Best Management Practices for Integrated Mosquito Management

American Mosquito Control Association

December 2, 2009

OVERVIEW OF INTEGRATED MOSQUITO MANAGEMENT

Integrated Pest Management (IPM) was first conceived as a means of achieving sustained, effective control of agricultural pests through concomitant employment of a wide range of control methodologies. IPM has been in widespread usage for many years and its success as a general strategy has led to usage of the term to describe an increasing number of approaches to control strategies – often leading to misunderstanding of its actual conceptual framework. To clarify the concept in terms of its relationship to the unique nature of mosquito prevention/control methodologies, we use the term Integrated Mosquito Management (IMM) in lieu of IPM.

Integrated Mosquito Management is a comprehensive mosquito prevention/control strategy that utilizes all available mosquito control methods singly or in combination to exploit the known vulnerabilities of mosquitoes in order to reduce their numbers to tolerable levels while maintaining a quality environment. IMM does not emphasize mosquito elimination or eradication. Integrated mosquito management methods are specifically tailored to safely counter each stage of the mosquito life cycle. Prudent mosquito management practices for the control of immature mosquitoes (larvae and pupae) include such methods as the use of biological controls (native, noninvasive predators), source reduction (water or vegetation management or other compatible land management uses), water sanitation practices as well as the use of EPA-registered larvicides. When source elimination or larval control measures are not feasible or are clearly inadequate, or when faced with imminent mosquito-borne disease, application of EPA-registered adulticides by applicators trained in the special handling characteristics of these products may be needed. Adulticide products are chosen based upon their demonstrated efficacy against species targeted for control, resistance management concerns and minimization of potential environmental impact.

Full implementation of modern-day IMM entails significant expenditure of resources that may be beyond the capabilities of many mosquito control programs subject to significant budget constraints. IMM requires a thorough understanding of mosquitoes and their bionomics by control personnel; careful inspection and monitoring for their presence and conditions favoring their development; and prevention of oviposition and human/mosquito contact through effective public education, sanitation and facility maintenance. All mosquito control programs should strive to employ these IMM components to the extent possible, but resource availability may limit what any individual program can do.

In IMM programs, all intervention measures are driven by a demonstrated need based on surveillance data and action thresholds. Applying any mosquito control measure on a pre-determined schedule absent a documented need is not acceptable practice in any IMM program.

INTRODUCTION

Since the need for mosquito control was recognized as a critical component of public health initiatives in the early twentieth century, increased knowledge of mosquito biology has driven the formulation of a variety of methodologies designed to successfully reduce both mosquito nuisance levels and mosquito-borne disease transmission. As the technologies and knowledge base from which these methodologies were derived have matured, they have been increasingly seen as mostly complementary or synergistic in nature, providing optimal control as part of an overall strategy. This has ultimately evolved into a strategy termed Integrated Mosquito Management (IMM). IMM has been developed to encourage a balanced usage of cultural and insecticidal methodologies and habitat manipulations in order to maximize control while minimizing adverse environmental impacts. IMM is knowledge-based and surveillance-driven, and when properly practiced is specifically designed to accomplish the following:

1. Protect human, animal and environmental health.
2. Promote a rational use of pesticides.
3. Reduce environmental contamination to soil, ground water, surface water, pollinators, wildlife and endangered species as a result of mosquito control activities.
4. Utilize biological controls (native, noninvasive predators) to conserve and augment other control methods.
5. Utilize source reduction (elimination, removal or reduction of larval mosquito habitats) where practical and prudent.
6. Use target specific pesticides at the lowest effective rates to the extent possible.
7. Emphasize the proper timing of applications.
8. Minimize pesticide resistance problems.

The circumstances necessitating formation of a mosquito control program, however basic, are unique for each jurisdiction in terms of available resources, topography, hydrology, and the bionomics of the mosquito species to be controlled. For this reason, considerable judgment must be exercised in allocation of limited resources to extract the maximum benefit for both the citizenry and the environment. It must be emphasized that program funding and other extrinsic factors will dictate the extent to which individual programs can implement the Best Management Practices (BMPs) described herein.

To assist in this calculation, the following document will outline a series of BMP program elements that constitute a fully integrated approach to mosquito management. These BMPs should be viewed as minimums that should be performed in concert with any general or individual National Pollution Discharge Elimination System (NPDES) permits that might be issued for mosquito control activities falling within the scope of Clean Water Act (CWA) requirements.

The extent and manner to which control agencies meet or exceed these BMPs should be ultimately based on the best professional judgment of mosquito control program personnel, often undertaken in consultation with local health and government authorities in addition to resources available. It is important to emphasize that adherence to these BMPs to the maximum extent practicable is to be considered the necessary minimum to undertake or perform for purposes of regulatory compliance with general or individual NPDES permits for mosquitocide use.

Best Management Practices for Mosquito Management

Best Management Practices (BMP) should form the fundamental approach to mosquito management for all mosquito control programs. It is acknowledged that individual agencies/entities charged with mosquito management responsibilities may not have the resources to practice all of the specific sub-elements discussed herein. Nevertheless, agencies should strive to adhere to these BMPs to the maximum extent practicable, given resource availability. Programs are encouraged to maintain documentation as to how they intend to employ the 9 BMP components listed below in a Pesticide Discharge Management Plan PDMP) as part of their operative NPDES permit.

1. **Surveillance** – Is the backbone of all IMM programs. Identifies problem species and population trends in order to direct and evaluate control methods.

    a. Determine species to ensure that the most appropriate control methodologies are chosen.

        i. Visually check jurisdiction for potential oviposition habitat and larval populations present that could contribute to unacceptable adult mosquito populations and determine if larval control is appropriate within resource constraints.

            1. Rural - swamps, salt & freshwater marshes, woodland pools, flooded fields/ pastures, roadside ditches, storm water retention ponds, tree holes, rice fields, etc.

            2. Urban - flower pots, tires, trash containers holding water, gutters, tree holes, septic ditches, roadside ditches, lawn swales, non-functional swimming pools, stagnant bird baths, street catch basins, junk yards, depressions in tarp covers, etc.

        ii. Determine population levels of adult mosquitoes using professionally acceptable techniques, including service requests, trap or collection data (if applicable) and/or landing rate counts (when appropriate), to establish needs for action.

    b. Monitor fluctuations in mosquito populations.

2. **Mapping** – Utilize maps of appropriate scale to continually monitor major sources of larval/adult mosquitoes in addition to documenting areas where control measures have been instituted. These maps should define treatment areas and can be used as appropriate in the PDMP.

3. **Set Action Thresholds** – Decisions to initiate control measures should be based on the analysis of either larval or adult mosquito surveillance or other available field data. Programs must establish a mechanism on which decisions to institute control measures are based.

    a. Determine which methodology shall be used to determine if and when control measures are instituted.

        i. For control of immature stages of mosquitoes, this methodology can consist of numbers of larvae and pupae observed in dip counts or observation of their presence in water sources.

ii. For adult mosquito control this methodology can consist of:

1. Number and pattern of citizen's service requests.

2. Visual – numbers of mosquitoes landing on inspector/applicator within 1-minute periods. When practicable, landing rate counts should be taken near or at times of peak mosquito activity for the species of concern. Performance of landing rate counts is only advised in areas or at times without significant mosquito-borne disease activity.

3. Counts of adult female mosquitoes collected.

b. Determine threshold values that trigger routine control measures. These values are meant to be for guidance only due to the myriad other factors that can influence when control operations are instituted – particularly in incipient disease scenarios or mosquito-borne disease prevention.

4. Physical Control or Source Reduction –Source reduction (the elimination, removal or modification of larval mosquito habitats) typically is the most effective and economical long-term method of mosquito control, but this may not be practicable for many larval habitats. Source reduction can be as simple as overturning a discarded bucket or disposing of a waste tire or as complex as habitat modification through Open Marsh Water Management techniques. These efforts often minimize and/or eliminate the need for mosquito larviciding in the affected habitat in addition to greatly reducing the need for adulticiding in nearby areas.

a. Determine feasibility of removing or modifying oviposition sites.

b. Encourage proper water management by public/private agencies responsible for storm water retention/detention structures and ditch and impoundment maintenance.

c. Maintain familiarization with jurisdiction health nuisance abatement policy.

5. Biological Control – These control methodologies are often resource-intensive and may not be advisable or practicable for many programs. Nonetheless, their feasibility should be explored.

a. Stocking of certain species of native, non-invasive fish known to be predators of mosquito larvae, if allowed by applicable state or local authorities, may provide significant reductions in larval mosquito populations in basic programs where management of large perennial oviposition sites is to be the primary control strategy.

b. Utilization of bats, birds, dragonflies and other putative predators of mosquitoes can be both ecologically problematic and ineffective as a primary control strategy and is therefore not recommended as a major component of any control strategy.

6. Public Health Mosquitocides – Handling, disposal, personal protective measures and applications must be made in full accordance with product label specifications.

a. Larvicides – Often may be the primary control method in natural or man-made wetlands (salt marshes or tidal wetlands, riverine bottomlands, woodland pools, freshwater marshes, meadow swales, roadside ditches, stormwater management ponds, etc.). These can also be a primary control method in locations where mosquito populations are determined to be arising from defined, concentrated sources in urban areas or in close proximity to houses. Due to continual influx of adult mosquitoes from outlying areas, larviciding programs may have limited visible effect on mosquito populations in jurisdictions lacking resources to adequately larvicide outlying production areas.

i. Several materials in various formulations registered by EPA are labeled for mosquito larviciding. Choice of active ingredient and formulation chosen will depend on site-specific factors and resistance management, and may include:

1. Biological larvicides

a. Microbial larvicides

b. Growth regulators and chitin synthesis inhibitors

c. Alcohol-derived monomolecular surface films

2. Chemical larvicides

a. Organophosphates

b. Oils – petroleum and mineral-based

ii. Larvicides should minimize impacts to non-target organisms and must, in many instances, be capable of penetrating dense vegetative canopies. Larvicide formulations (e.g., liquid, granular, solid) must be appropriate to the habitat being treated, accurately applied and based on surveillance data or preemptively applied to known oviposition sites.

iii. Larvicide application equipment should be calibrated and maintained per equipment manufacturer's specifications and timetable, or per instructions from product registrant.

b. Adulticides – Adulticides are applied so as to impinge upon the mosquito target in flight or at rest on vegetation. Adulticiding based on surveillance data is an extremely important part of any IMM program, and may form the primary treatment method for many programs where comprehensive larviciding is not practical.

Adulticides utilized in basic programs are typically applied as an Ultra-Low-Volume (ULV) spray where small amounts of insecticide are dispersed by aircraft or truck-mounted equipment. In some jurisdictions, adulticides may also be applied via "thermal fogs", utilizing heat to atomize droplets. Adult mosquitoes may also be targeted by "barrier treatments", which involve application of a residual insecticide to vegetation where mosquitoes are known to rest.

i. Adulticides should only be applied when established spray thresholds have been exceeded.

ii. Non-residual adulticides applied to the air column in order to impinge upon mosquitoes in flight should only be applied when the target species is active.

iii. Adulticides should be applied strictly according to label specifications. This will produce minimal effects on non-target organisms and promote efficacy. Adulticides should not be applied in rainy or windy conditions.

iv. Adulticides should only be applied by personnel trained or certified in their usage and handling, or when operating under the supervision of an individual having met the necessary certification requirements.

v. Adulticides labeled for mosquito control in part may include:

1. Organophosphates

        2. Natural pyrethrins

        3. Pyrethroids

        4. Pyrethroid derivatives

      vi. Adulticides should be applied at label rates that are efficacious as determined by monitoring. Applying doses lower than those that provide adequate control can in fact result in the need for additional adulticide treatments and might encourage development of insecticide resistance.

   c. Adulticide application equipment should be calibrated and maintained per equipment manufacturer's specifications and timetable, or per instructions from the product registrant to ensure performance meets product label specifications.

7. **Monitoring for Efficacy/Resistance –** Resistance management techniques attempt to minimize the risk of mosquitoes becoming resistant to the existing chemicals and should be practiced in even basic programs.

   a. Basic resistance management techniques can include:

      i. Utilizing physical control/source reduction and biological control methodologies to the maximum extent practicable.

      ii. Avoiding the use of the same class of chemical against both immature and adult mosquitoes.

      iii. Applying pesticide at the rate recommended on the label. Do not underdose.

      iv. Utilizing a different chemical class at the beginning and end of treatment season.

      v. Assessing susceptibility at the beginning and sometime during the mosquito season.

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

8. **Education & Community Outreach –** IMM is knowledge-based and involves a concerted effort by both control personnel and the community to manage mosquito populations based upon informed decision-making.

   a. Education of the general public should be encouraged to enlist resident's support in disposing of (or modifying) oviposition habitat, proper screening methods and proper application of personal protective measures such as repellents to minimize human/mosquito contact.

   b. Mosquito control programs should keep their constituents informed of surveillance and control activities to the maximum extent practicable.

   c. Mosquito control personnel are strongly encouraged to maintain and upgrade their professional knowledge through continuing education training and/or attendance at professional conferences.

9. **Record-keeping –** Operators/applicators should record the following for each application and maintain the records for the time specified by the lead regulatory agency:

a. Applicator’s name, address and pesticide applicator certification number (if applicable)

b. Application date and time of day

c. Product name and EPA registration number

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

e. Amount of material applied

f. Rate of application