SECTION 5

Use the Best Science and Data

This guidance is an excerpt from an ASTHO document - P*ublic Health Confronts the Mosquito: Developing Sustainable State and Local Mosquito Control Programs.* To view the full document visit http://www.astho.org/Programs/Environmental-Health/Natural-Environment/confrontsmosquito/.

INTRODUCTION

It is critical that science drives the assessment of state and local needs, strategies selected, and design and monitoring of mosquito control programs. More is being learned each year as scientists and other experts continue to study mosquito control and disease transmission. These historical lessons and current best practices must guide the development, implementation, and evaluation of quality mosquito control programs.[21, 22, 23, 24, 25, 26]

There are numerous proven methodologies and practices that guide the best mosquito control programs. All programs need to be based on an identified need that is matched with state and local resources and technically sound strategies. There may be gaps in knowledge in some areas such as outcome evaluations.

Focal or homeowner-based mosquito control strategies may be perceived as an alternative by the public in affected communities. There has been a rapid proliferation of backyard mosquito control equipment and technologies, as well as suggestions for new or unproven alternatives to currently recognized effective mosquito repellents. However, there is little data on the efficacy of these methods, machines, and materials either for area-wide or focal programs, especially for mosquito-borne disease control. Some of these technologies may result in the misuse of pesticides and have other negative impacts. If the public believes that these alternatives are best for them (for example, because of intensive advertising), they could rationalize not authorizing public support for community-wide mosquito control. Therefore, organized mosquito control programs could suffer. These methods also do not adequately address the need for surveillance, monitoring, source reduction, or larval control—all basic components of integrated mosquito management. In addition to not providing area-wide protection, focal strategies usually are more expensive than the annual per person cost of organized mosquito control.

THE SCIENCE OF MOSQUITO CONTROL

A quality mosquito control program has as its foundation a solid understanding of the biology of the mosquito species that occur locally. This includes such information as where the larvae are found, where the adults rest, what time of day the adults look for a blood meal, and what control measures are most effective against each species. In addition, control of disease-transmitting mosquitoes requires information on the timing and distribution of human and animal cases.

Epidemiology

Public health mosquito control efforts are driven by information accumulated and analyzed using the science of epidemiology. Epidemiologists at CDC, state health agencies, and local health agencies work cooperatively to monitor mosquito-borne illnesses. Monitoring the timing and distribution of both human and animal cases of mosquito-borne illness provides the basis and the targets for mosquito control in the field.[27]

Human case surveillance for mosquito-borne diseases involves receiving and recording reports of illness; confirming diagnoses; interviewing doctors and patients to determine the timing, geographic location, and conditions of infection; and scientifically analyzing the data accumulated.

Monitoring human cases alone is considered inadequate when dealing with mosquito-borne disease.[28, 29] Using epidemiological techniques to monitor equine and avian cases is very important in establishing early trends and allowing reasonable response times for control activities. Reporting networks for animal cases involve veterinarians, laboratories, wildlife agencies, agriculture agencies and organizations, and also the general public. These reporting systems require proactive

AS IDENTIFIED BY CDC, THE GOALS OF SURVEILLANCE FOR HUMAN CASES OF MOSQUITO-BORNE DISEASE ARE TO:

1. Assess the local, state, and national public health impact of West Nile virus and other mosquito-transmitted diseases and monitor national trends;
2. Demonstrate the need for public health intervention programs;
3. Allocate resources;
4. Identify risk factors for infection and determine high-risk populations;
5. Identify geographic areas in need of targeted interventions; and
6. Identify geographic areas in which it may be appropriate to conduct analytic studies of important public health issues.

and ongoing effort to implement and maintain. State health agencies collaborate with these partners to establish, maintain, and analyze these databases. The state also helps define the parameters of reportable cases and keeps physicians informed of changes in case definitions, routes of transmission, and treatment regimes. Developing guidelines and fact sheets on clinical features and treatment for physicians and personal protection guides for the public are ways the state health agency can provide important services to the medical community and the public.

Surveillance of Animal and Insect Populations

Zoonoses are different from human-to-human diseases because they involve other animal hosts and, frequently, insect or tick vectors. Much of the activity (transmission) of zoonotic pathogens takes place out of sight of, and physically removed from, humans. However, attacking the zoonotic cycle has the greatest impact in reducing the threat of disease in humans and domestic animals. By the time these diseases are detected in the human population it is often too late to have any impact on the transmission cycle. In fact, the zoonotic portion of the cycle may already be declining when human cases appear. At that point, the only effective strategies are avoidance, personal protection, and chemical control of the adult vectors (mosquitoes in this case).

To understand surveillance and monitoring strategies, it is necessary to know something about the ecology of the area, the mosquito species present, and the disease agents likely to be found. This information will set most of the parameters for the layout of the surveillance system. In general, adult mosquito collections (e.g., from light traps or gravid traps) are highest when traps are placed in an ecotone (i.e., the junction between two habitat types, such as forest and grassland, park land and urban housing, etc.). In monitoring for virus activity, roosting or nesting habitats of the bird hosts should also be considered in deciding where to place traps. Note that this is different from the placement of traps to detect the emergence of adult mosquitoes from larval habitats.

Public Health and Nuisance Mosquito Control

The objective of public health mosquito control is to prevent transmission of mosquito-borne diseases to humans. Reduction of nuisance mosquito species may be an added benefit, particularly in areas where tourism and other outdoor activities are major contributors to the local economy. Agricultural production may be impacted as well. Agricultural workers may be negatively impacted with health problems and productivity loss. Livestock may suffer death, disease, weight loss and/or production loss.

Nuisance mosquito management frequently focuses on different species and different habitats than public health mosquito control. However, a well organized integrated pest management (IPM, sometimes also referred to as integrated mosquito management or IMM) program can provide the basis for effective management of vector species.

Monitoring or surveillance as a part of a nuisance-based mosquito control program differs somewhat from virus surveillance programs. In the latter case, the objective is to detect activity of the vector species at the earliest possible point in time. Collections of larval mosquitoes in new or previously identified habitats often form the core of nuisance-focused surveillance. Adult mosquito surveillance is used mainly as an assessment tool to judge the effectiveness of control measures in nuisance-based control programs. In disease prevention and control programs, adult mosquito surveillance plays a much larger role, since the risk of pathogen transmission is often linked to adult mosquito density, infection rates, and age structure of the female population.

PLANNING A MOSQUITO CONTROL STRATEGY

Communities need to define their desire and need for mosquito control before they create a program. A scientific response to combat a nuisance mosquito may look very different from a program to combat mosquitoes carrying disease. However, it is important to remember that there is not a clear distinction between "nuisance" and "vector" species of mosquitoes. For example, *Aedes vexans*, perhaps the most widely distributed nuisance species, also appears to be involved in transmission of West Nile virus, as well as transmission of eastern equine encephalitis virus in some areas.

It is important to recognize that mosquito and mosquito-borne disease control programs cannot be created at a moment's notice, as too many agencies across the United States have learned in the wake of West Nile virus. As detailed in the "Plan Ahead" section, effective, efficient, and publicly embraced programs need to be planned and initiated well in advance of the onset of a disease outbreak or mosquito control emergency following a disaster. The best disaster or emergency responses come from ongoing programs with trained personnel, adequate equipment, and good procedures already in place and operating.

Communities need assistance in assessing the existing and necessary scientific and technical infrastructure for a program. Citizens need to know what proactive and reactive options are available. Communities need models of successful programs to weigh against their resources. They need information about minimum criteria and standards for programs with limited resources. They also need models for threat assessment that are timely and site-specific.

Mosquito Control Strategy Basics

There are several ways to prevent the emergence of adult mosquitoes, which is generally the most economical strategy. Larvae are confined to the aquatic habitat, which can be clearly identified and treated. Methods include:

- Source reduction (remove, cover, drain, fill) of larval habitats that are not environmentally sensitive or protected
- Chemical control (conventional and microbial larvicides)
- Biological control (mosquito fish, etc.)
- Public education (role of the homeowner in reducing peridomestic larval habitats)—schools, service clubs, radio and TV, other focal points in the community

Larviciding operations should be monitored by dipping or other accepted technique to assess the efficacy of the application.

If larval control fails, is inadequate, or not feasible in a given setting, it may be necessary to control the adult mosquitoes that emerge from the larval habitats. Adult mosquito control must cover a larger area, since adults of many species can fly long distances (ten miles or more for some species), which can drastically increase the cost of protection. Adult mosquito control methods include:

- Personal protection (use of repellents, clothing, maintain door/window screens)
- Public education (educate, gain public support for the program, source reduction around the home)
- Adulticides (usually applied as ultra-low volume (ULV) sprays by truck- or aircraft-mounted equipment)

Because adulticiding can be a divisive issue in many communities, its use should be clearly justified by using a decision matrix that specifies what events will trigger a given level of response. A decision matrix specifies a range of activities or responses to a given set of predictive parameters. [See Appendix A: Decision Matrix.] For example, recent temperature and rainfall, mosquito density, levels of virus transmission in sentinels, etc., can be factored into decision-making. The decision matrix helps policy makers avoid indecision and provides justification and confidence for a particular course of action.

Use area maps to indicate treated and untreated areas, and specify reasons for not treating an area (e.g., environmentally sensitive, opt-out, outside district boundary, no mosquitoes, etc.). Environmental parameters, such as temperature, wind speed and wind direction should be recorded during each application.

Adulticiding operations must be closely monitored, and the efficacy of the application should be assessed by pre- and post-treatment trapping, landing counts, or other techniques. All relevant application parameters (e.g., droplet size, flow rate, etc.) must be monitored in accordance with the product label and appropriate federal or state regulations.

Once communities have identified that mosquitoes are presenting a threat to the community, action must be taken based on the resources available to the state or community and the severity of the threat. Human disease and mosquito surveillance programs are necessary components for a public health mosquito-borne disease control program.

MOSQUITO CONTROL STRATEGY-PLANNING AND ACTION CHECKLIST

- ❑ Determine the community's need for surveillance of vector-borne disease.
- ❑ Determine what is involved in vector-borne disease surveillance. What agencies or groups will be involved in carrying out the surveillance program? How will coordination and communication be handled between the participating agencies?
- ❑ Identify the options for establishing a vector-borne disease surveillance and control program. What strategies work best for a given locality? What is the state's role?
- ❑ Discuss how the community can control or reduce mosquito populations effectively and with the least cost and environmental disruption.
- ❑ Coordinate local mosquito control programs with state and federal public health agencies to receive training for the operation of surveillance systems.
- ❑ Get local agencies involved in gathering data about disease and mosquito population patterns. Monitoring networks require maintenance and resources.

OPTIONS FOR MOSQUITO CONTROL ACTIVITIES AND PROGRAMS

Once the community has decided that there is a need for some sort of organized response to a mosquito or mosquito-borne disease problem, it is necessary to decide on the type of response and the magnitude of the effort. These decisions will be impacted by a variety of considerations, such as the severity of the problem, the financial resources of the community, public perceptions and attitudes, and the availability of technical expertise. This section deals with the technical aspects of organized mosquito control.

A primary focus of the MCC effort is to define the range of options for local mosquito programs from the simplest, but still effective, program, to the ideal program where resources are not the primary limiting factor. While this section provides options for local mosquito control programs, the role of the state in mosquito control varies from state to state, with some states providing direct mosquito control services for local communities. Therefore, these options can be used by both state and local governments. This document assumes that the programs described focus on both disease vector control and nuisance control. It also assumes that the area to be protected has been defined through some process (buffers around the community, city/county boundary, etc.). The following options describe three program levels:

- **Level I (Minimal)**
  Minimal or no resources to support mosquito control activities

- **Level II (Intermediate)**
  Little to moderate resources to support a program

- **Level III (Comprehensive)**
  Moderate to full resources to fund a complete mosquito control program

LEVEL I – MINIMAL PROGRAM

(Minimal or No Resources to Support a Program)

Even when there is no staff or budget within the local community, there are things that can be done to reduce the threat of mosquito-transmitted disease and, to some extent, the irritation of pest mosquitoes. Here are some low-cost or no-cost options that will be helpful in many situations.

Public education. Remember that some aspects of mosquito control are personal responsibilities. Each citizen should be made aware of ways in which they can prevent mosquito breeding on and near their property; how they can reduce the risk of being bitten by observing personal protection measures; and how they can help to inform local health agencies by reporting bird deaths or other unusual events. However, knowledge does not always lead to action. Public recognition or other rewards may increase action by the community.

- Many public information brochures and other materials are available from the CDC and from state and local health departments. These can be reproduced at minimal cost and distributed with monthly utility bills or other community mailings.

- The public schools can be an excellent means of educating the public. The American Mosquito Control Association, the CDC, and other groups have teaching materials for the K-12 grades, and these may be available free or for a small charge.

- Citizen action groups can be an extremely effective resource to spread information about mosquito control, homeowner participation, and similar issues. Be sure to refer citizens to sites with reliable information.

- Educate and inform the local media. They are an important resource for delivering mosquito control messages to the public.

Source reduction. Community cleanup programs can be an effective way to eliminate larval habitats from backyards, commercial sites, and abandoned premises. Service groups (e.g., Rotary, Lions, Kiwanis, 4-H clubs), churches, scouts, and similar programs can be enlisted in the effort to increase community awareness and to support cleanup programs.

ELEMENTS OF A MINIMAL PROGRAM

- ❑ Institute a public information program emphasizing personal responsibility, ways in which people can prevent mosquito breeding, and how they can reduce the risk of being bitten by observing personal protection measures.
- ❑ Encourage reporting of unusual events, such as dead birds or sick domestic animals, to local health agencies.
- ❑ Institute community cleanup programs to eliminate larval habitats from backyards, commercial sites and abandoned premises.
- ❑ Citizen participation (reporting suspected mosquito larval habitats, reporting dead birds or other unusual events) is essential for efficient data gathering.
- ❑ Educate and inform the local media.

LEVEL II – INTERMEDIATE PROGRAM

(Little to Moderate Resources to Support a Program)

Communities with limited to moderate resources available will have some capacity to conduct mosquito control activities, but cannot mount a comprehensive program. In this situation, the first question often is, "Should we use a contractor or should we develop an in-house program?" The answer depends on what other resources are available. In particular, the knowledge and training of individuals in the local health or public works department (or mosquito control program if one is being developed) are factors. Other issues that will impact the decision include the size of the community being served, proximity to other communities (with or without existing mosquito control programs), ecology of the region, and support by the community.

- In the absence of existing local expertise, it may be advisable to use a reliable contractor or, if feasible, form a collaborative or other arrangement with an adjoining county, parish, or municipality with an existing mosquito control program. Responsibility for program oversight and monitoring must be assigned to the appropriate agency. That agency should have the knowledge base and physical resources to carry out the program effectively.

- Regardless of which approach is selected, there should be a clearly defined statement of services or deliverables, and a clear performance evaluation document. What activities will be performed? What resources (equipment, staff, insecticides, etc.) will be provided? How often will inspections be conducted? How will efficacy be measured? What happens in the event of non-performance? The second common question deals with where to allocate the scarce resources. The answer will

again depend somewhat on local conditions, but there are some generalizations that can be made. The end objective is to have a fully integrated mosquito management program that relies on a thorough understanding of the ecology of the mosquitoes of the area, the extent of the disease threat or nuisance problem, and the history of the community.

- The program should include all of the public education and source reduction activities identified in Level I above. Some funding could be directed at improving programs in the public schools or, if needed, additional source reduction activities (e.g., draining or filling extensive larval breeding sites).

- The next step will be to focus on larval mosquito control, begun early in the season. This requires some knowledge of the local mosquito species and their ecology. Where are the larval habitats? When do they appear in the spring or summer? Thus, some mapping and record keeping will be needed. If insecticides are used, records must be kept of when, where, and how much of each material was used on any given day. In some localities, pre- and post-treatment larval counts are required to show whether the treatment was effective.

- One or two mosquito traps should be purchased and placed in operation. The CDC portable light trap or any of several similar traps have been shown to be effective. These traps can be placed at crucial sites within the community, perhaps where past experience has indicated particularly severe pest problems or increased disease activity. This will aid in assessing the effectiveness of the program. For example, trap counts before and after a particular control activity can be compared. As more resources become available, adjust the number of traps according to the size of the district and the variety of habitats within the district.

- If additional funds are available, it may be worthwhile to purchase or contract for equipment for adult mosquito control (ULV sprayers, etc.). Since mosquitoes can fly substantial distances (from less than 1 mile to more than 15 miles, depending on the species and conditions), it may be difficult to protect communities with large outlying areas that can generate millions of mosquitoes. However, these methods can increase protection of the community from mosquitoes if an adequate area can be covered and the insecticides are applied appropriately—usually at dusk or after sunset, depending on the species being controlled.

ELEMENTS OF AN INTERMEDIATE PROGRAM

- ❑ Continue measures established in the minimal-level program described above. Augment public education and source reduction efforts.
- ❑ Decide on the program format (e.g., in-house, contract, multi-jurisdictional collaborative).
- ❑ Decide which agency has the resources and expertise to conduct the program.
- ❑ Define the scope of the program-including such things as area to be covered and services to be performed-in relation to the available resources. Emphasize public education and source reduction, augmented by larval control. Consider adult mosquito control if sufficient resources are available.
- ❑ Ensure that all staff and public health advisors are appropriately trained and certified or licensed.
- ❑ Institute basic mosquito population monitoring to define the problem.
- ❑ Use passive disease monitoring (e.g., dead bird reporting) as an indicator of possible disease activity. Submit birds and/or mosquitoes for virus testing if such services are available.

LEVEL III – COMPREHENSIVE PROGRAM

(Moderate to Full Resources for a Program)

Communities with moderate to full resources will be able to develop and implement more comprehensive mosquito control programs. The recommendations in this section are drawn largely from the American Mosquito Control Association's Bulletin #4.[30] Please refer to that document or to the many excellent training manuals developed by state mosquito control associations for additional guidance in organizing a full-scale program.

A general principle of integrated control programs is that a specific control measure is only instituted when an action threshold, or "trigger," is met. An example of thresholds and suggested responses for West Nile virus activity is shown in Appendix A, Decision Matrix. These are broadly defined thresholds, and individual states or communities may wish to institute more precise thresholds that reflect local experience and concerns.

One of the first things to recognize, once funding becomes available, is that mosquito control is a year-round activity. The information in this section gives a general picture of the activities that will be needed for a basic year-round mosquito control program.

PRE- OR OFF-SEASON ACTIVITIES

General Issues

Many activities of the mosquito control program will normally be carried out in the "off season" when mosquitoes are not a problem—usually during the winter. These activities include staff training and certification; equipment purchase, repair and calibration; budgeting and other financial activities; and analysis of the previous year's data. In some areas, source reduction activities (see below) can also be done at this time.

Much of the information collected during mosquito control activities consists of maps, tables, and charts. Most of the information also is linked to a physical location. For this reason, it is useful to have a mapping program available to the mosquito control program. This can be done by coordinating with another city or county department that already has a geographical information systems (GIS) section or activity. Alternatively, there are inexpensive software programs that can be used if the expertise is available within the control program. The CDC offers a free software package, EpiInfo, which also contains a simple GIS program, EpiMap.[31] This provides an inexpensive entry into the world of in-house data management and mapping. EpiInfo can also be used to design data collection forms, data entry screens, and elementary graphing capabilities.

Surveillance

Surveillance, as applied to vector-borne disease, is the organized monitoring of levels of virus activity, vector populations, infections in vertebrate hosts, human cases, weather, and other factors to detect or predict changes in the transmission dynamics of arboviruses. Since all of this information is rarely collected by a single agency, it is extremely important that the various data-collecting agencies actively communicate and exchange information.[28, 29]

- Review all published data, past health department records, and other data to determine the types of mosquito-borne diseases, numbers of cases by year and date of onset (or diagnosis), economic and other costs, if known. Review complaint calls for nuisance mosquitoes by year and date, and determine the peak periods of nuisance problems.

- Collect and review historical meteorological data for the area: temperature, rainfall, humidity, and wind direction. Plot this information against mosquito abundance (or nuisance calls) to see if there are any predictors of high mosquito abundance, disease transmission, etc.

- Map the locations of high-risk populations (e.g., elderly citizens), using local census or other community data. This will allow the program to prioritize resources if an epidemic should occur.

- Collect and review topographic maps, aerial photography, and other similar resources to help in locating probable larval habitats, concentrations of bird or other hosts of mosquito-transmitted viruses.

- Use the data collected above to decide where to place light traps or other sampling stations, and where to concentrate efforts to monitor larvae.

- Based on the foregoing information, select the areas at greatest risk within the service area (city, district, county, etc.) and plan to concentrate the available resources in those areas.

Species Delimitation

In some respects, a mosquito control program can be compared to a military campaign: it is crucial to know the enemy. The more that is known about the important species in the area, the more likely they can be effectively and economically controlled.

- **Habitat mapping**. The off-season is a good time to map the locations of larval habitats within the mosquito control district. It may also be useful to map major sources of mosquitoes that may be located outside the boundaries of the control district, if these are known or suspected sources of problems during the mosquito season.

- **Seasonal characteristics**. If not already done, take this opportunity to construct graphs of seasonal abundance of mosquitoes, by species. This should be done for larval surveys as well as adult surveys. Over several years, it will be possible to construct an average count for each species, by week. When the current counts for a particular species rise above the long-term average, this may indicate an emerging problem.

Control Activities

This is the most visible part of the program, but its success is strongly dependent on attention to the points covered above.

- **Source reduction**. Several types of source reduction can be carried out during the off-season: clearing of stream channels, community cleanup (e.g., door-to-door inspections, tire amnesty programs), and similar activities.

- **Larval control**. Most control is done later in the season, but some areas can be treated before they become flooded by spring rains or runoff.

- **Adult control**. No adult control is done at this time.

- **Public education**. Public education, especially activities focused on K-12 school programs, can be carried out at any time of the year. Arrange for presentations at meetings of civic groups, nature groups, service clubs, and other groups that have an impact on the local community. To reach the agricultural community, coordinate activities with local county extension agents where those services are available.

EARLY-SEASON ACTIVITIES

Surveillance

In early-season activities, as above, surveillance gathers the intelligence data needed to combat the mosquitoes and prevent disease transmission.

- **Larvae**. With the arrival of spring warming and rain or flooding, *Aedes* and *Ochlerotatus* eggs will hatch, and diapausing *Culex* females will emerge, take a blood meal, and begin laying eggs. This is the time to begin monitoring larval populations. Triggers for control action should be determined: how many larvae per dip represent a health threat or a nuisance problem?

- **Adults**. Similarly, light traps, gravid traps, or other methods should be used regularly to monitor adult mosquito abundance. Triggers for control action should be determined: how many females per trap night of a particular species pose a health threat or a nuisance problem?

- **Disease surveillance**. Vertebrate hosts (e.g., dead birds as indicator for West Nile virus) should be monitored for evidence of virus activity. This may be simply recording and mapping the locations of dead birds reported by the public. Depending on other resources, a state laboratory or other facility may be available to perform virus testing on dead birds. Test kits are available for testing dead birds and mosquito pools without elaborate laboratory facilities. Mosquito infection rates can be an important indicator of a disease threat. The state health laboratory or other facility may be able to provide this service. Infection in domestic animals (horses, etc.) and humans is an indicator of impending trouble and an indication that immediate action is required. [See Appendix A: Decision Matrix.]

Species Delimitation

- Habitat mapping should be continued during the course of the mosquito season. New locations should be plotted on the map or entered into the GIS database. New locations should be added to the inspection and treatment routes of the field staff.

- Seasonal abundance characteristics may give evidence of approaching problems. Are the numbers of *Culex pipiens* far above normal? What about *Culex tarsalis* (western states)? Is *Aedes vexans* more abundant than normal?

Control Activities

- **Source reduction**. Activities can continue during this period. Efforts should concentrate increasingly on the elimination of potential disease vector species' larval habitats.

- **Larval control**. Biocontrol agents, such as mosquito eating fish (*Gambusia* spp. and others), copepods, or other agents, can help to balance out a good control program. "Biological pesticides" such as *Bacillus thuringiensis* var. *israelensis* (B.t.i.) and *Bacillus sphaericus* are effective mosquito control agents.

- **Chemical control of larvae includes a variety of materials**. Larvicidal oils and monomolecular films cover the water surface and prevent the larvae from breathing. Growth regulators, such as methoprene, affect the development of the mosquito larvae, preventing the adult from emerging from the pupa. Several other materials are available in some areas or for particular applications.

- **Adult control**. Selective use of adulticides may be advisable if there is evidence of virus activity early in the season, or if nuisance species are at high levels.

- Public education. Newspaper, radio, and television announcements can be prepared to increase public awareness of the threat of mosquito-transmitted disease. Coordination with local media can increase the community's awareness of the types of work done by the mosquito control program.

MID- AND LATE-SEASON ACTIVITIES

Activities for the remainder of the mosquito control season will be much the same as for the early season, with the exception that more and more effort will be dedicated to larviciding and, when needed, adulticiding. Disease surveillance data will guide the level of mosquito control, especially control of adult mosquitoes. Public education and close contact with media resources will be a continuing need.

As mosquito populations decline with the onset of cold weather, the program will return to the pre-season/off-season routine, in preparation for the next year.

ELEMENTS OF A COMPREHENSIVE PROGRAM

- ❑ Continue measures established in the intermediate-level program described above. Augment public education and source reduction efforts.
- ❑ In collaboration with other relevant agencies and stakeholders, define the full scope of the expanded program.
- ❑ Establish an advisory board or similar structure to provide feedback and communication between the program and relevant stakeholders.
- ❑ Hire and train appropriate professional staff needed to fulfill the requirements of the expanded program.
- ❑ Procure the necessary equipment, chemicals and other materials needed to carry out the expanded program.
- ❑ Build on the existing monitoring program, establishing a long-term database for comparison to current-year data.
- ❑ Prepare an emergency response plan for dealing with vector-borne disease outbreaks.
- ❑ Increase disease surveillance activities by instituting sentinel flocks, mosquito testing or other techniques as appropriate.
- ❑ Build risk maps to assign priorities to areas within the district using census data, mosquito abundance data, disease incidence and other relevant data.
- ❑ Maintain good communication among the Centers for Disease Control and Prevention, state public health and local public health agencies.
- ❑ Evaluate the governmental disease surveillance network.
- ❑ Evaluate and improve the disease reporting system among physicians, hospitals, laboratories and public health agencies.
- ❑ Develop and maintain a responsive animal and vector disease reporting system among veterinarians, wildlife agencies, the public, mosquito control contractors, laboratories and state and local public health agencies.
- ❑ Keep the public and public officials informed regarding disease incidence projections, cases identified and response planning.