid run off to water bodies or drainage system.

Do not discharge effluent containing this product into lakes, streams, ponds, estuaries, oceans, or other waters unless in accordance with the requirement of a National Pollutant Discharge Elimination System (NPDES) permit and the permitting authority has been notified in writing prior to discharge. Do not discharge effluent containing this product into sewer systems without previously notifying sewage treatment plant authority. For guidance, contact your State Water Board or Regional Office of the EPA.

PHYSICAL OR CHEMICAL HAZARDS
Do not use this product in or on electrical equipment due to the possibility of shock hazard.

STORAGE AND DISPOSAL:

Do not contaminate water, food, or feed by storage or disposal.

PESTICIDE STORAGE:
Store in a cool, dry area under lock and key. Post as a pesticide storage area. Always store pesticides in the original container. Store away from food, pet food, feed, seed, fertilizers, and veterinary supplies. Place liquid formulations on lower shelves and dry formulations above.

PESTICIDE DISPOSAL:
To avoid wastes, use all material in this container by application according to label directions. If wastes cannot be avoided, offer remaining product to a waste disposal facility or pesticide disposal program (often such programs are run by state or local government or by industry).

CONTAINER HANDLING
Nonrefillable container. Do not reuse or refill this container.

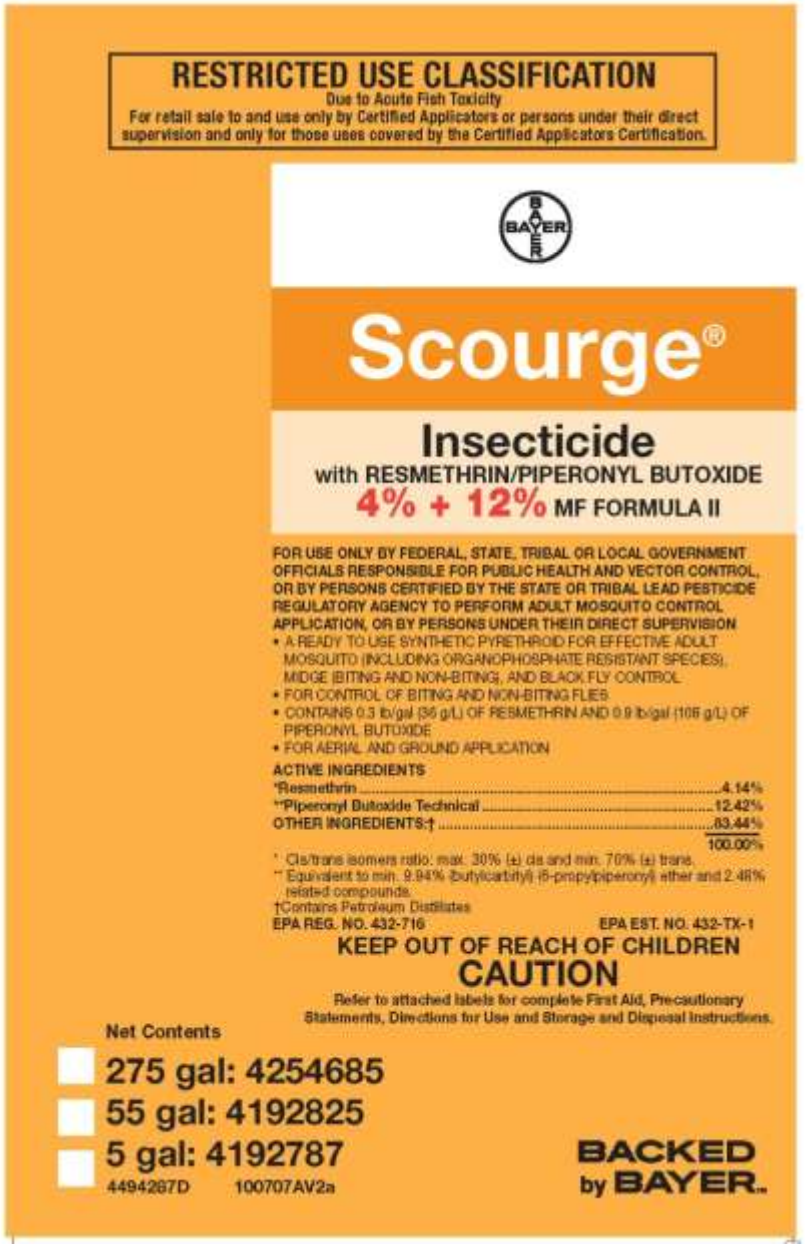
Triple rinse as follows: Empty the remaining contents into the application equipment or a mix tank and drain for 10 seconds after the flow begins to drip. Fill the container ¼ full with water and recap. Shake for 10 seconds. Pour rinsate into the application equipment or a mix tank or store rinsate for later use or disposal. Drain for 10 seconds after the flow begins to drip. Repeat this procedure two more times. Then offer for recycling if available, or puncture and dispose of in a sanitary landfill or by incineration. Do not burn unless allowed by state and local ordinances.

Onslaught® FASTCAP®
Spider & Scorpion Insecticide

EPA Reg. No. 1021-2574
EPA Est. No. 1021-MN-2
0113-0413

MGK®

2.5M-0612



RESTRICTED USE CLASSIFICATION
Due to Acute Fish Toxicity
For retail sale to and use only by Certified Applicators or persons under their direct supervision and only for those uses covered by the Certified Applicators Certification.

Scourge®

Insecticide
with RESMETHRIN/PIPERONYL BUTOXIDE
4% + 12% MF FORMULA II

FOR USE ONLY BY FEDERAL, STATE, TRIBAL OR LOCAL GOVERNMENT OFFICIALS RESPONSIBLE FOR PUBLIC HEALTH AND VECTOR CONTROL, OR BY PERSONS CERTIFIED BY THE STATE OR TRIBAL LEAD PESTICIDE REGULATORY AGENCY TO PERFORM ADULT MOSQUITO CONTROL APPLICATION, OR BY PERSONS UNDER THEIR DIRECT SUPERVISION

- A READY TO USE SYNTHETIC PYRETHROID FOR EFFECTIVE ADULT MOSQUITO (INCLUDING ORGANOPHOSPHATE RESISTANT SPECIES), MIDGE (BITING AND NON-BITING), AND BLACK FLY CONTROL
- FOR CONTROL OF BITING AND NON-BITING FLIES
- CONTAINS 0.3 lb/gal (36 g/L) OF RESMETHRIN AND 0.9 lb/gal (108 g/L) OF PIPERONYL BUTOXIDE
- FOR AERIAL AND GROUND APPLICATION

ACTIVE INGREDIENTS	
*Resmethrin	4.14%
**Piperonyl Butoxide Technical	12.42%
OTHER INGREDIENTS:†	83.44%
	100.00%

* Cis/trans isomers ratio: max. 30% (±) cis and min. 70% (±) trans.
** Equivalent to min. 9.94% (butylcarbityl) (6-propylpiperonyl) ether and 2.48% related compounds.
†Contains Petroleum Distillates

EPA REG. NO. 432-716 EPA EST. NO. 432-TX-1

KEEP OUT OF REACH OF CHILDREN

CAUTION

Refer to attached labels for complete First Aid, Precautionary Statements, Directions for Use and Storage and Disposal Instructions.

Net Contents

- 275 gal: 4254685
- 55 gal: 4192825
- 5 gal: 4192787

4494287D 100707AV2a

BACKED by BAYER.

PRECAUCION AL CONSUMIDOR: Si usted no lee ingles, no use este producto hasta que la etiqueta le hays sido explicada ampliamente. (TO THE USER: If you cannot read English, do not use this product until the label has been fully explained to you.)

FIRST AID	
IF SWALLOWED	• Call a poison control center or doctor immediately for treatment advice. • Do not induce vomiting unless told to do so by a poison control center or doctor. • Do not give any liquid to the person. • Do not give anything by mouth to an unconscious person.
IF ON SKIN OR CLOTHING	• Take off contaminated clothing. • Rinse skin immediately with plenty of water for 15 to 20 minutes. • Call a poison control center or doctor for treatment advice.
[Synthetic Pyrethroid]	
Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-800-334-7577 for emergency medical treatment information.	
Note To Physician: Contains petroleum distillates – vomiting may cause aspiration pneumonia.	

In case of medical emergencies or health and safety inquiries or in case of fire, leaking or damaged containers, information may be obtained by calling 1-800-334-7577.

PRECAUTIONARY STATEMENTS

Hazards To Humans & Domestic Animals

CAUTION

Harmful if swallowed or absorbed through skin. Avoid contact with skin, eyes, or clothing. Wash thoroughly with soap and water after handling.

Environmental Hazards

This pesticide is extremely toxic to fish, aquatic invertebrates and shrimp. Runoff from treated areas or deposition of spray droplets into a body of water may be hazardous to fish and aquatic invertebrates. Do not apply over bodies of water (lakes, rivers, permanent streams, natural ponds, commercial fish ponds, swamps, marshes or estuaries), except when necessary to target areas where adult mosquitoes are present, and weather conditions will facilitate movement of applied material away from the water in order to minimize incidental deposition into the water body. Do not contaminate water when disposing of equipment wash waters.

This pesticide is highly toxic to bees exposed to direct treatment on blooming crops or weeds. Do not apply this product or allow drift when bees are actively visiting the treatment area, except when applications are made to prevent or control a threat to public and/or animal health determined by a state, tribal or local health or vector control agency on the basis of documented evidence of disease causing agents in vector mosquitoes, or the occurrence of mosquito-borne disease in animal or human populations, or if specifically approved by the state or tribe during a natural disaster recovery effort.

DIRECTIONS FOR USE

It is a violation of Federal Law to use this product in a manner inconsistent with its labeling.
READ ENTIRE LABEL FOR DIRECTIONS

NOTICE: This concentrate cannot be diluted in water. Mix well before using. Avoid storing excess formulation in spray equipment tank beyond the period needed for application.

In treatment of corrals, feed lots, swine lots, and zoos, cover any exposed drinking water, drinking water fountains and animal feed before application.

Before making the first application in a season, it is advisable to consult with the state or tribal agency with primary responsibility for pesticide regulation to determine if permits or other regulatory requirements exist.

Do not exceed 25 applications at 0.007 pounds of resmethrin per acre (not to exceed a total of 0.18 pounds of resmethrin per acre) in any given season.

More frequent treatments may be made to prevent or control a threat to public and/or animal health determined by the state, tribal or local health or vector control agency on the basis of documented evidence of disease causing agents in vector mosquitoes or the occurrence of mosquito-borne disease in animal or human populations, or if specifically approved by the state or tribe during a natural disaster recovery effort.

GENERAL

Scourge is designed for application as an Ultra-Low Volume (ULV) aerosol to control adult mosquitoes and flies in residential, industrial, urban, recreational areas, and other areas where the labeled pests are a problem.

Scourge provides effective control of adult mosquitoes, black flies, gnats, biting and non-biting midges, stable flies, horse flies, deer flies, sheep flies, horn flies, yellow flies and nuisance flying insects such as house flies in areas such as but not limited to industrial areas, urban areas, parks, campsites, woodlands, athletic fields, golf courses, playgrounds, recreational and overgrown waste areas, roadsides, and other public areas where adult mosquitoes and flies occur. Apply when ground wind speed is equal or greater than 1 mph.

Scourge **can be applied as undiluted or diluted with refined** soybean oil, light mineral oil of 54 second viscosity or other suitable solvent or diluent.

PAGE 1 of 2

Spray Droplet Size Determination

Ground Equipment:

Spray equipment must be adjusted so that the volume median diameter is less than 30 microns (Dv 0.5 < 30 µm) and that 90% of the spray is contained in droplets smaller than 50 microns (Dv 0.9 < 50µm). Directions from the equipment manufacturer or vendor, pesticide registrant or a test facility using a laser-based measurement instrument must be used to adjust equipment to produce acceptable droplet size spectra. Application equipment must be tested at least annually to confirm that pressure at the nozzle and nozzle flow rate(s) are properly calibrated.

Aerial Equipment:

Spray equipment must be adjusted so that the volume median diameter produced is less than 60 microns (Dv 0.5 < 60 µm) and that 90% of the spray is contained in droplets smaller than 100 microns (Dv 0.9 < 100 µm). The effects of flight speed and, for non-rotary nozzles, nozzle angle on the droplet size spectrum must be considered. Directions from the equipment manufacturer or vendor, pesticide registrant or a test facility using a wind tunnel and laser-based measurement instrument must be used to adjust equipment to produce acceptable droplet size spectra. Application equipment must be tested at least annually to confirm that pressure at the nozzle and nozzle flow rate(s) are properly calibrated.

ULTRA LOW VOLUME APPLICATIONS

All types of applications should be conducted at temperatures of 50°F or higher. Apply when ground wind speeds are equal to or greater than 1 mph.

GROUND APPLICATION

Vehicle-Mounted ULV Cold Aerosol Generators or Vehicle-Mounted Non-Thermal Aerosol (Cold Fog): Apply through non-thermal ULV application equipment and base acreage calculations on the equipment manufacturer's recommended swath width. Apply at a rate not to exceed 0.007 pounds of resmethrin per acre in any given 24 hour period. An optimum swath is created when Scourge is applied from a truck that is being driven perpendicular to the wind direction. Direct the spray head of equipment to ensure even distribution of the spray cloud throughout the area. For best results, apply when insects are most active and meteorological conditions are conducive to keeping the spray cloud in the air column close to the ground. An inversion of air temperatures and a light breeze is preferable. Application during the cooler hours of the night or early morning is recommended. Scourge may be applied through ULV Cold Aerosol Generators, or other equipment designed for non-thermal ULV aerosol applications. The desired application rate may be obtained under different conditions by altering the dilution rate of Scourge, the flow rate of the insecticide from the application equipment and the vehicle speed. Examples are given in the following Table.

Treatment lb ai/A of Scourge Wanted Resmethrin/PBO	Fl oz/A of undiluted Spray to be Applied	Application Rate-Fl oz/Min	
		5 MPH	10 MPH
0.007/0.021	3.0	9.0	18.0
0.0035/0.0105	1.5	4.5	9.0
0.00175/0.00525	0.75	2.25	4.5
0.00117/0.00351	0.50	1.50	3.0

Where dense vegetation is present, the use of the higher rates and/or slower speed is recommended.

AERIAL APPLICATION

Scourge may be applied either diluted or undiluted at rates of 0.0035 to 0.007 pounds resmethrin per acre by fixed wing or rotary aircraft that are capable of making a ULV application. Aerial application of Scourge should be made at a minimum altitude of 75 ft for rotary and 100 ft for fixed wing aircraft. Applications shall only be made when recommended by public health officials and trained personnel of mosquito abatement districts and other mosquito control programs.

For best results, treat when insects are most active and meteorological conditions are conducive to keeping the spray cloud close to the ground. In order to compensate for windy conditions and ensure drift onto the target area aerial application with aircraft equipped with Global Positioning Systems (GPS) is recommended.

lb ai/A Wanted Resmethrin/PBO	Fl oz/A of Undiluted Spray to be Applied
0.007/0.021	3.0
0.0035/0.0105	1.5
0.00175/0.00525	0.75
0.00117/0.00351	0.50

BACKPACK ULTRA LOW VOLUME APPLICATIONS

For use in nonthermal ULV portable backpack equipment, mix 70 fl oz of this product with 1 gal of refined soybean oil, light mineral oil of 54 second viscosity or other suitable solvent or diluent. Adjust equipment to deliver fog particles of 18-50 microns mass median diameter. Apply at the rate of 4.25-8.50 fl oz of finished formulation per acre as a 50 ft swath while walking at a speed of 2 mph. This is equivalent to 0.0035-0.0070 pounds resmethrin per acre. Where dense vegetation is present, the use of higher label rates is recommended.

STORAGE AND DISPOSAL

Do not contaminate water, food or feed by storage or disposal.

PESTICIDE STORAGE AND SPILL PROCEDURES: Store upright at room temperature. Avoid exposure to extreme temperatures. In case of spill or leakage, soak up with an absorbent material such as sand, sawdust, earth, fuller's earth, etc. Dispose of with chemical waste.

Pesticide Disposal: Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility.

Container Disposal:

Rigid, Non-refillable containers small enough to shake (i.e., with capacities equal to or less than 5 gallons)

Non-refillable container. Do not reuse or refill this container. Offer for recycling, if available. Triple rinse or pressure rinse container (or equivalent) promptly after emptying. Triple rinse as follows: Empty the remaining contents into application equipment or a mix tank and drain for 10 seconds after the flow begins to drip. Fill the container 1/4 full with mineral oil and recap. Shake for 10 seconds. Pour rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Drain for 10 seconds after the flow begins to drip. Repeat this procedure two more times. Then offer for recycling or reconditioning or puncture and dispose of in a sanitary landfill or incineration, or if allowed by State and Local authorities, by burning. If burned, stay out of smoke.

Rigid Non-refillable containers that are too large to shake (i.e., with capacities greater than 5 gallons or 50 lbs)

Non-refillable container. Do not reuse or refill this container. Offer for recycling, if available. Triple rinse or pressure rinse container (or equivalent) promptly after emptying. Triple rinse as follows: Empty the remaining contents into application equipment or a mix tank. Fill the container ¼ full with mineral oil. Replace and tighten closures. Tip container on its side and roll it back and forth, ensuring at least one complete revolution, for 30 seconds. Stand the container on its end and tip it back and forth several times. Empty the rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Repeat this procedure two more times. Then offer for recycling or reconditioning or puncture and dispose of in a sanitary landfill or incineration, or if allowed by State and Local authorities, by burning. If burned, stay out of smoke.

Refillable container. Refill this container with pesticide only. Do not reuse this container for any other purpose. Cleaning the container before final disposal is the responsibility of the person disposing of the container. Cleaning before refilling is the responsibility of the refiller. To clean the container before final disposal, empty the remaining contents from this container into application equipment or mix tank. Fill the container about 10 percent full with mineral oil Agitate vigorously or recirculate mineral oil with the pump for 2 minutes. Pour or pump rinsate into application equipment or rinsate collection system. Repeat this rinsing procedure two more times.

IMPORTANT: READ BEFORE USE

Read the entire Directions for Use, Conditions, Disclaimer of Warranties and Limitations of Liability before using this product. If terms are not acceptable, return the unopened product container at once.

By using this product, user or buyer accepts the following Conditions, Disclaimer of Warranties and Limitations of Liability.

CONDITIONS: The directions for use of this product are believed to be adequate and must be followed carefully. However, it is impossible to eliminate all risks associated with the use of this product. Crop injury, ineffectiveness or other unintended consequences may result because of such factors as weather conditions, presence of other materials, or the manner of use or application, all of which are beyond the control of Bayer CropScience LP. All such risks shall be assumed by the user or buyer.

DISCLAIMER OF WARRANTIES: TO THE EXTENT CONSISTENT WITH APPLICABLE LAW, BAYER CROPSCIENCE LP MAKES NO OTHER WARRANTIES, EXPRESS OR IMPLIED, OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE OR OTHERWISE, THAT EXTEND BEYOND THE STATEMENTS MADE ON THIS LABEL. No agent of Bayer CropScience LP is authorized to make any warranties beyond those contained herein or to modify the warranties contained herein. TO THE EXTENT CONSISTENT WITH APPLICABLE LAW, BAYER CROPSCIENCE LP DISCLAIMS ANY LIABILITY WHATSOEVER FOR SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES RESULTING FROM THE USE OR HANDLING OF THIS PRODUCT.

LIMITATIONS OF LIABILITY: TO THE EXTENT OF THE LAW, THE EXCLUSIVE REMEDY OF THE USER OR BUYER FOR ANY AND ALL LOSSES, INJURIES OR DAMAGES RESULTING FROM THE USE OR HANDLING OF THIS PRODUCT, WHETHER IN CONTRACT, WARRANTY, TORT, NEGLIGENCE, STRICT LIABILITY OR OTHERWISE, SHALL NOT EXCEED THE PURCHASE PRICE PAID, OR AT BAYER CROPSCIENCE LP'S ELECTION, THE REPLACEMENT OF PRODUCT.

Produced for:
Bayer Environmental Science
A Division of Bayer CropScience LP
2 T. W. Alexander Drive
Research Triangle Park, NC 27709

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ANVIL® 2+2 ULV

Contains an Oil Soluble Synergized Synthetic Pyrethroid for Control of Adult Mosquitoes (Including Organophosphate-Resistant Species), Midges and Black Flies in Outdoor Residential and Recreational Areas

For use only by federal, state, tribal or local government officials responsible for public health or vector control, or by persons certified in the appropriate category or otherwise authorized by the state or tribal lead pesticide regulatory agency to perform adult mosquito control applications, or by persons under their direct supervision.

ACTIVE INGREDIENTS	
3-Phenoxybenzyl-(1RS, 3RS, 1RS, 3SR)-2,2-dimethyl-3-(2-methylprop-1-enyl) cyclopropanecarboxylate	2.00%
Piperonyl Butoxide*	2.00%
OTHER INGREDIENTS**	96.00%
	100.00%

Contains 0.14 lbs of Technical Sumithrin®/Gallon and 0.14 lbs of Piperonyl Butoxide/Gallon

*(butyl carbityl) (6-propylpiperonyl) ether and related compounds
** Contains a petroleum distillate

KEEP OUT OF REACH OF CHILDREN

CAUTION

PRECAUCION AL USUARIO: Si usted no lee ingles, no use este producto hasta que la etiqueta haya sido explicado ampliamente

FIRST AID	
Have the product container or label with you when calling a poison control center or doctor, or going for treatment. For information regarding medical emergencies or pesticide incidents, call 1-888-740-8712.	
IF ON SKIN OR CLOTHING:	Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Call a poison control center or doctor for treatment advice.
IF SWALLOWED:	Immediately call a poison control center or doctor. Do not induce vomiting unless told to do so by a poison control center or doctor. Do not give any liquid to the person. Do not give anything by mouth to an unconscious person.
Note to Physician: Contains petroleum distillate - vomiting may cause aspiration pneumonia.	

PRECAUTIONARY STATEMENTS

HAZARDS TO HUMANS AND DOMESTIC ANIMALS

CAUTION. Harmful if absorbed through the skin. Avoid contact with skin, eyes and clothing. Wash thoroughly with soap and water after handling and before eating, drinking, chewing gum, using tobacco or using the toilet. Remove and wash contaminated clothing before reuse.

Personal Protective Equipment (PPE): Mixers, loaders, applicators, and other handlers must wear the following: long-sleeve shirt, long pants, shoes and socks, chemical resistant gloves made of barrier laminate or viton. See engineering controls for additional requirements.

User Safety Requirements: Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables exist, use detergent and hot water. Keep and wash PPE separately from other laundry. Discard clothing and other absorbent material that have been drenched or heavily contaminated with the product's concentrate. Do not reuse them.

USER SAFETY RECOMMENDATIONS: Users should wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet. User should remove clothing/PPE immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing. Users should remove PPE immediately after handling this product. As soon as possible, wash thoroughly and change into clean clothing.

Engineering Controls: Pilots must use an enclosed cockpit that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides [40 CFR 170.240(d)(6)].

ENVIRONMENTAL HAZARDS

This pesticide is toxic to aquatic organisms, including fish and aquatic invertebrates. Runoff from treated areas or deposition of spray droplets into a body of water may be hazardous to fish and aquatic invertebrates. Before making the first application in a season, it is advisable to consult with the state or tribal agency with primary responsibility for pesticide regulation to determine if other regulatory requirements exist. Do not apply over bodies of water (lakes, rivers, permanent streams, natural ponds, commercial fish ponds, swamps, marshes or estuaries), except when necessary to target areas where adult mosquitoes are present, and weather conditions will facilitate movement of applied material beyond the body of water in order to minimize incidental deposition into the water body. Do not contaminate bodies of water when disposing of equipment rinsate or wash waters.

This product is highly toxic to bees exposed to direct treatment on blooming crops or weeds. Do not apply to or allow drift onto blooming crops or weeds when bees are visiting the treatment area, except when applications are made to prevent or control a threat to public and/or animal health determined by a state, tribal or local health or vector control agency on the basis of documented evidence of disease causing agents in vector mosquitoes, or the occurrence of mosquito-borne disease in animal or human populations, or if specifically approved by the state or tribe during a natural disaster recovery effort.

PHYSICAL OR CHEMICAL HAZARDS

Do not use or store near heat or open flame.

DIRECTIONS FOR USE

It is a violation of Federal Law to use this product in a manner inconsistent with its labeling.

USE RESTRICTIONS

IN CALIFORNIA: This product is to be applied by County Health Department, State Department of Health Services, Mosquito and Vector Control or Mosquito Abatement District personnel only.

IN FLORIDA: Do not apply by aircraft unless approved by the Florida Department of Agriculture and Consumer Services.

Do not treat a site with more than 0.0036 pounds of Sumithrin and piperonyl butoxide per acre in a 24-hour period. Do not exceed 0.1 pounds of Sumithrin or piperonyl butoxide per acre in any site in one year. More frequent applications may be made to prevent or control a threat to public and/or animal health determined by a state, tribal, or local health or vector control agency on the basis of documented evidence of disease causing agents in vector mosquitoes or the occurrence of mosquito-borne disease in animal or human populations, or if specifically approved by the state or tribe during a natural disaster recovery effort.

NOTE: When rotating products with other insecticides containing PBO, do not exceed 2 lbs PBO per acre per year.

Not for use in outdoor residential misting systems.

USE INFORMATION

USE AREAS: For use in mosquito adulticiding programs involving outdoor residential and recreational areas where adult mosquitoes are present in annoying numbers in vegetation surrounding parks, woodlands, swamps, marshes, overgrown areas and golf courses. ANVIL 2+2 ULV may be applied over agricultural areas for the control of adult mosquitoes within or adjacent to these areas.

For best results, apply when mosquitoes are most active and weather conditions are conducive to keeping the spray cloud close to the ground. Application in calm air conditions is to be avoided. Apply only when ground wind speed is greater than 1 mph. Air temperature should be greater than 50 °F when conducting all types of applications.

AL0200

NOTE: ANVIL 2+2 ULV cannot be diluted in water. Dilute this product with light mineral oil if dilution is preferred.

SPRAY DROPLET SIZE DETERMINATION

Ground Equipment: Spray equipment must be adjusted so that the volume median diameter (VMD) is less than 30 microns (Dv 0.5 < 30 um) and that 90% of the spray is contained in droplets smaller than 50 microns (Dv 0.9 < 50 um). Directions from the equipment manufacturer or vendor, pesticide registrant, or a test facility using a laser-based measurement instrument must be used to adjust equipment to produce acceptable droplet size spectra. Application equipment must be tested at least annually to confirm that pressure at the nozzle and nozzle flow rate(s) are properly calibrated.

Aerial Equipment: Spray equipment must be adjusted so that the volume median diameter produced is less than 60 microns (Dv 0.5 < 60 um) and that 90% of the spray is contained in droplets smaller than 80 microns (Dv 0.9 < 80 um). The effects of flight speed and, for non-rotary nozzles, nozzle angle on the droplet size spectrum must be considered. Directions from the equipment manufacturer or vendor, pesticide registrant, or a test facility using a wind tunnel and laser-based measurement instrument must be used to adjust equipment to produce acceptable droplet size spectra. Application equipment must be tested at least annually to confirm that pressure at the nozzle and nozzle flow rate(s) are properly calibrated.

GROUND ULV APPLICATION

Apply ANVIL 2+2 ULV through a standard ULV cold aerosol or non-thermal aerosol (cold fog) generator. Consult the following table for examples of various dosage rates using a swath width of 300 feet for acreage calculations. Vary flow rate according to vegetation density and mosquito population. Use higher flow rate in heavy vegetation or when pest populations are high.

Dosage Rate (Lbs. Sumithrin/ Acre)	ANVIL 2+2 Fl.oz/ Acre	Flow Rates in Fl.oz./Minute at truck speeds of:			
		5 MPH	10 MPH	15 MPH	20 MPH
0.0036	3.245	9.8	19.7	29.5	39.3
0.0024	2.163	6.6	13.1	19.7	26.2
0.0012	1.081	3.3	6.6	9.8	13.1

ANVIL 2+2 ULV may also be applied undiluted with non-thermal, portable, motorized backpack equipment adjusted to deliver ULV particles of less than 100 microns VMD. Use 1.081 to 3.245 fl.oz. of the undiluted spray per acre (equal to 0.0012 to 0.0036 lb ai/acre) as a 50 ft (15.2 m)swath while walking at a speed of 2 mph (3.2 kph). Do NOT use portable backpack equipment for application in enclosed spaces.

ANVIL 2+2 ULV may be applied through truck mounted thermal fogging equipment. Do not exceed the maximum rates listed above. May be applied at speeds of 5 to 20 mph. To reduce oil requirement and sludge buildup in equipment, use 100-second viscosity mineral "fog" oil. For use with hand-carried foggers, use same rates of active ingredient per acre. Do not wet foliage since oil base formulations may be phytotoxic. Use a clean, well-maintained and properly calibrated fogger. Fog downwind. Do not use hand held equipment for this type of application in enclosed spaces.

AERIAL APPLICATION

ANVIL 2+2 ULV may be applied at rates of 1.081 to 3.245 fluid ounces ANVIL 2+2 ULV per acre by fixed wing or rotary aircraft equipped with suitable ULV application equipment.

RELEASE HEIGHT FOR AERIAL:

Fixed wing: Apply using a nozzle height of no less than 100 feet above the ground or canopy.

Rotary wing: Apply using a nozzle height of no less than 75 feet above the ground or canopy.

STORAGE & DISPOSAL

Do not contaminate water, food or feed by storage and disposal.

PESTICIDE STORAGE: Store in a cool, dry place. Keep container closed.

PESTICIDE DISPOSAL: Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility.

CONTAINER DISPOSAL:

[For 2.5-gallon Jugs]: Nonrefillable container. Do not reuse or refill this container. Triple rinse container (or equivalent) promptly after emptying. Triple rinse as follows: Empty the remaining contents into application equipment or a mix tank and drain for 10 seconds after the flow begins to drip. Fill the container 1/4 full with mineral oil and recap. Shake for 10 seconds. Pour rinsate into application equipment or a rinse tank or store rinsate for later use or disposal. Drain for 10 seconds after the flow begins to drip. Repeat this procedure two more times. Offer for recycling if available or reconditioning if appropriate, or puncture and dispose of in a sanitary landfill, or by other procedures approved by state and local authorities.

[For refillable drums & totes]: Refillable container. Refill this container with pesticide only. Do not reuse this container for any other purpose. Cleaning before refilling is the responsibility of the refiller. To clean the container before final disposal, empty the remaining contents from this container into application equipment or mix tank. Fill the container about 10 percent full with water. Agitate vigorously or recirculate water with the pump for 2 minutes. Pour or pump rinsate into rinsate collection system. Repeat this rinsing procedure two more times. Offer for recycling if available or reconditioning if appropriate, or puncture and dispose of in a sanitary landfill, or by other procedures approved by state and local authorities.

FOR MORE INFORMATION CALL 1-800-323-5727

NOTICE: To the extent provided by law, seller makes no warranty, expressed or implied, concerning the use of this product other than as indicated on the label. Buyer assumes all risk of use/handling of this material when use and/or handling is contrary to label instructions.

ANVIL™ is a trademark of Clarke Mosquito Control Products, Inc.

Sumithrin™ is a trademark of Sumitomo Company Ltd.

MANUFACTURED FOR:
CLARKE MOSQUITO CONTROL PRODUCTS, INC.
159 N. GARDEN AVENUE
ROSELLE, ILLINOIS 60172

AVAILABLE PACKAGING: 2.5 GAL, 30 GAL, 55 GAL, 275 GAL, TOTE

LOT NO.: Marked on Container Label

EPA REG. NO. 1021-1687-8329

EPA EST. NO. 8329-IL-001

AL0260

Zenivex® E4 RTU

For use only by federal, state, tribal, or local government officials responsible for public health or vector control, or by persons certified in the appropriate category or otherwise authorized by the state or tribal lead pesticide regulatory agency to perform adult mosquito control applications, or by persons under their direct supervision.

- **FOR THE CONTROL OF ADULT MOSQUITOES, NON-BITING MIDGES, AND BLACK FLIES**
- **FOR USE AS A SPACE SPRAY BY AIR AND GROUND APPLICATION TO CONTROL ADULT MOSQUITOES**
- **APPROVED FOR USE OVER AGRICULTURAL CROPS (INCLUDING THOSE INTENDED FOR HUMAN CONSUMPTION), PASTURE AND RANGELAND**
- **READY TO USE WITHOUT DILUTION**
- **CONTROLS ADULT MOSQUITOES THAT MAY CARRY WEST NILE VIRUS, EASTERN EQUINE ENCEPHALITIS, ST. LOUIS ENCEPHALITIS**
- **CONTROLS NON-BITING MIDGES, NUISANCE AND BITING FLIES**
- **QUICK, PERMANENT KNOCKDOWN OF ADULT MOSQUITOES**

SPECIMEN LABEL

ACTIVE INGREDIENT:	
Etofenprox (CAS #80844-07-1)	4%
OTHER INGREDIENTS*:	96%
Total:	100%

*Contains petroleum distillates
Contains 0.30 lbs etofenprox per gallon

EPA Reg. No. 2724-807 EPA Est. No. 2724-TX-1

KEEP OUT OF REACH OF CHILDREN

CAUTION

See additional Precautionary Statements,

PRECAUTIONARY STATEMENTS HAZARDS TO HUMANS AND DOMESTIC ANIMALS CAUTION

Harmful if swallowed. Causes moderate eye irritation. Avoid contact with eyes, skin, or clothing. Applicators and other handlers must wear long-sleeved shirt, long pants, socks and shoes. Wash thoroughly with soap and water after handling and before eating, drinking, chewing gum, using tobacco, or using the toilet. Remove contaminated clothing and launder before reuse. Repeated exposure to etofenprox can cause skin irritation.

FIRST AID

If swallowed • Immediately call a poison control center or doctor. • Do not induce vomiting unless told to do so by a poison control center or doctor. • Do not give any liquid to the person. • Do not give anything by mouth to an unconscious person.

If in eyes • Hold eye open and rinse slowly and gently with water for 15-20 minutes. • Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eyes. • Call a poison control center or doctor for treatment advice.

Have the product container or label with you when calling a poison control center or doctor or going for treatment. You may also contact 1-800-248-7763 for emergency medical treatment information.

NOTE TO PHYSICIAN: May pose an aspiration pneumonia hazard. Contains petroleum distillate.

ENVIRONMENTAL HAZARDS

This pesticide is toxic to aquatic organisms, including fish and aquatic invertebrates. Runoff from treated areas or deposition into bodies of water may be hazardous to fish and other aquatic organisms. Do not apply over bodies of water (lakes, rivers, permanent streams, natural ponds, commercial fish ponds, swamps, marshes or estuaries), except when necessary to target areas where adult mosquitoes are

present, and weather conditions will facilitate movement of applied material away from water in order to minimize incidental deposition into the water body. Do not contaminate bodies of water when disposing of equipment rinsate or washwaters.

This product is highly toxic to bees exposed to direct treatment on blooming crops or weeds. Time applications to provide the maximum possible interval between treatment and the next period of bee activity. Do not apply to blooming crops or weeds when bees are visiting the treatment area, except when applications are made to prevent or control a threat to public and/or animal health determined by a state, tribal, or local health or vector control agency on the basis of documented evidence of disease-causing agents in vector mosquitoes or the occurrence of mosquito-borne disease in animal or human populations, or if specifically approved by the state or tribe during a natural disaster recovery effort.

PHYSICAL/CHEMICAL HAZARDS

Combustible. Do not use or store near heat or open flame.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling. **READ AND FOLLOW ALL LABEL DIRECTIONS.** Before making the first application of the season, it is advisable to consult with the state or tribal agency with primary responsibility for pesticide regulation to determine if other regulatory requirements exist.

GENERAL

ZENIVEX® E4 RTU is an effective insecticide used at low volumes to control adult mosquitoes, non-biting midges, biting and non-biting flies. Use **Zenivex® E4 RTU** undiluted as UltraLow Volume (ULV) for the control of pest species in or near residential, industrial, commercial, urban, recreational areas, woodlands, golf courses, and other areas where these pests are a problem. **Zenivex® E4 RTU** may be applied over agricultural areas prior to or following harvest for the control of adult mosquitoes within or adjacent to these areas. In the treatment of corrals, feedlots, swine lots, and zoos, cover any exposed drinking water, drinking water fountains, and animal feed before application. Apply **Zenivex® E4 RTU** aerially (both fixed and rotary aircraft) for low volume applications or through mist-blowers, backpack, and handheld sprayers for ground applications. **Zenivex® E4 RTU** will control mosquitoes and flies and can be used as part of a total integrated pest management program for controlling disease vectors. Apply **Zenivex® E4 RTU** at rates from 0.00175 to 0.0070 pounds of etofenprox per acre by ground ULV. Use this product undiluted only; do not mix with water. Apply when wind is ≥ 1 mph. Do not apply when wind speeds exceed 10 mph. A temperature inversion is preferable to keep the fog close to the ground and applications should be made when labeled insects are most active.

Do not spray more than 0.18 lbs etofenprox per acre per site per year. Do not make more than 25 applications per site per year. More frequent treatments may be made to prevent or control a threat to public and/or animal health determined by a state, tribal, or local health or vector control agency on the basis of documented evidence of disease-causing agents in vector mosquitoes or the occurrence of mosquito-borne disease in animal or human populations, or if specifically approved by the state or tribe during a natural disaster recovery effort.

GROUND APPLICATION

Use a vehicle-mounted cold aerosol ULV sprayer to apply the product. Direct the spray equipment nozzle to provide even distribution of the product. For best results, apply perpendicular to the wind direction using a swath width of 300 ft. Spray equipment must be adjusted so that the volume median diameter (VMD) is between 10-30 microns ($10\mu \leq D_{v0.5} \leq 30\mu$) and that 90% of the spray is contained in droplets smaller than 50 microns ($D_{v0.9} < 50\mu$). Directions from the equipment manufacturer or vendor, pesticide registrant, or test facility using a laser-based measurement instrument must be used to adjust equipment to produce acceptable droplet size spectra. Application equipment must be tested at least annually to confirm that pressure at the nozzle and nozzle flow rate(s) are properly calibrated.

The appropriate application rate can be achieved by using the following table. Refer to the following chart for examples.

Application rate pound A.I. per acre	Flow rates Undiluted Oz/Acre	Flow rates Undiluted Oz/Minute	Vehicle Speed
0.00175	0.75	2.25	5
		4.50	10
		7.00	15
0.00350	1.5	4.50	5
		9.00	10
		13.50	15
0.00700	3.0	9.00	5
		18.00	10

Use the higher label rates when spraying areas where dense vegetation is present. Conduct applications when temperatures are between 50-95° F.

Backpack Sprayer ULV Application

Apply **Zenivex® E4 RTU** undiluted through non-thermal ULV backpack sprayer capable of applying the product in the 10 to 30 micron range. Apply product to the area as evenly as possible. Apply at the rate of 0.00175 to 0.0070 pounds etofenprox per acre.

Urban ULV Mosquito Control Applications

For control of resting or flying adult mosquitoes, biting flies and non-biting midges in areas such as utility

tunnels, sewers, storm drains and catch basins, pipe chases, underground basements, underground passages, parking decks, crawl spaces or uninhabited buildings, apply **Zenivex® E4 RTU** using mechanical foggers, hand-held or truck-mounted ULV equipment, thermal foggers or other spray equipment suitable for this application. Apply **Zenivex® E4 RTU** at rates up to but not exceeding 0.0070 pounds of etofenprox per acre.

Thermal Fogging Application

Apply using a truck, dolly mounted, handheld, or other thermal fogging equipment. Following the equipment manufacturer's instructions, apply this product at a rate of 0.00175 to 0.0070 pounds etofenprox per acre. Direct fog to areas where mosquitoes and other pests are located. The volume median diameter (VMD) of droplets produced by thermal foggers is less than 60 microns ($D_{v0.5}$ < 60µ) and 90% of the spray is contained in droplets smaller than 100 microns ($D_{v0.9}$ < 100µ).

AERIAL APPLICATION

Apply **Zenivex® E4 RTU** aerially, undiluted, by fixed wing or rotary aircraft. Apply at the rate of 0.00175 to 0.0070 pounds of etofenprox per acre. Apply using ULV equipped and capable aircraft. Spray equipment must be adjusted so that the volume median diameter (VMD) produced is less than 60 microns ($D_{v0.5}$ < 60µ) and that 90% of the spray is contained in droplets smaller than 100 microns ($D_{v0.9}$ < 100µ). The effects of flight speed and, for non-rotary nozzles, nozzle angle on the droplet size spectrum must be considered. Directions from the equipment manufacturer or vendor, pesticide registrant, or test facility using a wind tunnel and laser-based measurement instrument must be used to adjust equipment to produce acceptable droplet size spectra. Application equipment must be tested annually to confirm that pressure at the nozzle and nozzle flow rate(s) are properly calibrated. Do not apply **Zenivex® E4 RTU** at altitudes below 100 feet. Apply at altitudes from 100-300 feet. Apply when wind speed on the ground is ≥ 1 mph. Apply when labeled insects are most active. For best results, use Global Positioning System (GPS) equipped aircraft.

IN FLORIDA: Do not apply by aircraft except with the approval of the Florida Department of Agriculture and Consumer Services.

APPLICATIONS OVER CROPS OR TO AREAS FAVORING DRIFT OVER CROPS

Zenivex® E4 RTU may be applied over crops (including row, tree, fruit, citrus, pasture and other areas where agricultural enterprises take place) or to areas, where drift over cropland could occur. **Zenivex® E4 RTU** can be applied to these areas by either ground or aerial application. Use label rates and follow directions for use as directed in this label. Applications over crops or where drift may occur over crops are limited to 4 applications per month to the same site but no more than two applications within a seven day interval. Do not apply more than 0.028 pounds of active ingredient per month to the same site within a month. Do not spray more than 0.18 lbs etofenprox per acre per site per year. Do not make more than 25 applications per site per year.

PESTICIDE STORAGE AND DISPOSAL

Do not contaminate water, food, or feed by storage or disposal.

STORAGE AND SPILL PROCEDURES: Store upright at room temperature. Avoid exposure to extreme temperatures. In case of spill or leakage, soak up with an absorbent material such as sand, sawdust, earth, fuller's earth, etc. Dispose of with chemical waste.

PESTICIDE DISPOSAL: Wastes resulting from the use of this product must be disposed of on site or at an approved waste disposal facility.

CONTAINER DISPOSAL: Refillable 30 Gallon Drums, 120 Gallon Mini-Tote and 275 Gallon Tote: Refillable container. Refill this container with pesticide only. Do not reuse this container for any other purpose. Cleaning the container before final disposal is the responsibility of the person disposing of the container. Cleaning before refilling is the responsibility of the refiller. If not refilled, offer for recycling if available, or puncture and dispose of in a sanitary landfill, or by incineration. To clean the container before final disposal, triple rinse (or equivalent) promptly after emptying. Triple rinse as follows: Empty the remaining contents into application equipment or a mix tank. Fill the container ¼ full with mineral oil or other suitable oil diluents. Replace and tighten closures. Tip container on its side and roll it back and forth, ensuring at least one complete revolution, for 30 seconds. Stand the container on its end and tip it back and forth several times. Turn the container over onto its other end and tip it back and forth several times. Empty the rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Repeat this procedure two more times. **Non-refillable 2.5 gallon containers: Non-refillable container.** Triple rinse (or equivalent), promptly after emptying. Triple rinse as follows: Empty the remaining contents into application equipment or mix tank and drain container for 10 seconds after the flow begins to drip. Fill the container ¼ full of with mineral oil or other suitable oil diluents and recap. Shake for 10 seconds. Pour rinsate into application equipment or a mix tank. Drain container for 10 seconds after the flow begins to drip. Repeat this procedure two more times. Once triple rinsed, recycle if available, or puncture and dispose of in a sanitary landfill, or by incineration.

To the extent consistent with applicable law, seller makes no warranty, expressed or implied, concerning the use of this product other than indicated on the label. Buyer assumes all risks of use and handling of this material when such use and handling are contrary to label instructions.

In case of an emergency or for product use information, call **1-800-248-7763**.

www.zenivex.com

Wellmark International
1501 East Woodfield Road 200W
Schaumburg, Illinois 60173

ZOËCON. Professional Products

VEC 14-006

January, 2014
Schaumburg, IL

FOR USE IN ORGANIC PRODUCTION

For control of adult mosquitoes in Outdoor Residential, Recreational and Agricultural Areas
Contains pyrethrins - a botanical insecticide derived from chrysanthemums

ACTIVE INGREDIENT:	
Pyrethrins: a botanical insecticide	5.0%
OTHER INGREDIENTS*	95.0%
	100.0%

Contains 0.41 pounds Pyrethrins per gallon
*contains petroleum distillate

KEEP OUT OF REACH OF CHILDREN

CAUTION

FIRST AID	
Have product container or label with you when calling a poison control center or doctor, or going for treatment. **For medical emergencies or information on health concerns for this product, you may call 1-800-214-7753.**	
IF SWALLOWED:	• Immediately call a poison control center or doctor. Do not induce vomiting unless told to do so by a poison control center or doctor. Do not give **any** liquid to the person. Do not give anything by mouth to an unconscious person.
NOTICE TO PHYSICIAN: Contains petroleum distillate. Vomiting may cause aspiration pneumonia.	

PRECAUTIONARY STATEMENTS:

HAZARDS TO HUMANS AND DOMESTIC ANIMALS

CAUTION. Contains petroleum distillate. Harmful if swallowed. Wash hands thoroughly with plenty of soap and water after handling and before eating, drinking, chewing gum, using tobacco or using the toilet. Remove and wash contaminated clothing before reuse. Prolonged or frequently repeated skin contact may cause allergic reactions in some individuals.

Personal Protective Equipment (PPE): Mixers, loaders, applicators and other handlers must wear the following: long-sleeve shirt, long pants, shoes and socks. In addition, all handlers, except for applicators using truck-mounted or aerial application equipment, must wear chemical resistant gloves (such as barrier laminate, nitrile rubber, neoprene rubber, Viton, Selection Category E). See engineering controls for additional requirements.

User Safety Requirements: Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables exist, use detergent and hot water. Keep and wash PPE separately from other laundry. Discard clothing and other absorbent materials that have been drenched or heavily contaminated with the product's concentrate. Do not reuse them.

User Safety Recommendations: Users should wash hands before eating, drinking, chewing gum, tobacco, or using the toilet. Users should remove clothing/PPE immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing. Users should remove PPE immediately after handling this product. As soon as possible, wash thoroughly and change into clean clothing.

Engineering Controls: Pilots must use an enclosed cockpit that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides [40 CFR 170.240(d)(6)]. Human flagging is prohibited. Flagging to support aerial application is limited to use of the Global Positioning System (GPS) or mechanical flaggers.

ENVIRONMENTAL HAZARDS

This pesticide is toxic to aquatic organisms, including fish and aquatic invertebrates. Runoff from treated areas or deposition of spray droplets into a body of water may be hazardous to fish and aquatic invertebrates. Do not apply over bodies of water (lakes, rivers, permanent streams, natural ponds, commercial fish ponds, swamps, marshes or estuaries), except when necessary to target areas where adult mosquitoes are present, and weather conditions will facilitate movement of applied material away from the water in order to minimize incidental deposition into the water body. Do not contaminate bodies of water when disposing of equipment rinsate or wash waters.

Before making the first application in a season, it is advisable to consult with the state or tribal agency with primary responsibility for pesticide regulation to determine if other regulatory requirements exist.

This product is highly toxic to bees exposed to direct treatment on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds while bees are actively visiting the treatment area, except when applications are made to prevent or control a threat to public and/or animal health determined by a state, tribal or local health or vector control agency on the basis of documented evidence of disease-causing agents in vector mosquitoes, or the occurrence of mosquito-borne disease in animal or human populations, or if specifically approved by the state or tribe during a natural disaster recovery effort.

DIRECTIONS FOR USE

It is a violation of Federal Law to use this product in a manner inconsistent with its labeling.

USE RESTRICTIONS

Apply this product only as specified on this label. This product is not for use in outdoor residential misting systems. Do not apply this product with thermal fogging equipment. Do not apply this product in enclosed spaces using hand-held or portable backpack spray equipment. Do not make applications during rain.

Apply this product only as an aerial or ground ULV (vehicle-mounted, backpack, or hand-held ULV) mosquito adulticide.

For use only by federal, state, tribal or local government officials responsible for public health or vector control, or by persons certified in the appropriate category or otherwise authorized by the state or tribal lead pesticide regulatory agency to perform adult mosquito control applications, or by persons under their direct supervision.

IN CALIFORNIA: This product is to be applied by County Health Department, State Department of Health Services, Mosquito and Vector Control or Mosquito Abatement District personnel, or persons under contract to these entities only.

IN FLORIDA: Aerial applications of this product require trained personnel to perform industry accepted assays to monitor resistance/tolerance in targeted mosquitoes.

The maximum application rate for wide-area mosquito adulticide applications is 0.0025 lb a.i./acre per day. When targeting *Aedes taeniorhynchus* and other difficult species, applications may be made up to 0.008 lb a.i./acre/day.

Do not apply more than 0.2 lb a.i. per acre per year in any treated area. More frequent treatments may be made to prevent or control a threat to public and/or animal health determined by a state, tribal, or local health or vector control agency on the basis of documented evidence of disease-causing agents in vector mosquitoes or the occurrence of mosquito-borne disease in animal or human populations, or if specifically approved by the state or tribe during a natural disaster recovery effort.

WIND SPEED: Apply only when wind speed is greater than 1 mph.

MERUS 2.0 may be used undiluted or diluted with suitable light mineral oil and applied as an ultra low volume (ULV) non-thermal aerosol (cold fog) or in suitable mechanical spray equipment. MERUS 2.0 cannot be diluted in water.

MERUS 2.0 may be used to control adult mosquitoes in mosquito control programs including residential, industrial, recreational, and agricultural areas, in vegetation surrounding swamps, marshes, overgrown waste areas, roadsides and pastures and other areas adult mosquitoes occur. For best results, treat when mosquitoes are most active. Application during the cool hours of the night or early morning is usually preferable, with a minimum application temperature of 50°F.

SPRAY DRIFT MANAGEMENT for WIDE AREA MOSQUITO ABATEMENT: A variety of factors including weather conditions (e.g., wind direction, wind speed, temperature, relative humidity) and method of application (e.g., ground, aerial) can influence pesticide drift. The applicator must evaluate all factors and make appropriate adjustments when applying this product.

GROUND-BASED WIDE-AREA MOSQUITO ABATEMENT APPLICATION:

Spray equipment must be adjusted so that the volume median diameter is less than 30 microns (Dv 0.5 < 30 µm) and that 90% of the spray is contained in droplets smaller than 50 microns (Dv 0.9 < 50 µm). Directions from the equipment manufacturer or vendor, pesticide registrant, or a test facility using a laser-based measurement instrument must be used to adjust equipment to produce acceptable droplet size spectra. Application equipment must be tested at least annually to confirm that pressure at the nozzle and nozzle flow rate(s) are properly calibrated.

To control mosquitoes, apply MERUS 2.0 using any standard ULV vehicle-mounted applicator capable of producing a non-thermal (cold fog) aerosol spray cloud with appropriately sized droplets. Apply undiluted at a flow rate of 3.0 to 4.7 fluid ounces per minute at an average vehicle speed of 10 mph. If a different vehicle speed is used, adjust rate accordingly. These rates are equivalent to 0.0016 to 0.0025 pounds active ingredient per acre. Within this range, vary flow rate according to vegetation density and mosquito population. Use higher rate in heavy vegetation or when pest population numbers are high.

AL0409

Rates to use MERUS 2.0 Undiluted for mosquito control:

a.i./Acre (lb)	Application Rates (Fl.oz./Minute) at vehicle speeds of:				MERUS 2.0 / Acre (Fl.oz.)
	5 MPH	10 MPH	15 MPH	20 MPH	
0.0025	2.4	4.7	7.1	9.5	0.78
0.0021	2.0	4.0	6.0	7.9	0.66
0.0018	1.7	3.4	5.1	6.8	0.56
0.0016	1.5	3.0	4.5	6.1	0.50

Applications up to 2.50 fl.oz. (0.008 lb a.i.) per acre may be made when targeting *Aedes taeniorhynchus* or other difficult to control species.

a.i./Acre (lb)	Application Rates (Fl.oz./Minute) at vehicle speeds of:				MERUS 2.0/ Acre (Fl.oz.)
	5 MPH	10 MPH	15 MPH	20 MPH	
0.008	7.6	15.1	22.7	30.3	2.50

If dilution is preferred, adjust the flow rate accordingly to achieve 0.0016 to 0.0025 pounds a.i./ Acre. Applicable flow rates for a 1 part concentrate to 1 part oil dilution are presented. If an alternate dilution rate is used, adjust the flow rate accordingly.

Rates to use a 2.5% pyrethrins dilution (1 to 1 dilution ratio) for mosquito control:

a.i./Acre (lb)	Application Rates (Fl.oz./Minute) at vehicle speeds of:				Finished Spray / Acre (Fl.oz.)
	5 MPH	10 MPH	15 MPH	20 MPH	
0.0025	4.7	9.5	14.2	18.9	1.56
0.0021	4.0	7.9	11.9	15.9	1.31
0.0018	3.4	6.8	10.2	13.6	1.12
0.0016	3.0	6.1	9.1	12.1	1.00

Urban ULV mosquito control: for control of resting or flying adult mosquitoes in areas such as utility tunnels, pipe chases, underground basements, underground passages, parking decks, crawl spaces or uninhabited buildings. Apply using handheld or truck-mounted ULV equipment, or other spray equipment suitable for this application. Apply at rates up to but not exceeding 0.0025 pounds a.i. per acre per day (0.78 fluid ounces of undiluted spray per acre per day). Do NOT use hand-held equipment for this type of application in enclosed spaces.

MERUS 2.0 may also be applied with non-thermal, portable, motorized backpack equipment adjusted to deliver ULV particles of less than 100 microns VMD. Use 0.50 to 0.78 fl.oz. of the undiluted spray per acre (equal to 0.0016 to 0.0025 lb ai./acre) as a 50 ft (15.2 m) swath while walking at a speed of 2 mph (3.2 kph). Dilute with a suitable mineral oil if dilution is preferred. Do NOT use portable backpack equipment for application in enclosed spaces.

AERIAL WIDE-AREA MOSQUITO ABATEMENT APPLICATION:

Spray equipment must be adjusted so that the volume median diameter produced is less than 80 microns (Dv 0.5 < 80 µm) and that 90% of the spray is contained in droplets smaller than 80 microns (Dv 0.9 < 80 µm). The effects of flight speed, and for non-rotary nozzles, nozzle angle on the droplet size spectrum must be considered. Directions from the equipment manufacturer or vendor, pesticide registrant, or a test facility using a wind tunnel and laser-based measurement instrument must be used to adjust equipment to produce acceptable droplet size spectra. Application equipment must be tested at least annually to confirm that pressure at the nozzle and nozzle flow rate(s) are properly calibrated.

Apply using nozzle height of no less than 100 feet for fixed wing aircraft or 75 feet for rotary wing aircraft above the ground or canopy, unless specifically approved by the state or tribe based on public health needs.

Apply by suitable fixed wing or rotary aircraft equipped with nozzles capable of producing a non-thermal (cold fog) aerosol spray cloud with appropriately sized droplets. Flow rate and swath width should be set so as to achieve 0.50 to 0.78 fluid ounces of undiluted MERUS 2.0 per acre.

a.i./Acre (lb)	MERUS 2.0 / Acre (Fl.oz.)
0.0025	0.78
0.0021	0.66
0.0018	0.56
0.0016	0.50

MERUS 2.0 may also be diluted with suitable diluent light mineral oil and applied by suitable aircraft at appropriate flow rates to achieve a dosage of 0.0016 to 0.0025 lb a.i. per acre. Diluted or undiluted, applications up to 2.50 fl.oz. MERUS 2.0 (0.008 lb a.i.) per acre/day may be made when targeting *Aedes taeniorhynchus* or other difficult to control species.

STORAGE AND DISPOSAL

Do not contaminate water, food or feed by storage or disposal.

PESTICIDE STORAGE AND SPILL PROCEDURES: Keep this product in its tightly closed original container when not in use. Store upright at room temperature in a dry (preferably locked) area that is inaccessible to children and animals. Avoid exposure to extreme temperatures. In case of spill or leakage, soak up with an absorbent material such as sand, sawdust, earth, fuller's earth, etc. Dispose of with chemical waste.

PESTICIDE DISPOSAL: Wastes resulting from the use of this product must be disposed of on site or at an approved waste disposal facility.

CONTAINER HANDLING:

(For Nonrefillable Containers of 5 gallons or less)

Nonrefillable container. Do not reuse or refill this container. Triple rinse container (or equivalent) promptly after emptying. Triple rinse as follows: Empty the remaining contents into application equipment or a mix tank and drain for 10 seconds after the flow begins to drip. Fill the container 1/4 full with mineral oil and recap. Shake for 10 seconds. Pour rinsate into application equipment or a rinse tank or store rinsate for later use or disposal. Drain for 10 seconds after the flow begins to drip. Repeat this procedure two more times. Offer for recycling if available or reconditioning if appropriate, or puncture and dispose of in a sanitary landfill, or by other procedures approved by state and local authorities.

(For Nonrefillable Containers over 5 gallons)

Nonrefillable container. Do not reuse or refill this container. Triple rinse container (or equivalent) promptly after emptying. Triple rinse as follows: Empty the remaining contents into the application equipment or a mix tank. Fill the container ¼ full with mineral oil. Replace and tighten closures. Tip container on its side and roll it back and forth, ensuring at least one complete revolution, for 30 seconds. Stand the container on its end and tip it back and forth several times. Turn the container over onto its other end and tip it back and forth several times. Empty the rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Repeat this procedure two more times. Offer for recycling if available or reconditioning if appropriate, or puncture and dispose of in a sanitary landfill, or by other procedures approved by state and local authorities.

(For Refillable Containers)

Refillable container. Refill this container with pesticide only. Do not reuse this container for any other purpose. Cleaning before refilling is the responsibility of the refiller. To clean the container before final disposal, empty the remaining contents from this container into application equipment or mix tank. Fill the container about 10 percent full with water. Agitate vigorously or recirculate water with the pump for 2 minutes. Pour or pump rinsate into rinsate collection system. Repeat this rinsing procedure two more times. Then offer for recycling, if appropriate, or puncture and dispose of in a sanitary landfill or by other procedures approved by state and local authorities.

NOTICE: To the extent consistent with applicable law, Clarke Mosquito Control Products, Inc. makes no other warranties, express or implied, of merchantability or of fitness for a particular purpose or otherwise, that extend beyond the statements made on this label. To the extent consistent with applicable law, Buyer assumes all risk of use/handling of this material when use and/or handling is contrary to label instructions.

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AL0409

Appendix H MMCD Technical Advisory Board Meeting February 21, 2018

TAB Members Present:
Sarma Straumanis, MN Department of Transportation
Greg Cremers (substitute for Christine Wicks), MN Dept. of Agriculture
Don Baumgartner, US EPA (remote link)
John Moriarty, Three Rivers Park District
Phil Monson, MN Pollution Control Agency
Gary Montz, MN Dept. of Natural Resources
David Neitzel, MN Department of Health
Robert Sherman, Independent Statistician
Vicky Sherry, US Fish and Wildlife Service
Susan Palchick, Hennepin County Public Health

Absent- reviewed document and contributed comments:
Roger Moon, University of Minnesota

MMCD Staff in Attendance: Stephen Manweiler, Nancy Read, Sandy Brogren, Janet Jarnefeld, Kirk Johnson, Carey LaMere, Mike McLean, Mark Smith, John Walz, Molly Nee, Jennifer Crites, Arleen Schacht, Jennifer Macchia

Guests: Erin Kough (MDH), Elizabeth Schiffman (MDH), Molly Peterson (MDH), Jenna Bjork (MDH), Chris Smith (MnDOT)

(Initials in the notes below designate discussion participants)

Welcome and Call to Order

Chair Sarma Straumanis (serving in place of Roger Moon, who could not attend) called the meeting to order at 12:30 p.m. All present introduced themselves. Sarma then introduced MMCD Entomologist, Sandy Brogren.

2017 Season Overview

Sandy Brogren started with a season overview and introduction to the mosquitoes found in the District, including spring *Aedes*, summer *Aedes*, cattail mosquitoes, and *Culex* species. The year 2017 had a warm winter and little precipitation until April-May, then more rain again in late summer. The cattail mosquito average in our weekly CO_2 trap collection was the highest since we've been running the traps (17 years), higher than the predicted amount from the rainfall-based model developed by Roger Moon.
SP – geographic distribution of cattail adults?
SB showed maps of weekly distribution of trap counts.
RS – how many traps? How to fill areas between traps, can be challenging. NR – we use inverse distance weighting to make these maps.
SB continued with forecasts for temperature and precipitation, looks like normal expectations March through August, expect warm September-November. She also commented on her upcoming retirement and how it's been a pleasure working with the TAB.

Kirk Johnson reviewed status of mosquito borne diseases. There were eight WNV cases, including one fatality, in District residents. There was one LAC case in MN, just outside the District boundary. We continue to put in effort to prevent LAC through tire and container removal. Kirk described the Jamestown Canyon virus life cycle, and that this is a current area of research. There were four cases diagnosed in District residents.
GM – the 70 U.S. cases, is that in part because there are places that are not submitting tests? Or is it really that low frequency?
DN – people haven't been looking because the tests weren't available, now they are and we are finding more.

Janet Jarnefeld presented background and current status of our tick-borne disease surveillance work. Tick numbers were down from 2016 but still quite high historically. Collected fewer mammals in 2017, also fewer *Dermacentor*. Looked at history since 1990 for overall increasing trend.

Carey LaMere presented an overview of black fly program. She showed locations of monitoring and treatment and described the surveillance done. In 2017, streams and rivers started out at average levels but went up over the course of the year. Treatments were done, and adult counts were second lowest since treatment started. Nontarget monitoring was done, and we are testing a different multiplate design.
[RM comments prior to meeting – test of different multiplate designs is sensible.]

There were no further questions from the TAB about the overviews.

Control Strategies and Expense Reductions

Stephen Manweiler presented on the financial status of MMCD and choices that were made regarding the mosquito control program that helped balance our income and expenses and try to make sure we have sufficient reserves for operations, after spending much of our reserves to deal with several years of high rainfall. He described several steps that were taken and estimates of how much was saved by each. Overall savings met the goal of reducing expense by over $1 million.

SM then presented a comparison of cattail mosquito collection in groups of CO_2 traps showing increased cattail populations in 2017 throughout the District. Counts in "Priority 1" area (P1) (highest human population density) were typically lower than in "Priority 2" area (P2) (lower human population density). He also described how treatments for floodwater mosquitoes have been more targeted to portions of large sites. In addition, we have stayed at a dose of 5 lb/acre through most of the summer instead of increasing to 8 lb when the vegetation got larger, and post-treat dips showed reasonable efficacy throughout the season. Comparison of the CO_2 trap groups showed lower numbers of summer floodwater mosquitoes in 2017 than in 2016.

Nancy Read discussed spring *Aedes* control and changes made to reduce costs. In 2016 we made over 40,000 acres of *Bti* treatments, including 10,000 acres outside P1. In 2017 we did no treatments outside P1. Comparison of trap results suggests there was no measurable change in the low numbers of this species group in CO_2 traps in P1. Trap counts were highly variable over time and location, with the north-eastern area of the District (mostly P2) having the most

consistent high counts. Recent years have had low counts for this species group in both CO_2 traps and sweep collections. She also discussed the relationship between sweep collections and calls. This lead to a brief discussion of the role of thresholds in treating spring *Aedes*.
SP – How many blood meals do spring *Aedes* mosquitoes take over their lifespan? This would be worth searching the literature, difference in blood meals gives an idea of how much difference there should be in thresholds, and also what their impact is likely to be as disease vectors.
SP, DN – How is Priority 1 boundary set, how often does it change? NR – Set by population density information we get through Metropolitan Council, updated annually as needed.
The focus is to make sure the District is allocating resources to minimize risk to the greatest number of people.

Nancy then discussed preliminary work exploring the relationship of snow cover data to spring mosquito numbers over time. Looking at the historical record, 2008 had high numbers of spring *Aedes* and we have not yet determined why that would be. While lack of snow seems to be related to lower spring *Aedes* counts, there was not a clear relationship of high mosquito numbers with high snow amounts, and we hope to look at other variables that could be added to improve predictions.
PM – Suggested looking at adding fall soil moisture records relating to the amount of water found in the vernal pools that make up spring *Aedes* habitat.
[RM comments prior to meeting – was there a shift in species between years? NR – will test when we have data sets assembled better for long-term analysis. RM also suggested NR and SB work with him on refinements to cattail predictive model and exploring spring *Aedes*.]

Stephen Manweiler said in 2018, MMCD plans to maintain the cost savings steps done in 2017. In addition, we are modifying our prehatch use to try to expand cattail treatments. Studies done in 2012 suggest that Natular could last longer than 30 days, so we are going to try treating every 6 weeks or after 4 rains. This would allow us to shift pellet treatments to expand cattail treatments.

(Break – 1:05 to 1:30)

Kirk Johnson presented information on a test of Sumilarv 0.5G, active ingredient (AI) is pyriproxyfen, an insect growth regulator, in catch basins. This was a pre-registration test. The intent of the test (4 done in US) was to find lowest dose that would be active for whole summer. The AI tends to adhere to structures. Advantages for us would be a single season-long treatment, and an alternative AI (reduce resistance risk). He described experimental design and results (see report). Very good control was found at all doses throughout the season.
JM –in my neighborhood, cb goes to wetland in my backyard? How is that figured in?
Any studies done re material in outflow? KJ – another research group is working on that, very important to us. Manufacturer thinks it will.
JM – will it affect other species? Odonates? KJ – nontarget studies available, chronic exposure, but in our scenario might be acute, might affect river as well as wetlands.
PM – might be able to go with a lower dose. What have you seen re testing, concentrations, analytical results, LC50s? KJ – quite a bit of research out there, WHO recommends use in non-permanent water.
RS – any idea of product cost? KJ – not known now.

PM – not registered in the US? Consider contacting MPCA, MDA.
GC – experimental use permit? [also a question from Don B.]
GC – where are your products stored? SM – described primary warehouses. GC – we have a compliance assistance program re: storage.
SM – we have been looking for "holy grail" of one-time per season catch basin treatment, Natular was flushed out and had questions re impacts on mussels and clams. This material, if it is developed, would be further evaluated for nontarget impacts and we would bring that info back to this group.
[RM comments prior to meeting – treatment and location were confounded in this design, if you do this again mix the treatments within each location, avoids problems with rainfall differences between locations.]

Discussion and Resolutions
Chair Sarma Straumanis asked for further discussion and any resolutions that the TAB would like to make to communicate with the MMCD Commissioners.

DN made the following
MOTION: The TAB thanks MMCD's Entomologist, Sandy Brogren, for her many years of work building up the lab and surveillance systems to a level recognized as one of the best in the country and reaffirms the importance of this work to generate an understanding of mosquito biology essential to managing an effective, efficient, and environmentally sound mosquito control program.
Second – Susan P.
Discussion – we've seen how important this information is in what's been reported here today and appreciate the work that has gone into this over the years.
Motion carried unanimously.

JM made the following
MOTION: The TAB supports the MMCD's review of raising the threshold for spring *Aedes*, with consideration for targeting areas where these mosquitoes are most likely to affect human populations.
Second by GM.
Discussion:
DN- encourage that treatments be more targeted to areas most at risk, especially given potential for Jamestown Canyon virus.
Motion passed without dissent.

Bob S. brought up this topic for discussion, and offered the following
MOTION: The TAB recommends MMCD review current developments regarding CRISPR-Cas9 and gene drive techniques being used in the control of mosquitoes and ticks.
Second – JM
Discussion – this came up regarding Zika response in other parts of the world, targeting *Aedes aegypti*.
RS- this technique can change the genome of the organism, very powerful but raises certain concerns. Hundreds of articles in the last year on this technique.

GM – DNR has been aware of this regarding control of aquatic invasive species, will need a lot more information and input from beyond the TAB. Concern is that once it is released, it's out there and can't get it back.
SM – can get information, it's a new frontier. The more we know the better off we are.
SP – note that this motion implies literature review, not experiments.
Motion passed without dissent.

After discussion of procedure, JM made following
MOTION: The TAB supports the program presented in the 2017 Operational Review and 2018 Plan and acknowledges the efforts of the MMCD staff on its presentation.
Second - RS
Motion passed without dissent.

Reaffirming the TAB's direction from last year, SS made the following
MOTION: The TAB commends MMCD for its efforts to improve the cost efficiency of its programs while continuing to protect public health through vector control, and considering long-term environmental effects of its programs.
Second - RS
Motion passed without dissent.

Discussion followed regarding the Rusty Patch Bumble Bee, which is now listed as an endangered species. The metro area has a number of "high potential zones" "where presence should be presumed for ESA section 7 purposes" (See map at https://www.fws.gov/midwest/endangered/insects/rpbb/rpbbmap.html).
Chris Smith reported MnDOT is taking steps to avoid and minimize disturbance and consults with the USFWS Minnesota-Wisconsin Field Office for its activities. Chris suggests MMCD contact USFWS Minnesota-Wisconsin Field Office regarding what to do about it. JM suggested considering an "incidental take" permit, listing steps you will take to prevent impacts. Chris noted that some male bees rest on plants at night (i.e., they do not return to the colony), something to consider re: fogging. Vicky said on the Refuge they worked out ways to do non-lethal bumble bee surveys to avoid "taking" the endangered bees. She offered to contact the USFWS endangered species coordinator about what steps MMCD should consider. Chris mentioned that another bumble bee species (yellow banded) is under consideration for endangered status.

TAB adjourned 3:35 p.m.

Next chair will be the representative from MN Dept. of Agriculture (Christine Wicks).

Our Mission

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.

Our Vision

Our Values

We value integrity, trust, cooperation, respect and competence in our interactions with colleagues and customers.

mmcd
METROPOLITAN MOSQUITO CONTROL DISTRICT

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