

INTRODUCTION TO ENVIRONMENTAL MOSQUITO MANAGEMENT

To control insect pests during the 1960's and 70's, pest control operators and farmers in both urban and agricultural environments leaned heavily toward the use of chemical insecticides. Pesticides have resulted in many astounding successes in controlling human insect-borne diseases, in the dramatic increase in food production worldwide, and in improving the quality of life for billions of people. However, this heavy reliance on chemicals has also spurred major concerns about the safety of these chemicals toward man and the natural environment. These sometimes real, and sometimes perceived environmental concerns have led to a major practical and philosophical shift toward the concept of Integrated Pest Management (IPM). There are several accepted definitions for IPM, here are two of the best:

Integrated Pest Management:

"A process consisting of the balanced use of cultural, biological, and chemical procedures that are environmentally compatible and economically feasible to reduce pest populations to a tolerable level"

"To control insect pests in a efficient, and economic manner while preventing damage to humans, wildlife and the natural environment"

Recent developments in mosquito control, include biological larvicides, ultra-low volume (ULV) application of adulticides at low dosages, computer technologies, and field control strategies which have provided the necessary tools to allow the implementation of a true Integrated Pest Management Program in Fenton Township.

By combining these tools with data that has been gathered in the Township over the past twenty years, Advanced Pest Management can continually refine an IPM approach, called Environmental Mosquito Management (EMM). The EMM process places an emphasis on survey and mapping, population monitoring, and intensive larval mosquito control using computer technology to target the use of biological controls. The adult mosquito control component will involve the careful and strategic application of rapidly biodegradable, ultra-low-volume materials when population thresholds are reached.

The objectives of the 2006-2009 Fenton Township EMM Program are to reduce nuisance mosquito populations to a pre-defined acceptable level, and to reduce the potential for the transmission of mosquito-borne disease, thereby improving the comfort, health and overall quality of life for the residents of Fenton Township.

EMM SURVEILLANCE AND MONITORING

Defining the distribution, density, and species makeup of a target mosquito population in relation to human populations is essential to the success of a program that is attempting to control nuisance and/or disease carrying mosquitoes. Several tools and techniques exist and are used within the Fenton Township Program.

New Jersey Light Trap Network. A major tool in any mosquito control program is a mosquito trapping device called a New Jersey Light Trap. This trap was developed in the mid-1930's and has been the standard tool for monitoring mosquito population levels, density, and species makeup for almost sixty years. Three traps are operated within the Township as part of a local network of 10 traps.

Aedes vexans Brood Prediction. The *Aedes vexans* mosquito is the primary nuisance mosquito throughout the Midwest. It is commonly called the floodwater mosquito because the female lays her eggs on dry ground, in flood prone areas. When a heavy rainfall occurs, the eggs become immersed, and this triggers the eggs to hatch. Unhatched eggs can lie dormant for several years. A period of heavy rains can cause a major hatch of millions of eggs all at the same time, leading to a population explosion and severe human annoyance. Another problem with these mosquitoes is their ability to migrate 15 to 20 miles in search of a blood meal. Advanced Pest Management has developed a degree-day model which uses rainfall and temperature data to accurately predict outbreaks of these mosquitoes. APM can then utilize this prediction, confirmation from the Light Traps and citizen input, to precisely time adult mosquito control operations.

Mosquito-borne Disease Monitoring. In 1975 a massive epidemic of St. Louis Encephalitis occurred in the United States in which nearly 2,000 cases were diagnosed, and 142 deaths were reported. Michigan reported 93 cases with 3 deaths. During the summers of 1991 and 1993 large outbreaks of Eastern Equine Encephalitis (EEE) occurred in south central Michigan. During the summers of 1997 and 1998 one fatality was reported as a result of (EEE). The latest disease to hit Michigan is the West Nile Virus (WNV). 574 positive cases were documented in Michigan in 2002, of which 48 were fatal. The primary carrier of WNV is the *Culex* mosquito, however there have been positive pools of *Aedes vexans* as well as other species. In 2004 Michigan reported 19 human cases of which none were fatal. The potential for mosquito-borne encephalitis certainly exists in the state. Advanced Pest Management communicates regularly with MSU, Bay, Midland, Saginaw, and Tuscola, Counties, other state agencies and with the Centers for Disease Control for updates on the potential for mosquito-borne disease transmission.

Weather Monitoring. Climatological data and daily weather conditions are critical factors in the monitoring and control of mosquitoes. As discussed earlier, rainfall and temperatures play a vital role in the hatch and development of *Aedes vexans* and other mosquitoes. Daily wind patterns, precipitation and temperatures have a great impact on operational activities. For these reasons APM keeps in close contact with the local National Weather Service Office for weather updates, predictions and climatological statistics.

EMM LARVAL MOSQUITO CONTROL

The foundation and focus of the Fenton Township EMM Program is the environmentally sensitive control of mosquito larvae within the community's boundaries. Effective control of larvae will prevent their development into adult mosquitoes, and therefore, reduce the need for adult mosquito control activities. The key to environmentally oriented larval control is the organization and classification of active and potential larval development sites.

Initially APM performs a survey to systematically map all potential mosquito development sites within a community. For each mapped site, the acreage is determined, and a reference number and habitat type are assigned. The community's site information is then input into a database to establish one of two fundamental CMMS files. The second file contains a detailed breeding History for each site. The historical database includes information on which sites have actually produced larvae, the time of the season, the frequency of larval occurrence, and the species found in each site. Over the initial three year period of database development, the site history file is filled with all the information gathered during routine site inspection and larviciding services. After the initial three year development period, using an interaction between the site information file and the site history file, APM can produce a field inspection and control strategy for each site within the community. The sites are split into two categories; non-breeding and targeted. The non-breeding sites are considered a low-priority, and monthly inspections will maintain the database for these sites. The sites with a history of producing mosquitoes will be targeted for intensive field inspections and subsequent appropriate larval control measures.

Just as no one medicine is prescribed for all illnesses, no one larvicide is suitable for the control of all mosquito species in every type of habitat. The CMMS system allows APM to do "prescription larval control" for each individual site. This strategy is based on habitat type, and species history. Permanent water targeted sites are monitored throughout the season and sometimes treated with Vectolex CG a naturally occurring soil bacteria that gives approximately 30 days control. Intermittently wet/dry prolific breeding sites are also targeted with Vectolex CG, and the balance of targeted sites that are listed as potentially requiring larviciding at some point during the season can be addressed with Bti granular. The community's CMMS is updated and fine-tuned continuously throughout the entire mosquito season.

APM's Computerized Mosquito Management System (CMMS) provides a cost-effective, site specific, "Prescription-Oriented" plan that prioritizes field operations and reduces costly inspections and unwarranted insecticide use. The CMMS system allows the mosquito control program to become much more environmentally sensitive, because the use of biological control is encouraged, and only minimum doses are required to maintain good control. The CMMS program is an indisputably effective tool in the Fenton Township Environmental Mosquito Management Program.

APM'S "PRESCRIPTION ORIENTED" LARVICIDES

Effective larval control can be achieved within the EMM framework by using only the most environmentally-sound and cost-effective materials currently available.

1. *Bacillus thuringiensis israeliensis* (Bti) is an organic biological insecticide derived from a naturally occurring soil bacteria. Bti is a species specific material that will only affect mosquito and black fly larvae. Activated by the specific pH in the gut of the larvae, the bacterially produced crystalline spore of Bti will, after being eaten by the larvae, destroy the digestive tract and kill the larvae, thus precluding development through the pupal stage to adulthood. The Bti product is formulated on a corncob granular carrier and is applied at the label rate of 5 lbs. per acre.

2. *Bacillus sphaericus*, (Bs) commonly called Vectolex is an organic biological insecticide derived from a naturally occurring soil bacteria. Vectolex is a species specific material that will only affect mosquito and black fly larvae. Activated by the specific pH in the gut of the larvae, the bacterially produced crystalline spore of Bti will, after being eaten by the larvae, destroy the digestive tract and kill the larvae, thus precluding development through the pupal stage to adulthood. Vectolex is very similar to Bti, however it is able to live longer than Bti and is typically used in more polluted breeding sites with higher organic content.

3. *Altosid IGR Briquets and pellets* (methoprene) are products with the active ingredient methoprene which is an IGR (insect growth regulator). Altosid is an analog of the mosquito's juvenile growth hormone. Altosid interferes with normal metamorphosis, thus preventing the immature mosquito from emerging as an adult.

Due to their relatively high cost the briquets are used primarily in open street catchbasins. Open street catchbasins are considered to be the primary source of *Culex* mosquitoes in residential areas. *Culex* mosquitoes are the vectors of St. Louis and other Encephalitis type diseases. In the EMM program all open catchbasins in the community will be treated using Altosid Briquets three times during the mosquito season, late June, July and August to suppress *Culex* mosquitoes during the key encephalitis virus amplification period.

4. *Source Reduction Recommendations.* As a part of our routine visual site inspections, APM inspectors will often note such areas as clogged ditches and streams, neglected swimming pools, and illegal tire and trash dump sites which are potential public health hazards. APM will outline these problems in our monthly reports, and is always available to assist local code enforcement officials in the location and identification of these sites.

EMM ADULT MOSQUITO CONTROL

The adult mosquito management portion of the EMM Program consists of two phases: Harborage Site Adulticiding and General Residential Adulticiding. The goal here is to concentrate control efforts in adult mosquito harborage areas with high humidity gradients such as stream or river valleys, margins of thick woodlots, and densely vegetated parks and recreational areas, away from the human population. The dispersal of the adult mosquito population into residential areas can be greatly reduced by applying adulticide materials into the harboring areas where adult mosquitoes congregate. As a result, general residential adulticiding can be limited to periods of excessively high annoyance, or during a public health emergency.

1. **Harborage Site Adulticiding.** Harborage areas can be defined as cool, humid spots where adult mosquitoes congregate during sunny, dry periods during daylight hours, before undertaking localized feeding flights at dusk. Species of mosquitoes with short flight ranges, such as *Aedes stimulans*, *Culex pipiens* and others, may be permanent residents of these harborage areas, while other species with longer flight ranges, such as *Aedes vexans*, often use these harborage areas as daytime stopovers during migration.

The treatment of harborage areas can be accomplished in several ways using either residual or non-residual adulticides. **Residual Treatment.** The treatment of harborage areas with residual materials has previously been called perimeter barrier application. The treatment of dense harborage vegetation with residual materials not only gives immediate control of existing adult mosquitoes but will prevent the rapid reinfestation of the harborage and adjacent residential areas. This type of application is usually accomplished by power backpack or truck-mounted mistblower sprayers. The material of choice here is generally a emulsifiable pyrethroid insecticide such as Tempo. **Non-residual Treatment.** Harborage site adulticiding can also be accomplished using truck-mounted ULV equipment to apply non-residual aerosol materials such as Biomist 3+15, Anvil 2+2, or Mosquitomist 1.5. However, residual treatments offer the considerable advantage of reduced reinfestation.

2. **General Residential Adulticiding.** During the course of a normal mosquito season, numerous large broods of *Aedes vexans* floodwater mosquitoes will periodically migrate into a community and override the local larviciding and harborage control efforts. In these cases General Residential ULV Adulticiding is the only effective means to reduce the local mosquito populations below an acceptable level. The decision to spray will be based only on the adherence to 20 females per trap per night, and/or the recognition of a severe nuisance problem generated by citizen complaints. To obtain the optimum effectiveness, the scheduling of the ULV application will depend on appropriate weather conditions, light trap counts, and resident input. The material of choice will be either Mosquitomist 1.5, Biomist 3+15, or Anvil 2+2. Mosquitomist 1.5 is an organophosphate insecticide, which has been used in the Fenton Township program effectively for over fifteen years. Biomist and Anvil are synthetic pyrethroid insecticides offering, low odor, rapid biodegradation, and excellent mosquito mortality. These materials will be applied using ultra-low-volume (ULV) techniques and in strict compliance with all U.S. EPA, Michigan Dept. of Agriculture regulations.

Pre-Spray Operational Procedures. Prior to starting a General Residential Adulticide Application, APM will contact those community residents that have health, environmental or philosophical concerns about the spraying and have requested that they be notified. A minimum of three attempts to reach each of these residents will be made between the hours of 12 noon and 9 P.M. prior to the spray application. Also, upon request, addresses will be staked and marked on APM's operational maps, and the ULV insecticide will be "shutoff" in front of, and upwind from, these properties.

ULV Equipment. Advanced Pest Management uses industry standard ULV sprayers. The efficiency of ULV spraying depends upon the proper droplet size output. All APM ULV sprayers are routinely calibrated and tested for proper operation.

Quality Control. All adult mosquito control operations will be monitored by various methods including; New Jersey light trapping results, and detailed monitoring of insecticide usage through equipment calibration and inventory depletion.

GENERAL SERVICES DESCRIPTION

All General Services are quoted for the 2006-2009 seasons at no charge, and are included as part of the total service package.

1. GENERAL LIABILITY/AUTO/WORKER COMPENSATION INSURANCE COVERAGE

Comprehensive \$1,000,000 (\$1 Million) per occurrence General Liability, Claims-made policy. Including chemical and pollution coverage. Fenton Township will be named as additionally insured. (See attached certificate). APM also includes \$1 Million Auto Liability Coverage and standard Workers Compensation coverage on all employees.

2. MOSQUITOLINE CUSTOMER RESPONSE SYSTEM

Twenty-four hour customer access telephone number for reception of mosquito annoyance complaints and information requests. This local access number will appear frequently throughout the summer in the local newspapers ads and articles.

3. IMMEDIATE RESPONSE[®] SYSTEM

Guaranteed 24 hour response/resolution time to all mosquito annoyance complaint calls, weather permitting. Includes monthly reporting of all pertinent call information (name, address etc.) and the steps taken to resolve each problem.

4. C.M.M.S.[®] (COMPUTER-ASSISTED MOSQUITO MANAGEMENT SYSTEM)

Use of APM's comprehensive computer data-base and reporting system to target specific larval mosquito control methods to historically active development sites. This method provides effective control and reduces the high cost of routine "hit & miss" site inspection.

5. COMPLETE WEATHER MONITORING SERVICE

Daily monitoring and recording of local weather conditions in our computer data-base for use in mosquito annoyance prediction, effective operational scheduling and efficient reporting.

6. MOSQUITO ANNOYANCE PREDICTION SERVICE

A computerized population and annoyance prediction system designed to give early warning of severe annoyance from the floodwater mosquito, *Aedes vexans*. This system is used to effectively schedule larviciding and adulticiding operations as well as to give the public advanced notice of severe situations.

7. MONTHLY REPORTS

Three monthly updates (June, July, August) on mosquito populations, work in progress, calls received via *MosquitoLine* System, *ImmediateResponse* analysis, budget analysis, etc.

8. ANNUAL REPORT

Comprehensive end of season report detailing work completed, actual to budget cost comparisons, MosquitoLine report, ImmediateResponse report, mosquito population graphs, weather data, etc.

9. PUBLIC RELATIONS

A. Maintenance of a complete and continuously updated SHUT-OFF File and map system which identifies all properties that have requested that the adulticide spray be shut-off in front of, and up-wind from their property. All Shut-off properties will be marked prior to any spray application.

B. A continuously updated NOTIFICATION File which lists those residents that desire advanced notification of adult control spray applications.

C. Complete access to all APM technical literature including Material Safety Data Sheets for all insecticides used in the program.

D. News releases will be issued to the local media when deemed appropriate and necessary, in cooperation with the Township Supervisor.

Risk Benefit Information

Introduction

Regulation 637, Pesticide Use, was promulgated under the authority of the Pesticide Control Act (Act 171, Public Acts of 1976, as amended). It became effective on October 29, 1993 and will be enforced by the Michigan Department of Agriculture (MDA), Pesticide and Plant Pest Management Division. Regulation 637 will impact all pesticide applicators, but most notably certified commercial applicators and commercial applicator firms. The following is a required addendum to this APM mosquito control proposal/contract in accordance with MDA Regulation 637.

Definition: Pesticide - a substance or agent used to kill pests such as insects, weeds, etc.

Pesticides are used to control undesirable, nuisance, and sometimes dangerous pests. Natural predators, disease and environmental conditions help to control pest populations. When natural controls are insufficient, pesticides are used to reduce the populations to acceptable levels.

One or more of the following pesticides are applied by APM per this proposal/contract to control mosquitoes representing the subfamilies Anophelinae and Culicinae.

Larvicides

Vectobac (Bacillus thuringiensis var. israelensis or Bti.) - A microbial insecticide which utilizes protein crystals cultured from bacterial spores. When ingested by mosquito larvae, the protein crystals cause lethal biochemical changes. Bti. granules are applied via power backpack to actively breeding sites at a rate of 2.5 - 5.0 pounds per acre. **CAUTION KEEP OUT OF REACH OF CHILDREN**

Vectolex CG, (Bacillus sphaericus Serotype(H-5a5b),strain 2362.)- A microbial insecticide which utilizes protein crystals cultured from bacterial spores. When ingested by mosquito larvae, the protein crystals cause lethal biochemical changes. Vectolex granules are applied via power backpack to actively breeding sites at a rate of 2.5 - 5.0 pounds per acre. **CAUTION KEEP OUT OF REACH OF CHILDREN**

Altosid (Methoprene) - A biochemical Insect Growth Regulator which causes a lethal disruption in the mosquito's metamorphic development. The application rate is one 150day residual briquet per catch basin. **CAUTION KEEP OUT OF REACH OF CHILDREN**

Abate (Temephos) - An organophosphorus insecticide which inhibits neural transmissions in targeted larval mosquitoes. Abate 30-day residual pellets are applied via power backpack to pre-season woodland pools and other actively breeding sites. The application rate is 4-10 pounds per acre. **DANGER KEEP OUT OF REACH OF CHILDREN**

Adulticides

Biomist 3+15 ULV (Permethrin 3% + Piperonyl Butoxide 15%) - A synthetic pyrethroid insecticide which inhibits neural transmissions in targeted adult mosquitoes. Biomist is applied via truck-mounted Ultra Low Volume equipment along rural and residential roads. The application rate is 1-3 fluid ounce per acre. **CAUTION KEEP OUT OF REACH OF CHILDREN**

Anvil 2+2 ULV (Sumithrin 2% + Piperonyl Butoxide 2%) - A synthetic pyrethroid insecticide which inhibits neural transmissions in targeted adult mosquitoes. Anvil is applied via truck-mounted Ultra Low Volume equipment along rural and residential roads. The application rate is 1-3 fluid ounce per acre. **CAUTION KEEP OUT OF REACH OF CHILDREN.**

Adulticides Continued

Mosquitomist 1.5 ULV (chlorpyrifos 19.36%) - An organophosphorus insecticide which inhibits neural transmissions in targeted adult mosquitoes. Mosquitomist 1.5 is applied via truck-mounted Ultra Low Volume equipment along rural and residential roads.. **CAUTION KEEP OUT OF REACH OF CHILDREN**

Tempo 20WP Residual Barrier (Cyfluthrin,cyano(4-fluoro-3-phenoxyphenyl)methyl 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropanecarboxylate 20%) A broad spectrum insecticide for control of crawling, flying, and wood destroying insect pests for indoor and outdoor surfaces. A 0.05%-0.1% active ingredient concentration solution is applied. **CAUTION KEEP OUT OF REACH OF CHILDREN**

General Exposure Information

If swallowed: Call a physician or Poison Control Center immediately. Do not induce vomiting unless otherwise directed to do so per the pesticide label. Do not give anything by mouth to an unconscious person.

If on skin: Immediately wash with plenty of soap and water. Get medical attention.

If in eyes: Flush with plenty of water for 15 minutes. Get medical attention.

If inhaled: Remove to fresh air if symptoms of exposure sickness appear and get medical attention immediately.

Always seek medical attention if an unusual condition develops following exposure to a pesticide.

Practicing common sense precautionary measures is the best action against pesticide exposure. Do not touch any surface which has been treated until the pesticide is dry. Remove yourself from the area being treated such as going indoors, closing windows, etc., for at least 30 minutes. Consult your pesticide applicator for exposure precautions.

Environmental Fate

Pesticides have been greatly improved in the area of environmental acceptability since the days of long-term residual insecticides such as DDT. All of the insecticides used in APM mosquito control programs are environmentally acceptable. Numerous acceptable and natural biological larval mosquito control agents have been implemented as part of APM's state-of-the art integrated pest management programs. *Bti* is a larvicide, which utilizes a natural biological active ingredient that is completely non-toxic and very insect specific. Other larvicides such as *Altosid* and *Abate* are used to control mosquitoes and disease in drinking water. ULV adulticides can biodegrade completely in as little as 4 hours. Pesticides formulated with residual properties are designed to biodegrade more slowly. This permits the pesticide to come in contact with more target pests thereby increasing its effectiveness. However, even these residual pesticides are formulated to biodegrade over a relatively short period of time. The physical environmental fate of pesticides vary due to the influences of other environmental conditions. These conditions may include soil pH, UV radiation, rainfall, microbial action and others. Overall, the pesticides applied by APM are low toxicity, biodegradable, and environmentally acceptable materials.