Durham Mosquito Abatement District
P.O. box 386
Durham, CA 95938

INTEGRATED MOSQUITO MANAGEMENT PLAN

Passed & adopted at a regular meeting of the Board of Trustees of the Durham Mosquito Abatement District, on July 11, 2018.

The proposed Integrated Mosquito Management (IMM) Policy & Plan will continue to evolve as new issues emerge and based on Durham Mosquito Abatement District resources.

BACKGROUND INFORMATION

Western Equine Encephalitis (WEE), Malaria, and West Nile Virus (WNV) are all mosquito-borne Arboviral diseases. The West Nile Virus is a pathogen which is a subgroup of Japanese encephalitis. Up until 1999, W.N.V. had never before been documented in the Western Hemisphere. In August of 1999 a hospital in Queens, New York notified the State Department of Health that they had diagnosed six cases of encephalitis. At first the disease was misdiagnosed as the St. Louis Encephalitis (S.L.E.). Local health officials noticed before and concurrent with this outbreak, an increase of dead birds, especially crows. On September 7, 1999, exotic birds in the Bronx Zoo started dying. Cause of death was encephalitis and inflamed hearts. Tissue samples were then forwarded by the USDA to the Centers for Disease Control and Prevention (CDC) in Atlanta. DNA analysis from the dead birds eventually led to the identification of the encephalitis as being WNV. This diagnosis was later confirmed by the University of California in Irvine, CA after testing tissue samples from the deceased victims of New York.

West Nile Virus can infect a wide range of vertebrates including, horses, cattle, birds, as well as humans. In humans though, WNV generally produces a milder form of the disease. Symptoms are a rapid onset of fever (100 –104 degrees Fahrenheit) lasting 5-6 days, muscle pain and weakness, stiff neck, breathing, problems, headache, pain associated with eye movement, swollen lymph nodes and rash. WNV can infect the heart, pancreas, and liver as well as the brain. Severe cases tend to be limited to older patients or patients with weakened immune systems. Some people can become infected with the disease and not display a single symptom.

Also see *(Best Management Practices for Mosquito Control in California and the California Mosquito-borne Virus Surveillance and Response Plan)*

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Durham Mosquito Abatement District Current Arboviral Disease Surveillance Programs

I. – Current Surveillance Programs

A. – New Jersey Light Trap Program

1. – Currently DMAD has 4 light traps located throughout the District of DMAD.
2. – Once a week contents of all 4 traps are collected and brought back to the office for analysis.
   a.) – The mosquitoes) are separated the from the rest of the trap's contents one trap at a time.
   b.) – After separating the contents, the different species of mosquitoes are identified and counted.
   c.) – The identification results and mosquito count are then recorded and filed in DMAD's records.
   d.) – The results are sent to the California Department of Health Services.

B. – Encephalitis Virus Surveillance Program (E.V.S. Traps)

1. – E.V.S. traps are designed to attract & capture live mosquitoes that are used to develop "mosquito pools."
   a.) – The "mosquito pools" contain 50 female mosquitoes and are shipped overnight to U.C. Davis, where the mosquitoes are tested for W.E.E. or S.L.E. and/or W.N.V.
   b.) – The E.V.S. traps are small units that are suspended from a tri-pod stand, which contain a small light and dry ice (as a source for carbon dioxide, CO_2) to attract live mosquitoes. These traps are placed at three representative locations throughout the DMAD at dusk.
      1. – Once the mosquitoes are attracted, a fan in the unit pulls the live mosquitoes into a net or sock unit which hangs below the entire unit.
         a.) – This sock unit keeps the mosquitoes alive until they can be collected the following morning.

      2. – After collection of all of the sock units, the live mosquitoes are brought to the office in order to create a mosquito pool.

   a.)– At the office, the live mosquitoes are anesthetized (put to sleep) and removed from the sock.
      b.)– Once anesthetized, the females are removed and identified.
         1.) – After segregated and identified, 50 mosquitoes are counted for 1 mosquito pool.
         2.) – Each pool is placed into a small vial, with dry ice and then placed inside a Styrofoam container to be shipped to U.C. Davis Disease Research lab.
         3.) – Mosquito Pools are collected when virus activity is high. There is typically several months out of the year when virus activity peaks.

C. – West Nile Virus Dead Bird Surveillance Program

1. – This Program requires a permit from the United States Fish & Wildlife Service.
2. – *Only trained personnel* picks up dead birds (i.e., Crows, Blue Jays, Magpies, Ravens, Black Birds, etc.,) dead Lagomorphs (rabbits and hares), and dead Rodents (e.g. Tree Squirrels) within DMAD.
3. – All dead birds are sent to U.C. Davis Arbovirus Research Lab for testing
4. – Only birds that have died within 48 hours of pick up will be tested.
5. – All dead corvids will be vec-tested in house before shipping to the lab for confirmation.

The District follows an IMM plan, where various methods to control mosquitoes are used.

1. Public education and outreach programs to educate the public about eliminating mosquito breeding sources on their ranches or around their homes, protecting themselves from mosquito bites with repellents, clothing, and avoiding mosquitoes when they are most active. DMAD does also do public events to educate its residents. When asked, DMAD does training in Durham Schools to educate youngsters.

2. DMAD technicians carefully check each mosquito breeding source and determine the most effective control method for each situation. The technicians choose between physically changing the environment so mosquitoes don't breed and or placing mosquitofish in the source to eat mosquito larvae, or applying specific pesticides regulated by the environmental protection agency to curb mosquito breeding. All larvacides and adulticides are chosen and used in a manner that minimizes risks to humans, wildlife, and the environment.

3. Thresholds

Treatment thresholds are established for mosquito developmental sites where potential disease vector and/or nuisance risks are evident. Therefore, only those sources that represent imminent threat to public health or quality of life are treated. Treatment thresholds are based on the following criteria:

: Mosquito species present
: Mosquito state of development
: Nuisance or disease potential
: Mosquito abundance
: Flight range
: Proximity to populated areas
: Size of source

: Presence/absence of natural enemies or predators
: Presence of sensitive/endangered species

Treatment thresholds for larvicide, pupacide, and adulticide applications for DMAD.

		Treatment Thresholds			
		Larvicide	Pupicide	Adulticide	
County		Dipper 1	Dipper 1	Landing Count 2	NJLT Index 3
Durham	All Areas	2	2	5	40

1. Average Number per Dip.
2. Average Number Landing per Pant leg per Minutes.
3. Per trap Night, based on Weekly index of Adult females.

4. <u>Selection of Control Strategy</u>

When thresholds are exceeded an appropriate control strategy is implemented. Control strategies are selected to minimize potential environmental impacts while maximizing efficacy. The method of control is based on the above threshold criteria but also

: Habitat type
: Water conditions and quality
: Weather conditions
: Cost
: Site accessibility
: Size of site and number of other developmental sites

CONTROL STRATEGIES

1. SOURCE REDUCING

Source reduction includes elements such as physical control, habitat manipulation and water management, and forms an important component of the DMAD IMM program.

2. PHYSICAL CONTROL

The goal of physical control is to eliminate or reduce mosquito production at a particular site through alteration of habitat. Physical control is usually the most effective mosquito control technique because it provides a long term solution by reducing or eliminating mosquito development sites and ultimately reduces the need for chemical applications.

Historically (circa1903), the first physical control efforts were projects undertaken to reduce the populations of salt mach mosquitoes in marshes near San Rafael, CA. Two years later, similar work was undertaken in the marshes near San Mateo. Networks of ditches were created by hand to enhance drainage and promote tidal circulation. Since then, various types of machinery have been used since then to dig ditches necessary to promote water circulation. In recent years, a number of environmental modification projects have been undertaken in collaboration with the U.S. Fish and Wildlife Service (USFWS) to reduce potential mosquito developmental sites and enhance wildlife habitat. Re-circulation ditches allow tidewater to enter the marsh at high tide and drain off at a low tide. Water remaining in the ditch bottoms at low tide provides habitat for mosquito-eating fish. These projects have reduced the need to apply chemical on thousands of acres of salt marsh in the San Francisco Bay.

Physical control programs conducted by the DMAD may be categorized into three areas: “maintenance”, “new construction”, and “cultural practices” such as vegetation management and water management.

Maintenance activities are conducted within seasonal wetlands, ditches, canals, and in some creeks adjacent to these wetlands. The following activities are classified as maintenance:

- Removal of sediments from existing water circulation ditches
- Repair of existing water control structures
- Removal of debris, weeds and emergent vegetation in natural channels
- Clearance of brush for access to streams tributary to wetland areas
- Filling of existing, non-functional water circulation ditches to achieve required water circulation dynamics and restore ditched wetlands.

New projects, such as wetland restoration, excavation of new ditches, construction of new water control structures, all require review and assessment under CEQA. Since this can be a time-consuming and expensive proposition, DMAD tries to work with landowners and resource groups to manage their lands in a manner that does not promote mosquito development. DMAD staff review proposals for wetlands construction to assess their impact on mosquito production. The district then submits recommendations on hydrological design and maintenance that will reduce the production of mosquitoes and other vectors. This proactive approach involves a collaborative effort between landowners and DMAD. Implementation of these standards may include cultural practices such as water management and aquatic vegetation control.

3. Biological Control

Biological control agents of mosquito larvae include predatory fish, predatory aquatic invertebrates and mosquito pathogens. Of these, only mosquitofish are available in sufficient quantity for use in mosquito control programs. Natural predators may sometimes be present in numbers sufficient to reduce larval mosquito populations. Biological control is sometimes used in conjunction with selective bacterial or chemical insecticides.

Mosquitofish

The mosquitofish, *Gambusia affinis*, is a natural predator of mosquito larvae used throughout the world as a biological control agent for mosquitoes. Although not native to California, the mosquitofish are now ubiquitous throughout most of the State's waterways and tributaries, where they have become an integral part of aquatic food chains. They can be stocked in mosquito larval sources by trained district technicians or distributed to the public for stocking in backyard ornamental ponds and other artificial containers.

4. Chemical Control

Pesticides that control mosquito larvae are called larvicides. Four types of larvicides (bio-rational, surface oil, growth regulating, and chemical products) encompassing seven active ingredients that are registered for use in California. Larvicides are applied by hand from backpack sprayer or vehicle-mounted engine-driven blowers, or by aircraft depending on the product, the formulation, and the target habitat. Applicators of any of these products must be certified by the CDPH.

A. Bio-rational Products

Bio-rational products exploit insecticidal toxins found in certain naturally occurring bacteria. These bacteria are cultured in mass and packaged in various formulations. The bacteria must be ingested by mosquito larvae so the toxin is released. Therefore bio-rational products are only effective against larvae since pupae do not feed. The bacteria used to control mosquito larvae have no significant effects on non-target organisms.

Two biological products that are used against mosquito larvae singly or in combination are *Bacillus thuringiensis israelensis* and *Bacillus sphaericus*. Manufactured *B. thuringiensis israelensis* contains dead bacteria and remains effective in the water for 24 or 48 hours; some slow release formulations provide longer control. In contrast, *B. sphaericus* products contain live bacteria that in favorable conditions remain effective for more than 30 days. Both products are safe enough to be used in water that is consumed by humans.

B. Surface Agents

Mosquito larvae and pupae breathe through siphons that extend above the water surface. Surface agents such as highly refined mineral oils or monomolecular films (alcohol derivatives) can spread across the entire surface of the water and prevent mosquitoes from breathing. Depending on the product, the film may remain on the water's surface from a few hours to a few days. Surface films are the only available products that are effective against fully developed larvae and pupae. Using surface agents may be restricted in sensitive habitats or where runoff may enter sensitive habitats.

C. Insect Growth Regulations

Insect growth regulators (IGRs) disrupt the physiological development of larvae thus preventing adults from emerging. The only product currently used for controlling mosquito larvae is methoprene.
The effective life of these products varies with the formulation. Methoprene can be applied in granular, liquid, pellet, or briquette forms.
There are no such restrictions to using methoprene. IGRs for mosquito control can be used in sources of water that are consumed by humans.

5. Adult Control

Adult mosquitoes can only be controlled with pesticides, known as adulticides. Many mosquito control programs in California include adulticiding as an integral component of the IPM program. Adulticiding falls into two categories – barrier applications and ultra-low volume (ULV) applications. Barrier applications target resting mosquitoes by applying pesticides to vegetation and structures. Barrier applications are typically applied on small properties.

ULV applications are used to control adult mosquitoes over large areas. Tiny oil water droplets carrying an "ultra-low volume" of insecticide are emitted from specialized equipment mounted to trucks or aircraft. The droplets kill adult mosquitoes on contact. ULV applications are made after sunset or before sunrise to coincide with the time that mosquitoes are most active, when non-target insects are least active, and when temperature inversions are most likely to occur. The applications are considered when most mosquito populations must be reduced immediately to halt disease transmission. Multiple applications are usually required for successful reduction of mosquito numbers.

Adult mosquitoes are controlled when mosquito-borne disease activity is documented and/or thresholds are reached or exceeded. Thresholds are based on local sampling of the adult mosquito population and/or when the risk of mosquito-borne disease increases above levels established by the statewide WNV surveillance and response plan. Thresholds are an integral component of mosquito control because they provide a range of predetermined actions based on quantified data. Thresholds also establish expectations and boundaries for responses that ensure appropriate mosquito control activities are implemented timely. The threshold for adult mosquito control can change depending on several factors including:

- How local citizens tolerate nuisance mosquitoes by evaluating public service requests.
- Overall mosquito abundance
- Presence of mosquito-borne disease in the region.
- Abundance of mosquito species that are vectors of disease.
- Local acceptance of adult mosquito control activities.
- Climate data.

Adverse effects from ULV applications are rare; however, people with health problems should be aware when and where the applications are being conducted. This information can be obtained by contacting the local vector control agency. Chemicals currently registered for ULV applications against mosquitoes in California (as of December 2007) include organophosphates (e.g., malathion and naled), pyrethrins (e.g. pyrethrum), and pyrethroids (e.g. resmethrin, sumithrin, and permethrin). Formulations of both pyrethrins and pyrethroids include the synergist piperonyl butoxide (PBO), which increases their activity against mosquitoes.

A. Organophosphates

Malathion and Naled are neurotoxins. Malathion is typically used early and late in the season.

B. Pyrethrins

Pyrethrins are natural insecticides derived from chrysanthemum flowers. Adult mosquitoes are rapidly paralyzed and killed on contact. Pyrethrins degrade rapidly by sunlight and chemical processes. Residual pyrethrins from ULV applications typically remain less than one day on plants, soil, and water.

C. Pyrethroids

Pyrethroids are manufactured pyrethrins. They have very low toxicity to birds and mammals but are toxic to fish if misapplied.

6. EVALUATION OF THE EFFICACY/ RESISTANCE OF BMPS

The efficacy of particular BMP strategies can be determined by sampling local populations of mosquitoes and assessing the risk of mosquito-borne disease transmission. The information can also be used to better characterize the most effective and efficient strategies for an individual location or land-use type. Factors such as treatment costs, proximity to densely populated areas, mosquito-borne disease activity, species present, treatment options, and ability to collaborate with local vector control agencies should be considered when evaluating the best approach for a particular location. After BMPs have been implemented, they should be continuously evaluated. Surveillance for potential sources of mosquitoes and mosquito-borne virus transmission should be ongoing.

A. Basic resistance management techniques can include:
   1. Do not use the same class of chemical against both immature and adult mosquitoes.
   2. Apply pesticide according to manufacturer's recommendations. Do not under dose.
   3. When possible, utilize a different chemical class at the beginning and end of treatment season
   4. If possible, assess susceptibility at the beginning and sometime during the mosquito season

B. Resistance management can also involve utilizing surveillance methods following larvicide or adulticide applications to continually check for control efficacy.

7. <u>RECORD KEEPING</u>- Operators/applicators record the following for each application and maintain the records for the time specified by the lead regulatory agency:

A. Applicator's name, address and pesticide applicator certification number (if applicable)

B. Application date and time of day

C. Product name and EPA registration number

D. General location of application and approximate size of area treated

E. Amount of material applied

F. Application rate

If a Mosquito-borne Arboviral Emergency is documented and/or a County Emergency is declared within Butte county, refer to the State of California Emergency Response Plan.