II. INTRODUCTION

A Generic Environmental Impact Report (GEIR), covering mosquito control activities within the State of Massachusetts, was mandated under the provision of Massachusetts General Laws Chapter 30A Section 61 by the Massachusetts Environmental Policy Act (MEPA) Regulation 301 CMR 10.32(5)(b) adopted on January 25, 1979. The State Reclamation and Mosquito Control Board (SRMCB), the state agency that oversees all local and regional mosquito control programs in Massachusetts, administers the GEIR. The SRMCB consists of one representative each from the Departments of Environmental Management, Environmental Protection, and Food and Agriculture. The latter presently serves as the Chairman of the Board.

A special committee designated as the Citizen's Advisory Committee (CAC) was established under MEPA Regulation 301 CMR 10.10(3) to assist the SRMCB and the MEPA office in developing a scope of what should be included in the GEIR. Following the committee's preparation of the GEIR scope and SRMCB approval of this document, potential GEIR contractors were invited to submit proposals in 1985. A subcommittee of the CAC was appointed to screen GEIR proposals and make recommendations on the awarding of the contract. A contract agreement with the University of Massachusetts (Dr. J. D. Edman) was signed in September of 1985, and the initial Draft GEIR was prepared.

The CAC received comments on the initial Draft GEIR but no action was taken on the comments nor was a Final GEIR published. In 1995 this situation was brought to the attention of the Executive Office of Environmental Affairs and the SRMCB was instructed to complete the GEIR. Due to the substantial time lag between the original Draft GEIR and the renewal of the process, a Notice of Project Change was filed with the Massachusetts Environmental Policy Act Unit in July, and the revised Scope (Section I above) was approved September 23rd of the same year. Mr. George Christie, a private mosquito-control consultant, was hired by the SRMCB committee to rewrite the GEIR to conform with the new scope.

This GEIR serves five purposes:

1. It provides a historic summary of all public activities in Massachusetts related to mosquito control, including a account of how mosquito control in Massachusetts has rapidly evolved over the past ten years.
2. It describes and quantifies Massachusetts mosquito problems and assesses the effectiveness of

past and current control programs.

3. It assesses the real and potential environmental impacts of past and current control practices and describes and evaluates alternative strategies.

4. It gives an IPM framework for mosquito control in Massachusetts and provides a series of operational standards for mosquito control practices.

5. It makes recommendations relative to the future organization and practice of mosquito control in Massachusetts. The recommendations were formed in collaboration with the CAC and the SRMCB and were based on a joint review of the background information summarized Sections III through VII of this report.

III. HISTORY AND CURRENT ORGANIZATION AND PRACTICE OF MOSQUITO CONTROL IN MASSACHUSETTS

A. Legislation and Regulation

1. Overview

There are four basic legislative Acts which regulate mosquito control activities in Massachusetts. Often associated with each of these Acts are regulations (or CMR), which are developed by the state agency charged with administering the provisions of the legislative acts. These serve as the rules or policy used in the day-to-day enforcement of the Acts.

The first Act of major importance is Chapter 252 of the Massachusetts General Laws (MGL), which establishes the State Reclamation and Mosquito Control Board (SRCMB) and procedures for creating local control projects. As now amended, 252 includes the important earlier provisions of Chapters 199 and 699 of the Acts of 1960. The word improvement (of wetlands) as frequently used in the narrative for this Act is misleading. Modification or alteration would have been a more appropriate and objective term to describe wetland drainage and filling activities. Although the word "improvement" will be used in this report, in order to maintain continuity with the Act, the reader should be aware that "modification" would be a more accurate description.

The second Act is the Wetlands Protection Act (Chapter 131 of MGL) which regulates activities in the aquatic and brackish habitats where most mosquitoes breed. However, organized mosquito control is generally exempt from the provisions of this State Law. Hence, the Federal Wetlands Protection Act as administered by the U. S. Corps of Engineers, is the principal regulating mechanism for mosquito-control alterations in wetlands. Regardless of the general exemption, mosquito control is not exempt from checking for the presence of rare and endangered species through the Massachusetts Natural Heritage Atlas, which lists estimated habitat maps for all rare and endangered species as developed by the Natural Heritage Endangered Species Program (NHESP). NHESP also overseeing vernal pool certification, not by actively certifying pools itself, but by certifying pools brought to its attention by individuals or organizations such as the Vernal Pool Association.

The third Act which influences mosquito control in the Endangered Species Act (Chapter 131A of MGL) which prohibits the "taking" of rare and endangered species. It also protects "significant habitats,' requiring a permit request for any work done in such areas.

The fourth State Act of importance to mosquito control activities is the Pesticide Control Act (Chapter 132B of MGL) which regulates pesticide use by mosquito control practitioners. Except as already mentioned, Federal Laws do not generally influence local mosquito control practices except where Federal lands are involved. This is true because Massachusetts State Laws are generally more restrictive than their Federal counterparts.

What follows is a brief summary of State and Federal Laws and regulations which may relate to mosquito control activities.

2. State Laws

a. MGL Chap. 252 as currently amended - Improvement of Lowlands. it should be noted that there are ongoing efforts to modify this law, one in particular is designed to require IPM practices in mosquito control.

Sections 1-4. The State Reclamation and Mosquito Control Board (SRMCB) consists of 3 members representing the Departments of Food & Agriculture (DFA), Environmental Management (DEM), and Environmental Protection (DEP). The SRMCB is housed in the Department of Food & Agriculture. Members of the SRMCB (appointed by the commissioners of their respective departments) receive no additional compensation for their service on the SRMCB, but are entitled to any expenses incurred in the performance of their duties. Although not required by this statute, the SRMCB elects one member to serve as Chairman. The SRMCB has the authority, under this chapter, to (1) drain or flow (flood) a lowland with multiple ownerships, (2) remove obstructions in rivers or streams leading to low lands, or (3) eradicate (abate) mosquitoes in infested areas whenever it considers such activities to be necessary or useful. This chapter requires that the SRMCB make an annual report. Employees (engineers, assistants, agents, etc.) may be hired by the SRMCB to carry out the provisions in this chapter. These parties are empowered to enter any private land which the SRMCB wishes to examine or survey.

Section 4A. The Commonwealth, acting through a State department or the Metropolitan District Commission, and any municipality, may, in its proprietary capacity, take part in lowland improvements described in this chapter. In their governmental capacity, these agencies/municipalities may take such action when the public health, safety, or convenience will be promoted by lowland improvements. The improvements made must be in accordance with Section 5A of this chapter. A petition by proprietors for lowland improvement does not require a majority rule. The governing bodies of the agencies/municipalities must act on the petition. Notice of a hearing before the SRMCB will be given to all petitioners, governing bodies, and to all known proprietors whose land

would be affected by such improvements. Municipalities are authorized to raise and appropriate money for the improvements.

Section 5. The majority (in either value or area) of proprietors of any area, may petition the SRMCB to improve the area. Upon receipt of the petition and appropriate fees, the SRMCB will investigate and survey the land to determine the practicability and advisability of the proposed improvements. If the improvements are deemed practicable and advisable, the SRMCB will give public notice of the petition in a regional newspaper and by registered mail to each known owner, stating the date of a hearing to be held by the SRMCB. After the hearing and upon the SRMCB's approval of the proposed improvements, the SRMCB will determine whether a reclamation district is necessary.

If a district is recommended, the SRMCB will appoint 3, 5, or 7 district commissioners to form a reclamation district. Commissioners will receive no more than ten dollars for each day of actual service plus compensation for expenses incurred in the performance of their duties. The district is responsible for paying such compensation and expenses, as well as the actual cost of improvements. The district must reimburse the SRMCB's contributors the money that was expended for improvements. However, this does not include any money that was given to the district for improvements, but returned to the SRMCB because it was not needed or used. The SRMCB may fire and hire commissioners for cause.

Section 5A. The SRMCB may determine that although improvements should be made, a reclamation district need not be formed. When the SRMCB is petitioned by an agency/municipality (as described in Section 4A), it will notify the petitioners of the estimated expense of the proposed improvements. Once money is received to cover the expense, the SRMCB will designate a name under which improvements will be made and sends the money to the State Treasurer who holds it in a special fund. When needed, the money may be disbursed on warrants drawn by the SRMCB. The SRMCB will appoint one or more commissioners to oversee the improvements. The commissioner(s) receive a compensation (fixed by the SRMCB), plus expenses incurred in the performance of their duties. The SRMCB has the authority to hire and fire commissioners for cause. Any excess funds are returned to the contributors (in proportion to their contributions). If funds contributed are insufficient to complete the improvements, the SRMCB will notify the contributors of their shares of the additional cost. Improvements will not continue until these additional funds are received by the SRMCB. In order to carry out the improvements, the SRMCB will have the powers conferred under Sections 2, 3, 4, 5 (except reimbursement of

expenses), and 8. Commissioners have the powers conferred under Sections 12 and 13 (provided any property taken by eminent domain is taken in the name of the municipality, and the municipality (1) authorizes the taking, (2) assumes liability for damages, and (3) has complied with all laws concerning land taking). Money for which the municipality is liable may be contributed by persons benefited by the improvements, in proportion to their respective benefits, or otherwise. Any municipality which has withdrawn from a mosquito control project may, with approval of the board and upon such conditions as the board my prescribe, rejoin by public vote.

Section 5B. Local Boards of Health (in areas not in mosquito control districts), and mosquito control district commissioners may determine a mosquito breeding area to be a public nuisance. They may give the owner of the area a written notice stating that a mosquito breeding area exists on their land, causing a public nuisance. The notice should also give treatment methods and set a deadline for abatement. If the owner refuses to abate, the Board of Health or the mosquito control district commissioners may abate the nuisance (in a manner approved by the SRMCB). In doing so, they may hire all necessary assistants who may enter upon the land for abatement purposes.

Section 6. For the purpose of organizing a mosquito control district, the district commissioners will call a meeting of the proprietors of the lands to be improved. A majority in interest (in either property value or area) must be present at the meeting, otherwise the meeting will have no power to act. At the meeting, a temporary clerk and a moderator are elected. The moderator submits the question of organizing a reclamation district (under the provisions of this chapter) to the proprietors. If accepted by a majority vote, the proprietors will then elect, by ballot, a district clerk and treasurer (one year terms), as well as 3-member prudential committee (three years terms; one member is replaced every year). At each annual meeting, elections will be held to replace the clerk, the treasurer, and one member of the prudential committee. At meetings, the district may borrow money for necessary expenses, and may issue notes, payable in not more than two years. These notes are subject to the provisions of Section 10 and MGL Chapter 44. The proceeds will be held by the district treasurer.

Subsequent meetings will be called by the clerk at the request of the commissioners or at least two proprietors. If the clerk neglects or refuses to call the meeting, the meeting may be called upon a warrant from a justice of the peace. Notices of meetings must be posted in two or more public places or should be mailed to each proprietor 7 days before the meeting. Vacancies in the office of clerk, treasurer, or member of the prudential committee may be filled at any legal meeting. If necessary, the prudential committee may appoint a person to temporarily fill a position until an election can be held or until the officer is no longer disabled.

The prudential committee is in charge of expenditures for maintenance of the improvements, and exercises the authority conferred upon the district by law.

The treasurer receives the district's money (except as otherwise specified in Sections 6 to 14A). He/she makes payments under the direction of the district or the prudential committee, in accordance with the requirements of Sections 1 to 14B and MGL Chapter 44.

By-laws may be adopted by a district formed under this section. These by-laws are subject to the approval of the SRMCB. The district has the rights and powers authorized to it under Section 14A for carrying out and maintaining improvements. The members of the district are the owners of land lying within its limits.

A district will not be dissolved without authorization by the General Court. This authorization will not be given until a provision has been made for payment of the obligations of the district.

Section 6A. Any district established under this chapter may buy the following insurance coverages:

(1) liability for bodily injuries and damage to property;

(2) liability for workmen's compensation;

(3) fire insurance (covering, among other things, loss by destruction or damage to buildings or personal property);

and (4) motor vehicle collision insurance.

Section 7. Once a district is organized, the commissioners will make surveys and investigations and will prepare a plan delineating district boundaries and proposed improvements. They will determine the total expense of the proposed improvements, along with the percentage to be paid by each proprietor (determined by estimating the benefits less any damages caused by the improvements. The proprietor will be awarded any damages in excess of the benefits. The commissioners will report their plan and estimates to the SRMCB who will approve, disapprove or modify them.

The commissioners must also submit a copy of their determination to each proprietor (hand-delivered or by registered mail). A proprietor has 15 days in which to file any objections with the SRMCB. The SRMCB will notify all proprietors of the receipt of any objections within 30 days; and at least 7 days after this notice is given, the SRMCB will hold a meeting to consider the objections and to make a decision. If the proprietors are not satisfied with this decision, they may petition the County Superior Court.

Once the percentages to be paid by each proprietor have been determined, the SRMCB will record in the

Registry of Deeds (1) a description of the area to be improved; (2) a copy of a plan; and (3) an estimate of the amount to be assessed from each parcel.

Section 8. If the SRMCB feels that certain improvements will benefit public health as a whole and should, therefore, be paid by the Commonwealth, the SRMCB must separately estimate that part of the expense, to be included with other estimates under MGL Chapter 29, Section 4.

Section 9. After recording the description, plan and estimate (from Section 7), the commissioners will call a meeting to decide on the method of financing (options are included in Sections 10 and 11). Approval of proposed expenditures requires a majority vote of a body of proprietors representing a majority interest in both acreage and value of the district's area.

The district commissioners may petition the county commissioners to vote to pay for the first expenditures involved in making improvements. Upon approval, the county treasurer may issue bonds or notes, payable within 25 years to defray expenses. Payment of principal and interest will be made by the county and repaid to the county by the district.

Section 10. The district may vote to adopt any of three methods of financing. It may raise money, by assessment or contribution, and deposit the funds required to cover the estimated expenses with the State Treasurer (payments are made as provided in Section 14). The district may take out a temporary loan in anticipation of assessments from district members and, thereby, pay for the improvements as the work is performed. The district may issue notes or bonds, payable for the amount of the estimated expense, on condition that the initial payment is made within 5 years of the issue date, and that the entire amount is paid within 25 years.

Indebtedness is subject to MGL Chapter 44 and other MGL's applicable to notes and bonds of districts. Money received from the sale of notes and bonds will be deposited with the State Treasurer. The State Treasurer will credit the district account for any district expenses that benefit the public health of the Commonwealth. Money remaining after payment of the total expenses will be paid to the district treasurer to redeem outstanding notes and bonds.

Section 11. The district clerk will certify to the assessors the amount of money voted to be raised and paid annually (on account of the interest and principal due) along with the amount to be paid by each proprietor. A copy of this certification must be filed with the SRMCB. The certified amount will be assessed from the land of the proprietors and will be committed to the local tax collectors. Each week, the tax collectors will remit the money

collected from the assessments to the district treasurer. Assessments will be considered a financial obligation under law, upon the recording of the description, plan and estimate (under Section 7), and will continue for two years as of July 1 of the year of assessment (i.e., reassessments are made every 2 years).

Section 12. If Sections 1-7 have been complied with, and payments for expenses have been arranged, the commissioners will carry out the improvements, as approved by the SRMCB. The commissioners may hire persons to perform the work under their direction. If improvements are for public use, the commissioners may take lands, easements, and rights in lands (under MGL Chapter 79), and may purchase and convey property within and beyond the limits of the Commonwealth if necessary. Any person damaged in his property (by an action under this and the following section), may recover damages from the district (as provided in MGL Chapter 79). These damages will constitute a part of the total expense of the improvements.

If the commissioners find it necessary to regulate water levels by operating floodgates or dams on the land of a person not a party to the proceedings (e.g., a person outside the district), the commissioners must give reasonable notice to the proprietor. The proprietor may appeal this work by petitioning the County Superior Court within 30 days after receipt of the notice. Until the appeal is determined, the commissioners must suspend the work.

The commissioners are required to submit to the SRMCB the bills incurred in meeting the cost of required improvements (under Section 14B), on a monthly basis. Once inspected and approved by the SRMCB, these bills will be rewarded to the County or State Treasurer who will make payment from available funds. The SRMCB must also approve bills for maintenance or further improvements reported by the prudential committee and the commissioners (as provided in Section 14A). Once approved, payment will be made by the district treasurer.

Section 14A. A reclamation district organized under this chapter may vote to undertake further improvements, and to incur debt (as provided in Section 10). Original improvements must be completed before this vote is passed. The district may also vote to request the SRMCB to appoint commissioners to carry out these further improvements (as provided in Section 5). Or, the district may authorize its prudential committee to carry out. these further improvements. In either case, both the prudential committee and the commissioners acting under this section will have the same powers as authorized under Section 5. The district will notify the SRMCB of their vote and the prudential committee/commissioners will submit to the SRMCB its/their plans for carrying out the improvements. Assessments from district members to pay for the improvements (modifications) will be made in the manner provided in Section 11.

Section 14B. No person obtaining additional water power or water by the work contemplated in Section 1 - 14B will gain the right to its use, nor may a person be entitled to compensation if the additional water is reclaimed. No water power may be developed by a district under this chapter except by vote of the district and approval of the SRMCB.

Anyone who obstructs or injures any structure constructed under the provisions of Sections 1 - 14B will be fined not less than ten dollars. In addition, the SRMCB may attempt to recover from the perpetrator any damages incurred. The provisions in Section 5A will govern the disposition of money recovered.

The mayor and aldermen or selectmen will receive two dollars for each day of service. The city or town clerk will receive (for recording the petition), the fee provided by Clause (68) of Section 34 of MGL Chapter 262.

Any party aggrieved by the mayor's and aldermen's or selectmen's refusal to make such an order, may petition the county commissioners. The county commissioners will proceed as if the petition had been originally filed with them.

Section 24. Greenhead fly control projects may be established, with the approval of the SRMCB, in any town or city along the seacoast, by vote of the city council/selectmen. By the same vote, any two or more adjoining cities or towns may form a district within their combined areas.

For these areas, the SRMCB will appoint 3 district commissioners. They will be paid a fixed compensation, not exceeding five dollars per day, along with other expenses incurred in the performance of their duties. Compensation and expenses will be paid by the district. The SRMCB may fire and hire Commissioners for cause. The duties of the commissioners will be established by the SRMCB.

Votes to form a district are binding for five years. Any city or town may vote to withdraw from the district within 60 days, but not less than 10 days, of any "anniversary date" of its original vote. They must notify the SRMCB within this time frame, as well.

Any city or town may vote to join an existing district, with the approval of the SRMCB.

Each project will determine its maximum annual budget, and will report its determination to the SRMCB. In the case of districts, the commissioners will make this determination. The SRMCB will, in turn, determine the proportionate share of the budget that each member municipality is to be held accounted for. The SRMCB will then report its determination to the treasurer of each member municipality.

One third of the budget will be paid by the member municipalities within a district in proportion to the salt

marsh area within its boundaries. Another third will be paid by the Commonwealth. The final third will be paid by the member towns/cities within a district in proportion to their respective taxable valuations. A project consisting of a single municipality is not entitled to subsidy by the Commonwealth.

Payments of each municipality's share of the budget will be made to the State Treasurer. Towns/cities may also raise money in advance to anticipate its liability. These funds would be held by the State Treasurer, as well, and would be credited against the municipality's liability.

Projects will be allocated funds annually from the State Treasury to eliminate or control Greenhead flies in accordance with the predetermined control strategy (prepared and devised by the SRMCB to effect the greatest measure of relief). Such work must be performed under the direction and control of the SRMCB. Additional control efforts may be carried out as long as additional funding is provided, such as funds voluntarily deposited with the State Treasurer for such purposes.

b. MGL Chap. 132B -- Pesticide Control Act (From the Code of Massachusetts Regulations 333 CMR 2.00 -10.00)

General Information

The Massachusetts Pesticide Control Act was inserted as MGL Chap. 132B of the Acts of 1978 (Chapter 3) as an emergency law and took effect immediately. The purpose of the Act is to have the laws of the Commonwealth conform with federal requirements on registration and certification of pesticides as set forth in the Federal Insecticide, Fungicide, and Rodenticide Act, Public Law 92-516, as amended, (FIFRA), and the federal regulations thereunder. To this end, the Massachusetts Pesticide Control Act creates administrative mechanisms to regulate the labeling distribution, sale, storage, transportation, use and application and disposal of pesticides. The Massachusetts Act also establishes standards and sets forth prohibitions with regard to each regulatory function. The responsibility for implementing the commands of the Massachusetts Pesticide Control Act is distributed by the Act among three governmental bodies:

i. Department of Food and Agriculture (DFA). The DFA has been designated as the state lead agency for implementation and administration of the Act and the Massachusetts pesticide program.

The Act charges the DFA with a wide range of specific regulatory functions and empowers it to promulgate and adopt regulations, standards and forms as are necessary for implementation and administration. Among the duties assigned to the DFA by the Act are:

a. Entering into cooperative agreements and contracts in matters related to the Act and FIFRA.

b. Taking actions necessary to secure for the Commonwealth the benefits of FIFRA and other federal legislation.

c. Establishing advisory councils.

d. Declaring pests and devices to be subject to the provisions of the Act.

e. Establishing the fee and preparing and accepting the applications for experimental use permits.

f. Establishing requirements for licensing and supervising pesticide dealers.

g. Establishing requirements for certifying, licensing and supervising various categories of pesticide applicators.

h. Controlling both storage and disposal of pesticides.

i. Issuing administrative orders to prevent unreasonable adverse effects on the environment or violations under the Act.

j. Right of entry and inspection as needed to administer the Act. Within the DFA, the pesticide regulatory functions shall be under the administrative supervision of a Pesticides Program Director.

ii. Pesticide Board. The Act creates within the DFA a Massachusetts Pesticide Board.

The Board's responsibilities entail advising the Commissioner of Food and Agriculture with respect to the implementation and administration of the Act The Board also hears appeals of those aggrieved by the actions or decisions of the DFA or the Subcommittee of the Pesticide Board. The Act, additionally, assigns the Board the responsibility for approving a variety of departmental actions within the DFA. Among the actions requiring Board approval are:

a. All regulations, standards and forms proposed by the DFA to implement and administer the Act.

b. Appointment of the Pesticides Program Director.

c. Cooperative agreements and contracts with respect to the Act and FIFRA.

d. Establishment of advisory councils.

e. Declarations of pests and devices to be subject to the provisions of the Act.

The Commissioner of Food and Agriculture or his designee serves as the Chairman of the Pesticide Board. Other members include the Commissioner of Environmental Protection or his designee, the Commissioner of Fisheries, Wildlife and Recreational Vehicles or his designee, the Commissioner of Environmental Management or his designee, the Commissioner of Public Health or his designee, the Director of the Division of Food and Drugs or his designee and the seven persons appointed by the Governor, one of whom has been engaged in the commercial production of a plant-related agricultural commodity for at least the preceding five years on land owned or rented by him, one of whom has been an active commercial applicator of pesticides for at least the preceding five years, one of whom has expertise in the health effects of pesticide use, one of whom is a physician, one of whom is experienced in the conservation and protection of the environment, and two of whom represent the public at large. Each member is appointed for a period of four years, except for persons appointed to fill vacancies, who serve for the unexpired term.

The appointive members of the Board receive fifty dollars for each day or portion thereof spent in the discharge of their official duties and are reimbursed for their necessary expenses incurred in the discharge of their official duties.

iii. Subcommittee of the Pesticide Board. The Act creates a subcommittee within the Pesticide Board of the DFA.

The subcommittee is responsible for registering all pesticides for use in the Commonwealth and for issuing all experimental use permits.

The Director of the Division of Food and Drugs serves as the Chairman of the Subcommittee. Other members include the Commissioner of Food and Agriculture or his designee, the Commissioner of Environmental Management or his designee, and the Commissioner of Public Health or his designee, and one person appointed by the Governor, who has been actively engaged in commercial application of pesticides for at least the preceding five years who is a member of the Pesticide Board.

c. 333 CMR 10.03 (21-23) - Amendments of 1983.

Amendment (21) to the Pesticide Regulations provides a list of conditions that must be met prior to all non-agricultural pesticide applications by aircraft. It calls for public notification of abutting Landowners 2-10 days before the application as well as notification of the Department of Food and Agriculture and the contractor. Application sites must be recorded on U.S.G.S topographical maps and records kept for 2 years. Amendment (22)

deals with the right of exclusion from pesticide applications of property owners and their tenants. Methods are outlined for requesting exclusion and for properly marking the boundaries of property to be excluded. Exclusion requests are not honored if public health or agricultural threats exist or if a recently introduced pest is being contained.

Amendment (23) requires a permit from the Department of Food and Agricultural for all private applications of pesticide by aircraft. Aerial applications for mosquito control are specifically exempted from this provision along with a few other classes of applications.

d. M.G.L., Chap. 91. Sections 1-63 -- Waterways

This law does not deal specifically with mosquito control but it does cover variety of activities associated with wetlands. Mosquito control is specifically exempted from the provisions of Sections 19A, 59 and 59A of this law but not from other provisions. As amended by Chap. 373 of the Acts of 1969, the Act makes provisions so that the use of oil for mosquito control in any lakes rivers, or tidal waters or flats under MGL 252 is exempt from the provisions of Section 59 and 59A of Chapter 91, provided it conforms to the rules and regulations and of the State Pesticide Board.

e. M.G.L., Chapter 40. Section 5 - Boards of Health and Supervision.

Clause (36) and (36C) have MGL Chapter 40 Section 5 refers to the appropriation of money by towns for mosquito abatement:

(Clause 36). At any town meeting, a town, whether or not a member of a mosquito control project, may appropriate money for lowland improvement (modification) and mosquito abatement. Outside agencies may be contracted by the Board of Health to carry out mosquito control, provided the SRMCB is notified. This outside agency is responsible for filing a detailed annual report of their mosquito control program with the SRMCB.

(Clause 36C). A town or city that is a member of a mosquito control project may appropriate money in addition to the amount assessed by the project for mosquito abatement. The abatement activities must, however, be carried out under the supervision and control of the mosquito control project.

f. M.G.L., Chapter 131. Section 40 - Wetlands Protection Act.

The Wetlands Protection Act controls the use of freshwater and coastal wetlands by establishing a public review and decision-making process through which certain activities affecting wetlands may be regulated. The Act is administered by local conservation commissions (or the mayor or selectmen of towns without conservation

commissions), and the Department of Environmental Protection (DEP). Any proposed project that may affect a wetland area must be approved by the local conservation commission. The proponent must apply for a permit with the conservation commission and the DEP, who will evaluate the proposed project to determine whether any land is subject to the jurisdiction of the Act. The Act is complemented by 310 CMR 10.00, which provides the conservation commission, and DEP with standard definitions and procedures by which to implement the Act. Proposed alterations to wetland habitats of rare wildlife must also be reviewed by the Natural history & Endangered Species Program (see Endangered Species Act below).

Mosquito control activities are exempt from the provisions of the Wetlands Protection Act, provided that the activities are carried out in compliance with Clause (36) of Section 5 of MGL Chapter 40, MGL Chapter 252, or of any special act. Nonetheless, there is still some debate concerning whether the exemption applies only to the maintenance of existing structures or also includes new structures. (see page 25)

g. Section 40A of Chapter 131. Inland Wetlands Restriction Act. Section 105 of Chapter 130. Coastal Wetlands Restriction Act.

The Inland Wetlands Restriction Act, together with the Coastal Wetlands Restriction Act makes up the statutory basis of the Massachusetts Wetlands Restriction Program. The objective of both Acts is to promote and protect the public safety, property, wildlife, fisheries, water resources, flood plain areas, and agriculture by restricting or prohibiting the altering or polluting of inland and coastal wetlands. Although the areas and interests protected are basically the same as those protected by the Wetlands Protection Act, the Wetlands Restriction Acts set forth a planning program that is not dependent on a proponent's initiative to apply for a permit. Through the Massachusetts Wetlands Restoration Program, inland and coastal wetlands are mapped out in each city and town. After a public hearing, a Restriction Order is issued by the administering agency, which prohibits certain activities in the wetland areas. The Order is then recorded in the Registry of Deeds and is binding to all present and future owners of the property.

Two regulations, which correspond to the Acts, are 302 CMR 4 and 6. These regulations contain the rules for adopting coastal and inland wetland orders. The Department of Environmental Management is the legal authority for both Restriction Acts. However, the administrative responsibility has been taken on in recent years by the DEP. A statutory transfer of the Massachusetts Wetlands Restriction Program is pending.

Mosquito control, as authorized by MGL Chapter 252, is exempt from the Wetlands Restriction Act.

h. M.G.L., Chapter 131A. Massachusetts Endangered Species Act.

This Act prohibits the “taking” of rare plants or animals. This includes all plants or animals listed as Endangered, Threatened, or Special Concern by the Massachusetts Division of Fisheries and Wildlife. Fines and jail terms may be imposed for illegally taking a rare species. This Act also protects “significant habitats,” which can be so designated after a public hearing process. Permits must be issued for any work in significant habitats.

The primary agency for determining rare species status and significant habitats is the Massachusetts Natural History & Endangered Species Program (NHESP) run from the office of the Division of Fisheries & Wildlife. NHESP has developed a series of Estimated Habitat Maps for state-listed rare species (contained in the Massachusetts Natural Heritage Atlas), which assist mosquito-control programs in determining the presence or absence of rare or endangered species.

Mosquito control activities are not exempt from the Endangered Species Act and care must be taken to ensure programs are in compliance with the Act. Both pesticide applications and storm water drainage are considered alterations and require permitting.

i. M.G.L., Chapter 132A. Sections 13-16, 18 -- Ocean and Coastal Sanctuaries Act

The following areas in Massachusetts are protected under the Act: the Cape Cod Ocean Sanctuary, the Cape Cod Bay Ocean Sanctuary, the Cape and Islands Ocean Sanctuary, the North Shore Ocean Sanctuary, and the South Essex Ocean Sanctuary. Section 13 of the Act demarcates the ocean sanctuaries, all of which extend approximately three miles seaward from a point on the mean low water line. The purpose of the Act, as described in Section 14, is to protect each ocean sanctuary from any "...exploitation, development, or activity that would seriously alter or otherwise endanger the ecology or the appearance of the ocean, the seabed, or the subsoil (of the sanctuaries), or the Cape Cod National Seashore."

The Ocean Sanctuaries Act does not require the issuance of permits other than those already required by law. In consequence, the Department of Environmental Management, the State agency authorized to oversee the Act, serves as a trustee rather than as a permitting agency. All other State and local permitting agencies are responsible for conducting their activities in conformation with the Act. Regulation 302 CMR 5.00 complements the Act.

Although not specifically exempted from the provisions of the Act, mosquito control activities are not performed within the boundaries of the ocean sanctuaries.

j. Acts of Enabling Legislation Establishing Mosquito Control Projects

Except for Cape Cod, all 10 current and disbanded MC Projects in Massachusetts were established after World War II when mosquito control first appeared both technically and economically feasible on a wide scale. The most recent were the Central Massachusetts and Suffolk County projects formed in 1973/74. Almost without exception, these projects were created as a result of lobbying efforts by local citizen groups who were concerned about both outbreaks of mosquito-borne disease (i.e. EEE) and biting annoyance created by high densities of mosquitoes. Local legislators and city selectmen or boards of health played roles in shepherding through the necessary legislation. The Cape Cod Chamber of Commerce was instrumental in the creation of the MC Project on the Cape. The Board of Reclamation often assisted local citizens and legislature with their efforts. especially in the case of the more recently established projects.

The East Middlesex and South Shore (disbanded in 1981) projects were formed under Chapter 252 of the General Laws. The remaining eight were created by special legislation (individual project descriptions below). An important change in the entering and leaving procedure was made in 1991 when state legislation required towns, upon joining a project, to commit to a minimum of a five-year membership. This provides both stability of funding to the projects and enables a more comprehensive pest management plan to be put in place (single-year memberships place emphasis on immediate results; multi-year memberships place emphasis on long-term results).

3. Federal Laws

Federal laws, which directly impact on mosquito control activities, are Sections 401 and 404 of the Clean Water Act and the Endangered Species Act. All other federal restrictions governing wetlands and pesticides are covered by Massachusetts's laws, which impose restrictions, and requirements that are equal to or greater than those in comparable federal law. The exception in the case of Section 404 arises because the state laws governing the ditching of wetlands exempt mosquito control but the Federal Clean Water Act does not.

a. Section 401. Clean Water Act: Water Quality Certification.

This section requires applicants wishing to discharge dredged or fill materials to obtain a certification or waiver from their state water pollution control agency (Massachusetts Bureau of Resource Protection, Division of Wetlands and Waterways). Section 401 is a federal mandate that is implemented by the state, resulting in some friction over precisely what does and does not require a water quality certificate and what issues the certification can and cannot address. The issue is rendered moot for mosquito control, however, as the U. S. Army Corps of Engineers will not permit a mosquito-control project that does not have a water quality certification. Section 401

provides DWW with the power to influence permit applications in two ways: by denial of the required water quality certification, and by issuing the water quality certification with limitations attached. To date, obtaining water quality certifications has not been particularly difficult for Massachusetts mosquito control programs.

b. Section 404. Clean Water Act (1972).

This Federal Act calls for a system of permitting to be carried out by the U. S. Army Corps of Engineers with a review of all permit applications by appropriate state and federal agencies. The mosquito-control activities, which require a permit under Section 404, are as follows:

a) Cutting or clearing new mosquito ditches in tidal areas below mean high water.

b) Placing material excavated from existing or new ditches on salt marshes or freshwater wetlands.

The Corps developed a draft plan in the early 1980's outlining procedures for issuing general permits for maintenance work (i.e. ditch cleaning) in existing mosquito ditches in each MC project. This plan was eventually shelved pending the preparation of a GEIR to serve as a guide. According to 1986 correspondence to the Norfolk County MCP from the Section Chief of the Regulatory Branch of the Operations Division, the Corps does not require a permit under Section 404 for ditch cleaning provided the spoil is scattered at a depth of no more than 3 inches.

The question of permit requirements for new construction in Massachusetts's salt marshes, such as the OMWM projects in Essex and Plymouth Counties, remains an ambiguous issue. The Audubon OMWM Manual (p. 2-2) indicates that, in addition to the Corps permit, permits are required from the Division of Waterways, Office of Environmental Affairs and a Letter of Consistency from the Office of Coastal Zone Management. Interagency correspondence suggests that even agency heads are unclear about the legality of any of these requirements when mosquito source reduction work is involved. However, in current practice the Corps is not issuing permits for OMWM projects without these two documents.

c. Endangered Species Act.

This act is designed to protect threatened and endangered species as listed on the National Historic Register Suffolk County has had to use Bti instead of Altosid in areas where the Blue-spotted salamander (*Ambystoma laterale)* and the banded bog skimmer (*Williamsonia lintneri*). Other projects, such as Bristol County MCP, have requested advice on osprey (Horseneck Beach in Westport) and the yellow-spotted turtle but have not had to modify their proposed work because of these animals. In both cases Bristol County was doing ditch maintenance. Should

the project have been proposing larviciding or more extensive source reduction work, there is a chance that their request would have been denied.

With the Suffolk County larviciding program, the issue of the effects of Altosid, an insect hormone mimic, on reproduction in amphibians has been the driving force behind the decision to not allow its use. The scientific claims for such effects are limited and more research in this area is required.

In Plymouth County, proposed drainage maintenance was halted by the local conservation commission because they felt that the drainage threatened the pools themselves, regardless of the presence of endangered species. Whether or not all vernal pools deserve complete protection remains a matter for research and debate.

The net effect of the Endangered species act on mosquito control has been small, but has provided another means of analyzing the environmental effects of mosquito control. research on the effects of source reduction on non-targets is lacking and this lack should be addressed.

B. Current Mosquito Control Programs in Massachusetts

1. Formal Mosquito Control Projects

Of the 351 Towns in Massachusetts, 158 (or 45%) currently belong to the 9 organized MC. These projects and the towns included in each are illustrated topographically in Fig. 1. Each project is managed by a superintendent who is hired and supervised by a Board of Commissioners representing the towns included in the project. Board members are appointed by the Board of Reclamation for designated terms (usually 3-5 years). Members are unpaid except for up to $75 per meeting in expenses. Boards generally meet once or twice monthly to authorize major expenditures and to review policy and program progress.

Questionnaires were sent to each MC Project in both 1985 and in 1996 (copies in Appendix 1). The projects' responses to the questionnaire formed the basis for the following summaries.

The State Reclamation and Mosquito Control Board exercises responsibility over all 9 projects. This responsibility includes, but is not necessarily limit to, the following:

1. Review and approve budgets
2. Administer project funds (payroll, process purchases, etc.)
3. Review program plans
4. Appoint commissioners
5. Issue control policies and recommendations

6. Administer emergency control funds provided to projects from the governor's or legislators emergency funds
7. Provide advice and guidance when requested by projects or towns
8. Moderate disputes
9. Assist towns seeking to join or organize a formal project or to withdraw from an existing project
10. Serve as a liaison between projects and other state and federal agencies and in legislative matters

Most projects indicated satisfaction with the administrative arrangement and the current functioning of the SRMCB. Suggestions for improvement centered around the Board providing more comprehensive services to the projects (this would require more staff) and more efficient and responsive staff for dealing with project budgets. More formal meetings with all projects to foster better communication and occasional attendance of Board representatives at project commission meetings were a common theme.

All projects have a Board of Commissioners appointed by the SRMCB. They represent the various towns within each project and exercise general control over the project. Their specific role involves, but is not necessarily limited to the following:

1. Appoint the project superintendent
2. Approve the appointment of all permanent project personnel
3. Approve payroll and sign all invoices prior to processing by the SRMCB
4. Review and set policy
5. Review budgets and salaries
6. Serve as liaison between the project and the towns they represent
7. Provide advice to project superintendent
8. Moderate disputes

The projects find this administrative structure to be responsive and appropriate. The wide range of expertise represented by the commission membership brings a broad information base to bear on important financial and operational issues. The superintendents make all day-to-day operational decisions concerning when and where to institute control and what methods to use.

The Nine Mosquito Control Projects of Massachusetts (see Tables 1 and 2 for budget figures presented in descriptions):

Berkshire County Mosquito Control Project

Created under:	Chapter 456 of the Acts of 1945
Area included:	The towns of Becket, Hinsdale, Lanesboro, Otis, Richmond, and Sheffield and Stockbridge.
Annual Assessment:	35 cents on each one thousand dollars of taxable valuations; sums so expended in proportion to their respective valuations.
Amendment to Assessment:	Chapter 459 of the Acts of 1970--20 cents on each one thousand dollars of the equalized valuations; sums so expended in proportion to their said valuations.

Formed in post-War 1945 under the leadership of the State Senator from Pittsfield. This countywide project originally had 32 member towns. All except 8 of these towns withdrew in the early 80's after the passage of Proposition 2 1/2 and considerable negative publicity. One additional town left later on. Since 1985, four towns have joined the project and four have withdrawn. Of these one (Hinsdale) withdrew and then rejoined and another (Pittsfield) joined and then withdrew. The reasons for withdrawing centered on cost, while the reasons for joining centered on municipalities responding to resident complaints.

Spring hatch *Aedes* are the major problem experienced in this mountainous terrain. Some reflood *Aedes* and *Cq. perturbans* problems also exist. In 1985 approximately 70% of the budget was devoted to source reduction through hand cleaning of ditches. By 1996, approximately 70% of the budget is devoted to larviciding and adulticiding. The program is evaluated by all four standard monitoring methods.

Over the past decade increasing citizen concern regarding pesticide use has been the most important change faced by the project. At present, providing the desired control services under very tight funding is given as the most important challenge facing the project.

Bristol County Mosquito Control Project

Created under:	Chapter 506 of the Acts of 1956
Area included:	All the cities & towns comprising Bristol County
Annual Assessment:	15 cents on each one thousand dollars of taxable valuations; sums so expended in proportion to their respective valuations.
Amendment to Assessment:	Chapter 638 of the Acts of 1970--8 cents on each one thousand dollars of the equalized valuations; sums so expended in proportion to their said valuations.

All twenty towns in Bristol County make up this control project, which was formed in 1959 during a period of high pest densities and threat from EEE. Senator Parker of Taunton played a key role in organizing the

project. Only one town (Dartmouth) subsequently withdrew from the project following negative publicity. It rejoined several years later during another EEE active period.

There are approximately 67,000 acres of fresh water swampland in Bristol County. As in the case of Norfolk and Plymouth Counties, this presents some unique problems. It has resulted in a large source reduction effort (78% of budget in 1995) and adulticiding (19%) over larviciding. Salt marsh mosquitoes have become an increasingly important part of the control program. Spring *Aedes* and *Cq. perturbans* are major pest problems and concern with EEE transmission is ever present. Light trap counts and cases of human/animal disease are used to evaluate the effectiveness of the program.

Over the past decade Bristol MCP has been faced with the double squeeze of increasing concern over wetlands alterations and increasing concerns over pesticide use. With source reduction and adulticiding being the two primary control techniques used by Bristol MCP, such concerns go to the heart of the project's effectiveness. As an example, Bristol MCP switched from malathion to resmethrin for adulticiding due to public pressure to end the use of malathion. However, resmethrin is more costly, which brings to the fore the continuing difficulties of budgets. Bristol MCP, like many other projects, faces difficulties in implementing newer control strategies due to tight budgets.

Cape Cod Mosquito Control Project

Created under:	Chapter 379 of the Acts of 1930
Area included:	The town comprising Barnstable County
Annual Assessment:	25 cents on each one thousand dollars of their respective valuations.
Amendment to Assessment:	Chapter 209 of the Acts of 1975--9 cents on each one thousand dollars of the equalized valuations; sums so expended in proportion to their said valuations.

The Cape Cod project was organized through the efforts of the Cape Cod Chamber of Commerce, beginning in 1928. Their motivation was the enhancement of the recreational resources of the Cape. All 15 towns in Barnstable County have belonged to the project continuously since its formal creation in 1930. There are approximately 20,500 acres of salt marsh and 2,600 acres of freshwater wetlands on the Cape capable of supporting mosquito development.

The Cape Cod project has chosen not to use adulticides as part of their program. Larviciding and source reduction (maintenance on existing water systems) form the backbone of the project. The Cape project is currently

conducting research into the use of native fish as biological control agents for mosquitoes. While larval surveys and larvicide applications are conducted during half of the year, the other half of the year is spent maintaining the current ditch systems (including work on pipes, culverts and sluiceways). Many towns' DPWs and Conservation Commissions utilize the project's expertise to help keep drainage systems open and running properly. Further, the Cape Cod project's work is recognized by the National Flood Insurance Program's Community Rating System as meeting the flood-plain maintenance requirements for towns to obtain lower flood insurance rates.

The Cape Cod project utilizes a Geographical Information System (GIS) that includes maps of all potential larval habitat, documentation of work done including larvicide application, and data from adult and larval surveys conducted at all mosquito development sites. Information from this system is used to write an annual report and is made available to the member towns.

This project also runs a greenhead fly control program. Over 600 blue box traps are placed on the salt marshes of Barnstable County every spring. Research was conducted by the project in the summers of 1992-1995 to determine the effectiveness of adding Octenol, an olfactory attractant to these traps. Success with that research has resulted in this project and others incorporating octenol into their greenhead fly trapping programs.

As an indication of the stability of the Cape Cod Project, all eighteen employees have over 4 years of experience with 50% of the employees having worked in mosquito control for over 15 years

Central Massachusetts Mosquito Control Project

Created under:	Chapter 583 of the Acts of 1973
Area included:	The area in Middlesex and Worcester Counties including the cities of Fitchburg, Leominster, and Marlborough and the towns of Ashland, Ayer, Berlin, Billerica, Blackstone, Boxborough, Chelmsford, Clinton, Dracut, Holliston, Hopedale, Hudson, Littleton, Lunenburg, Milford, Natick, Northborough, Sherborn, Shrewsbury, Southborough, Stow, Tewksbury, Westborough, Westford, and Wilmington.
Annual Assessment:	8 cents on each one thousand dollars of the cities' and towns' equalized valuations; sums so expended one quarter in proportion to their valuations and three quarters in proportion to their respective areas.

Twenty-eight towns make up this large project. It was organized in 1973 through the efforts of several town boards of health and concerned citizen groups. The Project has experienced significant turnover in membership. Two towns withdrew from the project early on but then rejoined. Seven other towns withdrew permanently prior to 1986, primarily as a result of Proposition 2 1/2 fiscal constraints and concern over pesticide

use, though concerns about mosquitoes coming into the town from areas not being treated played a role in Hopkinton's decision to withdraw. However, Fitchburg, Lunenburg, and Leominster were joining during the same period, in each case due to a desire to be a part of a regional approach to mosquito control. Since 1986, an additional seven towns have withdrawn (Harvard, Lancaster, Boylston, Grafton, Groton, Northbridge and Shirley). The towns left for budgetary reasons and environmental concerns. Five towns have joined the project since 1989, two (Wilmington and Natick) because town programs were abandoned, one (Blackstone) because of bad mosquito problems, one (Dracut) because of positive feedback from member towns, and the fifth (Stow) because they liked the environmentally responsible control techniques of the Project. Towns can withdraw or rejoin by a vote at town meeting but joining towns also must be approved by the SRMCB, which may impose special stipulations.

Up to 10,000 acres of mixed, freshwater wetlands and a large number of catch basins and tires are treated with larvicide's (35% of total budget) and/or have source reduction work done (40% of budget). Spring hatch and reflood *Aedes*, and *Cq. perturbans* account for the bulk of the pest problems in this project. All standard monitoring methods are used to evaluate program effectiveness.

Central Mass has assembled an impressive staff, with six staff members holding BS or BA degrees and several personnel having more than 15 years of mosquito-control experience.

Over the past decade the Project has worked to reduce its use of adulticides and increased its applications of larvicides such as Bti. Water management has been geared towards maintenance but wetlands restoration is playing an increasing role. Given that many towns have withdrawn from the project due to budget constraints, developing a modern, cost-effective control program is the highest challenge currently facing the Project.

East Middlesex Mosquito Control Project

Created under:	MCL Chapter 252, section 5A in 1945. There is no specific Massachusetts Law or Act which names the East Middlesex Control Project.
Area included:	Twenty cities and towns in Middlesex and Norfolk Counties including Arlington, Bedford, Belmont, Brookline, Burlington, Cambridge, Framingham, Lexington, Lincoln, Melrose, Newton, North Reading, Reading, Sudbury, Wakefield, Waltham, Watertown, Wayland, Wellesley, and Weston.
Annual assessment:	Cities and towns voluntarily appropriate funding each year for mosquito-control services. Funding is carried over from one fiscal year to the next.

This project was organized in 1945 as a trust agency to provide mosquito control for 6 cities and towns. The original goals for the Project cited by the representatives of the 6 municipalities were to form a cooperative

mosquito control program under the auspices of the State Reclamation Board. Policies for the Project were set by the Commission that would be comprised of representatives, appointed by the State Reclamation board, from each municipality. The primary reasons cited in 1945 for organizing the Project were the vector potential and nuisance caused by mosquitoes.

Currently the Project has 20 members. The newest municipalities to join the project have been North Reading (1991) and Melrose (1997). The twenty-member commission meets twice a year. Five Commissioners serve on the Executive Committee, which meets regularly. Funding is derived through voluntary appropriations. The Commission has a policy, which allows municipalities flexibility in choosing control methods. The Project recommends a control program for each municipality. The municipality then has control over which services it chooses to fund. Although this process has resulted in stable growth since 1983, the Project has historically had funding limitations because 33% of its area is urban with relatively minor mosquito pest problems.

Spring *Aedes* species, *Ae. vexans,* and *Cq. perturbans* are the major concerns in the district. *Culex* in urban areas are also a concern. Aerial larviciding against spring *Aedes* and *Aedes vexans* is the largest program in the district. Other programs include larviciding with a truck-mounted hydraulic sprayer and portable sprayers, catch basin larviciding in urban areas and adulticiding with truck-mounted ULV aerosol sprayers and portable aerosol and backpack mistblowers. Beginning in 1994, the Project entered into a cooperative agreement with the Essex County Mosquito Control project to use a backhoe and operator for East Middlesex ditch-maintenance operations. The Project continues to maintain ditches by hand in woodland areas. The Project maintains an extensive surveillance operation, which includes monitoring adult mosquitoes at 50 locations. The Project records extensive larval survey data to support it's larval control program. Beginning in 1995 the Project augmented its surveillance and record keeping programs by adding GIS mapping software.

North East Massachusetts Mosquito Control and Wetlands Management District
formerly Essex County Mosquito Control Project

Created under:	Chapter 516 of the Acts of 1958
Area included:	The area in Essex County not including any city or town already a member of an organized mosquito control project.
Annual Assessment:	15 cents on each one thousand dollars of taxable valuations; sums so expended one quarter in proportion to their valuations and three quarters in proportion to their respective areas.
Amendment of Assessment:	Chapter 679 of the Acts of 1970 -- eight cents on each thousand dollars of equalized valuation; on quarter in proportion to there said valuations and three quarters in proportion to their respective areas.

This seventeen-town project was established in 1965 after lobbying efforts by citizen groups who were concerned about pest mosquitoes. Prior to 1986 four towns (Essex, Merrimac, North Reading, Lynnfield) subsequently withdrew from the project by town meeting vote due to fiscal constraints and some negative publicity. One of these towns (Lynnfield) rejoined the following year due to a perceived increase in pest densities and threats to public health. Ten towns withdrew from the project in the late 'eighties, primarily because of budget constraints. Four towns (Ipswich, Newburyport, Salisbury and Amesbury) have since rejoined, all because of public demand following the halt of control activity (length of time out of project varied from one to three years).

A high proportion of the Essex County MCP budget is devoted to salt marsh mosquito problems (60%) and this project has taken the lead in working with environmental interests to develop OMWM plans and studies in some of its marshes. Catch basins are treated with Altosid briquettes and all other larviciding is carried out with the bacterial toxin Bti. This is mostly in woodland vernal pools in the spring and in unmanaged salt marshes. The project does little adulticiding. It also administers a greenhead fly control program using box traps in several coastal towns. All monitoring methods (i.e., complaints, and light emergence traps, and landing/larval counts) are used to evaluate the effectiveness of the program and for daily decision-making.

Essex County has been a leading project in developing Open Marsh Water Management as a mosquito-control and marsh-restoration technique in the Northeast, and has pushed to develop a set of standards for mosquito control in such areas as uplands ditch maintenance that will both standardize control throughout New England and provide a better framework for the permitting process.

Not surprisingly for a Project with a forward thinking approach, Essex County's program, over the past decade, has reduced adulticiding while implementing OMWM and increasing its ties with environmental agencies and groups. The loss of several towns has required a change in strategy from a regional to a municipal approach, a change not particularly desirable for area-wide control problems like mosquitoes. However, the challenge of revising the Project's strategies and techniques has been met and its most important challenge today is meeting the demand for marsh restoration work while continuing to maintain a high standard for mosquito control.

Essex County MCP changed its name in 1996 to the North East Massachusetts Mosquito Control and Wetlands Management District, but it will be referred to as Essex County in this report as the name is new and may not be recognized by readers at this time.

Norfolk County Mosquito Control Project

Created under:	Chapter 341 of the Acts of 1956
Area included:	The area in Norfolk County not including any city or town already a member of an organized mosquito control project.
Annual Assessment:	20 cents on each one thousand dollars of taxable valuations; sums so e expended on half in proportion to their valuations and one half in proportion to their respective areas.
Amendment of Assessment:	Chapter 496 of the Acts of 1975--8 cents on each thousand dollars of equalized valuations; sums so expended one quarter in proportion to their valuations and three quarters in proportion to their respective areas OR three quarters in proportion to their valuations and one quarter in proportion to their respective areas, WHICHEVER IS THE LESSER AMOUNT.

Twenty-two towns formed this project in 1956 and three more joined in the early 80's after the South Shore project disbanded. Two towns (Milton and Norfolk) later withdrew by a vote at town meeting or city council. Norfolk rejoined just one year later only to withdraw and rejoin again about 10 years later. Withdrawal votes were fueled by environmental concerns over pesticide use and negative publicity. Efforts to rejoin were precipitated by public health threats, biting complaints, and ineffective in-house control programs. Norfolk did not lose towns during the late eighties, so has had stable membership for more than a decade.

Over half of the project budget is spent on source reduction work. In the ‘80’s adulticiding was stressed over larviciding but this has changed and now larviciding, including aerial applications, far exceeds adulticiding. It is estimated that there are over 30,000 acres of freshwater swampland in Norfolk County, which can breed mosquitoes, but only 1,087 acres are treated for spring-hatch and 523 acres (there may be overlap) for summer reflood mosquitoes. Thirty-eight acres of salt marsh are under active control. All 4 standard surveillance methods are used to evaluate program effectiveness.

Over the past decade the project has faced increasing pressure from the public concerning pesticide use. The project has responded by providing a more localized response to fogging requests (no more town-wide applications are done), by increasing larval monitoring to better target larvicide applications, and by using Bti and IGR formulations for larviciding. In 1996, the Project purchased a third excavator for source-reduction work, went from five to nine field staff positions, hired two seasonal employees to improve their database information on wetlands and purchased computer mapping equipment to better target their control efforts.

These changes, while desirable environmentally, have their cost, and funding remains a primary concern.

In addition, environmental regulations likewise cause concerns, specifically when fueled less by scientific reason and more by emotional appeal.

Plymouth County Mosquito Control Project

Created under:	Chapter 514 of the Acts of 1957
Area included:	The area in Plymouth County not including any city or town already a member of an organized mosquito control project.
Annual Assessment:	25 cents on each one thousand dollars of taxable valuations; sums so expended on half in proportion to their valuations and one half in proportion to their respective areas.
Amendment of assessment:	Chap. 544 of Acts of 1970 -- 13 cents on each thousand dollars of equalized valuations; one-half in proportion to said valuation and one-half in proportion to their respective areas.

Twenty-one towns formed this project in 1958 during a period of major EEE threat. The Plymouth County Selectman's Association and local legislators led this movement to organize. Seven additional towns joined the project in the early 1980's when the South Shore project disbanded. Four of the original member towns withdrew by town meeting vote in the mid-sixties. Towns must have been a member for at least 3 years before they can vote to leave the project. Towns that withdrew did so primarily over concern for the impact of the wide-scale aerial spraying that the project was carrying out in the mid-sixties. The town of Halifax rejoined the project in 1985 after they determined that the Plymouth County project was more environmentally sound than the in-house program they had developed. Since that time, Abington, Hanover, Kingston, and Whitman have also rejoined. Bridgewater withdrew in 1990, due to budgetary concerns.

About 20% of the concern of this Project is with salt marshes. Water management, including OMWM efforts, is used to control most salt marsh *Aedes*. Spring and reflood Aedes receive a substantial amount of attention. *Cq. perturbans*, the cattail mosquito, causes a very significant problem but there are no recommended larvicides for this species at present. Although several projects contract for some aerial larviciding (and adulticiding in emergencies), Plymouth County is the only project, which owns fixed winged aircraft for doing its own aerial work. Ground adulticiding with resmethrin is still an important control strategy in this project because of inability to control the cattail mosquito, and other species developing in large woodland swamps, with larvicides. Up to 7,860 acres of Plymouth County's large acreage of swampland are treated with larvicide’s (Bti), targeted mainly against spring *Aedes*. The project evaluates its control effectiveness from complaints, landing counts, and larval counts.

The past decade has clearly been one of change at Plymouth. Malathion for adulticiding gave way to resmethrin and the larvicide Temephos was replaced by Bti. There has also been an increase in the number of member towns and increased service requests. Dr. Ludlam further notes that the State Reclamation Board has become stronger and there have been improved ties with the Massachusetts Department of Public Health. The most important challenge facing Plymouth today is the continued lack of a control strategy for *Cq. pertubans* in the larval stages.

Suffolk County Mosquito Control Project

Created under:	Chapter 606 of the Acts of 1973
Area included:	The area of Suffolk County comprising the cities of Boston and Chelsea.
Annual Assessment:	5 cents of each one thousand dollars of equalized valuations; sums so expended one quarter in proportion to their valuations and three quarters in proportion to their respective areas.

The Suffolk County project is the smallest in land area and encompasses Boston and Chelsea. The two other towns in Suffolk County, Revere and Winthrop, are members of the Essex County project, which predates this project. The project was organized in 1974 with strong leadership from legislators who were residents of the district and felt that a pest problem existed. Member town can withdraw from the project through a majority vote of the city council and mayor. Prior to the organization of the project, the Department of Housing Inspection contracted with a private applicator to do aerial spraying of salt marshes and the Parks Department did adulticiding with mistblowers.

About 30% of the mosquito problem is associated with salt marsh *Aedes* but no marsh management activities are carried out in the project's 200 acres of breeding salt marsh. Control is done with larvicide's. Another 130 acres of freshwater wetland breeding sites are also treated with larvicides, as are storm sewer catch basins. About 40% of the projects budget is devoted to adulticiding, the highest percentage of all the projects, but down for the 1980s. Program effectiveness is evaluated by complain levels, light traps, landing rates, and larval counts are used to evaluate the effectiveness of the program.

Over the past decade the project has used more Altosid for larviciding and reduced malathion use for adulticiding. Public pressure, both for increased spraying (to eliminate mosquitoes) and decreased spraying (to protect the environment) plays a strong role in the day-by-day operation of this populous project. There are also two MDC Reservations in which mosquito-breeding areas overlap endangered species habitat. Currently the project

can use Bti in these areas but would prefer to switch to Altosid. Permission to make this switch has not been granted.

Budgets

Budgets for all projects for 1993 and 1994 fiscal years are provided in Tables 1 and 2. The standard break down by category as used by the SRCMB is adopted in these Tables. The data used in these Tables were provided by the projects themselves.

2. Non-Member Communities.

For the initial GEIR, all Massachusetts Town Boards of Health were sent a concerning their town's mosquito control activities and 326 (93%) eventually responded. Fifty-seven towns (about 38% of those responding) indicated they do some mosquito control: 34 carry out the control work themselves using town personnel and 23 contracts with private applicators. Nineteen (83%) of the 23 towns with contracted control provided detailed information on costs and pesticides used; 23 (68%) of the 34 town-operated programs provided this information.

The decision by non-member towns to do mosquito control work (which in almost all cases was temporary, chemical control) is made by a variety of authorities: 68% by the BOH, selectmen, mayor or other town officials, and 32% by a public vote. Citizen complaints and a perceived health threat both weighed heavily in decisions to do control work. Approximately 1/4 of the towns had some mosquito survey information available as an aid in the decision-making process. The major criteria used to assess the effectiveness of the control work undertaken was the post-treatment level of citizen complaints (95% of all towns). Other considerations were, in order of importance: larval counts, light trap counts, level of disease, and human landing counts.

Table 1. Budgets for Mosquito Control Projects for Fiscal Years starting in 1993 and 1994.

Budget Item	1993	1994
Berkshire County MCP		
Administration		
a. Personnel (wages & benefits)	30,000	30,000
b. Other (office supplies, travel, etc.)	500	500
Field Operations		
a. Personnel (wages & benefits)	10,700	10,700

b.	Pesticides	5,792	0
c.	New equipment	0	0
d.	Other (gas, supplies, etc.)	20,000	25,792
TOTAL		$66,992	$66,992

Bristol County MCP

Administration			
a.	Personnel (wages & benefits)	75,370	75,518
b.	Other (office supplies, travel, etc.)	46,918	47,888
Field Operations			
a.	Personnel (wages & benefits)	260,615	255,550
b.	Pesticides	34,377	31,610
c.	New equipment	6,125	17,412
d.	Other (gas, supplies, etc.)	24,121	20,162
TOTAL		$447,526	$448,140

Table 1. Budgets for Mosquito Control Projects for Fiscal Years starting in 1993 and 1994 (continued).

Budget Item		1993	1994
Cape Cod MCP			
Administration			
a.	Personnel (wages & benefits)	585,000	585,000
b.	Other (office supplies, travel, etc.)	5,000	5,000
Field Operations			
a.	Personnel (wages & benefits)	204,495	204,495
b.	Pesticides	38,000	38,000
c.	New equipment	35,000	35,000
d.	Other (gas, supplies, etc.)		
TOTAL		$918,511	$918,511
Central Mssachusetts MCP			
Administration			
a.	Personnel (wages & benefits)	123,201	125,817
b.	Other (office supplies, travel, etc.)	36,546	17,241
Field Operations			
a.	Personnel (wages & benefits)	286,348	286,144
b.	Pesticides	15,000	37,527
c.	New equipment	18,154	18,970
d.	Other (gas, supplies, etc.)	84,181	77,731
TOTAL		$563,430	$563,430
East Middlesex MCP[a]			
Administration			
a.	Personnel (wages & benefits)	64.190	64,995
b.	Other (office supplies, travel, etc.)	27,507	24,804
Field Operations			
a.	Personnel (wages & benefits)	119,156	116,734
b.	Pesticides	18,422	21,508
c.	New equipment	0	11,927
d.	Other (gas, supplies, etc.)	18,843	23,159
TOTAL		$248,118	$263,126
Essex County MCP			
Administration			
a.	Personnel (wages & benefits)	47,320	53,000
b.	Other (office supplies, travel, etc.)	7,000	7,000
Field Operations			
a.	Personnel (wages & benefits)	188,105	188,737
b.	Pesticides	10,000	28,000
c.	New equipment	0	13,000
d.	Other (gas, supplies, etc.)	25,685	37,231
TOTAL		$278,110	$326,968

[a]Rounded to the nearest dollar from reported figures.

Table 1. Budgets for Mosquito Control Projects for Fiscal Years starting in 1993 and 1994 (continued).

Budget Item		1993	1994
Norfolk County MCP			
Administration			
a.	Personnel (wages & benefits)	184,427	161,640
b.	Other (office supplies, travel, etc.)	60,482	60,472
Field Operations			
a.	Personnel (wages & benefits)	79,040	121,939
b.	Pesticides	4,617	186
c.	New equipment	19,520	26,369
d.	Other (gas, supplies, etc.)	57,331	45,556
TOTAL		$405,417	$416,162
Plymouth County MCP			
Administration			
a.	Personnel (wages & benefits)	127,217	144,700
b.	Other (office supplies, travel, etc.)	37,388	40,000
Field Operations			
a.	Personnel (wages & benefits)	243,318	256,514
b.	Pesticides	30,590	31,500
c.	New equipment	54,625	32,100
d.	Other (gas, supplies, etc.)	71,311	59,635
TOTAL		$564,449	$564,449
Suffolk County MCP			
Administration			
a.	Personnel (wages & benefits)	No Figures supplied	
b.	Other (office supplies, travel, etc.)		
Field Operations			
a.	Personnel (wages & benefits)		
b.	Pesticides		
c.	New equipment		
d.	Other (gas, supplies, etc.)		
TOTAL			

Table 2. Total Budgets for the nine MCPs.

County	1993	1994
Berkshire County	66,992	66,992
Bristol County	447,526	448,140
Cape Cod	918,511	918,511
Central Massachusetts	563,430	563,430
East Middlesex	248,118	263,126
Essex County	278,110	326,968
Norfolk County	405,417	416,162
Plymouth County	564,449	564,449
Suffolk County	No Figures Supplied	
TOTAL	$3,492,553	$3,567,778

The choice of control strategy to be used was generally made by the town BOH or town personnel directly responsible for control activities. About 1/4 of the towns left this decision to the private applicator contracted to do the control work. One-third consulted outside public advisor such as the Board of Reclamation or neighboring MC project superintendents. About 1/6 sought advice from private sources such as pesticide salespersons. A similar breakdown of sources was used by towns to make decisions concerning when, where and how to apply the prescribed pesticides, except in the case of public and private consultants who were used less (only by 1/4 and 1/10 of the towns respectively). The choice of chemical to be used for control was based largely on its safety to the environment. Two-thirds of the towns predicated their decision on this consideration. Other concerns such as cost, effectiveness, and ease/safety of application were much less important. None of these criteria were used in selecting pesticides by more than 10 of responding towns. Decisions on when and how often to apply larvicides were based on larval sampling in about 2/3 of the towns and on a calendar spray schedule in 1/3 of the towns. Adulticide applications were mainly based on public complaints or pre-established calendar schedules, but a little over 50% of towns were prepared to modify their application schedules depending on weather conditions. Twenty-nine percent of towns indicated that scheduled pesticide treatments had actually been canceled due to adverse weather or for other reasons.

Most towns (ca. 80%) rely on newspaper and TV/radio announcements to inform the public of pending pesticide treatments. Twelve percent make no effort to inform the public at all. Fifty-three percent keep a list of beekeepers whose hives should be avoided but only 3% personally notify beekeepers of pending spray schedules. In

most towns, beekeepers must rely on the same information provided to the general public, which means that 9-12% of towns provide beekeepers with no warning whatsoever. In contrast, 94% of towns polled make some provisions for people to request that their property not be sprayed.

Nantucket is one town that has started a program in the time period between the first draft GEIR and this draft. The program has included aerial and ground applications of Altosid, and extensive Open Marsh Water Management. Activity and expense peaked in 1992 and 1993 when the OMWM system was dug. Since then the town has conducted small amounts of larviciding in salt marshes. No work is done in freshwater areas and no adulticiding is done.

3. Other Programs

a. Department of Environmental Management

The Division of Forests and Parks discontinued its own mosquito control program in 1978 at the suggestion of the MEPA office pending the completion of an Environmental Impact Report of statewide mosquito control. From 1966-77, their mosquito control program consisted of adulticide treatments of state parks twice each summer coinciding with the heavy use periods of Memorial Day and July 4th. Applications were made with a mist blower and a mixture of methoxychlor (9 gal of 25% EC), malathion (1 gal of 57% EC) and water (40 gal). There was no attempt to evaluate the effectiveness of these applications, which were presumably carried out at night.

The Essex County Mosquito Control Program adulticides as required at the Salisbury Beach State Park and at the Bradley Palmer State Park in Hamilton.

b. Department of Public Health

The Massachusetts DPH is responsible for surveillance for EEE Virus, risk assessment, public information and education on EEE disease, as well as providing advice to the State Reclamation and Mosquito Control Board on appropriate risk management for EEE. DPH is also responsible for recommendations for wide area aerial vector control interventions in the event of an EEE Public Health Emergency. The Process for Risk Assessment and Management of EEE is outlined in the "Vector Control Plan to Prevent EEE" (See Appendix B, Vector Control Plan: Risk Assessment Section VI).

Every year DPH's Eastern Equine Encephalitis Surveillance Program (EEESP) collects data to assess the risk of EEE. This is an on-going program, which is carried out at the State laboratory Institute in Jamaica Plain. Key variables used to determine the risk of EEE include precipitation levels, mosquito population abundance, and

presence of EEE virus in mosquitoes, horses, and humans. The purpose of the DPH EEE surveillance effort is to assess risk and use this information to advise the SRMCB and the public of the relative risk of EEE in any given season. In addition, the DPH chairs the Pesticide Review Board, which regulates pesticide use in the state.

In 1956 the EEESP was established in southeastern Massachusetts by the U. S. Public Health Service (CDC), in cooperation with the Massachusetts DPH, for the study of EEE. A surveillance program has continued since 1957 to the present, with funding solely from DPH beginning in 1970. Surveillance for EEE consists of monitoring mosquitoes to determine population levels in relation to previous years' levels, especially *Cs. melanura*, *Ae. vexans*, *Ae. canadensis*, *Cq. perturbans*, and *Ae. sollicitans*, testing samples of mosquito populations for the presence of EEE and Highland J (HJ) virus (HJ is an arbovirus which does not cause human disease but which is an indicator of arboviral activity in the bird population), testing suspected EEE horse cases and screening suspected human cases of encephalitis, meningoencephalitis or other cases of clinical disease that may mimic symptoms of EEE virus infection. Information is also compiled on precipitation, groundwater levels, and surveillance data from other sites. The surveillance program keeps abreast of new developments in the study of EEE and has expanded its trapping effort in response to these developments.

In recent years DPH has funded studies in collaboration with local universities aimed at furthering our understanding of EEE. These have included an assessment of the focality of EEE transmissions; *Cs. melanura* host preferences studies and research aimed at identification of the principal avian reservoir host species for the amplification and perpetuation of the EEE virus. In 1997, mosquito trapping was expanded to include several bird roost studies postulated to be critical foci for amplification of EEE virus (Komar et al., unpublished).

Each year the EEESP prepares a summary of the past season's surveillance activities in November, and provides an early prediction of the next season with regard to the likelihood of the presence of EEE virus in the environment and the potential for transmission to humans based on key variables of precipitation, mosquito populations and prior years' EEE activity in mosquitoes, birds, horses and humans. This information is provided to the SRMCB, EOEA agencies, the State Legislature, Boards of Health and the general public. Vector control meetings are held as needed with eastern Massachusetts Mosquito Control District Superintendents and the SRMCB throughout the season.

Surveillance provides an early warning of the presence of EEE in the environment. The EEE Surveillance Program begins no later than the first week in June and continues through early October, unless a killing frost brings

the mosquito season to an end earlier. This is a continuing program with an objective to provide epidemiological information on EEE virus and potential vectors of this disease to guide public health actions. EEE surveillance reports are issued weekly throughout the trapping season and provide a summary of weekly laboratory analyses for mosquitoes, horses and humans.

When EEE is found in trapped mosquitoes, supplemental surveillance activities are initiated. These may include increased trapping of bridge vector species (species that transmit the disease from birds to horses or humans) utilizing a variety of trapping methods, estimation of vector species larval abundance, and age structure determinations. Isolation of EEE also may trigger health alerts and advisories when appropriate.

The first emergency effort to control mosquitoes during a disease outbreak occurred in 1956 when $90,000 was made available from the governor's emergency fund for aerial adulticiding. In this effort 150,000 acres were sprayed with DDT. The EEE disease outbreak of 1973 led to an aerial ULV application of malathion in the late summer, when approximately 1.7 million acres in eastern Massachusetts were treated. In 1974 and 1975 approximately 82,000 acres were aerially treated. The cost of the 1973-75 vector control interventions was over $700,000. In the EEE outbreak of 1982-84, no state-funded aerial application was conducted, however, $150,000 was allocated from the governor's emergency fund to support intensified ground spraying. In 1990 another emergency aerial ULV malathion application occurred over the southeastern part of Massachusetts. In this intervention 524,096 acres were treated at a cost of approximately $800,000. All interventions were based upon the likelihood of multiple human cases of EEE. While the cost of EEE vector control interventions may appear high, the lifelong costs associated with just one residual case of EEE have been estimated at $3 million dollars (Villari et al. 1995).

c. Federal Lands

In general, states have no jurisdiction over federal property. Any mosquito control activity on U. S. government property in Massachusetts is only subject to federal laws and not to the laws of the commonwealth. Thus, the following description will be brief and informational only.

i. Parks, monuments, refuges, etc.

No mosquito control is carried out by the U. S. Department of Interior on any government-owned land in Massachusetts. The current philosophy of the U. S. Park Service and U. S. Fish and Wildlife Service seems to be adverse toward the initiation of pest control except in unusual circumstances, e.g., the campground in Everglades National Park, the Island Wildlife Refuge, etc. The Cape Cod National Seashore is perhaps the U. S. Park Service property with the most significant mosquito populations. Park Service biologists have conducted their own studies on the environmental impact of Cape Cod mosquito control activities (Portnoy 1983, 1984a, 1984b) in adjacent estuaries and have lobbied against certain ditch cleaning practices on environmental grounds.

The East Middlesex MCP has been controlling mosquitoes in Great Meadows National Wildlife Refuge since 1987. Annual aerial Bti applications targeted against spring *Aedes* species began in 1987 and applications to control *Aedes vexans* began in 1990. Prior to each application, the Eat Middlesex MCP submits data on pre-application larval populations. Following receipt of the data each year, Great Meadows National Wildlife Refuge issues a permit for the aerial application. The National Park Service reservation area (Paul Revere's Ride) in East Middlesex County has been declared off limits to any mosquito control activity (by East Middlesex MCP) except for ditch cleaning.

The Essex County MCP has completed OMWM projects on the Parker River Wildlife Refuge.

ii. Military Bases.

All U. S. Military bases have a pest control section, which often engage in some mosquito surveillance and control activity. In Massachusetts, Fort Devens has routinely carried out both larval and adult control. In the 1980s this has consisted of mist blowing with Malathion for adult control and Altosid briquettes for larval control. Hanscom Air Force Base joined the East Middlesex MC project in 1985 but still assists with surveillance and some control activities. None of the other military bases in Massachusetts (i.e., Barnes in Westfield, Westover in Chicopee, and Otis on the Cape) reported mosquito control activities in recent years.

d. Private Reserves.

There are several private reserves and estates in Massachusetts (e.g., Cranes Beach), which are frequently used by the public in one capacity or another. There is no indication that mosquito control is regularly practiced on any of these properties. It seems unlikely; therefore, that this represents a significant category of undocumented pesticide use or habitat modification for mosquito control, past or present. Certain MCPs include, by request, some

reservation properties in their overall program but those activities are included in their program summaries.

C. Historical Overview of Mosquito Control Practices in Massachusetts

1. Practices prior to 1980

Development along the Eastern Seaboard, especially for tourism, was predicated on an ability to control the hoards of salt marsh mosquitoes. The earliest experimental work took place in New Jersey salt marshes in the late teens and early 1920's. These successes encouraged the massive hand-ditching projects in East Coast marshes that took place during the WPA programs of the great depression, with some 3,000 miles of ditching being dug in Massachusetts's salt marshes alone. These ditching schemes, while quite effective in reducing salt marsh mosquitoes, were engineered to make work rather than for optimum biological efficiency. Moreover, the value of estuarine ecosystems was unrecognized at the time.

Early salt marsh mosquito control projects, such as the one on Cape Cod in the 1930's, were organized prior to the availability of synthetic pesticides following World War II and these projects expanded and maintained the WPA-dug ditch system as their main strategy for mosquito control. After DDT, BHC, and other organochlorine pesticides became available, they were used to both supplement larval control and, for the first time, to conduct residual spraying for adults. Aerial application of these pesticides became commonplace in the 1950's and early 60's. However, coastal projects that were organized after the introduction of these modern pesticides still relied heavily on source reduction to manage salt marsh mosquitoes. Paris Green (an arsenical) and petroleum oils were developed as mosquito larvicide's for malaria control during World War II and also became popular in the U. S. after the war. Waste crank case oil was not infrequently used in mosquito control despite the fact that thin oils (e.g., diesel fuel) with a spreading agent provide for the greatest and most effective surface coverage. The commercial mosquito control oil, Flit MLO, was introduced and widely used during the 70's, but was taken off the market in the mid-80's. Arosurf-MSF, a monomolecular surface film was available for several years, starting in the mid-80, but was taken off the market. It is now (1997) being returned to the market as Agnique MMF (Henley, personal communication).

Abate (temephos), one of the few organophosphates registered for aquatic use, was introduced a few years later and shared the larvicide market with surface oils. The first new generation pesticide introduced for mosquito control was the growth regulator Altosid (methoprene), a juvenile hormone mimic. It has been widely used in mosquito control since the mid-l970's. Projects in the Northeast were slow to switch to this highly selective

material, perhaps due to its delayed response and narrow window for control.

The choice of which larvicide to use is based equally on effectiveness and safety to the applicator and to the environment. Adulticiding is often predicated on public complaints. Weather conditions and field surveys also play a role in deciding when to schedule applications in most projects.

Chemical control in freshwater marshes followed a similar pattern to that in salt marshes. Treatment of catch basins, first with oils followed by organochlorines and organophosphates, dates back to the beginning of most Massachusetts projects.

Physical control was limited to drainage maintenance and expansion in both salt marshes and freshwater areas. Biological control was not conducted.

Controlling *Cs. melanura* larvae in large white cedar/red maple swamps was generally considered an impossibility so aerial adulticiding was adopted as the strategy of choice for vector control during epidemic threats. Projects within the main focus of EEE in southeastern Massachusetts were the only ones to routinely do aerial spraying. This work was gradually discontinued in the 1970's due to environmental concern over aerial adulticiding.

Projects have intermittently had the support service of a SMRCB entomologist. During 1976-81, a period when the projects had no entomological support from the SMRCB, an extension biting-fly specialist was available through a cooperative agreement with the University of Massachusetts. Each project contributed 0.5% of their annual operating budget as their share of support for this position, which was jointly funded by Massachusetts Cooperative Extension. The specialist developed control recommendations, evaluated new control methods, set up a statewide light trap surveillance program, and carried out other support services to the projects. Some controversy developed among projects, particularly over the control recommendations made by the specialist. Following his resignation, the SMRCB again hired an entomologist and the University position was discontinued.

2. Transitioning: from 1980 to 1995.

By the early 1980s, concerns over pesticide use and wetlands loss began to encroach on mosquito control. Grid ditching for larvae and malathion for adults was no longer a desirable one-two punch. Control trends during the eighties and early nineties include:

- Changing from traditional chemicals, such as Abate and Flit MLO, to Bti and methoprene for larval control (Table 3).

- Changing from malathion to permethrin or resmethrin for adult control (Table 3).
- Changing from open tidal ditching to open marsh water management for salt marsh mosquito control.
- Reduction in the number of towns belonging to Projects in the late 1980s. This trend has reversed in the past several years.

Table 3. A comparison, between the early 1980's and the mid-1990's of chemicals used by Massachusetts MCPs.

Active Ingredient	Toxicity Class	Used Between[a]	
		1981-1985	1993-1995
AS LARVICIDES			
Bacillus thuringiensis var. *israelensis*	IV	+	+++
Fenthion	II	-	N
Isooctadecanol[b]			
Malathion	III	+	N
Methoprene	IV	o	++
Methoxychlor	IV	++	N
Mineral Oil	III-IV	+++	o
Permethrin	III	-	N
Temephos	IV	+	-
AS ADULTICIDES			
Dibrom	II	+	N
Fenthion	II	o	N
Malathion	III	+++	-
Methoxychlor	IV	+	N
Permethrin	III	N	++
Resmethrin	III	-	+++

[a] +++ = Primary pesticide used
++ = Significant use
+ = Common but minor use
o = Infrequent use
- = Rarely used
N = Never used
[b] Discontinued product (Arosurf)

Altosid had come onto the market but acceptance was slow, both because it was hard to monitor the efficacy (larvae do not die for some time) and because of restrictions on the label against using in fish habitat. By the early '90s, however, it was in general use throughout Massachusetts. The extended-residual briquet form of Altosid was tested against *Cq. perturbans*, as was Arosurf-MSF, but results were mixed and the briquet's high cost prevents it from being an attractive control agent for large cattail areas. Trials with Altosid pellets were

encouraging but this control technique is not being used in Massachusetts.

In contrast to Altosid, the biological pesticide *Bacillus thuringiensis* var. *israelensis* was quickly accepted by Massachusetts's projects when introduced in the early 80's. It is a mainstay of most programs, despite some problems in salt marshes and aquatic habitats high in organic matter. The latter problem may be solved by the recent (1996) introduction of *Bacillus sphaericus*, a new biological pesticide that is designed specifically for *Culex* breeding in high-organic-matter habitats.

Flit-MLO disappeared from the market and was replaced by Golden Bear oils. Arosurf-MSF was used in small amounts for several years before it too was taken off the market. It has recently returned to the market as Agnique MMF. Bonide Mosquito Oil (Mineral oil) is now available but not used. Source reduction remained a mainstay of the projects during this time period but coastal communities shifted away from ditch maintenance towards open marsh water management. An emerging difficulty for control programs was the rise in wet basins mandated by storm water runoff regulations. If improperly designed these can breed considerable numbers of spring-brood and/or summer reflood mosquitoes.

The evaluation of control effectiveness by projects remained a combination of public complaints, adult counts, larval counts, and cases of human disease.

All projects maintained a public education component and several expanded their programs.

Throughout this period, outside of inadequate budgets and the inability to do more source reduction work, the main operational problems voiced by most projects has been the lack of applied research support to assist them in evaluating new technology and solving certain ever-changing problems. For example, the cattail mosquito, *Cq. perturbans*, is a major pest and potential epidemic vector of EEE in most projects but there is presently no recommended method for controlling this mosquito.

D. Current Mosquito Control Strategies in Massachusetts

1. Overview

Chemical control, including *Bacillus* products and IGRs (Table 4), and source reduction, including open marsh water management, dominate mosquito control in Massachusetts (Tables 5 and 6). Aerial applications of larvicides have been used by several programs (Table 7) and is likely to increase. Biological control has not been emphasized except to the extent that OMWM creates conditions under which biological control operates. Public education is a minor component of most programs.

Salt marsh mosquitoes are the primary target of coastal programs, whereas inland programs target spring-brood and summer-reflood *Aedes* (Tables 8 and 9). *Coquillettidea perturbans* is restricted by larval habitat to areas near cattail marshes. However, in those areas its populations can be extremely high.

Vector mosquitoes are not the primary targets of Massachusetts control programs, though projects do respond to requests for aid from DPH in times of EEE emergencies. *Culiseta melanura* larval populations may be incidentally reduced by treatment programs that target swamp areas. East Middlesex MCP did conduct trials with Altosid pellets aerially applied in April, 1992 for *Cs. melanura* control and were successful (Henley 1992). This work has not been repeated in Massachusetts.

Policy issues have revolved around wetlands and water quality preservation and endangered species. A chronic source of discussion is mosquito control's exemption from many of the state-level wetlands protection acts, making the Federal Section 401 Water Quality Certification Act (administered at the state level) and the state and federal Endangered Species Acts the primary means of "controlling" source-reduction work. Storm water runoff regulations have increased the number of wet basins (retention, wet detention) in many areas, on occasion creating breeding habitat. Engineers and public officials involved in designing and approving such basins have been slow to acknowledge mosquito control as design criteria, though the relevant sections of the Storm water Policy Handbook and Storm water Technical Handbook released by DEP in March 1997 should be incorporated into MCP practices (see Appendix E for listing of relevant information).

The EEE outbreak in 1990 highlighted a need for stronger DPH policies regarding emergency mosquito control. As a result, the Massachusetts Department of Public Health published "Vector Control Plan to Prevent Eastern (Equine) Encephalitis" (August 7, 1991) and implemented an extensive Public Education Program in 1991.

Table 4. Pesticide use by Project, 1993 through 1995.

Pesticide	Catagory	Amount Used		
		1993	1994	1995
Berkshire MCP				
Altosid Briquets	IV	24.3 lb	5.8 lb	1.8 lb
Bactimos Granules	IV	534.0 lb	2124.0 lb	
Bactomos Pellets	IV	232.0 lb	2026.0 lb	2093.0 lb
Abate 4E	III		0.6 gal	
Arosurf-MSF	III	16.0 gal	5.0 gal	
Scourge 18+54	III	10.1 gal	25.0 gal	20.1 gal
Bristol County MCP				
Altosid Briquets	IV		0.57 lb	45.6 lb
Bactomos Pellets	IV	1593.0 lb	80.2 lb	2300.5 lb
Scourge 12+36	III	151.9 gal	190.6 gal	173.4 gal
Cape Cod MCP				
Altosid Briquets[a]	IV	9.5 lb	8.4 lb	11.0 lb
Bactomos Pellets	IV	20,710.0 lb	41,497.0 lb	43,174.0 lb
GB 1111	III	671.0 gal	704.0 gal	330.0 gal
[a]Totals reported as briquets coverted to lbs				
Central Massachusetts MCP				
Altosid Briquets	IV	231.9 lb	192.7 lb	106.2 lb
Bactimos Granules	IV	281.1 lb	115.9 lb	2829.1 lb
Bactomos Pellets	IV	1223.0 lb	3313.0 lb	81.0 lb
Vectobac Granules	IV	96.9 lb		
Vectobac 12AS	IV		225.7 gal	171.7 gal
Witco GB-1356	III	65.1 gal	95.2 gal	5.6 gal
Witco GB-1111	III			23. 5 gal
Scourge 18 + 54	III	342.6 gal	398.5 gal	388.5 gal
[a]Dry and liquid ounces as reported coverted to pounds or gallons respectively				
East Middlesex MCP				
Acrobe	IV		125.0 gal	
Altosid Pellets	IV		15.0 lb	10.9 lb
Altosid Briquets[b]	IV	69.9 lb	20.7 lb	33.7 lb
Altosid XR Briquets[b]	IV	17.1 lb		
Arosurf MSF	III	2.3 gal	3.0 gal	
Bactimos Granules	IV		12,880.0 lb	6,785.0 lb
Bactimos Pellets	IV	2,324.0 lb		
Vectobac G	IV	8,062.0 lb	720.0 lb	
Vectobac 12AS	IV	8.4 gal	22.9 gal	169.2 gal
Permanone 10EC	III	2.4 gal	2.1 gal	1.7 gal
Scourge 18 + 54	III	20.2 gal	26.0 gal	18.1 gal
[a]Dry and liquid ounces as reported coverted to pounds or gallons respectively				

Table 4. Pesticide use by Project, 1993 through 1995 (continued).

Pesticide	Catagory	Amount Used		
		1993	1994	1995
Essex County MCP				
Altosid Pellets	IV			70.5 lb
Bactimos Granules	IV	3.8 lb		252.2 lb
Bactomos Pellets	IV	1993.1 lb	4439.6 lb	887.5 lb
Permanone 31-66[a]	III	39.0 gal	42.5 gal	12.8 gal
Scourge 18 + 54[a]	III	10.1 gal	25.0 gal	20.1 gal
[a]Ounces as reported converted to gallons				
Norfolk County MCP				
Altosid XR Briquets	IV	0.1 lb[b]	2.8 lb	254.8 lb
Bactimos Briquets	IV	0.6 lb	1.8 lb	48.8 lb
Vectobac 12AS	IV	79.0 gal	2.6 gal	
Vectobac AS	IV			52.3 gal
Arosurf-MSF	III	406.7 gal	83.1 gal	149.0 gal
Scourge 18 + 54	III	45.8 gal	53.2 gal	52.7 gal
[a]Rounded to the nearest tenth from reported values				
[b]Reported value = 0.038 lb				
Plymouth County MCP, Ground-application Pesticide Use[a]				
Altosid XR Briquets	IV			17.5 lb
Bactimos Pellets	IV	357.0 lb	500.0 lb	50.0 lb
Bactomos Briquets	IV	1.8 lb[b]	10.3 lb[b]	17.2 lb
Vectobac 12AS	IV	17.5 gal	2.5 gal	
Teknar HP-D	IV		17.5 gal	20.0 gal
Scourge 18 + 54	III	110.0 gal	85.0 gal	70.0 gal
[a]See Table 7, Aerial Application of Pesticides for information regarding aerial applications.				
[b]Total reported as briquets converted to lbs.				
Suffolk County MCP, Ground-application Pesticide Use[a]				
Altosid Briquets[a]	IV	3.5 lb	4.8 lb	3.3 lb
Altosid XR Briquets[a]	IV	57.5 lb	0.1 lb	11.4 lb
Bactimos Pellets	IV	25.8 lb	31.0 lb	
Vectobac 12AS[b]	IV	3.9 gal	7.9 gal	5.1 gal
Malathion 8EC[b]	III	1.5 gal	1.9 gal	0.2 gal
Permanone 10EC[b]	III	0.1 gal	1.4 gal	0.8 gal
Resmethrin[c]	III	11.2 gal		
Scourge 18 + 54[b]	III	6.3 gal	12.1 gal	3.5 gal
[a]Totals reported as briquets converted to lbs.				
[b]Rounded to the nearest tenth from reported values.				
[c]EPA reg #4-339-53853				

Table 5. Project distribution of operations by control method as expressed as a percentage of the budget allocated (average for 1981-1985) or as a percentage of the project's operations (1994 and 1995).

Berkshire MCP

	% of Budget 1981-1985		% of Operations 1994	1995
Source reduction	33	Source reduction (excluding OMWM)	20	20
		Open Marsh Water Management	0	0
Biological larviciding (Bti)	5		40	40
Chemical larviciding/pupiciding	50	Chemical larviciding/pupiciding(excluding IGRs)	0	0
		IGR larviciding (methoprene)	5	10
Adulticiding	10		30	20
Public Education	2		5	10

Bristol County MCP

	% of Budget 1981-1985		% of Operations 1994	1995
Source reduction	60	Source reduction (excluding OMWM)	75	78
		Open Marsh Water Management	0	0
Biological larviciding (Bti)	6		2	2
Chemical larviciding/pupiciding	3	Chemical larviciding/pupiciding(excluding IGRs)	0	0
		IGR larviciding (methoprene)	0	0
Adulticiding	30		22	19
Public Education	1		1	1

Cape Cod MCP

	% of Budget 1981-1985		% of Operations 1994	1995
Source reduction	70	Source reduction (excluding OMWM)	Information	
		Open Marsh Water Management		
Biological larviciding (Bti)	21			not
Chemical larviciding/pupiciding	4	Chemical larviciding/pupiciding(excluding IGRs)		
		IGR larviciding (methoprene)		Supplied
Adulticiding	0			
Public Education	5			

Central Massachusetts MCP

	% of Budget 1981-1985		% of Operations 1994	1995
Source reduction	70	Source reduction (excluding OMWM)	40	40
		Open Marsh Water Management	0	0
Biological larviciding (Bti)	5		25	25
Chemical larviciding/pupiciding	5	Chemical larviciding/pupiciding(excluding IGRs)	5	5
		IGR larviciding (methoprene)	5	5
Adulticiding	15		15	15
Public Education	5		10	10

Table 5. Project distribution of operations by control method as expressed as a percentage of the budget allocated (average for 1981-1985) or as a percentage of the project's operations (1994 and 1995) (continued).

East Middlesex MCP

	% of Budget 1981-1985		% of Operations 1994	1995
Source reduction	34	Source reduction (excluding OMWM)	26	42
		Open Marsh Water Management	0	0
Biological larviciding (Bti)	28		44	37
Chemical larviciding/pupiciding	27	Chemical larviciding/pupiciding(excluding IGRs)	<1	0
		IGR larviciding (methoprene)	4	4
Adulticiding	10		25	16
Public Education	1		1	1

Essex County MCP

	% of Budget 1981-1985[a]		% of Operations 1994	1995
Source reduction	--	Source reduction (excluding OMWM)	20	15
		Open Marsh Water Management	29	28
Biological larviciding (Bti)	--		40	50
Chemical larviciding/pupiciding	--	Chemical larviciding/pupiciding(excluding IGRs)	0	0
		IGR larviciding (methoprene)	0	1
Adulticiding	--		10	5
Public Education	--		1	1

[a]No response

Norfolk County MCP

	% of Budget 1981-1985		% of Operations 1994	1995
Source reduction	54	Source reduction (excluding OMWM)	50	50
		Open Marsh Water Management	0	0
Biological larviciding (Bti)	4		25	20
Chemical larviciding/pupiciding	13	Chemical larviciding/pupiciding(excluding IGRs)	0	0
		IGR larviciding (methoprene)	14	20
Adulticiding	25		10	8
Public Education	4		1	2

Plymouth County MCP

	% of Budget 1981-1985		% of Operations 1994	1995
Source reduction	25	Source reduction (excluding OMWM)	45	53.0
		Open Marsh Water Management	0	0.0
Biological larviciding (Bti)	5		30	25.5
Chemical larviciding/pupiciding	25	Chemical larviciding/pupiciding(excluding IGRs)	0	0.0
		IGR larviciding (methoprene)	0	0.5
Adulticiding	40		20	16.0
Public Education	5		5	5.0

Table 5. Project distribution of operations by control method as expressed as a percentage of the budget allocated (average for 1981-1985) or as a percentage of the project's operations (1994 and 1995) (continued).

Suffolk County MCP

	% of Budget 1981-1985		% of Operations 1994	1995
Source reduction	1	Source reduction (excluding OMWM)	5	5
		Open Marsh Water Management	0	0
Biological larviciding (Bti)	26		30	30
Chemical larviciding/pupiciding	25	Chemical larviciding/pupiciding(excluding IGRs)	0	0
		IGR larviciding (methoprene)	15	15
Adulticiding	46		40	40
Public Education	2		10	10

Table 6. Types of Control Activity,[1] by Habitat

	Salt Marsh	Spring Brood	Summer Re-Flood	Cattail
Berkshire County		C,F	C,F	
Bristol County	A	C	C	F
Cape Cod MCP	A,C,D,E	A,C,D,E	A,C,D,E	A,C,D,E
Central Massachusetts		A,C,E,F	A,C,D,E,F	A,C,D,E,F
East Middlesex		A,C,D	A,C,D	
Essex		B,C	A,C	A,C
Norfolk	A,C,D,F	A,C,F	A,C,D,F	F
Plymouth	A,C,D,F	A,C,F	A,C,F	F
Suffolk	C,D,F	A,C,D,F	A,C,D,F	F

[1]Types of control activities -- indicate the types of control activities carried out on each wetland type using the following categories:

A -- Source reduction
B -- OMWM
C -- Biological larviciding
D -- IGR larviciding
E -- Larviciding, non-IGRs
F -- Adulticiding

Table 7. Aerial application of Pesticides, 1993 through 1995

Project/Town	Dates	Time of day	Acreage	Pesticide	Rate	Target Area
1993						
East Longmeadow	4/26 - 5/12	Daylight	1,000	Vectobac 12AS	1 qt/acre	
E. Middlesex MCP	April 12-22	6 AM - 8 PM	2,017	Vectobac G	1 pt/acre	
				Bactimos Pellets	5 - 7.5 lb/acre	
Plymouth MCP[a]	April 12-16	4 AM -Noon	1,360	Vectobac 12AS	1 pt/acre	Spring Brood
	May 3-7	4 AM - Noon	1,400	Vectobac 12AS	1 pt/acre	Spring Brood
	May 10-14	4 AM - 9 AM	1,920	Vectobac 12AS	1 pt/acre	Spring Brood
1994						
Chelmsford	April 16-22	Dawn - 11 AM	700	Bactomis Granules	5 - 7.5 lb/ac	
East Longmeadow	May 5 - 12	Daylight	1,000	Vectobac 12AS	1 pt/acre	
E. Middlesex MCP	April 19-28	6 AM - 8 PM	2,700	Vectobac G	5 - 7.5 lb/ac	Wetlands
				Bactimos Granules	5 - 7.5 lb/ac	
	August 23-27	6 AM - 8 PM	1,000	Vectobac 12 AS	1 pt/acre	Flood Plain/ Wetland
				Acrobe	1 pt/acre	
Plymouth MCP[a]	April 18-22	4 AM - 9 AM	8,000	Bactimos Pellets	8 lb/acre	Spring Brood
	April 25-29	4 AM - 9 AM	16,000	Bactimos Pellets	8 lb/acre	Spring Brood
	May 2-6	4 AM - Noon	8,000	Teknar HP-D	1 pt/acre	Spring Brood
1995						
Chelmsford	April 16-22	Dawn - 11 AM	700	Bactomis Granules	5 - 7.5 lb/ac	
East Longmeadow	May 5 - 12	Daylight	1,000	Vectobac 12AS	1 pt/acre	
E. Middlesex MCP	April 12-22	6 AM - 8 PM	2,800	Vectobac 12 AS	1 pt/acre	
				Bactimos Granules	5 lb/acre	
Essex MCP	June 10-17	5 AM - Noon	1,400	Vectobac 12AS	1 qt/acre	Salt Marsh
	June 20-24	5 AM - Noon	1,000	Vectobac 12AS	1 qt/acre	Salt Marsh
	July 8-22	5 AM - 8:30 PM	1,000	Vectobac 12AS	1 qt/acre	Salt Marsh
	August 5-19	5 AM - 8:30 PM	1,400	Vectobac 12AS	1 qt/acre	Salt Marsh
Plymouth MCP	April 10-14	4 AM - Noon	11,000	Teknar/Acrobe	1 pt/acre	Spring Brood
	April 18-21	4 AM - Noon	11,000	Teknar/Acrobe	1 pt/acre	Spring Brood
	April24-28	4 AM - Noon	11,000	Teknar/Acrobe	1 pt/acre	Spring Brood
	May 1-5	4 AM - Noon	11,000	Teknar/Acrobe	1 pt/acre	Spring Brood
	May 8-12	4 AM - Noon	5,500	Teknar/Acrobe	1 pt/acre	Spring Brood

[a]These are actual treatments for Plymouth County. Forms filed with SRMCB were for more dates and larger areas than actually treated.

Table 8. Estimated wetlands acreage affected, by habitat, exclusive of adulticiding.

	Salt Marsh	Spring Brood[a]	Summer Re-Flood[a]	Cattail
Berkshire County	0	500	250	0
Bristol County — no figures given				
Cape Cod MCP — no figures given				
Central Massachusetts	0	10,000	5,000 to 10,000	2,000
East Middlesex	0	2,767	1,192	0
Essex	5,000	500	1,000	0
Norfolk	38	1,087	523	0
Plymouth	100	7,860	1,000	0
Suffolk	240	130	130	5
TOTAL	5,378	22,844	9,095	2,005

[a]There is overlap between acreage affected by spring brood and summer re-flood

Table 9. Percentage of control effort, from monitoring through adulticiding (includes source reduction), by breeding habitat by Project.

Habitat	% Effort		
	1994	1995	Species targeted
Berkshire MCP			
Salt marsh	0	0	
Freshwater			
Spring re-flood	90	90	spring brood *Aedes*
Summer re-flood	10	10	*Ae. vexans*
Cq. perturbans	0	0	
Bristol County MCP			
Salt marsh	50	50	*Ae. sollicitans, Ae. cantator*
Freshwater			
Spring re-flood	30	40	*Ae. canadensis, Ae. excrucians, Ae. cinereus*
Summer re-flood	15	10	*Ae. vexans*
Cq. perturbans	5	0	
Cape Cod MCP			
Salt marsh	50	50	
Freshwater			
Spring re-flood	50	50	
Summer re-flood	0	0	
Cq. perturbans	0	0	

Table 9. Percentage of control effort, from monitoring through adulticiding (includes source reduction), by breeding habitat by Project (continued).

Habitat	% Effort		
	1994	1995	Species targeted
Central Mssachusetts MCP			
Salt marsh	0	0	
Freshwater			
Spring re-flood	40	40	*Ae. absrratus, Ae. excrucians*
Summer re-flood	30	20	*Ae.vexans, Ae. canadensis*
Cq. perturbans	30	40	
East Middlesex MCP			
Salt marsh	0	0	
Freshwater			
Spring re-flood	45	52	*Ae. abserratus, Ae. aurifer, Ae. canadensis Ae. cinereus, Ae. excrucians*
Summer re-flood	37	28	*Ae. vexans, Ae. trivittatus*
Cq. perturbans	13	14	
Essex County MCP			
Salt marsh	50	60	*Ae. sollicitans*
Freshwater			
Spring re-flood	5	5	spring brood *Aedes*
Summer re-flood	45	35	*Aedes* species
Cq. perturbans	0	0	
Norfolk CountyMCP			
Salt marsh	10	10	*Ae. sollicitans, Ae. cantator*
Freshwater			
Spring re-flood	60	60	*Ae. excrucians, Ae. abserratus, Ae. cinereus Ae. canadensis, Ae. vexans*
Summer re-flood	15	15	
Cq. perturbans	15	15	
Plymouth County MCP			
Salt marsh	20	20	*Ae. sollicitans, Ae. cantator*
Freshwater			
Spring re-flood	60	60	*Ae. excrucians, Ae. abserratus*
Summer re-flood[a]	10	10	*Ae. vexans, Ae. cinereus, Ae. canadensis*
Cq. perturbans[a]	10	10	

[a]1994 and 1995 were extremely dry years which resulted in lower than normal control efforts toward summer reflood and *Cq. perturbans*.

Table 9. Percentage of control effort, from monitoring through adulticiding (includes source reduction), by breeding habitat by Project (continued).

Habitat	% Effort		
	1994	1995	Species targeted
Suffolk CountyMCP			
Salt marsh	30	30	*Ae. sollicitans, Ae. cantator*
Freshwater			
Spring re-flood	22	22	*Ae. excrucians, Ae. abserratus, Ae. canadensis*
Summer re-flood	42	42	*Ae. cinereus, Ae. vexans*
Cq. perturbans	6	6	

2. Current Practice

a. Salt marsh Mosquitoes

The combination of large, affluent human population (both permanent residents and visitors) and prolific pest mosquito populations near Massachusetts coastal marshes suggests that the public may always demand control programs to deal with this intense annoyance problem. Most salt marshes that breed *Aedes* mosquitoes are now under management and, in most cases, the strategy is source reduction.

Open Marsh Water Management (OMWM) projects now underway in Essex, Norfolk and Plymouth counties are being expanded to include essentially all problem marshes in those counties. OMWM plans are developed and tailored to the specific circumstances of each individual estuary. The permitting and review process for these projects is time consuming. Thus, it will be some time before all marsh management will consist of this strategy even though it is currently the most environmentally sensitive and rational marsh management strategy for most situations. Public and State agency support for OMWM is solid. Wolfe's (1996) review article on the effects of OMWM provides a strong basis for accepting OMWM as the best salt marsh mosquito control technique currently available. Wolfe makes the interesting point that salt marsh mosquitoes are an increasing problem not because they are breeding in greater numbers than before, but because more people are choosing to live near the coast.

Regardless of the benefits of OMWM, maintaining grid ditch networks is still an important part of coastal programs. Grid ditches are aesthetically unattractive and some have clearly had some negative impact on the

normal high salt marsh ecosystem. In contrast, evidence suggests that some ditched marsh may be more productive than unditched marshes (Shisler & Jobbins 1975). No qualitative studies on the impacts of grid ditching in Massachusetts have been done but clearly the habitat has been dramatically changed. Converting open systems to OMWM systems does create a more-nature, though still highly managed, system. In the interim, current ditch cleaning practice seems preferable to the increased use of larvicides.

There are certain salt marshes where old ditches are effectively controlling mosquito production and perhaps where new OMWM activities might actually disrupt the marsh more than maintaining the status quo. Thus, OMWM plans should not be automatically prescribed for every salt marsh without first examining this issue.

Larviciding is still carried out in salt marshes that are unditched or in which ditches are ineffective or unmaintained. Larvicides in current use include the biological pesticide Bti, the insect growth regulator Altosid, and surface oils. These are all pesticides that have lower risks associated with their use. Bti and Altosid have the least potential non-target effects because of their high selectivity for certain dipterous insects. Bti is not always as effective in highly organic salt marshes as it is in other habitats.

Adulticiding in coastal areas is often necessary because of the huge numbers of mosquitoes that breed on the marsh (a 99% kill with larvicide can still leave a lot of mosquitoes). Truck-mounted ULV application is the standard response, as is the case for freshwater adult mosquitoes discussed below.

b. Inland Freshwater Wetlands

Most projects do a considerable amount of source reduction work in freshwater wetlands. This activity consists primarily of ditch and culvert cleaning to discourage ponding along natural waterways and the resultant production of spring and reflood *Aedes.* Routine maintenance generally involves hand-cleaning of debris from drainage systems and brush removal where it is encroaching on the flow system. Machinery is not used for routine maintenance but is used where deteriorating conditions (a build-up of such sediments as road sand being a common example) require work that cannot be done by hand.

Larviciding is done with Bti products, Altosid or Golden Bear oil. The vast majority of larviciding is done after mosquito breeding has been documented. Most applications are made from the ground by backpack sprayer or by hand (briquets). Aerial applications to freshwater areas are limited, but increasing (Table 7). Pre-hatch work is done by several projects. In general the area must have a lengthy history of mosquito breeding.

Mosquito breeding in vernal pools, large acid swamps, and cattail/water willow ponds cannot be readily

controlled by source reduction work. Even larviciding is often difficult in large or deep permanent swamps. Projects with a large acreage of these habitats (i.e., Norfolk, Plymouth and Bristol) still depend more on adulticiding than do projects whose larval sources are more accessible to larviciding. Helicopter application of granular larvicides is perhaps the only way to reach many of these habitats with larvicides, but this practice has been hampered in the past by the fact that flight plans had to be filed too far in advance. This problem was overcome by the East Middlesex MCP by filing the flight plan when flooding started, not when larvae were first seen. This carried the risk of requesting a treatment that turned out to be unnecessary but the predictability of *Ae. vexans* breeding after flooding is high. Regardless, changes made to the Pesticide Board regulations at the start of 1997 season to make it easier to conduct aerial work. Norfolk MCP is actively increasing its aerial application program.

Coquillettidea perturbans remains a problem for larval control. Slow-release Altosid formulations looked promising for the control of cattail mosquitoes (Walker 1987) but this technique is not being used today, most likely because of high cost. Altosid pellets have been used with some effect (Ranta et al. 1994) and this approach may make expanding *Cq. perturbans* larval control possible. Fortunately, this mosquito has not been a significant pest over the last several years in most projects (see Table 9 for low % of effort directed towards *Cq. perturbans*). In East Middlesex MCP, however, *Cq. perturbans* has continued to greatly exceed nuisance threshold levels, being the main nuisance species between mid-June and mid-July. In nine cities and towns of the East Middlesex MCP, there is at least one light trap site which annually records greater than 500 *Cq. perturbans* per night during the peak period for that species. Dry the dry summers of 1993, 1995, and 1997, *Cq. perturbans* has been the only significant mid-summer mosquito problem.

No source reduction programs are in place for the maple/cedar swamps in which *Cs. melanura* breeds. Larviciding these areas has had some success (Henley 1992, Woodrow et al. 1995).

No control programs target permanent-water breeding *Culex* or *Anopheles* except in cases where *Aedes* are breeding as well and in urban habitats (see below). With the exception of minor work with dumped tires, *Ae. triseriatus* is not targeted for control.

Freshwater wetlands have been the sites most likely to have control restrictions due to endangered species. Salamanders, turtles and dragonflies have all been cited as reasons to either forego work or to restrict larvicide choice. In at least one case, the existence of vernal pools alone, regardless of endangered species presence, was sufficient for the local conservation commission to halt drainage maintenance in the area.

c. Irrigated and Other Man-Made Reflood Habitats

Very little agricultural land in Massachusetts is irrigated. Those lands which are irrigated tend to have sandy soils with good percolating characteristics. Golf courses, athletic fields, etc., which temporarily flood and produce reflood *Aedes* are generally very accessible and larvicidlng is the common practice for dealing with the habitats. Source reduction is occasionally used to eliminate or limit breeding in these poorly graded and drained grassy habitats.

d. Urban Habitats

Most projects do both source reduction (cleaning and repairing) and larviciding work on storm drain catch basins to control *Culex* breeding. Slow release larvicide formulations are popular in these small enclosed habitats. This urban mosquito control activity is non-controversial. It is effective, but the real impact of these mosquitoes on biting annoyance is not clear (see Part IV).

Wet basins have emerged as a primary problem in areas of new development. Shallow-water basins often hold water long enough in the spring to breed *Ae. canadensis*. Basins that have deep water in the spring (one-plus feet) may not breed mosquitoes then but may dry down in July and be perfect *Ae. vexans* breeding sites after a heavy August rain. Basins that are deep all year round may have invasive cattail on which *Cq. perturbans* can develop. Only basins that hold water for a week or less, even during the wet spring months, will probably not produce mosquitoes and even these require maintenance to avoid wetlands type vegetative growth that eventually causes longer pooling. Two other problems with basins is that many are fenced off, so that they are difficult to monitor, and ownership is often hazy so that maintenance lapses. Prevention of mosquito breeding in basins must become a design consideration.

3. Current Policies

a. Requests for Control

Requests for control are almost invariably for adult mosquito control, though individuals may request that wetlands on or adjacent to their property be checked and larvicided. Requests for adulticiding are handled in varying ways by the projects (Table 10). In most projects, complaint calls are considered a valid form of determining spray schedules, if not on an immediate basis, certainly over the long term. Responding rapidly to complaint calls is considered a primary objective of many projects, as they are service organizations. Of course, their service is to the common public good, and individual requests should be judged on that basis. Whether all

programs do so is not known.

Table 10. Adult Mosquitoes: Monitoring and Adulticiding Policies

	Techniques used to trigger adulticiding			
Project	Light Traps	Landing Count	Complaint Calls	Post-treatment Monitor
Berkshire	No	No	Yes (for local treat[a])	Reduction in calls
	Berkshire also stated that adulticiding is done on a pre-scheduled basis			
Bristol County	Not for Spray	No	Yes	Reduction in calls Reduction in light traps
Cape Cod	Yes, but no Adulticiding is done by Cape Cod			
Central Mass	Yes	3/min	Do landing count	Random re-checks
East Middlesex	100 human-biting	4/min (for local treat)	Supplement LT data	Not done
Essex	No	10+/min	5/square mile	Landing counts
Norfolk	Yes	2/min (for local treat)	Yes (for local treat)	Limited landing counts Reduction in calls
Plymouth	No	Informal	Yes	Staff observations Reports from residents
Suffolk	Yes	Yes	Do landing count	Informal checks

[a]Local treatment by hand-held or backpack sprayer only

Larviciding requests do not make up the majority of calls to MCPs. But, for example, East Middlesex MCP does receive calls for both larval control and information on how residents can control mosquitoes. In general these come as a result of their newspaper releases concerning larviciding or from residents who observe control crews in wetlands in the past (Henley, personal communication). Other programs most likely receive similar calls. In general, though, monitoring is based on historical knowledge and survey work by the MCP itself. When larvae are found, larviciding typically occurs.

Pre-hatch work, is an exception to the rule that larvae must be present and is conducted when the project superintendent feels there is sufficient historical data to justify applications prior to larval hatch.

b. Documentation for Control Implementation

All Projects keep records of complaint calls, most conduct light trapping and most conduct some landing counts (Table 10). Of the three, landing counts are the most casual, often being little more than a report that there are a lot of mosquitoes biting the field staff in a certain area. However, Berkshire County, Central Mass and Suffolk investigate each complaint call and take landing-count data.

Field workers record larval counts at the sites they visit. In some cases, they bring larvae back either for larval identification or for rearing to adults for ID. In many cases, the larvae are sight-IDed to genus and more specific identification is not done. Counts for aerial application and/or OMWM are much more detailed and generally involve taking a specific number of dips at a permanently situated sampling station.

An area that needs improvement is record keeping regarding aerial applications of larvicide. The general plans filed by projects with the state are not specific enough, as they tend to describe the maximum possible application acreage, rather than acreage actually treated. Projects do keep records of actual treatments and these should be filed with the state as a post-treatment report,

Record keeping for freshwater drainage maintenance is spotty and needs improvement. Without baseline data on channel cross-sections, it is impossible to monitor maintenance work to ensure that channels are not becoming larger.

c. Selection of Control Strategies

Control strategies may be selected at the project level for both short- and long-term work, and at the field worker level for short-term work. Examples of project-level long-term selections are the absence of adulticiding by the Cape Cod project and the strong push into wetlands restoration by the Essex County MCP. Short-term, project level decisions revolve around the choice of larvicides made available to field workers, aerial work, and the distribution of personnel among, surveillance, source reduction and pesticide application work. Project Superintendents use their experience, the input of their staff, professional journals, and any other resource that can guide them in creating a quality program.

An under-emphasized aspect of the selection process is the cost of each strategy. Strategies that cost more than is available will not be implemented. Ground application of larvicide is possible in larger areas than it is currently being done, however the manpower requirements are high. Altosid applications for *Cq. perturbans* populations control seem to be limited primarily due to cost.

Field staff are responsible for determining the need to treat a given site, the type of material to use (for

example, briquets versus a liquid treatment in a series of vernal pools), and whether or not physical control (removing debris clogging a culvert) should be done immediately or can wait for non-breeding periods. The effectiveness of any program is directly linked to the skill of the field staff in determining the most appropriate response to current local conditions and their motivation to carry out the appropriate response effectively.

One of the goals of the GEIR is to help establish procedures for determining which control technique to use. However, a large amount of basic research into mosquito and wetlands ecology needs to be done to improve our basic understanding of the cause and effect relationships among the environment and the control procedures available.

d. Evaluation of Efficacy

No project has developed a comprehensive and comparable data base on mosquito densities to document the long term impact of control efforts on annoyance levels in their communities. While they might be faulted for this failure, such an effort requires resources that many projects do not have. Nearly all projects routinely operate light traps or make landing rate counts in order to monitor adult population levels. Just how these data are analyzed and used is not clear. No publicity or publications utilizing quantitative data on mosquito populations have been produced by any project. All projects seem to keep good records of how many complaints they receive annually from each section of their jurisdiction. Statistical treatment of these data would be difficult and appears to have not been attempted.

Larval sampling is routinely carried out by all projects before pesticide applications. Post-treatment checks are less common. However, one of the reasons the projects did not accept Altosid very quickly was that it was hard to tell if the treatment had worked (the larvae can take up to a week to die). From this it can be inferred that post-treatment monitoring was occurring. This is an area where a state-level entomologist would be of considerable help as she could carefully monitor larvicide applications with an eye towards developing more accurate delivery techniques and application rates for varying situations.

Post-treatment monitoring of adulticide applications is done on an *ad hoc* basis (Table 10). A drop off in complaint calls is the primary criteria by which adulticiding efficacy is judged. While aerial ULV applications are effective (Mount *et al*. 1996), truck-mounted ULV treatments depend heavily on proper weather conditions and on there being an adequate road network. The general attitude, with the notable exception of Cape Cod, is that the residents pay for mosquito control and adutlciding kills mosquitoes. Developing better evaluation techniques for

efficacy of truck-mounted adulticiding would be a major step in improving mosquito control in Massachusetts.

e. Public Participation

All projects notify residents by press release or public notice of their intended control operations for the coming season. Most towns also notify the Departments of Health and the chief executive's office of the municipalities for which they do work of their plans for the season. In Norfolk, each health board receives a notice of which days of the week the project may be treating in their town. Maps are included. Suffolk takes the process one step further and notifies the mayor's office before each adulticide. With minor variations all projects do the same type of notification.

Requests for exclusion are handled virtually identically by all projects, with a list of exclusion sites given to drivers so that they know where to not treat. Maps of excluded properties are made available to the spray crews.

Multiple Chemical Sensitivity (MCS) is becoming an increasingly important concern to health officials as the number of individuals reporting disabilities linked to chemical exposure has increased dramatically over the past decade. Regardless, MCS has yet to become a major issue for mosquito control. In most cases, an individual with MCS can be accommodated by the standard exclusion request since most mosquito control programs do not, as a general rule, ask why an exclusion is requested. This lack of conflict, however, should not be taken to mean that MCS is a non-issue. Mosquito control programs are designed to protect people, not harm them, and individuals suffering from MCS deserve to have their needs addressed. At the same time, control programs must take into account the needs of those who do not suffer from MCS, yet do suffer from mosquito problems. So long as programs continue to work honestly and above-board with MCS suffers (and any other group which requests exclusion), and receives the same level of cooperation from those requesting exclusion, mutually acceptable solutions should continue to be the norm.

One source for additional information on MCS is:

MCS Referral & Resources, Inc.
508 Westgate Road
Baltimore MD 21229-2343
Telephone 410-362-6400
fax 410-362-6401

Public education is a vital component of a complete program but current education efforts represent only a tiny part of most projects (Table 5). Programs vary from distribution of handouts upon request to full-scale educational presentations, including videos and other visual aids (Table 11). In general, but not absolutely, the extent of the education program is a function of program size. It is not clear that all projects use the Fact Sheets currently available from DPH. These include "Eastern Equine Encephalitis", "Insect bites and Insect repellents", and "Mosquito Repellents" as well as a pamphlet "Bugged by Mosquitoes?"

E. Eastern Equine Encephalitis

1. Responsibility for Surveillance and Control.

Eastern Equine Encephalitis (EEE) is an alphavirus endemic to many passerine bird species found in freshwater swamp habitats. The virus is transmitted among wild bird populations in these areas by *Cs. melanura*, a mosquito species that feeds almost exclusively on birds. The freshwater swamp is the enzootic focus of EEE and under normal conditions the virus is restricted to this habitat, Occasionally, however, due to factors which include seasonal and yearly rainfall levels and temperatures, mosquito virus may "spill over" into mammalian populations. This phenomenon is due to the transmission of the virus from infected birds to mammals by one of more mosquito species which feed on both humans and birds. Species that transmit disease from normal reservoirs to accidental hosts are known as "bridge vectors". The Massachusetts mosquito species traditionally thought to be likely bridge vector species are *Cq. perturbans, Ae. vexans, Ae. sollicitans,* and *Ae. canadensis*. Recently published studies also suggest that *Anopheles* species and *Cx. salinarius* may be possible epidemic vectors (Edman et al. 1993; Vaidyananthan et al. 1997). EEE virus has been isolated from all of these species. The bridge vector(s) responsible for EEE transmission to humans has not, however, been unequivocally identified.

EEE is a rare form of encephalitis with a high rate of mortality. The overall case fatality rate is now about 30% and survivors often suffer lifetime disabilities. The severity of illness tends to be most grave at the extremes of age. Fatality rates are highest among the elderly and intermediate in children. Infants and children who survive the

Table 11. Public Education Programs.

Project	Visit Complaint Callers	Give Talks	Notes on Programs/Pamphlets Available
Berkshire	Yes	Yes	UMss Coop Extension Leaflet "Mosquitoes" the "Ten Commandments of Mosquito Control" Bookmark for schools
Bristol County	Yes	No	Supply information upon request
Cape Cod	Yes	Yes	Conducts school programs for all age groups, have developed and distribute an informational pamphlet, and routinely appear in local press.
Central Mass	Yes	Yes	News releases to member municipalities' press Project staff attend various meetings A video "Working for You", a display and a slide show are all available Pamphlets are distributed to Boards of Health and other offices and anyone else who requests them. School program for elementary schools.
East Middlesex	Yes	Yes	School eduation program (three grade groups: 1-3, 4-6, and 7+) Give talks upon request. 20-minute video DPH fact sheets Pamphlet on Mosquito IPM
Essex	Not mentioned	Not mentioned	Fact sheets available on request 3-panel display available to environmental groups Outreach through environemental groups
Norfolk	Sometimes	Yes	Fact sheets: IPM, Bti, Methoprene, The Facts about Mosquito Spraying Materials supplied to local Boards of health Provides interviews on Local Cable TV Personnel always available for town-sponsored meetings Has extensive school program Attend local health fairs
Plymouth	Sometimes	Yes	Speaker program: spokesperson available year-round for any community group Utilizes community channel on cable TV Pesticide information distributed to towns and available to residents upon request DPH fact sheets and pamphlet "Homeowner Mosquito Control" pamphlet
Suffolk	Yes	Yes (Schools)	Press releases in the spring Faxes to mayor prior to treatment

infection are most likely to be permanently neurologically impaired and often require lifelong supportive care.

Horse cases of EEE have been described as early as the nineteenth century in Massachusetts and human cases were likely to have occurred, although they were not recognized as EEE prior to 1938. Since the first recognized outbreak of human EEE in 1938, 74 cases have occurred in Massachusetts with cases disproportionately concentrated in the south-central and southeastern parts of the state.

Four multi-year outbreaks of human EEE have been recorded in the central-eastern and southeastern areas of Massachusetts,. Thirty-four (46%) cases were identified in 1938. Subsequent years of human EEE cases have been 1939 (1 case), 1955 (4 cases), 1956 (12 cases), 1970 (1 case), 1973 (2 cases), 1974 (3 cases), 1975 (1 case), 1982 (2 cases), 1983 (6 cases), 1984 (2 cases), 1990 (3 cases), 1992 (1 case), 1995 (1 case) and 1997 (1 case).

The two worst years for human cases of EEE (1938 and 1956) occurred before there was an EEE Surveillance Program. However, it is assumed that the virus carriage of mosquitoes, and mosquito populations, would have been unusually high compared to average levels of these indicators. Since the beginning of a prospective EEE Surveillance Program, there have been two years of extraordinarily high levels of virus carriage in mosquitoes, in 1973 and 1990. Although only a small number of human EEE cases were identified in 1973 (2 cases) and 1990 (3 cases), there were significant control interventions in each of the two outbreak years. Wide-area spraying with ULV malathion was done to reduce populations of the vector species.

In 1990, in response to surveillance data showing alarmingly high and increasing EEE virus levels in mosquitoes, multiple horse cases, and the risk of multiple human cases, the largest aerial application (ULV) of malathion in years was made over much of southeastern Massachusetts. Three people contracted the illness prior to the treatment and one died.

As a result of this outbreak, the Department of Public Health and the State Reclamation Board sought to strengthen ties between state and project officials and to better define their response to future outbreaks. While there was considerable controversy over what some felt to be an extreme response by the state, there can be no question that mosquito populations were effectively reduced by the application and that no new human cases of EEE occurred after the treatment. Mount et al. (1996) provide an excellent review of aerial applications of insecticide for mosquito control and conclude that ULV applications are efficacious, cost effective and can work over dense foliage or open housing. The results in 1990 in Massachusetts support these conclusions.

2. Effect of EEE on Projects

Of the nine Projects, Berkshire is outside the EEE risk area and Cape Cod and Essex County are defined as

low-risk areas. The other Projects provide significant support for EEE monitoring and mosquito control. When requested larval and adult monitoring data are also supplied by the Projects to DPH. Bristol, Norfolk, Plymouth and East Middlesex MCPs traditionally increase truck-mounted aerosol applications in areas of high public use when DPH indicates elevated risk of EEE. These Projects also supply support for, or actually conduct, aerial applications for larval (Bti) or adult (malathion) mosquito control at the request of DPH.

Though the Projects do not target EEE vectors specifically, unless so directed by DPH, their general operations permit surveillance and control work to be carried out against vector species as necessary. As an example, East Middlesex has 50 CDC light traps set up through out its district, a portion of which monitor *Cs. melanura* populations. East Middlesex has also conducted aerial applications of Altosid pellets to control *Cs. melanura*. Emphasizing the problem of *Cq. perturbans*, however, East Middlesex has been unable to develop a larva control program to adequately deal with this potential vector.

A continuing source of friction is the definition of a nuisance versus a health threat. While several projects were formed as much because of the possibility of EEE as the nuisance factor, no project today considers preventing EEE to be their primary goal. Fortunately, DPH and the Projects in EEE areas work well together and a system of graduated responses (from regional ground control up to state-mandated aerial adulticiding) has been put in place.