



*Suffolk County
Vector Control &
Wetlands Management
Long Term Plan &
Environmental Impact Statement*

**Task 3 Literature Review
Book 5 Part 1: Mosquito Control Agents**

Submitted to:

**Suffolk County Department of Public Works
Suffolk County Department of Health Services
Suffolk County, New York**

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November 2004

| <u>SUFFOLK COUNTY LONG TERM PLAN</u> | |
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Primary research for this report was conducted by Cameron Engineering (personnel including John Pascucci, PE). It was edited and revised in response to comments by Cameron Engineering (personnel including John Pascucci, PE) and Cashin Associates (personnel including David Tonjes, PhD). Review was provided by Integral Consulting (personnel including Judi Durda), Suffolk County Department of Public Works, Division of Vector Control (personnel including Dominic Ninivaggi, Mary Dempsey, and Tom Iwanjeko), and Suffolk County Department of Health Services (personnel including Amy Juchatz, Erin Duffy and Kim Shaw). Additional comments have been received from members of the Technical Advisory Committee.

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1. Mosquito Control Agents Utilized Outside of Suffolk County

An extensive survey of Mosquito Control agencies outside Suffolk County was conducted to develop an inclusive list of agents and chemicals used to control mosquito populations. Particular effort was placed on regional mosquito control programs. However, other areas of the country were included to examine the spectrum of mosquito control agents utilized under a variety of environmental conditions.

Research methods included e-mail contact with individual Mosquito Control agencies, Internet website investigations, and phone interviews. Initially, e-mail requests were sent to various state and local jurisdictions. Those were followed by website information documentation, and phone calls to clarify specific details. The survey yielded fourteen mosquito control agents that are in common use by the various reporting agencies (Table 2-1).

A complete list of the agencies contacted for information is presented in Table 2-2 on the next page. The results of the survey are presented on the following pages in three (3) tables: Adulticides (Table 2-3), Larvicides (Table 2-4), and Other Control Agents (Table 2-5).

Table 2-1 - Mosquito Control Agents in Common Use

| ACTIVE INGREDIENT | PRODUCT TRADE NAME | CLASS | FORMULATIONS |
|---|---|------------------------------------|---------------------------------|
| Bacteriological Control | | | |
| Bti (<i>Bacillus thuringiensis israelensis</i>) | Aquabac / Bactimos / Vectobac / Teknar | Larvicide | Liquid / granules / briquets |
| Bs (<i>Bacillus sphaericus</i>) | Vectolex | Larvicide | Liquid / granules |
| Insect Growth Regulators | | | |
| Methoprene | Altosid | Larvicide | Liquids / granules / briquets |
| Surface Films | | | |
| Petroleum Derivatives | Golden Bear Oil (GB-1111) / Bonide / BVA Oil 13 | Larvicide / Pupicide | Liquid |
| Ethoxylated Alcohol | Agnique MMF | Larvicide / Pupicide | Liquid |
| Chemical Control | | | |
| Temephos | Abate | Larvicide | Liquids / granules / briquets |
| Malathion | Fyfanon / Atrapa / Microflo | Adulticide | ULV aerosol / thermal fog |
| Resmethrin | Scourge | Adulticide | ULV aerosol |
| Sumithrin | Anvil | Adulticide | ULV aerosol |
| Permethrin | Permanone / Aqua Reslin | Adulticide | ULV aerosol / barrier treatment |
| Natural Pyrethrum | Pyroicide / Pyrenone | Adulticide / limited larvicide use | ULV aerosol |
| Fenthion | Baytex / Entex / Tiguvon | Adulticide | ULV aerosol / thermal fog |
| Naled | Dibrom / Trumpet | Adulticide | ULV aerosol |
| Chlorpyrifos | Dursban / Lorsban | Adulticide / limited larvicide use | ULV aerosol |

Agencies Contacted to Compile Pesticide List:

California - Contra Costa; Coachella Valley; Marin & Sonoma; Los Angeles West; San Gabriel Valley; Shasta; Sutter-Yuba
 Connecticut – Dept. of Environmental Protection
 Delaware – Dept. of Natural Resources
 Florida - East Flagler; Florida Keys; Leon; Manatee; Miami-Dade
 Maryland – Dept. of Agriculture
 Massachusetts - Bristol; Cape Cod; Central; East Middlesex; Northeast; Norfolk; Plymouth; Sussex
 Michigan - Saginaw; Tuscola
 Minnesota - Metropolitan (Minneapolis, St. Paul)
 New Jersey – Dept. of Environmental Protection; Atlantic; Bergen; Camden; Hunterdon; Mercer; Middlesex; Monmouth; Morris; Passaic; Union; Warren
 New York - New York City; Nassau
 Pennsylvania – Dept. of Environmental Protection

Table 2-2 - Mosquito Control Agencies Contacted

| STATE | AGENCIES CONTACTED | |
|----------------------|---|---|
| California | <ul style="list-style-type: none"> • Alameda County Mosquito Abatement District • Coachella Valley Mosquito and Vector Control District • Contra Costa Mosquito and Vector Control District • Greater Los Angeles County Vector Control District • Los Angeles County West Vector Control District • Marin/Sonoma Mosquito Vector Control District • Sacramento-Yolo Mosquito and Vector Control District | <ul style="list-style-type: none"> • San Gabriel Valley Mosquito and Vector Control District • San Mateo County Mosquito Abatement District • Santa Barbara Coastal Vector Control District • Santa Clara Vector Control District • Shasta Mosquito and Vector Control District • Sutter-Yuba Mosquito and Vector Control District |
| Connecticut | <ul style="list-style-type: none"> • State Department of Environmental Protection | |
| Delaware | <ul style="list-style-type: none"> • State Department of Natural Resources | |
| Florida | <ul style="list-style-type: none"> • Amelia Island Mosquito Control District • Beach Mosquito Control District • Broward County Mosquito Control Section • East Flagler Mosquito Control District • Florida Keys Mosquito Control District | <ul style="list-style-type: none"> • Lee County Mosquito Control District • Leon County Mosquito Control • Levy County Mosquito Control • Manatee County Mosquito Control District • Miami-Dade Mosquito Control |
| Maryland | <ul style="list-style-type: none"> • State Department of Agriculture | |
| Massachusetts | <ul style="list-style-type: none"> • Berkshire County Mosquito Control Project • Bristol County Mosquito Control Project • Cape Cod Mosquito Control Project • Central Massachusetts Mosquito Control Project • East Middlesex Mosquito Control Project | <ul style="list-style-type: none"> • Norfolk County Mosquito Control Project • Northeast Mosquito and Wetlands Management District • Plymouth County Mosquito Control Project • Sussex County Division of Mosquito Control |
| Michigan | <ul style="list-style-type: none"> • Saginaw County Mosquito Abatement Commission | |
| Minnesota | <ul style="list-style-type: none"> • Metropolitan Mosquito Control District | |
| New Jersey | <ul style="list-style-type: none"> • State Department of Environmental Protection • Atlantic County Office of Mosquito Control • Bergen County Division of Mosquito Control • Burlington County Mosquito Control • Camden County Mosquito Extermination Commission • Cape May County Mosquito Extermination Commission • Cumberland County Mosquito Control Division • Essex County Mosquito Control • Gloucester County Division of Mosquito Control • Hudson County Mosquito Control • Hunterdon County Mosquito Control | <ul style="list-style-type: none"> • Mercer County Division of Mosquito Control • Middlesex County Mosquito Extermination Commission • Monmouth County Mosquito Extermination Commission • Morris County Mosquito Extermination Commission • Ocean County Mosquito Extermination Commission • Passaic County Division of Mosquito Extermination • Salem County Mosquito Extermination Commission • Somerset County Mosquito Extermination Commission • Sussex County Division of Mosquito Control • Union County Mosquito Extermination Commission • Warren County Mosquito Extermination Commission |
| New York | <ul style="list-style-type: none"> • Nassau County Department of Public Works • New York City Department of Health | |
| Pennsylvania | <ul style="list-style-type: none"> • State Department of Environmental Protection | |

Table 2-3 - Mosquito Control Substances - Adulticides

| Category | Malathion | Resmethrin | Sumithrin | Permethrin | Naled | Pyrethrum | Deltamethrin |
|---|--|--|---|--|--|-----------------------------|---|
| NYS Registration? (Y/N) | Y | Y | Y | Y | Y | Y | Y |
| Class of Control: adulticide (A), barrier (B) | A | A | A | A/B | A | A | B |
| EPA Biopesticide? (Y/N) Chem. Class: Organo-Phosphate (OP), Pyrethroid (P) | N/OP | N/P | N/P | N/P | N/OP | Y | N/P |
| SCVC past use? (Y/N) | Y | Y | Y | Y | Y | N | Y |
| SCVC current use? (Y/N) | Y | Y | Y | N | N | N | Y |
| Use in NE US? (Y/N) Widespread (W), Scattered (S), Rare (R) | Y/W | Y/W | Y/W | Y/W | Y/R | Y/R | S |
| Use on East Coast? (Y/N) Widespread (W), Scattered (S), Rare (R) | Y/W | Y/W | Y/W | Y/W | Y/W | Y/R | S |
| Use elsewhere US? (Y/N) Widespread (W), Scattered (S), Rare (R) | Y/S | Y/W | Y/W | Y/W | Y/W | Y/R | S |
| Persistence (short, medium, long) | Medium | Short | Short | Medium | Short | Short | Long |
| EPA Toxicity Class ¹ | III | III | III | II/III | I | III | III |
| Label restrictions | Restricted near water, bees | No water setback, .007lb. AI/acre | No significant restrictions, .0035lb. AI/acre | 100 ft. water setback, bee restriction | Bee restrictions | Restrictions near water | Restrictions near water |
| Generalized/Specialized Use | Hand ULV, aerial ULV, thermal fog | Truck ULV, aerial ULV | Hand ULV, truck ULV, aerial ULV | Hand ULV, truck ULV, aerial ULV, barrier spray | Ground ULV, aerial ULV | Ground ULV, aerial ULV | Barrier spray |
| Advantages/Disadvantages | Less weather dependent, slow degradation | Nearly non-toxic to birds, rapid knockdown | Nearly non-toxic to birds, slower breakdown than Resmethrin | Nearly non-toxic to birds, slower degradation than other ULV Pyrethroids | Effective in wide range of conditions, toxic to birds, fish, bees, corrosive | Exempt from crop tolerances | Highly toxic to fish, aquatic invertebrates, bees |

1. The EPA classifies pesticides by four classes of toxicity, with Class I being the most toxic and Class IV being the least toxic.

Table 2-4 - Mosquito Control Substances - Larvicides

| Category | Bacillus thuringiensis israelensis | Bacillus spaericus | Methoprene | Ethoxylated Fatty Acids | Golden Bear Oil | Temephos |
|---|---|--|--|--|--|-----------------------------------|
| NYS Registration? (Y/N) | Y | Y | Y | Y | Y | Y |
| Class of Control: larvicide (L), pupacide (P) | L | L | L | L/P | L/P | L |
| EPA Biopesticide? (Y/N) Chem. Class: Organo-Phosphate (OP), Pyrethroid (P) | Y | Y | Y | N | N | N/OP |
| SCVC past use? (Y/N) | Y | Y | Y | N | N | Y |
| SCVC current use? (Y/N) | Y | Y | Y | N | N | N |
| Use in NE US? (Y/N), Widespread (W), Scattered (S), Rare (R) | Y/W | Y/W | Y/W | Y/S | Y/S | Y/S |
| Use on East Coast? (Y/N), Widespread (W), Scattered (S), Rare (R) | Y/W | Y/W | Y/W | Y/S | Y/S | Y/W |
| Use elsewhere in US? (Y/N), Widespread (W), Scattered (S), Rare (R) | Y/W | Y/W | Y/W | Y/S | Y/S | Y/W |
| Persistence (short, medium, long) | Short | Medium | Short | Medium | Medium | Medium |
| EPA Toxicity Class ¹ | IV | IV | IV | III | III | III |
| Label restrictions | -- | -- | Fish habitats for some formulations in New York | -- | -- | -- |
| Generalized/Specialized Use | Salt marsh, Freshwater, Flood areas | Ditches, catch basins | Salt marsh, drainage areas, catch basins | Variety of habitats, best in containers, artificial breeding sites | Variety of habitats, best in containers, artificial breeding sites | Variety of habitats, stored tires |
| Advantages/Disadvantages | Immediate control, non-toxic to other species, resistance highly unlikely | Best in permanent water, residual action | Larvae remain as food source, highly effective in salt marsh | Potential adverse impact to non-targets that use surface film | Potential adverse impact to non-targets that use surface film | Toxic to fish, birds, bees |

1. The EPA classifies pesticides by four classes of toxicity, with Class I being the most toxic and Class IV being the least toxic.

Table 2-5 - Mosquito Control Substances – Other Substances

| Category | Garlic Oil | Malaoxon | Isomalathion | Piperonyl butoxide |
|---|--------------------------|-----------------|---------------------|---------------------------|
| NYS Registration? (Y/N) | N | Not Applicable | Not Applicable | Y |
| Class of Control: barrier (B), synergist (S), degradate (D) | B | D | D | S |
| EPA Biopesticide? (Y/N) | Y | N | N | N |
| SCVC past use? (Y/N) | Y | | | Y |
| SCVC current use? (Y/N) | Y | | | Y |
| Use in NE US? (Y/N) Widespread (W), Scattered (S), Rare (R) | Y/S | | | Y/W |
| Use on East Coast? (Y/N) Widespread (W), Scattered (S), Rare (R) | Y/S | | | Y/W |
| Use elsewhere US? (Y/N) Widespread (W), Scattered (S), Rare (R) | Y/S | | | Y/W |
| Persistence (short, medium, long) | Long | | | |
| EPA Toxicity Class | Not Applicable | Not Applicable | Not Applicable | Not Applicable |
| Label restrictions | | | | |
| Generalized/Specialized Use | Outdoor area repellent | | | |
| Advantages/Disadvantages | EPA exempt, non-toxic | | | |

2. Mosquito Control Agent Priority List

Mosquito Control Agents are further categorized in this document into Primary and Secondary areas of investigation with appropriate investigative levels assigned to each. A complete and extensive literature review will follow on Primary agents. Secondary agents will receive a substantial, but less in-depth review. The results of the categorization effort are presented in Table 2-6 and Table 2-7. The discussion following the tables summarizes how each of the agents was categorized.

Table 2-6 - Primary Mosquito Control Agents

| AGENT | CLASS | TRADE NAME |
|---|------------|------------------|
| Bti (<i>Bacillus thuringiensis israelensis</i>) | Larvicide | Vectobac, Teknar |
| Bs (<i>Bacillus sphaericus</i>) | Larvicide | Vectolex |
| Methoprene | Larvicide | Altosid |
| Garlic Oil | Repellant | Garlic Barrier |
| Malathion | Adulticide | Fyfanon, Atrapa |
| Resmethrin | Adulticide | Scourge |
| Sumithrin | Adulticide | Anvil |
| Permethrin | Adulticide | Permanone |
| Malaoxon | Degradate | |
| Isomalathion | Degradate | |
| Piperonyl butoxide | Synergist | |

Table 2-7 - Secondary Mosquito Control Agents

| AGENT | CLASS | TRADE NAME |
|----------------------------|--------------------|--------------------|
| Ethoxylated Fatty Alcohols | Larvicide/Pupicide | Agnique |
| Temephos | Larvicide | Abate |
| Naled | Adulticide | Dibrom, Trumpet |
| Pyrethrum | Adulticide | Pyrocide, Pyrenone |
| Deltamethrin | Adulticide | Decis |
| Golden Bear Oil | Larvicide/Pupicide | GB-1111 |
| DEET | Repellant | |
| Fenthion | Adulticide | Baytex, Entex |
| Chlorpyrifos | Adulticide | Dursban, Lorsban |
| Octanol | Used in Traps | |
| Propane | Used in Traps | |

2.2.1. Bacteriological Control (Biopesticides)

Bti and Bs are microbial larvicides, and both are naturally occurring bacterium. When ingested by the mosquito larvae, they disrupt the natural digestion process, causing the larvae to die. They are believed to pose a minimal risk to non-target species, are widely used throughout the country, and will be given Primary consideration.

2.2.2. Insect Growth Regulators

Methoprene is a slightly to practically nontoxic compound in EPA Toxicity Class IV. It mimics the action of a mosquito growth-regulating hormone and prevents the larvae from maturing into adults. There are no significant label restrictions on its use. Methoprene has low toxicity to birds and fish, is widely used for mosquito control, and will be given Primary consideration.

2.2.3. Surface Films

Petroleum derivatives (e.g. Golden Bear Oil) spread a thin film on the surface of the water, which prevents the transfer of oxygen causing the mosquito larvae/pupae to drown. Ethoxylated Alcohols (Agnique) spread a thin surface film, which makes it difficult for mosquito larvae, pupae, and emerging adults to attach to the water's surface, also causing them to drown. The window of opportunity for use of these agents is limited within the mosquito life cycle. These agents also prevent the natural transfer of oxygen into the water body. There are also potential impacts to non-target species that rest on the water surface, such as dragonflies and water skimmers. Although they are used by some agencies around the country, their potential is for limited use, where non-target impacts are not of concern. They will therefore be given Secondary consideration.

2.2.4. Chemical Control

Other than Temephos, which is a larvicide, all of the agents listed are adulticides, which kill adult mosquitoes by bringing them in direct contact with a toxic chemical. Temephos is an organophosphate pesticide, and it is the only organophosphate with larvicidal use. Although it presents relatively low risk to birds and terrestrial species, available information suggests that it is more toxic to aquatic invertebrates than alternative larvicides. EPA is limiting its use to areas

where less hazardous alternatives would not be effective. Many current users are limiting its application to pooled water in stored tires. It will be given Secondary consideration.

Resmethrin and Sumithrin are synthetic chemical pesticides that act in a similar manner to pyrethrins, which are derived from chrysanthemum flowers. They are relatively low in toxicity, EPA Toxicity Class III, and do not have significant label restrictions. They are applied as an ultra low volume (ULV) aerosol, which kills adult mosquitoes on contact. Resmethrin and Sumithrin are currently part of the Suffolk County program and will, therefore, be given Primary consideration. Permethrin, as a similar pyrethroid compound being used elsewhere in the country, will also be given Primary consideration. Pyrethroids used in mosquito control are typically mixed with a synergist compound, such as Piperonyl Butoxide, which enhances the effectiveness of the active ingredient. Piperonyl Butoxide will be given Primary consideration.

Malathion is an organophosphate pesticide that is applied as a ULV aerosol, which kills adult mosquitoes on contact. As a component of Suffolk County's current program, it will be given Primary consideration. Malaoxon and Isomalathion, breakdown products of Malathion, will also be given Primary consideration.

Naled is another organophosphate pesticide that is applied as a ULV aerosol. Most use of Naled for mosquito control is in the southern states. There is potential for acute, and some potential for chronic risks to freshwater invertebrates from the use of Naled. Because of its high toxicity, EPA Toxicity Class I, Naled will be given Secondary consideration.

Pyrethrum is a naturally occurring pesticide that is derived from the chrysanthemum flower. It is more expensive to produce than the synthetic pyrethroids, which demonstrate the same efficacy against mosquito populations. It will be given Secondary consideration.

Deltamethrin is considered the most persistent of the synthetic pyrethroids, demonstrating a broad spectrum of toxic effects. Although not reported as a mosquito control agent in our survey, it is included in the literature search as a synthetic pyrethroid with applicability in this area. It can be used as a barrier treatment where its persistence is an advantage. It will be given Secondary consideration.

Fenthion and Chlorpyrifos are organophosphate pesticides with historical use for mosquito control. Both display moderate toxicity to mammals and high toxicity to birds. There was little reported use of these agents, which was primarily in the south, where its use is being phased out. They will be given Secondary consideration.

Also given Secondary consideration are DEET, Octanol, and Propane. DEET is used for personal protection from mosquitoes, and is often the preferred product in government publications. Octanol and propane are utilized in mosquito traps. It is possible that the Long-Term Plan developed in this project may lead to greater or lesser use of these products, and the impacts of those changes should be considered.

2.2.5. Repellants

Garlic oil has been tested as a repellent in public outdoor areas. Because of its potential for inclusion in the County's Long-Term Plan, it will be given Primary consideration.