Table of Contents

Executive Summary

The Metropolitan Mosquito Control District (MMCD) promotes health and well-being by protecting the public from disease and annoyance caused by mosquitoes, black flies, and ticks, in an environmentally sensitive and cost-effective manner. This report presents how MMCD staff carried out this mission in 2024 through surveillance, disease monitoring, control measures, product testing, data management, public communication, and other projects. It also presents plans for 2025 as we continue to provide an integrated pest management program for the benefit of all District residents.

Mosquito Surveillance

The winter of 2023-24 was warmer than average with very little snow cover for most of the season. Precipitation began to increase heading into spring and was then followed by the wettest summer Minnesota has experienced in several years. Between April 28 and September 28, 27.08 inches of rain fell across the District, which is well above the average of 19.64 inches and a significant increase over the preceding three years which all had periods of drought.

Adult spring *Aedes* emerged May 13 and peaked June 11. Spring *Aedes* mosquitoes were substantially above average in 2024 for the second year in a row. Summer *Aedes,* which are the primary pest mosquitoes in most years, began their main emergence on May 21 and they peaked on June 3. Despite heavy rains, adult summer *Aedes* numbers did not surpass the 24-year average after May.

Numbers of adult *Culex tarsalis*, a potential vector, were much higher than average. Numbers of adult *Culex salinarius*, a salt-tolerant potential vector species uncommon in our area, were unusually high. Another uncommon salt-tolerant species, *Aedes dorsalis*, also was found in unusually high numbers in 2024, suggesting possible habitat chemistry changes.

Populations of the cattail mosquito, *Coquillettidia perturbans*, which depend on adequate water levels in their marsh larval habitat from the previous fall through adult emergence in early July, were well below normal, but about what was expected based on previous history. Cattail mosquito numbers are predicted to spike significantly in 2025.

Mosquito- and Tick-borne Disease

Mosquito-borne illnesses such as La Crosse encephalitis (LAC), western equine encephalitis (WEE), eastern equine encephalitis (EEE), West Nile virus (WNV), and Jamestown Canyon virus (JCV) occur in Minnesota, as well as tick-borne illnesses such as Lyme disease and human anaplasmosis. District staff provide disease surveillance and control services, as well as public education, to reduce the risk of these diseases.

For LAC prevention we survey wooded areas for the primary vector, reduce larval habitats such as containers and tires, and if needed treat with adulticides. After low populations during the drought, the numbers of LAC vectors increased dramatically. Only one human case was reported to the Minnesota Department of Health, however, in Wright County, bordering the District.

For WNV prevention, we collect adult mosquitoes and test for presence of the virus as an early warning, conduct larval control, and, if needed, adult control where vector species are found. We conducted 1,200 tests and found the minimum infection rate peaked at 12.3 per 1,000 mosquitoes, and only averaged 2.14 per 1,000 over the season, a relatively low rate. There were eight WNV cases reported in District residents, slightly below average. The virus flourishes in hot, dry conditions, so the cool, wet summer may explain the lessened number of WNV detections in humans and mosquitoes.

The District continued monitoring the distribution of ticks in the metro area. In 2024, the District again collected *I. scapularis* (deer ticks) from at least one site in all seven counties. The average number of *I. scapularis* per mammal was 1.04 in 2024, which was slightly lower than 2023, though data is still being collected. A record number of *Amblyomma americanum*, also known as the "lone star tick," were collected in 2024. Thirty-three lone star ticks were collected in 2024 alone while a total of 55 had been collected in the previous 15 years combined (2009-2023).

Mosquito 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. In 2024, wet conditions increased the number of acres treated for larvae to levels not seen since 2016. The total acres of larvicide treatment (261,888) almost doubled that of 2023. This included over 61,000 acres to control spring species, a large increase over last year (46,000) and other recent drier years. Spring and summer treatments after rainfall totaled 178,358 acres, three times the amount used in last year's dry conditions, and similar to more normal rainfall years.

Over 274,000 street catch basin treatments were made to control potential vector *Culex* species, down from last year as staff tried to keep up with wetland treatments. Many of the wetlands treated for floodwater *Aedes* also had significant populations of vector *Culex* and contributed to the overall control of those species as well.

The wet conditions refilled the deeper cattail sites, and late-season sampling showed the number of acres with cattail mosquito larvae had rebounded quickly to record levels. Some of these sites were treated in the fall and the rest will be treated in 2025 before the larvae emerge as adults.

The number of larvicide acres treated by drone more than doubled, to 3,839 acres. Additional expansion is planned for 2025.

Adulticide treatments remain a small part of our program. Treatments were made with barrier spray or localized fog to 2,000 acres, an amount similar to recent years. Given that the risk of disease indicated by the minimum infection rate remained low, we did not choose to do more extensive truck-mounted fogging despite the high number of *Culex* adults.

Black Fly Control

MMCD applies *Bti* to streams and rivers when the larval population of the target black fly species meet the treatment thresholds, as outlined in our MnDNR permit. In 2024, the number of treatments was near the long-term average with 45 small stream treatments and 50 large river treatments. The very high-water flow in the Minnesota, Crow, and South Fork Crow rivers required a near-record number of gallons of *Bti*, and treatments were suspended at times due to safety concerns. The overall average adult black flies per sweep (1.13) was lower than the 1996-2023 average of 1.20.

Product and Equipment Testing

Evaluation of products, equipment, and processes is an important part of our program. In 2024, VectoBac® *Bti* was applied at varying dosage rates due to weather and program efficiency requirements. Mean efficacy as measured by checkbacks ranged from 79% at 5 lb/acre to 82% at 8 lb/acre. A smaller granule formulation was tested, and 94% efficacy was found. Evaluation of extended duration products like Natular® G30, CENSOR® G, and Duplex™-G was limited due to workload dealing with wet conditions. Staff plan to continue to evaluate these products in 2025. Helicopter and drone application equipment was calibrated to ensure accurate application rates prior to field treatments.

Data Management and Public Information

A major project to upgrade field and lab data entry in MMCD's enterprise data management system was completed, and virus data entry was added. Other specialized portions of the system are slated for upgrade in 2025 and 2026. A pilot project to start building new analysis tools got off to a successful start with multi-year graphs of adult mosquito abundance that made it easier to see the unusual species patterns in 2024.

Public reports of adult mosquito annoyance were the 3rd highest since 2014, peaking in early June in areas affected by the flooding of the Minnesota River. Requests for staff to check a larval site sank to a new low (198), while public hits on our self-service Public Web Map to see which sites have been checked and treated remained high (10,238 views). Calls to request tire recycling reached an all-time record high of 592 calls from residents. MMCD continued presentations to schools and community groups, and participated in fairs and parades, providing information and listening to the public. In addition, staff at MMCD collaborated with and presented to numerous local and national organizations to share our expertise in all things related to the control and management of mosquitoes, black flies, and ticks.

Chapter 1 *Mosquito Surveillance*

2024 Highlights

- The winter season was warm and relatively snow-free. Only 26.84 inches of snow fell, most of it in late March
- The spring/summer was wet; from May-September a total of 27.08 inches of rain accumulated
- There were 2 large spring snowmelt *Aedes* broods and 3 small, 6 medium, and 6 large summer *Aedes* broods
- 29,831 larval samples taken and 6,420 adult samples (excluding NJ trap samples)
- Adult spring *Aedes* detected May 13 and peaked June 11
- The summer *Aedes* emergence began May 21; despite heavy rains, populations were never above the 24-yr average after May
- *Cq. perturbans* were detected at the end of May and low levels occurred through August, well below the 24-yr average
- Predicted catch rate for *Cq. perturbans* for 2024 was 19.2/trap. The actual value was 15.3/trap. The prediction for 2025 is 87.9 per trap
- Biogents BG Pro vs current CO_2 trap being evaluated

2025 Plans

- Publish a paper on the mosquito fauna of the Twin Cities metropolitan area
- Long-Term CO_2 trap analysis in process

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. MMCD uses a variety of surveillance strategies 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-three known mosquito species occur in Minnesota, although one (*Aedes albopictus*) is reintroduced yearly, all with a variety of host preferences. Forty-nine species occur in the District, 24 of which are human biting. Other species prefer to feed on birds, large mammals, reptiles, amphibians, and even worms. Mosquitoes differ in their peak activity periods and in how strongly they are attracted to humans or trap baits (e.g., light, CO_2, or highly organic water); 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 common species) begin hatching in late April and early May in response to rainfall and warmer temperatures. Adults can lay multiple egg batches and live on average two weeks. *Coquillettidia perturbans* (the cattail mosquito) develops in cattail marshes. There is one emergence which begins in early June, peaking around the Fourth of July. Disease vectors include *Aedes triseriatus*, *Culiseta melanura*, and *Culex 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.

2024 Surveillance

Precipitation

Rainfall is a key factor for understanding floodwater mosquito populations and planning control efforts. Generally, rain amounts over one inch can induce a hatch of *Aedes* mosquitoes. For that reason, MMCD uses a network of rain gauges, read daily by staff or volunteers, to measure rainfall. The rainfall network was established over 60 years ago. These data are shared with the Minnesota State Climatologist's office for analysis. Currently, 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 Center (RFC) creates a 4x4 km grid of precipitation estimates based on a combination of NEXRAD (Next Generation Weather Radar), satellite, and ground rain gauge measures (including MMCD's gauges submitted through CoCoRaHS). This dataset is one of the best sources of timely, high resolution precipitation information available.

Average seasonal rainfall in the District is calculated from May-September using historical MMCD rain data and CoCoRaHS gauges. This time-period is referred to as the 'mosquito season'. Rainfall during the mosquito season (April 28-September 28, 2024) was 27.08 inches – well above the 65-year District average of 19.64 inches. April rainfall can influence adult emergence in May as well. The average precipitation for the weeks of March 24 through October 5, 2024 was 32.29 inches.

Figure 1.1 shows the sum of daily rainfall averages by week across the District from March 25-September 23, 2024. Weekly average rainfall greater than one inch occurred nine times from May through September. Two large rain events occurred the last two week of May and June had three major rain events, the biggest being the week of June 17 when an average of 4.45 inches fell. July had two major rain events, as did August. September was dry.

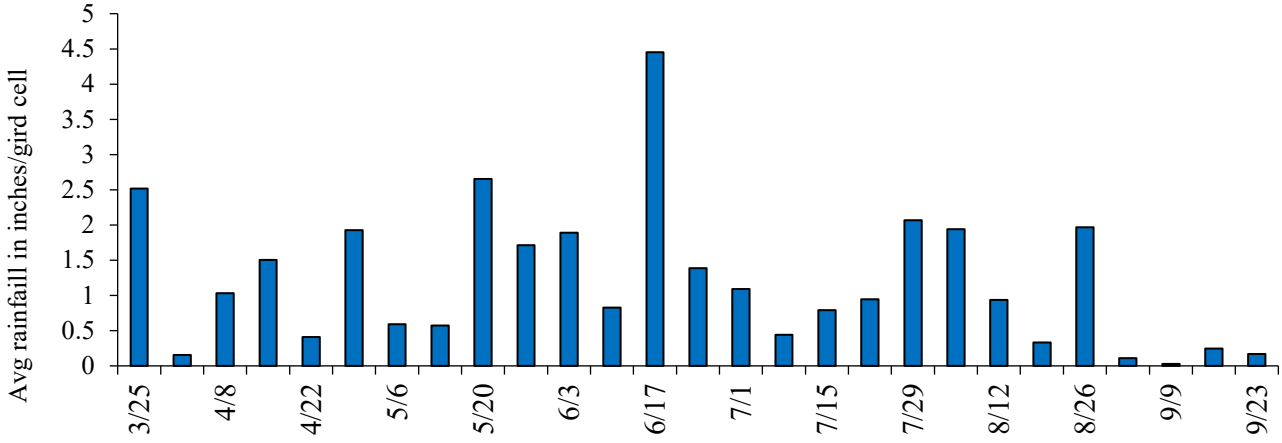


Figure 1.1 Sum of daily rainfall averages per week per grid cell, 2024 (RFC data). Dates represent the Monday of each week.

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. Figure 1.2 shows the temperature and precipitation departures from normal in 2024. The winter/spring of 2024 was the warmest on record averaging 29.9 degrees (the normal average is 19.6 degrees). Temperatures from January through May were all above the norm. February was a remarkable 12.7 degrees above the norm (Fig. 1.2). June, July, and August were slightly cooler than normal, while temperatures thereafter were above the norm into December. In fact, 2024 was the warmest year on record. The frost left the ground on April 9, and ice-out on Lake Minnetonka occurred March 13 – one month before the median ice-out date.

The MN Department of Natural Resources called the 2023-2024 winter season The Lost Winter (https://www.dnr.state.mn.us/climate/journal/lost-winter-2023-24.html). Only 26.84 inches of snow was recorded at the MSP airport, most of which happened in a late March snowfall. The Twin Cities normal average snowfall is 54 inches (from 1981-2010). There were two record setting stretches without precipitation: Sept 20-October 23 and February 16-March 20 (ranked 2nd and 3rd in Minnesota history). Those dry stretches were interspersed with a very wet April-August period when each month had precipitation above the norm. Total monthly rainfall in inches for April was 4.19, 5.81 in May, 7.27 in June, 5.37 in July, and 5.37 in August.

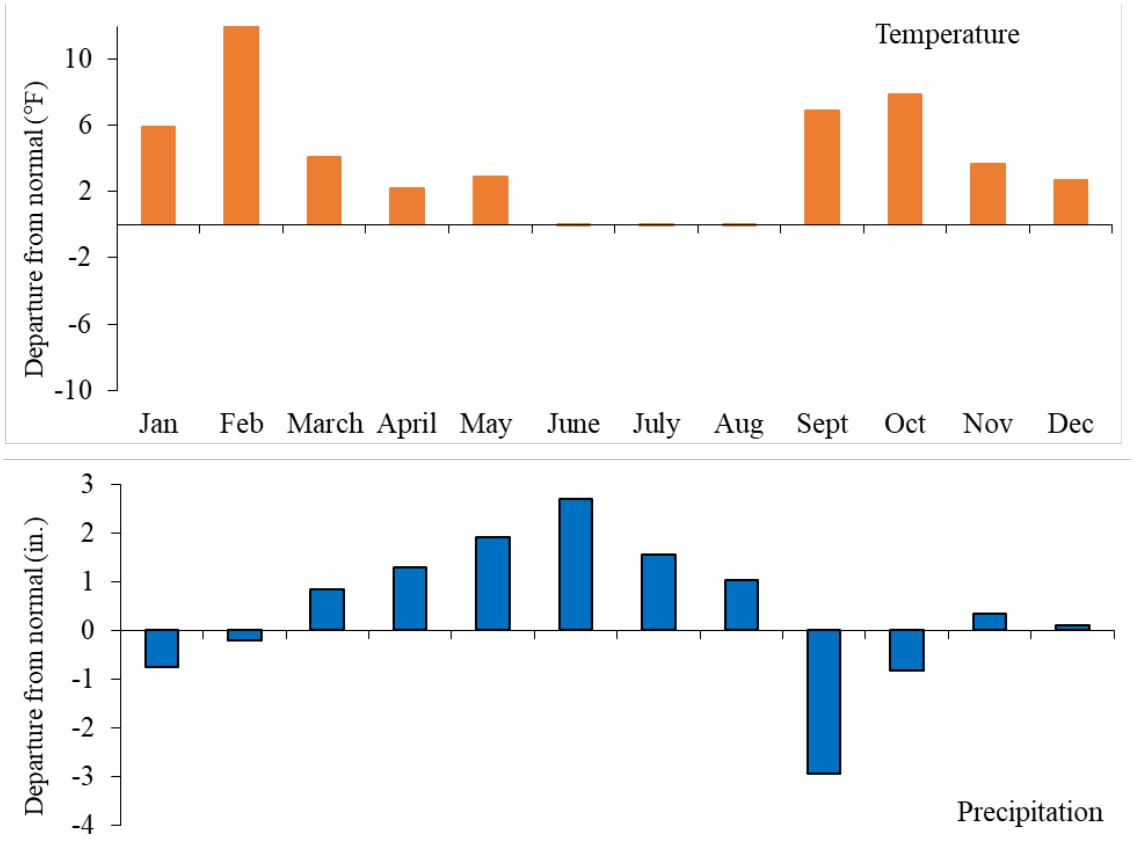


Figure 1.2 Monthly departures from normal for temperature and precipitation January-December 2024 (source: National Weather Service, Twin Cities Station).

Snowmelt and rainfall through early May triggered spring *Aedes* and floodwater *Aedes* to hatch. We treated a large spring brood (hatch) on April 30, 2024 and again on May 10, 2024. By May 12, the species composition transitioned to floodwater *Aedes*. There were 15 rain events sufficient to produce floodwater *Aedes* broods. Three small (<1,000 acres), six medium (1,000-9,999 acres), and six large (>10,000 acres) broods were treated. The actual area affected by rainfall, the amount of rainfall received, and the resultant amount of mosquito production and acreage treated by helicopter determines brood size. One of the small broods was in response to river flooding on the Minnesota River in mid-May. Figure 1.3 depicts the geographic distribution and magnitude of weekly rainfall received in the District from March 24-September 14, 2024. Since some weeks had multiple rain events, the cumulative weekly rainfall does not identify individual rain events. Medium to dark gray shading indicates rainfall greater than or equal to one inch, enough to initiate a brood.

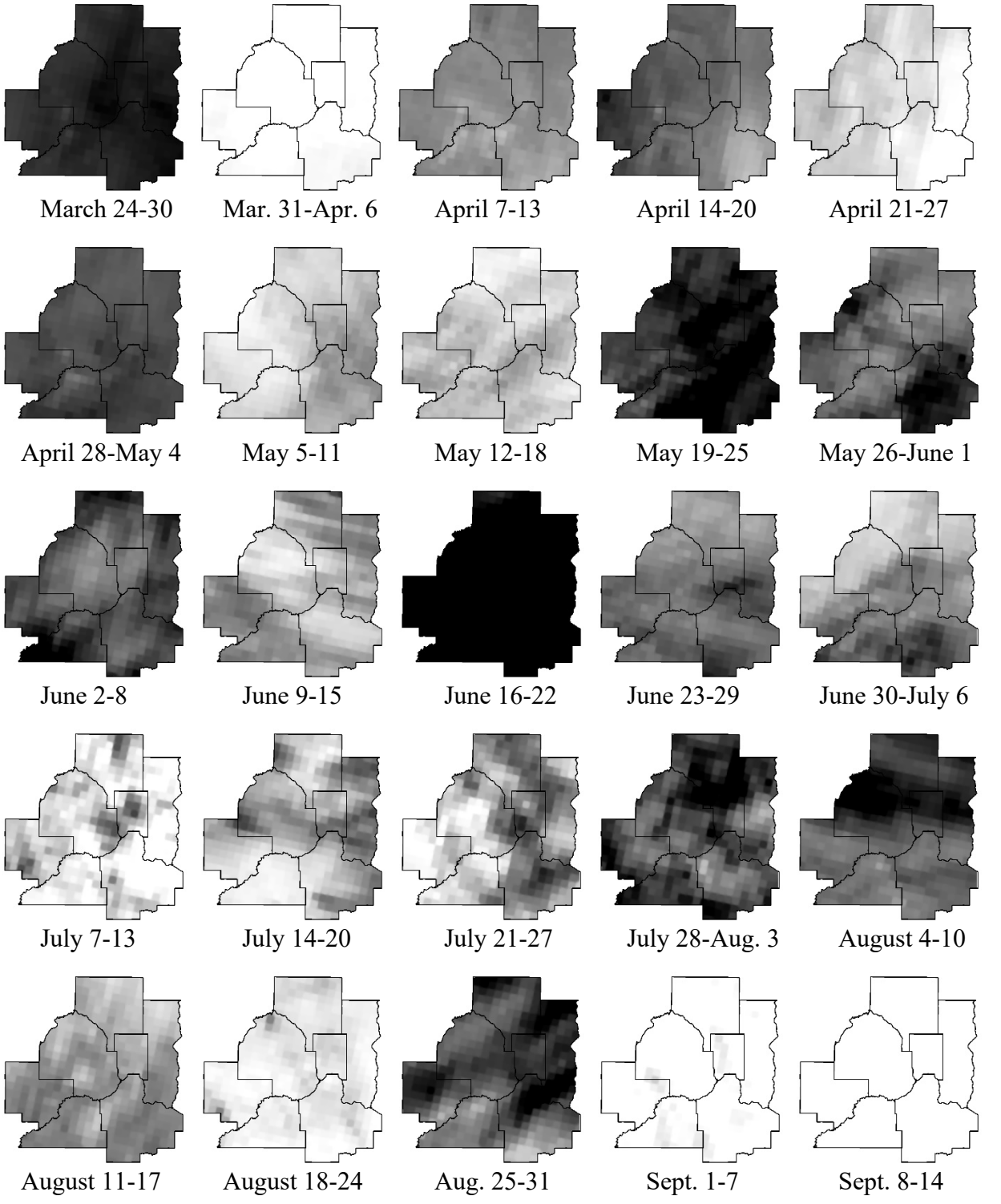


Figure 1.3 Weekly rainfall in inches, 2024. RFC-corrected data using 406 4x4 km grid cells. Inverse distance weighting was the algorithm used for shading maps.

Larval Collections

Larval mosquito inspections are conducted to determine if targeted species are present at threshold levels or to obtain species history in larval development sites. A variety of habitats are 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 10 dips is recorded as the number of larvae per dip. Larvae are submitted to MMCD's Entomology Lab for identification.

To expedite sample processing for high priority helicopter treatments (air sites), most larvae are identified to genus only, we identified the spring *Aedes* to species until May 12, when the prevalent larval species were summer floodwater *Aedes*. After that time, we returned to genera level identifications. *Culex* larvae are always identified to species to differentiate vectors and other *Anopheles*, *Culiseta*, *Psorophora*, and others are speciated when possible. Staff process lower priority samples as time permits and those are identified to species.

In 2024, field staff submitted 29,831 larval samples (Fig. 1.4). The 25-year average is 19,560 larval samples per year. From mid-May to the end of August, near weekly one-inch rainfalls resulted in staff sampling many sites for floodwater *Aedes*. At times, back-to-back broods occurred.

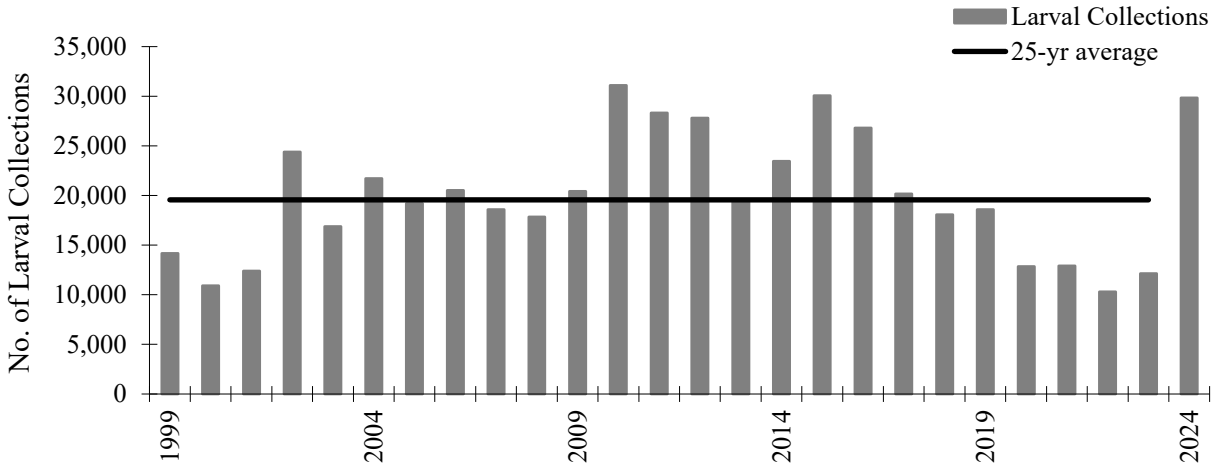


Figure 1.4 Yearly total larval collections, 1999-2024, and 25-year average. After 2015, container samples are included in these totals. Low sample numbers from 2020-2023 were due to low staffing levels during the COVID-19 pandemic and prevailing drought conditions from 2021-2023.

The results of 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 are from wetlands, but we also sample catch basins, stormwater structures, and other man-made features (e.g., swimming pools, culverts, and artificial ponds). Those results are displayed separately (shaded column) from the wetlands results in Table 1.1, which will be updated as soon as identifications are completed.

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, 2024; the total number of samples processed to species is in parentheses. Results are preliminary.

	Percent of samples where species occurred by facility							
Species	North (4,194)	East (4,284)	South Rosemount (2,386)	South Jordan (1,715)	West Plymouth (2,131)	West Maple Grove (2,263)	Wetland Total (16,973)	Structures Total (1,287)
Aedes abserratus	1.29	0.96	0.38	0.17	1.08	0.27	0.80	-
aurifer	0.26	0.23	-	-	0.19	0.22	0.18	-
canadensis	1.00	1.56	4.11	2.97	0.66	0.44	1.66	-
cinereus	9.97	11.16	9.81	13.94	13.05	12.28	11.34	1.32
dorsalis	0.02	0.12	0.25	0.12	0.19	0.18	0.13	0.23
excrucians	7.87	7.59	6.54	4.08	4.60	5.08	6.45	-
fitchii	1.34	1.45	1.01	0.58	0.19	0.27	0.95	-
flavescens	-	-	-	-	-	-	-	-
hendersoni	-	-	-	-	-	-	-	-
implicatus	0.26	0.07	0.08	0.29	0.05	-	0.13	-
intrudens	0.02	-	0.04	-	-	-	0.01	-
japonicus	0.33	0.28	0.29	-	0.09	0.04	0.21	9.63
nigromaculis	0.02	0.05	-	-	-	-	0.02	-
provocans	3.22	1.26	0.34	0.12	0.19	0.75	1.30	-
punctor	0.72	0.51	0.29	0.41	0.52	0.53	0.52	0.08
riparius	0.12	0.40	0.08	0.29	0.14	-	0.19	-
spencerii	-	-	-	-	-	-	-	-
sticticus	2.27	1.14	2.64	1.98	0.94	1.68	1.76	-
stimulans	14.88	15.22	19.03	10.96	7.70	9.10	13.48	-
triseriatus	0.05	0.02	-	-	0.05	0.09	0.04	0.62
trivittatus	0.33	1.59	2.98	1.28	0.70	1.59	1.33	0.31
vexans	20.96	20.73	26.99	18.83	12.39	19.31	20.24	10.96
Ae. unidentifiable	36.91	36.53	28.46	26.41	26.56	30.27	32.38	7.23
Anopheles earlei	-	-	-	-	-	-	-	-
punctipennis	2.67	2.08	1.30	1.05	1.74	1.59	1.90	1.32
quadrimaculatus	1.10	1.03	0.34	1.05	0.61	1.10	0.91	0.23
walkeri	0.05	0.02	-	-	0.05	0.04	0.03	0.08
An. unidentifiable	9.90	11.13	5.91	6.18	11.40	6.54	9.01	3.50
Culex erraticus	-	-	-	-	-	-	-	-
pipiens	4.63	5.32	3.14	5.95	8.40	9.41	5.84	51.44
restuans	14.95	15.22	13.12	19.48	24.68	14.36	16.36	69.23
salinarius	0.79	0.89	0.46	0.76	0.66	0.27	0.68	0.70
tarsalis	1.36	1.19	1.26	1.40	2.21	1.63	1.45	1.01
territans	40.41	34.36	27.95	34.29	44.63	33.85	36.17	12.35
Cx. unidentifiable	4.51	5.44	3.23	7.06	10.18	4.77	5.57	50.19
Culiseta inornata	10.97	15.45	17.35	21.98	20.18	14.63	15.75	3.65
melanura	-	-	-	-	-	-	-	-
minnesotae	0.55	0.82	0.13	0.17	0.80	0.35	0.52	0.23
morsitans	0.10	0.07	-	0.06	-	-	0.05	-
Cs. unidentifiable	2.65	3.06	0.63	1.69	3.19	1.94	2.34	0.54
Or. signifera	-	-	-	-	-	-	-	-
Ps. ciliata	-	-	-	-	-	-	-	-
ferox	-	0.07	0.08	0.17	-	0.04	0.05	-
horrida	-	0.02	-	-	-	-	0.01	-
Ps. unidentifiable	0.05	0.14	0.04	-	0.09	0.04	0.07	-
Ur. sapphirina	1.10	1.77	0.75	0.58	0.99	0.31	1.05	0.16

The top five most frequently encountered species in wetland samples were *Culex territans* (36.2% of samples), *Aedes vexans* (20.24%), *Cx. restuans* (16.4%), *Culiseta inornata* (15.8%), and *Ae. stimulans* (14.5%) (Table 1.1). The most frequently encountered species in stormwater structures were *Cx. restuans* (69.2%) and *Cx. pipiens* (51.4%) (Table 1.1).

Adult Mosquito Collections

The District uses a variety of adult surveillance strategies which exploit different behaviors inherent to mosquitoes. Sweep nets are used to survey the mosquitoes attracted to a human host. We use carbon dioxide-baited (CO_2) traps with small, incandescent lights to monitor host-seeking, phototactic (i.e., attracted to light) 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 use an olfactory bait to attract and capture egg-laying *Culex* and *Aedes* species. BG sentinel traps use an attractant lure that mimics human odor to target the invasive species *Ae. aegypti* and *Ae. albopictus* and are placed in areas at high risk for species introductions.

Monday Night Network The sweep net and CO_2 trap data reported here are weekly collections referred to as the 'Monday Night Network'. Staff make two-minute sweep net collections at a prescribed time at their homes on Monday evenings to monitor mosquito annoyance experienced by citizens. In addition, CO_2 traps are set up in natural areas such as parks or wood lots to monitor overall mosquito abundance. To achieve a District-wide distribution of CO_2 traps, some employees set traps in their yards as well. Figure 1.5 shows the sweep net and CO_2 trap locations and their uses [i.e., general monitoring, virus testing (West Nile virus), and eastern equine encephalitis (EEE) vector monitoring]. Although a few locations are located beyond District boundaries, only data from locations within are included in the analysis. This network of sweep net and CO_2 trap collections was run weekly from May 13-September 23.

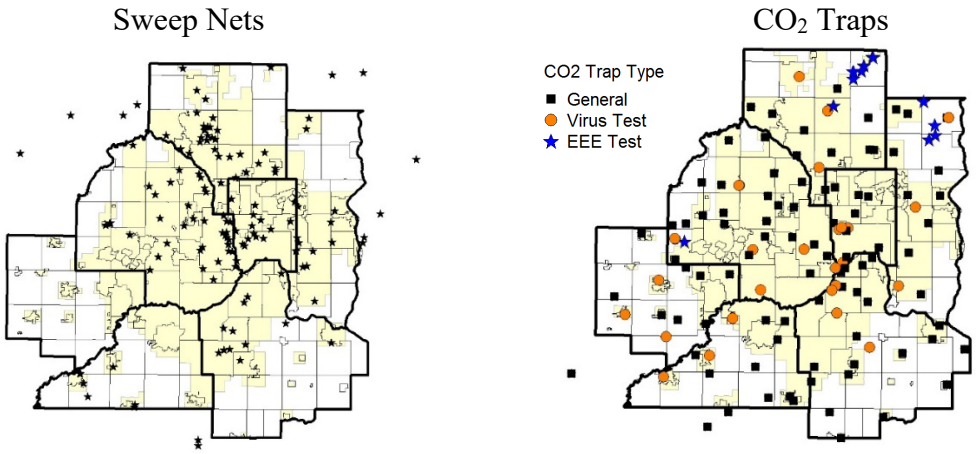


Figure 1.5 Locations of weekly sweep net and CO_2 traps used to monitor general mosquito populations and disease vectors (virus test and EEE test), 2024.

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., *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, are also attracted to mammals; this species is important in the transmission of WNV to humans and is best captured in CO_2 traps. Refer to Appendix A for a description of the biologies of the groups of mosquitoes and a species list which includes their significance and occurrence in the District.

Sweep Net The District uses weekly 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. There were 132 sweep locations in 2024, and the number of collectors varied from 42-100 per evening. The treatment threshold for sweep net sampling is two mosquitoes per two-minute sweep for *Aedes* and one mosquito per two-minute sweep for *Culex*4 (i.e., *Cx. pipiens*, *Cx. restuans*, *Cx. salinarius*, and *Cx. tarsalis*).

Staff made 1,565 collections containing 2,757 mosquitoes in 2024. Table 1.2 shows the average number of the different species groups collected per sweep net collection. Summer *Aedes* and *Cq. perturbans* populations were about the same as last year. Spring *Aedes* populations were above the 24-year average, as they were in 2023 (Table 1.2). This was the highest *Culex tarsalis* population since 2002 when an average of 0.029 *Cx. tarsalis* per sweep was detected.

Table 1.2 Average number of mosquitoes collected per evening sweep net collection within the District, 2020-2024 and 24-year average, 2000-2023 (± 1 SE)

Year	Summer *Aedes*	*Cq. perturbans*	Spring *Aedes*	*Cx. tarsalis*
2020	0.53	0.48	0.02	0.001
2021	0.13	0.07	0.01	0.002
2022	0.25	0.02	0.05	0.000
2023	0.93	0.09	0.51	0.002
2024	0.92	0.10	0.38	0.017
24-yr Avg.	1.49 (±0.26)	0.30 (±0.04)	0.11 (±0.03)	0.007 (±0.001)

CO_2 Trap CO_2 traps baited with dry ice are used to monitor host-seeking mosquitoes and the presence and abundance of species that transmit pathogens that cause human disease. The standard placement for these traps is approximately five feet above the ground, the height at which *Aedes* mosquitoes typically fly. Some locations have elevated traps which are placed ~25 feet high in the tree canopy to monitor bird biting species (i.e., *Culex* spp.). The treatment threshold is 130 nuisance mosquitoes per CO_2 trap. Vector species thresholds are discussed in Chapter 4.

In 2024, we had 128 trap locations, 11 of which also had an elevated trap (Figure 1.5). Three traps were outside District boundaries, at employee homes, and were not included in these analyses. The "General" trap type locations are used to monitor non-vector mosquitoes. There are 48 traps designated as "Virus Test"; all *Culex*4 collected from these traps are tested for WNV (Figure 1.5). 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 species' populations and to obtain specimens for EEE testing (Figure 1.5, "EEE Test" trap type).

A total of 2,341 District low CO_2 trap collections taken contained 385,165 mosquitoes in 2024. The total number of traps operated weekly varied from 109-122. The average number of mosquitoes detected in CO_2 traps is found in Table 1.3. Summer *Aedes*, typically our most abundant species, increased slightly from 2023, but were still half of the 24-year average. Despite having abundant rainfall, it seems that floodwater mosquito eggs did not hatch and may not have been viable from the three successive years of drought. The drought also affected *Cq. perturbans* populations, which were very low again in 2024, and well below the 24-year average. Spring *Aedes* levels were high again in 2024, over four times the 24-year average. *Culex tarsalis* numbers were also very high (63% higher than the 24-year average) and only behind 2002 when an average of 2.89 were detected. There were many large rain events in 2024 which resulted in ample standing water, the ideal habitat for *Culex* mosquitoes, which contributed to the high levels of *Culex tarsalis* in 2024.

Table 1.3 Average numbers of mosquitoes collected in CO_2 traps within the District, 2020-2024 and 24-year average, 2000-2023 (± 1 SE)

Year	Summer *Aedes*	*Cq. perturbans*	Spring *Aedes*	*Cx. tarsalis*
2020	182.4	127.3	3.5	0.2
2021	35.0	28.3	2.7	1.3
2022	53.3	13.9	8.3	0.4
2023	81.9	14.7	32.4	0.3
2024	93.7	15.3	31.5	2.6
24-yr Avg.	184.6 (±25.0)	52.3 (±7.3)	7.3 (±1.4)	1.6 (±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, respectively. The computer-assisted interpolations of mosquito abundance portray the predicted abundance of mosquitoes at locations without CO_2 traps. Therefore, some dark areas are the result of single collections without another trap close by and may not reflect actual densities of mosquitoes. Priority area 1 (P1) receives full larval control. A full description of priority areas is in Chapter 4: Mosquito Control.

Spring *Aedes* populations were detected during the first week of trapping, May 13, in western Carver County, northeastern Anoka County, and northern Washington County (Figure 1.6). Populations began to build thereafter with high levels in western Carver County and also in Scott, Hennepin, Anoka, and Washington counties. The inner core of the metro area and Dakota County had low levels of spring *Aedes* mosquitoes. Two locations, one in western Carver County and one in northeastern Washington County, had high levels of spring *Aedes* on July 8. Spring *Aedes* levels diminished District-wide by the end of July.

On May 13, a large emergence of summer floodwater *Aedes* occurred in western Hennepin County (Fig. 1.7). The following week, populations were evident throughout the District. From the end of May through mid-July, widespread abundant populations occurred in all parts of the District. From then on, levels were lower but still there were some locations with traps exceeding threshold levels for treatment. After August, very few floodwater mosquito producing rain events occurred.

Traps began collecting *Coquillettidia perturbans* in early June in Carver, Ramsey, and Washington counties (Figure 1.8). From mid-June emergence increased weekly thereafter and continued through August. Highest levels occurred during June 24-July 15. Highest populations occurred in eastern Anoka and northern Washington counties. Detections in those counties continued into August. Populations steadily declined thereafter. As is typical, the highest levels occurred outside of priority area 1.

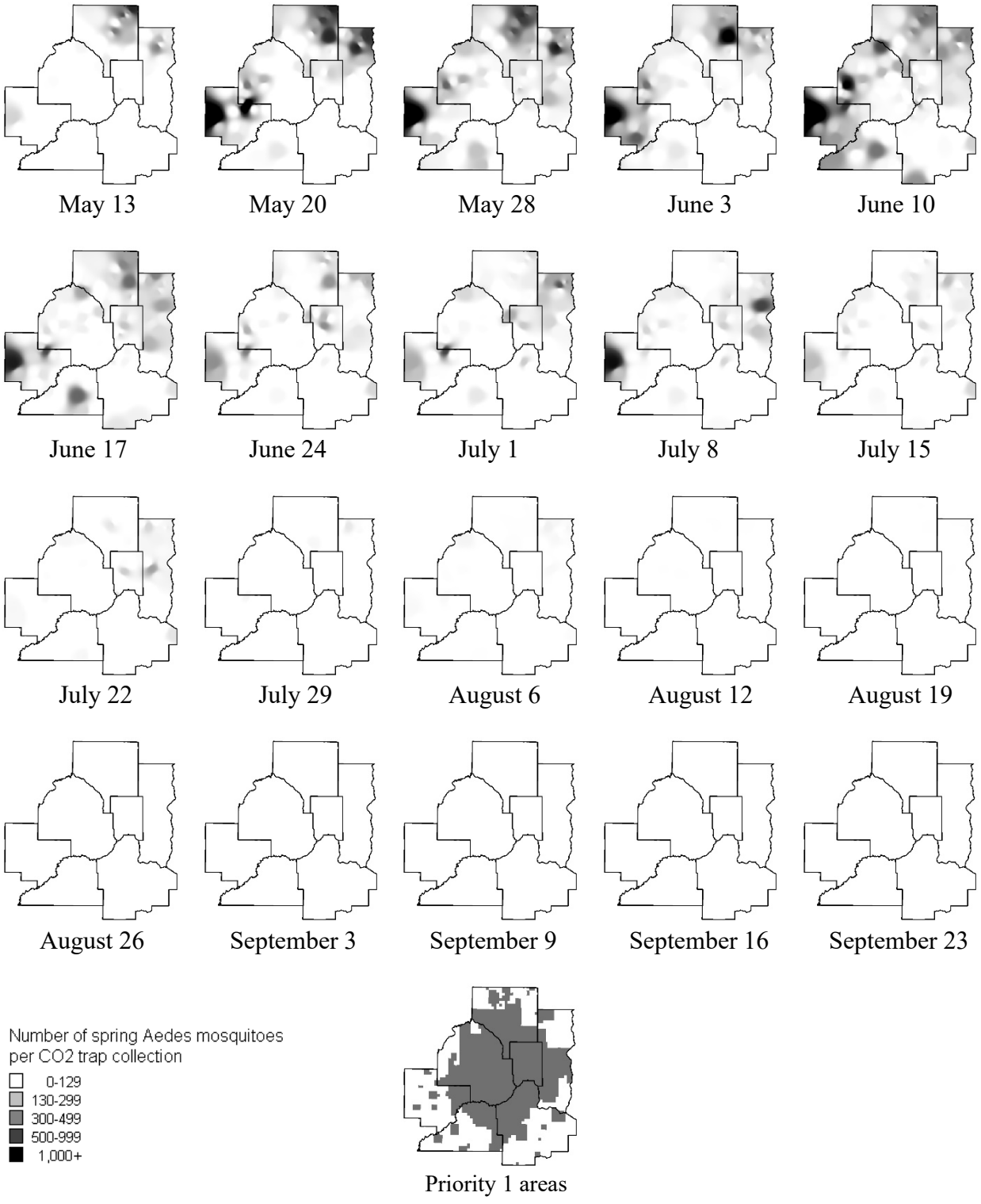


Figure 1.6 Number of spring *Aedes* in District low (5 ft) CO_2 trap collections, 2024. The number of traps operated per night varied from 109-122. Inverse distance weighting was the algorithm used for shading of maps. Treatment threshold is >130 mosquitoes/trap night. Priority 1 area map for reference.

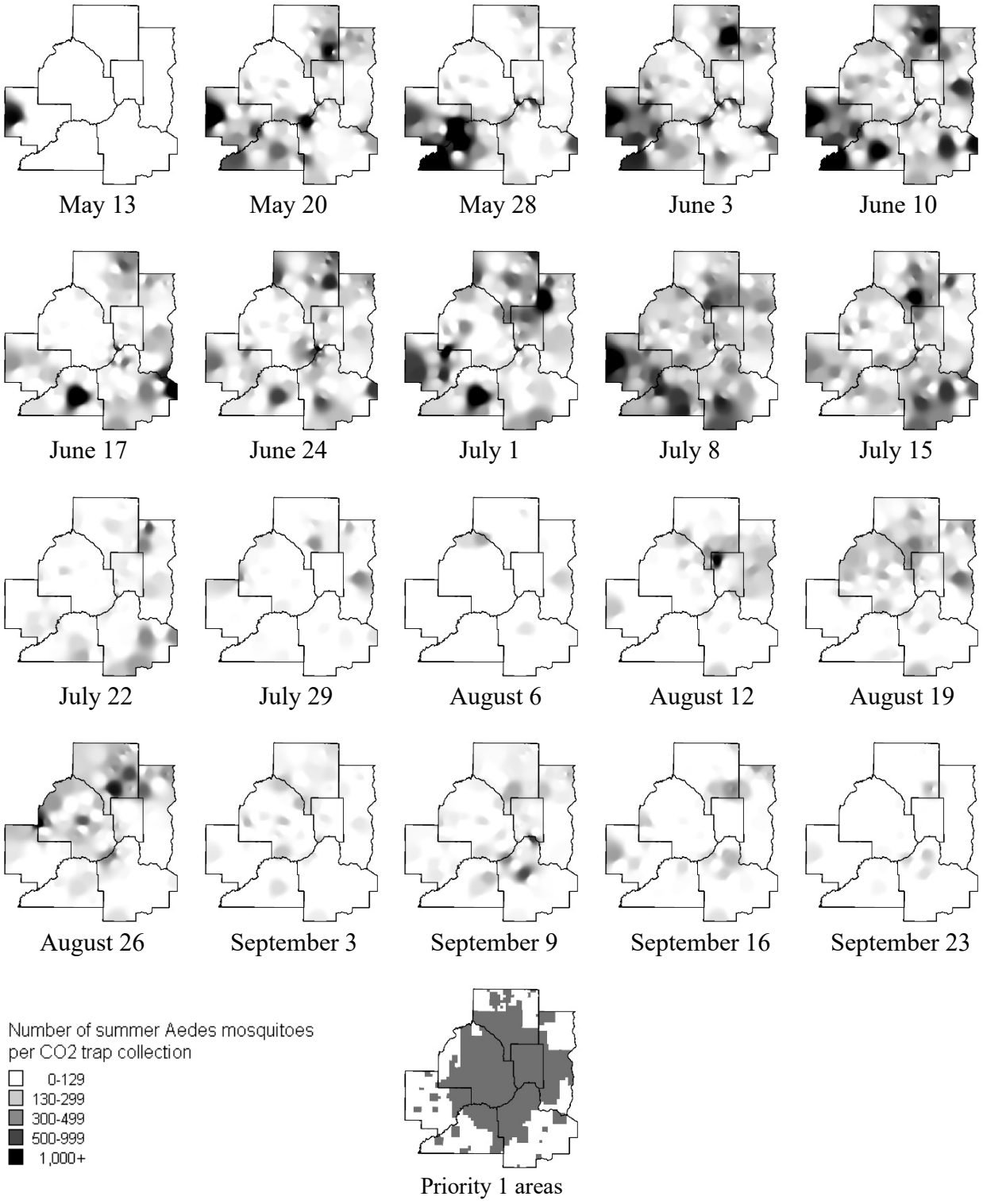


Figure 1.7 Number of summer *Aedes* in District low (5 ft) CO_2 trap collections, 2024. The number of traps operated per night varied from 109-122. Inverse distance weighting was the algorithm used for shading of maps. Treatment threshold is >130 mosquitoes/trap night. Priority 1 area map for reference.

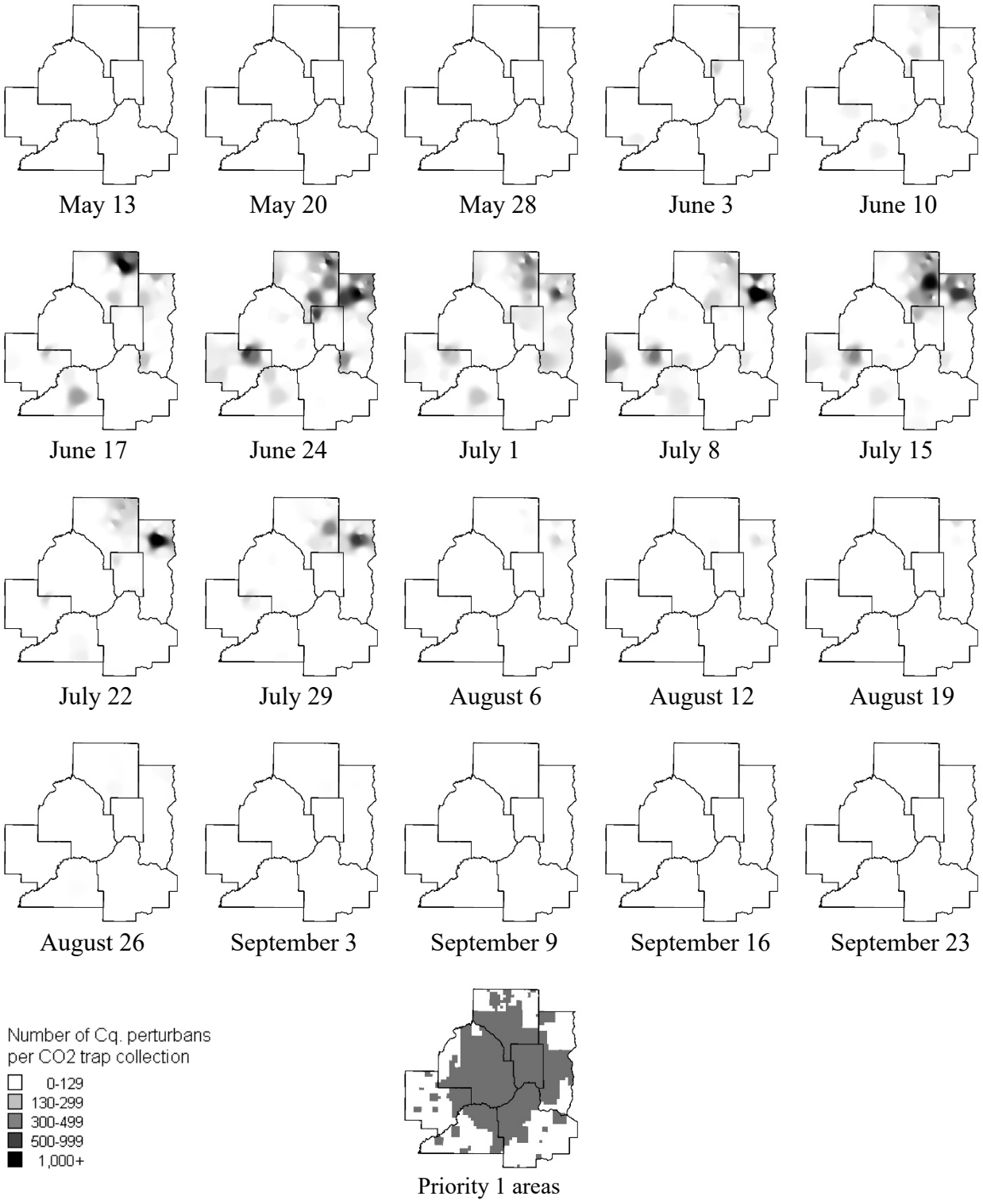


Figure 1.8 Number of *Cq. perturbans* in District low (5 ft) CO_2 trap collections, 2024. The number of traps operated per night varied from 109-122. Inverse distance weighting was the algorithm used for shading of maps. Treatment threshold is >130 mosquitoes/trap night. Priority 1 area map for reference.

Seasonal Distribution As described earlier, spring *Aedes*, summer *Aedes,* and *Cq. perturbans* have different patterns of occurrence during the season based on their phenology. 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 9:00 PM. on the scheduled sampling night. In 2024, sampling with sweep nets and CO_2 traps started May 13. Temperatures at the time of sweep netting were above the minimum mosquito flight threshold all season, although on 5/28 the minimum temperature was 52°F and on 9/23 the minimum temperature was 50°F.

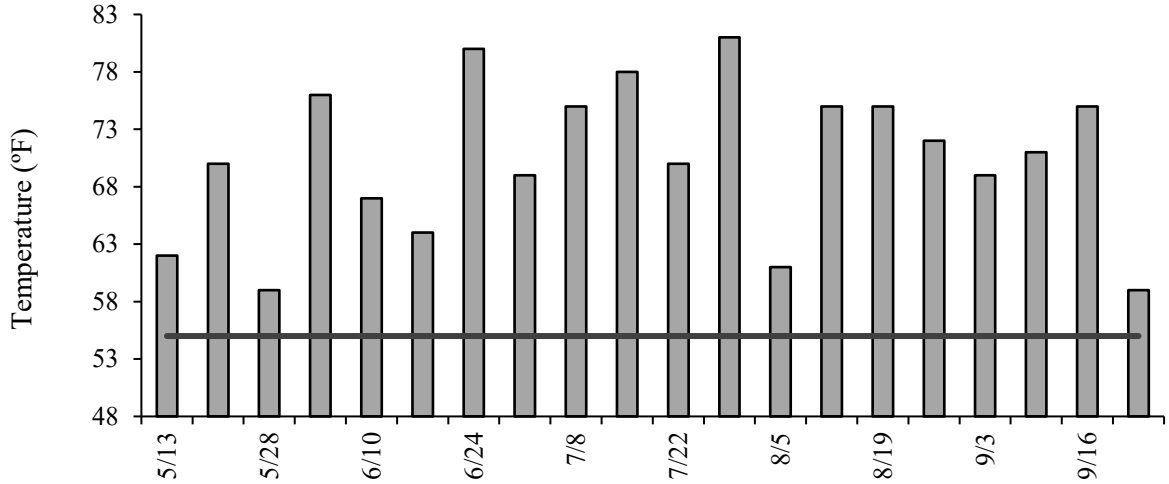


Figure 1.9 Temperature at 9:00 PM on actual dates of Monday night surveillance, 2024 (source: https://www.ncdc.noaa.gov/cdo-web/datatools/lcd). The black horizonal line indicates the mosquito flight threshold, 55°F.

Figures 1.10 and 1.11 show the seasonal distribution of the three major groups of mosquitoes detected in sweep nets and CO_2 traps. Sweep netting detected the adult spring *Aedes* emergence on the season's first night of surveillance, May 13. Mosquito levels peaked on May 28, and for the second year in a row they were far above the 24-year average (Fig. 1.10). Spring *Aedes* populations peak, on average, around June 10. High levels were detected through mid-July, and by July 22 they were near the 24-year average. In CO_2 traps, the highest captures also occurred from May 14 through June 11 (five times the 24-year average on July 11), and populations detected in CO_2 traps were above the 24-year average through July (Fig. 1.11).

Summer *Aedes* were first detected in sweep nets and CO_2 traps the night of May 13. Highest levels in sweeps occurred on the fourth night of sampling (June 3) at 2.37 per two-minute sweep. (Fig. 1.10). Despite many rain events in 2024, the levels of summer *Aedes* were below the 24-year average until August 12 when they reached the average levels. The highest levels in CO_2 traps were on June 11, below the 24-year average (Fig 1.11) and remained so throughout the summer.

Coquillettidia perturbans was detected from June 10-August 19 in sweep nets and from May 29-September 24 in CO_2 traps. The highest levels detected in sweeps were from June 24-July 15 (Fig. 1.10). Highest levels in CO_2 traps occurred from June 18-July 30 (Fig. 1.11) and were below the 24-year average the entire year.

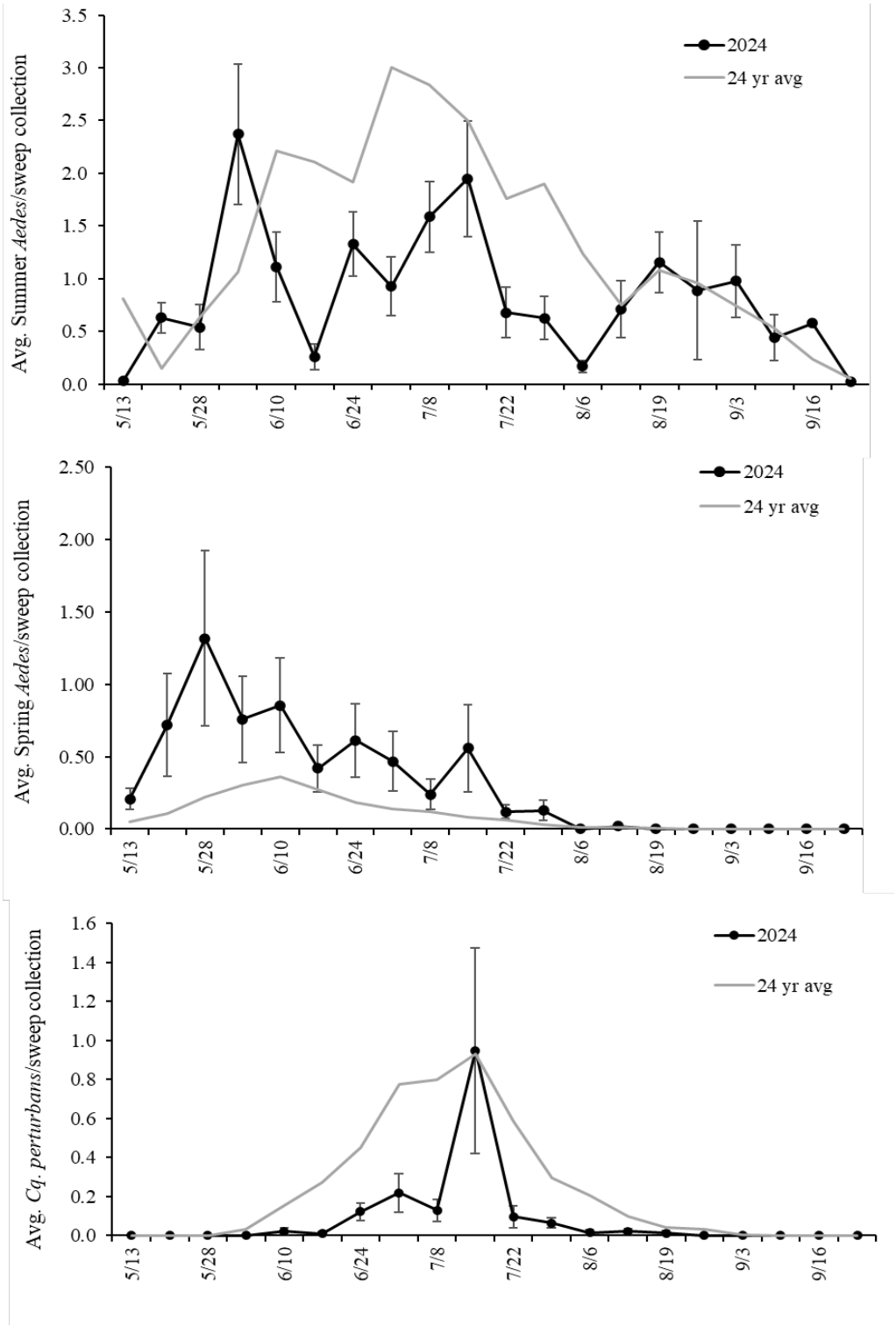


Figure 1.10 Average number of spring *Aedes*, summer *Aedes*, and *Cq. perturbans* per sweep net collection, 2024 vs. 24-year average. Dates are the Mondays of each week. Error bars equal $\pm$ 1 standard error of the mean.

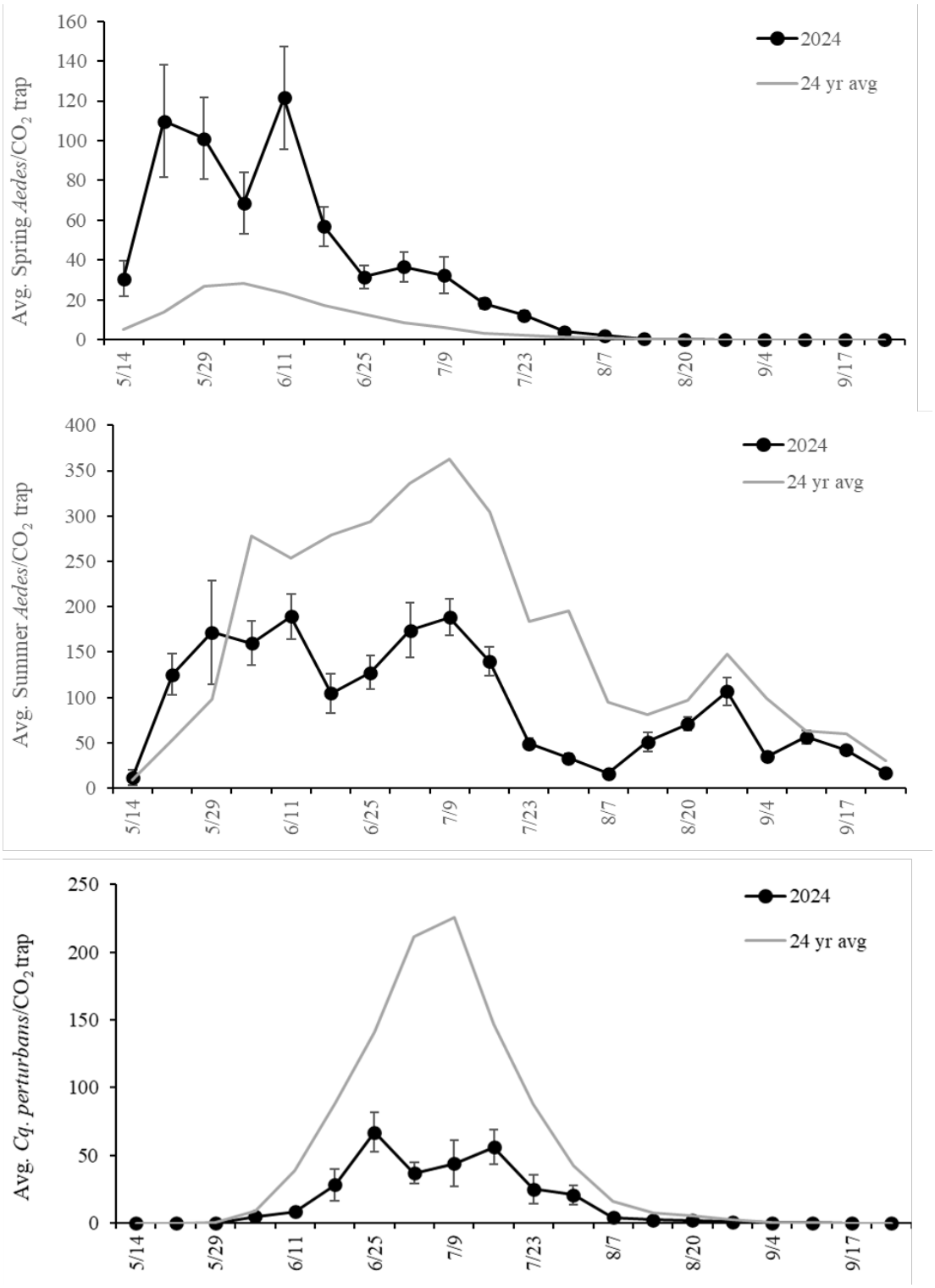


Figure 1.11 Average number of spring *Aedes*, summer *Aedes*, and *Cq. perturbans* per CO_2 trap, 2024 vs. 24-year average. Dates are the Tuesday of each week, except when sampling falls on a holiday. Error bars equal $\pm$ 1 standard error of the mean.

The difference in mosquito levels in priority zones (P1 = full larval treatment and P2 = limited or no larval treatment) is shown in Figure 1.12. Mosquito levels were low in P1, as expected. Summer *Aedes* was the most abundant species group in P1 and P2. Spring *Aedes* were highest in P2 as was *Cq. perturbans*.

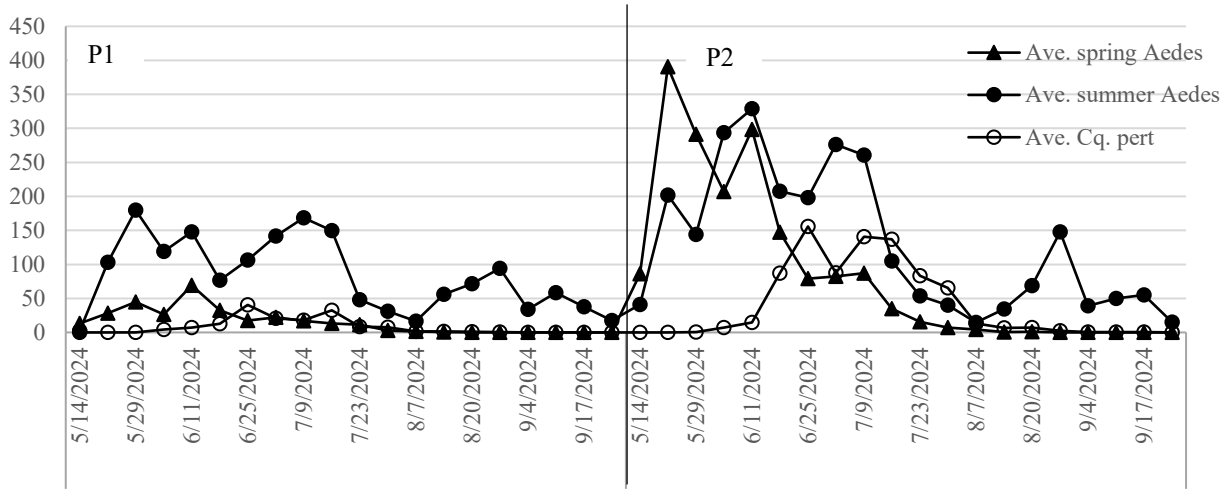


Figure 1.12 Average number of spring *Aedes*, summer *Aedes*, and *Cq. perturbans* per CO_2 trap, 2024 in P1 and P2.

New Jersey (NJ) Light Traps For many years, mosquito control districts used the NJ light trap as their standard surveillance tool. The trap uses a 25-watt incandescent 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.

In 2018, we reduced the trapping locations to only include those sites that were productive and that have been operating for twenty years or more. The four traps are in the following locations: Trap 9 in Lake Elmo, Trap 13 in Jordan, Trap 16 in Lino Lakes, and Trap CA1 in the Carlos Avery State Wildlife Management Area (Figure 1.13). Traps 9 and 16 have operated from 1965-2024. The CA1 trap started in 1991. Trap 13 has been at MMCD's Jordan Office location since 1998.

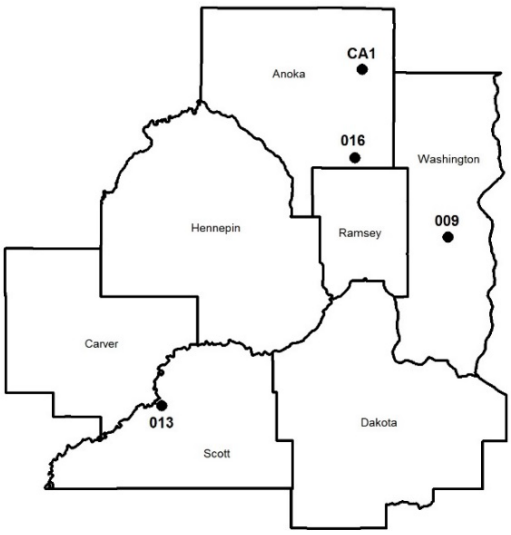


Figure 1.13 NJ light trap locations, 2024.

Trapping occurs nightly for 20 weeks from May through September and staff identify all adult female mosquitoes to species. Adult male mosquitoes are simply counted. A comparison of the major species collected from those four traps will be shown in Appendix B; however, sample processing is ongoing and results will presented in the final TAB report.

Long-term CO_2 Trap Network

In 2021, we began identifying all adult mosquitoes from randomly selected Monday Night Surveillance Network traps. The goal was to augment the information obtained in the New Jersey light traps. The rationale and trap locations are discussed in previous TAB reports (2021, 2022). The designated traps are shown in Table 1.5 and Figure 1.14 shows the selected trap locations in the regions of the District. Full species identifications for the 15 traps are in progress and will be found in Appendix C in the final TAB report.

Table 1.5 Traps used for long-term study by region

West Region	South Region	Northeast Region
C013 – Watertown	D063 – Thompson Co. Pk	A120 – (v) Ajawah EEE
H625 – Ft. Snelling Golf Course*	D181 – Miesville	A183 – Innsbruck Park
H284 – Dayton	DSR4 – Eureka (Rice Lk)	E001 – Stillwater
H291 – Eden Prairie	S139 – Credit River	E004 – Forest Lake
H566 – Eagle Ridge	S154 – (v) Jackson Town Hall	SF02 – (v) Grandstand

*The Ft. Snelling Golf Course trap (H625) replaced the Post Road low trap (H157) in 2022 and is located less than 1 mile away

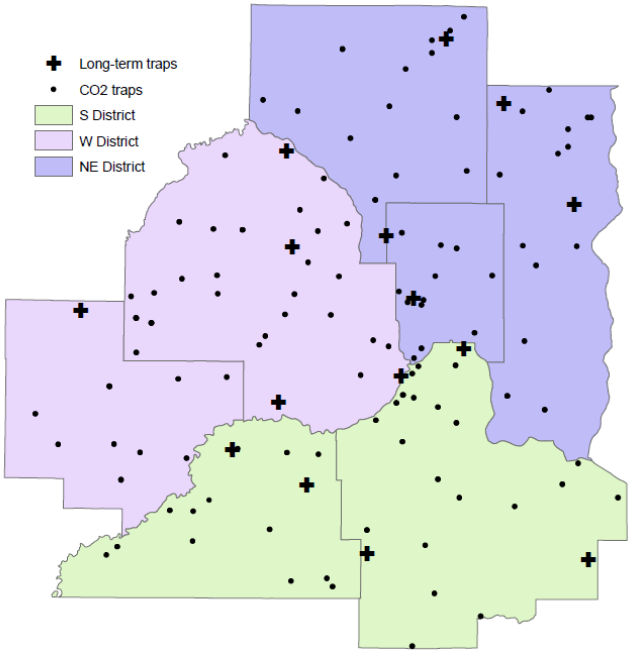


Figure 1.14 Locations of 15 traps selected for long-term CO_2 trap full species level identifications. Green shading is South, lavender shading is West, and purple shading is Northeast.

Coquillettidia perturbans Population Prediction

Coquillettidia perturbans, or cattail mosquitoes, are a significant summer species which emerges from June through July, typically peaking around July Fourth. Adult populations are influenced by rainfall amounts from the previous year. We have been using a model developed by Dr. Roger Moon (University of MN) since 2017 to predict *Cq. perturbans* in the coming year based on the number of adults collected and the average weekly total rainfall in the previous year.

The predicted catch rate in 2024 was 19.2 *Cq. perturbans* per CO_2 trap, but the actual rate was 15.3 (Figure 1.15). The predicted number of *Cq. perturbans* collected per CO_2 trap in 2025 is 87.9. This model explains ~80% of the variation in predicted *Cq. perturbans* abundance (adjusted R-squared = 0.793). The prediction helps identify population trends for the coming year, and larval dips confirm presence and treatment locations.

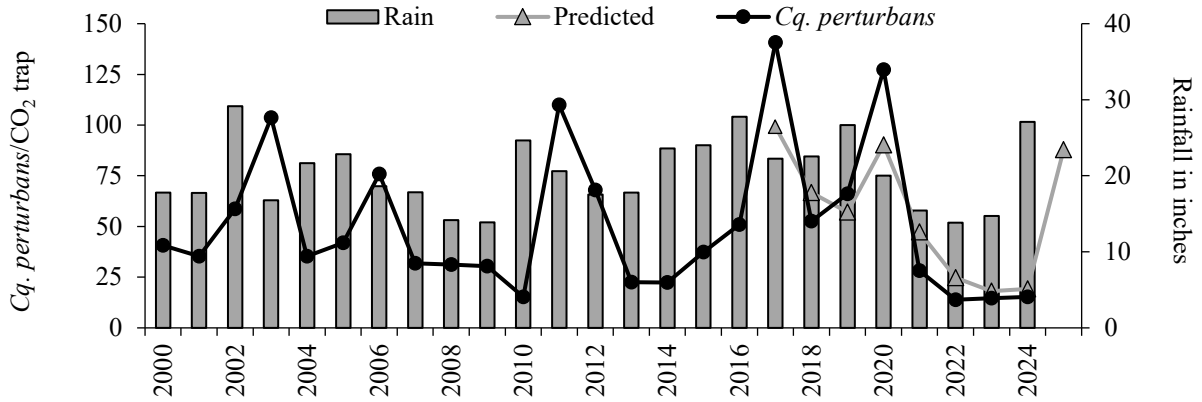


Figure 1.15 Average seasonal rainfall per gauge, average number of *Coquillettidia perturbans* in CO_2 traps, 2000-2024 and predicted amounts for 2017 and beyond.

Rare Detections

Culex erraticus is an uncommon mosquito in our area whose populations have been decreasing every year since 2021 (Figure 1.16). *Culex erraticus* can transmit eastern equine encephalitis virus, however it occurs in relatively low numbers compared to our other *Culex* species (see Chapter 2 Mosquito-borne Disease). It is common in the southern United States.

Psorophora species have also been on the rise since the mid-2000s. *Psorophora ferox* populations have been higher than *Ps. horrida* in most years, however, *Ps. horrida* was dominant in 2024 (Figure 1.17). Range maps for both *Psorophora* species indicate a more southern range (Darsie and Ward, 2005); in recent years they seem to be moving northward.

Another uncommon species that occurred in great numbers this year was *Culex salinarius* (Figure 1.18). Over 4,000 adults were captured, which is almost 160 times more than last year! This mosquito occurs from Texas to South Dakota to the Eastern Seaboard (Darsie and Ward, 2005). Despite being called the "Saline American Typical Mosquito", larvae are mostly found in fresh water (Wilkerson, Linton, and Strickman, 2020). In our area, it can transmit eastern equine encephalitis and West Nile virus.

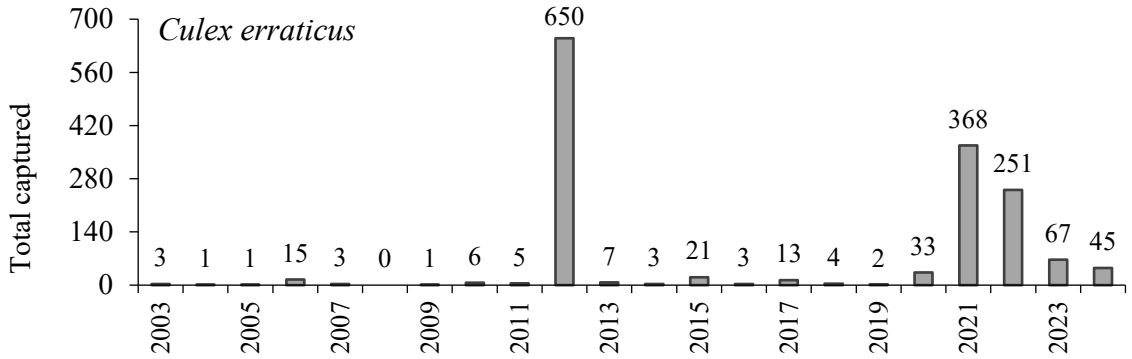


Figure 1.16 Total yearly *Culex erraticus* collected from Monday Night CO_2 traps (low, elevated, and any outside District), 2003-2024.

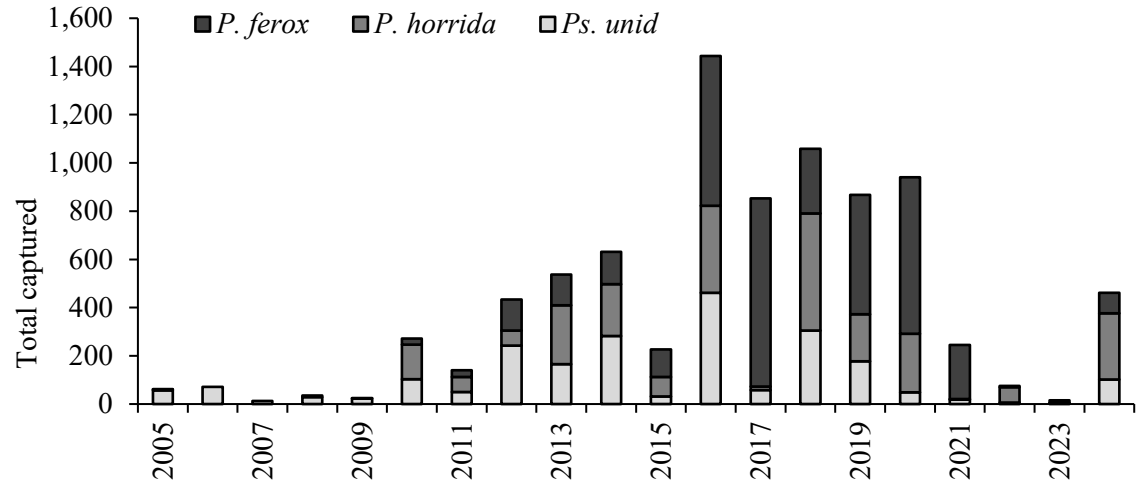


Figure 1.17 Total yearly *Ps. ferox, Ps. horrida,* and *Ps. ferox/horrida* (*Ps. unid*) collected from Monday Night CO_2 traps (low, elevated, and any outside District), 2005-2024.

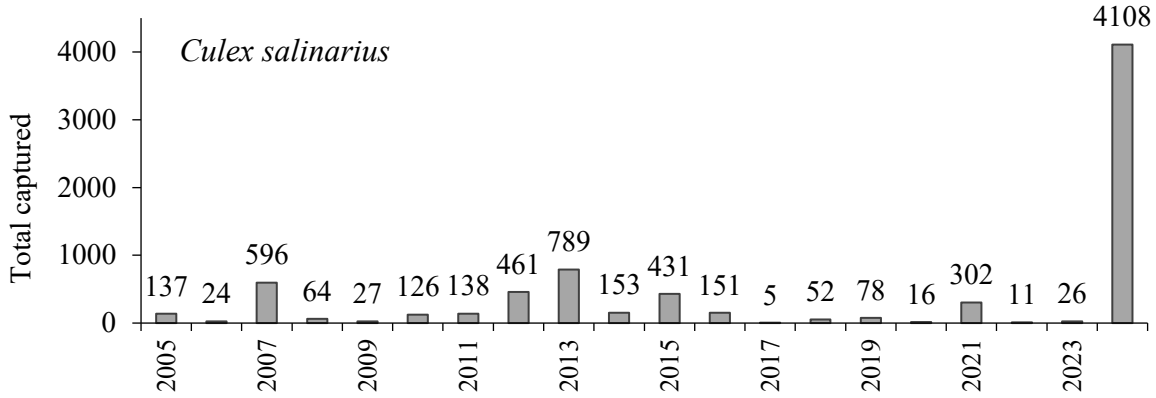


Figure 1.18 Total yearly *Culex salinarius* collected from Monday Night CO_2 traps (low, elevated, and any outside District), 2005-2024.

Last year we reported elevated collections of *Aedes dorsalis*. This year, we had an over 1,000% increase in detections from 2023 (Figure 1.19). In fact, it is 160% higher than the record, which happened in 2005. Other researchers in the region were also detecting increased levels of *Ae. dorsalis*. *Aedes dorsalis* is salt tolerant using both brackish and freshwater habitat and may travel 22 miles or more from its larval site. This species is very common in the western plains of the United States, tidal marshes of the Pacific coast, and along the margins of the Great Salt Lake in Utah (Wilkerson, Linton, and Strickman, 2020). We speculate that the three preceeding years of drought changed the soil chemestry so that conditions (concentrated salts) provided favorable habitat for their eggs to hatch.

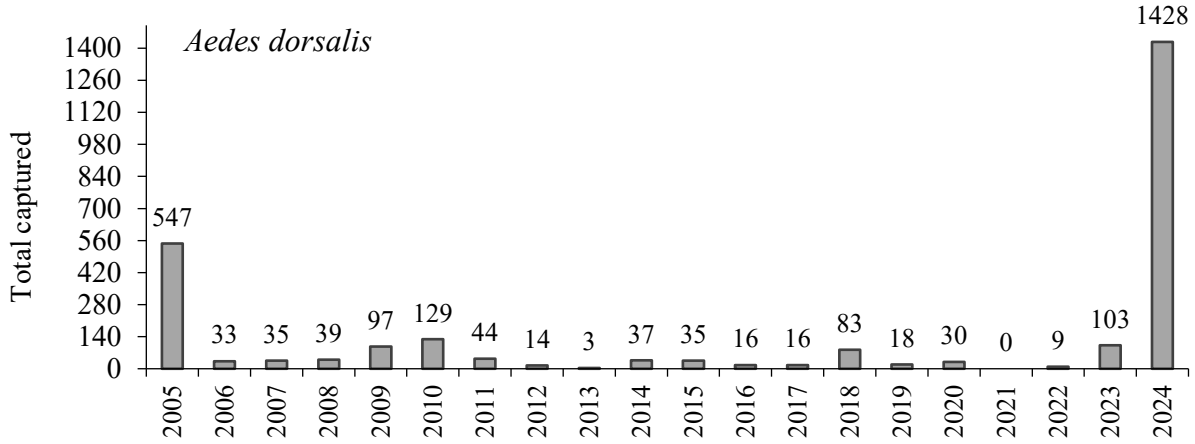


Figure 1.19 Total yearly *Ae. dorsalis* collected from Monday Night CO_2 traps (low, elevated, and any outside District), 2005-2024.

References Cited

Darsie, Jr, R. F. and R.A. Ward. Identification and geographical distribution of the mosquitoes of North America, north of Mexico, 2nd edition. University of Florida, USA 2005. 416 pp.

Wilkerson, R.C. Y-M Linton, and D. Strickman. Mosquitoes of the World, Volume 1. Johns Hopkins University Press, Baltimore, MD, USA. 2020. 599 pp.

Surveillance Evaluations

CO_2 trap comparison: In 2023, we began a study to compare our current CO_2 trap style (American Biophysics ABC trap) with a new type of CO_2 trap (Biogents BG-Pro) The new trap is different than the current style. Most notably, it uses LED rather than incandescent light; the airflow is bidirectional where the ventilator creates a downward flow though the suction funnel in the center of the trap then the airflow changes direction inside the trap body and is released through the top surface surrounding the suction funnel; and the collection bag is placed above the fan which reduces specimen damage. The study is designed to compare the two types of traps to determine if there is a difference in the species composition and abundance, as well as the amount of nontarget insect bycatch captured.

We began the study on June 21, 2023, but soon realized that the BG-Pro traps outfitted with the LED lights captured an outlandish amount of bycatch. We then proceeded to test the BG-Pro trap in lightless configuration similar to an EVS-style (encephalitis vector surveillance) mosquito trap. However, due to a lack of rain and the subsequent lack of mosquito production the trap comparisons were terminated for the 2023 season. In 2024, we compared the BG-Pro trap (without LED light) to the ABC traps we typically utilize. Analysis is ongoing.

We tested an additional new trap type in 2024, the automated Biogents BG-Counter 2 trap. This is a "remote monitoring device for mosquitoes". The BG-Counter trap attempts to differentiate mosquitoes from other flying insects, enumerate them, and wirelessly transmits the data to your desktop for viewing the results. We chose a location where long-term mosquito surveillance has occurred. The mosquitoes and other insects captured were collected on a nearly daily basis to compare the number of mosquitoes captured and retrieved in the samples to the number of mosquitoes "counted" by the BG-Counter trap. Analysis is ongoing.

2025 Plans – Surveillance

Ongoing: Surveillance will continue as in past years. We will evaluate sweep net, CO_2, and gravid trap locations to ensure adequate distribution, and that target species are collected.

Faunal paper: Submit a manuscript for a checklist of the mosquito fauna of the Twin Cities metropolitan area.

Long-term CO_2 Trap analysis: We now have three years of data so we will evaluate species richness between trap locations, regions, and even against New Jersey trap results.

Chapter 2 Mosquito-borne Disease

2024 Highlights

- There were 18 WNV cases reported in Minnesota residents, 8 in District residents
- There was one LAC case reported in Minnesota
- There were four JCV cases reported in Minnesota
- Eastern equine encephalitis was not detected in Minnesota
- WNV was detected in 63 District mosquito samples
- MMCD collected and recycled 10,411 tires

2025 Plans

- Provide surveillance and control for La Crosse encephalitis prevention
- Work with others to better understand Jamestown Canyon virus transmission
- Conduct catch basin and stormwater structure larvicide treatments to manage WNV vectors
- Communicate disease prevention strategies to other local governments
- Conduct surveillance for WNV and other mosquito-borne viruses
- Monitor for *Ae. albopictus* and other invasive species
- Conduct *Cs. melanura* surveillance and control 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 virus (JCV), and West Nile virus (WNV).

La Crosse encephalitis prevention services were initiated in 1987 to identify areas within the District where significant risk of acquiring LAC 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 this 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 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. *Culex tarsalis* 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 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.

2024 Mosquito-borne Disease Services

Source Reduction

Water-holding containers such as tires, buckets, tarps, and 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 2024, District staff recycled 10,411 tires that were collected from the field (Table 2.1). Since 1988, the District has recycled 744,619 tires. In addition, MMCD eliminated 1,067 containers and filled 61 tree holes (Table 2.1). This reduction of larval habitats occurred through inspection of public and private properties and while conducting a variety of mosquito, tick, and black fly surveillance and control activities.

Table 2.1 Number of tires, containers, and tree hole habitats eliminated during each of the past 10 seasons and long-term averages

Year	Tires	Containers	Tree holes	Total
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
2018	9,730	1,993	478	12,201
2019	9,763	1,611	395	11,769
2020	11,824	3,134	375	15,333
2021	10,939	1,086	162	12,187
2022	11,753	1,087	92	12,392
2023	11,139	2,331	96	13,566
2024	10,411	1,067	61	11,539
Ave 2014-2024	13,956	1,973	269	16,149

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 2024, there were 35 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.

In 2024, MMCD staff collected 954 aspirator samples to monitor *Ae. triseriatus* populations. Inspections of wooded areas and surrounding residential properties to eliminate larval habitat were provided as a follow-up service when *Ae. triseriatus* adults were collected. The District's adulticide treatment threshold (≥ 2 adult *Ae. triseriatus* per aspirator collection) was met in 212 aspirator samples. Adulticides were applied to wooded areas in 94 of those cases. Adult *Ae. triseriatus* were captured in 359 of 745 wooded areas sampled. The mean *Ae. triseriatus* capture of 1.52 was the highest observed over the past 20 years (Table 2.2).

Table 2.2 *Aedes triseriatus* aspirator surveillance data, 2005-2024

Year	Total areas surveyed	No. with *Ae. triseriatus*	Percent with *Ae. triseriatus*	Total samples collected	Mean *Ae. triseriatus* per sample
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
2018	1,211	374	30.9	1,394	0.75
2019	1,055	342	32.4	1,170	0.97
2020	1,604	437	27.2	2,001	0.57
2021	1,516	309	20.4	1,959	0.42
2022	1,258	245	19.5	1,459	0.57
2023	1,440	281	19.5	1,700	0.48
2024	745	359	48.2	954	1.52

Aspirator sampling began during the week of May 27 and continued through the week of September 2. Weekly mean collections of *Ae. triseriatus* remained near or above the long-term average most of the season as the weather was consistently wet through August (Fig. 2.1). We observed a season peak of 4.25 *Ae. triseriatus* per sample during the week of July 29.

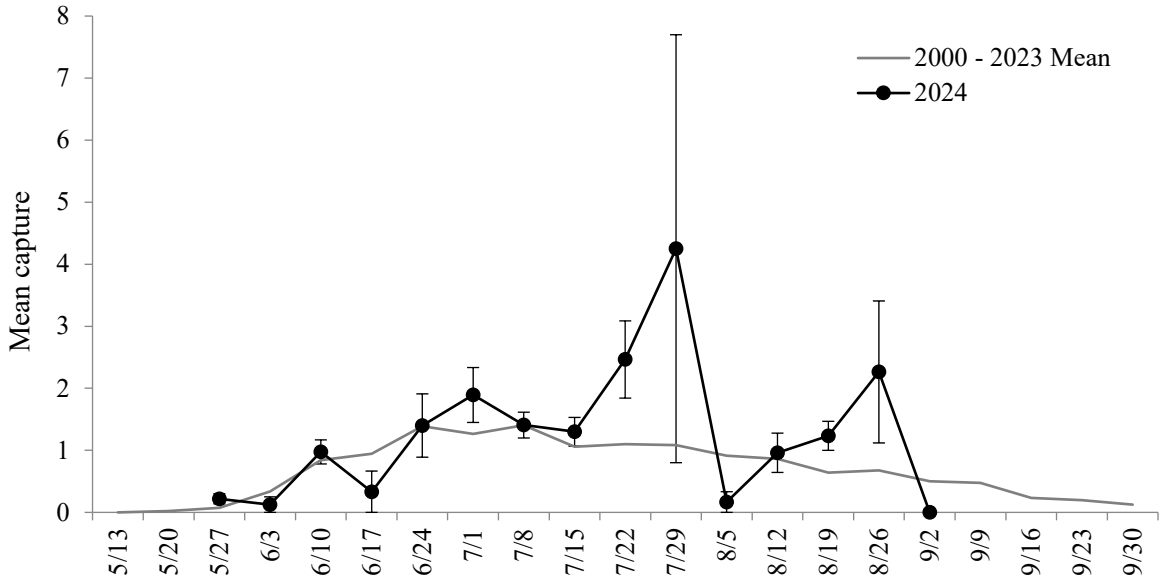


Figure 2.1 Mean number of *Ae. triseriatus* adults in 2024 aspirator samples plotted by week compared to mean captures for the corresponding weeks of 2000-2023. Dates listed are Monday of each week. Error bars equal ± 1 standard error of the mean.

La Crosse Encephalitis in Minnesota There was one LAC case reported in Minnesota in 2024 in a resident of Wright County. Since 1970, the District has had an average of 1.89 LAC cases per year (range 0-10, median 1). Since 1990, the mean is 1.2 cases per year (range 0-8, median 0).

Invasive Species Each season, MMCD conducts surveillance for invasive mosquito species. MMCD laboratory technicians are trained to recognize invasive 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 invasive mosquito 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 United States in 1985, are established in many states south and east of Minnesota and are occasionally introduced to the District in shipments of used tires or by transport of other water-holding containers. *Aedes japonicus* were first collected in the eastern United States in 1998 and were first found in the District in 2007. They are now widespread across eastern North America and commonly collected throughout the District.

Aedes albopictus *Aedes albopictus* were collected in 12 adult surveillance samples in 2024. All the samples were collected from a tire recycling facility or adjacent properties in Scott County. Six BG Sentinel trap samples contained the species; specimens were collected from July 17 to September 11. Three aspirator samples contained *Ae. albopictus* from July 26 to September

19. Three gravid trap samples contained *Ae. albopictus* from September 5 to September 18. *Aedes albopictus* were reared from eight ovitrap samples collected over five weeks from August 5 to September 6. Routine surveillance of tires and containers from throughout the District did not result in the collection of *Ae. albopictus* larvae in 2024.

This was the 22nd year in total and 13th consecutive year when *Ae. albopictus* were collected by MMCD staff; the first was in 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 now 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.

In 2024, *Ae. japonicus* larvae were found in 415 samples. Most were from containers (194), and tires (92). Larvae were also found in samples from 66 stormwater structures/artificial ponds, 60 catch basins, 36 wetlands, and 5 tree holes.

The frequency of *Ae. japonicus* occurrence in larval samples from containers and tires generally increased each year as they spread throughout the District. Since becoming more common, the frequency of occurrence has fluctuated. In 2024, we observed an increase in *Ae. japonicus* collections over the previous three drought years (Fig. 2.2). The frequency of collection from containers and tires was in the range of the peak previously observed in 2020. Since arriving in the District, *Ae. japonicus* have been collected less frequently from tree holes than in tires and containers. Of 40 larval samples from tree holes, only 5 contained the species in 2024.

Aedes japonicus adults were identified in 720 samples. They were found in 317 aspirator samples, 198 gravid trap samples, 143 CO_2 trap samples, 42 two-minute sweep samples, 19 BG Sentinel trap samples, and one BG Pro trap sample. The New Jersey trap samples have not been identified to date so the total number of samples may increase.

In 2024, the rate of capture of *Ae. japonicus* in aspirator samples was well above average for most of the year (Fig. 2.3). The species was collected in 31% of the season's aspirator samples and the season mean collection was 1.83 *Ae. japonicus* per sample.

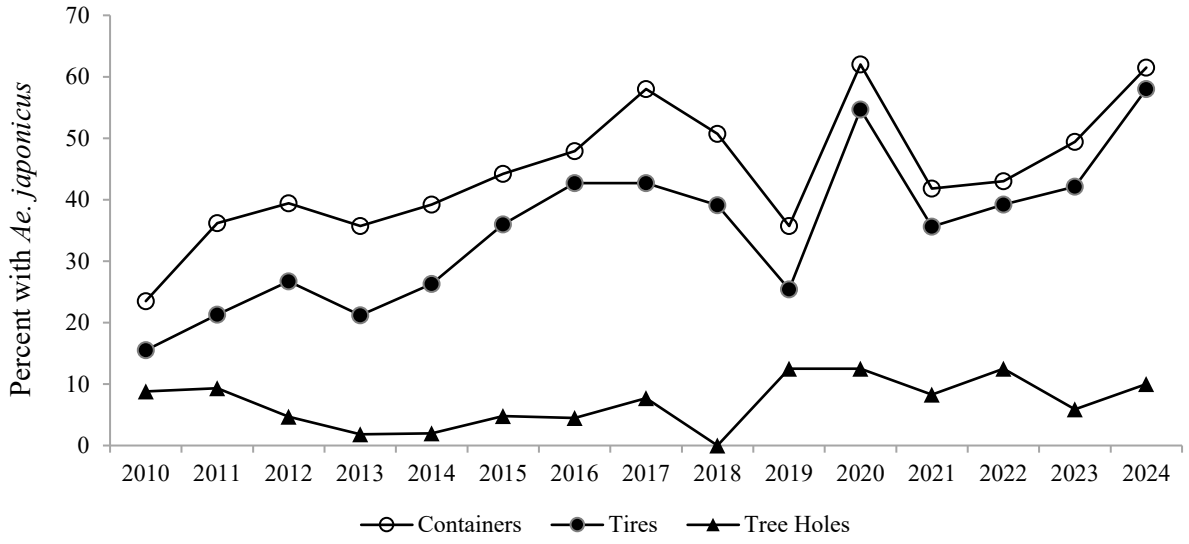


Figure 2.2 Percentage of larval samples from containers, tires, and tree holes containing *Ae. japonicus* by year.

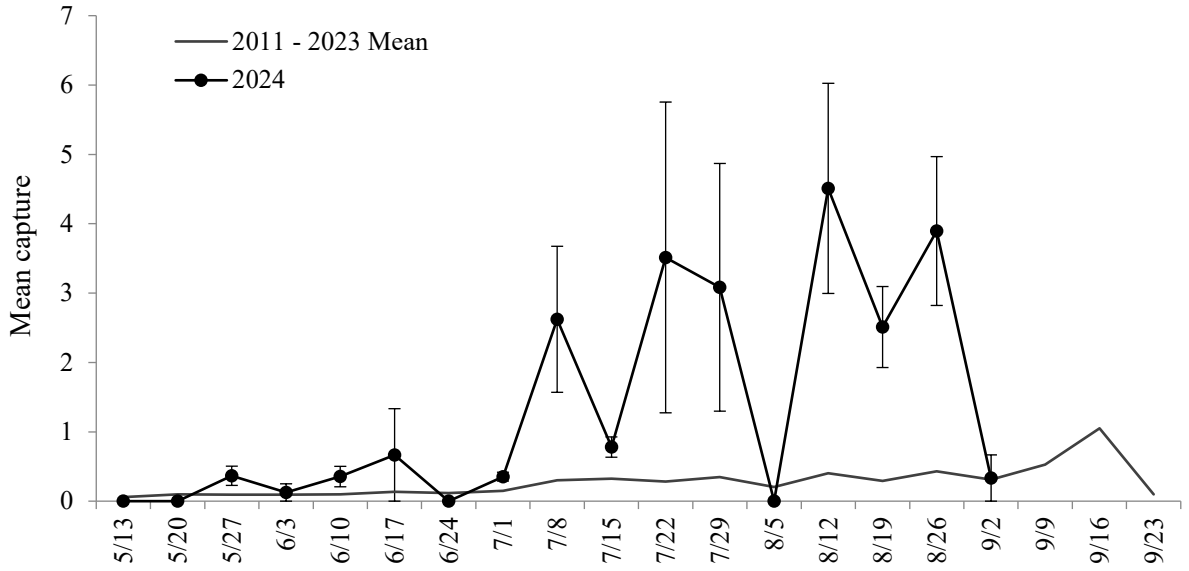


Figure 2.3 Mean number of *Ae. japonicus* adults in 2024 aspirator samples plotted by week compared to mean captures for the corresponding weeks of 2011-2023. Dates listed are Monday of each week. Error bars equal ± 1 standard error of the mean.

West Nile Virus (WNV)

West Nile virus circulates among many mosquito and bird species. It was first detected in the U.S. in New York City in 1999 and has since spread throughout 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 The U.S. Centers for Disease Control and Prevention received reports of 1,466 West Nile illnesses from 49 states and the District of Columbia. Texas reported the greatest number of cases with 176. Nationwide screening of blood donors detected WNV in 291 individuals from 32 states and the District of Columbia.

WNV in Minnesota The Minnesota Department of Health confirmed 18 WNV illnesses in residents of Minnesota in 2024. There were seven reports of WNV positive blood donors from Minnesota residents. Additionally, there were seven veterinary reports of WNV illness in animals in Minnesota.

WNV in the District There were eight WNV illnesses reported in residents of the District in 2024. There were two illnesses each in residents of Carver and Ramsey counties, and one each in residents of Hennepin, Dakota, and Scott counties. Since WNV arrived in Minnesota, the District has experienced an average of 10.3 WNV illnesses each year (range 0-27, median 8). When cases with suspected exposure locations outside of the District are excluded, the mean is 8.6 cases per year (range 0-27, median 7).

Surveillance for WNV: Mosquitoes Surveillance for WNV in mosquitoes began during the week of May 20 and continued through the week of September 23. Several mosquito species from 48 CO_2 traps (11 elevated into the tree canopy) and 38 gravid traps were processed for viral analysis each week. In addition, we processed *Cx. tarsalis* and *Cx. salinarius* collected by any of the CO_2 traps in our Monday Night Network for viral analysis. MMCD tested 1,200 mosquito pools using the rapid analyte measurement platform (RAMP®), 63 of which were positive for WNV. 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, 2024; MIR is calculated by dividing the number of positive pools by the number of mosquitoes tested

Species	Number of mosquitoes	Number of pools	WNV+ pools	MIR per 1,000
Cx. pipiens	1,511	42	2	1.32
Cx. restuans	2,249	61	1	0.44
Cx. salinarius	2,608	139	2	0.77
Cx. tarsalis	7,120	360	5	0.70
Cx. pipiens/Cx. restuans	7,886	296	27	3.42
Culex species	8,128	302	26	3.20
Total	29,502	1,200	63	2.14

West Nile virus was first detected in mosquitoes during the week of June 17 when a pool of unidentifiable *Culex* species was positive. Only five pools of the primary vector of WNV in human infections, *Cx. tarsalis*, were positive for WNV, even though the number of *Cx. tarsalis* collected and tested was high. Of the season's 63 WNV positive mosquito samples, 22 were collected in Hennepin Co., 12 in Ramsey Co., ten in Anoka Co., nine in Dakota Co., six in Carver Co., two in Washington Co., and one each in Scott and Sibley counties.

West Nile virus was detected in mosquitoes collected by MMCD in all but five weeks of testing (five of the first six weeks). Positive results were obtained in consecutive weeks from the first week of July through the last week of September (Fig. 2.4). The minimum WNV infection rate in mosquitoes peaked during the week of September 9 at 12.3 per 1,000 mosquitoes tested. For the season, the MIR was 2.14/1,000 mosquitoes tested.

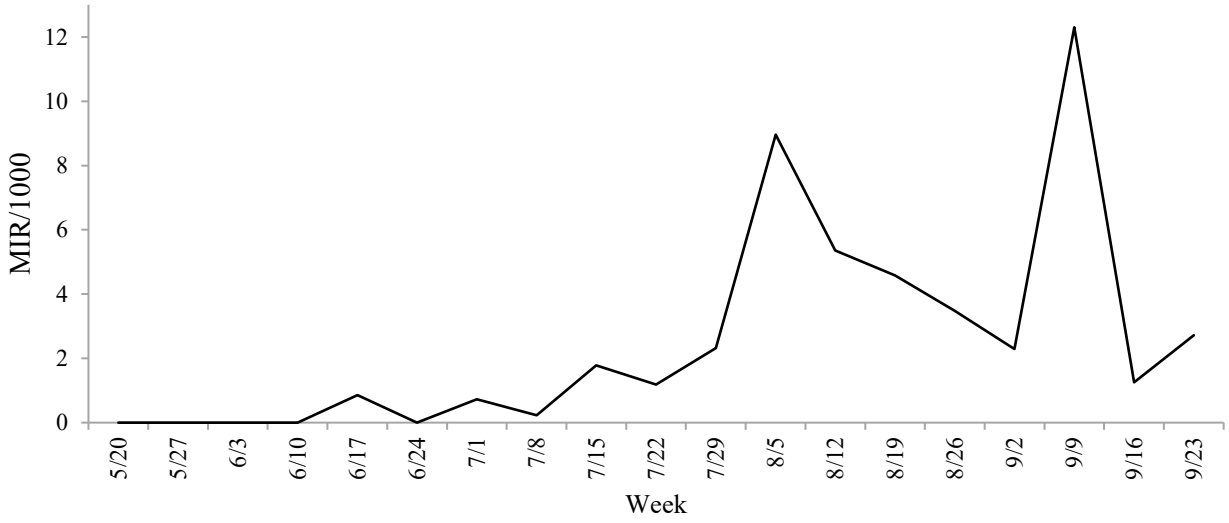


Figure 2.4 Weekly minimum WNV infection rates (MIR) per 1,000 *Culex* specimens tested in 2024. Dates listed are the Monday of the sampling week.

Adult *Culex* Surveillance

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

Culex tarsalis is the most likely vector of WNV for human exposures in our area. Collections of *Cx. tarsalis* in CO_2 traps were high in July and moderate during most of the rest of 2024. Weekly mean collections peaked at 26.0 *Cx. tarsalis* per sample on July 16 (Fig. 2.5). As is typical, few *Cx. tarsalis* were captured using gravid traps in 2024 (Fig. 2.6). The sweep net collections we conduct demonstrate the attraction of Cx. tarsalis to humans, and in 2024 they were collected at numbers ~150% above average.

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. The CO_2 trap captures of *Cx. restuans* peaked on July 8 at 7.4 per trap.

Culex restuans were more prevalent than *Cx. pipiens* in gravid traps until mid-July. The peak rate of *Cx. restuans* captured in gravid traps occurred during the week of July 15 at 36.7 per trap (Fig. 2.6).

Culex pipiens is an important WNV vector 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 early in the season and peak late in the summer when temperatures are typically warmer. In 2024, the *Cx. pipiens* population was high and collections in both CO_2 traps and gravid traps occurred at similar rates for much of the season which is atypical. *Culex pipiens* collections peaked in both traps during the week of August 12; at 9.1 per trap for both trap types.

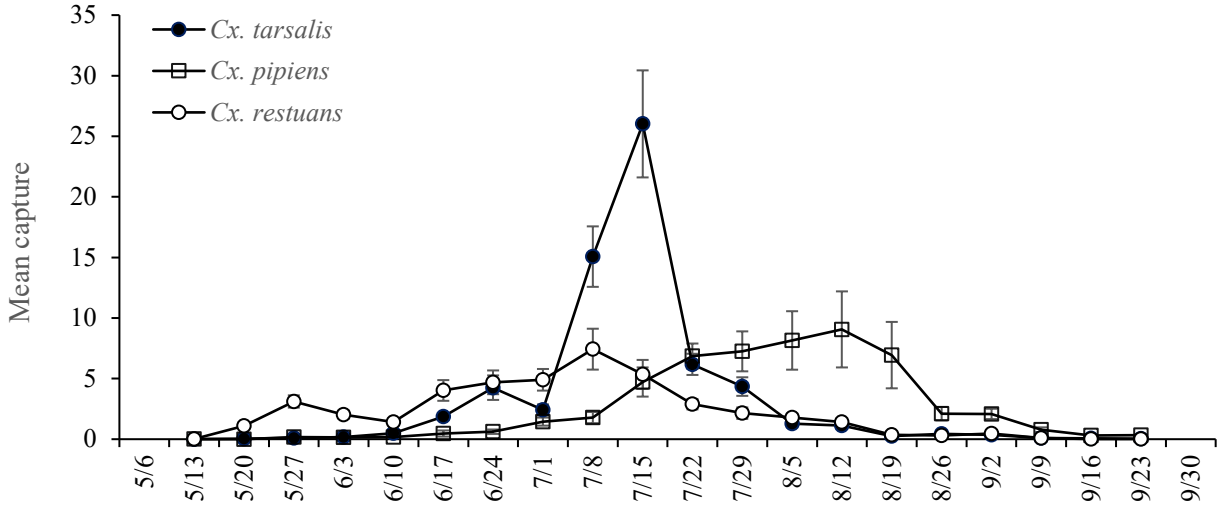


Figure 2.5 Average number of *Cx. tarsalis*, *Cx. pipiens*, and *Cx. restuans* in CO_2 traps, 2024. Dates are the Monday of each sampling week. Error bars equal ± 1 standard error of the mean.

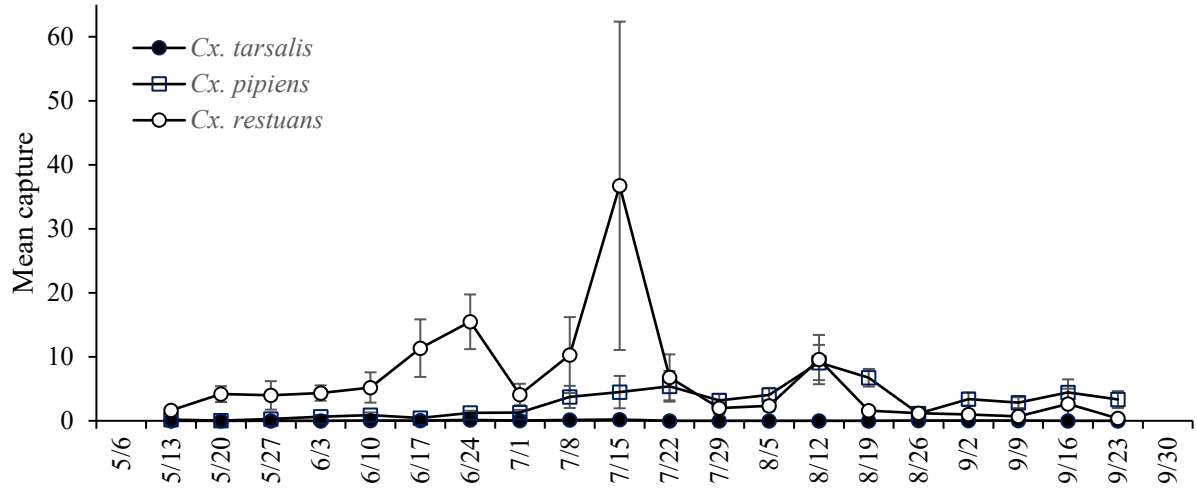


Figure 2.6 Average number of *Cx. tarsalis*, *Cx. pipiens*, and *Cx. restuans* in gravid traps, 2024. Dates are the Monday of each sampling week. Error bars equal ± 1 standard error of the mean.

Often, *Cx. pipiens* and *Cx. restuans* adults are difficult to distinguish from each other. In these instances, they are grouped together and identified as *Cx. pipiens/restuans* (Fig. 2.7; Fig. 2.8). When *Culex* mosquitoes can only be identified to genus level due to poor condition of the specimens, they are grouped as *Culex* species (Fig. 2.7; Fig. 2.8). 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. Collections of both groups mimicked each other week to week in 2024 and likely consisted of mostly *Cx. restuans* until mid-July and mostly *Cx. pipiens* thereafter.

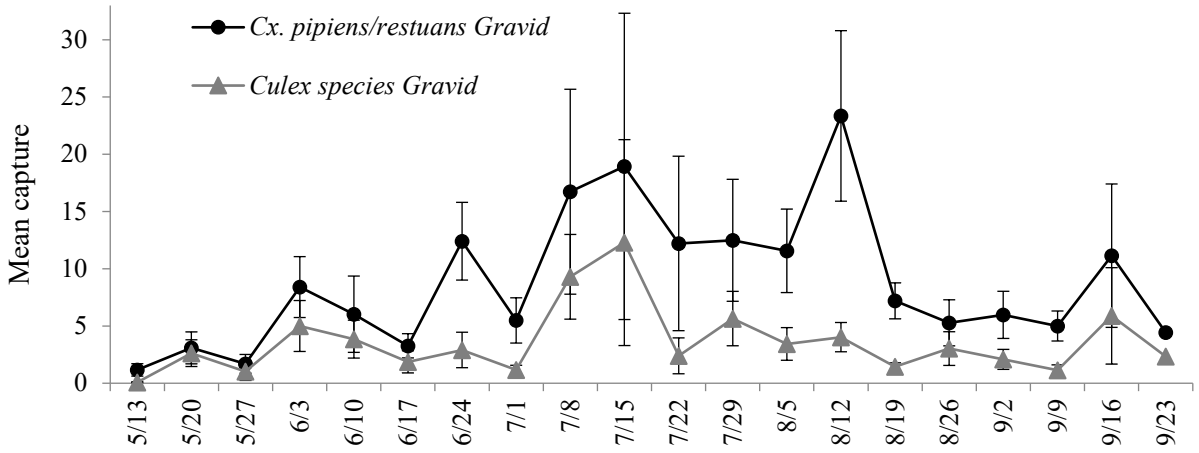


Figure 2.7 Average number of *Culex pipiens/restuans* and *Cx.* species in gravid traps, 2024. Dates are the Monday of each sampling week. Error bars equal ± 1 standard error of the mean.

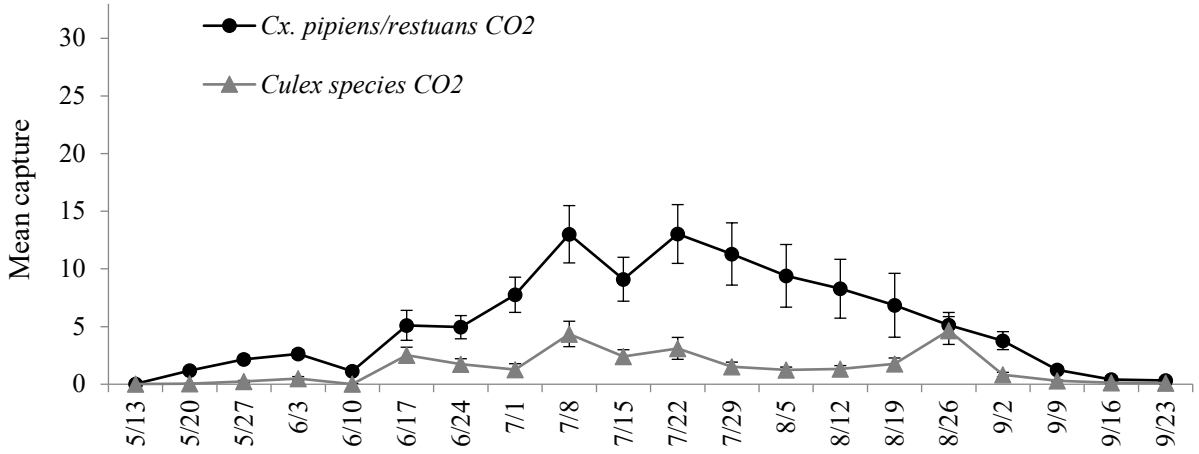


Figure 2.8 Average number of *Culex pipiens/restuans* and *Cx.* species in CO_2 traps, 2024. Dates are the Monday of each sampling week. Error bars equal ± 1 standard error of the mean.

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 habitats, 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, curb and gutter, swimming pools, ornamental ponds, and intermittent streams.

Technicians collected 676 larval samples from stormwater structures and other constructed habitats. *Culex* vectors were found in 84.5 percent of the samples in 2024 (Table 2.4). *Culex pipiens* were collected at a lower rate than during the previous two years. The frequency of *Cx. restuans* collections was within the range typically observed for these habitats.

Table 2.4 Frequency of *Culex* vector species in samples collected from stormwater management structures and other constructed habitats from 2019-2024

	Yearly percent occurrence				
Species	2020 (N=404)	2021 (N=1,236)	2022 (N=938)	2023 (N=1,496)	2024 (N=676)
Cx. pipiens	24.0	40.8	65.7	65.2	43.8
Cx. restuans	59.9	65.8	69.1	68.8	61.1
Cx. salinarius	0.0	0.0	0.0	0.1	0.7
Cx. tarsalis	0.7	3.5	2.7	1.3	1.9
Any *Culex* vector spp.	71.0	83.2	89.2	89.7	84.5

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 United States 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 2024, we continued the cooperative mosquito control plan for underground habitats. Fourteen 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. Municipalities treated 1,007 stormwater structures using 1,021 briquets.

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 assisting with underground stormwater habitat treatments, number of structures treated, and the number of briquets used in 2024

City	No. of structures treated	No. of briquets used	City	No. of structures treated	No. of briquets used
Arden Hills	15	15	Mendota Heights	18	19
Bloomington	92	95	Minneapolis	346	346
Brooklyn Park	4	15	Mounds View	5	5
Columbia Heights	12	16	New Brighton	5	8
Eagan	61	61	Richfield	13	25
Golden Valley	132	132	Roseville	27	29
Maplewood	255	255	Shoreview	22	25

Larval Surveillance in Catch Basins Catch basin larval surveillance began the week of May 15 and ended the week of October 2. Larvae were found during 636 of 890 catch basin inspections (71.5%) in 2024. Despite a warm spring, frequent rainfall negatively impacted the presence of mosquito larvae in catch basins early in the season. Larvae were collected from less than 50 percent of catch basins inspected during six of the 21 weeks of surveillance, but only once after the week of June 19 (Fig. 2.9).

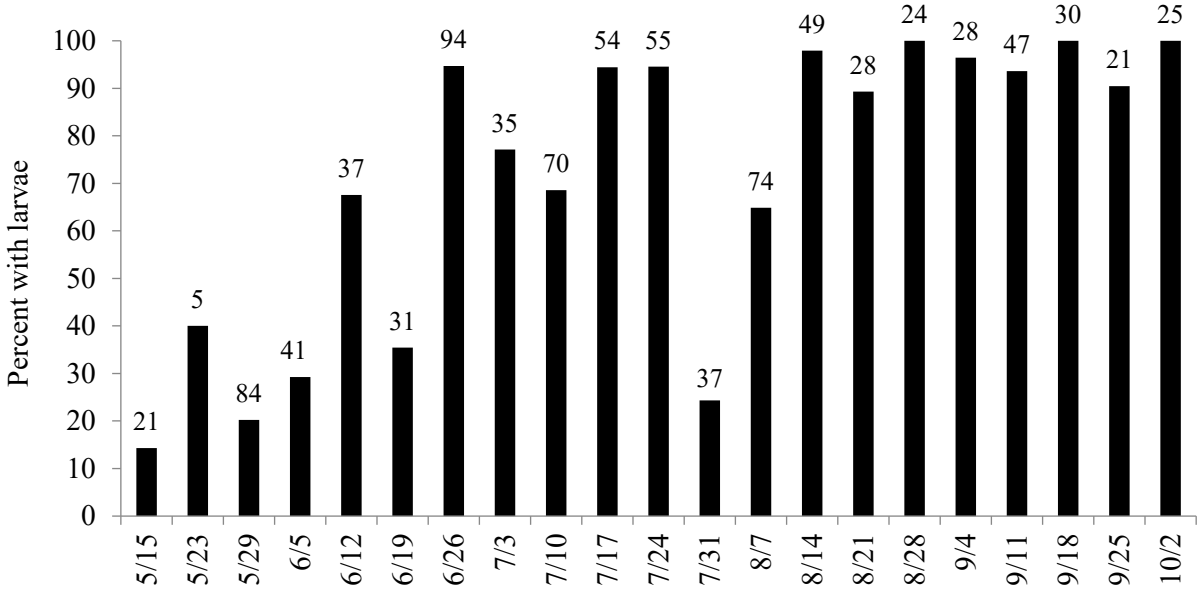


Figure 2.9 Percent of catch basins inspected with mosquitoes present in 2024. Bars are labeled with the number of inspections occurring during the week.

Mosquito larvae were identified from 635 catch basin samples. *Culex restuans* were found in 77.0 percent of catch basin larval samples. *Culex pipiens* were found in 57.8 percent of samples. At least one *Culex* vector species was found in 99.2 percent of samples. *Culex restuans* were collected more frequently than *Cx. pipiens* until late July; *Cx. pipiens* were more prevalent after the middle of August (Fig. 2.10).

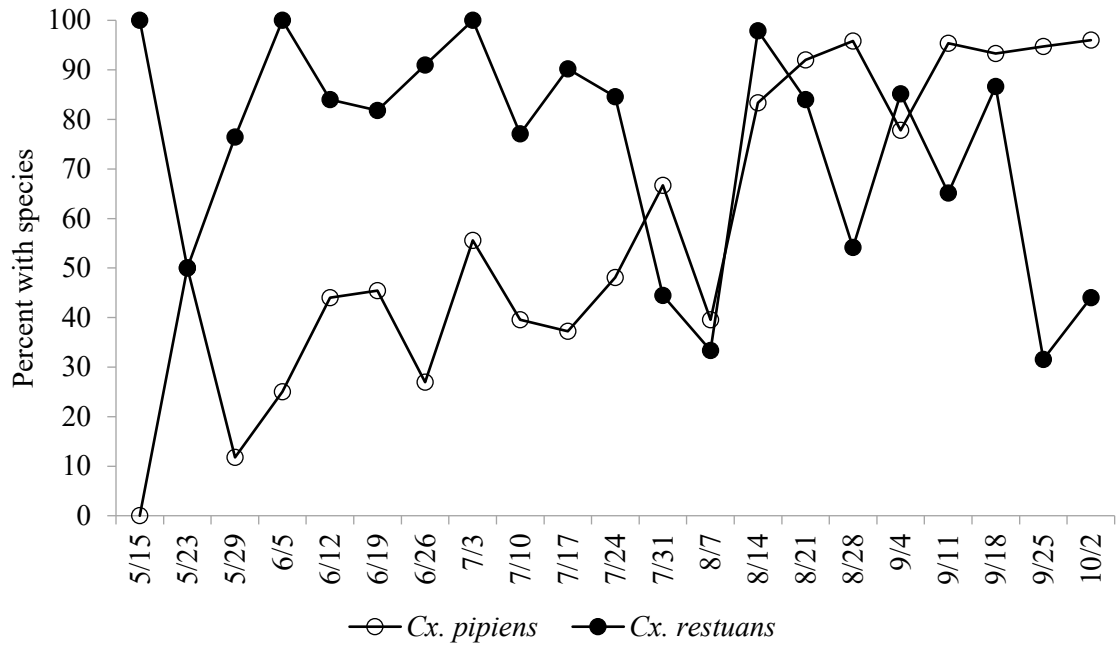


Figure 2.10 Percent occurrence of *Cx. pipiens* and *Cx. restuans* in catch basin larval samples by week.

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, *Culiseta 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 has repeatedly detected the EEE virus or antibodies to the EEE virus in wolves, moose, elk, and ruffed grouse in northern Minnesota.

In 2024, 19 human EEE illness were reported to CDC from nine states including Wisconsin. There were additional reports of EEE activity from 146 counties in 21 states. The nearest EEE detection to Minnesota was in Eau Claire County, Wisconsin. There were no detections of the EEE virus in Minnesota in 2024.

***Culiseta melanura* Surveillance** *Culiseta melanura* is relatively rare in the District and is 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. 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 progeny of the late summer cohort become 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.

Surveillance for adults by CO_2 trap and aspirator indicated the 2024 *Cs. melanura* population recovered quickly after three consecutive summers of drought dramatically reduced the quality of available larval habitat.

District staff monitored adult *Cs. melanura* at 11 locations (Fig. 1.5, p. 8) using 12 CO_2 traps. Six 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 during the week of May 27 (Fig. 2.11). Collections of *Cs. melanura* generally increased through the season and peaked during the week of August 26 at 4.7 per trap; more than 14 times higher than the peak rate of capture in 2023.

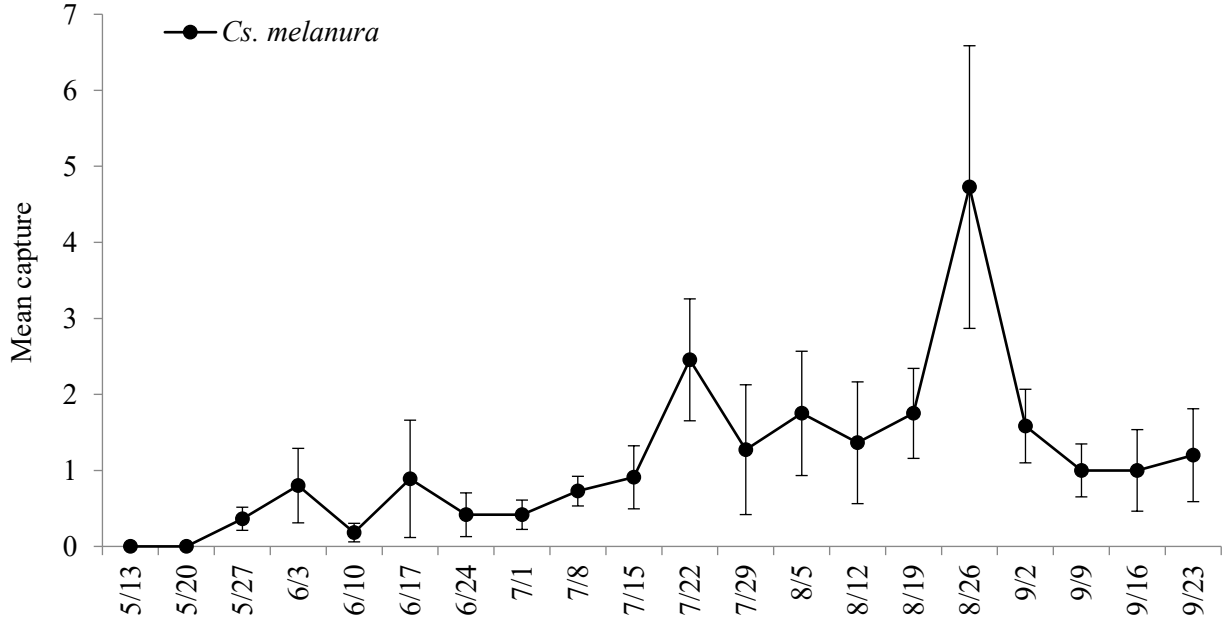


Figure 2.11 Mean number of *Cs. melanura* adults in CO_2 traps from selected sites, 2024. Dates listed are the Monday of each sampling week. Error bars equal ± 1 standard error of the mean.

Staff took a total of 49 EEE aspirator samples from wooded areas near bog habitats in 2024. Twenty-four of those samples yielded 281 *Cs. melanura*. The first aspirator collections occurred during the first week of July and sampling continued through the end of August. No *Cs. melanura* were detected the first week of sampling, but populations steadily rose thereafter until

the week of August 5 when the peak occurred. The average rate of capture was 25 per aspirator sample on that date (both male and female *Cs. melanura* are recorded in aspirator samples.)

Thirty-two samples of adult *Cs. melanura* were pooled to test for the EEE virus in the MMCD laboratory in 2024. All results were negative for EEE.

Culiseta melanura develop primarily in bog habitats in the District, and larvae can be difficult to locate. Following three drought seasons, water levels in bogs were still low in the spring of 2024 when *Cs. melanura* larval surveillance typically occurs. Four sites in Anoka County were inspected, *Cs. melanura* larvae were collected in three of the sites.

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 by University of Minnesota researchers in southern Minnesota. The virus has not been detected in Minnesota since then.

Jamestown Canyon Virus (JCV)

Jamestown Canyon virus is native to North America and circulates among mosquitoes and deer. 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.

Twenty-two JCV cases were reported nationally from five states in 2024. There were four JCV illnesses reported in Minnesota in residents of Cass, Chisago, Itasca, and Pine counties.

2025 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, tire, and container habitat reduction. Eliminating small aquatic habitats will also serve to control populations of *Ae. japonicus*, *Cx. pipiens,* and *Cx. restuans*.

The District will continue to survey aquatic habitats for *Culex* larvae for use in the 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 to reduce WNV amplification.

MMCD will continue to conduct surveillance for LAC, WNV, JCV, and EEE vectors and for other mosquito-borne viruses in coordination with MDH and others involved in mosquito-borne disease surveillance in Minnesota. We plan to work with other agencies, academics, and individuals to improve vector-borne disease prevention in the District. The District and its staff will continue to serve as a resource for others in the state and the region.

Chapter 3 Tick-borne Disease

2024 Highlights-preliminary

- Number of sites positive for *Ixodes scapularis* was 60 out of 100 (through wk 12)
- Average *I. scapularis* per mammal 1.04 (through wk 12)
- *Amblyomma americanum* tracking by the MMCD and/or MDH: From 2009-2023: 40 adults, 4 nymphs, 11 unknown. In 2024: 32 adults and 1 nymph collected
- Latest available (2022) Lyme case total: 2,685 confirmed + probable (source MDH)
- 2022 anaplasmosis: 540 confirmed + probable cases (source MDH)
- Powassan and SARS-CoV-2 virus testing: results pending.

2025 Plans

- *I. scapularis* surveillance at 100 sampling locations
- Education, identifications, and homeowner consultations
- Update the Tick Risk Meter, provide updates on Facebook, and post signs at dog parks
- Track collections of *Amblyomma americanum* or other new or unusual tick species, including *Haemaphysalis longicornis*
- Participate in the inter-agency collaboration across MN for *H. longicornis* tracking
- SARS-CoV-2 and possible additional tick-borne disease testing projects

Background

Infected *Ixodes scapularis* (deer/blacklegged tick) transmit the bacterial pathogens of Minnesota's two most prevalent tick-borne diseases: Lyme disease (*Borrelia burgdorferi*), and human anaplasmosis (*Anaplasma phagocytophilum*) and also pathogens that cause rare diseases like human babesiosis and Powassan virus. Attachment time influences transmission.

In 1989, the state legislature mandated the District "*to consult and cooperate with the Minnesota Department of Health (MDH) in developing management techniques to control disease vectoring ticks*." The District responded by forming the Lyme Disease Tick Advisory Board (LDTAB) to assist with the development of a tick surveillance program. The LDTAB included MMCD and MDH staff, local scientists, and experts from other agencies.

Over the years 1990-1992 the MMCD's tick surveillance program sampled 545 sites and determined the initial range and abundance of *I. scapularis*. Today, we use a subset (100) of those original sites to continue to identify and monitor the distribution of deer ticks. In addition, our study allows us to rank deer tick activity throughout the season, to possibly detect new tick species, to educate us and others regarding areas of new or higher *I. scapularis* densities, and in some years, to provide samples for tick-borne disease testing. All collected data are summarized in a report and presented to the LDTAB. The MDH and other agencies also use the information for risk analyses or other purposes. The MMCD collaborated with the University of Minnesota (UMN) on spirochete and anaplasmosis studies for over eight years.

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

2024 Tick-borne Disease Services

Lyme Disease and Human Anaplasmosis

Movement of *I. scapularis* into Hennepin and Scott counties was first detected in 1998, the first of two years with slightly higher *I. scapularis* collections than in years prior. An obvious increase to higher yearly *I. scapularis* collection numbers followed in 2000. Yearly collections have been maintained at that increased level since, with *I. scapularis* expansion following the initial increase in abundance. In parallel, but with a two-year lag (to 2002), the MDH documented higher numbers of human tick-borne disease cases statewide, after having tabulated a small increase to the case totals in the two years prior. In 2002 their confirmed Lyme disease case totals had doubled to 867 from 463 (in 2000) and 465 (in 2001). Since 2004, yearly Lyme disease case totals typically average >1,000 (range 896-1,431 cases). The all-time Lyme disease record high case total of 1,431 was set in 2013. Human anaplasmosis (HA) cases have also been on the rise. Through 1999, HA case totals averaged roughly 15 per year, then from 2000-2006 HA case totals increased (ranging from 78 to 186). They continued to increase from 2007-2022 (range 280-788), and the all-time HA record high of 788 was set in 2011. The MDH reported 2,685 Lyme disease cases in 2022 (confirmed and probable). However, the new case definition which among other things combines confirmed and probable cases and makes the number of cases look like a dramatic increase but in reality it is similar to those of past years. Human anaplasmosis cases totaled 540 (confirmed + probable) in 2022, the latest year of data available.

Ixodes scapularis Distribution Study

The District continued to sample the network of 100 sites set up in 1991-1992 to monitor potential changes in tick distribution over time. As in previous years the primary sampling method involved capturing small mammals from each site and removing any attached ticks from them. Collections from the northeastern metropolitan area (primarily Anoka and Washington counties) have consistently detected *I. scapularis* since 1990. *Ixodes scapularis* began expanding its range and in 2007 we collected at least one *I. scapularis* from each of the seven counties within our service area for the first time. *Ixodes scapularis* is prevalent now in its preferred wooded habitat across our entire service area, both north and south of the Mississippi River. The 2022, 2023, and 2024 Lyme Tick Distribution Study reports will be available on our website when complete (https://mmcd.org/publications/). Some preliminary 2024 highlights (through week 12) follow.

Through week 12, the 2024 average number of *I. scapularis* collected per mammal is 1.04. In comparison, yearly averages from 1990-1999 were lower (range 0.09-0.41). Since 2000, yearly averages were all > 1.0, aside from only six years, whose yearly averages ranged between 0.39-0.80 (Table 3.1). The record high of 2.11 *I. scapularis* ticks per mammal was set in 2022. In 2022, as in all years since 2007, except for 2011, we collected at least one *I. scapularis* from all seven counties in our service area. We tabulated 60 positive sites through week 12 in 2024, which is similar to the yearly positive site totals between 2000-2009 (typically in the 50s) and 2017-2022 (all in the 60s). The first time the yearly positive site total was 70 or more was in 2010 and 80 or more, in 2015. The record high of 82 positive sites was set in 2016. Maps are included in our yearly Lyme tick distribution study report.

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 *Ixodes scapularis* per mammal, 1990-2024 (preliminary); 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. scapularis* / 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
2018	765	1439	219	68	1007	139	6	1.50
2019	1121	1164	280	54	645	181	4	0.80
2020	1109	1264	75	61	1072	49	7	1.01
2021	799	767	131	61	439	135	1	0.72
2022	746	2067	386	109	1474	98	0	2.11
2023	1096	2060	476	204	1219	158	3	1.26
2024	1591	1046	289	112	493	161	2	1.04

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

[b] other species mostly *Ixodes muris.* In 1999, a second adult *I. muris* was collected

Tick-borne Disease Prevention Services

Identification Services and Outreach The overall scope of tick-borne disease education activities and services in 2024 included tick identifications of emailed photos or mailed ticks, updating our Tick Risk Meter on our website, and providing tick-borne disease information via telephone and on MMCD's Facebook page.

Posting Signs, Dog Parks Since the 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 Limited distribution of brochures, tick cards, and/or posters occurred.

Additional Updates & Collaborations

***Ixodes scapularis* Tick-borne Disease Testing.** Dragging for ticks in natural areas managed by county governments, the MnDNR, F&WS, or other landholders continued in 2024 based on a sampling design created for the 2023 season. Ticks collected by drag sampling are sent to the Centers for Disease Control (CDC) for tick-borne disease testing. However, due to the continual rain events that occurred, very few sampled locations were productive for *I. scapularis* nymphal ticks.

Powassan Virus: Results Pending This rare virus (yearly Minnesota case totals range from 0-11, median 4) is transmitted by three species of ticks, all in the genus *Ixodes*, but only *I. scapularis* commonly bites people. For the last several months of the tick surveillance season, staff collected blood samples from mammals obtained via tick surveillance, saved any ticks found on themselves while performing field work, and dragged for ticks. All collections were provided to Dr. Matthew Aliota, U of M College of Veterinary Medicine for Powassan virus testing. This project continued in 2024.

SARS-CoV-2 Virus: Results Pending In October 2021, Abbey Novotny from the North Region, collected samples for a pilot study test. All samples were negative. In 2022, samples were taken from a subset (123) of our surveillance-collected *Peromyscus leucopus*. One mouse had initially tested positive but subsequent testing determined it as a false positive result. Samples were collected again in 2024 and expanded to include all mammal species collected. This effort is a collaborative project with Professor Jeff Bender, a veterinarian and epidemiologist at the University of Minnesota.

Asian Longhorned Tick (*Haemaphysalis longicornis)* Surveillance Continued The Asian longhorned tick (*H. longicornus*), first detected in North America on a sheep in New Jersey in the fall of 2017, was later determined to have been present in the United States since at least 2010. The type apparently introduced into the US is parthenogenetic (asexual). The implication is that an introduction of a single tick into an area could potentially cause the Asian

longhorned tick to become established in that area. There have been no known introductions of this tick into Minnesota to date.

MMCD continues to participate in an interagency Asian longhorned tick surveillance collaboration. Participating agencies include:

- Indian Health Services (northern MN)
- Minnesota Board of Animal Health
- USDA Animal and Plant Health Inspection Service
- Minnesota Department of Health
- Metropolitan Mosquito Control District
- University of Minnesota
- Wildlife Rehabilitation Center of Minnesota

All agencies will keep each other informed of any *H. longicornis* found, and any tentatively identified Asian longhorned ticks will be sent to an independent tick expert for confirmation of identifications.

MMCD – Asian Longhorned Tick Specific Plans MMCD is in a good position to detect introductions of *H. longicornus* in our service area.

- Staff will continue to turn in any unusual looking adult ticks for identification
- Our tick identification service that has been in place for many years provides us with a good platform to encourage the public to continue to turn in ticks
- Since *H. longicornis* immatures are thought not to feed on mice or other small mammals, our tick surveillance study will not detect them; however, performing and discussing our tick surveillance work within the agency keeps us more attuned to ticks and their associated health risks, which theoretically should make us more likely to check for and to notice unusual tick specimens
- MMCD staff will distribute the Asian longhorned tick identification cards (with lone star ticks on the opposite side) to help the public learn what to look for and to assist us in detecting any possible introductions
- MMCD will continue to utilize Facebook to keep the public informed of *H. longicornis* updates and to enlist their help in watching for this tick

Lone Star Tick (*Amblyomma americanum*): Record Number Collected in 2024

Amblyomma americanum is an aggressive human biter that can transmit a number of tick-borne diseases. It is also the tick responsible for causing red meat allergy. It is more common to the southern U.S., but the range of *A. americanum* is moving northward. *Amblyomma americanum* was first collected by MMCD in 1991 via a road-kill examination of a white-tailed deer (*Odocoileus virginianus*) and were also submitted to MMCD from the public on a rare, sporadic basis through 2008. However, in 2009, for the first time in several years, the public submitted *A. americanum* to both MDH and MMCD (from Minneapolis and Circle Pines). As part of the tick submission process, each agency made, and continues to make, queries regarding travel history so that ticks that may have been picked up elsewhere can be excluded from the dataset. Neither the MMCD nor the MDH received any *A. americanum* in 2021, and in total, from 2009-2023, 55 *A. americanum* (40 adults, 4 nymphs, 11 unknown) were collected by or

reported to the MMCD and the MDH. Comparatively, in 2024 alone, a total of 33 *A. americanum* (32 adults, 1 nymph) were collected.

2025 Plans for Tick-borne Disease Services

Surveillance and Disease Prevention Services

The metro-based *I. scapularis* distribution study that began in 1990 is planned to continue. We will continue our tick-borne disease education activities and tick identification services, homeowner consultations, updating the Tick Risk Meter on our website, and using social media. We will stock local government agencies, libraries, and other locations with tick cards, brochures, and/or posters, distribute materials at local fairs and the Minnesota State Fair, set up information booths at events as opportunities arise and offer a comprehensive presentation that covers tick biology, pathogens transmitted that cause disease, and prevention measures. We will also continue to post signs 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 typically ceases for the year.

As of January 2025, the only confirmed testing project for 2025 is SARS-CoV-2 virus testing.

Amblyomma americanum and Other New or Unusual Ticks

***Amblyomma americanum* (Lone Star Tick)** MMCD and MDH continue to discuss possible strategies that would enable both agencies to detect possible establishment of the lone star tick 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.

***Haemaphysalis longicornus* (Asian Longhorned Tick), Possible Minnesota Introductions** We will continue to partner with the other Minnesota agencies involved in this effort. All agencies will keep each other informed of any Asian longhorned ticks found. An expert in tick taxonomy will independently confirm identification of any suspected Asian longhorned ticks collected by MMCD.

Chapter 4 Mosquito Control

2024 Highlights

- Wet conditions increased the number of larval acres treated to levels last seen in 2016
- In 2024, 119,540 more acres were treated with larvicide (261,888 acres) than in 2023 (142,348 acres)
- In 2024, 129 more acres of adulticide treatments were made (2,040 acres) than in 2023 (1,911 acres)
- A cumulative total of 274,303 catch basin treatments were made to control WNV vectors
- In 2024, MMCD treated 15,189 more acres for spring *Aedes* (61,245) than in 2023 (46,056)

2025 Plans

- Expand MMCD drone program to every facility
- Share staff between facilities
- Successfully use our budget to support control materials, our IPM efforts, and all aspects of our program
- Effectively use our control materials to control nuisance and vector mosquito in an environmentally safe manner
- Use larval and adult control materials in similar fashion to 2024 to control nuisance and vector mosquitoes in and environmentally safe manner

Background

The mosquito control program targets the principal summer pest mosquito *Aedes vexans*, several species of spring *Aedes*, the cattail mosquito (*Coquillettidia perturbans*), several known disease vectors (*Ae. triseriatus, Culex tarsalis, Cx. pipiens, Cx. restuans, Cx. salinarius*), and *Ae. 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 (~85,000 potential sites) are scrutinized for all target mosquito species.

Larval habitats are diverse. They vary from 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). Some smaller sites (i.e., sites that are smaller than three acres and are difficult to treat by can be treated using a drone.

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® FG) and *Saccharopolyspora spinosa* or "spinosad" (Natular® G30). Pre-hatch control uses time-release products which can be applied to larval habitat prior to egg hatch for extended larval control. Products have various control durations from 7-150 days dependent on the formulation. In most applications, MMCD uses 30-day products in areas of historical larval production and are targeted to the most prolific sites. The benefits of pre-hatch treatments are longer-term control which allows staff to conduct surveillance and conduct operations in other areas during that timeframe.

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

Two synthetic pyrethroids were used in 2024: permethrin and etofenprox. 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 immediately kill mosquitoes, and the material dissipates within hours. A description of the control materials is found in Appendix D. Appendix E 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. Appendices F and G contain a historical summary of the number of acres treated with each control material. Insecticide labels are in Appendix H.

The District uses priority zones to focus service in areas where the highest numbers of people 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 less 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. P1 receives 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, 2024.

2024 Mosquito Control

Larval Mosquito Control

Thresholds and Control Strategy Larval surveillance occurs prior to treatments, and control materials are applied when established treatment thresholds are met, as appropriate. Ground site treatments and cattail site treatments are based on presence/absence criteria. For treatments by air, larval numbers must meet treatment thresholds. Table 4.1 displays the treatment thresholds established for each species group and priority zone. The threshold is the average number of larvae collected in 10 dips using a standard four-inch diameter dipper. P1 and P2 areas can have different thresholds to help focus limited time and materials on productive sites near human population centers.

Table 4.1 Air site larval thresholds by priority zone and species group in 2024

Priority zone	Spring *Aedes*	Summer *Aedes*	*Culex*4[a]	Summer *Aedes* + *Culex*4 combined
P1	1.0	2.0	2.0	2
P2	1.0	5.0	2.0	2

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

Control for a season begins in the fall of the previous year when we survey cattail sites for larvae of the cattail mosquito, *Cq. perturbans*. Some sites are treated with VectoLex® (*Bacillus sphaericus*) to eliminate larvae before they overwinter. Some sites where *Cq. perturbans* larvae are limited to holes in cattail mats are treated with Altosid® briquets (methoprene) in February or early March when the wetlands are still frozen. Other sites with cattail mosquito larvae present are treated with controlled release methoprene products (such as MetaLarv® S-PT and Altosid® P35) by air or ground starting in late May to prevent adult emergence (usually peaking around July 4). Surveillance and control for the next season begins again in the fall.

Spring *Aedes* tend to be long-lived, aggressive biters and can lay multiple egg batches. Consequently, they have a lower treatment threshold than summer *Aedes* (Table 4.1), which typically lay only one batch of eggs. In 2018, the spring *Aedes* threshold was raised from 0.5 to 1 per dip in P1 due to historically low adult numbers and the high resource use. This allowed for more resources to be available for P2 areas where numbers of adult spring *Aedes*, which are potential Jamestown Canyon virus (JCV) vectors, were much higher. After mid-May, when most larvae found are summer floodwater species, the summer *Aedes* threshold of 2/dip in P1 and 5/dip in P2 is used (Table 4.1). The *Culex*4 (*Cx. restuans*, *Cx. pipiens*, *Cx. salinarius*, *Cx. tarsalis*) threshold is 2/dip in both priority zones (Table 4.1). If *Aedes* and *Culex* vectors are both present in a site and neither meet the threshold individually, the site can be treated if the combined count meets the 2/dip threshold.

Some sites that have a sufficient history of floodwater *Aedes* larval presence are treated with controlled-release materials formulated to apply before flooding (“pre-hatch”). This allows staff more time to check and treat other sites after a rainfall. The first ground and aerial prehatch

treatments (Natular® G30, Altosid® P35, MetaLarv® S-PT) were applied in mid-May with a second round in mid-June and a third in mid-July.

Season Overview In 2024, a mild winter, with little snow, turned into a busy spring with late March snowfall and a rainy April. The rain continued throughout the season, and peaked in June, when the metro had the 2nd rainiest June on record. All this rain filled the wetlands back to predrought levels. This led to the most larval acres treated (261,888 acres) since 2016 (305,990 acres). It also created some great habitat areas for our cattail mosquitoes (*Cq. perturbans*). We found over 45,000 acres of wetlands breeding cattails mosquitoes during our inspection period of August-October. This is the most cattail mosquito acreage we have ever found. To help complete all the work during the 2024 season, we hired 195 seasonal staff, which is one more than we hired in 2023.

Spring *Aedes* Control Strategy Staff detected the first spring *Aedes* larvae on February 26, the earliest date on record for MMCD. In comparison, the first mosquito was found on April 10 in 2023. After the first mosquito was found, the weather did cool back down, allowing more normal mosquito activity to begin in April, as it typically does.

The MMCD mosquito season started in April with extensive larval production and 61,245 acres treated for spring *Aedes* (Table 4.2). In comparison, we treated 46,056 acres in 2023 and much less in the previous years (Table 4.2). Aerial *Bti* treatments to control the spring *Aedes* brood began on April 20, six days earlier than 2023 (April 26). This spring brood stretched out with treatments into May until it was determined that species composition change on May 12. The majority of this spring brood was treated with *Bti* at an 8 lb/acre rate, as we did in 2023. In an effort to finish the extensive acreage prior to pupation, the District made the decision to lower the application rate to 5 lb/acre to increase efficiency and acres covered. In addition to the aerial *Bti* treatments, aerial prehatch (Natular® G30) was applied in mid-April to breeding sites that have been productive spring breeders in the past. This prehatch allowed our limited spring staff to get to, inspect, and treat all the other breeding sites with *Bti* on time. Staff continued to expand the larval spring *Aedes* surveillance in P1 and P2 in areas with higher past adult abundance.

Table 4.2 Aerial *Bti* treatment-acres to control spring *Aedes* in P1 and P2 during 2020-2024

	Number of acres treated by year				
Priority area	2020	2021	2022	2023	2024
P1	18,304	28,008	18,955	42,687	58,299
P2	0	2,676	1,465	3,369	2,946
Total	18,304	30,684	20,421	46,056	61,245

Summer *Aedes* Control Strategy The mosquito species composition switched to primarily summer floodwater *Aedes* in mid-May; the summer *Aedes* larval threshold was used beginning on May 12. A busy spring turned into a busy summer. Staff responded to 15 different summer broods, varying in size. In total we treated 178,358 acres with *Bti* in response to rain events in the spring and summer. In comparison, we treated only 64,616 acres with *Bti* in 2023 (Table 4.3). Prehatch materials (Natular® G30, Altosid® P35, MetaLarv® S-PT) were also applied in

areas that were considered likely to have floodwater egg hatch if water levels rose. Overall, the number of acres treated in 2024 (261,888) was 84% greater than the previous year (Table 4.3).

Table 4.3 Comparison of larval control material usage in wetlands, stormwater structures (other than catch basins) and containers, and in stormwater catch basins for 2023 and 2024 (research tests not included)

	2023		2024	
Habitat/Active/Product	Amount used	Acres treated	Amount used	Acres treated
Wetlands and structures				
Methoprene				
Altosid® briquets (cases)	227	216	185	182
Altosid® P35 (lb)	96,311	35,357	108,268	39,658
MetaLarv® S-PT (lb)	56,025	19,349	54,393	18,790
Spinosad				
Natular® G30 (lb)	64,712	13,640	80,857	16,502
CENSOR® G (lb)	5,360	620	0	0
B. sphaericus				
VectoLex® FG (lb)	120,870	8,537	120,403	8,273
B. thuringiensis israelensis				
VectoBac® G (lb)	366,709	58,067	897,340	138,573
VectoBac® GS (lb)	46,263	6,549	250,451	39,785
Methoprene+*Bti*				
Duplex-G	87	13	251	31
Total wetland and structures		142,348		261,888
	Amount used	No. CB treatments	Amount used	No. CB treatments
Catch basins				
Methoprene				
Altosid® briquets (cases)	1.48	472	1.99	439
Altosid® P35 (lb)	2,825.46	316,762	2,292.70	273,835
B. sphaericus				
VectoLex® FG (lb)	0.04	5	1.03	30
Total catch basin treatments		317,239		274,303

Aerial pre-hatch treatments (Natular® G30, Altosid® P35, MetaLarv® S-PT) to control floodwater *Aedes* were applied in mid-May, mid-June, and mid-August. The late summer application was completed to ensure productive breeding sites were covered as staffing levels dropped. Most aerial treatments to control cattail mosquitoes during the 2024 season using MetaLarv® S-PT were applied May 20-May 23 (Figure 4.2).

Due to the increased workload from responding to all the rain events, we treated 13.5% less catch basins in 2024 (274,303) than in 2023 (317,239) (Table 4.3). Though this didn't seem to have a negative effect on the vector minimum infection rate (see Chapter 2), we will review our process for 2025 to ensure we are treating everything that is necessary to help control vector mosquito species.

Cattail Mosquito Control Strategy The cattail mosquito (*Cq. perturbans*) work started in April this season, when we treated some of these wetlands that were found breeding in the fall of 2023 with Altosid® briquet. These treatments are typically done in February-March, but because of the mild winter and lack of ice, treatments occurred into April this year. MMCD has also reduced these briquet treatments by treating some sites with drones instead, as they are safer than staff going onto the ice.

Aerial helicopter, drone, and ground treatments, using the methoprene products Altosid® P35 and MetaLarv® S-PT occurred May 20-May 23 (aerial helicopter) and May 17-June 20 (drone and ground treatments) (Fig. 4.2). The effect of the drought from 2023 drastically reduced treatment acres to under 9,000 acres, about 5,000 less acres than we treated in 2023.

Inspections for the cattail mosquito started the last week of August and were completed by the last week of October. It was predicted that because of the drought conditions from the last few years, which had reduced habitat for cattail mosquito larvae, and that the number of adult *Coquillettidia* perturbans captured during our summer surveillance was very low, that we would find the same or slightly more acres of wetlands breeding *Cq. perturbans*. However, the wet summer recharged the wetlands faster than we predicted, and our staff found a record number of *Cq. perturbans* acres breeding, over 45,000 acres.

Similar to the last few years, 7,500 acres of VectoLex® FG was applied on September 16 to control the overwintering larval cattail mosquito population. The rest of the treatments will occur during late May-early June 2025.

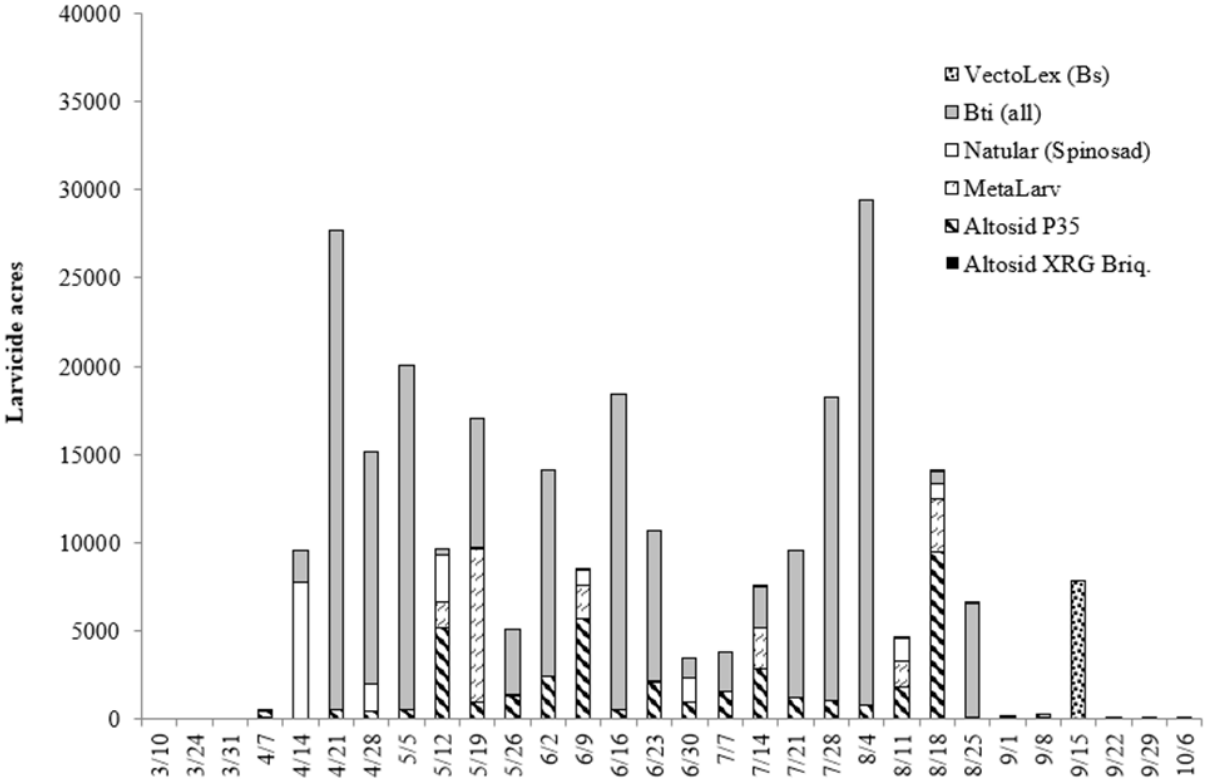


Figure 4.2 Acres treated with larvicide each week (March-September 2024). Date represents start date of week.

Unmanned Aircraft Systems (Drones) Unmanned aircraft systems (UAS), which we commonly refer to as drones, are used by many mosquito control agencies to check difficult-to-access mosquito habitats, capture aerial imagery, and apply insecticides. This technology is rapidly evolving, and rules and regulations are in place to protect the privacy and safety of humans and their property.

MMCD received our first COA (Certificate of Waiver or Authorization) from the FAA in 2020 which granted us the ability to apply control materials from a treatment drone. Multiple full-time staff members are certified as UAS pilots under the FAA's Part 107 regulation for commercial use of drones. In 2023, we changed our drone fleet to DJI drones, which made us have to write multiple new COAs because they are aircraft specific, and we have multiple treatment drone models. All MMCD treatment drones are registered with MnDOT. In addition, those staff that are certified to treat by drone applications obtained their Category B license (Minnesota Department of Agriculture - pesticide application with an aircraft) to treat sites via drones in Minnesota.

In 2024, we increased our drone fleet to three DJI drones, that performed larval treatment at mainly three facilities (Plymouth, North, and Maple Grove). The drones treated wetlands mainly with prehatch materials (Natular® G30, Altosid® P35, MetaLarv® S-PT, VectoLex® FG) but also did some treatments with *Bti.* Overall, the drones treated 3,839 acres in 2024, which was 2,189 more acres than 2023 (Figure 4.3)

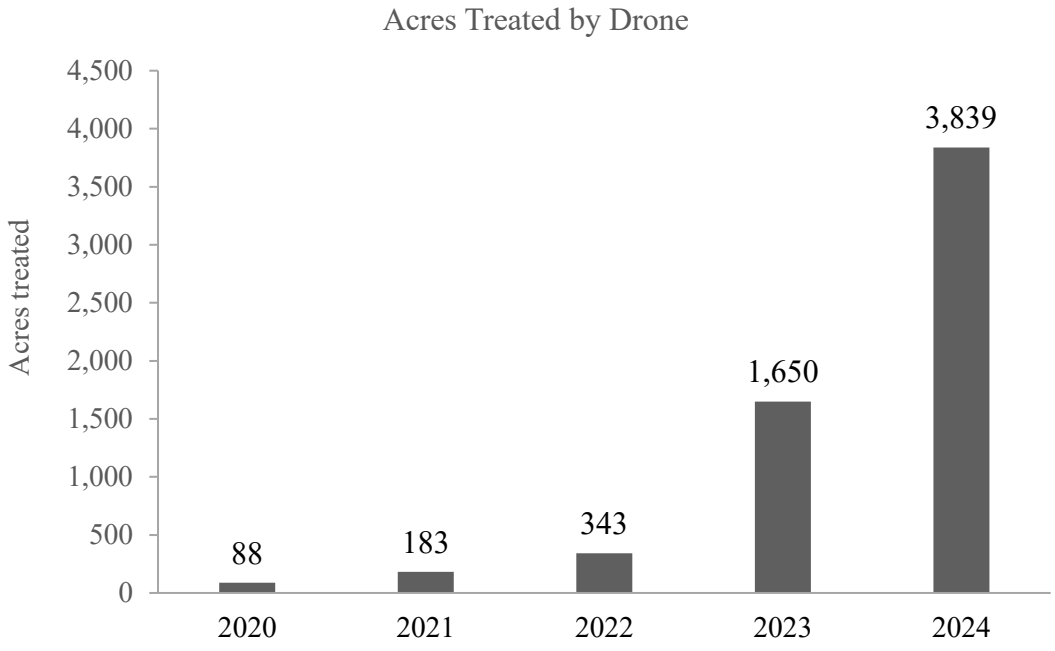


Figure 4.3 Acres treated by drone 2020-2024.

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 peoples' 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 Threshold levels by sampling method for important nuisance and vector species. *Aedes* spp. and *Cq. perturbans* are considered nuisance mosquitoes; all other species 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 [a]	130		
*Culex*4[b]	2004	1	5	1[c]	5
Ae. japonicus[d]	2022	2	2	2	2
Cs. melanura	2012		5	5	

[a] 2-minute slap count may be used.
[b] *Culex*4 = *Cx. restuans*, *Cx. pipiens*, *Cx. salinarius*, *Cx. tarsalis.*
[c] Aspirator threshold only for *Cx. tarsalis.*
[d] *Ae. japonicus* threshold was changed in 2022; from 2009-2021 it was 1 per collection.

Season Overview In 2024, adult mosquito levels were elevated at the beginning of the season. Spring *Aedes* adult mosquitoes were again above the 24-year average for the entire season and the summer *Aedes* adult mosquitoes were only above the average until late May before dropping to low levels below the long-term average (Chapter 1, Fig. 1.11). In 2024, MMCD applied 129 more acres worth of adulticides than in 2023 (Table 4.5, Appendix F). The first adult mosquito control peak was in early June in response to the elevated spring *Aedes*. From July onward, despite a wet summer, the adulticide response was for vector mosquitoes, not the floodwater species we typically see (Figure 4.4). At the end of August MMCD applied adulticides to protect the millions of state fair-goers from vector species (Figure 4.4). In 2024, we only treated ~2,000 acres as we rely heavily on our larvicide program to keep adult mosquito populations low and mostly reserve adulticiding for public health emergencies related to the detection of mosquito-borne pathogens and human illness. It should be noted that the percentage of traps over threshold for potential vector mosquitoes was above 50% for most of the season. Our main response to treating these adult mosquitoes has typically been ULV fogging with truck mounted foggers in the past. During the season, we worked closely with our vector ecologist and determined that the species captured, and the overall minimum infection rate, did not justify widespread truck mounted fogging. If the justification was there, we were prepared to treat adult mosquitoes using Anvil® (sumithrin) and Zenivex® (etofenprox).

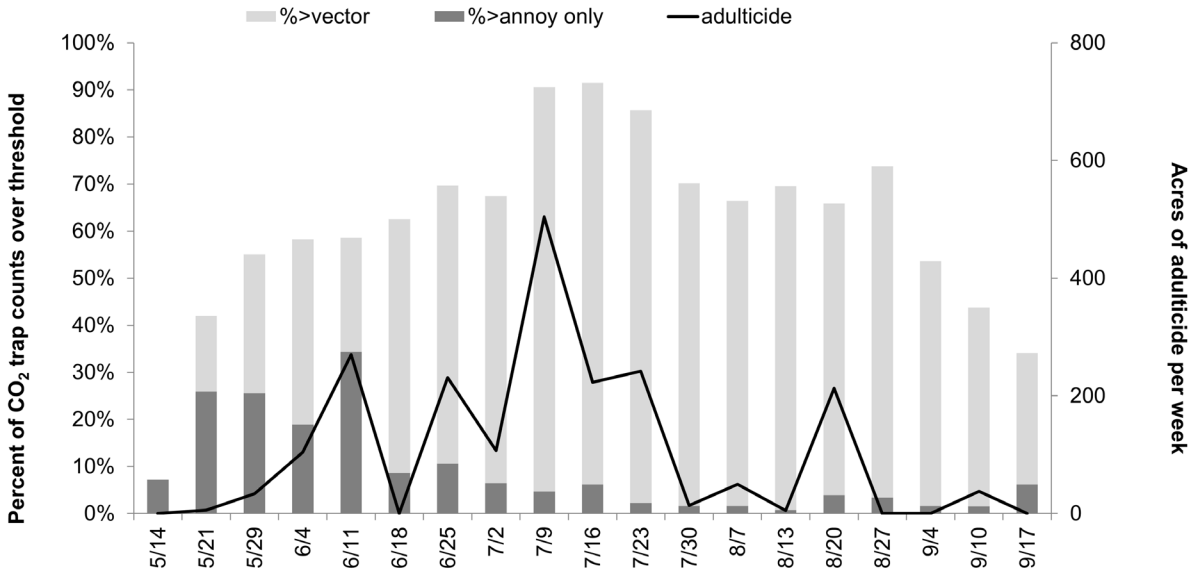


Figure 4.4 Percent of Monday CO_2 trap locations with counts over threshold compared with acres of adulticides applied in 2024 (solid line). Dark bars indicate the percentage of traps meeting annoyance mosquito thresholds and lighter bars represent the percentage of traps meeting the vector thresholds (*Culex*4, *Ae. triseriatus*, *Ae. japonicus*, *Cs. melanura*) on each sampling date. Date is day of CO_2 trap pick up.

Table 4.5 Comparison of adult control material usage in 2023 and 2024

	2023		2024	
Material	Gallons used	Acres treated	Gallons used	Acres treated
Permethrin	139.44	765	101.93	521
Sumithrin*	16.25	756	0	0
Etofenprox*	5.33	389	17.80	1,519
Total	161.01	1,911	119.73	2,040

* Products labeled for use in agricultural areas

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.

2025 Plans for Mosquito Control Services

Integrated Mosquito Management Program

In 2025, MMCD will continue to review 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, maximizing mosquito control services given available resources, and complying with all NPDES-related permit requirements.

Larval Control

Unmanned Aircraft Systems (Drones) In 2025 MMCD will increase its drone fleet and use a total of eight DJI treatment drones for mosquito larvicide applications. This expansion allows for treatments at every facility. These treatments drones will focus on treating larger ground sites and smaller air sites (less than 5 acres). The drones will treat wetlands mainly with prehatch materials (Natular® G30, Altosid® P35, MetaLarv® S-PT, VectoLex® FG) but may also use *Bti* if necessary.

To fully use these eight treatment drones, we will increase our seasonal drone technician staff from 6 (2024) to 16 (2025). All of these staff will be trained and fully licensed via an FAA part 107 license and through the Minnesota Department of Agriculture category B licenses.

Sharing of Staff Between Facilities When responding to mosquito work, one of the largest hurdles we face is time, responding to the target larval mosquito before pupation. Trying to solve this issue means moving staff around the District where they are needed. The last few years, we have made a concerted effort during air inspections and treatments to share and move staff between facilities. This has allowed the work to be completed before pupation.

For 2025 we will continue this effort of sharing staff and spread it to all aspects of our IPM program. As we review our programs, and develop further metrics to evaluate our work, we will be able to focus our work and our staff better to ensure we are responding to mosquitoes and black flies at appropriate levels in all areas of our work.

Control Material Budget 2025 MMCD has revised the managing of its control material budget for 2025. In the past years, MMCD has been conservative in managing its control material budget and often has had significant funds remaining at the end of the year. These funds were often held back for additional rain events that never transpired. These funds were put into reserve, resulting in a growing fund balance.

For the 2025 budget, we have based our control materials budget on the average expenditures for the past nine years. We then reallocated funds to hire additional lab and field staff in addition to a new quality control/quality assurance position and a safety coordinator. A portion of MMCD's reserves have been assigned to support additional control expenses if we experience a year with above average precipitation. Going forward, MMCD will treat according to our IPM plan and not arbitrarily withhold treatment as a hedge against increased expenses later in the season**.**

Floodwater Mosquitoes The primary control material will again be *Bti* corn cob granules. Larvicide needs in 2025, mainly *Bti* (VectoBac® G), Altosid® P35, Natular® G30, and MetaLarv® S-PT, are expected to be similar to the five-year average larvicide acreage usage (188,888 acres). In 2025, we plan to continue the spring *Aedes* larval threshold used in 2024 (1 per dip in both P1 and P2) and consider expanding P2 treatments as resources allow to reduce potential JCV vectors in areas where human populations are present. Depending on the environmental conditions, we plan to treat spring *Aedes* sites with *Bti* at 8 lb/acre. With each brood, staff will review environmental conditions, budgetary considerations, proposed acreage, and available treatment time to determine if a *Bti* dosage rate change is necessary or pertinent. MMCD may drop to a lower *Bti* application rate when water temperatures are warm and vegetation is low, and this often coincides when we switch to the summer *Aedes* threshold. Regardless of annoyance levels, MMCD will maintain sufficient resources to protect the public from potential disease risk.

Staff will treat ground sites with Natular® G30, methoprene products (Altosid® P35, Altosid® briquets, MetaLarv® S-PT), or *Bti* (VectoBac® G). 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 2024.

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. Drought conditions have impacted site histories and surveillance records of some of our prolific breeding habitats. Some areas may not have produced mosquitoes in past years, but the mosquito eggs laid in these sites can persist up to 3-7 years. Pre-hatch treatment decisions will be made on surveillance history created over multiple years.

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* species. Catch basin treatments control *Cx. restuans* and *Cx. pipiens* in urban areas. Most catch basins will be treated with Altosid® P35. 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 Altosid® P35 treatments by June 25 with subsequent Altosid® P35 treatments every 30 days thereafter.

Cattail Mosquitoes In 2025, control of *Cq. perturbans* will use a strategy similar to that employed in 2024. MMCD will focus control activities on the most productive cattail marshes

near human population centers. Due to the additional acres found in the fall of 2024, our overall treatments acres will increase from 2024.

Altosid® briquet applications will start in February or 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® P35 and MetaLarv® S-PT to minimize per-acre treatment costs. Beginning in late May, staff will apply Altosid® P35 (3 lb/acre) and MetaLarv® S-PT (3 lb/acre) aerially and by ground. Staff will complete late summer VectoLex® FG applications (15 lb/acre), based upon site inspections completed between mid-August and mid-September.

Adult Mosquito Control

Staff will continue to review MMCD's adulticide program to ensure effective resource use and minimize possible non-target effects. 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:

- Use Anvil® (sumithrin) and Zenivex® (etofenprox) as needed to respond to elevated levels of adult mosquitoes as needed
- Use Anvil® and Zenivex® as needed to control WNV vectors including in agricultural areas because current labels now allow applications in these areas
- Ensure all employees who may apply adulticides have passed applicator certification testing for both restricted and non-restricted use products
- Review adult mosquito control in regard to potential impacts on endangered species and to protect pollinators
- Review available products, equipment, technology, and research to ensure that MMCD is using the appropriate methods in our adulticiding program

Chapter 5 Black Fly Control

2024 Highlights

- Made 45 small stream treatments with *Bti* when the *Simulium venustum* or *S. tuberosum* larval populations met the treatment threshold; used 22.6 gallons of *Bti*
- Made 50 *Bti* treatments on the large rivers when the larval population of the target species met the treatment threshold; used 5,406.3 gallons of *Bti*. This was the second highest *Bti* amount used since 1996
- Monitored adult populations using overhead net sweeps and CO_2 traps; the average black fly/overhead sweep count was 1.13
- Placed non-target invertebrate monitoring samplers on Mississippi River

2025 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
- Continue monitoring *Simulium tuberosum* larval and adult populations to understand its distribution and abundance better
- Process the non-target study monitoring samples from Mississippi River

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 by staff at 202 small stream and 31 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 following MMCD's permit from the Minnesota Department of Natural Resources (MNDNR).

The small stream treatment program for *Simulium venustum* began in 1984. *Simulium tuberosum* was included in the small stream treatment program for the first time in 2021 due to the increased population of this human-biting species in recent years. Based on the success of a pilot *S. tuberosum* treatment program in five small streams in 2021, the MNDNR permitted up to two *S. tuberosum Bti* treatments at any of the small stream sites listed on MMCD black fly permit that meet the treatment threshold starting in 2022. A second treatment is allowed for *S. tuberosum*, because there is more than one annual cohort. 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.

2024 Program

Small Stream Program: *Simulium venustum* and *Simulium tuberosum* Control

Simulium venustum and *S. tuberosum* are human-biting black flies that develop in small streams in the MMCD and are targeted for control. *Simulium venustum* has one cohort during the spring and *S. tuberosum* is multivoltine with two or more cohorts. Adults of *S. venustum* and *S. tuberosum* first appear in early to mid-May.

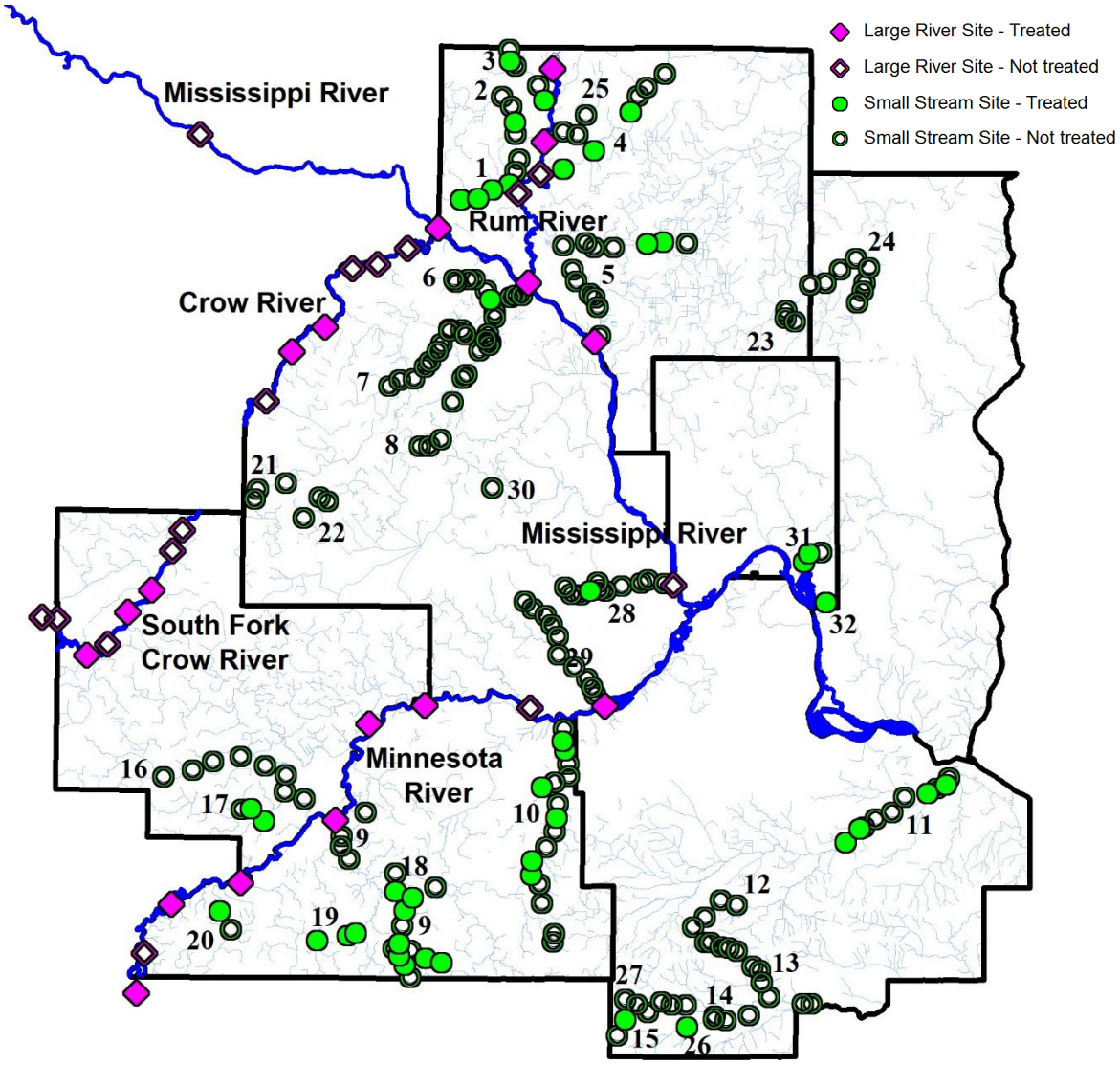


Figure 5.1 Large river and small stream black fly larval monitoring and treatment locations, 2024.

Note: the large river site located outside the District on the Mississippi River is for monitoring only. Since 1991, more than 450 of the 600+ original small stream treatment sites were eliminated from the annual small stream sampling program due to the increased treatment threshold and 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* or *S. tuberosum* populations. The numbers on the map refer to the small stream names listed below:

1=Trott	8=Elm	15=Dutch	22=Painter	29=Nine Mile
2=Ford	9=Sand	16=Bevens	23=Clearwater	30=Plymouth
3=Seelye	10=Credit	17=Silver	24=Hardwood	31=Battle
4=Cedar	11=Vermillion	18=Porter	25=Ditch 19	32=Fish
5=Coon	12=Vermillion S. Br.	19=Raven W.Br.	26=Chub Trib. 1	
6=Diamond	13=Chub N. Br.	20=Robert	27=Dutch Trib. 1	
7=Rush	14=Chub	21=Pioneer	28=Minnehaha	

Sampling to assess larval populations of *S. venustum* and *S. tuberosum* for treatment thresholds at the MNDNR-permitted small stream sites was conducted between April and early-June using MMCD's standard grab sampling technique. The treatment threshold was 100 larvae per sample for both species.

In late April and early May, 38 sites on 15 small streams met the treatment threshold for *S. venustum* and these sites were treated once with a total of 19.9 gallons of VectoBac® 12AS *Bti*. The treatment threshold for *S. venustum* was also met in early May on the Rum River and it was treated with 45 gallons of *Bti*. Data for *S. venustum* monitoring and *Bti* treatments on the Rum River are tallied with the large river totals in accordance with the MNDNR permit.

In early May, two sites on two streams met the treatment threshold for *S. tuberosum* and 0.27 gallons of *Bti* were used to treat these sites. A second cohort of *S. tuberosum* was treated at five sites in late May/early June on three streams using 2.44 gallons of *Bti*. One site on the Battle Creek and one site on Fish Creek were treated for both *S. tuberosum* cohorts.

A total of 22.6 gallons of *Bti* was applied to the small streams in 2024. In comparison, the average amount of *Bti* used to treat small stream sites annually during 1996-2023 was 28.9 gallons (Table 5.1).

Table 5.1 Summary of *Bti* treatments for black fly control by the MMCD in 2024 versus long-term average

	2024			Long-term average[1]		
Waterbody	No. sites treated	Total no. treatments	Gal. of *Bti* used	No. sites treated	Total no. treatments	Gal. of *Bti* used
Small stream	43	45	22.6	46.4	46.8	28.9
Large river						
Mississippi	2	10	1,812.8	2.1	10.1	1,100.9
Crow	2	5	149.7	2.0	4.7	86.9
S. Fork Crow	3	3	50.5	5.4	11.2	99.5
Minnesota	7	18	3,232.2	6.0	15.8	1,709.6
Rum	3	14	161.1	3.3	19.5	140.9
Large river totals	17	50	5,406.3	17.0	57.7	3,105.9

[1] The Mississippi, Crow, Minnesota, Rum, and small stream averages are from 1996-2023. The South Fork Crow average is from 2005-2023.

Large River Program

The MMCD targets larval populations of the large river black fly species that are pests of humans for control with *Bti*. *Simulium luggeri* larvae occur mainly in the Rum and Mississippi rivers, although smaller numbers are also found in the Minnesota, Crow, and South Fork Crow rivers. Depending on river flow, *S. luggeri* larvae are present from mid-May through September. *Simulium meridionale* and *S. johannseni* larvae occur primarily in the Crow, South Fork Crow, and Minnesota rivers. These species are most abundant in May and June, although *S. johannseni* emerge earlier than *S. meridionale*. *Simulium johannseni* are univoltine. *Simulium meridionale*

are multivoltine with the largest numbers occurring in the first cohort in May and June, but populations can also be high throughout the summer if river flows are sufficient for good larval production.

Larval black fly populations were monitored weekly between May and mid-September using artificial substrate samplers (yellow plastic tapes) at the 31 sites permitted by the MNDNR on the Rum, Mississippi, Crow, South Fork Crow, and Minnesota rivers in 2024. 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 are the same treatment thresholds that have been used since 1990.

A total of 373 larval monitoring samples were collected from the large river sites in 2024. The treatment threshold was met in 50 samples from 17 of the permitted sites; the associated sites were treated with a total of 5,406.3 gallons of VectoBac® 12AS *Bti* (Table 5.1). The average amount of *Bti* used annually for the large river treatments between 1996 and 2023 was 3,105.9 gallons. The average number of treatments done annually from 1996 to 2023 was 57.7 at 17.0 sites (Table 5.1).

The average monthly flows between April and September on the Rum, Mississippi, Minnesota, Crow, and South Fork Crow rivers were 26%, 43%, 158%, 159%, and 252% above the long-term average, respectively. Overall, most rivers had above average flows from May through September.

Larval monitoring and *Bti* treatments were suspended on the Minnesota, Crow, and South Fork Crow rivers from June through mid-July due to safety concerns caused by the dangerous conditions from flood-level flows. Even without treatments during this time, the amount of *Bti* used to treat the large rivers was well above average in 2024 (Table 5.1), in fact, it was the second highest since 1996. Since the amount of *Bti* required to achieve the prescribed dose is directly proportional to stream flow, higher than normal river levels all season, especially on Minnesota and Mississippi rivers accounted for more *Bti* usage (Table 5.1).

The efficacy of the VectoBac® 12AS *Bti* treatments was measured by determining larval mortality 250 m downstream from the application point 24 hours after most treatments in 2024. Post-treatment mortality averaged 97% on the Minnesota River, 87% on the Crow River, 96% on the Rum River, and 97% on the South Fork Crow River. Only one checkback was performed on a Mississippi River treatment (July 12) with 93% mortality.

Adult Population Sampling

Daytime Sweep Net Collections The adult black fly population was monitored at 54 standard locations (Figure 5.2) using the District's black fly over-head net sweep technique that was established in 1984. Prior to 2004, samples were taken twice weekly. Since then, samples have been 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 2024 was 1.13/sweep (± 3.78 SD). In comparison, the average of all species captured in net sweeps from

1996 (the start of operational *Bti* treatments) to 2023 was 1.20/sweep (± 0.78 SD). 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/sweep (± 3.04 SD) (Table 5.2).

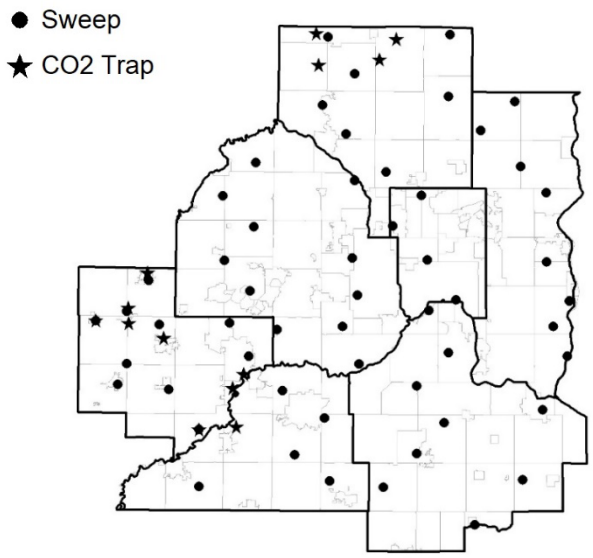


Figure 5.2 Standard overhead sweep net sampling locations (n=54) and CO_2 trap (n=13) sampling locations, 2024.

The county with the highest number of total black flies captured in the sweep net monitoring samples was Scott County, where a mean of 2.26 (± 4.01 SD) per sample for all species was recorded. The county with the second-highest sweep net count for total black flies was Carver County, where the mean was 2.07 (± 7.00 SD) per sample. Ramsey County was the third-highest county for the net sweep count of total black flies with a mean of 2.06 (± 4.56 SD) per sample.

The most abundant black fly species collected in the overhead sweep net samples in 2024 was *S. meridionale*, comprising 65% of the total black fly adults captured with an average of 0.73 (± 2.53 SD) per sample. The second most abundant black fly species captured was *S. luggeri,* comprising 19.8% of the total with an average of 0.22 (± 2.10 SD) specimens per sample. The third most abundant black fly species captured was *S. vittatum,* comprising 12.2% of the total with an average of 0.14 (± 1.11 SD) per sample. The fourth most abundant black fly species captured was *S. venustum,* comprising 1.8% of the total with an average of 0.02 (± 0.2 SD) per sample. Few *S. tuberosum* were collected in 2024, comprising 0.65% of the total captured in overhead sweep net samples.

Simulium meridionale was most abundant in the Carver County samples, with a mean of 1.44 (± 4.58 SD) per sample. Ramsey County had the second-highest number of *S. meridionale* with a mean of 1.39 (± 3.23 SD). *Simulium luggeri* was the most numerous in Ramsey County and Carver County sweep samples. The mean number of *S. luggeri* per sample was 0.64 (± 2.75 SD) in Ramsey County and 0.54 (± 4.32 SD) in Carver County.

Table 5.2 Mean number and standard deviation (SD) 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]	Time period	Mean ± SD			
		All species[4]	*Simulium luggeri*	*Simulium johannseni*	*Simulium meridionale*
No treatments	1984-1986	14.80 ± 3.04	13.12 ± 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	1996-2023	1.20 ± 0.78	0.88 ± 0.75	0.01 ± 0.02	0.20 ± 0.26
	2024	1.13 ± 3.78	0.22 ± 2.10	0.001 ± 0.03	0.73 ± 2.53

[1]1988 and 2021 were severe drought years which limited black fly production.
[2]The first year of operational treatments (treatment of any MNDNR-permitted sites) on the large rivers was 1996.
[3]Expanded operational treatments began in 2005 when permits were received from the MNDNR for treatments on the South Fork Crow River.
[4]All species includes *Simulium luggeri*, *S. meridionale*, *S. johannseni*, and all other black fly species collected.

Black Fly-Specific CO_2 Trap Collections Adult black fly populations were monitored from mid-May through June in 2024 with CO_2 traps set twice weekly at nine sites in Scott/Carver counties and four sites in Anoka County (Figure 5.2). These traps augment the daytime sweep net collections in the spring to monitor the *S. venustum* population. The adult black fly populations at these locations have been monitored with CO_2 traps since 2004. Black flies captured in the CO_2 traps were preserved in alcohol.

A total of 225,128 black flies were captured in the CO_2 traps in 2024. The most abundant species collected in 2024 was *S. meridionale,* with a total of 192,942 specimens that comprised 85.7% of the total black flies collected in the CO_2 samples. *Simulium venustum* was the second most abundant species collected, with a total of 23,391 specimens that comprised 10.4% of the total collection. The third most numerous species collected was *S. johannseni* with a total of 4,698 specimens that comprised 2.1% of the total. A total of 3,822 *S. luggeri* were captured in 2024, comprising 1.7% of the total collection. Few *S. tuberosum* were collected in the CO_2 trap collections in 2024, only 0.01%.

Black Fly Annoyance Complaints The number of black fly annoyance complaints in 2024 was 41, compared to 44 in 2023, 11 in 2022, 151 in 2021, 43 in 2020, 7 in 2019, and 36 in 2018. Most of the complaints were from Carver, Scott, and southern Hennepin counties, especially areas around the Minnesota River (Fig. 5.3).

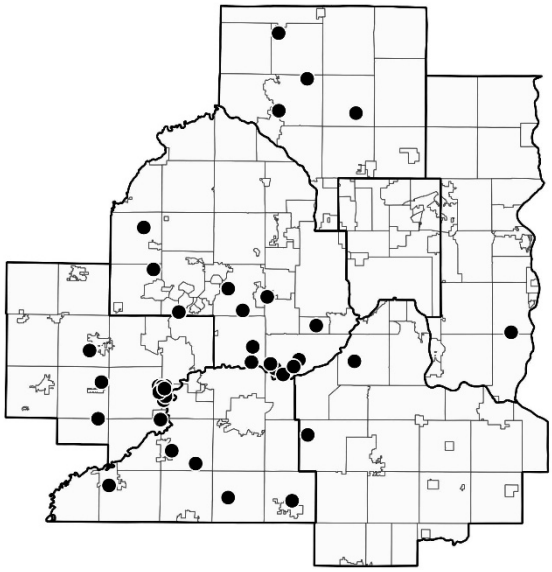


Figure 5.3 Black fly (biting gnats) annoyance complaint locations (n=41), 2024.

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 2024. 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 5.4. The areas in dark gray and black represent the highest numbers collected, ranging from 250 to more than 500 per trap. High levels of black flies were observed in May through July in Carver, Scott, Dakota, and southern Hennepin counties (Figure 5.4). The peak average number of black flies occurred on July 8 (Figure 5.5). The average number of black flies was above the 17-year average in May, near average through mid-June, then rose well above average through July. These high numbers were a result of no treatments to the Minnesota River during June due to flooding conditions.

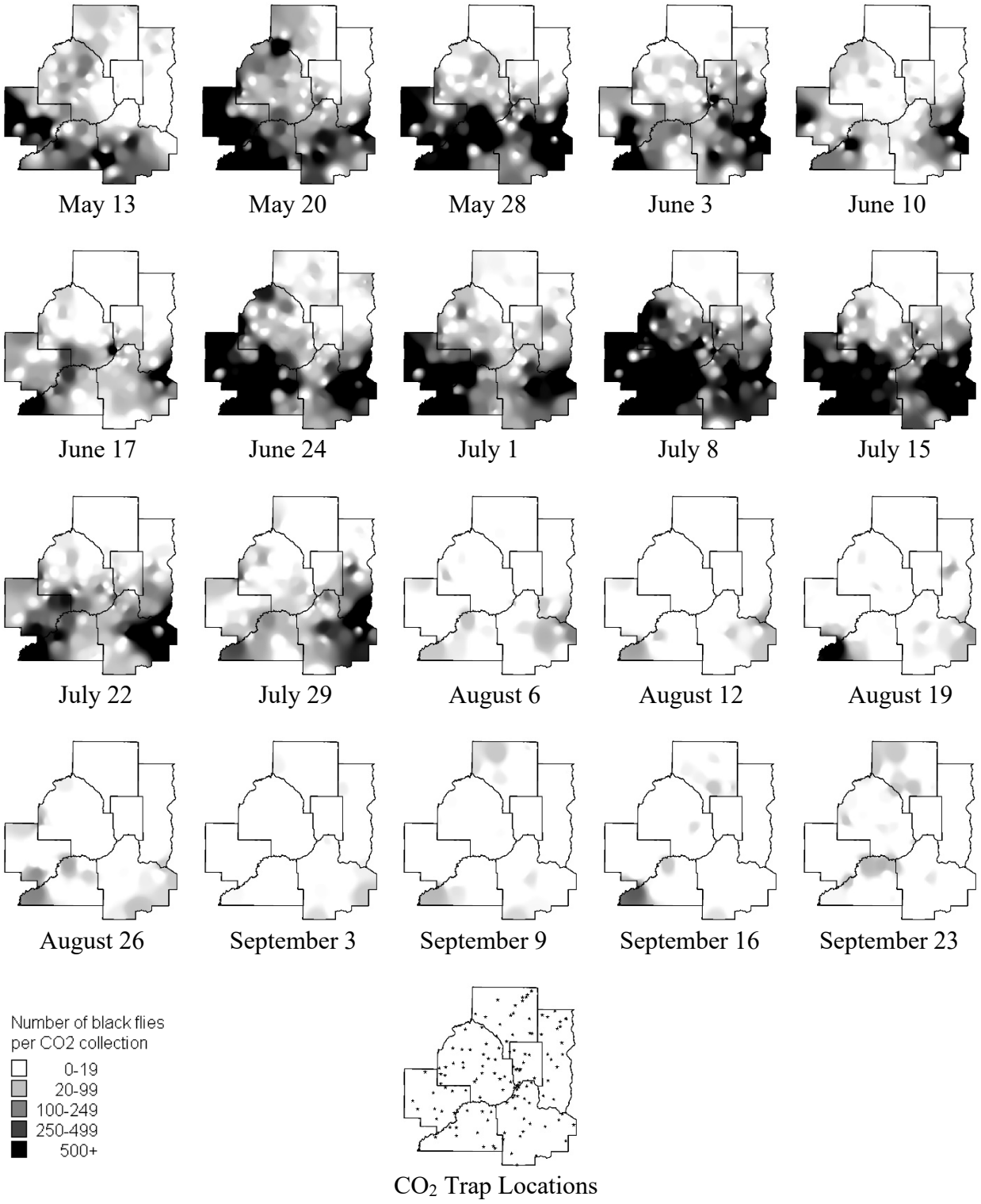


Figure 5.4 Number of black flies collected in mosquito surveillance District low (5 ft) CO_2 traps, 2024. The number of traps operated per night varied from 109-122. Inverse distance weighting was the algorithm used for shading of maps.

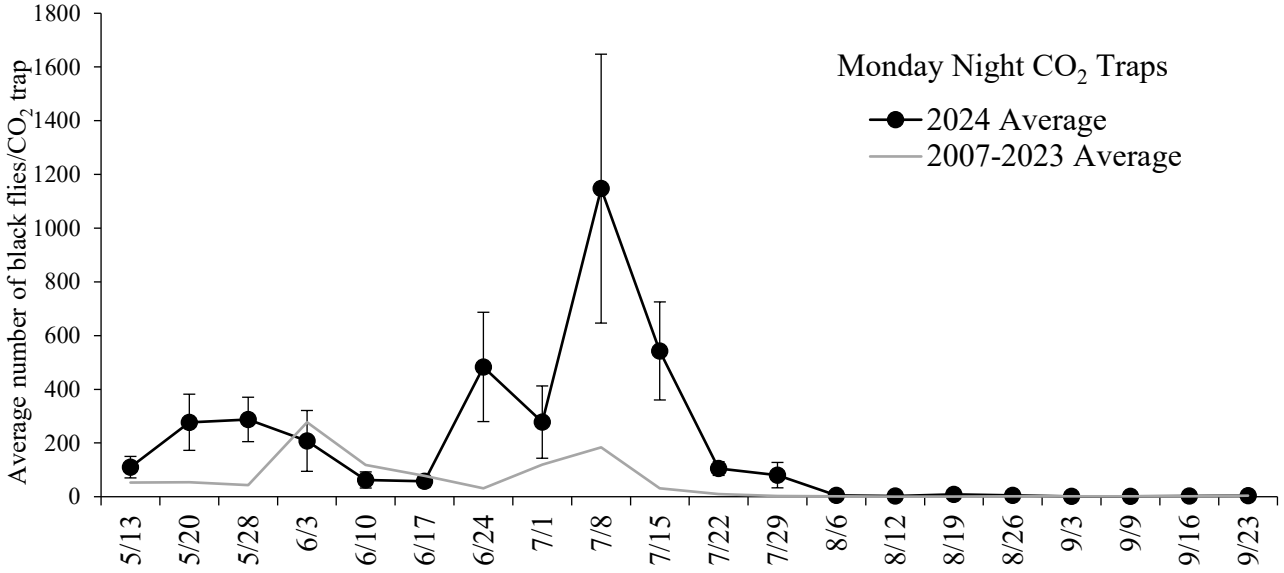


Figure 5.5 Average number of black flies per Monday Night Network CO_2 low trap, 2024-vs. 17-year average (2007-2023).

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. Results compiled from the thirteen separate years that monitoring samples were collected biennially between 1995 and 2019 indicate that no large-scale changes have occurred in the macroinvertebrate community in the *Bti*-treated reaches of the Mississippi River.

The drought in the spring and summer of 2021 led to flows in the Mississippi River that were too low for proper deployment of the Hester-Dendy multiplate macroinvertebrate samplers for the scheduled biennial non-target sampling study. MMCD consulted with the MNDNR about this situation, and it was mutually agreed to delay sampling until 2022. The monitoring samples were collected in 2022. The 2022 samples were processed, and a report was submitted to the MNDNR in July 2024. Results from 2022 indicated that no large-scale changes have occurred in the macroinvertebrate community in the *Bti*-treated reaches of the Mississippi River.

Seven-plate Hester-Dendy samplers were placed on the Mississippi River in 2024. Sample picking and invertebrate identifications and enumeration are in progress with report completion planned for spring of 2026.

2025 Plans – Black Fly Program

2025 will be the 41st year of black fly control in the District. The primary goal in 2025 will be to continue to effectively monitor and control black flies in the large rivers and small streams. The

larval population monitoring program and thresholds for treatment with *Bti* will continue as in previous years. The 2025 black fly control permit application was submitted to the MnDNR in January. Processing of Hester-Dendy multiplate samples collected in 2024 for the non-target invertebrate monitoring program on the Mississippi River will continue.

Studies on the distribution, abundance, and ecology of immature and adult *S. tuberosum* will continue to increase the District's understanding of this species. The MMCD will continue to communicate cooperatively with the MnDNR to develop an effective and environmentally sound strategy to reduce the impacts on humans that has been caused by the recent increase in the numbers and range of this species in the Twin Cities area. Program development will continue to emphasize improvements in effectiveness, surveillance, and efficiency.

Chapter 6 Product & Equipment Tests

2024 Highlights

- VectoBac® *Bti* application rates varied throughout the season due to operational efficiency requirements
- VectoBac® FG *Bti* produced equivalent control throughout the season in air sites
- Evaluations of extended duration products were limited due to wet weather conditions, continued operations, and staff availability

2025 Plans

- Increase staff capacity to develop a more robust evaluation and product testing program
- As part of our strategic planning, develop new metrics to improve our ability to measure operations and focus priorities
- Continue to evaluate residual products: Natular G30, CENSOR® G and Duplex™-G
- Evaluate expansion of our drone program as it is used in multiple facilities
- Continue evaluations of LiDAR, photogrammetry, and geographic mapping in larval habitats using drones

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.

2024 Projects

Quality assurance processes focused on product evaluations, equipment, and waste reduction. Before being used operationally, all products must be evaluated under MMCD field conditions to demonstrate their effectiveness. The District is evaluating six control materials for operational use. 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. 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 may contract an independent testing laboratory, Legend Technical Services, to complete the AI analysis. Manufacturers provide 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 2024 were all within acceptable limits (Table 6.1).

Table 6.1 AI content of Altosid® (methoprene) briquets and P35 granules; MetaLarv® S-PT granules (methoprene), and Natular® G30 granules (spinosad), 2024

		AI content		
Product evaluated	No. samples analyzed	Label claim	Analysis average	SE
Altosid® XR-briquets	6	2.10%	2.19%	0.0105
Altosid® P35 granules	11	4.25%	4.27%	0.0299
MetaLarv® S-PT granules	5	4.25%	4.30%	0.0211
Natular® G30 granules	15	2.50%	2.52%	0.0247

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 ensure that all adulticides (purchased, formulated, and/or stored) meet the necessary quality standards. Due to no additional adulticide purchases, MMCD did not sample adulticide products or save 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 2024. Aerial *Bti* treatments to control the spring *Aedes* brood began on April 15, thirteen days earlier than in 2023. The operational treatment rate was 8 lb/acre. The application rate did vary throughout the season. This variation was due to the necessity of completing the air work in a limited treatment window. *Bti* is ineffective when not ingested by the larvae. MMCD can efficiently cover more acres per load using a 5 lb/acre rate when mosquitoes are developing rapidly, and staff are concerned that they will miss the feeding stages of their life cycles. Multiple broods required this rate adjustment throughout the season. The control efficacy (Table 6.2) was shown to be similar between the two application rates in 2024. Percent mortality was calculated by comparing pre- and post-treatment dip counts.

Table 6.2 Efficacy of aerial VectoBac® G applications during the 2024 mosquito season (n = number of sites dipped)

Time period	Dosage rate	n	Mean mortality	±SE*
April 15-Aug 30	5 lb/acre	148	79.02%	2.8%
April 20-Aug 28	8 lb/acre	329	82.45%	1.8%

*SE= standard error

New Control Material Evaluations

The District, as part of its continuous quality improvement philosophy, strives to continually improve its control methods. Testing in 2024 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.

Larvicide Materials

In 2024, control material research was limited due to the extremely wet conditions and limited workforce available for evaluating new control materials. Therefore, there was a limited focus on product evaluations during the 2024 season.

Natular® G30 granules MMCD staff requested an updated evaluation of the Natular G30 product to review its efficacy in field operations. Staff completed 1,569 applications at a 5 lb per acre rate and conducted 100 checkbacks. MMCD applications achieved 63.62% control within a 33-day period. This evaluation makes assumptions that if a checkback was completed and no larvae were found in the site, the treatment was working effectively. With the continued flooding from new rains, many sites were producing new mosquito broods and the timing of the checkbacks may have affected our efficacy results. Additionally, *Culex* mosquitoes were very abundant and widespread across the District and may have confounded the perceived lack of control efficacy at these locations due to their continuous production in some areas. MMCD will continue to evaluate the Natular® G30 product in 2025.

VectoBac® GS *Bti* granules MMCD staff wanted to look at a different granule size of the VectoBac® product. The smaller sized granule is used in many other parts of the U.S. in mosquito operations. A smaller granule (GS) (10/14 mesh size) would increase the number of granules per square foot at the same application rate as our current product (5/8 mesh size). MMCD staff also wanted to compare application rates (5 and 8 lb/acre) in spring sites. Quality spring applications are critical. Spring *Aedes* mosquito species are long lived, can take multiple bloodmeals, and can contribute to increased risk of vector-borne disease (i.e., Jamestown Canyon virus).

A total of 1,164 breeding sites were treated using the 8 lb/acre rate. Staff completed 94 checkbacks and found 94.06% control within six days of the application. Historically, MMCD has used the larger corn cob size to reduce possible product drift with helicopter applications. When compared to VectoBac®'s 5/8 granule at similar rates, the GS granule achieved greater efficacy and staff believed they had better site coverage. MMCD will continue to evaluate this smaller granule in 2025.

Duplex™-G methoprene & *Bti* granules The Duplex™-G granule is a combination product that is designed to provide immediate efficacy and have up to 28 days of residual activity. A dual product may have applicability in situations where multiple broods may occur. The spring season may be a good opportunity to use this product. Various spring and summer

mosquito species may hatch at different times as site water temperatures warm up. This product would allow staff to visit more sites without returning to the same sites to search for additional broods.

The *Bti* component is designed for immediate release when applied to water. Theoretically, the *Bti* would remain active in the feeding column up to 72 hours before settling out. In reviewing the immediate efficacy of the *Bti* component within three days of application, Duplex™-G granules demonstrated an average control rate of 80.12% in 17 sites.

In four facilities, 84 sites were treated at an 8 lb/acre rate and evaluated for residual control. Staff completed 16 pupal bioassays to measure emergence inhibition (% EI) of the methoprene component. Within these sites, it showed 82.58 % EI overall in the May and June evaluation period.

This testing showed that the product has applicability in spring and early summer ground sites. Staff will continue to evaluate how to best utilize this product within our operations and weigh its benefits over other control materials in field operations.

CENSOR® G granules The CENSOR® G corn cob granule is a spinosad product with a 7-day residual period. It is designed to work in similar situations where *Bti* granules are currently used in our operations. An advantage of the spinosad active ingredient is that it does not have to be ingested to obtain control. Therefore, in cold water where mosquito larvae are less active and their feeding activity is reduced, this product may be more effective earlier in the season. It does have some residual activity which may also enhance control when multiple hatches are occurring in the spring.

MMCD did not complete any CENSOR® G evaluations in 2024. Staff did not have the opportunity to conduct additional testing with the extremely busy workload and time required to properly evaluate products.

Adulticide Tests

MMCD did not complete any tests of adulticides in 2024. Staff was focused upon larval applications due to the wet weather conditions.

Equipment Evaluations

Automated Systems for Insect Identification and Pooling In previous seasons, MMCD staff reviewed two automated systems for assistance with taxonomic identification and sample separation. After review, staff determined that only one system has the capabilities to meet our sample volume requirements. This developing technology will be monitored to determine if it has applicability, capacity, and ability to assist MMCD in completing our mission.

This technology is in its early stages of development. A fully operational system that can identify all our species would be considered, but staff could not justify the current benefits, significant expense, or the time and effort required to help develop the vendor's products. MMCD will

continue to monitor these innovative systems and consult with agencies that are using these technologies within their operations.

Helicopter Swath Analysis and Calibration Procedures for Larvicides Field operations staff and Technical Services conducted four aerial calibration sessions for dry, granular materials during the 2024 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 Le Sueur Municipal Airport in Le Sueur, MN. Staff completed swath characterizations for seven different operational and experimental control materials. In total, six Jet Ranger helicopters were calibrated, and each helicopter was configured to apply an average of five different control materials.

Drone Swath Analysis and Calibration Procedures for Larvicides Field operations staff and Technical Services conducted aerial calibration sessions for various drone models (Agras T-10, Agras T-20, Agras T-30) for dry, granular materials in field sites. Staff completed swath characterizations for three control materials applied in 2024 (Altosid® P35 granules, Valent MetaLarv® S-PT granules, and Valent VectoLex® FG granules). These various drone models continue to develop into a quality application platform to increase our efficiency, improve the quality of treatments, and enhance employee safety and satisfaction.

LiDAR Technology Evaluation MMCD partnered with Frontier Precision to evaluate the capabilities of a drone-mounted LiDAR system. Light Detection and Ranging (LiDAR) systems use a pulsed laser to measure distances to the ground. Through this flight process, the unit can produce a map of earth contours similar to physical surveying. The advantages of such a system are that it can be done efficiently by air without entering the site. Theoretically, it can penetrate vegetation and provide an accurate topographical map to differentiate lower elevations which could hold water. Therefore, LiDAR may help to identify mosquito habitats which may be obscured by vegetation and assist staff to effectively find these specific areas.

MMCD will work with the vendor to conduct a future trial in desired habitat. The wet weather and flooded wetlands in 2024 did not allow a detailed physical land survey to be completed. Therefore, MMCD did not conduct any additional survey flights to directly compare to aerial LiDAR-derived data and the land survey information.

MMCD will continue to review LiDAR information from other state agencies and organizations. MMCD may be able to use lower intensity LiDAR mapping to assist in the physical land survey and then, be able to compare different LiDAR intensities, other wetland vegetation mapping technologies, and physical mapping to gain more pertinent knowledge about this technology.

Optimizing Efficiencies and Waste Reduction

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 collect their empty plastic containers at their facility and package them in large plastic bags for recycling. MMCD did not conduct significant adulticide treatments in 2024 and therefore, did not generate a significant number of plastic jugs. The District did not utilize the ACRC program and will save empty containers for proper disposal in 2025.

The District also 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, thus reducing the District's overall generation of waste products.

Recycling Insecticide Pallets In 2024, MMCD produced over 774 empty hardwood pallets used in control material transport. Our warehouse staff worked with our vendors and arranged to return the pallets 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 continuing to work with Valent BioSciences to explore using the recycled materials of our empty *Bti* and VectoLex® FG 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.

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 2024, Central Life Sciences shipped Altosid® P35 granules (110,000 lb) in 91 totes and reduced the packaging by 2,757 bags. Valent sent MetaLarv® granules (55,000 lb) in 55 bulk totes and reduced the packaging by 1,100 bags. Clarke shipped Natular® G30 granules (80,000 lb) in 50 totes and reduced the packaging by 2,000 bags. Staff were able to spend less time dealing with waste, and the District eliminated 5,857 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.

Waste Packaging of Control Materials Valent BioSciences representatives met with MMCD staff to review this large waste issue and proposed viable solutions. They are continuing to attempt to produce a recyclable or more biodegradable bag. MMCD is attempting to stay out of the waste processing cycle (collection, processing, storage, shipping) and does not have local facilities that accept pesticide waste. Valent is willing to work with our sustainability team to continue to find solutions to this issue.

2025 Plans – Product and Equipment Testing

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 ensure the collection of quality information for all evaluations, so decisions are based upon quality data.

A new full-time Quality Assurance/Quality Control (QA/QC) coordinator position is being created to assist with the evaluation of our treatment program and to coordinate product testing. This coordinator will be responsible for developing the QA/QC program, evaluation tools, and conducting statistical analysis. MMCD's goal is to have a comprehensive program which can assist staff in making quality, data-based operational decisions.

As part of our strategic planning, MMCD will continue to develop various new metrics and program evaluation techniques to enhance operations. These measures will assist staff in establishing priorities and focus on providing services to all of our citizens.

We will continue to improve our calibration and application techniques to optimize all our mosquito control equipment.

MMCD will continue to expand our drone program and find ways to use this technology effectively. MMCD will be reviewing larger capacity drones (Agras T20 and T30) to see if that opens some additional advantages to our program. Besides control material applications, we will continue to evaluate LiDAR, photogrammetry, and geographic mapping of mosquito habitat to provide new insights into our field operations.

Chapter 7 Supporting Work

2024 Highlights

- Completed field and lab data entry portions of major data system upgrade
- Added virus data entry and management to the data system
- Public Web Map use continues to be high
- Calls requesting adult treatment returned to wet-year levels, peaking in early June in areas affected by the Minnesota River flooding
- Requests for tire recycling pickups reached a record high of 592 calls from residents
- Public events and school presentations continue

2025 Plans

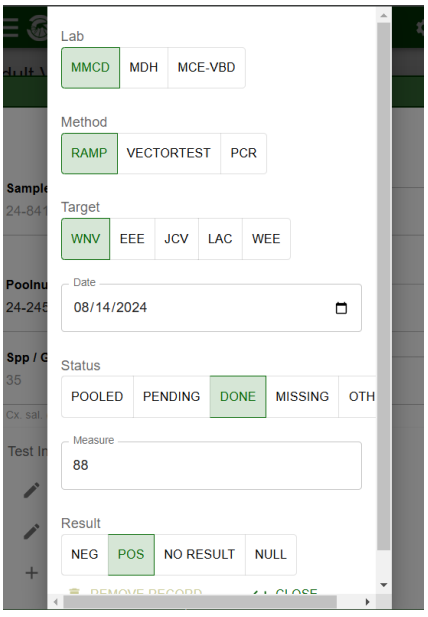
- Expand data analytics capabilities and provide tools to users and managers
- Continue upgrade of other portions of data system, including Customer Call management
- Expand use of internal wiki for documentation, training, and IPM info
- Continue consultations on endangered species concerns

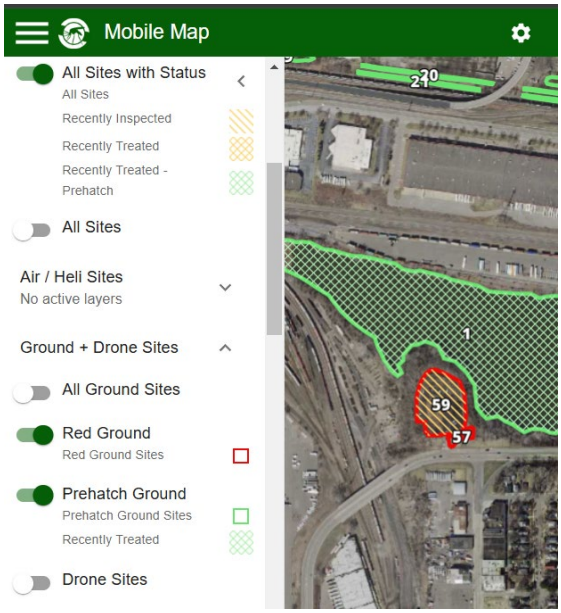
2024 Projects

Data Systems & Mapping

In 2024, we finished upgrading major data entry and management portions of our web-based enterprise data and mapping system "Webster" developed by MMCD staff and Houston Engineering Inc. This system is used daily by field and lab staff for finding sites, recording work, entering IDs, generating reports, tracking calls, monitoring helicopters and balancing inventory.

In addition to upgrades, we added virus test entry including pool tracking and test results (Fig. 7.1). Virus data is stored in a format compatible with national reporting for mosquito-borne disease. We also added more ways to use rainfall data to guide inspections and made more past history visible on the mobile field maps (Fig. 7.2).





We are expanding data exploration and use for decision-making. A multi-year review of data on sites treated with prehatch materials (methoprene, spinosad) helped target additional sampling efforts needed to justify continued treatments. Queries were used to monitor larval species and instar distribution to guide treatment. New tools were developed using the statistics program R and R shiny to display adult surveillance results with real-time graphs and compare species distribution with past years (Fig. 7.3).

Staff continued to use QGIS, our open-source desktop mapping software, to produce map products and access data in the Webster cloud database.

Internal Wiki We expanded our internal wiki and continue to use it to manage, share, find, and update information about MMCD data systems and other topics within MMCD. The data analysis tools made with R and R Shiny are made available to all staff through the wiki. Since all of these tools are open source, no license management is needed for user access.

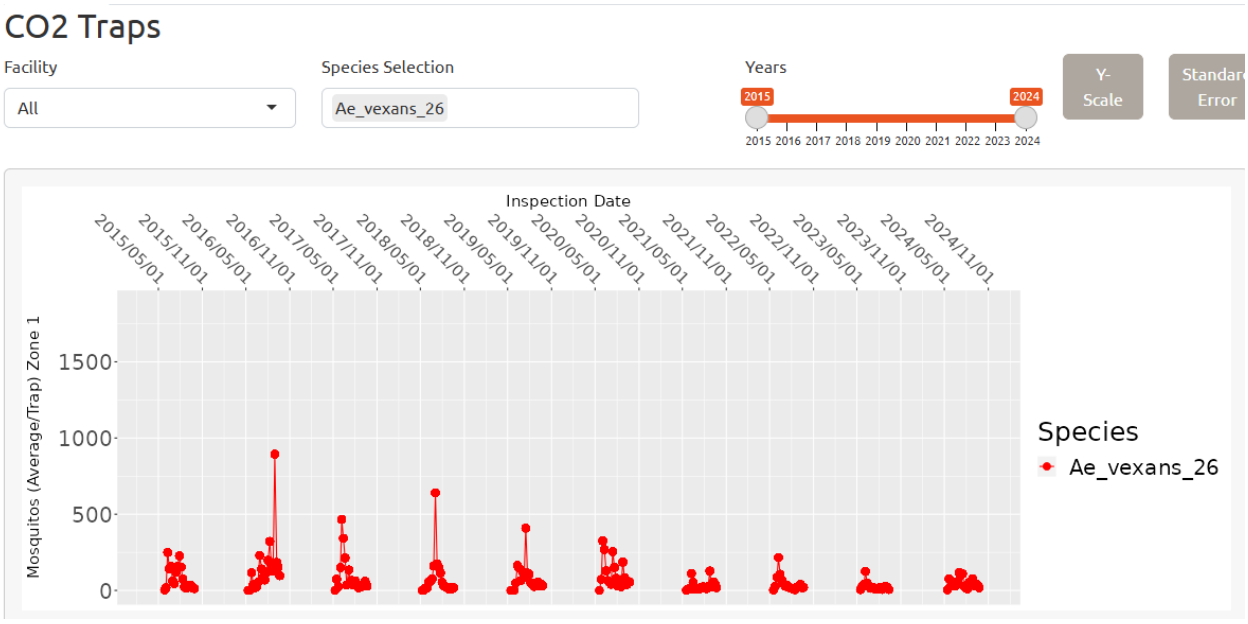


Figure 7.3 Interactive live-update graph of adult surveillance data.

Public Web Map MMCD's public access map on https://mmcd.org/district-maps/ continues to let people see wetland inspection and treatment activity on over 80,000 sites in real time and access history back to 2006. Inspection and treatment information is updated automatically from our data system. Web stats showed 10,238 views, similar to previous years. There was a large peak in activity in early June and another in mid-July, coinciding with peaks in customer calls (discussed below).

GIS Community MMCD staff participate in the MetroGIS collaborative, and we benefit from work by many other units of government. We continue to use access to recent spring aerial photos provided by metro-area counties for our wetland mapping. MMCD uses basemap and

geocoder services from the Metropolitan Council and share our wetland data through MnGeo's Geospatial Commons.

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.

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

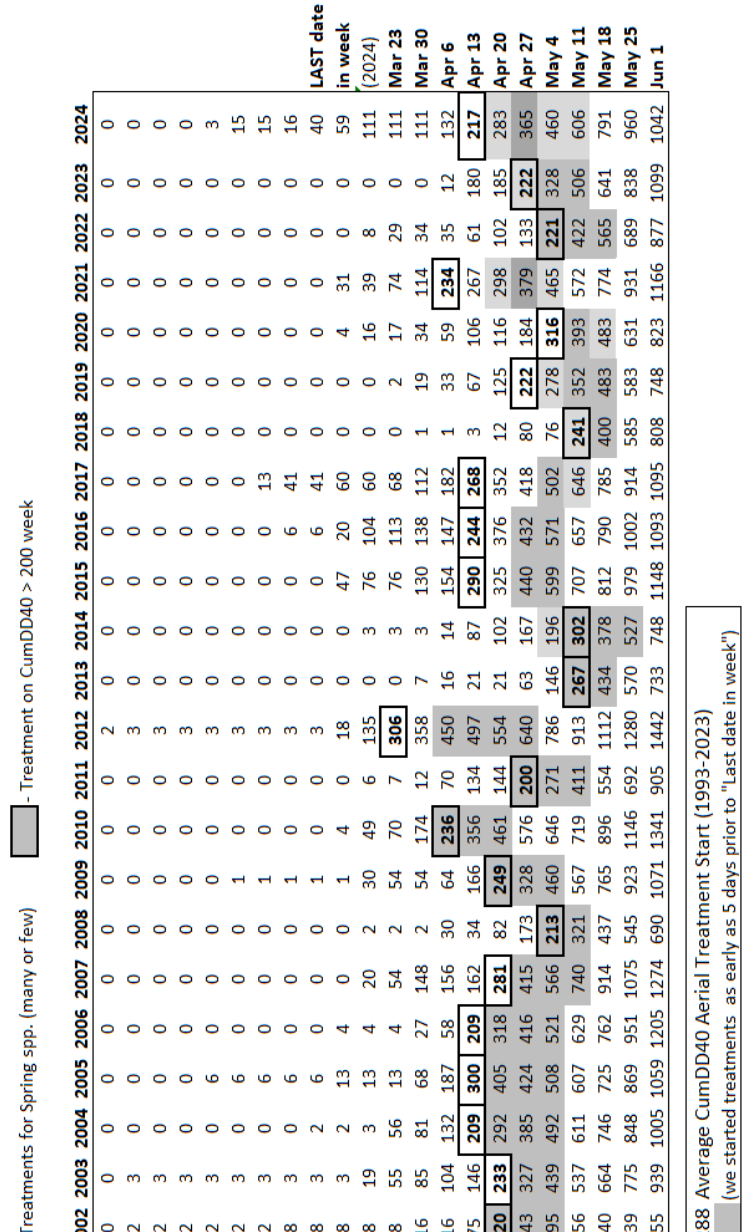
Figure 7.4 shows the cumulative sum of DD_{40F} from Jan 1 by week of the year (DD value at end of week), for each year from 1993-2024. Week numbers were based on standard CDC weeks (week starts on Sunday, week 1 = first week with four or more days, modified so that all dates after Jan. 1 were in week 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 2024, there was significant warmth early in the year, but major fluctuations slowed accumulations. The DD_{40F} total went over 200 in week 15 (ending April 13), one week earlier than the median for the last 20 years. Aerial treatments for spring *Aedes* (gray boxes) started one week later and were completed by May 11. Aerial treatments are not started until a sufficient number of sites are over threshold, seasonal technicians are hired, and helicopters have been calibrated.

Evaluating and Reducing Nontarget Risks

Previous Nontarget Work At the direction of the TAB, MMCD has done studies over the years on possible nontarget effects of the control materials we use. Studies on Natular® (spinosad) in vernal pools and cattail marshes done in 2014-2015 have been discussed in previous Annual Reports, and a publication based on that work was released in 2021. Earlier publications and reports on the 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 website at https://mmcd.org/non-target-impact-studies/ and web use stats show it was viewed 119 times in 2024 (about the same rate as most previous years).

Pollinators and Mosquito Control Pollinator populations (e.g., honeybees, native bees, butterflies, flies, beetles, etc.) are a matter of concern, and MMCD continues efforts to minimize negative effects on pollinators. Our larval control materials pose no risk to bees. The pyrethroids we sometimes use as fog or vegetation spray to control adult mosquitoes have label restrictions that protect pollinators and, when used correctly, are relatively low risk for bees. Staff are trained to recognize areas where pollinators may be active so they can adjust operations to minimize exposure. Beekeepers register hives through "BeeCheck", and in our Pesticide Applicator Training for Certification we train our staff to check for those hives on DriftWatch



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	2018	2019	2020	2021	2022	2023	2024	LAST date in week (2024)
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	0	0	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	0	0	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	0	0	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	0	0	0	0	0	0	0	
5	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	0	0	0	0	0	0	0	
6	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	0	0	0	0	0	0	3	
7	0	0	0	0	0	1	0	0	0	2	3	0	0	0	0	0	1	0	0	3	0	0	0	0	13	0	0	0	0	0	0	15	
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	0	0	0	0	0	0	16	
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	0	0	0	0	0	0	40	
10	0	4	5	0	0	17	0	104	0	8	3	2	13	4	0	0	1	4	0	18	0	0	0	47	20	60	0	0	4	31	0	59	
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	0	0	16	39	8	0	111	
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	0	2	17	74	29	0	111	**Mar 23**
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	1	19	34	114	34	0	111	**Mar 30**
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	1	33	59	**234**	35	12	132	**Apr 6**
15	44	100	100	37	80	**234**	181	233	66	75	146	**209**	**300**	**209**	162	34	166	356	134	497	21	87	**290**	**244**	**268**	3	67	106	267	61	180	**217**	**Apr 13**
16	106	199	129	81	100	335	**231**	268	115	**220**	**233**	292	405	318	**281**	82	**249**	461	144	554	21	102	325	376	352	12	125	116	298	102	185	283	**Apr 20**
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	80	**222**	184	379	133	**222**	365	**Apr 27**
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	76	278	**316**	465	**221**	328	460	**May 4**
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	**241**	352	393	572	422	506	606	**May 11**
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	400	483	483	774	565	641	791	**May 18**
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	585	583	631	931	689	838	960	**May 25**
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	808	748	823	1166	877	1099	1042	**Jun 1**

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

(https://mn.driftwatch.org/map). MMCD staff watch for hive locations when doing field work and modify adulticide treatments as needed.

Rusty Patched Bumble Bee - MMCD consulted with the U.S. Fish & Wildlife Service (F&WS) in 2018 about the rusty patched bumble bee (*Bombus affinis*), an endangered species listed in 2017. Based on the bee's biology and the timing, location, and materials MMCD uses, the overall risk of MMCD's operations to the bee was very low (see report at https://www.mmcd.org/docs/publications/RustyPatchedBumblebeeReview.pdf). We continue to update our information about the bee and its habitats as that becomes available.

Monarch Butterfly - In December 2020, the F&WS announced that the monarch (*Danaus plexippus* was a candidate for listing under the Endangered Species Act, and its status would be reviewed annually. MMCD continues to be in active conversation with Monarch Joint Venture (MJV), a national nonprofit partnership of agencies and organizations working to protect monarch migration across the U.S. In 2023, MMCD staff spoke at the MJV annual meeting and provided information on MMCD operations in relation to monarch protection. In all likelihood, after a 90-day comment period, the monarch butterfly will be listed as a threatened species in mid-March 2025.

Northern Long-eared Bat - In December 2022, the F&WS listed the northern long-eared bat (*Myotis septentrionalis*) as endangered under the Endangered Species Act. MMCD started consulting with the F&SW in order to determine any potential impacts MMCD's control operations may have on the health of the northern long-eared bat. A complete list of the insecticides authorized for use by MMCD was supplied. The MnDNR supplied us with a shapefile with locations of these bats' roost trees and hibernacula in Minnesota. Using this location data MMCD can determine if any of our treatments overlap with northern long-eared bat habitats, and we await further consultation with the F&WS.

MMCD staff participated in the 2024 Pollinator Festival in St. Paul's Bruce Vento Park. We stay in communication with organizations such as the Beekeepers Association and MJV to update information and practices as needed.

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 Minnesota Pollution Control Agency (MPCA) procedures for pesticide NPDES permits are described at https://www.pca.state.mn.us/water/pesticide-npdes-permit-program. The checklist for mosquito control permits is given at https://www.pca.state.mn.us/sites/default/files/wq-wwprm9-05b.pdf.

MMCD's Pesticide Discharge Management Plan (PDMP), first submitted in 2011, describes contact people, target pests and data sources, thresholds and management, and steps to be taken to respond to various types of incidents. 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 website.

U.S. Fish & Wildlife Service – Mosquitoes and Refuges MMCD works with the F&WS regarding mosquito surveillance on and near F&WS 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 F&WS staff allow treatment of disease vectors if "a mosquito-borne disease human health emergency exists in vicinity of the Refuge" (agreed on by MDH, F&WS, and MMCD) and such treatment "is found to be appropriate." An annual analysis of adult mosquito counts around the MVNWR is done by MMCD staff based on the CO_2 trap locations in Figure 7.5.

Culex pipiens and *Cx. restuans* serve as the enzootic or maintenance vectors of 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; subsequently other mosquitoes can become infected on or near the refuge. *Culex pipiens* and *Cx. restuans* populations do not rely on frequent rainfall and these species tend to thrive during drought. Even though CO_2-baited light traps collect low numbers of these two species, they were consistently found in most traps monitored near MVNWR. Three traps had season mean collections in excess of 12.0 per trap (FS1, H291 & S154), the three traps are all more than ½ mile from the refuge. The larval habitats for these species include wetlands, stormwater management structures, and backyard containers. These mosquitoes originate near the traps where they are captured as both species have relatively short flight ranges.

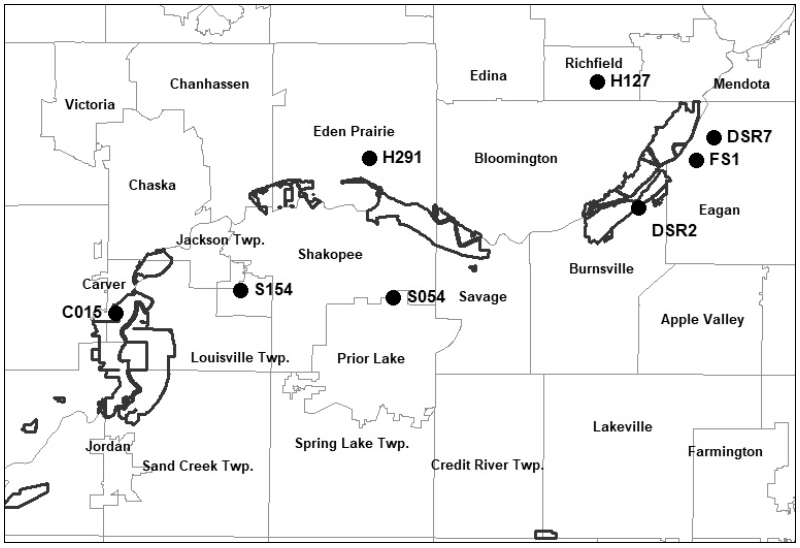


Figure 7.5 CO_2 trap locations (circles) near the Minnesota Valley National Wildlife Refuge. Solid, black lines delineate refuge boundaries.

The primary target species for surveillance on the MVNWR is *Culex tarsalis,* a competent vector of WNV to humans. *Culex tarsalis* collections across most of the MMCD service area were high during July 2024, with a season average of 2.94 per trap (regular and elevated CO_2-baited light traps within the District). The season's mean collection in traps near MVNWR was lower at 2.47. Trap H127 averaged 6.9 *Cx. tarsalis* per collection night for the season and trap S154 averaged 4.8; they are the two traps furthest from MVNWR. Larval habitats for this species tend to be larger wetlands with grassy borders where water stands for more than one week. The adult flight range is much farther than that of *Cx. pipiens* or *Cx. restuans.*

Mean collections of *Aedes vexans* near MVNWR in CO_2-baited light traps were low, likely due to impacts on the population related to three consecutive summers of drought prior to the 2024 season. The peak rate of capture occurred on May 21 at 262.9 per trap. Average collections of *Aedes vexans* exceed 100 only four times; May 21, June 25, July 16, and August 27. Collections of *Ae. vexans* were greatest within one mile of the refuge.

Mosquitoes collected from traps near MVNWR were tested for WNV from the last week of May through the last week of September. There was one WNV positive sample from the area in 2024. It was a mixed pool of *Culex pipiens* and *Culex restuans* collected from the DSR7 location on July 23.

Because of the extensive flooding of the Minnesota River Valley and heavy demands on staff time due to the high number of rainfall events, MMCD did not request permission to conduct larval mosquito surveillance within the Minnesota Valley National Wildlife Refuge in 2024.

Integrated Pest Management Plans

MMCD is committed to using integrated pest management (IPM). In 2021 we documented our approach in species-specific IPM plans as a way to:

- Ensure a common understanding of what we do and why
- Show the basis for our surveillance and control practices
- Help discover what's going well and what to improve

The structure of each plan was based on state and national pesticide applicator training, AMCA "Best Practices," and basic problem-solving steps. We also have a brief "Pest Alert" format (Fig. 7.6) for training new staff.

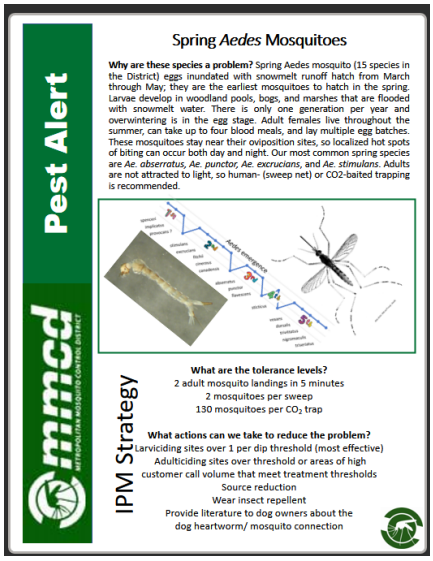


Figure 7.6 IPM Pest Alert

Each species group plan covers the following questions:

1. Why is this species (or group) a problem?
2. What are the tolerance levels?
3. Where and when are those levels exceeded
4. What action can we take to reduce the problem? (and not cause more problems)
   - Public Education
   - Prevention

- Treatment (action thresholds, dose, targeting, timing, materials, resistance)

5. How do we know we've reduced the problem, and show that to the public?

Plans were developed for the following species groups: Spring *Aedes*, Floodwater Mosquitoes, Cattail Mosquito, Vector Mosquitoes (container *Aedes*, *Culiseta melanura, Culex restuans/pipiens, Cx. tarsalis, Cx. salinarius*), Black Flies (*Simulium johannseni, S. luggeri, S. meridionale, S. tuberosum, S. venustum*) and Ticks (*Ixodes scapularis*).

In 2024, we continued incorporating the plans in the internal wiki to make them more accessible to all staff. We are working on ways to make the plans more dynamic by adding real-time graphs and maps showing current status for each species group.

Public Communication

Notification of Control The District continues to post daily adulticide information on its website and e-mail notification is available through GovDelivery. Aerial larvicide treatment schedules (helicopter activity) are also posted on the website and posted on Twitter/X, Facebook, and NextDoor.

Calls Requesting Service A surge of mosquitoes in certain areas during the spring of 2024 led to very high call numbers to request service during the last week of May. A majority of the calls were concentrated around the Minnesota River bottoms with the majority coming from the cities of Carver and Chaska. In the beginning of June, calls began to decline, and they remained low throughout the rest of the summer despite a few weeks with high mosquito numbers in July. (Figure 7.7).

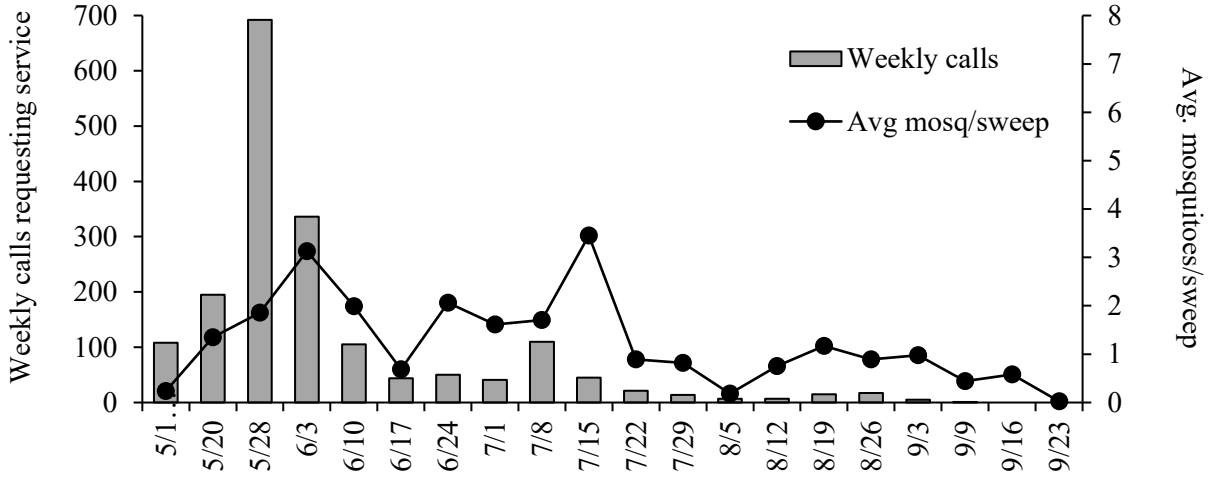


Figure 7.7 Calls requesting service and sweep net counts, by week, 2024.

Calls to report adult mosquito annoyance in 2024 were similar to the total that came in during the 2023 season (Table 7.1). The majority of the 2024 calls came from the one-month period between May 20 and June 20 which accounted for 1,504 of the year's 3,045 total calls. Calls to request tire pickups continued to increase with a new 10-year high reached in 2024. Requests for

treatments at public events and requests for limited or no treatment remained at similar levels to the previous year. About 2,700 restricted access locations remain active after the removal of 244 locations where there was evidence of a change in land ownership.

Table 7.1 Yearly call totals (including emails) by service request type, 2014-2024

	Number of calls by year										
Service request type	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Check a larval site	1,068	447	886	1,151	601	802	438	234	472	684	198
Report adult mosquito annoyance	2,454	1,633	2,499	1,157	1,212	1,144	1,030	176	384	1,522	1,704
Public event, request treatment	93	91	105	101	91	71	12	43	61	64	63
Request tire removal	429	366	377	363	325	411	411	374	377	534	592
Calls about restricted access sites	146 [a]	139	158	126	75	69	76	73	79	87	78 [b]

[a] Beehive locations added into call system to track restrictions
[b] Field staff removed outdated Restricted Access calls

Website MMCD continues to make improvements to the public website in order to offer more resources, updates, and education. In 2024, MMCD switched our website statistics to Google Analytics/Site Kit from Jetpack, which measures traffic differently, mmcd.org had 114,464 sessions in 2024.

The MMCD website has a contact form called “Submit a Tip” where residents can submit informational items or requests for service that are then routed directly to field staff through the MMCD call system. This form saw continued high use in 2024 with 1,440 service requests which was just lower than the 1,560 requests that came in 2023.

Community and School Presentations MMCD continued to expand our educational offerings in 2024 in the form of in-person presentations delivered to schools and community groups. Throughout 2024 we delivered classroom presentations to 29 schools across the District serving elementary, middle, and high school students. We participated in large educational events like the Children’s Water Festival in St. Paul and Science Night at Cedar Ridge Elementary in Minnetonka.

Public Events MMCD offered public education and outreach at several events throughout the year. The biggest event of the year was the Minnesota State Fair where District staff had conversations with over 11,760 people during the 12-day event. MMCD also attended county fairs in Anoka, Dakota, Carver, Scott, and Washington counties and participated in successful events like Grand Old Day in St. Paul and the Great Minnsect Show at the University of

Minnesota. We participated in 17 parades throughout the District in 2024 where we featured our mosquito mascot "Vectoria."

Figure 7.9 MMCD staff delivering presentations at the Children's Water Festival (left) and Twin Oaks Middle School (center). MMCD's booth at the Minnesota State Fair (right).

Social Media As part of an ongoing effort to notify residents when and where treatment is to take place, provide fun and educational information, and create another point of contact with the District, MMCD has maintained a presence on Facebook, Twitter, and Instagram. MMCD currently has 1,074 Twitter/X followers, up from 1,048 followers at the end of 2023; 2,211 followers on Facebook, up from 1,923 in 2023; and 644 followers on Instagram, up from 532 at the end of 2023.

MMCD also uses GovDelivery to give advance notification to District residents of adult mosquito treatments, and to distribute press releases and make announcements about job openings. At the end of 2024, there were 10,332 individual subscribers who opted to receive some sort of communications from MMCD, which is up from 9,729 at the end of 2023.

Professional Association Support

American Mosquito Control Association MMCD staff members continued to provide support for the national association. Kirk Johnson, Vector Ecologist, was on the Federal Lands Subcommittee of the Legislative and Regulatory Committee. Entomologist Diann Crane is featured in the Adult Surveillance module for AMCA's virtual training on best practices for integrated mosquito management. The goal of this training program is to teach people new to the field how to perform science-based mosquito control.

Midwest Center of Excellence for Vector-borne Disease The MCE-VBD brings together academic and public health expertise from Illinois, Iowa, Michigan, Minnesota, and Wisconsin. Scott Larson and Kirk Johnson collaborate with the MCE-VCD as experts in tick-borne and mosquito-borne disease, respectively. Weekly conference calls with regional partners allow for the dissemination of trends in vector populations and for relaying results of research. In 2024, MMCD collected *Culex* larvae from catch basins that were sent to Madison, WI for insecticide resistance testing. Unfortunately, not enough larvae survived to receive an adequate measure of

methoprene resistance. In 2025, we plan to send many more *Culex* larvae from catch basins in order to uncover the level of methoprene resistance in our local *Culex* mosquitoes.

North American Black Fly Association Carey LaMere maintained the association's website, https://nabfa.org/. The 2024 NABFA meeting was February 7-9 in Harrisburg, PA.

Scientific Publications, Presentations, and Posters

MMCD staff attend a variety of scientific meetings throughout the year and publish scientific studies. Following is a list of publications released in 2023-2024, and papers and posters presented during 2024 or planned in 2025.

Publications

Cassens, J., J. Jarnefeld, J.D. Berman, and J.D. Oliver. 2023. Environmental drivers of immature *Ixodes scapularis* in Minnesota's metro area. EcoHealth 20, 273-285. https://doi.org/10.1007/s10393-023-01656-5

2024 Presentations & Posters

Crane, D. and C. LaMere. 2024. Efficacy and nontarget effects of a spinosad-based larvicide in Minnesota vernal pools and cattail marshes. In: What Have We Learned: A Conversation on 15 Years of Spinosad Use in Public Health Symposium. Annual Meeting of the American Mosquito Control Association, March 4-8 (Dallas, Texas) (Presented by S. Larson).

Elling, J. and J. Kirkman 2024. Metropolitan Mosquito Control District unmanned aircraft systems larvicide program. In: UAS Ops in Mosquito Control Symposium. Annual Meeting of the American Mosquito Control Association, March 4-8 (Dallas, Texas).

Guenther, C. and S. Partyka 2024. Expanding drone field operations. In: UAS Ops in Mosquito Control Symposium. Annual Meeting of the American Mosquito Control Association, March 4-8 (Dallas, Texas).

LaMere, C.L. 2024. MMCD Black Fly Program update. North American Black Fly Association Annual Meeting, February 7-9 (Harrisburg, PA).

Larson, Scott. 2024. Metropolitan Mosquito Control District Operations when Drought Turns to Flood. Annual Meeting of the Illinois Mosquito & Vector Control Association. November 22 (Springfield, IL).

Larson, Scott. 2024. Experience with Invasive Species presented to the Young Professionals Pre-conference Workshop. Annual Meeting of the American Mosquito Control Association, March 4-8 (Dallas, Texas).

McMillan, J. and S. Larson 2024. Aligning data streams for (successful) entomological evaluations of larviciding for control of *Culex* mosquitoes in Minneapolis-St. Paul, Minnesota. Annual Meeting of the American Mosquito Control Association, March 4-8 (Dallas, Texas).

Read, N. 2024. Can you help? Public calls about mosquitoes. Minnesota GIS/LIS Conference, October 3 (Duluth, Minnesota).

Smith, M. 2024. Overview of Pan-African Mosquito Control Association meeting, Addis Ababa, Ethiopia. Annual Meeting of the Michigan Mosquito Control Association, February 7-8 (Battle Creek, Michigan).

2025 Presentations & Posters

Carlson, Alex and Kathy Beadle. 2025. Leaning on younger, cooler seasonal staff for social media content. Annual Meeting of the American Mosquito Control Association, March 3-7. (San Juan, Puerto Rico).

Crane, Diann, Carey LaMere, and Scott Larson. 2025. Changes: A 66-yr historical record of the Minneapolis/St. Paul mosquito fauna including notes on range shifts of Minnesota species. Annual Meeting of the American Mosquito Control Association, March 3-7. (San Juan, Puerto Rico).

Herrmann, Casey. 2025. Enhancing efficiency and sustainability in black fly control: Implementation of a bulk container treatment system. Annual Meeting of the American Mosquito Control Association, March 3-7. (San Juan, Puerto Rico).

Guenther, C. 2025. Vector-borne disease safety in Minnesota. MDH Drinking Water Protection Conference, January 30 (Brainerd, MN).

LaMere, C.L. 2025. MMCD Black fly program update. North American Black Fly Association Annual Meeting, February 12-13 (Town of Colton, NY).

Larson, Scott. 2025. Predicting the seasonal abundance of the cattail mosquito (Coquillettidia perturbans) in Minnesota, USA. Annual Meeting of the American Mosquito Control Association, March 3-7. (San Juan, Puerto Rico).

Mueller, Rosa. 2025. MMCD operational overview of the 2024 season. Michigan Mosquito Control Association Annual Conference. February 6. (Traverse City, MI).

Appendices

APPENDIX A Mosquito and Black Fly Biology and Species List

Mosquito Biology

There are 53 species of mosquitoes in Minnesota, although one species is introduced yearly via the tire trade. Forty-five species are detected regularly 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 et al. 2015), 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 CO_2 traps and New Jersey light traps.

Other *Culex* Three additional species of *Culex* (*Cx. pipiens, Cx. restuans,* and *Cx. salinarius*) are vectors of WNV. All three species use permanent and semi-permanent sites for larval habitat, and *Cx. pipiens* and *Cx. restuans* use storm sewers, containers, 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 collect *Cx. pipiens* and *Cx. restuans* for WNV testing.

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 common 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) stimulates 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. The adults will feed on humans. Numerous viruses have been isolated from species in this genus, however, there is no confirmation that these species transmit pathogens that cause human disease in the District. Four species occur here: *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 *Ps. 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. The 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 nets.

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 as well as *Uranotaenia sapphirina.* 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 (except *Ur. sapphirina* which feeds exclusively on annelids and *Cx. territans* which feeds on amphibians and snakes). They overwinter in places like caves, hollow logs, stumps, or buildings.

Culiseta inornata and *Anopheles quadrimaculatus* are notable permanent water species in our area. *Culiseta inornata* is one of the first mosquitoes seen in the springtime. They are quite large and will leave their hibernacula in search of a bloodmeal on warm spring days. While they are normally reluctant to feed on humans, they will do so in the spring. Resident reports of mosquitoes in March and April are usually *Cs. inornata*.

Anopheles quadrimaculatus was relatively rare in our area until the early 2000s, when we documented an uptick in their population. It is now considered common here. The type location (first time a species was identified) is Wabasha, MN. In southern states this species transmits malaria, and although we had malaria in our area in the early 20th century, there have been no locally transmitted instances of malaria in Minnesota.

Rare Species or Invasive

Orthopodomyia signifera is a treehole and container-breeding mosquito that is rarely encountered in collections made by MMCD. *Aedes albopictus*, discussed above, is an invasive species that almost certainly cannot overwinter in the District and is reintroduced each year.

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, South Fork Crow, and Rum) as well as small streams. Most larval black flies develop under water for ten days to several weeks depending on the water temperature. The 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, adults emerge and ride 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 conducted by MMCD show that the majority of black flies in the region lay only one egg batch. The following biologic information for specific black fly species is based on Adler et al. (2004).

Targeted Species

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.

Simulium tuberosum develops in a wide range of flowing waters from small streams to large rivers. In the District, it has been found primarily in small stream samples but can occur in large river samples as well. It is assumed multivoltine and females are presumably mammalophilic.

Non-Targeted Species

Simulium vittatum develops in a wide range of flowing waters from small streams to large rivers. Larvae are tolerant of extreme temperatures, low oxygen, pollution, and a wide range of current velocities. It is not targeted for treatment, because adults are not known to bite humans. Hosts include large mammals such as horses and cattle.

Reference Cited

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

Harris, M.C., E.J. Dotseth, B.T. Jackson, S.D. Zink, P.E. Marek, L.D. Kramer, S.L. Paulson, and D.M. Hawley. 2015. La Crosse virus in *Aedes japonicus japonicus* mosquitoes in the Appalachian region, United States. Emerging Infectious Diseases. 21(4): 646-649.

Species Code and Significance/Occurrence of the Mosquitoes in the Metropolitan Mosquito Control District, Those in Northern Minnesota, and Incidental or Unverified Species

Code	Genus	species	Significance, Occurrence, Disease
Mosquitoes			
1.	*Aedes*	*abserratus*	common, spring
2.		*atropalpus*	rare, summer
3.		*aurifer*	rare, spring
4.		*euedes*	very rare, spring
5.		*campestris*	very rare, spring
6.		*canadensis*	common, spring-summer
7.		*cinereus*	ubiquitous, spring-summer
8.		*communis*	very rare, spring
9.		*diantaeus*	very rare, spring
10.		*dorsalis*	uncommon, spring-summer
11.		*excrucians*	ubiquitous, spring
12.		*fitchii*	common, spring
13.		*flavescens*	very rare, spring
14.		*implicatus*	uncommon, spring
15.		*intrudens*	very rare, spring
16.		*nigromaculis*	rare, summer
18.		*punctor*	common, spring
19.		*riparius*	common, spring
20.		*spencerii*	rare, spring
21.		*sticticus*	common, spring-summer
22.		*stimulans*	ubiquitous, spring
23.		*provocans*	uncommon, early spring, JCV
24.		*triseriatus*	common, summer, LAC
25.		*trivittatus*	common, summer
26.		*vexans*	ubiquitous, #1 summer species
50.		*hendersoni*	uncommon, summer
51.		*albopictus*	uncommon, invasive, vector[1]
52.		*japonicus*	common, summer, LAC
118.		*abserratus/punctor*	inseparable when rubbed
261.	*Ae.* unidentifiable		
262.	Spring *Aedes* (adult samples only)		
263.	Non-*vexans Aedes* (larval airwork)		
264.	Summer *Aedes* (adult samples only)		
Other Minnesota species			
17.	*Aedes*	*pionips*	very rare, spring, northern MN
53.	*Aedes*	*decticus*	very rare, spring, northern MN
49.	*Wyeomyia*	*smithii*	very rare, northern MN[2]
Incidental			
	Aedes	*cataphylla*	verified[3]
	Culiseta	*impatiens*	unverified

Code	Genus	species	Significance, Occurrence, Disease
27.	*Anopheles*	*barberi*	rare, tree hole
28.		*earlei*	rare[4]
29.		*punctipennis*	common
30.		*quadrimaculatus*	common
31.		*walkeri*	common
311.	*An*. unidentifiable		
32.	*Culex*	*erraticus*	uncommon[5]
33.		*pipiens*	ubiquitous, WNV
34.		*restuans*	ubiquitous, WNV
35.		*salinarius*	uncommon, WNV
36.		*tarsalis*	common, WNV
37.		*territans*	ubiquitous
371.	*Cx*. unidentifiable		
372.	*Cx.*	*pipiens/restuans*	when inseparable
38.	*Culiseta*	*inornata*	ubiquitous
39.		*melanura*	uncommon, EEE
40.		*minnesotae*	common
41.		*morsitans*	uncommon
411.	*Cs*. unidentifiable		
42.	*Coquillettidia perturbans*		ubiquitous
43.	*Orthopodomyia signifera*		rare
44.	*Psorophora ciliata*		very rare
45.		*columbiae*	very rare
46.		*ferox*	uncommon
47.		*horrida*	uncommon
471.	*Ps*. unidentifiable		
48.	*Uranotaenia sapphirina*		common, summer
491.	Males (adults)		tallied in NJ traps
501.	Unidentifiable mosquito		
601.	Non-mosquito insect (ex. phantom midge)		

[1]Invasive species introduced yearly through tire trade.
[2]Larvae develop in pitcher plants found in bog habitat in northern Minnesota.
[3]Two *Aedes cataphylla* larvae were collected in April 2008 in Minnetonka.
[4]Last larval collections were in 2012.
[5]Adult collections have been increasing since 2002; larvae are very rarely collected.

Genus Abbreviations for Mosquitoes

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

Occurrence Rankings (number of times collected)

Very rare = 0-9	Common = 1,000-9,999
Rare = 10-99	Ubiquitous = ≥ 10,000
Uncommon = 100-999	

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

Code	Genus	species	Significance/Occurrence/Treated or non-treated
Black Flies			
91.	*Simulium*	*luggeri*	common, summer, treated
92.		*meridionale*	common, summer, treated
93.		*johannseni*	common, spring, treated
94.		*vittatum* spp group	common, spring/summer, non-treated
95.		*venustum* spp group	common, spring, treated
96.	Other Simuliidae		can use to speed small stream ids, used pre-2019 for codes 98-112
97.	Unidentifiable Simuliidae (family level)		too small to id, or damaged
98.	*Simulium*	*annulus*	rare, spring, non-treated
99.		'aureum' spp group	rare, spring/summer, non-treated
100.		*croxtoni*	rare, spring, non-treated
101.		*excisum*	rare, spring, non-treated
102.		*decorum*	uncommon, spring/summer, non-treated
103.		*rugglesi*	uncommon, spring/summer, non-treated
104.		*silvestre*	rare, spring, non-treated
105.		*tuberosum* spp group	common, spring/summer, treated
106.		*verecundum* spp group	rare spring/summer, non-treated
107.	*Cnephia*	*dacotensis*	common, spring, non-treated
108.		*ornithophilia*	rare, spring, non-treated
109.	*Ectemnia*	*invenusta*	rare, spring, non-treated
110.	*Heledon*	*gibsoni*	uncommon, spring, non-treated
111.	*Prosimulium*	unidentifiable	rare, spring, non-treated
112.	*Stegoptera*	*mutata/emergens*	uncommon, spring, non-treated

APPENDIX B Average Number of Common Mosquitoes Collected per Night in Long-term NJ Light Trap Locations and Average May to September Rainfall, 1965-2024. 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
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

Year	Spring *Aedes*	*Aedes cinereus*	*Aedes sticticus*	*Aedes trivittatus*	*Aedes vexans*	*Culex tarsalis*	*Cq. perturbans*	All species	Avg. Rainfall
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	27.76
2017	0.01	0.08	0.09	0.17	25.71	0.05	9.62	37.85	22.27
2018	0.02	0.04	0.18	0.26	15.21	0.05	1.88	20.76	22.54
2019	0.02	0.03	0.03	0.19	5.86	0.02	0.89	8.27	26.67
2020	0.09	0.05	0.12	0.21	10.52	0.01	3.88	16.49	20.00
2021	0.01	0.00	0.00	0.00	1.37	0.06	0.66	3.79	15.43
2022	0.05	0.14	0.09	0.05	3.45	0.02	0.36	6.09	13.84
2023	0.27	0.35	0.33	0.01	1.19	0.07	0.49	7.85	14.71
2024	*In progress*								

*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 Total Number of Mosquitoes by Species Collected per Night in 15 Long-term CO_2 Trap Locations, 2024 (*in progress*)

APPENDIX D Description of Control Materials Used by MMCD in 2024

The following is an explanation of the control materials currently used by MMCD. The specific names of products used in 2024 are given. The generic products will not change in 2025, although the specific formulator may change.

Insect Growth Regulators

Methoprene 150-day briquet 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 granule Central Life Sciences
Altosid® P35 EPA# 89459-95

Altosid® P35 consists of methoprene formulated in spherical granule. Altosid® P35 is 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 3-5 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. Smaller sites less than 3 acres may be treated with drones at a rate of 3 lb per acre.

Methoprene pellet 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 used at 3 and 4 lb per acre. 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 3-4 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.

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*) corn cob** Valent Biosciences
VectoBac® GS EPA#73049-10

VectoBac® GS is a smaller grit size when compared to VectoBac® G. VectoBac® GS has more granules per pound thus applications produce more granules per square foot than VectoBac® G. This material 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® FG EPA# 73049-20

VectoLex® FG 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. Drones may conduct fall applications at a rate of 15 lb per acre and would be conducted on smaller sites less than 3 acres.

***Bacillus thuringiensis israelensis* (*Bti*) & methoprene granules** Central LifeSciences
Duplex-G® EPA# 89459-93

Duplex-G® granule is a sand formulation containing methoprene and *Bti*. Duplex® may be applied in all types of larval habitat. The combination material controls existing larvae with *Bti* and has a 21 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 8 lb per acre (0.41 lb/acre *Bti* and 0.12 lb/acre methoprene). In evaluations, the material is applied to pockety sites with cyclone seeders or power backpacks. In addition, the material was also applied by helicopter to floodwater sites.

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

Natular® is a sand 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. This product is OMRI listed for use in and around organic farms and gardens. The Natular® granule is formulated on a sand granule base. Natular® G30 is formulated as long-release granules (30-day) and can be applied to dry or wet sites.

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

CENSOR® G is a corn cob formulation of spinosad, a biological toxin extracted from the soil bacterium *Saccharopolyspora spinosa,* that was developed for larval mosquito control. CENSOR® G does not hold the same organic certification as Natular® G30 due to its corn cob carrier. USA suppliers of corn cob cannot guarantee that all cob is GMO free primarily due to pollen transfer via wind currents. CENSOR® G is formulated as a residual 7 day granule that can be applied to dry or wet sites. This product was evaluated (9 lb/ac) in early spring sites due to its cold water activity and multiple modes of action (contact & ingestion) of the active ingredient.

Pyrethrin Adulticides

Natural Pyrethrin Clarke
Merus™ 3.0 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™ can be used by the District to treat adult mosquitoes in known areas of concentration or nuisance where crop restrictions (organic growers) prevent treatments with permethrin 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.

Pyrethroid Adulticides

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 5.7 mixture 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. 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).

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 E 2024 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® P35	Methoprene	4.25	2.5 lb	0.1063	30
			3 lb	0.1276	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
CENSOR® G	Spinosad	0.60	9 lb	0.0450	7
VectoBac® G	*Bti*	0.20	5 lb	0.0100	1
			8 lb	0.0160	1
VectoLex® FG	*Bs*	7.50	8 lb	0.6000	7-28
			15 lb	1.1250	7-28
			0.044 lb* (20 g)	0.0034*	7-28
VectoLex® WSP***	*Bs*	7.50	0.022 lb** (10 g)	0.0017**	7-28
VectoPrime® FG***	*Bti* and Methoprene	6.07 *Bti* 0.10 Methoprene	4 lb	0.2428 *Bti* 0.0040 Methoprene	7 single flood
Duplex-G	*Bti* and Methoprene	5.35 *Bti* 1.60 Methoprene	8 lb	0.4100 *Bti* 0.1200 Methoprene	21 single flood
Permethrin 57%OS [b]	Permethrin	5.70	25 fl oz	0.0977	5
Zenivex® E4 [c]	Etofenprox	4.00	1.0 fl oz	0.0023	<1
Anvil® [d]	Sumithrin	2.00	3.0 fl oz	0.0035	<1
Pyrocide® [e]	Pyrethrins	2.50	1.5 fl oz	0.00217	<1
Merus™ [f]***	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] 0.30 lb AI per 128 fl oz (1 gal)
[d] 0.15 lb AI per 128 fl oz (1 gal)
[e] 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)
[f] 0.4096 lb AI per 128 fl oz (1 gal)
* Catch basin treatments—dosage is the amount of product per catch basin.
** Catch basin treatments—dosage is the amount of product per pouch, catch basins can be treated with one or two pouches.
***Experimental

APPENDIX F Acres Treated with Control Materials Used by MMCD for Mosquito and Black Fly Control, 2016-2024.The actual geographic area treated is smaller because some sites are treated more than once

Control Material	2016	2017	2018	2019	2020	2021	2022	2023	2021	2022	2023	2024
Larvicides												
Altosid® XR Briquet 150-day	168	166	167	162	180	141	133	216	141	133	216	182
Altosid® XR Briquet catch basins (count)	448	445	509	476	470	414	316	472	414	316	472	438
Altosid® Pellet 30-day	19,173	17,939	10,202	12,020	729	0.16	0	0	0.16	0	0	0
Altosid® Pellet catch basins (count)	240,806	252,694	262,851	265,915	264,399	13,550	0	0	13,550	0	0	0
Altosid® P35 30-day	0	0	0	0	26,784	26,511	22,068	35,357	26,511	22,068	35,357	39,752
Altosid® P35 catch basins (count)	0	0	0	0	11,648	270,810	301,352	316,762	270,810	301,352	316,762	273,834
MetaLarv® S-PT +2	33,409	23,740	23,574	23,003	18,408	19,431	19,295	19,349	19,431	19,295	19,349	18,790
Duplex-G *Bti*+Methoprene	0	0	0	0	0	0	0	13	0	0	13	31
Natular® G30 (Spinosad)	13,023	12,271	15,662	17,277	8,946	19,968	13,468	13,640	19,968	13,468	13,640	16,502
CENSOR® G (Spinosad)	0	0	0	0	0	0	0	620	0	0	620	0
VectoLex® FG granules	6,076	4,773	4,660	5,036	1,858	5,255	4,235	8,537	5,255	4,235	8,537	8,273
VectoBac® G *Bti* corn cob granules	234,120	136,173	134,926	156,089	139,006	78,992	70,309	58,067	78,992	70,309	58,067	138,573
VectoBac® GS *Bti* corn cob gran.	0	0	0	0	0	0	0	6,549	0	0	6,549	39,785
VectoBac® 12 AS *Bti* liquid (gal)	3,112	3,621	3,234	4,362	4,085	1,172	3,609	1,333	1,172	3,609	1,333	5,429
Adulticides												
Permethrin 57% OS	8,128	5,038	3,771	3,367	1,742	113	334	765	113	334	765	521
Scourge® 4+12 Resmethrin/PBO	23,072	2,090	0	0	0	0	0	0	0	0	0	0
Anvil® 2 + 2 Sumithrin/PBO	16,399	11,683	7,790	3,665	584	257	727	756	257	727	756	0
Zenivex® Etofenprox	34,984	23,097	26,918	15,289	4,124	2,166	640	389	2,166	640	389	1,519

APPENDIX G Graphs of Larvicide, Adulticide, and ULV Fog Treatment Acres, 1984-2024

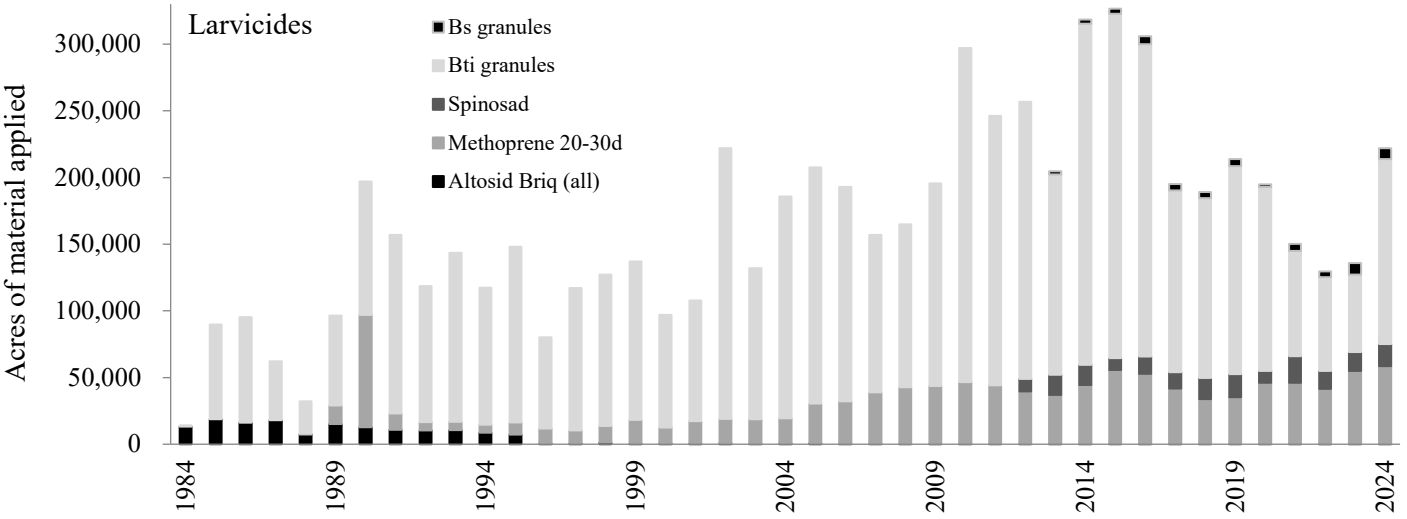


Figure G.1 Summary of total acres of larvicide treatments applied per year since 1984. For materials that are applied to the same site more than once per year, the actual geographic acreage treated is less than that shown.

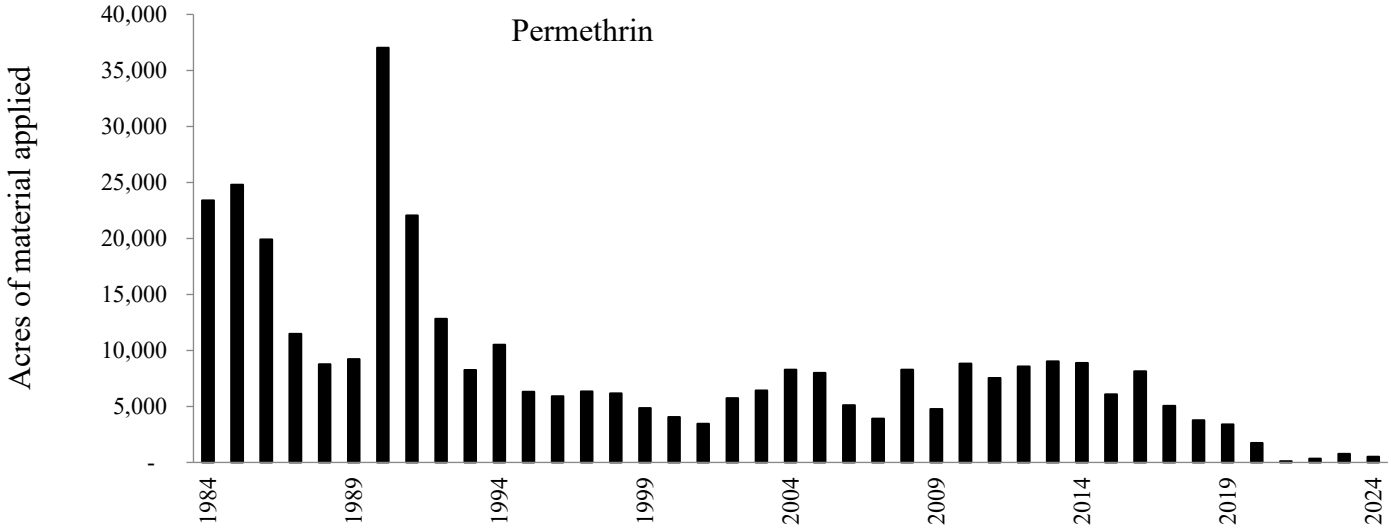


Figure G.2 Summary of total acres of permethrin treatments applied per year since 1984. This material may be applied to the same site more than once per year, so the actual geographic acreage treated is less than that shown.

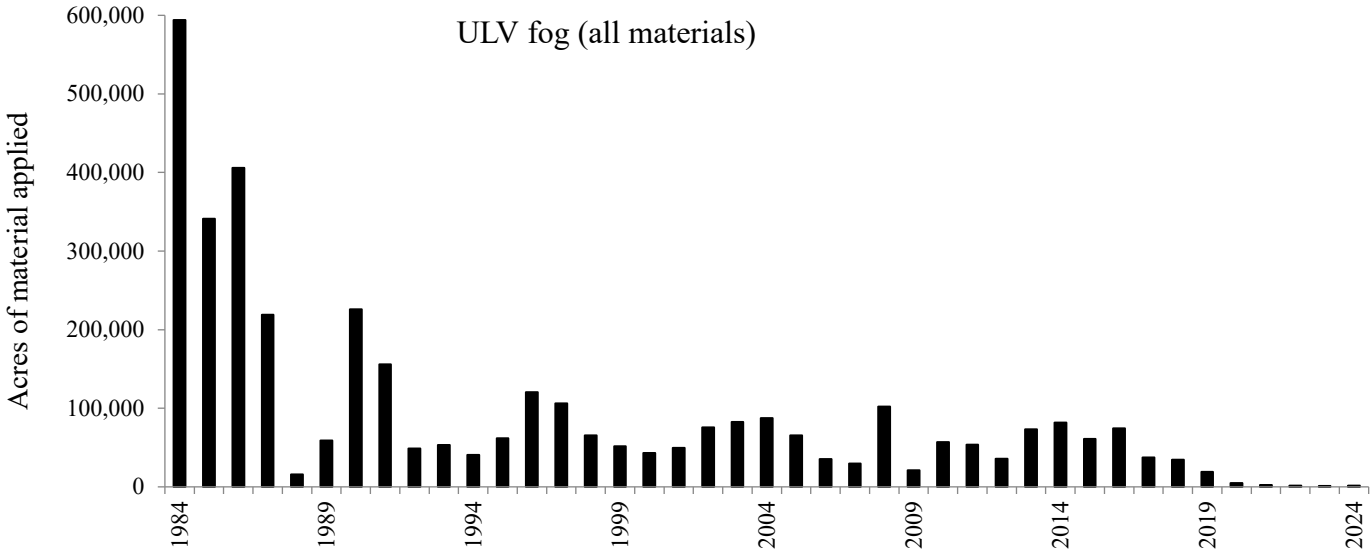


Figure G.3 Summary of total acres of ULV fog treatments applied per year since 1984. This material may be applied to the same site more than once per year, so the actual geographic acreage treated is less than that shown.

APPENDIX H Control Material Labels

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

Altosid® P35 (EPA# 89459-95)

Duplex™-G (EPA# 89459-93)

MetaLarv® S-PT (EPA# 73049-475)

VectoBac® 12AS (EPA# 73049-38)

VectoBac® G (EPA# 73049-10)

VectoBac® GS (EPA# 73049-10)

VectoLex® FG (EPA# 73049-20)

Natular® G30 (EPA# 8329-83)

CENSOR® (EPA# 8329-80)

Permethrin 57% OS (EPA# 8329-44)

Anvil® 2+2 ULV (EPA# 1021-167-8329)

Zenivex® E4 RTU (EPA# 2724-807)

Merus™ 3.0 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 ft^2. 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 ft^2.

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 ft^2.

***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 ft^2 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

An extended residual INSECT GROWTH REGULATOR GRANULAR PRODUCT TO PREVENT ADULT MOSQUITO EMERGENCE *(including those mosquitoes which may transmit diseases, including West Nile virus, Dengue, Chikungunya, and the Zika virus)*

Controls mosquitoes for up to 35 days of continuous wet conditions

Dust free formula

Controls ***Aedes, Culex, Psorophora, Anopheles, Coquillettidia, Mansonia, Ochlerotatus,*** and other mosquitoes

Consistent size granule

May be applied to both crop and non-crop sites

SPECIMEN LABEL

ACTIVE INGREDIENT:

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

EPA REG. NO. 89459-95 EPA EST. NO. 2724-TX-1

KEEP OUT OF REACH OF CHILDREN

CAUTION

SEE ADDITIONAL PRECAUTIONARY STATEMENTS

Causes moderate eye irritation. Avoid contact with eyes or clothing. Due to the size and abrasiveness of the granule, use protective eyewear and clothing to minimize exposure during loading and handling. 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.

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 1-800-248-7763 for emergency medical treatment information.	

ENVIRONMENTAL HAZARDS

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

INTRODUCTION

Zoecon® Altosid® P35 (Altosid® P35) larvicide is used against mosquito larvae in a variety of habitats. **Altosid® P35** provides consistent release of the Insect Growth Regulator (IGR), S-Methoprene to provide residual control for multiple broods for up to 35 days of continuous wet conditions. **Altosid® P35**, when applied to the water column releases effective levels of the IGR to begin affecting larval development thereby preventing adult mosquito emergence. **Altosid® P35** controls the major species of mosquitoes including: *Aedes, Anopheles, Psorophora, Culex, Culiseta, Ochlerotatus, Coquillettidia* and *Mansonia* spp.

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

GENERAL DIRECTIONS: Altosid® P35 begins releasing effective levels of IGR soon after application to inhibit and prevent the emergence of adult mosquitoes for up to 35 days after application. Continue applications throughout the entire season to maintain control. IGR treated larvae continue to develop normally to the pupal stage where they die.

Rotary and fixed-wing aircraft equipped with granular spreaders capable of applying rates listed below may be used to apply **Altosid® P35**. Ground equipment which will achieve even coverage at these rates may also be used. Apply **Altosid® P35** uniformly and repeat application as necessary.

NOTE: Altosid® P35 has no effect on mosquitoes which have reached the pupal or adult stage prior to treatment.

APPLICATION TIMING: Apply **Altosid® P35** at any stage of larval mosquito development. Granules may be applied 7 to 15 days prior to flooding (i.e., "pre-hatch" or "pre-flood") in areas which flood. In such areas, one application of **Altosid® P35** can prevent adult mosquito emergence from several subsequent wetting events. The actual length of control depends on the duration and frequency of wetting events.

APPLICATION RATES: **Altosid® P35** controls the major species of mosquitoes including: *Aedes, Anopheles, Psorophora, Culex, Culiseta, Coquillettidia* and *Mansonia* spp. Apply **Altosid® P35** at 2.5 - 20 lb/acre (5.6 - 11.2 kg/ha). Within these ranges, use lower rates when water is shallow [< 6"-12"] and vegetation and/or organic matter are minimal. Use higher rates when water is deep [> 1 foot] and/or vegetation and organic matter are heavy. In water depths greater than 2 feet, double the application rate for each subsequent foot of water. Depending on water depth and degree of organic matter, lower use rates may provide less IGR residual. Application of **Altosid® P35** to sites subject to water flow or exchange will diminish the product's effectiveness and residual activity, which may require higher application rates and/or more frequent applications.

APPLICATION SITES: Altosid® P35 may be applied to both crop and non-crop areas as directed above to temporary and permanent sites which support mosquito larval development. Examples of such sites include: snow pools, salt and tidal marshes, freshwater swamps and marshes (cattail, red cedar, white maple marshes), woodland pools and meadows, dredging spoil sites, drainage areas, ditches, wastewater treatment facilities, livestock runoff lagoons, retention ponds, harvested timber stacks, swales, storm water drainage areas, sewers, catch basins, tree holes, animal watering troughs, water-holding receptacles (e.g., tires, urns, bird baths, flower pots, cans, and other containers), irrigated and non-irrigated pastures, hoof prints and other natural and manmade water-holding sites, containers and depressions. Examples of crop areas include: irrigated croplands, pastures, rangeland, vineyards, rice fields (domestic and wild), date palm, citrus, fruit and nut orchards, berry fields, bogs and row crops.

STORAGE AND DISPOSAL: Do not contaminate water, food or feed by storage or disposal. **Pesticide Storage:** Store closed containers 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 (Paper/Plastic Bags):** Nonrefillable container. Do not reuse or refill this container. Completely empty container into application equipment. Then offer for recycling if available or 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.

(For refillable totes): Refillable container. Refill this container with this product only. Do not reuse this container for any other purpose. Return empty container to Central Garden & Pet Company [Central Life Sciences] for cleaning and recycling. 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 the container is not returned, completely empty container by tapping sides and bottom to loosen material. Then offer for recycling if availabale or dispose of in a sanitary landfill or by other procedures approved by state and local authorities.

WARRANTY

IMPORTANT: READ BEFORE USE

Read the entire Directions for Use, Conditions 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. 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 Central Garden & Pet Company. All such risks shall be assumed by the user or buyer.

DISCLAIMER OF WARRANTIES: To the extent consistent with applicable law, Central Garden & Pet Company 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 Central Garden & Pet Company is authorized to make any warranties beyond those contained herein or to modify the warranties contained herein. To the extent consistent with applicable law, Central Garden & Pet Company 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 consistent with applicable 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 Central Garden & Pet Company's election, the replacement of product.

For information, call **1-800-248-7763** or visit our Web site: **www.centralmosquitocontrol.com**

Manufactured for:

Central Garden & Pet Company
1501 East Woodfield Road 200W
Schaumburg, Illinois 60173

ZOËCON Professional Products

VEC 18-001

October 2017
Schaumburg, IL

A DUAL ACTION extended residual BIOLOGICAL LARVICIDE AND INSECT GROWTH REGULATOR GRANULAR PRODUCT TO KILL MOSQUITO LARVAE AND PREVENT ADULT MOSQUITO EMERGENCE
(including those mosquitoes that may transmit diseases, including West Nile virus, Dengue, Chikungunya, and Zika virus)

SPECIMEN LABEL

ACTIVE INGREDIENT:

Bacillus thuringiensis subspecies *israelensis* Strain BMP 144 solids, spores,and insecticidal toxins*	5.35%
(S)-Methoprene (CAS # 65733-16-6)	1.60%
OTHER INGREDIENTS:	93.05%
TOTAL:	100.00%

*Equivalent to 375 International Toxic Units (ITU/mg).
NOTE: The percent active ingredient does not indicate product performance and potency measurements are not federally standardized.

EPA REG. NO. 89459-93 EPA EST. NO. 39578-TX-1

KEEP OUT OF REACH OF CHILDREN

CAUTION

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.

HOTLINE 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 1-800-248-7763 for emergency medical treatment information.

PRECAUTIONARY STATEMENTS

HAZARDS TO HUMANS AND DOMESTIC ANIMALS

CAUTION: Causes moderate eye irritation. Avoid contact with eyes or clothing. Due to the size and abrasiveness of the granule, use protective eyewear and clothing (e.g., waterproof gloves) to minimize exposure during loading and handling. 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.

Mixers/loaders and applicators not in enclosed cabs must wear a NIOSH-approved particulate respirator with any N, P or R filter with NIOSH approval number prefix TC-84A; or a NIOSH-approved powered air purifying respirator with an HE filter with NIOSH approval number prefix TC-21C. Repeated exposure to high concentrations of microbial proteins can cause allergic sensitization.

ENVIRONMENTAL HAZARDS

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

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 treated, finished drinking water reservoirs or animal watering troughs.

Zoëcon® Duplex™-G (Duplex™-G) is a unique combination of a *Bacillus thuringiensis v. israelensis (Bti)* biological larvicide and S-Methoprene Insect Growth Regulator (IGR) that provides dual action control. **Duplex™-G** provides quick kill of existing mosquito larvae and residual control of subsequent broods. This dual combination larvicide is highly effective against multiple broods of mosquitoes in a variety of habitats. **Duplex™-G**, when applied to the water column, releases effective levels of *Bti* to begin killing larvae within 24 hrs. after application. Once the *Bti* has killed existing larvae, the IGR in **Duplex™-G** provides residual control and prevents adult mosquito emergence for up to 28 days when applied at rates of 5 – 20 pounds per acre.

Duplex™-G releases effective levels of the *Bti* biological larvicide for up to 72 hours after application and S-Methoprene insect growth regulator prevents the emergence of adult mosquitoes. Continue applications throughout the entire season to maintain control. IGR treated larvae continue to develop normally to the pupal stage where they die.

Rotary and fixed-wing aircraft equipped with granular spreaders capable of applying rates listed below may be used to apply **Duplex™-G**. Ground equipment that will achieve even coverage at these rates may also be used.

Apply **Duplex™-G** uniformly and repeat at intervals of 14 to 28 days.

NOTE: Duplex™-G has no effect on mosquitoes that have reached the pupal or adult stage prior to treatment.

APPLICATION TIMING: Apply **Duplex™-G** at any stage of larval mosquito development. Granules may be applied 7 to 14 days prior to flooding (i.e., "pre-hatch" or "pre-flood") in areas which flood. In such areas, one application of **Duplex™-G** can prevent adult mosquito emergence from several subsequent floodings. The actual length of control depends on the duration and frequency of flooding events.

APPLICATION RATES: Duplex™-G controls the major species of mosquitoes including: *Aedes, Anopheles, Culex,* and *Culiseta*. Apply **Duplex™-G** at 2.5 - 20 lb/acre (5.6 - 11.2 kg/ha). Within these ranges, use lower rates when water is shallow [<6"-12"] and vegetation and/or organic matter are minimal, and use higher rates when water is deep [>1 foot] and vegetation and/or organic matter are heavy. In water depths greater than 2 feet, double the highest application rate for each subsequent foot of water. Depending on water depth and degree of organic matter, lower use rates may provide less IGR residual. Application of **Duplex™-G** to sites subject to water flow or exchange will diminish the product's effectiveness and may require higher application rates and/or more frequent applications. Lower residual activity may be seen at rates used at 5 pounds per acre or less; for consistent 28-day control, use rates at 7.5 pounds per acre or higher.

APPLICATION SITES: Duplex™-G may be applied to both crop and non-crop areas as directed above to temporary and permanent sites that support mosquito larval development. Examples of such sites include: snow pools, salt and tidal marshes, freshwater swamps and marshes (cattail, red cedar, and white maple marshes), woodland pools and meadows, dredging spoil sites, drainage areas, ditches, wastewater treatment facilities, livestock runoff lagoons, retention ponds, harvested timber stacks, swales, storm water drainage areas, sewers, catch basins, tree holes, water-holding receptacles (e.g., tires, urns, flower pots, cans, and other containers), irrigated and non-irrigated pastures, hoof prints and other natural and manmade water-holding sites, containers and depressions. Examples of crop areas include: irrigated croplands; pastures; rangeland; vineyards; rice fields (domestic and wild); date palm, citrus, fruit, and nut orchards; berry fields; bogs and row crops.

STORAGE AND DISPOSAL: Do not contaminate water, food or feed by storage or disposal. **Pesticide Storage:** Store closed containers in a cool, dry place. **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: Plastic Bags:** 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, or if allowed by state and local authorities, by burning. If burned, stay out of smoke.

VEC 16-023

Refillable Totes (2000 lbs): Refillable container. Refill this container with this product only. Do not reuse this container for any other purpose. Return empty totes to Central Garden & Pet Company for cleaning and recycling. 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 the container is not returned, to clean the container before final disposal, completely empty container by tapping sides and bottom to loosen clinging material. Then offer for recycling if available or dispose of in a sanitary landfill or by other procedures approved by state and local authorities.

For information, call 1-800-248-7763 or visit our Web site: www.centralmosquitocontrol.com

WARRANTY: IMPORTANT: READ BEFORE USE. Read the entire Directions for Use, Conditions 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. 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 Central Garden & Pet Company. All such risks shall be assumed by the user or buyer. **DISCLAIMER OF WARRANTIES:** To the extent consistent with applicable law, Central Garden & Pet Company 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 Central Garden & Pet Company is authorized to make any warranties beyond those contained herein or to modify the warranties contained herein. To the extent consistent with applicable law, Central Garden & Pet Company 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 consistent with applicable 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 Central Garden & Pet Company's election, the replacement of product.

Manufactured for:
Central Garden & Pet Company
1501 East Woodfield Road 200W
Schaumburg, Illinois 60173

ZOËCON.

April, 2017
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

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 registered trademark of Valent BioSciences Corporation.

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

Seller makes no warranty, express or implied, of merchantability, fitness or otherwise concerning 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.

VectoBac is a registered trademark of Valent BioSciences Corporation.

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	Suggested Range Rate*
(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	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.

VectoBac is a registered trademark of Valent BioSciences Corporation.

VALENT BIOSCIENCES CORPORATION
870 TECHNOLOGY WAY
LIBERTYVILLE, IL 60048 USA
PH: 800-323-9597

VectoBac® GS

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. 05103

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 GS 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 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 Handling: 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

To the extent consistent with applicable law, 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.

VALENT BIOSCIENCES CORPORATION
870 TECHNOLOGY WAY
LIBERTYVILLE, IL 60048 USA
PH: 800-323-9597

VectoLex® FG

BIOLOGICAL LARVICIDE

FINE GRANULE

ACTIVE INGREDIENT:

Bacillus sphaericus 2362, Serotype H5a5b, strain ABTS 1743 fermentation solids, spores, and insecticidal toxins	7.5%
OTHER INGREDIENTS	92.5%
TOTAL	100.0%

Potency: This product contains 50 BsITU/mg or 0.023 Billion BsITU/lb.
Expiration Date: (Two years from the date of manufacture).

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.
If inhaled	• Move person to fresh air. • If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably by mouth-to-mouth if possible. • Call a poison control center or doctor for further 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. Harmful if absorbed through the skin or inhaled. Avoid contact with skin, eyes or clothing. Wear protective eyewear. Avoid breathing dust. 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.

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 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 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 must be disposed of on site or at an approved waste disposal facility.

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 or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

5.0 DIRECTIONS FOR USE - VECTOLEX FG

5.1 Application Directions

MOSQUITO CONTROL

VectoLex® FG Biological Larvicide Fine Granule (hereafter referred to as VectoLex FG) is a selective microbial insecticide for use against mosquito larvae in a variety of habitats. VectoLex FG can be applied to areas that contain fish, other aquatic life, and plants. VectoLex FG can be applied to areas used by or in contact with humans, pets, horses, livestock, birds, or wildlife.

CONTINUED

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**
Stormwater/Drainage Systems: Storm sewers, catch basins, drainage ditches, retention ponds, detention ponds 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.	0.5-2 lbs/ 1000 sq. ft.

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

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

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

* Mosquito species effectively controlled by VectoLex FG, including many of those known to carry/transmit West Nile virus:

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	
Coquillettidia 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 decisions.

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 the use of this product other than as indicated on this label. To the extent consistent with applicable law, user assumes all risks of use, storage or handling not in accordance with accompanying directions.

VALENT BIOSCIENCES CORPORATION
870 TECHNOLOGY WAY
LIBERTYVILLE, IL 60048 USA
PH: 800-323-9597

SPINOSAD	GROUP	5	INSECTICIDE

NATULAR® G30
Mosquito Larvicide / Extended Release Granule

Controls larvae of mosquitoes which may transmit Dengue, Chikungunya, or Zika.

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	100.0%

U.S. Patent No. 5,362,634 and 5,496,931
Natular® G30 is a 2.5% extended release granule.

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.

Product Information
Natular® G30 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® 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.

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.
- Monitor after application for unexpected target pest survival. If the level of survival suggests the presence of resistance, consult with your local university specialist or Clarke representative.
- 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 this 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 flight path overlaps while dispensing granules. Do not exceed labeled limits.

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 rates (see table) for the targeted treatment site. Within these rate ranges apply at a rate appropriate to site habitat and conditions at the time of application. Use lower labeled rate when water is shallow, vegetation and/or pollution are minimal, and mosquito populations are low. Do not use less than labeled minimum rate. Within the labeled rate range, use higher rates when water is deep, vegetation and/or pollution are high, and mosquito populations are high in number.

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, if needed for extended control in continuously flooded habitat. More frequent applications may be made if monitoring indicates that larval populations have reestablished or weather conditions have rendered initial treatments ineffective.

AL0997

Treatment Area	Natular® G30
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. **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). **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.	Apply 5 to 12 lbs per acre (5.6 to 13.5 kg per hectare). Rate is equivalent to 5 to 12 g per 100 sq. ft. of water.
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.	Apply 5 to 20 lbs per acre (5.6 to 22.4 kg per hectare). Rate is equivalent to 5 to 20 g per 100 sq. ft. of water.
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. Do not apply to natural or artificial containers of water intended for consumption by people, animals, or livestock.	Apply 5 to 20 lbs per acre (5.6 to 22.4 kg per hectare). Rate is equivalent to 5 to 20 g per 100 sq. ft. of water. For small to medium size containers, apply 0.16 g of Natular G30 per 10-25 gallons of water. For very small containers, apply a pinch of Natular G30 (about 0.02 g) per 5 liters (1.3 gallons) of water. This is approximately 8-10 granules per 5 liters of water.
Agricultural Crop Sites Where Mosquito Breeding Occurs: Apply Natular® G30 to standing water within agricultural crop sites where mosquito breeding occurs to kill mosquito larvae species, including: pastures/hay fields, rangeland, orchards, vineyards, and citrus groves. Do not apply to waters intended for irrigation.	Apply 5 to 20 lbs per acre (5.6 to 22.4 kg per hectare). Rate is equivalent to 5 to 20 g per 100 sq. ft. of water.

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. Keep away from moisture.

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 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 approved 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 re-filler. 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 approved 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.
1-800-323-5727

EPA Reg. No.: 8329-83
EPA Est. No.: 8329-IL-03
Net Contents: _____
Lot: _____

AL0697

SPINOSAD	GROUP	5	INSECTICIDE

CENSOR®

Mosquito Larvicide Granule

Controls larvae of mosquitoes that may transmit West Nile Virus, Eastern Equine Encephalitis, St. Louis Encephalitis, Zika, Dengue, or Chikungunya.

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%

KEEP OUT OF REACH OF CHILDREN

Precautionary Statements

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.

Product Information

CENSOR® 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. CENSOR® may be applied with suitable ground or aerial application equipment.

Use Precautions

Integrated Pest Management (IPM) Programs

CENSOR® 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)

CENSOR® 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 IPM program.

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

- Base insecticide use on comprehensive IPM and IRM programs.
- Monitor after application for unexpected target pest survival. If the level of survival suggests the presence of resistance, consult with your local university specialist or Clarke representative
- 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. Apply CENSOR® prior to flooding as a prehatch application to areas that breed mosquitoes, or at any stage of larval development after flooding in listed sites. The following recommendations are provided for ground and aerial application of CENSOR®.

Ground Application

Use conventional ground application equipment and apply CENSOR® at the designated rate for the targeted site.

Spot Treatment

Apply CENSOR® 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 CENSOR® 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 CENSOR® dosage above recommended limits.

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. CENSOR® 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	CENSOR® 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 manmade 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 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, livestock pond 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 Do not apply to natural or artificial containers of water intended for consumption by people, animals, or livestock.	3.5 - 9 (0.018 - 0.045) For small to medium size containers, apply 1/8 teaspoon (about 0.37 g) of CENSOR® per 10-20 gallons of water. For very small containers, apply a pinch of CENSOR® (0.02 g) per ½ - 1 gallon of water. This is approximately 7 - 9 granules per ½ - 1 gallon of water.

Agricultural/Crop Sites Where Mosquito Breeding Occurs:

Apply CENSOR® at the rate of 3.5 to 9 lb per acre (0.018 - 0.045 lb ai/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 or disposal.

Pesticide Storage: Store in a cool dry place in original container only. Keep away from moisture.

Pesticide Disposal: Wastes resulting from the use of this product may 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.

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.

IN CASE OF MEDICAL EMERGENCY, CALL THE INTERNATIONAL POISON CONTROL CENTER 1-800-214-7753

Manufactured By:
CLARKE MOSQUITO CONTROL PRODUCTS, INC.
159 North Garden Avenue
Roselle, IL 60172, U.S.A.
1-800-323-5727

EPA Reg. No.: 8329-80

EPA Est. No.: 8329-IL-03

Net Weight: _____

Lot: _____

AL0778

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.

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 dichlorethenyl)-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 1-800-214-7753.

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.

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 feet 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.

AL0271

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 this 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

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. Technical SUMITHRIN®/Gallon and 0.14 lbs. Piperonyl Butoxide/Gallon
* (butylcarbityl)(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	
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 a 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.	
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 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)

Some materials that are chemical-resistant to this product are: barrier laminate or Viton. Mixers, loaders, applicators, and other handlers must wear long-sleeve shirt, long pants, shoes and socks. In addition, all handlers except for applicators using motorized ground equipment, pilots, and flaggers, must wear chemical-resistant gloves. 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.

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)].

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. User should remove PPE immediately after handling this product. As soon as possible, wash thoroughly and change into clean clothing.

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: Aerial applications of this product require trained personnel to perform industry accepted assays to monitor resistance formation in targeted mosquitoes.

Do not treat a site with more than 0.0036 pounds of Sumithrin® or piperonyl butoxide per acre in a twenty-four 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 fog 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.

AL0397

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.

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. a.i./acre) as a 50 ft. (15.2 m) swath while walking at a speed of 2 mph (3.2 kph). Do not use hand held equipment for this type of application in enclosed spaces.

Dosage Rate (Lbs. Sumithrin® / acre)	Fl.oz. ANVIL 2+2 ULV per Acre	Flow Rates in fluid 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 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 AND 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: 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.

CONTAINER DISPOSAL: 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.

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 and/or 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 U.S.A
FOR MORE INFORMATION CALL: 1-800-323-5727

EPA Reg. No.: 1021-1687-8329 EPA Est. No: _____

NET CONTENTS: [ ] 2.5 GAL [ ] 30 GAL [ ] 55 GAL [ ] 275 GAL LOT No.: _____

AL0397

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

clarke

MERUS® 3.0

FOR USE IN ORGANIC PRODUCTION

For control of adult mosquitoes in Outdoor Residential, Recreational, Urban, Industrial, and Agricultural Areas. For use over agricultural crops, including those intended for human consumption, pasture, and rangeland. For Aerial and Ground ULV Application.

Active Ingredient:	
Pyrethrins, a botanical insecticide	5.0%
Other Ingredients	95.0%
	100.0%

Contains 0.365 pounds Pyrethrins per gallon

KEEP OUT OF REACH OF CHILDREN

PRECAUTIONARY STATEMENTS

HAZARDS TO HUMANS AND DOMESTIC ANIMALS

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. 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. 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 washwaters.

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 foraging 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

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.

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 formation 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./acre/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.

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, airblast, chemigation) can influence pesticide drift. The applicator must evaluate all factors and make appropriate adjustments when applying this product.

WIND SPEED: Apply only when wind speed is greater than 1 mph.

USE INFORMATION

MERUS® 3.0 is approved for application as an Ultra Low Volume (ULV) non-thermal aerosol (cold fog) in mosquito adulticiding programs involving outdoor residential, urban, industrial, and recreational areas where adult mosquitoes are present in annoying numbers, and in vegetation surrounding parks, woodlands, swamps, marshes, overgrown areas and golf courses.

MERUS® 3.0 may be applied over crops or to areas favoring drift over crops, including row, tree, fruit, citrus, pasture and other areas where agricultural enterprises take place.

MERUS® 3.0 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® 3.0 cannot be diluted in water.

SPRAY DROPLET SIZE DETERMINATION

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.

AL0594

Appendix I MMCD Technical Advisory Board Meeting Notes February 12, 2025

TAB Members Present

Elizabeth Schiffman, MN Department of Health (in person)
Steve Kells, University of Minnesota (in person)
Sara Hollie, Hennepin County Public Health (in person)
Don Eaton, Chair, MN Dept. of Natural Resources (in person)
Vicky Sherry, US Fish and Wildlife Service (in person)
Christine Wicks, Minnesota Department of Agriculture (in person)
Jacob Bova, US EPA (online)
Steven Hogg, Three Rivers Park District (in person)
Chris Smith, MN Department of Transportation (in person)

TAB Members unable to attend:
Philip Monson, MN Pollution Control Agency (online)

All TAB Members received a draft report of the annual report to the TAB prior to the meeting.

MMCD Staff in Attendance

Daniel Huff, Mark Smith, Alex Carlson, Scott Larson, Carey LaMere, Janet Jarnefeld, Jon Peterson, Nancy Read (online), Monte Ebbesen, Diann Crane

Guests

No guests were in attendance.

Welcome and Call to Order

Chair Don Eaton called the meeting to order (in-person at MMCD office, and in virtual meeting room) at 12:32 p.m., welcomed everyone to the meeting, and asked all present to introduce themselves, starting with himself.

The Chair asked Mark Smith to begin MMCD presentations. Mark Smith explained that the Technical Services team is making some changes to the TAB meeting presentations. Mark believes it is redundant to go in-depth when members are already provided with reports; thus, presentations will be highlight-based, rather than a repeat of the report.

Recap of 2024 TAB Meeting Resolutions
– Mark Smith, MMCD Integrated Services Manager

Mark reiterated the resolutions made regarding the 2023 TAB report in early 2024 and mentioned how the review topics will address each. Mark stressed that MMCD entomology staff work closely with connections around the country. MMCD also expanded tick dragging, in both areas sampled and sampling methodology. Mark noted that MMCD staff have done well this year in communicating with federal/state agencies regarding vectors and populations.

2024 Season - Overview

Surveillance & Entomology Update
– Diann Crane, MMCD, District Entomologist

Diann described the mosquito surveillance program and conditions in 2024. The winter was mild and followed by a lot of rainfall. The pattern of rainfall favored permanent-water species such as *Culex* and there were unusually few summer floodwater mosquitoes. Effects of the 3-year drought showed in the low numbers of cattail mosquitoes (*Coquillettidia perturbans*). For 2025, the District could have a lot of spring *Aedes*, more floodwater species, and expect a lot of cattail mosquitoes (if there is normal precipitation). However, Diann mentioned that NOAA is predicting average to lower-than-normal precipitation for MN.

Mosquito-borne Disease Review
– Mark Smith, MMCD, Integrated Services Manager*
*presented by Mark due to former MMCD Vector Ecologist Kirk Johnson's departure

Mark mentioned that MMCD is keeping an eye on emerging diseases, and our main efforts to combat disease is source reduction. MMCD is reworking our tire program, which has become a huge part of our program (financially and otherwise), and we are looking for better ways to manage demand. Mark mentioned we are piloting drop-offs in the southern Metro in the 2025 season. Catch basins (CB or CBs) are a source for *Culex*, and 71% of CBs have larvae in them. MMCD performed over 274,000 CB treatments. Mark showed a table of mosquito-borne disease numbers nationally, state-wide, and in the District.

ES - MN WNV cases are more like 25, but District number is right. MS - what rate of WNV would constitute epidemic? ES - not sure, MS - read that the minimum infection rate would have to exceed 20.

Mark also presented information on invasive species that are potential vectors. He noted that *Ae. albopictus* does not overwinter, but they are consistently found in an area in Scott County.

DE - *Ae. albopictus* can't survive over winter here? MS - yes, it's a tropical mosquito. DE - brought in every year? MS - yes.

CS - does avian flu affect mosquitoes and our program. ES - no, not at all.

SHollie - what are catch basins exactly? MS - [clarified what a catch basin is]. SHogg - some CBs are covered or blocked with vegetation, very concerning for standing water; DH: Minneapolis CBs do not have sump, St. Paul does which means those catch water and debris; catch basin design differs by city. CS: DOT are trying to phase out sumps, instead filling with concrete; maybe the District could work with communities to improve catch basins to reduce standing water. DH - cost would be good to know, CS: could be marked "incidental". JP - do you do further work in the water system, then? Cities are trying to reengineer systems for less waste/pollution. CS - presumes that engineers are keeping in mind standing water issue, DH: keep in mind time, if water disappears in five days, then not a breeding issue. SK - grass cuttings wash into sumps, creating nutrition for mosquitoes breeding.

MMCD Tick Vector Services and Tick Surveillance
– Janet Jarnefeld, MMCD, Tick Specialist

Janet presented that tick-borne disease cases have increased significantly since 1996, both Lyme disease and anaplasmosis, coinciding with the time of increasing tick numbers. Tick 2024 projects included surveillance and virus testing. Preliminary results from surveillance showed average or below tick numbers per mammal so far. Analysis of ticks per mammal (on those with ticks) showed an increase over time. Results of tick testing by UMN researchers are pending. Other field work obligations due to wet year cut down on drag samples so we did not meet the minimum for reporting.

DE - in your collections, is there a time when you see most nymphs? JJ - generally earlier in season. SK - are you speciating small mammals in collection? JJ: - yes, but we mostly favor *Peromyscus leucopus* (white-footed mouse). Traps also get other species, some data available.

Mosquito Control
– Jon Peterson, MMCD, Assistant Director of Operations

Jon Peterson presented on field operations, showcasing the drone in the middle of the room. Jon and TAB members expressed excitement for expanding MMCD drone use. We are a regional larvicide program, prioritized by human population density. MMCD in the future may have to change district boundaries due to urban sprawl/increase in population. Lots of habitats for staff to cover. Jon described the larvicide materials we use, no non-target impacts, multiple materials enable rotating to prevent resistance. Season highlights included high number of larval acres treated, similar to other wet years, much above average. Spring larval treatments went up again to record levels, lots of eggs from the record snowmelt year before. Difficult time for treatments because of difficulty finding staff early in the year. Drone treatments increased – increasing efficiency for sites of a certain size range. Cattail treatments needed for next year are high, working on finding resources to do all the work but may need to prioritize. Customer calls peak in May was related to river flooding, plus some social media posts. Adult treatments are used sparingly. Overall, rain amounts were challenging, with 15 broods of floodwater larvae to deal with. Some other work was reduced, such as catch basin treatments and suco (harborage) samples.

DH - when we have a high rain year, something has to give. In this case it came from some vector response, such as CBs and sucos. We are working on restructuring our budget to deal with heavy rain years and how we prioritize when we have too much to do. Strategic planning is putting all these factors and considerations under a microscope.

JP - 2025 MMCD plans to conduct more staff sharing between facilities; we have done some in the past years.

Opened for comments. SHogg: are all staff internal? JP: yes, everyone but our helicopter contracts.

MMCD Black Fly Control Program
– Carey LaMere, MMCD, Black Fly Specialist

Carey LaMere presented on the Black Fly (BF) program. She described the spring small stream and summer large river sampling and treatments. In 2024, we had less flow and less treatment in small streams, given low snowfall. In large rivers, however, high water limited treatment (June to mid-July) or required high amounts. In 2024, MMCD used the second highest amount of liquid *Bti* in the history of the BF program. There were some very high BF adult counts from areas not treated. Continuing doing non-target monitoring with DNR in the rivers to ensure we are not affecting other species.

Product Evaluation
– Mark Smith, MMCD Integrated Services Manager

Mark presented MMCD's approaches to product evaluation, including random sampling of incoming products for quality assurance and calibration of application equipment. MMCD also aims to do a 10% checkback of field sites. If MMCD starts with experimental products, we will make a more focused evaluation. MMCD is developing a QA program to improve overall program. Mark noted different mortality rates of different products we use; current products have a control rate of about 80%. We tested a smaller granule size for *Bti* and found good success with that, apparently it penetrates vegetation better than the larger granule we had preferred because of concerns about drift from wind. Measured mortality rate for Natular G30 was lower than we expected, but there are some concerns about whether staff had time to take measurements at the appropriate time. We are looking at more prehatch. Mark theorized that numbers from 2024 are difficult to ascertain due to high rainfall in 2024 season.

We are looking at developing new metrics and data analysis. Dr. Nancy Read and our data team are working on historical analyses and interactive options. QA will include new metrics. We continue to work on reducing packaging waste, using more bulk containers and returning packaging for reuse.

DE - bag situation, have you discussed with companies about reusable or recyclable bags? MS - difficult with keeping lifespan of material, needs 2-year shelf life. We would like a biodegradable option but that comes with logistical problems for us and them.

CS - has the District investigated PFAS? exposure for staff? MS: we've looked at the possibility, non-fluorinated jugs do not have PFAS?, one company did recall it recently, but no issues with dry products. CS - thanked MS for work on products.

Refer to Chapter 7: Supporting Work.

Potential USFWS Listing of the Monarch Butterfly
– Scott Larson, MMCD Assistant Entomologist

Mark referred TAB to the Supporting Work chapter and introduced Dr. Scott Larson to discuss the Endangered Species Act and mosquito control. Scott described past efforts to evaluate the

rusty patched bumble bee through informal review with US F&W. Conclusions were that exposure risk was low. For the northern long-eared bat, MMCD also did an informal consultation. There was no concern expressed about the larvicides we use. We contacted MnDNR to get locations of bats, and we are working on summarizing locations of adulticides relative to those few areas. The latest concern is the monarch butterfly, which is proposed to be listed as threatened. The Midwest has a significant portion of eastern monarch habitat. Studies done by MMCD under the guidance of the TAB in 2005 showed there was little overlap between adulticide applications and milkweed habitats. Plants treated with permethrin, however, had a negative effect on caterpillar survival. MMCD takes many precautions in our operations that act to reduce risks to monarchs and pollinators.

VS - we have a new project leader at USFW Eco Services Office, willing to talk to MMCD folks about endangered species; noted that federal government is looking for public comment on non-agricultural pesticide use; MMCD has lots of data that is important, SL - would like to talk to new leader, should MMCD comment or individuals? VS - probably organization, there is also another bat of concern.

CS - would behoove MMCD to make committee to make a formal comment, highest risk to monarch is during fall migration grouping, can you speak to seasonality of use of adulticides? SL - we reserve adulticides for disease response, unfortunately it happens near fall, but not normally as late; in general, we work at the whim of disease, MMCD can look at our timeline of adult treatment. CS - spring spray would have trivial impact, MMCD numbers of treatment are low risk but still a risk, as season progresses, risk gets higher. MS - reiterating public health, based on surveillance, mentioned State Fair and July 4 as the most use of adulticides. CW - there is a tracking system for monarchs, resources are out there, maybe more collaboration between applicators and these organizations. AC - Monarch Joint Venture participates in certification workshops too.
CS - Endangered Species Act has carveouts where regulations don't apply, there is language that says immediate threat can supersede protection, worth mentioning in public comment that MMCD only acts in response to disease. SK - Coordinate with health department about when to spray for disease? Risk assessment is difficult, work into narrative of our work that effect on insect population is due to more factors than just pesticides. CS - ESA regulates individuals, not populations. SK - is there any way to put in wording about monitoring "take" of application? Or talk to county commissioners about refugia?

DH - size of district allows us to focus on larvicide, but we have lots of land where we can't treat, and suburban areas are encroaching on these areas. We need to figure out how to treat these areas. If we could do so, we can reduce the need for adulticides. CS - good to discuss with [field] managers. DE - future conversations will be interesting with agencies. DH - resource management is push and pull. ES - as member of MDH, cannot imagine a situation where spraying will be required for limiting a potential epidemic, not on "top of list of asks". Can include in comment to federal government.

15-minute break

2025 District Update
– Dan Huff, MMCD Executive Director

Updated board on new positions and hiring. QA program went away in 1990s due to budget, went down to supervisor level. Bringing QA back. Out of need, adding position in lab. New FOS position to help in Anoka. Hired a new Administrative Assistant due to growth.

Explained strategic planning and 10-year goal: "We protect all people in the district from vectors and improve their time outdoors." Prouty took input from all major stakeholders, including TAB. Shifted focus from treatment/land to people/our taxpayers/who we serve. This allows us flexibility in our IPM and approach in serving various locations. Our priorities are resources and capacity, outreach and collaboration, and environmental sustainability, and border-to-border IPM.

Extended invitation to members to attend open house on February 26 for strategic planning description. Approval will occur later in spring. Informed members of new Commissioners on board. Said that 3% levy was approved in December. $11 a year for our services. Informed of new attorneys.

Explained changes to Technical Services, separation into Integrated Services and Entomology. Explained that this aids with the goal of keeping science as the goal of our organization, which TAB gave concerns about previously.

DE - asked for strategic planning presentation to be sent to members. SHollie - suggested that MMCD organizational chart can be useful for members.

Proposed Changes to Technical Advisory Board Meeting
– Mark Smith, MMCD, Integrated Services Manager

Briefly described the purpose of TAB and format of meeting. Traditionally, MMCD presents and there may be brief discussion. Mark suggests that there are better ways to include the expertise of board members in the format of the review. How can we better utilize the wisdom of the board members?

Proposition: have focused meetings on specific aspects of the program: IPM plans, surveillance, vector control, control materials and methods, and environmental impact. Bring members into the field to observe and analyze. Spoke with DE about increased interaction between Commissioners and TAB members. Mark stated that he wants to respect the time of the TAB members but believes we can make it work with increased time commitment. He envisions the next TAB meeting to be a recap of the focused meetings, especially since not everyone will be able to attend all meetings. Combine TAB into a large annual report, thorough but more succinct; would like the science information to be delivered through more interactive methods online.

MS opens the floor to discussion regarding his proposition.

CS - wants to ride in helicopter. CW - maybe operate the drone? DE - recounted experience with North facility, answered most of his questions about operations, expressed desire to continue exposure to field. In support of field days, time is a problem. CW - personal staff have attended a calibration event and appreciated expertise, time will be difficult, if planned far enough in advance, manageable and likes the idea. CS - likes idea too, would like to also see lab side of operations. SHollie - would like to see what we do, block off possible dates for a visit, very interested in asking questions about environmental health aspects. SHogg - interest from Three Rivers Park District, would offer a site to host a field day.

DH - would like experts to look into our surveillance methodology and materials, want to take advantage of expertise. TAB members are an incredible resource for MMCD. SHollie - re: merging reports, good idea. VS - expressed difficulty of timing, MMCD should ask group what they want to learn about, if we spread out meetings, can be doable, members can be involved in what they're interested. JP - Staff love to talk about their work and can show you what you want to see. SHollie - allow community members to be involved, $11 a year is excellent. MS - if members would like to know about something, send an email to Mark and he can coordinate, we want to be accommodating; will propose a schedule for field days. DE - community members can be more involved, may invoke empathy/understanding of our organization. NR - any online science reports for us to work off of as an example [for new iteration of annual report/tab report]? CW - water monitoring reports, can take a look, 2024 in progress; careful when doing a demonstration of pesticides for public. MS - send examples to Mark.

Discussion and Resolutions
– Don Eaton, Chair, MN DNR

The Chair asked for MMCD staff to bring up 2024 TAB meeting resolutions, suggesting to repeat three from the 2023 report.

During this process, CW inquired about use of AI. DH - drones use some AI. DC & SL - AI could be used to identify mosquito species, but it requires a lot of samples and is not yet accurate. Companies have asked for MMCD samples to train machine.

JP - is Dept of Ag. using AI? CW - Encouraged to use online, looking for one to contract it. In short, using but approach is "don't trust but verify". JJ - elaborated that AI for turning language into "journal-ese" could be used in the future. Some systems also turn large amounts of data in digestible amounts. SK - uses in classroom, can be useful for NR team for production of graphics, one caveat: legally, you would like to own the data set, so AI doesn't steal [your data]. CW - steal credit? SK - monetary value, too.

CS - free tools use data. Is MMCD doing any environmental DNA (eDNA) work? MNDOT is experimenting with this technique. DC - MMCD is operational, MMCD is crunched for time sometimes. CS - you can contract out detections and equipment. SL - saw presentation for application of invasive species, not sure about utility of technology given that we use thresholds for treatment. CW - MMCD is focused on quantity, not presence. CS - some technologies can focus on quantity/proportion. SL - could answer a question we get which is about bat's diet, CS - indeed we use it for bat guano: "Species from Feces".

NR: MMCD should visit MNDOT, some of our folks are looking into using AI for data tools.

TAB members began with resolutions from previous year.
2023 Report Resolution #1: The TAB supports the program presented in the 2023 review and acknowledges and appreciates the efforts of the MMCD staff in its preparation

DE moves. CW seconds. SK tells MS that he offers some revisions to the report. DE and SK discuss if it affects the resolution. SK notes that with the federal government relaxing on certain initiatives, MMCD program review ought to emphasize certain aspects and provided notes to this end. The following resolution passed:

Resolution #1 The TAB supports the program presented in the 2024 review and acknowledges and appreciates the efforts of the MMCD staff in its preparation.

2023 Report Resolution #2: The TAB supports the innovations and technological advancements used in the delivery of services for the residents of the District.

DE wanted to know the reason for this resolution last year. SHogg noted that it was most likely in response to the starting/expanding drone program. CS - what is the purpose of these resolutions? MS - Up to the board. MMCD ought not offer any words as resolutions.

SK - add “ongoing” into the verbiage. DE - accounts for sharing staff and budget changes CW - Apt word to show that innovative and advancement continue. SHollie - let’s include budget. ES - add “operational” to include budget. CW - the word helps include the strategic innovation required for this past year.

DE moved. SK seconded. The following resolution passed as amended:

Resolution #2 The TAB supports the ongoing operational innovations and technological advancements used in the delivery of services for the residents of the District.

2023 Report Resolution #3: The TAB supports MMCD’s continued emphasis on surveillance of disease vector species and acknowledges influence of climate change and the need for monitoring and addressing new and emerging vector-borne diseases

DE moved. SH seconded. DE opened to discussion.

CS - is using the phrase “climate change” wise in this political climate? DE - how much is MMCD affected by the feds? DH - [luckily,] none to very little. CW - is this public? DH - yes, but not very trafficked. DE - Commission meetings are public, so commissioners will see. Worth keeping climate change in. CS - concerned that verbiage would “disenfranchise” those with opposing views. SK - maybe change to “weather variability”? CW - Theory vs empirical data. CS - just wanted to discuss the issue. SHollie - Commissioners I know should be okay with it, but don’t know all of them. CW - happy medium for various political positions [to include both terms]. The following resolution passed as amended:

Resolution #3 The TAB supports MMCD's continued focus on surveillance of disease vector species and acknowledges influence of climate change and weather variability, emphasizing the need for monitoring and addressing new and emerging vector-borne diseases.

DE opened for further possible resolutions. SHogg suggested a resolution regarding the ESA. SHogg moved. CS seconded. Resolution passed. After discussion, TAB members resolved a fourth resolution:

Resolution #4 The TAB supports the continued attention by MMCD to the Endangered Species Act in minimizing the impact of operations on listed and proposed animal species and their habitats within the District.

ES suggested a resolution regarding MMCD's commitment to evolving MMCD's approach to the TAB. ES moved. CS seconded. Resolution passed:

Resolution #5 The TAB appreciates MMCD's commitment to updating meeting formats and report styles to best accommodate the needs and utilize the strengths of the TAB, the Commission, and the MMCD.

SK suggested a resolution regarding the Strategic Plan. After some discussion, SK proposed, SK moved, and ES seconded. Resolution passed:

Resolution #6 The TAB supports MMCD's efforts to advance the mission of the organization through their new strategic plan and a renewed focus of District resources on Quality Assurance and Quality Control.

Closing
DE moves to adjourn at 4:04 pm. CW seconds. Meeting is adjourned without further discussion.