METROPOLITAN MOSQUITO CONTROL DISTRICT

1998 OPERATIONAL REVIEW AND PLANS FOR 1999

EXECUTIVE SUMMARY

The Metropolitan Mosquito Control District's (MMCD) mission is: ". . . to promote health and well being by protecting the public from disease and annoyance caused by mosquitoes, black flies and ticks, in an environmentally sensitive manner." Performing this mission in a metro area of 2600 square miles and 2.5 million inhabitants means a high degree of visibility and public scrutiny.

In 1998 the Legislative Auditor conducted a complete, season-long review of MMCD operations. This program audit came on the heels of an intense debate about how best to notify metro citizens before mosquito control activities. The audit reflected favorably on MMCD and offered constructive suggestions to improve District operations. In 1998 MMCD enhanced its public notification efforts by running newspaper ads, and posting more signs in public areas. The effectiveness and accuracy of these methods were discussed in focus groups. In 1999 the District intends to modify its methods of providing notification, in line with recommendations received from the focus groups.

A single case of LaCrosse encephalitis was reported in the metro area during 1998. Continuing its cooperation with the Minnesota Department of Health, MMCD crews responded quickly by thoroughly canvassing the case site area. Vector-borne disease control work also included a University of Minnesota/MMCD cooperative study that looked for *Ehrlichia* (the causative bacterial agent of ehrlichiosis) in the metro area.

The mosquito control season was characterized by an early emergence of *Cq. perturbans* that overlapped a mid-July peak of *Ae. vexans*. Mosquito numbers were low during the later part of the season. Larval mosquito control acreage increased with the addition of a sixth helicopter. Regarding adult control, the number of acres treated with permethrin in 1998 was similar to 1997, but significantly fewer acres were treated with resmethrin in 1998. The decrease in resmethrin use was due to an overlapping - and shorter - infestation period when levels were at or above threshold.

MMCD improved its method of inventorying control materials in 1998. This has resulted in achieving a greater level of accuracy when recording the storage and use of these materials. District field trials of laginidium – a fungus spore that specifically targets mosquito larvae -- were successful. Wider testing will continue in 1999.

The black fly treatment program continued to be successful and significantly reduced black fly annoyance for metro area residents in 1998. Large river flows were significantly lower in 1998 resulting in less use of control materials. MMCD's black fly program continues under a permit from the Minnesota Department of Natural Resources.

The District's Wright County long-term study of non-target effects continued in 1998. Preliminary results suggest that differences in invertebrate numbers in treated vs. untreated sites were not significantly different. Also, some subtaxa of chironomids increased their numbers in treated sites.

MMCD is committed to identifying and meeting customer satisfaction. To reach this goal, the

District surveys public opinion in the metro area at two-year intervals. Public perception about the importance of mosquito control continues to rise, and general awareness of, and satisfaction with, MMCD continues at very high levels.

METROPOLITAN MOSQUITO CONTROL DISTRICT

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Metropolitan Mosquito Control District
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Metropolitan Mosquito Control District
Mission Statement & Governance

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

The Metropolitan Mosquito Control District, established in 1958, controls mosquitoes and gnats and monitors ticks in the metropolitan counties of Anoka, eastern Carver, Dakota, Hennepin, Ramsey, Scott and Washington. The District operates under the seventeen member Metropolitan Mosquito Control Commission, composed of county Commissioners from the participating counties. A Director is responsible for the operation of the program and reports to the Commission.

Technical Advisory Board Statutory Authority

The TAB was formed in 1981 by the Commission to provide annual independent review of the field control programs and to enhance inter-agency cooperation. In addition, the TAB was created to facilitate compliance with Minnesota State Statue 473.716 Cooperation with other agencies; advisors:

> "Subdivision 2. The commissioners of agriculture, of natural resources, of transportation, the commissioner of Minnesota department of health, the head of the department of entomology and economic zoology of the University of Minnesota shall act in an advisory capacity to the metropolitan mosquito control commission and the director of the said commission shall furnish to each of these departments a copy of the operational plan and pertinent technical reports of said district."

Metropolitan Mosquito Control Commission-1999

Randy Johnson, Chair* Hennepin County
Dallas Bohnsack, Vice-Chair* Scott County
Victoria Reinhardt, Secretary* Ramsey County

David McCauley Dick Lang Margaret Langfeld*	Anoka County
Ursula Dimler* John Siegfried, alternate	Carver County
Willis Branning Don Maher* Nancy Schouweiler	Dakota County
Mike Opat Penny Steele	Hennepin County
Tony Bennett Janice Rettman	Ramsey County
Joe Wagner	Scott County
Dennis Hegberg Myra Peterson*	Washington County

* Executive Committee Member

Metropolitan Mosquito Control District
Staff in Attendance

Director, Joseph Sanzone
Technical Services, Stephen Manweiler (Technical Services Coordinator), Sandy Brogren, Diann Crane, Janet Jarnefeld, Nancy Read, Mark Smith, John Walz

Public Information, James Stark (Public Affairs Coordinator), Michael McLean

Control Services, Jeff Leudeman (Group Leader, Vector Ecology)

ADMINISTRATION

Background

The administration of the Metropolitan Mosquito Control District enables operations staff to accomplish their tasks in an effective and efficient manner, while controlling and coordinating resource use. Staff seek to work with the public to identify and define citizen expectations. These service level expectations are communicated to the Commissioners. Staff design activities and systems to implement Commission policies and goals.

Administrative objectives include:

- Provide leadership and support in the District's operation, particularly focusing on optimizing resource use in meeting the District's mission and goals.
- Meet the operational need for increased numbers of qualified seasonal employees to perform the operations of the District through our recruitment efforts
- Focus on information management to provide more consistent efficient sources of documentation.

1998 Program

In 1998 District resources were not quite as restricted as in 1997. Morale remained high in 1998 as staff responded to the needs of customers, as well as the needs of employees.

1999 Plans

Service levels will be similar to 1998. Our primary focus will be meeting customer needs.

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SERVICE AND ACTIVITIES

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1. Public Affairs

1.1. Background

The District is committed to openly communicate its activities to citizens, media and organizations who interact with the program. Communication with the public is designed to be clear, concise, and timely. MMCD staff conduct public information/education programs for elected officials, citizen groups, civic organizations, and schools within the District. Media releases to newspapers, television, radio, and community newsletters also provide information about program activities. In addition, literature is developed, updated and distributed to citizens throughout the District.

1.2. 1998 Program

Media Relations

Print media coverage of District activities was up 25 percent in 1998. Broadcast coverage of MMCD activities was comparable to 1997. The 1998 season was marked by a high-profile debate in the spring about public notification of mosquito control activities, and a case of LaCrosse encephalitis in the Chaska area late in the summer. These issues focused media attention on MMCD's activities during 1998. MMCD continues to update media contact lists and uses a broadcast fax system to distribute press releases.

MMCD Information Booths

MMCD staffs information booths at a variety of venues. On display are samples of mosquito and biting gnat larvae, black-legged ticks (deer ticks), a dog heart infected with heartworm, and control materials. Information on mosquito-borne disease, Lyme disease, heartworm disease, and printed information concerning District services is also available.

In 1998 MMCD staffed information booths at events including: The Clean Water Festival at the Grey Freshwater Institute, a Public Health Nursing conference at the University of Minnesota, Earth Day in the St. Paul Skyway, and several City Showcases. MMCD also staffs information booths at the state and seven metro county fairs (For state and county fair information see Table 1.1).

Table 1.1 1998 County Fair Attendance

Event	Date	Estimated Attendance
Anoka	August 4 through August 9	3,984
Carver	August 12 through 16	2,288
Dakota	August 10 through 16	3,348
Hennepin	July 23 through 26	1,138
Ramsey	July 15 through 19	1,872
Scott	July 22 through 26	3,330
Washington	July 28 through August 2	2,656
Minnesota State Fair	August 27 through Sept.7	14,099
TOTAL		32,715

Adopt-A-Site

In 1997 MMCD conducted a pilot project in Maple Grove called Adopt-A-Site. Volunteers were solicited to undertake larval control using *Bti* in wetlands on their property. Strict participation criteria were established and, of 40 residents who expressed interest, eight were chosen to participate.

Although the sample group was too small to draw conclusions about treatment effectiveness, participants expressed enthusiasm to continue the project. Volunteers also provided suggestions about improvements including more effective training and follow-up contact. Specifically, volunteers requested that more training be held in the field including more practice sampling mosquitoes. MMCD made this program available in other areas of the District in 1998. Numbers of participants are still too low to determine the effectiveness of this program, but new methods to recruit volunteers are being considered to overcome the shortage of volunteers. The Adopt-A-Site program will be reevaluated at the end of 1999.

Customer Response

District outreach efforts continue to increase program awareness and customer response. In 1998 the District received over 3,900 calls from citizens at the main switchboard in St. Paul (See Table 1.2). Most of the calls were requests for additional service. Citizens wanted more control of mosquitoes and biting gnats, and more services to reduce the risk of mosquito and tick-borne disease.

Table 1.2

Type of Call	1991	1992	1993	1994	1995	1996	1997	1998
Citizen Issues & Concerns	234	292	233	349	164	189	233	794
Mosquito Breeding Site Location	347	273	359	293	202	451	364	575
Mosquito/Biting Gnat annoyance	112	161	173	137	164	388	865	1396
Public Treatment Requests	161	137	171	147	145	186	192	119
General Information	194	210	387	111	84	360	514	568
Waste Tire Removal					155	243	398	456
Total	1048	1073	1323	1037	914	1817	2566	3908

Customer Satisfaction Survey

MMCD expanded its survey of customer satisfaction during 1998. Customers who called the District during the 1998 field season were surveyed to determine the overall level of satisfaction with aspects of District services. Surveys were sent to all callers identified with the following call types: mosquito annoyance, Black fly annoyance, information requests, and requests for tire pickup. The survey was on the back of a pre-paid post card addressed to the District main office.

Total number of surveys sent = 1795
Total number of respondents = 1009
56.2 percent response

Of those who responded: 90.4 percent (912) were satisfied or very satisfied in all categories surveyed; 9.6 percent (97) not satisfied in one or more of the categories surveyed.

Question 1: How satisfied were you with how quickly the District responded to your concern?
97.62 percent (985) satisfied or very satisfied; 2.38 percent (24) not satisfied

Positive comments included many thank you notes for quick response to heavy mosquito infestations -- especially around public or private events.

Negative comments had to do with the time it took for District employees to pick up tires, or the fact that, in some cases, customers did not request service in time for the District to respond before neighborhood or civic events.

Question 2: How satisfied were you with the service the District provided?
92.07 percent (929) satisfied or very satisfied; 7.93 percent (80) not satisfied

Positive comments included many thanks for making summer more enjoyable.

Most negative comments suggested that the mosquitoes were still terrible after treatment, or that the treatment effect didn't last long enough. Some respondents did not live within District boundaries. A few respondents requested service late in the season when control material supplies were low.

Question 3: How satisfied were you with the way staff conducted themselves?
98.71 percent (996) satisfied or very satisfied; 1.29 percent (13) not satisfied

A few people claimed that the District did not respond at all to their request for service, or were not aware of what had been done.

Question 4: How did you first become aware of service provided by MMCD?

The most common way respondents found out about the District was through word of mouth, followed by the news media, and city/county office referrals.

Adult Mosquito Control Information Line: 651-643-8383.
To inform citizens about the time and location of mosquito adulticiding operations, MMCD offers an adulticiding information line. The information line enables citizens to hear a recorded message updated daily identifying where adulticide activities will occur. While this has significantly reduced the number of telephone calls to selected citizens alerting them to adult control, staff will continue to call those citizens who still desire advanced notice of adult mosquito control treatments. The number of calls received were tallied at the end of the season (Table 1.3).

Table 1.3 Number of calls to the Adult Control Information Line. Summary by Facility 1993-97

Facility	1994	1995	1996	1997	1998	1998 % by County
Anoka	106	96	66	150	160	13
Carver	43	68	18	51	141	11
Dakota	51	92	32	63	157	13
N. Hennepin	85	116	48	118	182	15
S. Hennepin	186	230	130	228	211	17
Ramsey	95	119	53	111	120	10
Scott	44	96	22	57	159	13
Washington	30	74	33	69	99	8
Total	640	891	402	847	1229	100

Public Opinion Survey

As recommended by the TAB, MMCD conducts a public opinion survey every two years, using similar questions and methods to allow comparisons between years. In 1998 MMCD hired Northstar Interviewing Service, Inc. to do a telephone survey of 422 metro-area residents. The survey was conducted July 22 through August 12. The survey was based on a random-digit sample of telephone households in the District, and respondents within households were randomly chosen using the most recent birthday method. Response rate was 65 percent (completed interviews as a percent of refused + completed); six interviews were completed in Spanish. Results have a margin of error of ± five percent.

Eighty-three percent of respondents rated the importance of controlling mosquitoes five, six, or seven on a seven-point scale (1 = not important, 4 = neutral, 7 = very important), up from 79 percent in 1996 and significantly higher than the 72 percent rating in 1994. Sixty percent rated gnat control important, about the same as in 1996 (62 percent) and 1994 (58 percent).

The percentage of respondents agreeing that "MMCD provides an important service" (77 percent), "MMCD is a good buy for the money" (67 percent), and "mosquito and gnat control should be increased" (59 percent) were up significantly (six to nine percent) from 1996. These had not changed between 1994 and 1996. The percentage of respondents agreeing that "MMCD funding should be increased" (44 percent) was slightly higher than the 1996 (42 percent), and significantly higher than 1994 (32 percent).

Seventeen percent thought larval control harms environment or health. Twenty percent thought adult control harms environment or human health. These have not changed significantly from 1996 or

1994. However, 63 percent agreed with the statement "Spraying has some risk, but the benefit of a professionally-done spray program outweighs the risk." Only 10 percent disagreed with this statement, and 27 percent were neutral. Sixty-one percent reported being aware of "a local government agency called the Metropolitan Mosquito Control District", about the same as 1996 (64 percent) and 1994 (62 percent).

Forty-two percent reported having someone in their household that reacts strongly to mosquito bites (swelling or itching that lasts more than a few hours). Sixty-nine percent use repellents, 20 percent use yard spray, fog, or powder, 40 percent use citronella candles, and 0.2 percent had paid a company to treat their yard (similar to 1996 results). Median amount spent on control or repellent was ten dollars.

Notification studies

As part of the negotiations with legislators regarding the withdrawal of restrictive legislation (HR 2320) in February, 1998, MMCD agreed to perform research on how to notify citizens of adult mosquito control activities. Two projects were completed in 1998.

First, several questions were added to the District-wide telephone survey (reported above) that addressed notification issues and citizens' awareness of their right to request no treatment. Fifty percent of those surveyed agreed with the statement "MMCD would stay away from my property if I asked them to," with only five percent disagreeing. Thirty-four percent said they were aware that citizens have the right to request that their property not be treated, and 11 percent had seen the ad in the paper this spring. Seventy-nine percent felt MMCD should stay with the current system of notification (phone line, web site, and press releases) or do less notification, rather than take money away from control efforts. Fifteen percent wanted increased notification, even if it means less control.

Second, three focus groups were convened in September to study methods of notifying about adult mosquito control treatments. Each group consisted of six to seven randomly-chosen metro area residents. Wilder Research Center staff recruited participants, provided a moderator and assistant moderator, and provided a report of results.

The groups started with the notice signs currently posted in adult mosquito treatment areas. First impressions of the sign were that it was attention-getting and implied danger. About half the participants said they would leave the area if they saw the sign, and others were concerned about children or pets being exposed. Some were concerned by information on the sign about effects on the environment. All groups wanted the signs to include information about how long to stay away from the treated area and when it was safe to return. When presented with conclusions from the MDH 1993 risk assessment on these adulticides, participants were reassured and some suggested putting that information on the sign.

The groups were then shown the May, 1998 newspaper ad regarding adulticide treatments and citizens' right to request no treatment. Most thought the ad was not very noticeable and did not remember seeing it. Some participants thought it provided good information and felt they might call to find out more, but the environmental information was described as "inflammatory" by one participant.

The moderator then solicited ideas from participants on how important notification was to them, and what their preferred methods for notification of treatments were, given cost estimates. Participants were ambivalent about the need and feasibility of notifying citizens if their neighborhoods were scheduled for treatment. They quickly realized that while they felt it was important that they be informed, the scope and uncertainty (due to weather) of treatments would make notification difficult and expensive, and they were reluctant to recommend costly methods. Most recommended use of "free" TV coverage through news stories or Public Service Announcements. Telephone notification, especially for people who contacted MMCD and identified themselves "sensitive", was popular if it could be done inexpensively. Some suggested more promotion of the current "Bite-line" phone number and web site. Some considered an annual newspaper ad a minimum effort. Notice signs in sprayed areas were recommended by some, especially at access points for parks or trails. Some wanted signs a day in advance in their neighborhood, while others thought informing a neighborhood would be prohibitively expensive.

The final topic discussed was how to handle conflicts when one citizen's no-treatment request affects service for their neighbors. After discussion of the rights of both the citizen and the rights of their neighbors, all three groups concluded that the rights of the no-treatment requester should be respected, but that the buffer provided should be the minimum possible, that other methods (e.g., backpack) be used that have a smaller buffer, and that nearby neighbors be informed of how they can control mosquitoes themselves.

The Wilder Research Center report concludes: "The focus groups revealed a great deal of support for the work of the Metropolitan Mosquito Control District. Participants were not generally aware that the District's control efforts focus primarily on larval mosquitoes. They were concerned about the hazards materials the District uses to control adult mosquitoes might pose to their health and to the environment. They were reassured by the Department of Health's risk assessment of the chemicals used. Despite their concerns, they want the benefits of mosquito control. They would appreciate being notified if the District is going to spray in their neighborhoods, but they do not want the District to spend more tax money than is already being spent on notification. It appears that they would rather spend money to control appropriately inside of no-spray zones and still respect other property owners' rights."

1.3. 1999 Plans

The District created and distributes a LaCrosse encephalitis brochure, and is working closely with MDH and local health agencies in increasing awareness, and reducing the risk of this potentially serious disease. In 1997 MMCD created a Lyme tick identification card, and worked with MDH in the development of a Lyme disease brochure and slide presentation. In 1999 MMCD will use these information pieces throughout the District. The District plans to produce and distribute public service announcements (PSAs) with the theme of LaCrosse encephalitis prevention. These PSAs will be patterned after successful public service campaigns in Florida.

MMCD will increase its presence on the World Wide Web during 1999. Citizens can use internet access to get information about daily activities through MMCD's web site. Information will include daily adulticide treatment location information, and weekly mosquito bite risk maps of the metro area. MMCD's web site address is: www.mmcd.org. MMCD will also emphasize the establishment of links to other relevant web sites.

The District will expand its use of city and county newsletters in 1999. Particular emphasis will be placed on increasing the visibility and use of the adult information line and the District's web site.

2. Vector-borne Disease Management

2.1. Background

In 1998, District staff provided a variety of disease surveillance and control services (including public education) to help reduce the risk of contracting the following diseases in the metro area: LaCrosse encephalitis, western equine encephalitis, Lyme disease, and ehrlichiosis. Past District efforts have included determining metro area risk due to Jamestown Canyon virus, babesiosis, Rocky Mountain spotted fever, and Sin Nombre virus.[1] District staff continue to provide tick identification services upon request and are used as a tick referral resource by agencies such as the Minnesota Department of Health (MDH) and the Minnesota Department of Natural Resources (MNDNR). The Lyme Disease Tick Advisory Board (LDTAB) -- comprised of local scientists and agency representatives -- was created in early 1990 to add expertise to the tick-borne disease effort.

LaCrosse encephalitis prevention services were initiated in 1987 to identify areas within the District where significant risk of acquiring this disease exists. High risk areas are defined as having high populations of the primary vector *Aedes triseriatus* (tree-hole mosquito) and a history of LaCrosse encephalitis cases. These areas are targeted for intensive control efforts including public education, mosquito breeding site removal, and limited adult mosquito treatments. Additionally, routine surveillance and control activities are conducted at past LaCrosse encephalitis case sites. An *Aedes albopictus* (Asian tiger mosquito) surveillance program has also been initiated to detect infestations of this potential disease-vector before it becomes established within the District.

In 1989 the District was mandated by the state legislature "to consult and cooperate with the Minnesota Department of Health (MDH) in developing management techniques to control disease vectoring ticks"[2]. The District responded by inititating tick surveillance and creating the Lyme Disease Tick Advisory Board (LDTAB)--comprised of MMCD and MDH staff, local scientists, and agency representatives who still offer their expertise to the tick-borne disease effort. MMCD initiated tick surveillance to determine the range and abundance of the black-legged tick (*Ixodes scapularis*- also known as deer tick) and the Lyme disease spirochete (*Borrelia burgdorferi*) within the District. To date, MMCD has mapped the current distribution of black-legged ticks (545 total sites sampled) and continues to monitor the metropolitan area *I. scapularis* population[3], as well as undertaking

[1]Reports or additional summary information can be obtained through the MMCD. A single metro area RMSF case is now considered by the MMCD and the MDH to have been an anomaly. JCV risk undetermined; rest low to nonexistent.

[2]MN state statutes 473.701 to 473.716 et esq. Laws 1989, c. 146, §1.

[3]A yearly *Ixodes scapularis* Distribution Study report is distributed to LDTAB members. For published 1990 - 1991 results see Neitzel, Jarnefeld, and Sjogren. An *Ixodes scapularis* (deer tick) Distribution Study in the Mpls - St. Paul, MN Area. *Bulletin of the Society for Vector Ecology* 18:1. p. 67-73. 1993. Although designed strictly as a presence/absence study, other aspects have been examined.

cooperative spirochete and ehrlichiosis studies with the University of Minnesota.[4] All data collected are summarized and given to the MDH for their risk analysis. Since no ecologically or economically wide-scale tick control measures exist to date, tick control is limited to public education activities which emphasize tick-borne disease awareness and prevention.

2.2. 1998 Program

Aedes triseriatus Surveillance.

In 1998, intensive surveillance for adult *Ae. triseriatus* populations continued in several hundred wooded areas in the Lake Minnetonka region of Hennepin and Carver counties. The majority of past LaCrosse encephalitis cases have occurred in this area; six since 1994 (Fig. 2.1). Adult *Ae. triseriatus* populations have been monitored in wooded neighborhoods in this region since 1987. Additional surveillance activities occurred in wooded areas of Dakota County where LaCrosse encephalitis cases have also occurred, and elsewhere as necessary. Adult mosquitoes were collected from each site using a vacuum aspirator. Adult *Ae. triseriatus* were found in 343 wooded areas of 713 that were checked. These areas will be targeted for additional control efforts early in the 1999 field season. Similar surveillance was conducted at all past LaCrosse encephalitis case locations to prevent further cases in those areas.

Before the 1998 field season, MMCD inspector staff modified and improved the design of the vacuum aspirator. The newer model was reportedly much easier to maneuver in the field than the previous model. Many new aspirators were constructed and were fully implemented during the 1998 field season. Measures of average wind speed from the back of both aspirator models did not differ significantly in a laboratory test at the main office in St. Paul.

Aedes triseriatus Control.

As in past years, staff distributed LaCrosse encephalitis prevention brochures to citizens living in identified risk areas. MMCD also distributed brochures at county and state fairs, and other public functions. In addition, interpretive posters and other information were presented at each county fair and the State Fair. These brochures and presentations described LaCrosse encephalitis, and stressed water-holding container removal to prevent the disease (See the Public Affairs section for information on media placements about LaCrosse encephalitis).

In 1998, staff removed 29,492 waste tires from high risk areas of the District (320,101 since 1988). Cooperative waste tire removal efforts continued with several county environmental management departments resulting in the disposal of many waste tires (especially Carver and Dakota counties).

Field staff removed artificial containers and modified wet tree holes in several areas including the Lake Minnetonka area. Treatments were made against adult *Ae. triseriatus* populations at or above

[4] Cooperative research efforts with the U of M have been ongoing since 1992. *B. burgdorferi* infection rates in the small mammal population appear to be lower than in the Eastern US (unpublished data). Also, see Gill, McLean, Neitzel, & Johnson. Serologic Analysis of White-Tailed Deer Sera for Antibodies to *Borrelia burgdorferi* by Enzyme-Linked Immunosorbent Assay & Western Immunoblotting. *Journal of Clinical Microbiology* p. 318-322. February 1993.

threshold numbers to lower the immediate disease risk until the larval breeding habitat in these areas could be found and removed.

Four probable LaCrosse encephalitis cases were reported from three Minnesota counties in 1998. One of the four cases was reported in early August from Chaska (Carver County, Fig. 2.1); the others were reported from outside the seven-county metro area. Staff responded to possible exposure areas associated with the Chaska case (victim's residence and the Minnesota Landscape Arboretum) which included intensive vector surveillance and control efforts. These efforts were implemented and supported by field, Technical Services, and Public Affairs staff. Adult *Ae. triseriatus* reared from larvae collected during site inspections have been forwarded to the MDH for virus isolation testing. The exposure areas associated with this case will receive further surveillance and control efforts in 1999.

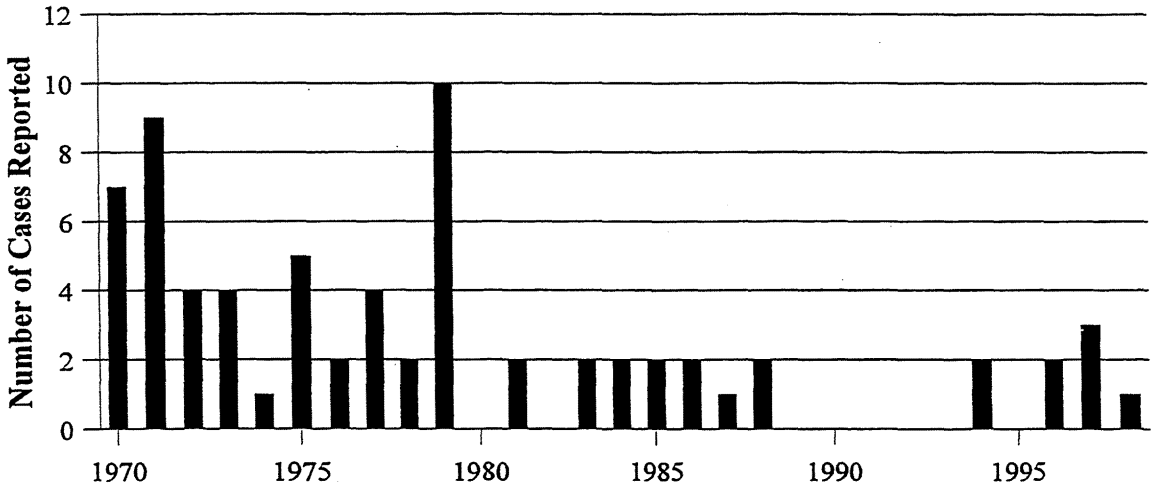


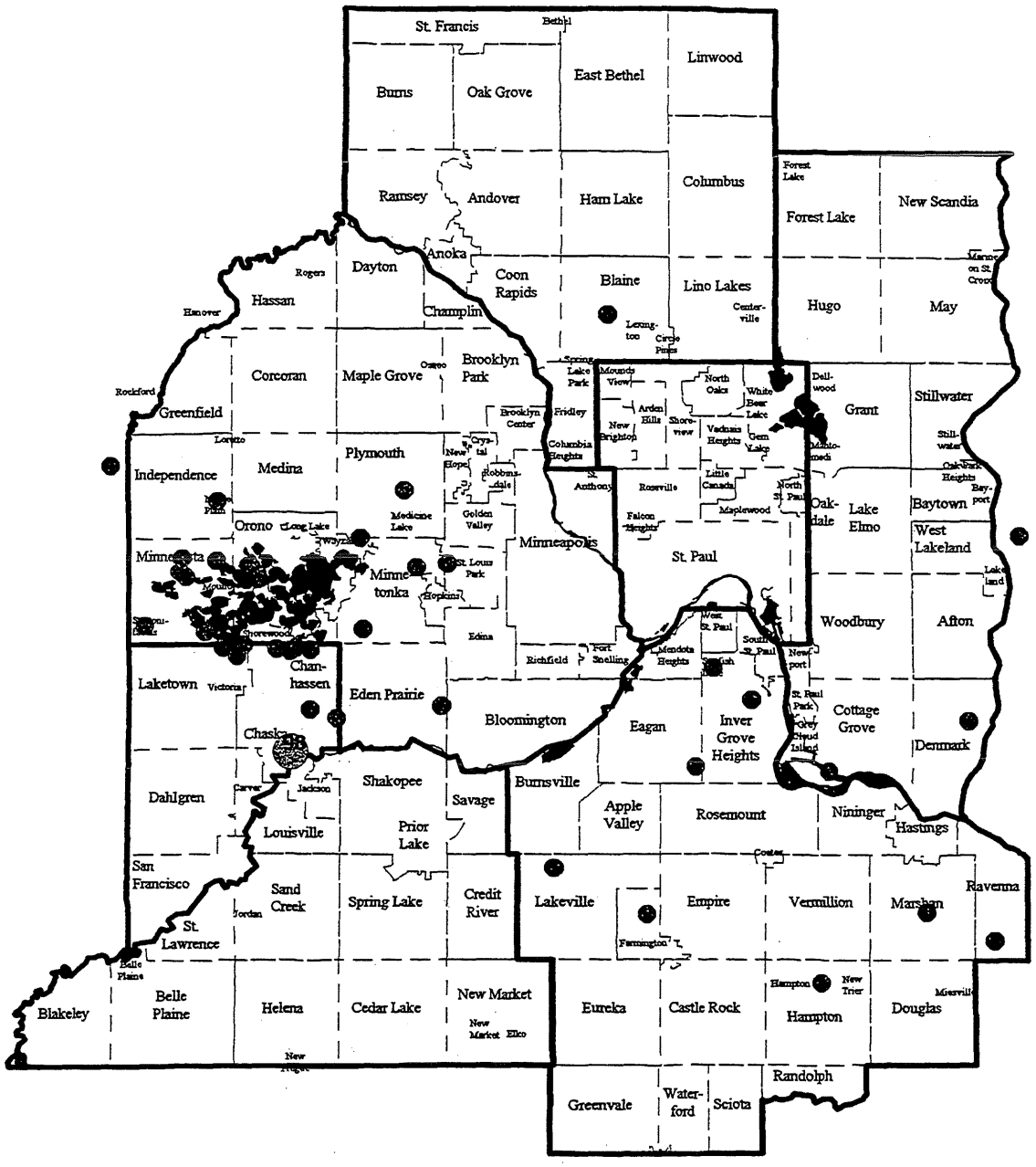
Figure. 2.2. The number of LaCrosse encephalitis cases reported from the seven-county metropolitan area 1970 - 1998.

***Aedes albopictus* (Asian tiger mosquito) Surveillance.**

Aedes albopictus is an aggressive nuisance and disease-vector mosquito capable of transmitting the LaCrosse encephalitis virus. It breeds in tree-holes and in containers (e.g. tires, cans, bird baths, and other water-holding containers) typically associated with human activity. This mosquito is native to Korea and Japan, but has spread throughout many parts of the world including the United States mainly with the trade and subsequent movement of used tires. Its northern range limit in the US is believed to be Chicago, IL.

Aedes albopictus has been found in or near the District in three of the past eight field seasons. In 1991 and 1996, infestations of this mosquito were detected at waste tire recycling businesses in Scott County. In 1997, field staff found *Ae. albopictus* adults and larvae while inspecting grounds in

Figure 2.1. Locations of Probable and Confirmed Cases of LaCrosse Encephalitis Reported from the Seven-County Metropolitan Area



response to a reported LaCrosse encephalitis case in Delano. The infestation presumably resulted from infested containers that accompanied a citizen who moved to the area from Florida in July, 1997.

A surveillance plan for the Delano area was drafted and collaborated with the Minnesota Department of Health before the 1998 field season. Wooded areas and nearby grounds within a half mile radius of the Delano case site were intensively surveyed and inspected during the field season. The purpose was twofold: to detect and eliminate any *Ae. albopictus* larvae or adults that may have successfully overwintered in the area, and to remove larval mosquito breeding habitat. Despite their surveillance efforts, field staff did not detect an infestation in the Delano area in 1998.

Weekly monitoring of the Elko tire recycling facility in Scott County where *Ae. albopictus* larvae were collected in September 1996 also did not detect a further infestation.

***Culex tarsalis* and Western Equine Encephalitis (WEE) Surveillance.**
Based on CO_2 trap and sweep net surveillance results, adult *Cx. tarsalis* numbers remained low throughout the season with three minor spikes occurring in July and August (CO_2 trap results). Weekly blood samples drawn from three sentinel chicken flocks located along the District's western border (Anoka, Hennepin, and Scott counties) detected no WEE virus activity.

***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. At least one *I. scapularis* was collected from 39 of the sampling locations in 1998 with a total of 1246 mammals inspected (Table 2.1). Most of the *I. scapularis* collections continued to occur in the northeastern metropolitan area in Washington and Anoka counties, additionally *I. scapularis* was collected for the first time in this study in Hennepin and Scott counties.[5]

Although this study is designed strictly as a presence/absence study, other aspects have been examined in past years. In addition, *Ixodes scapularis* distribution and density estimates seem to correlate with human case data[6] (case data source MDH) where the highest metropolitan area risk appears to be Washington county, but *I. scapularis* have been collected in all seven metropolitan counties with human Lyme disease cases occurring in each county but Carver (Table 2.2).

[5](1) larva collected in Hennepin County; (3) larvae from a single site in Scott County. *I. scapularis* has been collected previously in both counties using other methods.

[6]Human case distribution by county of exposure was shown to be significantly correlated with tick distribution in a Wisconsin study. See Kitron & Kazmierczak. Spatial Analysis of the Distribution of Lyme Disease in Wisconsin. *American Journal of Epidemiology* 145:6. p. 558-566. 1997. Also, the MDH has stated that human case data combined with tick data puts into perspective the local risk for this area (Craig Hedberg LDTAB meeting minutes March 18, 1993).

Table 2.1. Results from the 100 sampling locations selected for repeat sampling- *Ixodes scapularis* Distribution Study Metropolitan Mosquito Control District.

Year	No. sites positive	No. *I. scapularis*	No. small mammals	Avg. *I. scapularis*	Avg. *I. scapularis* (rounded)
[1]1990	31	308	1302	0.237	.2
1991	39	411	2354	0.175	.2
1992	24	113	1268	0.089	.1
1993	37	409	1543	0.264	.3
1994	35	543	1672	0.325	.3
1995	35	306	1406	0.218	.2
1996	30	102	791	0.129	.1
1997	24	118	728	0.162	.2
1998	39	506	1246	0.406	.4

[1] Number of sample sites in 1990=75.

Table 2.2. Number of metropolitan area Lyme disease cases by county of exposure versus *Ixodes scapularis* Distribution Study results 1993-1997 by county, illustrating correlation between human Lyme disease case data and average number of *I. scapularis* collected per mammal.

County	[1]No. metro Lyme disease cases	Percent of sites positive	No. *I. scapularis*	No. small mammals	Avg. No. *I. scapularis*	Avg. No. *I. scapularis* (rounded)	Tick loads # mammals with ≥10 larvae &/or nymphs
Washington	81	57%	963	1408	0.684	.7	20
Anoka	24	52%	409	1716	0.238	.2	4
Ramsey	20	27%	22	176	0.125	.1	0
[2]Hennepin	10	0	0	669	0	0	0
Dakota	7	17%	81	1096	0.074	.1	0
[2]Scott	1	0	0	594	0	0	0
[2]Carver	0	0	0	483	0	0	0

[1]Source 1993-1997 human Lyme disease case data by county of exposure Minnesota Department of Health.
[2]*I. scapularis* (≤ 3 larvae or nymphs total in each county) has been collected through MMCD distribution study efforts for years excluded here.

Ehrlichia and *Borrelia burgdorferi* Cooperative Studies

Research in cooperation with Dr. Russell Johnson of the University of Minnesota has continued and *Ehrlichia*[7] research expanded in 1998. Blood samples from *Peromyscus leucopus* (the white-footed mouse) collected for our *I. scapularis* distribution study were analyzed for the presence/absence of antibodies to *Ehrlichia* species.[8] In addition, intensive sampling occurred at three locations in Washington County to determine the small mammal population infection rate status to *Ehrlichia* species in addition to *Borrelia burgdorferi*. Site selection was based on past research results. Final results should be available by spring of 1999.

Public Education

The District continued to emphasize tick-borne disease in its public education efforts in 1998, focusing on increased awareness of *I. scapularis* distribution, personal protection measures, and tick identifications. In addition to public education efforts at local fairs, District staff gave Lyme disease presentations to various organizations. Lyme disease brochures and the District tick identification cards were distributed.

2.3. 1999 Plans

LaCrosse encephalitis prevention services will continue to emphasize *Ae. triseriatus* surveillance and control. Historically, surveillance was concentrated within the Lake Minnetonka region of Hennepin and Carver counties, and in northern Dakota County. Due to recent viral activity in other areas of MMCD, we will continue to increase surveillance and control efforts. Waste tire removal will also continue to be a priority across the entire District. MMCD will continue to work with county environmental management departments in cleaning up and disposing of larger waste-tire collections.

MMCD will continue the *I. scapularis* distribution study although the cooperative *Ehrlichia* and *B. burgdorferi* studies with the University of Minnesota may be discontinued or drastically reduced in scope based on the low overall *Ehrlichia* exposure results of the past several years in tandem with finding comparable *B. burgdorferi* results to past years. The Lyme Disease Tick Advisory Board (LDTAB), made up of local scientists and agency representatives with Lyme disease expertise, will be updated on the progress of tick-borne disease studies during the spring of 1999. Public education efforts will continue at a similar level to past years with a focus on tick-borne disease awareness and prevention. District staff will be trained to be able to respond to general questions from the public regarding the newly approved human Lyme disease vaccine.

[7]Ehrlichiosis is a newly discovered bacterial disease thought to be caused by several *Ehrlichia* species & transmitted by *I. scapularis*. The HGE agent (northern form) has been detected in previous studies. See Walls, Greig, Neitzel, & Dumler. Natural Infection of Small Mammal Species in Minnesota with the Agent of Human Granulocytic Ehrlichiosis. *Journal of Clinical Microbiology* 35:4. p. 853-855. See Bakken, Dumler, Chen, Eckman, Van Etta, Walker. Human Granulocytic ehrlichiosis in the Upper Midwest US. *JAMA* 272:3. p. 212-218. 1994.

[8]No mammals collected in 1996 during cooperative research in North Oaks (Ramsey Co.) tested positive to *Ehrlichia*. Testing of blood samples of distribution study-collected *P. leucopus* began in 1997 (11 positive samples detected).

Human Lyme disease vaccine update: The human Lyme disease vaccine received final licensing approval by the Food and Drug Administration in December of 1998. This vaccine will protect people from Lyme disease only, not other tick-borne diseases, and will consist minimally of three inoculations given within a one-year period (duration of immunity unknown). Results seem to indicate that the vaccine is effective for adults between the ages of 18 to 65 years old but is only 45% effective for those adults over age 65 for some as yet unidentified reason. Because the vaccine was not tested in children, the effectiveness for this younger age group is not currently known.[9] Future operational implications could include a decrease in the level of tick surveillance activity, but surveillance will remain unchanged in 1999. Public education efforts will remain minimally at existing service levels.

[9]See Centers for Disease Control and Prevention (CDC) MMWR (Morbidity and Mortality Weekly Report) 48:2. p.35,36, & 43. January 22, 1999.

3. Mosquito Surveillance

3.1. Background

MMCD conducts a variety of surveillance activities to identify the need for control and to monitor the District's progress toward reducing mosquito levels. Rainfall information is collected to help identify where mosquito production is likely. Larval samples taken from breeding sites before treatment are identified to detect the presence and amount of human-biting mosquito species. MMCD uses New Jersey light traps to monitor disease vectors and provide historical data of mosquito populations. Additionally, employees and volunteers take sweep net and CO_2 trap collections in the evening to monitor mosquito levels experienced by most citizens.

3.2 Mosquito Biology

There are 50 species of mosquitoes in Minnesota. Thirty-nine species are found within the MMCD, of which 15 are human biters. Species can be grouped according to habits and habitat preferences; spring *Aedes*, summer *Aedes*, the cattail mosquito (*Cq.perturbans*), and permanent water species.

—Spring snowmelt *Aedes*—

Spring *Aedes* are the earliest mosquitoes to hatch in the spring. They breed in woodland pools, bogs, and marshes. There is only one generation per year and overwintering is in the egg stage. Adult females live throughout the summer and can take up to four blood meals. These mosquitoes do not fly very far from their breeding sites, so localized hot spots of biting can occur both day and night. Our most common spring *Aedes* species are *Aedes abserratus*, *Aedes excrucians* and *Aedes stimulans*. Spring *Aedes* adults are not attracted to light, so human or CO_2-baited trapping is recommended.

—Summer floodwater *Aedes*—

Summer *Aedes* eggs hatch in late April and early May. Eggs are laid at the margins of grassy depressions, marshes, and along river floodplains. There are multiple generations per year resulting from rainfalls greater than one inch. Overwintering is in the egg stage. Adult females live about three weeks. Most species can fly great distances and are highly attracted to light. Peak biting activity is as at dusk. *Aedes vexans*, the floodwater mosquito, is our most numerous pest. Other summer *Aedes* are *Aedes cinereus*, *Aedes sticticus* and *Aedes trivittatus*. New Jersey light traps, CO_2-baited traps, and human-baited sweep net collections are effective methods for adult surveillance of these species.

—Coquillettidia perturbans —

Coquillettidia perturbans, the cattail mosquito, is a summer species that breeds in cattail marshes. Unlike other mosquito larvae, *Cq. perturbans* obtains oxygen by attaching its specialized siphon to the roots of cattail plants. They overwinter in this manner. Adults begin to emerge in late June, with peak emergence around the first week of July. They are very aggressive biters, even indoors, and will fly up to five miles from the breeding site. Peak biting activity is at dusk and dawn. Surveillance of adults is best accomplished with CO_2 traps.

—Permanent water species—

There are three genera of mosquitoes that breed in permanent and semipermanent sites; *Anopheles*,

Culex, and *Culiseta.* These mosquitoes are multi-brooded and lay their eggs in rafts on the surface of the water. The adults prefer to feed on birds or livestock but will bite humans. The adults overwinter in places like caves, hollow logs, stumps or buildings. We do not usually target these species for surveillance or control.

—Disease vectors—

One exception to the habits of the summer *Aedes* is *Ae. triseriatus*. Also known as the eastern treehole mosquito, it breeds in treeholes and artificial containers, especially discarded tires. *Aedes triseriatus* is the vector of LaCrosse encephalitis. The adults are found in wooded or shaded areas and stay within 1/4 to 1/2 miles from where they emerged. They are not aggressive biters and are not attracted to light. Vacuum aspirators are best for collecting this species.

Culex tarsalis is the vector of western equine encephalitis. In late summer, egg laying spreads to temporary pools and artificial containers, and feeding shifts from birds to horses or humans. MMCD closely monitors this species using New Jersey light traps and CO_2 traps. Viral activity is monitored by testing blood from sentinel chicken flocks.

More detailed surveillance information is included in the Vector-borne Disease Management section of this report.

3.3. 1998 Summaries

Rainfall

MMCD maintains a network of 78 rain gauges located throughout the District to monitor rainfall amounts. A one-inch rainfall can produce a brood of floodwater mosquitoes. Staff monitor the gauges immediately after a rain and areas that receive high rainfall are sampled for mosquitoes first. This rainfall information is also forwarded to the Minnesota Department of Natural Resources State Climatology Office to supplement their network.

Average rainfall per gauge in the District from May 1 through September 30, 1998 was 19.43 inches (Table 3.1) . This is very close to the 40-year District average of 19.33 inches. Higher than average rainfall occurred in the southern areas of the District while the northern and western areas were below average.

Table 3.1. Average amount of rainfall received in each county from May through September 1995-1998 and 40-year average.

	Anoka	Carver	Dakota	Hennepin	Ramsey	Scott	Wash.	District
1995	22.75	18.85	17.42	20.18	21.99	19.39	23.59	21.00
1996	13.23	11.91	15.64	13.04	12.66	13.50	14.31	14.06
1997	19.21	24.01	26.27	19.52	23.21	23.49	22.34	21.33
1998	18.95	18.70	23.53	18.30	19.26	22.06	19.89	19.43
40-Year Avg.	18.89	NA	19.62	19.45	19.69	19.30	20.04	19.33

The 1998 mosquito season started early with a warm spring and rains in late March. This was the season of big storms that contained straight-line winds causing much tree damage to several areas of the District. The first major storm occurred on May 15, covering the District with 1-2 inches of rain (Fig 3.1). The second major storm on May 30 produced straight-line winds and another 1-2 inches of rain. The southern part of the District received heavy rains on June 27 with over 6 inches in some areas. A District-wide storm of 1-3 inches occurred on June 15 and half the District received heavy rains on Aug. 7. Another major storm hit the south on Aug. 22, dumping 4 inches of rain.

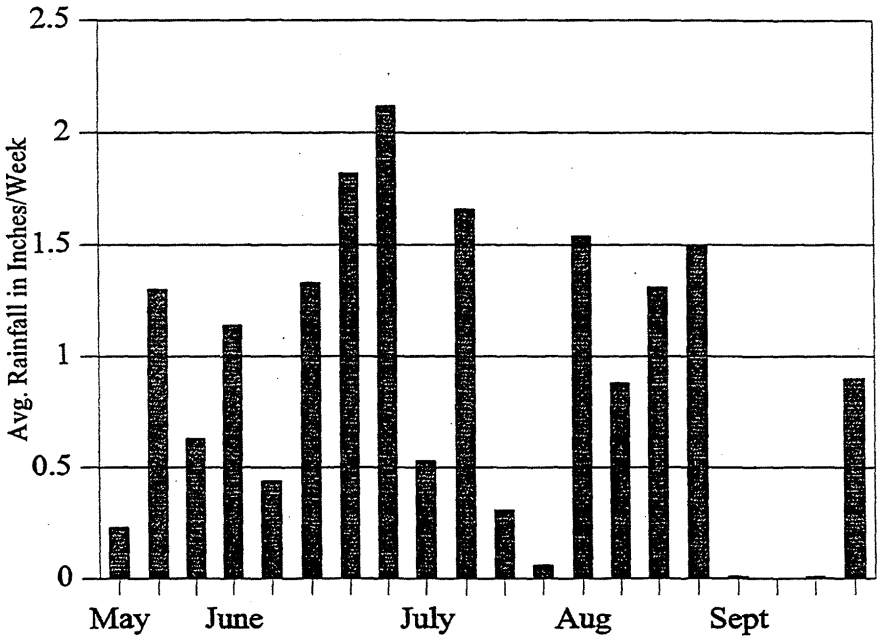


Fig. 3.1. Mean rainfall in inches per gauge per week.

MMCD continues to experiment with NEXRAD radar imaging for viewing rainfall amounts. Staff in the field offices are able to download NEXRAD images on their computers to view areas of high rainfall. The NEXRAD system is not always reliable and staff still rely on rain gauge readings to determine where to send field crews.

Larval Collections

Larval collections are taken from breeding sites to determine whether human-biting mosquito species are present. During a brood, Technical Services personnel quickly process larval samples and relay the results to field personnel so they can do treatments. Samples taken from sites treatable by helicopter have priority over other samples. Again this year Technical Services seasonal personnel processed samples at some field offices during a brood. This eliminated the need to immediately bring samples to the Technical Services lab (an hour drive in some cases) for identifications, and greatly speeded up helicopter treatments.

In 1998, personnel identified 14,750 larval collections. In the past three years the District has had an average of 6-8 small broods and 3-4 medium to large broods. Average rainfall in 1998 produced eight broods of mosquitoes—four large broods and four medium broods.

Adult Collections

—New Jersey Light Traps—

New Jersey light traps are the standard collection devices for many mosquito control districts. MMCD has used New Jersey light traps since 1960 to collect historical data on mosquito populations. Light from a 25-watt light bulb acts as an attractant and a timer turns traps on and off. Personnel empty traps daily from May to September.

Because the traps are baited with light, they collect male mosquitoes, species that are non human-biting and many other insects which makes them time consuming to process. To reduce processing time, the number of New Jersey light traps operated in 1997 was reduced from 18 to five. The five locations were chosen for historical information (traps 1, 9, and 16 have been sampled each year since 1960) and for species diversity. Trap1 is located in St. Paul, trap 9 in Lake Elmo, trap 16 in Lino Lakes, trap 20 in Elm Creek Park Reserve and trap CA in Carlos Avery Wildlife Refuge. These traps are located in the northern and eastern part of the District (Fig. 3.2).

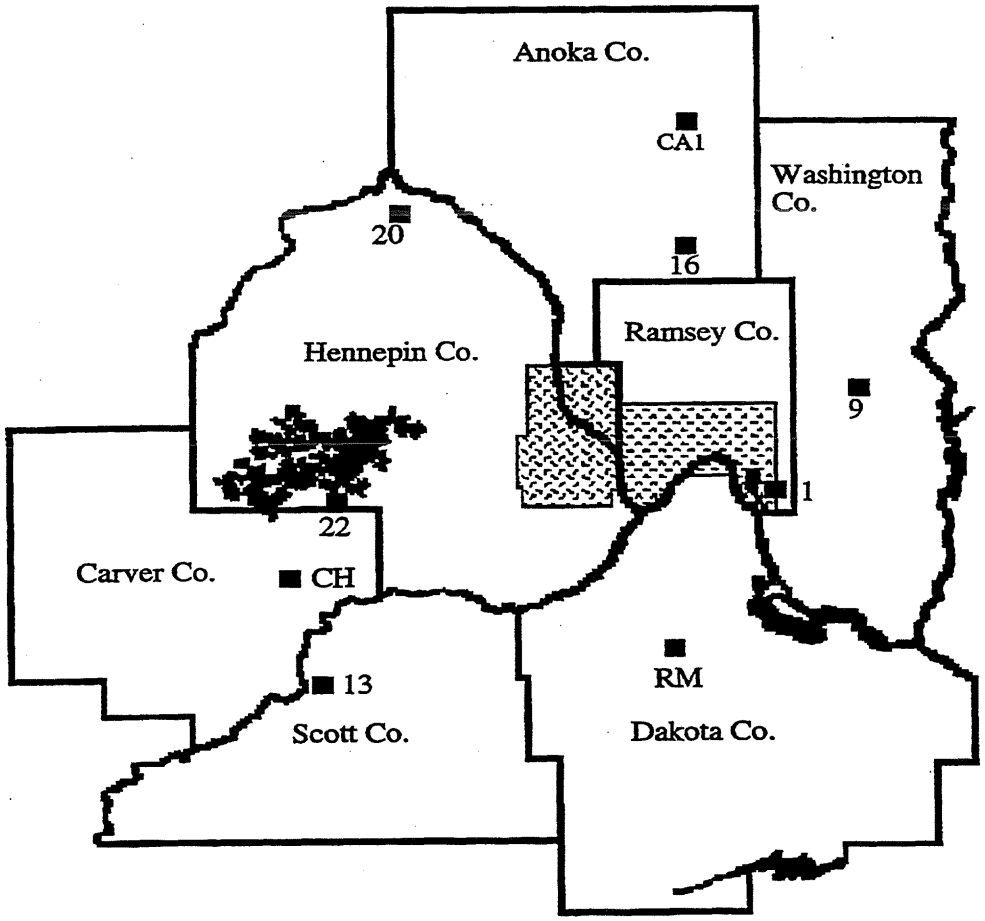


Figure 3.2 New Jersey Light Trap Collection Locations-1998

In 1998, we added four more traps in the west and south—trap 22 in Excelsior, trap CH in Chaska, trap 13 in Jordan and trap RM in Rosemount. Due to mechanical or collector problems, data from four of the traps (1, 22, CH, RM) were not used in the summaries.

All female mosquitoes collected in New Jersey traps are identified to species. *Aedes vexans* was the predominant species collected in the traps, comprising 54 percent of the female mosquitoes collected (Table 3.3). *Coquillettidia perturbans*, the cattail mosquito, was the second most common species at 36 percent. Eight species are included in the spring *Aedes* group. Since these species are not attracted to light, they constituted only 3.5 percent of the female total. *Aedes triseriatus* is also not attracted to light and was only 0.03 percent of the females collected.

Summer *Aedes* mosquitoes, which includes *Ae. vexans*, were higher in 1998 than the last two years but lower than in 1995 (Table 3.2). *Coquillettidia perturbans* populations were higher this year than last year, probably due to late summer rains in 1997 raising water levels in cattail marshes. New Jersey traps are useful to monitor for *Culex tarsalis*, whose populations remained low this year.

Table 3.2. Average number of mosquitoes collected per night in five New Jersey light traps, 1995-98.

Species	1995	1996	1997	1998
Summer *Aedes*	133.6	30.7	77.6	119.7
Cq. perturbans	48.3	104.9	48.5	76.3
Spring *Aedes*	2.2	2.0	1.7	2.0
Ae. triseriatus	0.04	0.01	0.04	0.03
Cx. tarsalis	0.4	0.1	0.1	0.1

The *Cq. perturbans* emergence began in early June, earlier than usual due to the warm spring (Fig. 3.3). Summer *Aedes* populations peaked in the middle of July. This peak partially overlapped the *Cq. perturbans* population peak in late-June to early July. Mosquito populations remained low the remainder of the season.

Table 3.3. New Jersey light trap collection totals, 1998.

Trap No.	9	13	16	20	CA1	Season	% of Female	Average
Location	Lk. Elmo	Jordan	Lino Lks.	N. Henn.	Carlos	Total	Total	per Night
No. of Collection	133	133	130	131	132	659		
SPECIES								
1. Ae. abs.	0	0	0	1	249	250	0.18%	0.38
6. can.	0	1	1	0	4	6	0.00%	0.01
7. cin.	16	7	53	193	163	432	0.31%	0.66
10. dor.	0	0	4	0	0	4	0.00%	0.01
11. exc.	1	0	1	5	2	9	0.01%	0.01
12. fit.	1	0	0	25	1	27	0.02%	0.04
18. punc.	0	0	4	1	45	50	0.04%	0.08
19. rip.	0	0	2	0	2	4	0.00%	0.01
21. stic.	18	64	1	28	0	111	0.08%	0.17
22. stim.	2	0	0	40	4	46	0.03%	0.07
23. prov.	0	0	0	0	1	1	0.00%	0.00
24. tris.	9	0	1	10	0	20	0.01%	0.03
25. triv.	276	369	13	17	76	751	0.54%	1.14
26. vex.	8,647	4,374	28,610	10,390	22,957	74,978	53.93%	113.78
261. Ae. sp.	120	38	118	1,614	723	2,613	1.88%	3.97
118. abs/punc	1	0	0	20	907	928	0.67%	1.41
28. An. earl.	4	23	23	11	69	130	0.09%	0.20
29. punc.	32	235	56	514	138	975	0.70%	1.48
31. walk.	21	147	546	28	3,509	4,251	3.06%	6.45
311. An. sp.	2	7	34	434	108	585	0.42%	0.89
34. rest.	54	9	28	1	16	108	0.08%	0.16
35. sal.	0	7	7	2	1	17	0.01%	0.03
36. tars.	3	16	35	2	12	68	0.05%	0.10
37. terr.	14	3	24	40	62	143	0.10%	0.22
371. Cx. sp.	119	33	126	170	58	506	0.36%	0.77
38. Cs. inor.	26	14	52	10	135	237	0.17%	0.36
39. melan.	0	0	0	0	1	1	0.00%	0.00
40. minn.	5	7	479	20	162	673	0.48%	1.02
41. mors.	8	0	34	11	22	75	0.05%	0.11
411. Cs. sp.	3	3	80	14	42	142	0.10%	0.22
42. Cq. pert.	205	107	2,922	1,444	45,589	50,267	36.16%	76.28
471. Ps. sp.	0	0	0	0	0	0	0.00%	0.00
48. Ur. sapp.	63	9	7	30	1	110	0.08%	0.17
501. Unident.	16	7	48	150	288	509	0.37%	0.77
Female Total	9,666	5,480	33,309	15,225	75,347	139,027	89.89%	210.97
Male Total	1,675	1,736	3,642	2,650	5,942	15,645	10.11%	23.74
Grand Total	11,341	7,216	36,951	17,875	81,289	154,672		234.71
Trap No.	9	13	16	20	CA1	Total		

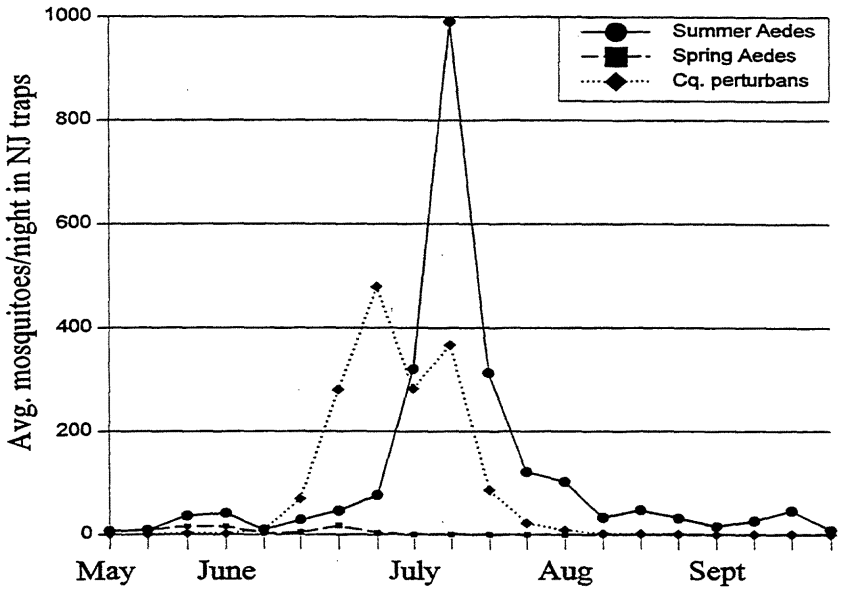


Fig. 3.3. Average number of summer *Aedes*, spring *Aedes* and *Cq. perturbans* collected per night in New Jersey light traps, 1998.

Mosquito Abundance

—Evening sweep net collections—

Sweep net collections are used to detect mosquitoes annoying to people—both species composition and abundance. Sampling occurs during the peak mosquito activity period, five minutes after the end of twilight, which is about 35-40 minutes after sunset. Employees take two-minute collections in the evening in their yards once per week for 20 weeks. The number of sweep net collections varied from 57-121 per night.

Summer *Aedes* were the predominant species in the evening sweep net collections, with an average of 4.2 mosquitoes per collection (Table 3.4). The 1998 season had the second highest percentage of *Ae. vexans* in the past four years. *Coquillettidia perturbans* was the second most common species, averaging 1.4 per collection. The increase in the levels of *Cq. perturbans* from 1997 is partly due to cattail marshes filling up with rains last fall. Winter snow melt was low and the 1998 number of spring *Aedes* was the lowest of the past four years. Compared to summer *Aedes* or *Cq. perturbans*, the amount of spring *Aedes* collected was very low. Numbers of the District's two disease vector mosquitoes (*Culex tarsalis* and *Ae. triseriatus*) remained very low.

Table 3.4. Mean number of mosquitoes collected per evening sweep net collection, 1995-98.

Species	1995	1996	1997	1998
Summer *Aedes*	6.1	1.5	4.0	4.2
Cq. perturbans	1.7	2.2	0.7	1.4
Spring *Aedes*	0.1	0.1	0.1	0.1
Cx. tarsalis	0.04	0.01	0.01	0.04
Aedes triseriatus	0.01	0.01	0.01	0.01

—Evening CO_2 trap collections—

CO_2 traps baited with dry ice are used to monitor mosquito population levels during the peak mosquito activity period, and to monitor disease vector mosquito species. Employees set traps in their yards on the same nights as the sweep net collections, once per week for 20 weeks. As in 1997, the traps ran all night instead of the 2-hour period used in previous years. The time period was changed to enable us to compare this network of CO_2 traps with other overnight CO_2 traps used for treatment threshold determination and disease monitoring. Because the duration of trapping was different, yearly comparisons with trapping previous to 1997 cannot be made. We operated 56 traps in 1998.

The CO_2 traps collected predominantly summer *Aedes,* whose average was 138.2 mosquitoes per collection (Table 3.5). *Coquillettidia perturbans* averaged 31.9 mosquitoes per collection, slightly higher than 1997 levels. Spring *Aedes* were collected more frequently in the CO_2 traps than the sweep nets, but both contained low numbers compared to summer *Aedes* and *Cq. perturbans*.

CO_2 traps collected *Cx. tarsalis* more efficiently than the sweep net because this species is not usually attracted to humans. Levels of *Cx. tarsalis* were low in 1997 and 1998. *Aedes triseriatus* adults stay very close to their breeding sites and are daytime biters. When they are found in our evening CO_2 traps, a nearby breeding site can usually be found.

Table 3.5. Mean number of mosquitoes collected per night in CO_2 collections 1995-98.

Species	1997	1998
Summer *Aedes*	182.7	138.2
Cq. perturbans	30.9	31.9
Spring *Aedes*	2.4	0.9
Cx. tarsalis	0.7	0.4
Aedes triseriatus	0.5	0.2

Seasonal Distribution
The evening sampling of week four was cancelled due to continuous cool, rainy weather.

—Sweep Netting—
Summer *Aedes* had one major peak this season in the third week of July (Fig. 3.4). *Cq. perturbans* has one generation per year with the peak usually around the Fourth of July. The sweeps displayed this peak, which overlapped with the rise in summer *Aedes*. Despite storms in August, levels of summer *Aedes* remained low until surveillance ended in September.

—CO2 Trapping—
The CO_2 traps reflected the same seasonal distribution for summer *Aedes* as the sweep nets, except the peak occurred a week earlier in July (Fig. 3.5). The traps detected a rise in summer *Aedes* populations in the third and fourth weeks of June following the rains in late May. The *Cq. perturbans* peak occurred one week earlier in the traps than the sweeps. Spring *Aedes*, displayed as a District average, do not occur in great numbers in our surveillance summaries. Since they do not fly very far from their breeding sites, they can be locally abundant.

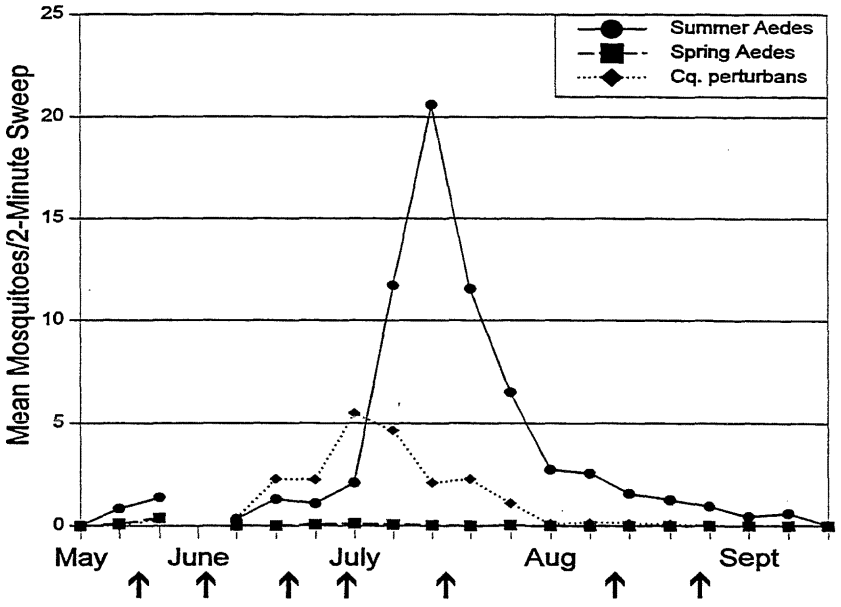


Fig. 3.4. Average number of summer *Aedes*, spring *Aedes*, *Cq. perturbans* per night in sweep net collections, 1998. Major rainfall events are marked with arrows. Sampling week 4 was canceled due to rainy and cool weather.

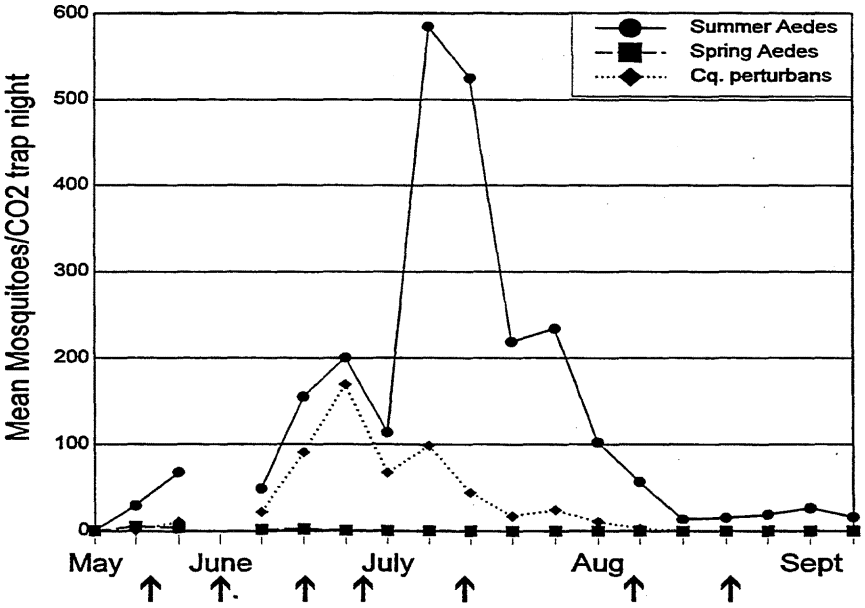


Fig. 3.5. Average number of summer *Aedes*, spring *Aedes* and *Cq. perturbans* per night in CO_2 trap collections, 1998. Sampling week 4 was canceled due to rainy and cool weather.

3.4. CO_2 Trap Design Study

Introduction

CO_2 traps are an important tool in surveillance. Treatment decisions are made based on trapping results. There are many variables that affect the number of mosquitoes collected in a trap such as weather, trap placement, etc. The trap itself is not one of these variables. Our goal is to have the traps as standardized as possible.

We are concerned about the mechanics of our current traps. Currently we use the Hauserr's Machine Works CO_2 trap. Hauserr's only supply the trap, not the container for the dry ice. In past years, we made dry ice containers from paint cans. Over the years these cans have been replaced with Igloo cooler jugs. The Igloo jugs were an improvement over the paint cans which rusted and were easily dented. Holes were drilled in the cans and coolers to allow the CO_2 to be released. As the CO_2 releases, the holes frequently frost over and become plugged, inhibiting the release of CO_2. Another concern we have is that the trap motors have been replaced over the years with different brands of motors. We believe the variability in the amount of CO_2 released from the different containers and the variability in motor speeds may influence the number of mosquitoes collected in the traps.

Materials and Methods

In 1998, we experimented with two different models of traps to determine the one most accurate, economical and easy to use, but not significantly different from our current model. We compared our current trap design (Current) with two traps from American Biophysics: a trap baited with CO_2 from a tank (Tank) and a state-of-the-art trap baited with dry ice (AB).

A Latin square design was used to compare the three traps at three sites on three nights. Two people rotated the traps through three sites in their yard on three separate nights.

Results

The Latin square ANOVA detected no difference between yard ($p=0.187$) and site ($p=0.895$). Night did affect mosquito catches significantly ($p=0.05$). The numbers of mosquitoes caught by the three trap designs seem to differ, although the difference was not quite significant ($p=0.064$) (Table 3.6).

Table 3.6. Results of trap design comparison

	Mean	95% CI Upper	95% CI Lower	Standard Error	Standard Deviation
Current	467.7	1193.5	-258.1	282.4	691.6
AB	170.0	390.4	-50.4	85.7	210.0
Tank	37.5	97.5	-22.5	23.4	57.2

The Current and AB traps are similar in ease of use. The AB trap regulates the amount of CO_2

released and does not ice up at the release points. Drawbacks to the Tank trap were that it was difficult to handle and set up because of the weight of the tank, the release of CO_2 could not be observed and the equipment was very expensive. Additionally, the Tank trap collected very few mosquitoes and it was uncertain whether the trap was operating correctly. Staff will continue to evaluate the AB and Current traps but not the Tank trap in 1999.

3.5. Plans for 1999

Background surveillance using CO_2 traps, sweeps, New Jersey light traps will continue in 1999. CO_2 design comparison studies will continue in 1999. We will purchase more AB traps and continue to compare them with our current traps.

The sweep net sampling time used in evening collections was determined in previous studies to be the peak mosquito biting period. Some employees have experienced greater mosquito biting activity earlier in the evening than the designated sweep net sampling time. In 1999, a study will be conducted to determine if time of day, time of year and location in employees' yards effect the number of mosquitoes collected in the evening sweep collections.

Mosquito taxonomic keys with photographs will be developed to improve training of seasonal Technical Services staff.

4. Mosquito Control Services

4.1. Background

The mosquito control program targets the principal summer pest mosquito, *Aedes vexans*, several species of spring *Aedes*, and the cattail mosquito *Coquillettidia perturbans*. Larval control is the main focus of the program but is supplemented by adult mosquito control when necessary. *Aedes* larvae hatch in response to snow melt or rain with adults emerging at various times during the spring and summer. Cattail mosquito larvae develop in cattail marshes over twelve months and emerge as adult mosquitoes in June and July. See the Mosquito Surveillance section of this report for a more in-depth description of biologies of the various mosquito species found in the District.

Floodwater mosquitoes are adept at using the natural resources of the metropolitan area. These same natural resources contribute to the recreation and enjoyment of the citizens living here. The rolling topography provides many highly productive breeding sites for mosquito larvae. Lush, wooded areas serve as protection from daily heat and low humidity for the resting adult mosquitoes.

4.2. Control Strategy Overview

Due to the large size of the metropolitan region (2,600 square miles), larval control was considered the most cost effective control strategy in 1958 and remains so to date. Mosquito control services target the most prolific mosquito breeding locations for all human biting mosquitoes. An insect growth regulator (Altosid® or methoprene) and a soil bacterium (*Bacillus thuringiensis israelensis* or *Bti*) are the primary larval control materials.

Adult mosquito control supplements the larval control program. Adulticide applications are performed (only after sampling detects mosquito populations meeting or exceeding threshold levels) primarily in high use park and recreation areas, for public events and in response to citizen mosquito annoyance reports. Two synthetic pyrethroids (resmethrin and permethrin) are used for adult mosquito control.

A description of the control materials is found in Appendix 1. Appendix 2 summarizes the number of acres treated with each control material and Appendix 3 shows the amount of control materials used for each facility. Pesticide labels are located in Appendix 5.

4.3. 1998 Mosquito Control

Larval Mosquito Control

In 1998 more acres were treated with briquets than in 1997 (Table 4.1), with about 75% of the total acreage being treated with a 90-day briquet available to MMCD at reduced cost on a one-time basis. The district increased *Bti*- and Altosid® pellet treatments in 1998 compared to 1997 (Table 4.1). The thresholds for treatment with *Bti* were 0.1 larvae per dip (spring *Aedes*) and 2 larvae per dip (*Aedes vexans*) in Priority Zone I and higher in Priority Zones II and III (0.5 larvae per dip (spring *Aedes*) and 5 larvae per dip (*Aedes vexans*)) to help target limited control materials to sites with the most intense breeding and potential to affect the most citizens (i.e., proximity to human population). Thresholds remained unchanged in 1998.

Table 4.1. Acres treated with larvicides in 1998 and 1997. Acres treated are calculated from dosage rates and from amount of material used. The actual geographic area treated is smaller because some sites are treated more than once (See also Appendix 2).

Year	Briquet (150-day)	Briquet (90-day)	Pellets (30-day)	SR-20 (10-day)	*Bti* corncob (1-day)	Total
1997	501	0	8851	1645	106755	117752
1998	371	961	10432	425	113538	125727

Adult Mosquito Control

Adult mosquito control operations were triggered when mosquito levels were above threshold (2 mosquitoes in a 2-minute sweep or 2-minute slap test, 130 mosquitoes in an overnight CO_2 trap), with most treatments occurring in July and early August. Staff conducted treatments in areas identified by District surveillance and customer mosquito annoyance reports. The number of acres treated with permethrin in 1998 (6,164 acres) was similar to 1997 (6,340 acres), whereas, significantly fewer acres were treated with resmethrin in 1998 (65,356 acres) compared to 1997 (106,065 acres). This decrease was primarily due to high adult mosquito populations (populations exceeding threshold) occurring during a shorter part of the 1998 season (Fig. 3.4, 3.5) compared to 1997 (Fig. 4.1, 4.2).

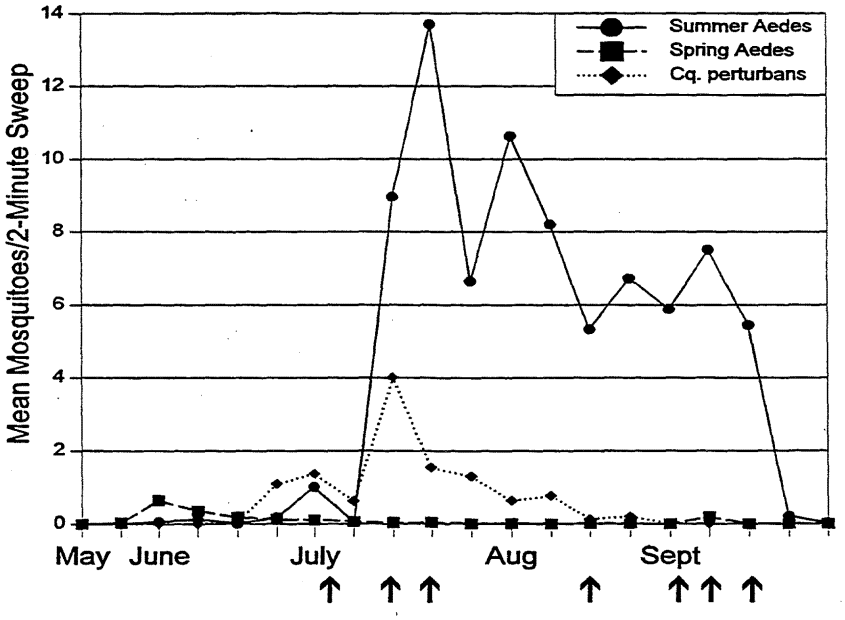


Figure 4.1 Average number of summer *Aedes*, spring *Aedes* and *Cq. perturbans* per night in sweep net collections, 1997. Major rainfall events are marked with arrows. Month name designates the beginning of that month.

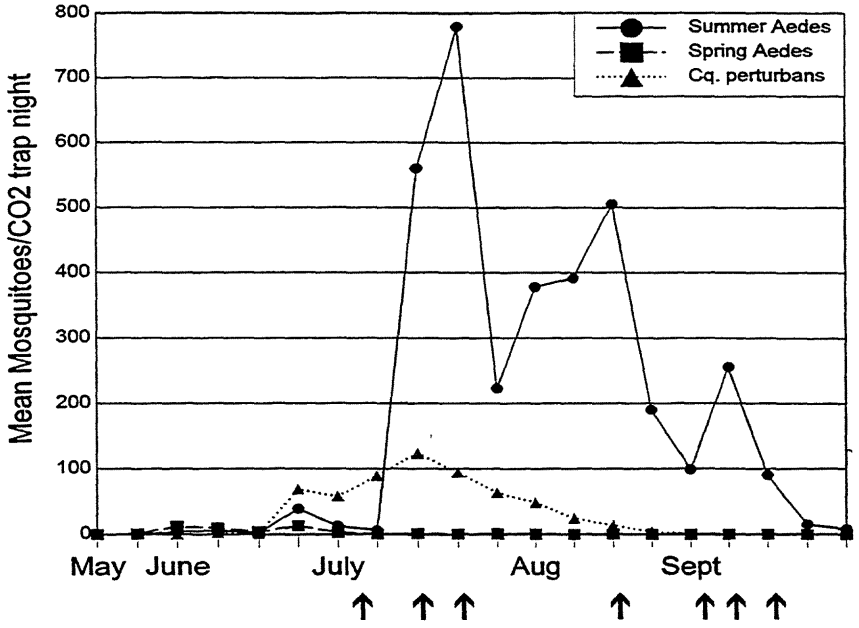


Figure 4.2 Average number of summer *Aedes*, spring *Aedes* and *Cq. perturbans* per night in CO_2 trap collections, 1997. Month name designates the beginning of that month.

4.4. 1999 Plans for Mosquito Control Services

Larval Control: Cattail Mosquito

Coquillettidia perturbans has a limited flight range of five miles. Consequently, MMCD will focus control activities on the most productive cattail marshes near human population centers. Briquet applications will start in early March to frozen sites (floating bogs, deep water cattail sites, remotely located sites). Beginning in late May, staff will treat with pellets applied by helicopter at a rate of 4 lbs/acre. MMCD plans to treat 500 acres with Laginex® at a rate of 40 oz/acre in late May to control the 1999 emergence. An additional 1,500 acres will be treated with Laginex® in late August (total of 2,000 acres treated in 1999) to control the year 2000 emergence. During the summer months staff will monitor treatment efficacy of Laginex® treatments with emergence traps.

Larval Control: Floodwater Mosquito and other species (except *Cq. perturbans*, *Ae. triseriatus* and *Ae. albopictus*)

The larval treatment strategy for 1999 will be similar to 1998. Staff will treat ground sites (<3 acres) with methoprene products and *Bti* corn cob granules. MMCD also plans to continue using six helicopters for the treatment of air sites. Based on the same larval thresholds as used in 1998, breeding sites in highly populated areas will receive treatments first, during a wide-scale mosquito brood. The District will expand treatments into less populated areas where treatment thresholds are higher.

The primary control material will again be *Bti* corn cob granules. Forecasted material needs (*Bti* and similar experimentals) in 1999 are similar to 1998. As in previous years, to minimize shortfalls, control material use may be more strictly rationed during the second half of the season, depending upon the amount of the season remaining and control material supplies. Regardless of annoyance levels, MMCD will maintain sufficient resources to protect the public from potential disease risk.

Adult Mosquito Control
Forecasted permethrin and resmethrin requirements in 1999 are similar to 1997 and 1998. MMCD will direct adult mosquito control treatments to provide the greatest customer benefit—generally high risk disease areas and areas that have high levels of mosquitoes. Also, MMCD will provide service in high use park and recreation areas and for public functions.

The Adult Mosquito Control Information Line (651-643-8383) will again enable citizens to hear a daily recording on where adult mosquito control operations are taking place (eg. parks, neighborhoods, and public events). MMCD will also have this information on its internet web site (www.mmcd.com). MMCD will continue notification in 1999 at the same level as in 1998.

Vector Mosquito Control
Field staff routinely monitor and control *Ae. triseriatus* (LaCrosse encephalitis vector) and *Cx. tarsalis* (western encephalitis vector) populations. See the Vector-Borne Disease Management section of this report for details.

Breeding Site Maps
A major goal in 1999 is the creation of a GIS (Geographic Information Systems) database that includes all mosquito breeding sites. Our initial goal is to enter information about all breeding sites located in Priority Zone I by March 1999. Breeding sites in Zones II and III will be entered later. We plan to develop methods to link surveillance and treatment information (FF2, FF3, FF10, evening sweeps and CO_2 traps) with the GIS database.

Adulticide Non-target Research
In 1999, we have three goals; (1) to finish a review of the literature, (2) to include caged non-target species (including lepidoptera (butterflies) and *Galerucella* sp., a chrysomelid beetle used by DNR in the purple loosestrife biological control program) in planned adulticide efficacy tests (see QA section) and (3) explore more intensive non-target research for inclusion in the year 2000 budget.

Quality Assurance

5.1. Background

Quality assurance (QA) is an integral part of MMCD services. The QA process focuses on control material evaluations, label compliance, application analysis, calibration and exploration of new technologies to improve our operations. The Technical Services team provides project management and technical support. The regional process teams provide coordination of field testing and data collection.

5.2. 1998 Projects

Quality assurance processes focused on standardization of control material inventory processes and new product evaluations. The District brought in ten control materials for evaluation in 1998. These ongoing material evaluations will lead to products being certified and therefore eligible for bidding for the 1999 control material contracts. These evaluations provide the process teams important information on which to base purchasing, budgeting, and operational decisions.

Inventory Process Improvements

After the 1997 season, MMCD's usage and physical inventory records were reconciled and comparisons demonstrated that a critical review of our processes should be conducted. Analysis of these inventory decrepancies found two main areas of focus. These areas of improvement were: (1) standardization of our physical measurement techniques (2) Seedvac material management. Two subgroups (Inventory, Seedvac) were formed to address these concerns.

The Inventory Subgroup worked to standardize our measuring and recording processes at the field offices. 1998 process improvements were: purchase of digital scales, daily material usage checks, weekly comparisons of inventory usage with field form databases, three physical audits of all materials during treatment season, standardized liquid measuring devices, inventory breakdown of *Bti* materials and increased overall education of material tracking processes to all staff. These process modifications greatly improved material tracking and database accuracy in 1998 and further process refinement is set for 1999.

The Seedvac Subgroup looked at improving material tracking and physical measurement of our bulk material helicopter loading system. The subgroup developed a workbook to assist staff in all aspects of the equipment's use. It contains specific instructions on how to measure bulk inventory transactions on both field forms and inventory records. In 1998, we also worked with vendors to produce a standard 1,000 pound bag. These changes substantially improved the bulk *Bti* tracking process. We will continue to evaluate this system by concentrating its use in two regions this upcoming season.

Acceptance Testing of Altosid® (methoprene) Briquets, Pellets, XR-G and Altosand.

During 1998, staff collected random Altosid® product samples from shipments received from the

Zoecon Corporation for methoprene content analysis. MMCD contracted an independent testing laboratory, Legend Technical Services, Inc., to complete the analysis. The testing methodologies were furnished by Zoecon Corporation, Dallas, Texas. The laboratory protocols used were CAP No. 311, "Procedures for the Analysis of S-Methoprene in Briquets and Premix" and CAP No. 313, "Determination of Methoprene in Altosid Sand Granules". Table 5.1 summarizes results indicating that all samples were at or above the label claim of percent methoprene.

Table 5.1. Results of Analyses of samples of various methoprene formulations applied in 1998. * SD = 0 because the mean 0.07% ai level is near the lower limit of detectability of the assay.

Methoprene Product	Samples Analyzed	Methoprene Content: Label Claim	Methoprene Content: Analysis Average	SD
150-day XR Briquets	25	1.80%	2.28%	0.06
90-day XR Briquets	25	1.80%	2.09%	0.09
30-day Pellets	30	4.00%	4.48%	0.13
20-day XR-G Sand	10	1.50%	1.16%	0.10
10-day Altosand*	6	0.07%	0.07%	0.00

Efficacy of Control Materials

Altosid® Briquet, Pellet and Liquid Applications: MMCD was extended an opportunity to make a special one-time purchase of 90-day XR briquets in 1998. The District purchased 1,012 cases and used this residual material for the floodwater mosquito control program. MMCD continued to use the 150-day XR briquets, 30-day pellets and Altosid® Liquid Larvicide (SR-20) in both the floodwater and cattail mosquito breeding sites. Two Altosid® sand formulations were evaluated and results can be found in the following "New Control Material Evaluations" section.

Staff applied both formulations of Altosid® briquets by hand to breeding sites. The XR-150 briquets were applied to 240 breeding sites (371 acres) and the XR-90 briquets were applied to 1,348 breeding sites (961 acres). 11,545 pellet applications were completed by helicopter, seeder or by hand which totaled 10,432 acres (some sites received more than one application). Altosid® Liquid Larvicide (SR-20) was applied by using a hand sprayer, pump sprayer or by hand. Staff completed 817 applications covering a total of 425 acres. The pupal collection method recommended by the manufacturer, Zoecon Corporation was used to assess field performance of methoprene products (Table 5.2).

A major issue collecting bioassay information was the significant number of sites that must be visited to successfully collect adequate numbers of pupae for efficacy calculations. Either pupae

could not be found or sites dried down prior to mosquito pupation. In a pilot study, the East region recorded the number of sites visited from which no pupae could be collected to better measure the significance of this problem. They were unable to collect pupae at a total of 160 sites (41% of all sites visited by six facilities), 10 sites treated with 150-day briquets, 6 sites treated with 90-day briquets, 92 sites treated with pellets,17 sites treated with SR-20 liquid and 35 sites treated with XR-G sand. Other facilities did not record similar information. Since the ratio of successful vs. unsuccessful collections was significant at one facility, we intend to expand our investigation of this issue in 1999.

Table 5.2 Bioassay results (Emergence Inhibition [E. I.] corrected for untreated control mortality) for Altosid® briquets, pellets and SR-20 liquid.

	Sample Taken	E. I.	Corrected	for	Control	Mortality	
	(days)						
Material	post treatment	Count	Mean	Median	S. D.	Min	Max
Pellets	1 to 5	1	N/A	N/A	N/A	0.00	0.00
(30-day)	6 to 30	28	72.26	97.11	36.37	0.00	100.00
	>30	45	70.95	91.92	37.37	0.00	100.00
	Total	74	71.44	92.63	36.75	0.00	100.00
Briquet	1 to 5	0	N/A	N/A	N/A	N/A	N/A
(150-day)	6 to 150	5	33.81	16.32	42.45	0.45	100.00
	>150	0	N/A	N/A	N/A	N/A	N/A
	Total	5	33.81	16.32	42.45	0.45	100.00
Briquet	1 to 5	1	N/A	N/A	N/A	0.00	0.00
(90-day)	6 to 90	36	64.02	83.35	39.45	0.00	100.00
	>90	5	45.99	49.98	27.59	0.00	73.45
	Total	42	60.35	73.45	39.10	0.00	100.00
SR-20	1	0	N/A	N/A	N/A	N/A	N/A
(10-day)	2 to 10	4	90.26	97.83	15.83	66.53	98.85
	>10	31	74.22	97.69	38.63	0.00	100.00
	Total	35	76.05	97.69	36.96	0.00	100.00
Untreated	Total	47	13.36	4.65	22.08	0.00	100.00

***Bti* Corncob Applications**: Vectobac® brand *Bti* from Abbott Laboratories was the main *Bti* product applied by helicopter in 1998. The *Bti* corncob granules are the 5/8" mesh size. The application rate was 8 lbs/acre throughout the spring and early summer. After water temperatures rise above fifty degrees, the treatment rate can be reduced to 5 lbs/acre without a significant drop in efficacy. Later in the season, the rate is elevated to the 8 lb/acre to compensate for the water's increased organic content and higher vegetation density found in sites. An experimental *Bti* product, LarvX, was evaluated in 1998. This formulation uses a different active ingredient (AI) carrier and results can be found in the following "New Control Material Evaluations" section.

Field staff measured efficacy in 15.1 percent of the 4,831 helicopter *Bti*-treated sites during the year (Table 5.3). Efficacy was calculated in terms of pre-treatment and post-treatment larval counts. This method consisted of taking a series of dips in a breeding site soon after a rain event and estimating the average number of mosquito larvae per dip (pre-treatment count). The process was repeated in a randomly selected sample of sites 24-48 hours after treatment (post-treatment count). Percent control was calculated as a percent reduction based on the differences between the two counts.

Table 5.3. Efficacy of aerial *Bti* applications in 1998.

Treatment Period	(Start-End Date) Duration	Helicopter *Bti* Treatment Rate	Average Mortality Rate	Number of Checkbacks
Spring	4/20/98 - 7/16/98	8 lb/acre	88.3 %	441
Midsummer	7/16/98 - 8/16/98	5 lb/acre	85.9 %	103
Late Summer	8/16/98 - 8/28/98	8 lb/acre	88.8 %	180
Overall			88.4 %	724

New Control Material Evaluations

The District, as part of its Continuous Quality Improvement philosophy, desires to continually improve its control methods. It is the District's policy to attempt to use the most environmentally friendly products possible while achieving acceptable control rates. As part of this process, MMCD certifies materials acceptable with District-run evaluations before using the products operationally.

LarvX SG Biological Soluble Granules (Meridian Vector Management): The soluble granule carrier is a new technology to mosquito control. Advantages of this new *Bti* carrier is that it is denser than corn cob granules and sinks immediately where applied. By sinking, the granule can not float away or get blown off open water areas which affects overall control. As the LarvX granule hydrates, it slowly breaks apart and the *Bti* particles are pulled to the surface by tiny gas bubbles. This process allows the *Bti* to pass through the mosquito's feeding column twice and allows the District to apply less AI to the environment.

West-Plymouth used 2,000 lbs of LarvX granules throughout the treatment season. Average control of helicopter treated sites was 87% (n=5) and hand seeder applied sites showed 97% (n=8). Due to the sinking characteristics of this product, a treatment verification system will be developed to collect aerially applied granules. Staff recommended LarvX for certification testing in 1999.

Laginex® AS (AgraQuest, Inc.): *Lagenidium giganteum* is a fungal parasite specific to mosquitoes. Laginex® applied aerially (25 oz/acre) in August 1997 to four sites (total = 30.2 acres) suppressed emergence of adult *Cq. perturbans* by 82% percent (measured using adult emergence cages) from June through July 1998. Laginex® was applied aerially to 395 acres of cattail marshes near Lake Minnetonka in August 1998. Eight sites (201 acres) were treated at 25 oz/acre; the remaining six sites (194 acres) were treated with 40 oz/acre. MMCD will evaluate the efficacy of those treatments in June and July of 1999 using adult emergence cages.

XR-G 20-day Altosid Sand (Zoecon Corporation): This 20-day residual control was a new commercially available material in 1998. Historically, MMCD repeatedly treats large breeding sites with *Bti* by helicopter after each successive rain. During the midsummer season, some sites can meet thresholds and could be treated up to three times within a twenty day period. XR-G sand could be applied to these sites instead of repeating *Bti* treatments. MMCD is exploring the other possibilities of expanding residual coverage of ground sites, possible helicopter application cost savings and/or treatment of additional breeding acreage during summer's limited 7-10 day treatment window.

East region used 880 lbs of XR-G sand in 1998. Staff found 54.71% emergence inhibition in 52 sites (Table 5.4). East Region recommended that additional testing be completed in 1999.

Table 5.4. Bioassay results (Emergence Inhibition [E. I.] corrected for untreated control mortality) for Altosid® XR-G sand and Altosand. Control mortality values in Table 5.2.

	Sample Taken	E. I.	Corrected	for	Control	Mortality	
	(days)						
Material	post treatment	Count	Mean	Median	S. D.	Min	Max
XR-G Sand	1	1	N/A	N/A	N/A	96.88	96.88
(20-day)	2 to 20	42	54.49	49.09	41.00	0.00	100.00
	>20	9	51.05	28.44	43.57	0.00	100.00
	Total	52	54.71	49.09	41.06	0.00	100.00
Altosand	1	0	N/A	N/A	N/A	N/A	N/A
(10-day)	2 to 10	23	68.74	86.15	35.90	0.00	100.00
	>10	0	N/A	N/A	N/A	N/A	N/A
	Total	23	68.74	86.15	35.90	0.00	100.00

10-day Altosand (Zoecon Corporation): MMCD experimented with producing a residual product using SR-20 Altosid Liquid. This economical sand product is easily manufactured and provides a ten-day control that could be used similarly to XR-G sand. The Maple Grove and Jordan facilities used 5,000 lbs. and found emergence inhibition of 68.74% in 23 sites (Table 5.4). Both facilities suggested that larger scale testing be completed in 1999.

Teknar Bti Liquid (Thermo Trilogy): The black fly team evaluated a new commercial *Bti* product in both the Minnesota and Mississippi River. The product performed well in the Mississippi River (3-hour post check 96.4%) but had questionable results in the Minnesota River (3-hour post check 69% [compared to 98% for Vectobac]). A spring evaluation in the Minnesota River is planned for 1999.

Icybac *Bti*-Aqueous Frozen Granules (Abbott Laboratories): This experimental material was manufactured in Germany and shipped via air freight to MMCD for evaluation. East Region found excellent control against floodwater species (84% 24 hours post treatment, 99% 48 hours post treatment; n=6 sites, treatment rate = 20 lb/acre) and the dense pellet was found to easily penetrate vegetation. This material would probably not be feasible for wide-scale operational use because of the need to keep product frozen until application. An early spring application trial is being considered for 1999.

Agnique MMF (Henkel, Inc): This monomolecular film reduces surface tension of the water and makes it difficult for insects to attach. The film also blocks their breathing tubes and larvae and pupae drown. This material was being tested as a control for mosquitoes that breed in treeholes, tires and other artificial containers. Field staff could easily carry an eyedropper bottle of this material and use it to treat these containers until they could return to fill or remove them. Laboratory tests against *Ae. triseratus* (the treehole mosquito and LaCrosse encephalitis vector) showed 100% control of emerging adult mosquitoes. Future testing is currently pending.

Anvil 2+2 (Clarke Mosquito Control Products, Inc): This newly available Sumithrin / PBO adulticide is a non-restricted control material which could be a more environmentally friendly product. MMCD attempted to evaluate the product in August but adult mosquito numbers were too variable for a quality evaluation. The test has been rescheduled for summer, 1999.

Aqua Reslin (AgrEvo Environmental Health): This water-based Permethrin / PBO product was used as a ULV adulticide and was applied using a truck-mounted cold fogger. This initial small scale test showed inconclusive results due to low mosquito numbers. These low insect numbers limited additional testing in August and staff suggested further testing be completed in 1999.

Mosquito Beater 4+4 (Bonide Products Inc.): A special formulation of this Permethrin / PBO adulticide was produced for evaluation by MMCD. This versatile control material could be applied as a barrier or ULV treatment. The District attempted to evaluate this control in August but adult mosquito populations did not maintain high enough numbers for a proper evaluation. This product will be tested in 1999.

Biodac Granules (Edward Lowe): Biodac is a recycled paper and clay product that is used as an insecticide carrier. Technical Services evaluated this inert material during our annual helicopter calibration. This small granular product repeatedly demonstrated quality swath patterns at a five lb/acre rate. This evaluation laid the groundwork for future control material evaluations that use Biodac as a carrier.

Equipment Evaluations

Seedvac Pneumatic Helicopter Loading System: The District continued to evaluate the bulk material loading system that improves the utilization of staff, their efficiency, staff safety, and reduces the packaging waste of control materials.

A major revision of the inventory tracking system of this equipment was incorporated into the 1998 field operations. This change greatly improved the overall measurements and aided staff in using the equipment. Seven evaluations took place during the mosquito season and staff generally responded positively to this new technology. However, a review by a Seedvac Evaluation Subgroup identified some issues and possible improvements. In 1999, we will attempt to correct the identified problems and focus the evaluation in specific regions of the District.

DC-III Portable Droplet Analyzer: MMCD improved its calibration techniques in 1998 by using a computerized analyzer to measure droplet sizes of our cold fogging equipment. Previously, MMCD completed this analysis by microscopic measurement of droplets on teflon slides. This new technology reads thousands of droplets, gives instantaneous results and standardizes our techniques. The test results allow staff to precisely adjust their equipment for optimum performance. The analyzer was provided by Clarke Mosquito Control Products. MMCD will purchase a DC-III unit to expand its equipment testing in 1999.

ELF Variable Flow Controller (Clarke Engineering): MMCD purchased three flow control units to replace inoperable original flow control units on our truck cold foggers. Three different regions used this adulticide speed proportioning device throughout the mosquito season. District staff found the equipment worked effectively and was easy to use. Staff recommended this flow controller as a quality replacement for future systems.

Monitor II – Total Monitoring System (ADAPCO): MMCD purchased an advanced system to control, monitor and report vehicle-applied mosquito control chemicals. This unit replaced an inoperable original flow control unit on a truck cold fogger. This computerized system stored adulticide application information that could be downloaded into a treatment database. The Monitor II offers more detailed information on spray events and provided accurate records on multiple treatments. The applicator and the District both benefit from the advantages of a precise recordkeeping device and a computer integrated system. Despite the longer learning curve to operate the system, staff felt the system performed adequately throughout the season and would recommend it as a replacement for future systems.

Waste Reduction of Control Material Packaging

Bulk *Bti* Granule Bags: Before using the Seedvac System, MMCD used 40 lb. bags for all aerial *Bti* treatments. To increase operational efficiency and decrease the quantity of waste bags, staff evaluated using 1,300 lb and 1,000 lb bulk bags. In 1998, MMCD used 29,780 lbs. of bulk *Bti*, which reduced the amount of waste by 745 bags. MMCD spearheaded the redesign of the bulk bags to 1,000 lb units. This new size gave all facilities the ability to load the bulk trailer and assisted staff to track bulk weights more easily. The District will continue to use this waste reducing packaging.

Recyclable 40 lb. Bags: MMCD continues to support the development of an acceptable container that is 100 percent recyclable. Staff continue to work with vendors, local recycling centers and packaging companies to develop new containers that protect the product's integrity.

5.3 Plans for 1999

Quality assurance processes will continue to be incorporated into the everyday operations of the regional process teams. A primary goal is to assure the collection of adequate information for all evaluations. We will continue to improve our calibration techniques to optimize our adult mosquito control equipment. The District will continue to improve and make quality decisions based upon data.

We plan to review the various methoprene formulations used against floodwater mosquitoes (primarily *Ae. vexans*) since 1995 because (1) the amounts used have changed (e.g., briquet use has decreased drastically), (2) priorities/staff changes have caused bioassay data to be more difficult to acquire and (3) the data seem more variable than in years previous to 1995. Methoprene products (briquets and pellets especially) are among the most expensive products (on a per acre basis) used by the District. This cost is offset to a certain degree by long field lifetimes (residual activity), operationally a very useful characteristic. We intend to investigate whether efficacy truly has changed since 1995 and try to demonstrate which factors are causing variation. The ultimate goal is to use each product where it will most effectively achieve District goals, and to determine how best to measure efficacy using bioassay data.

In 1999, MMCD's goal is to certify four larvicides and up to three adulticides for expanded future use throughout the District. These new materials will provide staff with additional tools to develop and promote the continuous quality improvement process.

New larval mosquito control materials continue to become available and these materials will be evaluated for potential use in the District. Teknar *Bti* granules use a recycled paper/clay based carrier that has shown excellent swath coverages in helicopter calibration testing. Vectolex, a *Bacillis sphaericus* product, will be considered as a potential cattail mosquito control material. A larger scale evaluation featuring four adulticides (Aqua Reslin, Anvil, Mosquito Beater and Scourge) is planned to simultaneously test these adulticides under similar conditions. Overall, MMCD will be evaluating eleven materials in 1999.

MMCD will also evaluate two truck-mounted electric ULV cold foggers in 1999. These foggers provide an extremely consistent droplet size spectrum which will allow the District to optimize adulticide applications. The electrical power generation is significantly quieter that its gas power equivalents.

6. Black Fly Control Services

6.1. Background

The goal of the black fly program is to reduce pest populations of adult black flies within the MMCD to tolerable levels. Black fly larval populations which develop in the small streams and large rivers during the spring and summer are monitored using standardized sampling techniques. Sites where the population reaches a treatment threshold are treated with liquid *Bti*. The small stream program began in 1984. The large stream program began with experimental treatments and non-target impact studies in 1987, but a full-scale treatment program did not go into effect until 1996.

6.2. 1998 Program

Simulium venustum Control

Simulium venustum is a human biting black fly with one early spring generation in the MMCD region. Larvae breed primarily in small streams throughout the District, although the largest populations generally are found in Anoka County.

A total of 149 potential *S. venustum* breeding sites were sampled in mid-April in order to determine larval density using the standard grab sampling technique developed by the MMCD in 1990. Treatment decisions were based on a threshold of 90 *S. venustum* per sample. A total of 57 sites on 13 streams met the threshold and were treated once with *Bti*. A total of 23.74 gallons of *Bti* was used (Table 6.1).

Table 6.1. Summary of *Bti* treatments for black fly control by the MMCD in 1998.

Water body	Number of Application sites	Total number of treatments	Gallons of Bti used
Small streams	57	57	23.74
Mississippi River	2	22	2135.00
Crow River	4	7	106.00
Minnesota River	7	21	1858.30
Rum River	3	27	109.96
Total	73	134	4233.00

Large River Program

There are 3 large river-breeding black fly species that the MMCD targets for control. *Simulium luggeri* breeds mainly in the Rum and Mississippi rivers, although it also breeds in smaller numbers in the Minnesota and Crow rivers. *Simulium luggeri* is abundant from mid-May through August. *Simulium meridionale* and *S. johannseni* breed primarily in the Crow and Minnesota rivers. These

species are most abundant in May and June, although *S. meridionale* populations will remain high throughout the summer if stream flow is also high.

The black fly population density at each treatment location was measured every seven days using artificial substrates at a total of 21 sites permitted by the Minnesota Department of Natural Resources on the Rum, Mississippi, Crow and Minnesota rivers. The treatment thresholds used in 1998 were the same as those used since 1990. A total of 4209.26 gallons of *Bti* were applied to the large rivers for control of black fly larvae in 1998. This was 1210.04 gallons less than was used in 1997. The main reason less *Bti* was used in 1998 compared to 1997 was that the flows in the four large rivers were substantially lower in 1998 compared to 1997 (Table 6.4, large river discharge). There also were 12 more treatments made in 1998 compared to 1997.

Adult Population Sampling

The adult black fly population was monitored in 1998 at the 48 standard locations throughout the MMCD using the over-head net sweep technique established in 1984. Samples were taken twice weekly from early May to mid-September, generally between 8 and 10 AM. The average number of all species of adult black flies captured in 1998 was 2.85 (Table 6.2). The 1998 count was slightly less than the 2.91 adults per site observed in 1997 and was generally similar to the average annual counts recorded since 1991 when the District's area-wide control program began. Prior to the start of the area-wide large river larval control program, the average annual count ranged between 6 and 18 (excluding the drought in 1988). Peak black fly adult activity within the MMCD occurred in mid-May, mid-June and late August in 1998.

As has been observed in all previous years of the program, the most abundant black fly collected in the over head net-sweep samples in 1998 was *Simulium luggeri* comprising 93% of all adult black flies collected. *Simulium luggeri* was most abundant in Anoka County in 1998, as it has been in all previous years of the program. This is due to the close proximity of the Rum and Mississippi Rivers. *Simulium meridionale*, the second most abundant black fly in the MMCD in 1998, was most commonly found in Carver and Scott counties. These two counties are near the Minnesota River, which is *S. meridionale's* major breeding habitat in the MMCD. The *S. johannseni* population was higher in 1998 than in the several previous years. This may have been in response to the favorable breeding conditions created by the higher than average stream flows in 1997.

The average number of adult *S. venustum* captured in 1998 was 0.05 which, as in previous years, was a low percentage of the total black flies collected in net sweep samples. In 1997 and 1998 the District conducted a study to develop a more effective method to sample the adult *S. venustum* population. The goal of the studies was to compare the relative effectiveness of human collectors vs. CO_2 baited light traps and to determine the optimal time of day to sample. The data suggest early evening is the optimal time to sample. Both human collectors and CO_2 baited traps were found to be effective for sampling *S. venustum* but CO_2 baited traps are more cost-efficient and allow for more sampling locations than if human collectors are employed. Large numbers of *S. venustum* were collected during the study, clearly indicating that the current method of sampling between 8 and 10 AM with human collectors does not provide a good index of the *S. venustum* population. Studies on sampling *S. venustum* adults will continue again in 1999. They will primarily focus on expanded

experimental sampling in other regions of the MMCD using CO_2 traps and human collectors.

Table 6.2. Annual mean number of black fly adults captured in over-head net sweeps in bi-weekly samples taken at 48 standard sampling locations throughout the MMCD between mid-May and mid-September. The first operational treatments of the Mississippi River began in 1990 at the Coon Rapids Dam. 1988 was a severe drought year and limited black fly production occurred.

Year	All species[1]	*Simulium Luggeri*	*Simulium johannseni*	*Simulium Meridionale*
1984	17.95	16.12	0.01	1.43
1985	14.56	13.88	0.02	0.63
1986	11.88	9.35	0.69	1.69
1987	6.53	6.33	0.02	0.13
1988	1.60	1.54	0.05	0.00
1989	6.16	5.52	0.29	0.18
1990	6.02	5.70	0.01	0.24
1991	2.59	1.85	0.09	0.60
1992	2.63	2.19	0.12	0.21
1993	3.00	1.63	0.04	1.24
1994	2.41	2.31	0.00	0.03
1995	1.77	1.34	0.32	0.01
1996	0.64	0.51	0.01	0.07
1997	2.91	2.49	0.00	0.25
1998	2.85	2.64	0.04	0.04

[1]All species includes *S. luggeri, S. meridionale, S. johannseni, S. vittatum* and *S. venustum*

Non-target Monitoring

Semi-annual monitoring of non-target invertebrates in the Mississippi River is required as part of the permit for black fly control issued to the District by the Minnesota Department of Natural Resources. Analysis of the non-target monitoring samples collected from the Mississippi River in 1997 has been completed. A draft report has been submitted to the Minnesota Department of Natural Resources for review.

6.3 Black Fly Control Services -1999 Plans

Our goal is to continue to effectively control black flies in the large rivers and small streams. The thresholds for species that breed in the large rivers will remain the same. The threshold for *S. venustum* will increase to 100 larvae per sample. The *S. venustum* adult sampling study will be continued as well as monthly collection of non-target monitoring samples from the Mississippi River.

6.4 Historical Treatment Records

Table 6.3. Small stream treatments and amounts of *Bti* used .

Year	Number of Sites Treated	Gallons *Bti* used
1995	48	8.95
1996	74	28.64
1997	66	26.20
1998	57	23.74

Table 6.4. Large river treatments, amounts of *Bti* used and discharge.

Year	Number of Treatments	Gallons *Bti* used	Discharge[1] (cfs)
1995	58	3583.55	7420
1996	67	2996.10	6353
1997	65	5419.30	9446
1998	77	4209.26	5076

[1]Average daily discharge, measured in cubic ft/sec., for Mississippi, Minnesota, Rum and Crow rivers combined.

7. Supporting Work

7.1 Continuation of Long-Term Study of Nontarget Effects of Mosquito Larvicides (Wright County Study)

As recommended by the SPRP in their final report (January 1996), MMCD has continued treating the long-term study sites using the same experimental design and funded additional sampling in 1997 and 1998 to assess the effect of continued treatment.

The 1997-1998 sampling was directed and reviewed by a Continuation Panel including original SPRP members R. Anderson, S. Hurlbert, R. Moon, W. Schmid, M. Zicus and K. Simmons, plus J. Helgen (as available), and TAB member D. Belluck. MDNR staff G. Montz was kept current on Panel activities. N. Read from MMCD served as administrative staff, and S. Manweiler was the liaison with the MMCD Management Team.

The contract for benthic insect sampling and related work was awarded (based on a competitive review process in 1997) to the Lake Superior Research Institute (LSRI), UW-Superior, with Dr. Mary Balcer and Dr. Kurt Schmude as principal investigators. LSRI staff sampled the Wright County wetlands 5 times in 1997, using dip net and bottle trap sampling for mobile insects in the water column, as well as core samples for benthic insects as were used in the previous study. Treatments were done by MMCD as previously. Statistical analysis for LSRI was done by Ann Lima, who also did the analysis for the previous study.

A report on the 1997 work was reviewed by the Panel in March, 1998. The report showed that the apparent trend of increasing impacts in the 1991-1993 samples (Hershey et al. 1998) had not continued. Treatment effects in 1997 were small (when detectible at all) and inconsistent, showing on only 1 or 2 of the 5 sampling dates and in limited taxa. However, water levels in 1997 had ranged from extremely high early in the year to quite low in mid-summer, hindering some sampling. In addition there were some problems with the methoprene material availability from the manufacturer, resulting in use of a slightly different formulation of sand-based material for some of the treatment dates. Fish were also encountered in several sites, with potential for impact on invertebrate populations.

The Panel decided to extend the contract with LSRI and continue sampling and treatment in 1998 to see if the results were consistent. Contributions toward funding of an additional year's research were obtained from Abbott, a manufacturer of *Bti*, and Wellmark, the current company manufacturing methoprene products, as well as from the MMCD 1998 budget. Treatments were again made to the 25 sites (9 control, 9 *Bti*, 7 methoprene) on 6 dates in 1998, and were verified by ground data collection summarized by Dr. Lyle Shannon of the University of Minnesota - Duluth (as has been done continuously since 1991). LSRI sampled the sites on 5 dates, including one date prior to the first treatment in the spring. Sampling included benthic core samples, artificial substrates, fish traps and fyke nets.

Water levels in 1998 did not drop as low as they did in 1997, allowing complete sets of benthic core samples at all the sites on all treatment dates, and there were no problems with treatment material availability. In general, invertebrate numbers were somewhat higher in 1998 than in 1997, and the chironomid midges accounted for about 40% of the invertebrates found. Chironomid numbers and biomass were generally somewhat higher in the untreated sites than in the methoprene or *Bti* sites in 1998, but the difference was not statistically significant. Some subtaxa of the Chironomidae had significantly lower numbers and biomass on some dates, but other subtaxa had higher numbers in the treated sites, reducing the overall effect on the midge family in 1998.

The Panel is currently reviewing the 1998 results, and will be deciding on production of a final report from the 1997-1998 sampling.

In addition to the invertebrate research, the Panel was able to arrange for a preliminary survey of frog populations at 18 of the Wright County study sites in cooperation with Dr. Lucinda Johnson of NRRI and Dr. Val Beaseley of Univ. of Illinois - Champaign/Urbana. Frogs were collected for a standard collecting time, evaluated visually for malformations, and a sample preserved for further pathology lab evaluation. Preliminary results showed that some malformations were found, but were at least as common in untreated sites as in methoprene-treated sites. Final results will be reported separately when lab studies are completed. Both outside funding sources and the researchers have expressed interest in confirming these results in an additional survey in 1999, if MMCD and the Panel are willing to continue administration of the project.

7.2 MMCD Y2k Preparations

MMCD is putting together a Y2K plan (as required by the League of MN Cities for insurance purposes) and will be addressing Y2K issues throughout its operations in 1999. Renters (911 Board, JTPA) will be informed, and we are requesting similar information from the owners of the Oakdale Facility office space. We anticipate Y2K contingency planning to work hand-in-hand with our existing Disaster Recovery plans. A designated person from each MMCD facility or region will document the items/services that are checked for compliance.

7.3 Effects of Restricted Access on MMCD Operations

The 1998 Sierra Club campaign to have all members call MMCD and refuse service on their properties resulted in several hundred "no treatment" requests ("RE" or "refused entry"). Measuring the impact of these REs is crucial for MMCD to determine if changes to its operational strategies are warranted. For example, buffer zones associated with REs could exclude control activities in certain areas to render them logistically infeasible or ineffective. In such cases MMCD would need to decide what (if any) control services it could offer to citizens living in these areas who desire control services and how to explain to them the situation.

After much discussion MMCD developed three strategies to quantify how significantly REs affect MMCD operations.

1. Outcome based methods.
2. Outlining tasks necessary to complete a control-related operation.
3. Mapping REs/RE database design.

Outcome based methods: This involves tallying the outcome of an initial cause. For example, a treatment may result from a customer call. The treatment is the outcome and the customer call is the initial cause. The cause could also be an above-threshold dip count or the breeding history of a site (perhaps one targeted for a briquet treatment). We started with outcomes resulting from customer calls because the customer call database categorizes calls into several discrete types and includes the vast majority of RE requests. Therefore our causes and outcomes were already pretty well defined, meaning we needed only to tally them.

To evaluate how many outcomes were impacted by REs we first determined how many different types of outcomes could result from each type of customer call. Then we used the caller database records to tally each outcome.

We wanted to expand the list of causes to include all reasons that MMCD might conduct an operation (e.g., an inspection, treatment, etc.) to quantify how REs impacted the outcomes of these activities but we were unable to extract the information for the treatment databases. In 1999 we intend to develop a way to record these data to analyze RE impacts.

Outlining tasks: Outlining tasks involves listing the flow of actions that lead from a cause to an outcome. This means creating an outline for each cause that includes all possible outcomes with REs being included in the outline where they could affect the outcome. This could permit us to determine if extra steps were caused by dealing with an RE. Calculating how much time is required to perform each step and converting the time into money (i.e., salaries, resources, etc.) would permit us to estimate how much REs were costing MMCD in dollars and personnel time (hours spent dealing with RE-related activities that could otherwise have been devoted to control operations). Conceptually this seemed simple and straightforward but turned out to be much more complex than expected using the data we currently have. Therefore we focused upon outcome-based methods in 1998.

Mapping REs/RE database: Another subgroup is developing a RE layer in MapInfo and an object model from which a RE database can be designed. The model includes objects, the relationships between these objects that describes how data are grouped together and the interconnections between data that must be incorporated into the database (or databases) so that specific questions can be answered. Example questions include using MapInfo to indicate all RE properties that could affect a planned treatment. This is conceptually a pictorial way to figure out what the outlining strategy is also trying to measure. A further advantage of the MapInfo database is that it can be used to predict the impact of REs in

"what if?" scenarios.

Results

Outcome based methods: The 1998 customer call database records yielded the outcomes of 3,747 calls categorized into 12 types (Table 7.1). A significant number of calls (619 calls, 16.5%) concerned refused entry requests.

Table 7.1 Types of customer calls received in 1998 (as of 1 November 1998).

Type of Call	Number of Calls	Percent of Total
Tires	366	9.77%
Information	21	0.56%
Larval Breeding	701	18.71%
Adult Mosquito (Private Citizen)	1,835	48.97%
Adult Mosquito (Public Park)	28	0.75%
Adult Mosquito (Events)	149	3.98%
Complaints (Notification)	19	0.51%
Complaints (Information)	9	0.24%
Refused Entry (Citizen)	330	8.81%
Refused Entry (Medical)	47	1.25%
Refused Entry (Environmentalist)	237	6.33%
Refused Entry (Government)	5	0.13%
Total	3,747	100.00%

Table 7.2 Outcomes of calls about larval breeding and adult annoyance affected by REs or label restrictions in 1998.

Type of Call	RE Impacted	Label Restrictions	Not Impacted	Total
Larval Breeding	8	0	693	701
Adult (Private Citizen)	72	135	1,628	1,835
Adult (Public Park)	2	1	25	28
Adult (Events)	5	9	135	149
Subtotal	87	145	2,481	2,713

Label restrictions did not impact the outcome of any call about larval breeding whereas label restrictions impacted a significant number (145 of 2,012 calls, 7.2%) of outcomes of calls about adult mosquito problems (Table 7.2). 1.1% (8 of 701) of outcomes of larval breeding calls and 3.9% (79 of 2,012) of outcomes of adult mosquito annoyance calls were impacted (treatments either curtailed or canceled) by refused entries.

1999 Plans

Describing refused entry effects upon outcomes of other (not related to customer responses) MMCD operations: Because we do not have a way to go back through 1998 treatment records and clearly figure out how many treatments were impacted by a refused entry, an initial way to compare the impact of refused entry sites was to tally them by number of sites and acres. These tallies should be categorized by location (Priority Zone), whether they were first enacted in 1998 or earlier, and by source (private citizen, government agency, cities, private organizations such as nature centers). This should permit us to calculate how much acreage was added in 1998 compared to that already declared refused entry before 1998. The effect can be evaluated by location within the District compared to where treatments are made and theoretical mosquito production from refused entry sites compared to nearby treated sites.

Two issues will need to be decided before the beginning of the 1999 season: (1) what questions about refused entry effects we want to answer in 1999 and (2) what information we need to collect to answer those questions.

7.4 Field map digital conversion

Maps of field sites are an essential tool for MMCD field staff. One of the major projects using GIS tools at MMCD is converting current paper-only field site maps to digital format to allow easy revision and expanded information use. In 1998, staff completed setting up all 6 field offices with digital orthophotos (taken April 1997) and current street data acquired through MetroGIS, set up file structures, and trained field staff for digitizing mosquito breeding site boundaries. For Scott and Dakota counties the digitizing process was expedited by acquisition of existing data from county surveyors. Staff completed the mosquito breeding site entry for the Priority 1 zone by Mar. 1, 1999. In some areas Priority 2 breeding sites and/or adult harborage areas have also been digitized. Some offices used digital maps to help keep track of restricted areas for adult mosquito control treatments in 1998, and more offices will be making use of this in 1999.

In the past, MMCD paid $10,000 to $16,000 for a set of aerial photos. By contributing to MetroGIS, we have cut that cost in half and have a GIS-compatible product that allows new uses. We are continuing discussions with MetroGIS about updated photos for the year 2000. We are also working on how to distribute our digital wetland information to those who request it.

7.5 Digital map use for LaCrosse encephalitis

Field staff used the digital photos available as an aid for neighborhood inspections when responding to the LaCrosse (LAC) encephalitis case reported in 1998. We are also working with Dakota County Environmental Health staff to provide locations of vector populations and LAC prevention activity to link with Dakota County's information to alert residents nearby and examine risk factors.

7.6 Data Management

MMCD's Computer Support and Data Management Team has been working on improving data structures and processes for field data collection. In 1997 and 1998 data entry was done in-house by field staff, which expanded staff's understanding and operational use of electronic data, but also resulted in some data quality issues in 1997, most of which were resolved in 1998. A study of the time and cost of in-house data entry in 1998 showed that, while errors per keystroke were comparable to the promised rates of commercial data entry services, costs (as hourly wage) for some of our major data files were somewhat higher in-house. In 1999, we plan to outsource much of our basic data entry, and are working on plans for improving data quality through more structured error checking, including weekly comparisons of electronic treatment records and physical inventory at all field offices. We are using Business Object Modeling and related data system design tools to evaluate our information needs and guide improvements, including expanding links between mapped data and master site lists and treatment databases.

The increase in calls from customers requesting no adulticide use on their property resulted in an evaluation of our electronic data structures for handling those records. In early 1999 the data structure for this information was revised. In 1999, we are updating the information in those files and plan to coordinate it with digital maps of the properties involved. The GIS system offers the advantage of automatically calculating and drawing buffer areas for these properties.

APPENDIX

Description of Control Materials

Control Material Usage and Acres Treated

Amount of Material Used by Facility or Service 1998

TAB Meeting Notes/Letter to MMCC Chair

Pesticide Labels

Legislative Audit Summary

Appendix 1
Description of Control Materials

The following is an explanation of the control materials currently in use by MMCD. The specific names of products used in 1998 are given. The generic products will not change in 1999, although the specific formulator may change.

ALTOSID® (methoprene) 150-DAY BRIQUETS

(Sandoz Agro-Altosid® XR Extended Residual Briquet)

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

Cattail mosquito (*Cq. perturbans*) breeding sites are treated at 330 briquets per acre in rooted sites or 440 briquets per acre in floating cattail stands. Applications are made in the winter and early spring.

ALTOSID® (methoprene) LIQUID

(Sandoz Agro-Altosid® Liquid Larvicide Concentrate-A.L.L. Liquid)

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

ALTOSID® (methoprene) PELLETS

(Sandoz Agro-Altosid® Pellets)

Altosid® pellets consist of methoprene formulated in a pellet shape. Altosid® pellets are designed to provide up to 30 days control but trials have indicated control up to 40 days. Applications will be made to ground sites (less than 3 acres in size) at a rate of 2.5 lbs. per acre for *Aedes* control and 4-5 lbs. per acre for *Cq. perturbans* control. Applications are also done by helicopter in sites which are greater than three acres in size at the same rate as ground sites, primarily for *Cq. perturbans* control.

***Bacillus thuringiensis israelensis* (*Bti*) CORN COB**

(Abbott Laboratories Vectobac® G; Becker Microbial Aquabac G)

Bti corn cob may be applied in all types of mosquito breeding sites which have targeted mosquito larvae in the water. *Bti* can be effectively applied during the first three instars of the

mosquito breeding cycle. Typical applications are by helicopter in sites which are greater than three acres in size at a rate of 5-10 lbs. per acre. In sites less than three acres, *Bti* may be applied to pockety sites by ground crews with cyclone seeders or power back packs.

***Bacillus thuringiensis israelensis* (*Bti*) LIQUID**

(Abbott Laboratories Vectobac® 12AS; Becker Microbial Aquabac XT)

Bti 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 MDNR. *Bti* is applied at pre-determined sites, usually at bridge crossings (applied from the bridge) or by boat. MMCD will investigate use of *Bti* liquid for mosquito larval control.

PERMETHRIN

(Clarke Mosquito Control Products - Permethrin 57% OS; Vectec- Punt 57 OS)

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

Adult control is initiated when MMCD surveillance (harborage and light trap collections) indicates nuisance populations of mosquitoes, when employee conducted landing rate collections document high numbers of mosquitoes, or when a large number of citizen complaints of mosquito annoyance are received from an area. In the case of citizen complains, MMCD staff evaluate mosquito levels to determine if treatment is warranted. Harborage spraying can also be initiated prior to large outdoor civic events when requested by public officials.

The District mixes permethrin with soybean and food grade mineral oil and applies it to wooded areas with a power backpack mister at a rate of 25 oz. of mixed material per acre (0.1 lb active ingredient per acre)

RESMETHRIN

(AgrEvo Environmental Health - Scourge® 4+12)

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

Appendix 2
Acres Treated with Control Materials Used by MMCD for Mosquito & Black Fly Control for 1991-1998*

Control Material	1991	1992	1993	1994	1995	1996	1997	1998
Altosid® XR Briquet 150-day	10,862	10,376	10,537	8,557	7,303	422	501	371
Altosid® XR Briquet 90-day	0	0	0	0	0	0	0	961
Altosid® Sand-Products	0	625	630	678	871	712	1,096	1,868
Altosid® Pellets 30-day	75	5,689	5,562	5,374	8,212	10,654	8,851	10,432
Altosid® SR-20 liquid	1	3,279	15	13	668	565	1,645	425
Bti Corn Cob granules	134,011	101,877	126,778	102,860	131,589	68,355	106,755	113,538
Bti Liquid Black Fly (gallons)	3,574	4,418	5,090	4,047	3,606	3,025	5,445	4,233
Permethrin Adulticide	22,062	12,812	8,261	10,499	6,305	5,914	6,340	6,164
Resmethrin Adulticide	155,922	48,716	53,345	40,687	61,858	120,472	106,065	65,356

* These values are updated, therefore some values may differ from similar values in earlier publications. The actual geographic area treated is smaller because some sites are treated more than once.

Appendix 3. Control Material Breakdown of Use by Facility

	North	East	West Maple Grove	West Plymouth	South Jordan	South Rosemount	SPRP Research	Total *
150-day XR Altosid Briquets (cases)	31.00	109.00	163.00	59.00	111.00	82.00	0.00	555.00
90-day XR Altosid Briquets (cases)	168.00	172.00	168.00	168.00	168.00	168.00	0.00	1,013.00
30-day Altosid pellets (pounds)	5,192.00	7,678.00	6,556.10	5,126.00	5,038.00	1,707.50	0.00	31,297.70
SR-20 Altosid liquid (ounces)	32.10	84.00	60.00	74.00	75.95	129.60	0.00	528.11
20-day XR-G Altosid granules (pounds)	0.00	879.00	0.00	0.00	0.00	0.00	3,360.00	4,239.00
10-day Altosand granules (pounds)	0.00	0.00	4,000.00	0.00	1,100.00	0.00	0.00	5,100.00
Vectobac Bti Corncob - 40 lb bags (pounds)	164,444.80	151,995.00	177,677.70	156,072.00	109,755.10	65,965.15	6,999.00	832,956.55
Vectobac Bti Corncob - bulk bags (pounds)	6,000.00	2,060.00	5,040.00	0.00	7,140.00	9,540.00	0.00	29,780.00
LarvX Bti Granules (pounds)	0.00	0.00	0.00	780.00	0.00	0.00	0.00	780.00
Laginex Liquid (gallons)	0.00	0.00	0.00	125.00	0.00	0.00	0.00	125.00
Icybac Frozen Bti Granules (pounds)	0.00	33.50	0.00	0.00	0.00	0.00	0.00	33.50
Vectobac Bti Liquid (gallons)	118.70	0.00	1,995.00	107.50	1,805.08	6.17	0.00	4,033.00
Teknar Bti Liquid (gallons)	0.00	0.00	145.00	0.00	55.00	0.00	0.00	200.00
5.7% Permethrin Mixture (gallons)	163.00	204.95	243.50	188.00	279.15	143.38	0.00	1,210.53
Scourge 4+12 Resmethrin ULV (gallons)	201.50	108.50	101.70	104.75	211.75	25.97	0.00	740.60
Anvil 2+2 Sumithrin ULV (gallons)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aqua Reslin Permethrin ULV (gallons)	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.18
Mosquito Beater 4+4 ULV (gallons)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Agnique MMF pupicide (gallons)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01

* Totals might vary slightly from cross column addition due to end of season inventory adjustments and small research quantities used by St. Paul's Technical Services.

Appendix 4
Fall TAB Meeting Notes
Letter to MMCC Chair
Spring TAB Meeting Notes
Legislative Audit Summary

Friday, December 4, 1998

TAB members present:
Vicki Sherry - USF&WS
Dave Belluck - MnPCA
Robert Wryk - MnDOT
David Neitzel - MnDOH (for Craig Hedberg)
Gary Montz - MnDNR
Larry Gillette - Hennepin Parks
Alan Singer - MnDNR (metro division)
Joseph Sanzone - MMCD Director
Robert Sherman - Public member (chair)
Dana Dunklau -- Clark Mosquito Control (for Bill Jany)
Richard Anderson - US EPA
Roger Moon - U of M Entomology Dept.
Dave Noetzel - U of M Professor Emeritus
Art Mason - MnDOA
Susan Palchick - Hennepin Co. Community Health

MMCD staff present:
Jeff Luedeman
Mike McLean
Stephen Manweiler
Nancy Read
Sandy Brogren
Diann Crane
John Walz
Mark Smith
Jim Stark
Janet Jarnefeld

Guests:
Susan Von Mosch, Office of the Legislative Auditor

The meeting was brought to order at 12:30 p.m.
Joe Sanzone gave an introduction and distributed a history of the Technical Advisory Board (attached).

Members introduced themselves and Stephen Manweiler led discussion of the 8-page preliminary overview of 1998 that had been sent to TAB members for review

Vector-borne disease -- Jeff Luedeman described the modifications made to vacuum aspirator. He gave a brief update of the District's response to LaCrosse encephalitis. There was one probable case in the metro area this year. TAB members probed the MMCD tick surveillance program and encouraged MMCD to continue to work with MDH on Lyme disease issues. They asked that additional information comparing Lyme disease and tick surveillance results in the metro area with that in other parts of the state and U.S. be added in the final TAB report.

Mosquito Abundance and Control Program -- Weekly sweep net collection results showed that 1998 was unusual in that high *Ae. vexans* counts in April overlapped with the usual Spring *Aedes* mix of species. TAB members asked how weekly surveillance data were used, and how they compare with previous years. Surveillance data, used along with customer response, site information and treatment history, guide larval and adult control efforts.

Total material usage for the year was presented and showed resmethrin usage was down during 1998 compared to 1997. Lower mosquito numbers required less adulticide use. TAB members and staff discussed the factors used in determining appropriate adulticide use. TAB members asked for more information on the possible impact of refused entry on MMCD's overall control program.

Laginex update -- Stephen Manweiler reported optimism about Laginex field trials. Laginex appears to be more host-specific and lower in cost than current control strategies. TAB members discussed *Laginidium* species host specificity and non-target effects and requested MMCD do further research on the potential of this product.

Wright County Long Term Study (WCLTS) -- Nancy Read reported that the Lake Superior Research Institute has completed processing samples collected during 1998, and results are ready to go to the statistician for analysis. The Natural Resources Research Institute included 18 WCLTS sites in their three-state frog survey. TAB members discussed the findings of long-term studies conducted in other locations in North America.

Black Fly update -- Black Fly treatments continue under DNR permits that set thresholds for treatments in large rivers and small streams. TAB discussed the history of the Black Fly program and how treatment thresholds evolved.

Public Affairs -- Jim Stark gave an overview of Public Affairs activities in 1998 noting that it was a busy year in terms of media placements, customer calls and use of MMCD web site and

adulticide hot line. Results of the biennial Customer Satisfaction Survey and a Focus Group study were presented to the TAB. MMCD has maintained a public awareness rate in excess of 60 percent. TAB members requested a copy of the Focus Group study on notification when it becomes available.

The issue of treatment notification and media coverage in 1998 was discussed. A TAB member suggested that MMCD work with opponents to establish criteria that would bring closure to issues of disagreement.

Black Fly brainstorming session -- While the Black Fly program continues to be successful at reducing adult black fly numbers in the metro area a couple of issues are emerging. Black Fly control coordinator John Walz is concerned that there continues to be high numbers of *S. luggeri* in Anoka County, and that current sampling is underestimating *S. venustum* adults. TAB members' suggestions included: comparing larval and adult counts, establishing human tolerance levels for black fly annoyance, searching the literature and the internet for information on other Black Fly programs, exploring the possibility of control outside District boundaries, and continuing to work closely with the DNR on these issues.

Adulticide Non-Target Research -- Continuing a discussion begun by the TAB last year, Stephen Manweiler presented information from literature currently available on adulticide effects on non-target organisms. TAB suggestions included: Plan to initiate an adult non-target pilot study in 1999, and bring a research proposal to the Spring TAB meeting. MMCD should solicit a group modeled after the Scientific Peer Review Panel to guide the study, explore collaborative research studies, find out what research has already been done. MMCD should consider having someone outside MMCD do the research itself.

A TAB member asked that the upcoming annual report include maps of complaints, larvicide use, and adulticide use to show how adulticides relate to larval control

The following motion was passed without dissent. The TAB affirms that MMCD continues to conduct its mosquito control program with a primary focus on larval control. The TAB endorses this strategy. Note: Gary Montz, DNR representative to the TAB was not present at this point in the meeting.

A TAB member suggested that MMCD explore more intensive *Cq. perturbans* larval control efforts, since this species accounted for the majority of mosquitoes collected during the time period with the peak of phone calls.

Susan Von Mosch, of the Office of the Legislative Auditor, told TAB members that she would send copies of the Program audit (in progress) to TAB members who had been interviewed during the audit.

meeting adjourned at 3:45 p.m.

Robert E. Sherman, Ph.D.
Statistician

2421 Sheridan Avenue South
Minneapolis, Minnesota, 55405

Home Phone (612) 374-1697 E-mail: sherm014@tc.umn.edu

January 18, 1999

Commissioner Randy Johnson, Chair
Metropolitan Mosquito Control Commission
2099 University Avenue West
St. Paul, Minnesota, 55104

Dear Commissioner Johnson:

The MMCD Technical Advisory Board (TAB) met December 4, 1998 to review the MMCD activities of 1998 and its plans for the future. As documented in the attached TAB minutes, MMCD's activities, methods, and focus were actively discussed and generally supported. Particular concerns and constructive suggestions are noted in the minutes. Only one formal motion was made, and it was passed without dissent:

The TAB affirms that the MMCD continues to conduct its mosquito control program with a primary focus on larval control. The TAB endorses this strategy.

Best Regards,

Robert Sherman

Robert E. Sherman, Ph.D.
TAB Chair, 1998-99

TAB minutes, Friday, March 26, 1999 – DRAFT –

TAB members present:
Bill Jany, Clark Mosquito Control
Larry Gillette, Hennepin County Parks
Art Mason, MN DOA
Roger Moon, U of M, Department of Entomology
Richard Anderson, US EPA
Bob Wryk, MN DOT
Susan Palchick, Hennepin County Public Health
David Nietzel, MN DOH
Chris Kane (for Vicki Sherry, USF&WS)
Gary Montz, MN DNR

Guests: Carrie Meyerhoff, Office of Legislative Auditor; Dana Dunklau, Clark Mosquito Control

Staff present: Joe Sanzone; Stephen Manweiler; Nancy Read; John Walz; Jim Stark; Michael McLean; Janet Jarnefeld; Jeff Luedeman

Susan Von Mosch from the Office of Legislative Auditor gave an overview of the 1998 audit of MMCD. VM noted that the presentation she gave was the same one given to the MMCC and to the Legislative Audit Commission (see attached summary of the Audit).

MMCD Director Joe Sanzone noted that MMCD accepted the report as constructive criticism of its operations. Except for the recommendation that the makeup of the commission be changed, MMCD agrees with the overall direction of the report.

Ms. Von Mosch thanked members of the TAB for their cooperation while her team did the audit. She also indicated that changes in MMCD operations will be incorporated in future presentations of this report.

Joseph Sanzone reviewed the history of the TAB and outlined the representation called for in legislation. He said the challenge was to improve communication between the TAB and MMCC. Richard Anderson noted that a Commission member used to be present at TAB meetings to provide that link.

Roger Moon noted that the TAB has three purposes -- which often conflict: 1) Purely technical review of MMCD operations; 2) to represent the mission of the agency each member represents, and 3) a political purpose -- getting people to work together.

Susan Palchick agreed that the technical review goal of the TAB is often lost or given short shrift. Gary Montz announced that Alan Singer -- who represented the environmental group perspective -- is no longer available to serve due to his new job at the DNR. That leaves the TAB without an Environmental Group representative. Roger Moon said that perhaps it was time to give environmental groups a more serious role in the TAB.

Richard Anderson suggested that the TAB be divided into two groups -- one purely technical, the other more public in nature. A public review committee could be established, for instance, which would hold a public meeting.

As recommended by Art Mason, Roger Moon made the following motion, seconded by Larry Gillette: Group or agency members listed in Subdivision Two should develop a Technical Advisory Board (TAB) reorganization plan and present recommendations to the TAB.

The TAB unanimously appointed Susan Palchick to chair the next TAB meeting and lead a subgroup of TAB members to determine an appropriated direction for the group.

The TAB reviewed the draft operational review and made recommendations to modify 1999 operational plans. Stephen Manweiler facilitated discussion of the 1999 operational plans as presented in the draft TAB report.

Larry Gillette suggested that data on public treatment requests and annoyance calls be separated in the TAB report.

Roger Moon noted that better ways must be found to measure the effectiveness of MMCD's education program. It was suggested that Public Service Announcements, for instance, be monitored for effectiveness.

Jeff Luedeman noted that a statistical drop in the number of tires picked up by MMCD has to do with a new way of measuring tires at the recycling facility.

Further reviewing the disease vector control program, Susan Palchick mentioned a need for better characterization of *tarsalis* breeding sites. She recommended that some effort be placed on this during the coming field season. David Neitzel recommended that sentinel chicken flocks continue. Sixty chickens are bled weekly from mid-May to September. Gary Montz asked about what creates good conditions for western encephalitis mosquito production.

Larry Gillette asked about consistency of thresholds used to trigger adult mosquito control. Stephen Manweiler indicated that there are a variety of factors that come into play to decide whether to do adult control. These include human population density and the District's responsibility to people outside the larval treatment area.

New products and testing procedures were discussed. Roger Moon and Gary Montz asked about

the specificity of Laginex and its effect on chironomid midges. Stephen Manweiler noted that 10 years of laboratory and field trials demonstrate no effect on chironomids.

Susan Palchick asked about the variability of rates of application of *Bti* by helicopter. This variability was noted by the Scientific Peer Review Panel (SPRP). Nancy Read responded MMCD responded to SPRP concerns by improving equipment calibration over the past four to five years.

Maintenance of the Restricted Access (RA) database was also discussed. Staff stressed that more formal procedures for adding property to the database were being implemented due to increased requests by members of environmental groups that they be exempted from mosquito control. MMCD has sent a postcard to every address listed on the RA database asking people to renew or change their status.

Meeting adjourned 3:40 p.m.

ABBOTT LABORATORIES

VectoBac® 12AS

Biological Larvicide
Aqueous Suspension

ACTIVE INGREDIENT:

Bacillus thuringiensis, subsp. *israelensis*, 1200 International Toxic Units (ITU) per mg (Equivalent to 4.84 billion ITU per gallon, 1.279 billion ITU per liter)	1.2%
INERT INGREDIENTS	98.8%
TOTAL	100.0%

EPA Reg. No. 275-102
EPA Est. No. 33762-IA-1 List No. 5605

INDEX:

KEEP OUT OF REACH OF CHILDREN

CAUTION

1.0 STATEMENT OF PRACTICAL TREATMENT

If in Eyes: Flush with plenty of water. Get medical attention if signs of irritation persists.

If on Skin: Wash thoroughly with plenty of soap and water. Get medical attention if signs of irritation persists.

2.0 PRECAUTIONARY STATEMENTS

2.1 HAZARD TO HUMANS (AND DOMESTIC ANIMALS)

CAUTION

Hazards to Humans

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.

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 treated, finished drinking water reservoirs or drinking water receptacles.

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.

3.1 Chemigation

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

4.0 STORAGE AND DISPOSAL

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

Storage: Store in cool [59-86° F (15-30° 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: Triple rinse (or equivalent). Then 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.

5.0 APPLICATION DIRECTIONS

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

Mosquito Habitat *(Such as the following examples):*	Suggested Rate Range*
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 - 1 pt/acre

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

CONTINUED

5.0 APPLICATION DIRECTIONS (continued)

*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 SMALL QUANTITY DILUTION RATES

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

	VectoBac 12AS		
Rates in Pints Per Acre	10 Gal/A	25 Gal/A	50 Gal/A
0.25	0.2	0.1	0.04
0.5	0.4	0.2	0.08
1.0	0.8	0.33	0.16
2.0	1.6	0.65	0.32

7.0 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 pts/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.

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

A person knowledgeable of the 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.

8.1 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.

9.0 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.

ABBOTT LABORATORIES

VectoBac® G

Biological Larvicide Granules

Active Ingredient:

Bacillus thuringiensis, subspecies *israelensis*
200 International Toxic Units (ITU) per mg
(Equivalent to 0.091 billion ITU per pound) 0.2%
Inert Ingredients 99.8%
Total 100.0%

EPA Registration No. 275-50
EPA Est. No. 33762-IA-1 List No. 5108

INDEX:

KEEP OUT OF REACH OF CHILDREN

CAUTION

1.0 STATEMENT OF PRACTICAL TREATMENT

If in eyes, flush with plenty of water. Get medical attention if irritation persists.

2.0 DIRECTIONS FOR USE

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

3.0 STORAGE AND DISPOSAL

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

Storage:

Store in a cool, dry place.

Pesticide Disposal:

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

Container Disposal:

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.

4.0 APPLICATION DIRECTIONS

VectoBac G biological larvicide is an insecticide for use against mosquito larvae.

Application Rate for Mosquitoes

Mosquito Habitat	Suggested Range Rate*
(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.	2.5 - 10 lbs/acre
In addition, standing water containing mosquito larvae, in fields growing alfalfa, almonds, asparagus, corn, cotton, dates, grapes, peaches 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.

Do not apply directly to treated, finished drinking water reservoirs or drinking water receptacles.

Apply uniformly by aerial or ground conventional equipment.

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

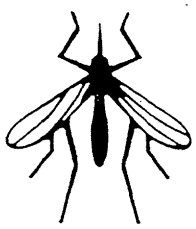
5.0 NOTICE TO USER

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.

Abbott Laboratories – Quality Health Care Worldwide
Agricultural Products, North Chicago IL 60064 (800) 323-9597

AG4916/R1 2/95

Altosid® Liquid Larvicide CONCENTRATE



PREVENTS EMERGENCE OF ADULT FLOODWATER MOSQUITOES

SPECIMEN LABEL

ACTIVE INGREDIENT:

(S)-Methoprene [Isopropyl (2E, 4E, 7S)-11-methoxy-3,7,11-trimethyl-2,4-dodecadienoate]	20.0%
INERT INGREDIENTS:	80.0%
Total	100.0%

Contains 1.72 lb/gal (205.2 g/LITER) active ingredient

EPA Reg No. 2724-446-64833

KEEP OUT OF REACH OF CHILDREN

CAUTION

Because of the unique mode of action of **ALTOSID** Liquid Larvicide Mosquito Growth Regulator, successful use requires familiarity with special techniques recommended for application timing and treatment evaluation. See **Guide to Product Application** or consult local Mosquito Abatement Agency.

PRECAUTIONARY STATEMENTS
HAZARDS TO HUMANS
CAUTION

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

DIRECTIONS FOR USE

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

CHEMIGATION

Refer to supplemental labeling entitled **Guide to Product Application** for use directions for chemigation. Do not apply this product through any irrigation system unless the supplemental labeling on chemigation is followed.

MIXING AND HANDLING INSTRUCTIONS

1. SHAKE WELL BEFORE USING. **A.L.L.**™ may separate on standing and must be thoroughly agitated prior to dilution.
2. Do not mix with oil; use clean equipment.
3. Partially fill spray tank with water, then add the recommended amount of **A.L.L.**, agitate and complete filling. Mild agitation during application is desirable.
4. Spray solution should be used within 48 hours. Always agitate before spraying.

RECOMMENDED APPLICATIONS

INTRODUCTION

A.L.L. must be applied to 2nd, 3rd, or 4th larval instars of **floodwater mosquitoes** to prevent adult emergence. Treated larvae continue normal development to the pupal stage where they die. This insect growth regulator **has no effect when applied to pupae or adult mosquitoes. A.L.L.** has sufficient field life to be effective at recommended rates when applied to larval stages under varying field conditions. For further information, see **Guide to Product Application.**

METHODS OF APPLICATION

AERIAL

Use the recommended amount of **A.L.L.** listed below in sufficient water to give complete coverage. One-half to 5 gals. of spray solution per acre is usually satisfactory. Do not apply when weather conditions favor drift from areas treated.

GROUND

Determine the average spray volume used per acre by individual operators and/or specific equipment. Mix **A.L.L.** in the appropriate volume of water to give the rate per acre recommended on the following page.

APPLICATION RATE

Apply 3/4 to 1 fl. oz. of **A.L.L.** per acre in water as directed.

APPLICATION SITES

CROP AREAS

A.L.L. may be applied to irrigated croplands after flooding to control mosquito emergence. Examples of such sites are vineyards, rice fields (including wild rice), date palm orchards, fruit and nut orchards and berry fields and bogs. Irrigated pastures may be treated after each flooding without removal of livestock.

INTERMITTENTLY FLOODED NONCROP AREAS

A.L.L. may be applied as directed above when flooding may result in floodwater mosquito hatch. Typical sites include freshwater swamps and marshes, salt marshes, woodland pools and meadows, and, dredging spoil sites, drainage areas, waste treatment and settling ponds, ditches and other natural and man-made depressions.

DENSE VEGETATION OR CANOPY AREAS

Apply an **A.L.L.** sand mixture using standard granular dispersal equipment. For detailed preparation instructions, refer to **Guide to Product Application.**

STORAGE & DISPOSAL

Store in cool place, away from other pesticides, food and feed. In case of leakage or spill, soak up with sand or another absorbent material. Triple rinse or equivalent. Then offer for recycling or reconditioning or puncture and dispose of in a sanitary landfill, or incineration, or, if allowed by State and local authorities, by burning. If burned, stay out of smoke. Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility. Do not contaminate water, food or feed by storage or disposal.

For information call 1-800-248-7763

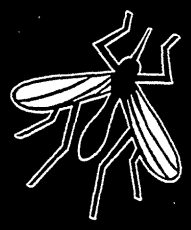
Always read the label before using the product.

SANDOZ
SANDOZ AGRO, INC.
1300 EAST TOUHY AVENUE, DES PLAINES, ILLINOIS 60018

SP-431
ZPP0094

March 1996
Des Plaines, IL

Altosid® PELLETS
MOSQUITO GROWTH REGULATOR



Supplemental Labeling

All label restrictions and Directions for Use of Altosid® Pellets Mosquito Growth Regulator apply. Now Labeled for use in known fish habitats.

ACTIVE INGREDIENTS:

(S)-Methoprene [Isopropyl(2E, 4E, 7S)-11-methoxy-3,7,11-trimethyl-2,4-dodecadienoate]: 4.25%*

INERT INGREDIENTS: *. 95.75%*

TOTAL: *. 100.00%*

**US patents: 3,904,662 and 3,912,815*

KEEP OUT OF REACH OF CHILDREN

CAUTION

EPA Reg. No. 2724-448-64833

PRECAUTIONARY STATEMENTS

ENVIROMENTAL HAZARDS: *This product is toxic to aquatic dipteran (mosquitoes) and chronomid (midge) larvae. Using it in a manner other than that described by the label could result in harm to aquatic dipteran. Do not contaminate water when disposing of rancid or equipment washwaters.*

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

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

GENERAL DIRECTIONS: *ALTOSID Pellets release effective levels of ALTOSID Insect Growth Regulator for up to 30 days under typical environmental conditions. Treatment should be continued through the last brood of the season. Treated larvae continue to develop normally to the pupal stage where they die.*

NOTE: This insect growth regulator has no effect on mosquitoes which have reached the pupal or adult stage prior to treatment.

APPLICATION SITES AND RATES:

MOSQUITO HABITAT	***RATES (Lb/Acre)***
FLOODWATER SITES	
Pastures, meadows, ricefields, freshwater swamps and marshes, salt and tidal marshes, cattail marshes, woodland pools, floodplains, tires, other artificial water-holding containers	*2.5 - 5.0*
Dredging spoil sites, waste treatment and settling ponds, ditches and other manmade depressions	*5.0 -10.0*
PERMANENT WATER SITES	
Ornamental ponds and fountains, fish ponds, cattail marshes, water hyacinth beds, flooded crypts, transformer vaults, abandoned swimming pools, construction and other manmade depressions, treeholes, other artificial water-holding containers	*2.5 - 5.0*
Storm drains, catch basins, roadside ditches, cesspools, septic tanks, waste settling ponds, vegetation-choked phosphate pits	*5.0 - 10.0*

Use lower 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 and/or pollution are high, and mosquito populations are high.

APPLICATION METHODS: Apply ALTOSID Pellets up to 15 days prior to flooding, or at any stage of larval development after flooding or in permanent water sites. Fixed wing aircraft or helicopters equipped with granular spreaders capable of applying rates from 2.5 to 10.0 lb/acre may be used to apply ALTOSID Pellets. The pellets may also be applied using ground equipment which will achieve good, even coverage at the above rates. ALTOSID Pellets may be applied to artificial containers such as tires and catch basins, etc.

STORAGE AND DISPOSAL: Store closed containers of ALTOSID Pellets in a cool, dry place. Do not contaminate water, food, or feed by storage or disposal. Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility. Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, 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, express or implied, concerning the use and handling of this product other than indicated on the label. Buyer assumes all risks of use and handling of this material when such use and handling are contrary to label instructions.

For information, call: 1-800-248-7763.

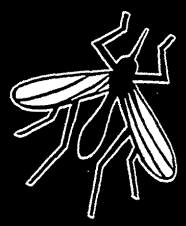
Registrant:

SANDOZ
SANDOZ AGRO, INC.
1300 EAST TOUHY AVENUE, DES PLAINES, ILLINOIS 60018

April1997
Des Plaines, IL

97-24-0061

Altosid® XR
EXTENDED RESIDUAL BRIQUETS



Supplemental Labeling

All label restrictions and Directions for Use of Altosid® XR Extended Residual Briquets apply. Now Labeled for use in known fish habitats.

ACTIVE INGREDIENTS:	
(S)-Methoprene [Isopropyl(2E, 4E, 7S)-11-methoxy-3,7,11-trimethyl-2,4-dodecadienoate]* (Dry Weight Basis):	2.1%
INERT INGREDIENTS:	97.9%
TOTAL:	100.0%

*US patents: 3,904,662 and 3,912,815

This product contains water, therefore the weight of the briquet and percent by weight of active ingredient will vary with hydration. The ingredient statement is expressed on a dry weight basis.

KEEP OUT OF REACH OF CHILDREN

CAUTION

EPA Reg. No. 2724-421-64833

INTRODUCTION: *ALTOSID® XR Briquets are designed to release effective levels of methoprene insect growth regulator over a period up to 150 days in mosquito breeding sites. Release of 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 and Psorophora spp.) from treated water. Treated larvae continue to develop normally to the pupal stage where they die.

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

PRECAUTIONARY STATEMENTS

ENVIRONMENTAL HAZARDS

This product is toxic to aquatic dipteran. Using it in a manner other than that described by the label could result in harm to aquatic dipteran. Do not contaminate water when disposing of rancid or equipment washwaters.

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

APPLICATION TIME: *Placement of ALTOSID XR Briquets should be at or before the beginning of the mosquito season. ALTOSID XR Briquets can be applied prior to flooding when sites are dry, or on snow and ice in breeding sites prior to spring thaw. Under normal conditions, one application should 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 and Psorophora spp.: For control in non-(or low-) flow shallow depressions (≤ 2 feet in depth), treat on the basis of surface area, placing 1 methoprene briquet per 200 ft². Briquets should be placed in the lowest areas of mosquito breeding sites to maintain continuous control as the site alternately floods and dries up.*

Culex, Culiseta and Anopheles spp.: Place one ALTOSID XR Briquet per 100 ft².

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

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, 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, all of the water holding sites in the system should be treated to maximize the efficiency of the treatment program.*

STORAGE AND DISPOSAL:

STORAGE: *Store in a cool place. Do not contaminate water, food, or feed by storage or disposal. Do not reuse empty container.*

DISPOSAL: *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.*

WARRANTY AND CONDITIONS OF SALE: *Seller makes no warranty, express or implied, concerning the use and handling of this product other than indicated on the label. Buyer assumes all risks of use and handling of this material when such use and handling are contrary to label instructions.*

For information, call 1-800-248-7763

SANDOZ
SANDOZ AGRO, INC.
1300 EAST TOUHY AVENUE, DES PLAINES, ILLINOIS 60018

April 1997
Des Plaines, IL

97-24-0060

PERMETHRIN 57% OS

CLARKE

For Application Only By Public Health Officials and Trained Personnel of Mosquito Abatement Districts and Other Mosquito Control Programs. A SYNTHETIC PYRETHROID FOR EFFECTIVE CONTROL AND REPELLENCY OF ADULT MOSQUITOES. For Use As An Effective ULV and Barrier Spray for Control of Adult Mosquitoes, Gnats, Biting and Non-Biting Midges, Blackflies, Deer Flies and Other Biting Flies.

Precautionary Statements

HAZARDS TO HUMANS AND DOMESTIC ANIMALS

CAUTION

Harmful if swallowed or absorbed through skin. Avoid contact with skin, eyes or clothing. Wash thoroughly after handling.

STATEMENT OF PRACTICAL TREATMENT

If Swallowed, call a physician or Poison Control Center. Do not induce vomiting. This product contains aromatic petroleum solvent. Aspiration may be a hazard.

ENVIRONMENTAL HAZARDS

This product is extremely toxic to fish and other aquatic organisms. Do not apply directly to water, to areas where surface water is present or to intertidal areas below the mean high water mark. Drift and runoff from treated areas may be hazardous to aquatic organisms in treated areas. Do not contaminate water when disposing of equipment washwaters. This product is highly toxic to bees. Do not apply this product or allow it to drift to blooming crops or weeds while bees are actively visiting the treatment area.

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.

CONDITIONS and RATES to USE for MOSQUITO CONTROL

FOR A BARRIER SPRAY

This product is effective for reducing mosquito annoyance and control of mosquitoes that may transmit diseases such as La Crosse encephalitis, dog heartworm, denque fever and western encephalitis. Apply product with mist blower, power backpack or ULV machine. If ULV machine is used, adjust pressure to deliver particles from 35-200 microns. Do not allow spray treatment to drift on pasture land, crop land, poultry ranges or water supplies. Do not use on crops used for food, forage or pasture.

Normal use pattern of product requires a residual application on plant and other surfaces where mosquitoes may rest. Product commonly provides sustained control in wooded areas lasting up to 14 days in shaded areas. Secondary activity of product is through repellency. Apply product by ground application equipment such as mist blower, ULV equipment, power backpack or pressure sprayer. Not to be used within 100 feet (30 meters) of lakes and streams. 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 oil-mixture is obtained by mixing one part of soybean oil to two parts of mineral oil. Non-phytotoxic oils must be used. The following chart represents some possible dilutions based on a 2 MPH walking speed with a fifty (50) foot swath. If a different dilution ratio or walking speed is used, adjust flow rate accordingly so as to achieve 0.1 pounds of Permethrin per acre.

For A Two (2) Mile Per Hour Walking Speed And A 50 Foot Application Swath—The Following Are Typical Field Dilutions.

Permethrin 57%	Oil	Fl. oz. Finished Spray Per Acre	Fl. oz./Min.
1 Part	9.0 Parts	25.0	5.0
1 Part	5.8 Parts	17.5	3.5
1 Part	4.0 Parts	12.5	2.5

ACTIVE INGREDIENT:

Permethrin (3-Phenoxyphenyl)methyl (±) cis, trans-3-(2,2-dichlorethenyl)-2,2-dimethyl-cyclopropanecarboxylate	57.00%
INERT INGREDIENTS	43.00%
	100.00%

Contains petroleum distillates.

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

Contains 5 lb./gal. Permethrin

CAUTION

KEEP OUT OF REACH OF CHILDREN

MANUFACTURED BY

CLARKE MOSQUITO CONTROL PRODUCTS, INC.

159 N. GARDEN AVENUE

ROSELLE, ILLINOIS 60172

E.P.A. EST. No. 8329IL01

EPA Reg. No. 8329-44

NET CONTENTS _____

NOTICE: Seller makes no warranty, expressed or implied concerning the use of this product other than 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.

This is equivalent to 0.1 lb. of Permethrin/Acre. Apply the product with sufficient carrier to allow distribution over the area to be treated using particle sizes from 35-200 microns mmd. To obtain optimum results, cover the immediate surroundings of housing, buildings including plant surfaces where mosquitoes may rest. For large recreational areas such as football fields, stadiums, racetracks, and public parks, spray the insecticide-oil mixture at the above mentioned application rate on the interface of woods surrounding the main area where the event is to take place. Spray may also be applied in any vegetated area where mosquitoes may rest causing infestations in residential areas.

To Kill Gypsy Moths and Tentcaterpillars infesting woodland and forest areas: Apply the insecticide-oil mixture (as described above) directly to insect nests and vegetation by backpack applicator using 62 Fl. Oz./acre at a walking speed of 2 MPH over a swath of 50 feet, applying 12.6 Fl. Oz./minute. This is equivalent to 0.25 lb. of Permethrin/acre. Apply thoroughly to all foliage and insect nests.

TRUCK MOUNTED -ULV- EQUIPMENT

PERMETHRIN 57% is recommended for application as an ultra low volume (U.L.V.) nonthermal aerosol (cold fog) to control adult mosquitoes in residential and recreational areas where these insects are a problem, such as but not limited to, parks, campsites, woodlands, athletic fields, golf courses, residential areas and municipalities, gardens, playgrounds, recreational areas and overgrown vacant lots. Do not apply this product within 100 feet (30 Meters) of lakes and streams. Do not allow spray treatment to drift on pasture land, cropland, poultry ranges, or water supplies. For best results treat when mosquitoes are most active and weather conditions are considered to keeping the fog close to the ground, e.g. cool temperatures and wind speed not greater than 10 mph. Applications during the cool hours of the night or early morning is usually preferable. Repeat treatment as needed.

U.L.V. Nonthermal Aerosol (Cold Fog) Application: To control Mosquitoes, Midges and Blackflies, apply PERMETHRIN 57% using any standard U.L.V. ground applicator capable of producing a nonthermal aerosol spray with droplets ranging in size from 5 to 30 microns and a mass median diameter (MMD) of 10 to 20 microns. Apply the product undiluted at a flow rate of 0.54 to 3.25 fluid ounces per minute at an average vehicle speed of 10 mph. If a different vehicle speed is used, adjust rate accordingly. These rates are equivalent to 0.0035 to 0.021 pounds of Permethrin per acre. Vary flow rate according to vegetation density and mosquito population. Use higher flow rate in heavy vegetation or when populations are high. An accurate flow meter must be used to ensure the proper flow rate. PERMETHRIN 57% may also be applied by diluting with a suitable solvent such as a non-phytotoxic mineral oil. The following charts represent some suggested dilution and application rates for ground U.L.V. applications. If an alternate dilution rate is used, adjust flow rate accordingly.

FOR A 1:4 PERMETHRIN 57%/SOLVENT DILUTION RATIO

Mix one (1) part PERMETHRIN 57% with four (4) parts solvent and apply at the following rates.

Permethrin pounds/acre	Application Rates Fl. oz./Min. 5MPH	10MPH	15MPH	Fl. oz. finished spray per acre
0.007	2.70	5.40	8.1	0.90
0.0035	1.35	2.70	4.0	0.45
0.00175	.68	1.35	2.0	0.23

FOR A 1:9 PERMETHRIN 57%/SOLVENT DILUTION RATIO

Mix one (1) part PERMETHRIN 57% with nine (9) parts solvent and apply at the following rates.

Permethrin pounds/acre	Application Rates Fl. oz./Min. 5MPH	10MPH	Fl. oz. finished spray per acre
0.007	5.40	10.75	1.80
0.0035	2.70	5.40	0.90
0.00175	1.35	2.70	0.45

FOR A 1:14 PERMETHRIN 57%/SOLVENT DILUTION RATIO

Mix one (1) part PERMETHRIN 57% with fourteen (14) parts solvent and apply at the following rates.

Permethrin pounds/acre	Application Rates Fl. oz./Min. 5MPH	10MPH	15MPH	Fl. oz. finished spray per acre
0.007	8.0	16.0	32.0	2.70
0.0035	4.0	8.0	16.0	1.35
0.00175	2.0	4.0	8.0	0.68

For proper application, mount the fog applicator so that the nozzle is at least 4½ feet above ground level and directed out the back of the vehicle. Failure to follow the above directions may result in reduced effectiveness. Aerial applications should be done by suitable aerial U.L.V. equipment capable of producing droplets with an MMD of 50 microns or less with no more than 2.5% exceeding 100 microns. Flow rate and swath width should be set so as to achieve 0.2 to 0.6 fluid ounces of PERMETHRIN 57% per acre. PERMETHRIN 57% may also be diluted with a suitable diluent such as mineral oil and applied by aerial ULV equipment so long as 0.6 fluid ounces per acre of PERMETHRIN 57% is not exceeded. Both aerial and ground applications should be made when wind is loss than 10 MPH.

IN FLORIDA: Do not apply by aircraft except in emergency situations and with the approval of the Florida Department of Agriculture and Consumer Services.

STORAGE & DISPOSAL

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

PESTICIDE STORAGE AND SPILL PROCEDURES: Do not store at temperatures below 40°F (4.5°C). If this material has been exposed to temperatures below 40°F (4.5°C), 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 on site or at an approved waste disposal facility.

CONTAINER DISPOSAL: Triple rinse (or equivalent) then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or by other approved state and local procedures.

CONTAINERS ONE GALLON AND SMALLER: Do not reuse container. Wrap containers in several layers of newspapar and discard in trash.

CONTAINERS LARGER THAN ONE GALLON: Metal Containers—Triple rinse or equivalent. Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or by other procedures approved by state and local authorities. Plastic Containers—Triple rinse or equivalent. Then offer for recycling or reconditioning, 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. Then dispose of in a sanitary landfill or by other approved state and local procedures.

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

1/95

AgrEvo

RESTRICTED USE CLASSIFICATION
Due to Acute Fish Toxicity
For retail sale to and use only by Certified Applicators or persons under their direct supervision and only for those uses covered by the Certified Applicators Certification.

SCOURGE®
INSECTICIDE

with SBP-1382*/PIPERONYL BUTOXIDE 4% + 12% MF
FORMULA II

- *A READY TO USE SYNTHETIC PYRETHROID FOR EFFECTIVE ADULT MOSQUITO (INCLUDING ORGANOPHOSPHATE RESISTANT SPECIES), MIDGE (BITING AND NON-BITING), AND BLACK FLY CONTROL*
- *TO BE APPLIED BY MOSQUITO ABATEMENT DISTRICTS, PUBLIC HEALTH OFFICIALS AND OTHER TRAINED PERSONNEL IN MOSQUITO CONTROL PROGRAMS.*
- *CONTAINS 0.3 lb/gal (36 g/L) OF SBP-1382 AND 0.9 lb/gal (108 g/L) OF PIPERONYL BUTOXIDE*
- *FOR AERIAL AND GROUND APPLICATION*

ACTIVE INGREDIENTS:

* Resmethrin	4.14%
**Piperonyl Butoxide Technical	12.42%
INERT INGREDIENTS†:	83.44%
	100.00%

Cis/trans isomers ratio: max. 30% (±) cis and min. 70% (±) trans. AgrEvo Environmental Health, Inc.'s SBP-1382 brand of resmethrin insecticide.
**Equivalent to 9.94% (butylcarbityl) (6-propyl piperonyl) ether and 2.48% related compounds.
†Contains Petroleum Distillates.
*Scourge and SBP-1382 are registered trademarks of AgrEvo Environmental Health, Inc.

PRECAUCION AL CONSUMIDOR: Si usted no lee ingles, no use este producto hasta que la etiqueta le haya sido explicada ampliamente.
(TO THE USER: If you cannot read English, do not use this product until the label has been fully explained to you.)

EPA REG. NO. 432-716 **EPA EST. NO.**

KEEP OUT OF REACH OF CHILDREN
CAUTION
STATEMENT OF PRACTICAL TREATMENT

IF SWALLOWED: Call a doctor or get medical attention. Do not induce vomiting. Do not give anything by mouth to an unconscious person. Avoid Alcohol. This product contains aromatic petroleum solvent. Aspiration may be a hazard.
IF ON SKIN: Wash with soap and plenty of water. Get medical attention.

See Side Panel For Additional Precautionary Statements

NET CONTENTS:

716rest Q072798tk

PRECAUTIONARY STATEMENTS
Hazards To Humans & Domestic Animals

CAUTION
Harmful if swallowed or absorbed through skin. Avoid contact with skin, eyes, or clothing. Wash thoroughly with soap and water after handling.

Environmental Hazards

This pesticide is highly toxic to fish. For terrestrial uses, do not apply directly to water, to areas where surface water is present or to intertidal areas below the mean high water mark. Drift and runoff from treated sites may be hazardous to fish in adjacent waters. Consult your State's Fish and Wildlife Agency before treating such waters. Do not contaminate water by cleaning of equipment or disposal of equipment wash waters.

DIRECTIONS FOR USE

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

STORAGE AND DISPOSAL

Do not contaminate water, food or feed by storage or disposal.
Storage: Store product in original container in a locked storage area.
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: Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or by other procedures approved by State and Local authorities.

READ ENTIRE LABEL FOR DIRECTIONS
For use only by certified applicators or under the supervision of such applicators, for the reduction in annoyance from adult mosquito infestations and as a part of a mosquito abatement program.

IN THE STATE OF CALIFORNIA: For use only by local districts or other public agencies which have entered into and operate under a cooperative agreement with the Department of Public Health pusuant to Section 2426 of the Health and Safety Code.

This product is to be used for control of adult mosquitoes (including organophosphate resistant species), midges (biting and non-biting) and blackflies by specially designed aircraft capable of applying ULTRA LOW VOLUME of finished spray formulation or by ground application with nonthermal or mechanical spray equipment that can deliver spray particles within the aerosol size range and at specified dosage levels.

NOTICE: This concentrate cannot be diluted in water. Mix well before using. Avoid storing excess formulation in spray equipment tank beyond the period needed for application.

ULTRA LOW VOLUME APPLICATIONS
For use in nonthermal ULV portable backpack equipment similar to the Hudson B.P., mix 70 fl oz (2068 ml) of this product with 1 gal (3.79 L) of refined soybean oil, light mineral oil of 54 second vis-

cosity or other suitable solvent or diluent. Adjust equipment to deliver fog particles of 18-50 microns mass median diameter. Apply at the rate of 4.25-8.50 fl oz of finished formulation per acre (311-621 ml/ha) as a 50 ft (15.2 m) swath while walking at a speed of 2 mph (3.2 kph). This is equivalent to 0.0035-0.0070 lb ai SBP-1382/A (3.92- 7.85 gm/ha) plus 0.0105- 0.0210 lb ai piperonyl butoxide tech./A (11.77-23.54 gm/ha). Where dense vegetation is present, the higher rate is recommended.

For truck mounted nonthermal ULV equipment similar to LECO HD or MICRO-GEN or WHISPERMIST-XL, adjust equipment to deliver fog particles of 8-20 microns mass median diameter. Consult the following chart for application rates.

Treatment lb ai/A of Scourge Wanted SBP-1382/PBO	Fl oz/A of Undiluted Spray to be Applied	Application Rate-Fl oz/Min	
		5 MPH	10 MPH
0.007/0.021	3.0(90 ml)	9.0(266.2ml)	18.0(532.3ml)
0.0035/0.0105	1.5(45 ml)	4.5(133.1 ml)	9.0(266.2 ml)
0.00175/0.00525	0.75(22.5 ml)	2.25(66.6 ml)	4.5(133.1 ml)
0.00117/0.00351	0.50(15 ml)	1.50(45 ml)	3.0(90 ml)

Where dense vegetation is present, the use of the higher rates and/or slower speed is recommended.

For best results, fog only when air currents are 2-8 mph (3.2-12.9 kph). It is preferable to fog during early morning and evening when there is less breeze and convection currents are minimal. Arrange to apply the fog in the direction with breeze to obtain maximum swath length and better distribution. Direct spray head of equipment in a manner to insure even distribution of the fog throughout the area to be treated. Avoid prolonged inhalation of fog.

Where practical, guide the direction of the equipment so that the discharge nozzle is generally maintained at a distance of more than 6 feet (1.83 m) from ornamental plants and 5-15 feet (1.5-4.5 m) or more from painted objects. Temperature fluctuations will require periodical adjustment of equipment to deliver the desired flow rate at the specified speed of travel. The flow rate must be maintained to insure the distribution of the proper dosage of finished formulation.

Spray parks, campsites, woodlands, athletic fields, golf courses, swamps, tidal marshes, residential areas and municipalities around the outside of apartment buildings, restaurants, stores and warehouses. Do not spray on cropland, feed or foodstuffs. Avoid direct application over lakes, ponds and streams.

DIRECTIONS FOR STABLE FLY, HORSE FLY, DEER FLY CONTROL:
Treat shrubbery and vegetation where the above flies may rest. Shrubbery and vegetation around stagnant pools, marshy areas, ponds and shore lines may be treated. Application of this product to any body of water is prohibited.

For control of adult flies in residential and recreational areas, apply this product undiluted at a rate of 178 fl oz/hr (5.26 L/hr) by use of a suitable ULV generator travelling at 5 mph (8 kph) or at a rate of 356 fl oz/hr (10.53 L/hr) while travelling at 10 mph (16 kph). When spraying, apply across wind direction approximately 300 ft (91.4 m) apart.

Apply when winds range from 1-10 mph (1.6-16.0 kph). Repeat effective control.

DIRECTIONS FOR AERIAL APPLICATIONS
FOR USE WITH FIXED-WING AND ROTARY AIRCRAFT

This product is used in specially designed aircraft capable of applying ultra low volume of undiluted spray formulation for control of adult mosquitoes (including organophosphate resistant species), midges (biting and non-biting) and blackflies.

Aerial application should be made preferably in the early morning or evening. Application should be made preferably when there is little or no wind.
It is not recommended to make application when wind speeds exceed 10 mph (16 kph). Repeat applications should be made as necessary. Apply preferably when temperatures exceed 50°F (10°C).

May be used as a mosquito adulticide in recreational and residential areas, and in municipalities, around the outside of apartment buildings, golf courses, athletic fields, parks, campsites, woodlands, swamps, tidal marshes, and overgrown waste areas.

Do not spray on cropland, feed or foodstuffs. Avoid direct application over lakes, ponds and streams.

APPLICATION INSTRUCTIONS FOR PRODUCT IN AIRCRAFT USAGE

lb ai/A Wanted SBP-1382/PBO	**Fl oz/A of Undiluted Spray to be Applied**
0.007/0.021	3.0 (90 ml)
0.0035/0.0105	1.5 (45 ml)
0.00175/0.00525	0.75 (22.5 ml)
0.00117/0.00351	0.50 (15 ml)

NOTICE: Buyer assumes all responsibility for safety and use not in accordance with directions.

AgrEvo Environmental Health
95 Chestnut Ridge Road
Montvale, NJ 07645

Mosquito Control District Performance Is Mixed

SUMMARY

The Metropolitan Mosquito Control District uses approved and registered insecticides, and generally has applied them according to label instructions. However, a report issued by the Legislative Auditor's Office identifies concerns with the District's adult mosquito treatment policies and practices among other things.

The Metropolitan Mosquito Control District is responsible for controlling mosquitoes and black flies and monitoring disease-carrying ticks in the Twin Cities area. The District uses *Bti*, a natural soil bacteria, to kill mosquito larvae. It also uses products containing methoprene, a growth regulator that stops mosquito larvae from hatching into adults. Finally, it sprays synthetic chemicals (resmethrin and permethrin) to kill adult mosquitoes.

After a review of U. S. Environmental Protection Agency documents and scientific literature, the study concluded that *Bti* and methoprene pose little risk to people and most nontarget species. While resmethrin and permethrin have the potential to harm other types of insects, they should not be harmful to humans or the environment if properly applied.

The District's 1998 budget of $8.6 million was financed primarily from property taxes. In 1998, the District employed 47 full-time staff and 164 seasonal staff, most of whom provided mosquito control services from regional offices. The District treated almost 197,500 acres with insecticides in 1998, a 15 percent reduction from 1997. Treatment of mosquito larval breeding acres represented 64 percent of all acres treated in 1998. Drier weather conditions allowed the District to reduce the number of acres it treated with insecticides to kill adult mosquitoes by 37 percent in 1998.

A review of the District's treatment data showed that in 1998 the District applied insecticides only after pretreatment counts of mosquito larvae or adults indicated that treatments were necessary. However, the study also found that the District provided adult mosquito treatments for some for-profit enterprises and private functions in 1998, contrary to its adult mosquito treatment policy. The report recommends that the District review and clarify its policy for providing adult mosquito treatments to for-profit enterprises.

Since 1982, state law has given private landowners the right to refuse the District access to their property. The study found that language in state law on the District's access to *public property* is unclear and contradictory. State law gives the District access to any property "subject to the paramount control of the county and state

Program Evaluation Report

Metropolitan Mosquito Control District

January 14, 1999

Key Findings:

- Contrary to its policy, the District provided adult mosquito treatments to some for-profit enterprises and private functions in 1998.
- The effectiveness of most larval insecticides used by the District has been reasonable, but it has been inconsistent for others.
- Language in state law on the District's access to public property is unclear and contradictory.

Recommendations:

- The Metropolitan Mosquito Control Commission should adopt a clear, comprehensive adult mosquito treatment policy and the District should ensure that its practices conform with its policy.
- The District should reevaluate the effectiveness and future use of methoprene products used to kill floodwater mosquito larvae and insecticides used to kill adult mosquitoes.
- The Legislature should clarify whether the Department of Natural Resources should have the right to refuse treatment on its land.

The report is available at our web site:
http://www.auditor.leg.state.mn.us/pe9903.htm
Copies of the full report or summary are also available by calling 651/296-4708.

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authorities," but it requires the Commissioner of Natural Resources to allow the District on Department of Natural Resources (DNR) property for mosquito control purposes. While state law allows counties and state authorities the right to determine what mosquito control activities occur on their land, its removes that right from DNR. The report suggests that the Legislature consider clarifying this language.

The District determines how well it controls mosquitoes overall by testing the effectiveness of the insecticides it uses. The study found that some of the insecticides used by the District killed a reasonable number of mosquito larvae—between 78 and 99 percent depending on the insecticide and how it is used. However, the effectiveness of methoprene products used to kill floodwater mosquitoes has been inconsistent. In addition, research by the District in 1996 showed that the insecticides used to kill adult mosquitoes reduced adult mosquito populations by an average of 57 percent. The report recommends that the District examine how it measures the effectiveness of methoprene products used to kill floodwater mosquitoes and insecticides used to kill adult mosquitoes and use the results of these studies to reevaluate the continued use of these products.

The District has used a telephone information line, web site, press releases, telephone calls to individuals, and signs posted on public land to notify the public of mosquito control activities and adult insecticide applications. In 1998 the District also placed an advertisement in newspapers and left posted notices up longer than in the past. The report recommends that the District should continue the level of public notification provided in 1998. It also suggests that the District exercise care to present the most accurate information possible to the public.

The District is currently governed by a 17-member commission composed of county commissioners appointed annually by their respective county boards. The study considered several alternative governance structures for the commission. Although the report does not recommend a major restructuring at this time, it suggests that the Legislature consider changing the composition and reducing the size of the commission.

Copies of the report, entitled *Metropolitan Mosquito Control District*, may be obtained from the Office of the Legislative Auditor at 651/296-4708 or at http://www.auditor.leg.state.mn.us/pe9903.htm. For further information, contact Susan Von Mosch or Roger Brooks at 651/296-4708.

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