WEST NILE VIRUS:
The Role of Mosquito Management in its Control

HEARING BEFORE THE

U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON GOVERNMENT REFORM
SUBCOMMITTEE ON ENERGY POLICY, NATURAL RESOURCES
AND REGULATORY AFFAIRS

TESTIMONY
OF
JOSEPH M. CONLON
TECHNICAL ADVISOR

ON BEHALF OF
THE AMERICAN MOSQUITO CONTROL ASSOCIATION
681 US HIGHWAY 1 SOUTH
NORTH BRUNSWICK, NJ 08902

OCTOBER 6, 2004

Good morning, Mr. Chairman and Members of the Subcommittee. My name is Joseph Conlon. I am an entomologist serving as Technical Advisor for the American Mosquito Control Association (AMCA), a nonprofit organization dedicated to enhancing health and quality of life through the suppression of mosquitoes and other vectors of public health importance. I welcome this opportunity to provide a public health perspective to the deliberations of this committee concerning West Nile Virus and will limit my testimony to mosquito management methodologies that contribute to its control.

The introduction and spread of West Nile Virus in the United States has reawakened an appreciation of mosquitoes as vectors of diseases. I use the term "reawakened" advisedly, for mosquito-borne diseases were once quite prevalent in the United States and, indeed, played a major part in shaping our nation's destiny. Dengue Fever, long a scourge in the tropics worldwide, was in fact first described by Dr. Benjamin Rush in Philadelphia in 1780. Additionally, Yellow Fever caused over 100,000 deaths in 135 separate epidemics in the United States from 1793 until 1900, and as late as 1934, there were 125,566 cases of malaria. These diseases no longer claim victims in the United States as a matter of course largely due to the exemplary efforts of organized mosquito control agencies, in conjunction with an enlightened and effective public health infrastructure. Indeed, the mosquito control profession enjoys a long and proud legacy of community service in its pursuit of improved quality of life and a society relatively free from the ravages of mosquito-borne diseases that have afflicted our country in times past.

Since its introduction into the United States in 1999, West Nile Virus has spread southward and westward at an alarming pace, with a total of almost 15,700 human cases and 650 fatalities as of 24 September, 2004. Approximately 20% of human West Nile cases develop West Nile Fever, whose symptoms include fever, headache, tiredness, and body aches, occasionally with a skin rash (on the trunk of the body) and swollen lymph glands. This condition can last anywhere from a few days up to several weeks. Almost 30% of symptomatic human West Nile cases develop a more severe form of neuroinvasive disease characterized by headache, high fever, neck stiffness, stupor, disorientation, coma, tremors, convulsions, muscle weakness, and paralysis. The neuroinvasive form occurs most often in people over age 50 and some immuno-compromised persons (for example, transplant patients), but can occur at any age in healthy individuals. To date in 2004, a total of 1508 human cases have been reported. Of these, 45 have been fatal, 532 (35%) exhibited neuroinvasive symptoms, and 622 (41%) were classified as West Nile fever. In 2003 a total of 9862 human cases were reported. A total of 264 of these were fatal, 2866 (29%) were diagnosed as neuroinvasive, and 6830 (69%) were classified as West Nile fever.

The costs these cases entail are extraordinary and extend far beyond medical and vector control expenditures. It has been estimated by CDC that the average cost per patient hospitalized with WNV infection in Louisiana in 2002 was $51,826, with the total cost of treatment and control exceeding 69 million dollars. However, these numbers fail to address the additional emotional cost to families of victims of mosquito-transmitted disease, a radically-changed quality of life of the victims and similar issues.

West Nile Virus has wrought havoc with wildlife as well. A total of 208 avian species and 29 mammalian species have been found infected. Although accurate counts of absolute numbers of birds and mammals fatally infected are problematic, the toll for corvids (crows, jays, etc.) is estimated to be in the millions. Horses suffer a 40% mortality rate from infection with this virus. The cost to the horse industry in vaccinations, medical costs, prevention/control measures, and mortality is estimated to exceed one billion dollars.

Great strides have been made in defining the transmission dynamics of West Nile Virus. However, considering that it is a comparatively recent epidemiological phenomenon, there remains much to learn in order to establish and verify baseline data. The cycle involves birds as a reservoir of infection and means of spread through migration, avian-feeding species of mosquitoes amplifying the virus among bird populations, and bridging species of mosquitoes that feed upon both birds and mammals transmitting the virus to humans and equines. At present, 59 of the 176 species of mosquitoes currently recognized in the United States have tested positive for the virus. Of these, generally one species is primarily responsible for transmitting the disease in a particular area. The extent to which other species contribute to the problem is often poorly understood. Each species utilizes preferred aquatic habitats within which to breed. These habitats vary widely, from salt marshes to used car tires. Virtually any collection of stagnant water is fair game, with some species successfully utilizing even soda bottle caps. Factors favoring choice of breeding habitat depend upon the mosquito species involved, topography, climate and human use patterns.

As early as 1905, mosquito control pioneers recognized the value of a diversified approach to control, integrating surveillance, source reduction, personal protection, and chemical and biological control. Early control methods consisted of ditching, draining, and/or filling marshes, applying oils to water to kill immature mosquitoes, and insecticide sprays against adults. Realizing there now existed a means to obtain a measure of public health protection heretofore unavailable, citizen groups began conducting referenda to establish special taxing districts to fund organized mosquito control activities. The first districts were established in NJ in 1912. California and Florida followed suit in 1915 and 1925, respectively. In the ensuing years, mosquito control districts and state agencies were established nationwide. Mosquito control personnel refined their methods through applied research and assisted federal and state agencies in developing certification criteria to ensure conformance to stringent safety standards. Since the 1950's, control programs have progressively adopted the use of nationally registered public health larvicides and adulticides to further exploit mosquito vulnerabilities within an increasingly environmentally friendly context. That tradition continues today. In fact, the American Mosquito Control Association has established a formal partnership with the EPA in investigating means of improving effective mosquito control while reducing reliance upon public health insecticides. This Pesticide Environmental Stewardship Program (PESP) has the full and active support of the entire mosquito control profession.

This success did not come about in a regulatory vacuum. Since its inception, the Environmental Protection Agency (EPA) has regulated mosquito control through enforcement of standards instituted by the Federal Insecticide, Fungicide, and Rodenticide Act. This legislation mandated documentation of extensive testing for public health insecticides according to EPA guidelines prior to their registration and use. These data requirements are among the most stringent in the federal government and are met through research by established scientists in federal, state and private institutions. This process costs a registrant several million dollars per product, but ensures that the public health insecticides available for mosquito control do not represent health or environmental risks when used as directed. Indeed, the five or six adulticides currently available are the selected survivors of literally hundreds of products developed for these uses over the years. The dosages at which these products are legally dispensed are at least 100-fold (and often greater than 1000-fold) less than the point at which public health and environmental safety merit consideration. In point of fact, literature posted on the websites of the EPA Office of Pesticide Programs, Centers for Disease Control and Prevention (CDC), American Association of Pesticide Safety Educators and National Pesticide Telecommunications Network emphasizes that proper use of mosquitocides by established mosquito control agencies does not put the general public or the environment at unreasonable risk from runoff, leaching or drift when used according to label specifications.

Even with these safeguards, organized mosquito control agencies often go to extraordinary lengths to accommodate individuals who, for varying reasons, prefer their property not be sprayed with approved public health insecticides. When surveys indicate the need for adult sprays, they are approved, planned and conducted with special regard to the concerns of chemically sensitive persons. Personal notification of chemically-sensitive individuals of spray times in addition to using Global Positioning Systems (GPS)/Global Information Systems (GIS) technology and drift-modeling computer programs to reduce the likelihood of drift over unauthorized areas are but a few of the means utilized to ensure mosquito control serves the entire public spectrum.

Successful West Nile Virus control programs as practiced nationwide today rely upon principles of Integrated Pest Management (IPM). IPM, as the name implies, utilizes a variety of physical, chemical, mechanical, cultural, biological, and educational measures, singly or in appropriate combination, to exploit the mosquito's vulnerabilities and attain the desired level of mosquito control consistent with community needs. Application of these measures is predicated upon surveillance data indicating a need for intervention. In this light, the *sine qua non* of effective, sustainable West Nile Virus control is a sound, comprehensive surveillance program driving intervention efforts. Knowledge of the target mosquito vector allows efficient allocation of control resources specifically tailored to safely counter each stage of the mosquito life cycle. Larval control through water management, vegetation management and source reduction, where compatible with other land management uses, is a prudent pest management alternative - as is use of the environmentally friendly EPA-approved larvicides currently available. When source elimination or larval control measures are clearly inadequate, or in the case of imminent disease, the EPA and CDC have emphasized in a published joint statement the need for considered application of adulticides by certified applicators trained in the special handling characteristics of these products. The extremely small droplet aerosols utilized in adult mosquito control are designed to impact primarily on adult mosquitoes that are on the wing at the time of the application. Degradation of these small droplets is rapid, leaving little or no residue in the target area at ground level. These special considerations are major factors that favor the use of very low application rates for these products, generally less then 4 grams active ingredient per acre, and are instrumental in minimizing adverse impacts.

Components of contemporary West Nile Virus control programs include the following:

<u>Prevention</u>

Surveillance - A sustained, consistent surveillance program targets vector species, identifies and maps their larval habitats by season, documents the need for control through larval and adult trapping regimens. It thus also monitors the effectiveness of the control program. Appropriate and timely response to surveillance data is the key to preventing human and animal disease associated with WNV. Detection of epizootic transmission of enzootic arboviruses Control activity should be intensified in response to evidence of virus transmission, as deemed necessary by the local health departments.

- Virus Surveillance of Mosquitoes/Birds - Detection of WNV in bird and mosquito populations appears to be the most sensitive early detection system for WNV activity, typically preceding detection of human cases by several days to several weeks. Early-season detection of WNV activity in birds and mosquitoes appears to be correlated with increased risk of human cases later in the season.
    - Surveillance programs based upon dead birds are the most sensitive method of detecting WNV presence in an area.
    - Captive sentinel surveillance typically utilizing chickens and programs based upon free-ranging bird surveillance have both been used. Both of these approaches requires extensive knowledge of local transmission dynamics and may require animal use and care protocols and other authorization permits.
    - Mosquito surveillance based upon trapping remains the primary tool for quantifying the intensity of virus transmission in an area. In addition, these techniques can monitor efficacy of control programs.
        - Light traps and gravid traps remain classical methodologies
        - If appropriate, human biting/landing counts can be used to establish accurate data regarding mosquitoes questing for human meals.

- Human Surveillance - Human case surveillance, both passive and active, alone should not be used for the detection of arbovirus activity, except in jurisdictions where arbovirus activity is rare or resources to support avian-based and/or mosquito-based arbovirus surveillance are unavailable.

Public Information and Outreach – Studies have shown that information programs, while crucial to the overall prevention/control strategy, have a moderate effect on modifying population behaviors related to personal protective measures. About half of the population actively attempts to reduce breeding habitats around their domiciles. A smaller percentage use repellents due to perceived risk and other complex demographic factors. Nevertheless, programs should include strategies to facilitate protective actions and to address barriers that hinder preventive actions. Effective programs include developing a community task force, interventions to improve access to window screening materials or repellents, and social marketing to reinforce preventive behaviors. These are critical components of any mosquito control program, but cannot, in and of themselves, replace established prevention/control methodologies.

Source Reduction - Source reduction involves the elimination, where possible, or modification alteration of water sources to make them unavailable for mosquito breeding. Removing breeding habitat is the most effective long-term mosquito control where allowed, but modification through the selective use of herbicides to make the habitat unsuitable for breeding is also extremely effective. Source reduction includes activities as simple as the proper disposal of used tires, paint cans and trash, in addition to the cleaning of rain gutters, bird baths, and unused swimming pools by individual property owners. This can also include extensive regional water management projects conducted by mosquito control agencies on state and/or federal lands, where permitted. Source reduction activities can be separated into the following two general categories:

- Sanitation – Cleanup of peridomestic stagnant water sources provides a substantial reduction in biting activity. Educational information about the importance of sanitation in the form of videos, slide shows, and fact sheets distributed at press briefings, fairs, schools and other public areas can be effective in reducing these as breeding habitats. Considering that mosquitoes breeding in these containers tend to feed upon humans in close proximity, they constitute an important disease risk.

- Water Management – Proper stormwater management and both fresh and saltmarsh management are critical and resource-intensive forms of source reduction of important nuisance and vector species. Included in this strategy is vegetation management through physical removal or herbicide applications within potential habitats to remove means for larvae to escape predation.

<u>Control</u>

Surveillance results drive all facets of the control program. Control ultimately consists of reducing the contact between the vector mosquito and humans. This is accomplished through removing, modifying or treating larval habitats; modification or removal of adult mosquito resting areas, adulticide treatments when indicated; use of repellents. Most Best Management Practices (BMP) utilized in mosquito control districts employ a phased response based upon surveillance data, using only those measures likely to be most effective based upon a variety of bionomic, atmospheric and environmental factors. Such programs should consist of public education emphasizing personal protection and residential source reduction; municipal larval control to prevent repopulation of the area with competent vectors; adult mosquito control to decrease the density of infected, adult mosquitoes in the area; and continued surveillance to monitor virus activity and efficacy of control measures.

The following components may be used concomitantly or at intervals determined by target bionomics, host demographics or environmental factors.

- **Larval Control** – Mosquito larvae, although air-breathers, require a source of reasonably stagnant water in which to feed and ultimately metamorphose into adults. Larval control is extremely efficient, in that the larvae are confined within the aquatic habitat and are usually concentrated. While this makes possible a variety of strategies to effect control, environmental considerations are of paramount concern.
    - Biological Control – this may involve augmentation of natural predator species such as mosquitofish, but may also include cannibalistic species of mosquito larvae, viruses, fungi, bacteria and predaceous aquatic invertebrates.
        - Fish, most notably *Gambusia*, are extensively used throughout the country but their use must generally be cleared with local Fish and Wildlife officials.
        - Augmenting or introducing aquatic predators of mosquito larvae alters the local ecosystem in often unforeseeable ways, and should be done with great caution.
    - Chemical Control – Because chemical larvicides are to be used in sensitive aquatic environments, they are specifically designed to minimize their impact on non-target organisms. They must be applied, by law, only to a predefined target site whose guidelines are specified on the label. To ensure its effectiveness, the application rate for each larvicide is calculated on the basis of its toxicity profile and degradation characteristics. For example, the application rate for methoprene is calculated to achieve a final concentration in water of between 0.22 to 1.1 parts of product per billion (ppb). This would be equivalent to an initial dose of roughly one

drop in an Olympic sized swimming pool. Chemical larvicides roughly fall into the following categories:

- Bacteria such as the various species of *Bacillus* are widely used and extremely effective means of control. They must be ingested by the larvae and therefore are less effective in habitats with high organic loads serving as competeing food sources.

- Insect growth inhibitors constitute insect metamorphosis hormone analogs that prevent the mosquito larvae from molting eventually to the adult stage.

- Surfactants reduce surface tension of the water, making it impossible for the larvae to attach their breathing apparatus, drowning them.

- **Adult Mosquito Control** – Adult mosquitoes, being active fliers in a three dimensional space, present a unique challenge for their control. Control methodologies vary with the species involved, their peaks of activity, known resting areas, and other environmental factors.

  - Elimination of resting areas – Eliminating brush and high grass removes places where mosquitoes avoid dessication during their non-active periods. This makes the immediate vicinity less hospitable for questing female mosquitoes.

  - Personal protective measures – Measures to reduce biting include alteration of schedules to avoid peaks of mosquito activity, proper dress when outside, and use of repellents.

  - Encouragement of natural predation on adult mosquitoes – Use of bats and certain bird species has great public appeal, but has been disappointing in terms of reducing mosquito populations.

  - Chemical control - Modern pest management strategies endorsed by EPA and the Centers for Disease Control and Prevention recommends application of adulticides when surveillance indicates that larval control measures have proven inadequate to prevent imminent disease outbreaks. Certified operators trained in the special handling requirements of adulticides apply them after dusk under specified atmospheric conditions when mosquitoes are most active and non-target species are generally not at risk. Adulticides are usually applied in aerosol form of extremely small droplets (10 million of the standard 20-micron droplets could fit inside of a BB) so that they remain airborne to impinge upon mosquitoes in flight at the time of application. The minute droplet size also ensures that products dissipate and degrade quickly, to minimize any deposition of active ingredient on the ground or other surfaces. The low application rates of these aerosols—generally less then ¾ ounce of insecticide per acre treated—further minimizes environmental risk.

There is a large body of scientific literature demonstrating significantly reduced trap counts after adulticide applications. Since the size of questing female mosquito populations is crucial to disease transmission, it would be prudent to utilize all approved means to reduce these populations below transmission threshold. Adulticide applications should not be the sole means of control in an urban setting. But that is not to argue that adulticides should not be used at all. Even a 30% kill rate would still have a significant impact on disease transmission.

Adulticides used in the United States fall into two general chemical categories, organophosphates and pyrethroids. The pyrethroids and organophosphates are rotated at specified intervals in mosquito management programs to prevent the mosquitoes from becoming resistant after long-term exposure to a single group of pesticide.

- Only two organophosphates, malathion (Fyfanon) and naled (Dibrom, Trumpet), are in general use for adult mosquito control. Malathion is a popular choice because of its low price, proven efficacy and low level of toxicity (it's less toxic than table salt). Naled is an extremely effective adulticide when applied aerially.

- Pyrethroids constitute the other class of adulticides. Three products currently on the market, resmethrin (Scourge), sumethrin (Anvil) and permethrin (Aqua-Reslin) are produced from a highly potent chrysanthemum extract. These synthetic derivatives have both a longer shelf life and are as much as 50 times less toxic than the natural insecticide, while performing the same function.

The safety profiles of these public health insecticides are undergoing increasing scrutiny because of concerns with how the specialized application technology and product selection protect the exposed public and environment. In fact, well over 200 peer-reviewed scientific studies in various national and international refereed journals since 1980 have documented the safety and efficacy of these public health insecticides at label rates in addition to their application techniques. Despite intense pressures to eliminate the use of public health insecticides, the Centers for Disease Control and Prevention, World Health Organization and other public health organizations agree that it is essential that these products remain available for disease prevention and that editorial or irresponsible misrepresentation of the risks involved not lead to the greater risk of not having them available when truly needed. They simply must remain available for the control of vectors in the times of even greater public health emergency that are sure to come.

This reasoning, coupled with the spread of WNV into areas without established mosquito control programs, provided impetus for renewed investigation into means to develop functional abatement programs on short notice. Infrastructure shortfalls in capabilities for addressing the threat of vector-borne disease were identified and drove establishment in 2004 of a Mosquito Control Collaborative (MCC), comprised of members of the Association of State And Territorial Health Officials (ASTHO), the National Association of County and City Health Officials (NACCHO) and U.S. Centers for Disease Control and Prevention. Further motivation for forming the MCC came from the Mosquito Abatement for Safety and Health (MASH) Act (Public Law 108-75). The MASH Act authorizes grants through the Centers for Disease Control and Prevention to states for coordination of mosquito control programs within a state and assisting localities by providing assessment and planning grants. The MASH Act also authorizes operating grants directly to localities that have conducted assessments and have coordinated with the state to prevent mosquito-borne diseases. As of June 1, 2004, Congress had not appropriated any funds to cover the cost of the MASH Act.

Recommendations put forth by the MCC will serve as a resource to states and localities should funds for MASH Act implementation ultimately become available. The AMCA fully supports the MASH Act and requests action to appropriate the funds for its full implementation. The MMC identified four components of effective, sustainable state and local mosquito control programs.

- Timely Planning and Preparation - Developing an effective mosquito control program requires intense preplanning and timely collaboration with a wide range of agencies and jurisdictions. Understanding the structures and roles of the state, local and federal participants, defining equipment needs, workforce and training requirements, identifying legal authority and funding alternatives, and developing strategies for evaluating programs are key elements of any successful planning effort. In anticipation of the potential for future mosquito-borne disease outbreaks, communities should enact statutes permitting legal action to abate mosquito-related public health nuisances. In addition, legislation must be in place to allow creation of and provide funding for municipally-based integrated mosquito management programs. Local jurisdictions can contact their respective state mosquito control associations to provide examples of enabling legislation, generally involving creation of special taxing districts.

- Involve key participants - Governments should identify and engage a wide variety of stakeholders early in the process. Mosquito control issues can be contentious. Therefore, successful programs should identify all points of view early, present relevant scientific information in a transparent format, and work to a negotiated agreement, where necessary.

- Science should drive the process - 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 local and state resources and technically and environmentally sound strategies. Control strategies can focus on preventing the emergence of adult mosquitoes (larviciding), addressing biting stages (adulticiding), and other prevention measures such as breeding pool reduction and bite prevention. The mix of strategies used by each state and local community will vary based on their individual political, legal, environmental, geographic, demographic and resource concerns.

- Public Education - The public has concerns about problems related to mosquito populations and insecticide spraying. Addressing these concerns is critical to maintaining support of the citizenry. Successful programs having the have multi-phase communications plans that educate the public about preventing the breeding of mosquitoes, personal protection guidance, and the various activities of the agencies involved.

Provision of a safe and healthy environment is a core value of my profession. To this end, mosquito control professionals have devoted a substantial amount of their expertise to the development of numerous mosquito abatement strategies that reduce reliance upon public health insecticides. Indeed, provisions of the Clean Water Act (CWA) mandating measures to reduce pollution provide both significant challenges and opportunities to those charged with protecting the public's health. In pioneering the use of integrated mosquito control strategies, mosquito control programs fully endorse the CWA's intent of reducing pollutant load in the nation's clean water while allowing productive use of that resource.

However, even well-designed and maintained mosquito prevention programs will require corrective mosquito control efforts within an IPM context to address mosquito populations escaping natural predation in federal and state wetlands, vernal pools, marshes, etc. Addressing this problem has been complicated considerably by recent rulings rendered by both the 9th and 2nd Circuit Courts mandating issuance of National Pollution Discharge Elimination System (NPDES) permits required by the CWA to mosquito control agencies contemplating use of EPA-registered larvicides and adulticides as part of their integrated mosquito control program. These rulings, in effect, reduce or eliminate incentives for utilizing the full measure of integrated pest management techniques to mitigate mosquito populations due both to permit and water quality monitoring costs borne by mosquito control agencies.

The American Mosquito Control Association is strongly opposed to any interpretation of the CWA that requires NPDES permits be obtained for the legal application of public health mosquito larvicides in accordance with registered label stipulations. The AMCA considers NPDES permits to be both redundant and unnecessary for the application of public health larvicides specifically registered by USEPA under the Federal Insecticide Fungicide and Rodenticide Act (FIFRA) for application to water. Furthermore, the fiscal and logistical burdens that NPDES permits entail through compliance measures and threat of civil suit will ultimately divert scarce mosquito control resources away from the primary mission of protecting human health, while not contributing tangibly to the critical goal of environmental health. As a result, the AMCA believes that such interpretations are both contrary to congressional intent and inimical to public health and safety. In January of 2003, the AMCA proposed a rulemaking by EPA to exempt mosquito larvicides duly registered under FIFRA for water application from the NPDES permit requirement. This could be easily accomplished via EPA interpretation clearly articulating the removal of their status as point-source pollutants. The EPA currently has this issue under active review, but at some point definitive action by the Agency is needed or the citizen suits attendant to CWA will continue to proliferate.

West Nile Virus has now spread to 47 states and the District of Columbia and has now accounted for almost 16,000 human cases, 650 fatalities and 4,800 cases of potentially crippling neuroinvasive disease. While the statistics are startling, they are but a pale shadow of the real human toll exacted by this disease. Its emergence and rapid spread through areas historically lacking functional mosquito control infrastructures has underscored the need for establishing mosquito control programs to meet unforeseen threats. Indeed, the continued increase in worldwide tourism and trade virtually guarantees further challenges from exotic mosquito-borne diseases such as Japanese B encephalitis and Rift Valley Fever requiring ready control expertise to prevent their establishment and spread. Should these mosquito-borne diseases of man and animals settle into the American public health landscape, particularly as an unintended consequence of otherwise laudatory environmental policy initiatives, we will have only ourselves to blame, for we have the means to control these diseases within our grasp. A robust inter-agency cooperation in the design, resourcing and implementation of sustainable mosquito-borne disease programs is a cornerstone of this national effort. In conjunction with judicious application of federally registered and NPDES-exempt public health mosquito insecticides, when warranted, our shared goals of both a healthy populace and environment can thus be attained.