Report
To the Joint Standing Committee on Agriculture, Conservation and Forestry

Pursuant to Resolve 2013, Chapter 13

Concerning the Development of A State Plan to Protect the Public Health from Mosquito-borne Diseases

Submitted by the
Maine Department of Agriculture, Conservation and Forestry
In Cooperation with the
Maine Department of Health and Human Services

December 20, 2013

Report and Plan To the Joint Standing Committee on Agriculture, Conservation and Forestry Pursuant to Resolve 2013, Chapter 13: Directing the Department of Agriculture, Conservation and Forestry To Develop a Plan for the Protection of the Public Health from Mosquito-borne Diseases

ACRONYMS USED

Maine Center for Disease Control	ME CDC
Maine Department of Agriculture, Conservation and Forestry	DACF
Vector-borne Working Group	VWG
U.S. Environmental Protection Agency	EPA
U.S. Center for Disease Control	US CDC
Mosquito-borne Diseases	MBD
Maine Department of Environmental Protection	DEP
Integrated Pest Management	IPM
West Nile Virus	WNV
Eastern Equine Encephalitis	EEE
Maine Board of Pesticides Control	BPC

SECTION 1: EXECUTIVE SUMMARY

This report and accompanying plan were prepared as directed by Resolve 2013, Chapter 13 (appendix 2). The resolve was enacted instead of LD 292, which sought to establish state authority to plan, improve readiness and potentially intervene during a mosquito-borne disease outbreak (appendix 3). Mosquito-borne disease (MBD) is expected to become an increasing threat in Maine yet no state agency has explicit authority to plan, prepare or intervene in a MBD outbreak.

A proactive approach on the part of the state will ultimately reduce the incidence of MBD, thereby saving lives and preventing potentially debilitating disease.[1,2,3,4] Currently, the Maine Bureau of Health Center for Disease Control (ME CDC) coordinates implementation of a MBD surveillance and prevention plan. However, this program is inadequate for adequately characterizing the scope or severity of MBD threats. The Department of Agriculture, Conservation and Forestry (DACF) and ME CDC agree that upgrading the state's mosquito monitoring capability is the single most important recommendation for preventing MBD.

The U.S. Center for Disease Control (CDC) has taken the position that the benefits of controlling mosquitoes prior to and during a disease outbreak demonstrably exceed the risks.[1] A coordinated effort and long-term plan would accommodate the use of non-pesticide strategies and lower-risk pesticides than would of necessity be used in an emergency situation.[5] The cost of vector-borne disease prevention is considerably less than the cost of control during an epidemic. [6,7] Mosquito control strategies have been researched extensively and can be refined such that risks to humans and the environment are minimized. Maine is one of the most conservative states in the country relative to pesticide use;[8] DACF and ME CDC fully support and expect this philosophy will continue in the management of MBD. However, Maine is unprepared to mount an effective response to protect people in the event of a MBD outbreak.

In many states, the mosquito control programs are conducted by state-level agencies, or by mosquito control districts with jurisdiction over counties or towns.[9] Maine's current policy of relying entirely on municipalities to conduct their own emergency mosquito control operations is less than ideal, because:

- In general, emergency responses are handled at the state and federal level, especially those that involve multiple jurisdictions;
- Municipalities don't necessarily have the expertise, infrastructure, or funds for emergency responses;
- MBD require a very rapid response to be effective, and it is unclear whether municipalities have the ability to conduct such a response;
- MBD do not follow municipal boundaries.

Entomological expertise within DACF may be of critical importance in enhancing Maine's readiness to prepare or intervene to prevent a MBD outbreak. It is the position of DACF that state authority to coordinate and/or implement emergency MBD responses is in the public interest and will ultimately save lives.

The Maine Legislature should also be aware that—because certain types of mosquito-control activities now must be conducted in accordance with Maine Department of Environmental Protection (DEP) Waste Discharge Laws—wide-area mosquito control programs are currently not practical because of

CMR 06-096, Chapter 2, which requires applicants to demonstrate they have title, rights and interest in the land being sprayed, which is not useful or feasible during a wide-area mosquito control program.

SECTION 2: BACKGROUND INFORMATION

Resolve 2013, Chapter 13

Based on evidence of increasing West Nile Virus (WNV) and Eastern Equine Encephalitis (EEE) activity[10] and the potential for MBD impacts, DACF submitted legislation in 2012 to establish state authority to coordinate and/or conduct mosquito control activities to prevent a mosquito-borne disease outbreak, and to plan a coordinated response in the event such an outbreak occurred.

LD 292 (appendix 3) was not enacted by the 126th Maine Legislature. Instead, a resolve (appendix 2) was enacted directing DACF to develop, within existing resources, and in cooperation with the Maine Department of Health and Human Services (DHHS), a plan for the protection of the public health from MBD. This report explains those planning efforts and discusses a number of associated issues.

Why Should the State Be Concerned About Mosquito-borne Diseases

The incidence of MBD is on the rise across the U.S. and there is evidence that MBD virus activity is increasing in Maine, too. Public health officials and entomologists are particularly concerned that EEE virus has become much more active in Maine. Although EEE is a relatively rare among people, the severity of the illness is high; two-thirds of the people who become ill with EEE die or suffer permanent neurological impairment. Although Maine has not yet had a confirmed human case of EEE, there is concern that could happen in the near future (appendix 4).

These important trends and indicators lead public health officials and entomologists to be concerned about mosquito-borne virus risks in the near future[10]:

- Since its arrival in North America in 1999, WNV has spread steadily throughout the continent, and mosquito testing in Maine confirmed its presence in Maine beginning in 2002.
- The first confirmed human case of WNV occurred in 2012. In addition, in-state mosquito monitoring reveals an overall upward trend.
- Detections of EEE virus—which were unheard of in Maine until recently—have been on the upswing over the last decade. For instance, in 2009, 15 horses, one llama, and three flocks of pheasants all fell victim to EEE. And in 2013, 26 separate mosquito pools tested positive for EEE, plus three horses, one emu and one flock of pheasants. In addition, three mosquito pools tested positive WNV.
- Blood samples taken from moose, deer and turkeys since 2009 reveal that the EEE virus is established in at least 15 of Maine's 16 counties.
- Recent and projected changes in Maine weather patterns suggest conditions will favor increased mosquito-borne virus risk over the next 30 years. Warmer, wetter summers favor increases in mosquito populations. Longer, frost-free warm seasons favor increased virus amplification between birds and mosquitoes.

Both WNV and EEE can cause encephalitis, which is sometimes fatal or can result in permanent neurologic impairment. Either outcome is very costly to the health care system. The cost of a single

human case of EEE has been estimated to range from $21,000 for mild, transient illness, to as much $3 million for individuals who suffer permanent neurologic damage.[6] The average medical cost per case of WNV is $36,000.[11]

A study of the 2005 WNV outbreak in California, involving 163 human cases, concluded a total economic impact of $2.28 million. A cost-benefit analysis indicated that only15 cases of West Nile neuroinvasive disease would need to be prevented to make the emergency spray cost-effective.[12]

SECTION 3: STATES' ROLE

How Other States Address Mosquito-borne Diseases

Most states currently address emergency mosquito control activities in statute, in part because municipalities are not well positioned to conduct timely and effective mosquito control projects. In the majority of the states, there are established mosquito-control programs that are most often run at the municipal, county or control district level. Some of these programs date back to the early 1900s. Many of the local-area mosquito control programs were expanded, augmented or redirected over the last decade as state public health officials strove to address the emerging threat of WNV. In some states, state organized wide-area control programs were also instituted when the surveillance data indicated that WNV disease risk was high.[6]

In the five other New England states, some form of government-sponsored mosquito-control program has been conducted over the last few years. Moreover, all five states have established mosquito control districts covering at least a portion of the state.[13]

A New Hampshire legislative task force in 2007[14] reached similar conclusions and made similar recommendations as ME CDC and DACF do in this report. The New Hampshire task force findings included:

- Mosquito surveillance is an important tool, both for detection and for public awareness, and that long-term surveillance is important;
- Maintaining surveillance during years in which human infection is perceived to be low provides early warning, awareness, and educational benefits;
- A state committee would be valuable in providing oversight and coordination of interagency efforts;
- The state should consider taking responsibility for mosquito trapping and development of entomology expertise;
- Revenue for effective long-term mosquito surveillance is necessary.

South of New England, more aggressive and wide-scale mosquito abatement programs are common. According to information provided by the American Mosquito Control Association (AMCA), at least 41 states have organized mosquito-control districts that participate in the AMCA. In addition, at least 15 states have local mosquito control agencies (county or municipal) that participate in the AMCA. Governmental mosquito control programs of some type occur in all 48 contiguous states. A number of publications note that mosquito control programs have expanded or became focused on disease prevention since 1999.[15]

The emergence of WNV has also created a great deal of state legislative activity. According to the National Conference of State Legislatures, 116 mosquito control bills were introduced into state legislatures between 2003 and 2006, the period during which WNV became prevalent across the continental United States.[16]

Maine's Current Approach to Preventing Mosquito-borne Diseases

The Vector Borne Working Group (VBWG) was established by DHHS in 1986 to coordinate state efforts in combating vector-borne diseases. By 2005, the VBWG and the ME CDC had begun developing Maine's first Mosquito-borne Disease Response Plan which later evolved into the "State of Maine Arboviral (Mosquito-borne) Illness Surveillance, Prevention and Response Plan" (Arboviral Plan)(appendix 4). Most states developed similar plans modeled on the US CDC guidance for the prevention of WNV, first published in 2003.[1]

Currently, the ME CDC administers the ME CDC Arboviral Plan which is updated annually. A cornerstone of the ME CDC Arboviral Plan involves disease surveillance. Under this plan, ME CDC conducts a variety of disease surveillance activities, including a small mosquito surveillance program, avian surveillance, non-human mammal surveillance and human disease surveillance. When that surveillance indicates that the disease threat is elevated, ME CDC initiates public education activities intended to help the public reduce the chances of being bitten by vector mosquitoes. Press releases are issued and municipal and school health officials in the affected areas are alerted to the elevated risk and the recommended personal protection steps to reduce those risks.

When surveillance data indicates that the mosquito-borne disease risk is approaching a critical level, ME CDC directly communicates with the municipal and school officials in affected areas, to review and emphasize appropriate disease prevention strategies. To date, insecticide applications have been a very limited part of the response by municipalities, in large part because Maine's disease surveillance network is not adequate to definitively characterize the level and geographic extent of the risk. However, the elevated risk circumstances in Maine have occurred late in the season, when daily temperatures began to discourage mosquito activity, pesticide efficacy was expected to be reduced due to low overnight temperatures, and the likelihood of a mosquito-killing hard frost was increasing.[17]

Under the Maine Arboviral Plan, municipalities bear complete responsibility for mosquito control activities. Maine does not have mosquito control districts and the state has neither authority nor funding to conduct mosquito control. Officials from both ME CDC and DACF have raised questions about the capacity of municipalities to conduct a rapid, coordinated response to a mosquito-borne public health emergency. Concerns about the capacity of municipalities to adequately respond were one of the principle reasons that DACF submitted LD 292 (appendix 3). At least two Maine town governments (Kittery and York) have contracted for mosquito surveillance and preemptive mosquito control services for a number of years.

SECTION 4: POTENTIAL FOR ADVERSE PUBLIC HEALTH IMPACTS FROM USE OF INSECTICIDES FOR THE PREVENTION OF MOSQUITO-BORNE DISEASES

ME CDC and DACF have investigated the potential risks to human health arising from wide-area, public-health related mosquito-control programs. ME CDC conducted a Rapid Health Impact Assessment which involved an epidemiologic literature review of 34 studies (appendix 5). DACF

performed a thorough review of the updated human health risk assessments completed by the U.S. Environmental Protection Agency (EPA), the most authoritative source of scientific risk data for pesticides (appendix 6). The whole range of potential risks including acute poisoning, carcinogenicity, allergic, respiratory and other chronic effects were evaluated. Based on these assessments both agencies agree that—when the risk of disease is high—the best available science indicates that the benefits of public health vector control programs far exceed the human health risks, especially when the control programs are conducted using best practices.

The ME CDC literature review concluded:

> "The literature consistently shows that when used at recommended concentrations for ULV applications, pyrethroid insecticides pose very low risks to human health. It also shows that when applied aerially, the risk to human health is lower than when applied by truck mounted sprayers. The products that have been suggested for use in Maine by the Maine BPC in the case of a mosquito-borne public health emergency have active ingredients that are the least acutely toxic of the pyrethroids (d-phenothrin (sumithrin®), further reducing the potential risk for adverse human health effects due to pesticide exposures. Finally, in epidemic arboviral transmission settings, it has been consistently determined that the risk to human health from MBD is greater than the risk of acute pesticide poisoning." (appendix 5)

Both agencies also agree that the potential health risks of applying pesticides should be given serious consideration, and all proven risk-reduction strategies should be promoted and implemented. Those strategies include:

- To the extent feasible, promote and utilize non-chemical strategies for reducing mosquito vector populations before pesticides are used.
- Exercise great caution around any decision to apply insecticides for control of mosquitoes.
- Use careful analysis of the best available science in selecting/recommending products for use in adult mosquito control programs. The EPA has approved several active ingredients for public-health mosquito-control programs. While EPA has determined that the ingredients all have acceptable human health risks when used for this purpose, state agency personnel agree that certain ingredients are preferable from a human health perspective.
- Conduct wide-area control programs at night to reduce human exposure.
- Conduct aggressive public notice campaigns using multiple communication tactics (such as reverse 911 calling, door hangers, radio, TV and newspapers) prior to any wide-area control program so that the public can further reduce any chance of pesticide exposure and increase efficacy.
- Carefully monitor wide-area programs for public health and ecological impacts.

SECTION 5: POTENTIAL FOR ADVERSE ENVIRONMENTAL IMPACTS FROM USE OF INSECTICIDES FOR THE PREVENTION OF MOSQUITO-BORNE DISEASES

Given the value of Maine's natural resources and the importance of protecting our environment it is critical that potential impacts are carefully considered, and steps taken to mitigate them, before any mosquito control activities are conducted in Maine. All control methods of either larval or adult mosquitoes have the potential for adverse environmental impacts. DACF scientists reviewed reports and published literature evaluating potential ecological impacts of various mosquito control methods,

as well as impact assessment studies conducted as part of actual mosquito control programs in other states (see appendix 1). In addition, the DACF pesticides toxicologist summarized the risks to terrestrial organisms and aquatic sediment organisms from wide-area public-health mosquito insecticide use (appendix 6). The attached DACF Plan, and the recommendations in this report, are based on the best available science on ecological impacts and impact mitigation strategies of mosquito control activities.

Strict adherence to Integrated Pest Management (IPM) principles will—by definition—serve as a solid basis for minimizing both the use of pesticides and any associated risks. In an IPM program, non-chemical control methods are the first resort and chemical strategies generally are applied only if needed. For example, non-chemical control strategies such as community campaigns to promote elimination of man-made mosquito breeding habitats like bird baths and used tires, have been shown to be effective in reducing WNV risk. However, pesticides are, at present, a critical tool for protecting human health when other strategies are not sufficient. This is especially true of EEE vector mosquitoes which breed primarily in natural wetlands, where non-chemical methods are not feasible and could be more environmentally disruptive.

In Maine, larval mosquito control programs are already tightly regulated under a DEP Waste Discharge License, which limits pesticide use to circumstances where there is a demonstrated public health need. In addition, only approved products such as the bacterial pesticides *Bacillus thuringiensis israeliensis* (*Bti*) or *Bacillus sphericus* (*Bs*) may be used. These biological products have specific targets in the gastro-intestinal tracts of biting flies, including mosquitoes, which limit their effects to non-target organisms.

Public health related adult-mosquito-control activities generally involve insecticide spraying, and should be conducted using extreme caution. The primary ecological concerns surrounding adult mosquito insecticide spraying relates to non-target effects on both aquatic and terrestrial invertebrates. Again, close adherence to IPM principles is of paramount importance in minimizing those risks.

A number of researchers have investigated ecological impacts of public health related mosquito spraying. While there is evidence that certain control protocols can negatively impact honey bee populations, it has been demonstrated that impacts on pollinators can be effectively managed by utilizing the most recent protocol preferred in the Northeast United States, which utilizes extremely short lived synthetic pyrethroids applied at ultra-low rates at night. Bee health monitoring conducted in Massachusetts demonstrated no effects on bee mortality under this protocol.[18] The Northeast protocol also serves to minimize the risks to other invertebrates due to the combination of the extremely short life of the product and the exceptionally low application rate of 0.0036 pounds of active ingredient per acre.

One study of California creeks raises questions about the potential impacts on sediment invertebrates of the synergist piperonyl butoxide, which is used to enhance the efficacy of pyrethrins and pyrethroids.[19] EPA is currently seeking data on piperonyl butoxide and the other pyrethroids regarding effects on sediment dwelling invertebrates. The DACF is mindful of these questions and recommends extra care be exercised, and monitoring for effects should be a component of any public health related mosquito control program. However, overall, the scientific consensus suggests that the ecological risks are low for public health related adult mosquito control programs, and that using the Northeast protocol further reduces the risk.[20] [21]

SECTION 6: STATE AND FEDERAL HEALTH AGENCY POSITION ON PUBLIC HEALTH MOSQUITO CONTROL

The US CDC position on controlling mosquitoes as a means of reducing the incidence of mosquito-borne disease is described in the 2013 revision to the publication, "West Nile Virus in the United States: Guidelines for Surveillance, Prevention and Control."[1] The US CDC position is also articulated in the "Joint Statement on Mosquito Control in the United States from the U.S. Environmental Protection Agency (EPA) and the U.S. Centers for Disease Control and Prevention (CDC)."[22] In summary, the US CDC recognizes when the risk of disease transmission is high that mosquito control is an appropriate intervention strategy for reducing the incidence of human disease. Both the EPA and CDC promote non-chemical strategies for reducing vector mosquito populations before the use of chemicals. Both federal agencies also support carefully planned use of adult mosquito control products when circumstances necessitate such use. The US CDC goes on to state:

> "Insecticides to control larval and adult mosquitoes are registered specifically for that use by the U.S. Environmental Protection Agency (EPA). Instructions provided on the product labels prescribe the required application and use parameters, and must be carefully followed. Properly applied, these products do not negatively affect human health or the environment. Research has demonstrated that ULV application of mosquito control adulticides did not produce detectable exposure or increases in asthma events in persons living in treated areas. The risks from WNV demonstrably exceed the risks from mosquito control practices."[1]

ME CDC has not taken an official position about the propriety of controlling adult mosquitoes to reduce the incidence of MBD; however, the Rapid Health Impact Assessment (an epidemiologic literature review) performed by ME CDC staff came to the conclusion that:

> "In the event that all other options for mosquito control have been exhausted when confronted with a mosquito-borne public health emergency, it would be beneficial for human health to perform aerial insecticide applications in designated high-risk areas. The pesticides that would be used, specifically synthetic pyrethroids, do not appear to have any significant risk to human health when applied using the recommended concentrations." (appendix 5)

SECTION 7: ABOUT THE DACF PLAN

The DACF Plan attached to this report reflects the research and planning conducted by DACF, in cooperation with ME CDC and other experts from across the U.S. This plan was developed to address mosquito-borne illness, within existing resources, as directed by Resolve 2013, Chapter 13 (appendix 2). The plan acknowledges that most of the capacity available through the ME CDC is already described and committed by way of the State of Maine Arboviral Plan (appendix 4). Accordingly, the DACF plan primarily explores opportunities to leverage existing Department expertise to assist the ME CDC in its disease prevention efforts.

SECTION 8: MOSQUITO CONTROL APPROACHES

DACF and ME CDC staff have expended considerable resources researching the best available science around the emergence of MBD in Maine and the best practices for mitigating that threat (appendix 1). Authoritative sources recommend an IPM approach that emphasizes 1) public education to promote personal protection and community engagement to elimination stagnant water sources around the home, 2) control of vector mosquito species in the larval stage using minimum risk pesticides and strategies when possible, and, 3) wide area applications of adulticides to prevent or respond to critical MBD risk. However, larval control of mosquitoes in a rural and wet state like Maine would require enormous resources, and must be initiated prior to the time of year when the threat of MBD can be characterized. Furthermore, while eliminating stagnant water around the home is somewhat effective against WNV vectors, this strategy has limited effect on EEE vectors, which breed primarily in natural habitats such as maple swamps. These factors suggest that relying primarily on larval control strategies to prevent mosquito-borne disease in Maine may be largely impractical.

Historically, Maine has been conservative about the use of pesticides.[8] DACF and ME CDC staffs fully agree it's appropriate to act very cautiously with respect to the use of insecticides in Maine for the purposes of preventing MBD. However, given the impracticality of relying on larval mosquito control for preventing disease in a rural, wet state like Maine, there are some distinct advantages to considering carefully conducted and targeted adult mosquito spraying limited to periods of critical disease risk. Such a strategy allows government agencies to limit the use of insecticides to only those times and location where it's needed most, which reduces unnecessary pesticide use and costs.

The disadvantage of relying on the "critical need only" insecticide use approach is that spraying adult mosquitoes involves greater risks than use of the bacterial insecticides used to control mosquito larvae. However, in New England, adult mosquito-control methodology and product selection (the Northeast protocol) has been demonstrated to effectively reduce the human disease threat while minimizing risks. Improving Maine's preparedness and capability to prevent or respond to an MBD outbreak through the use of limited, targeted, ultra-low volume adulticide applications if necessary will improve our ability to protect human health. [18, 23, 24]

Mosquito ecologists in Maine, Massachusetts and New Hampshire agree that a significant challenge in EEE vector management is that these mosquitoes breed in 'crypts' among the submerged tree roots and cattails in wetlands dispersed across New England. Maine has EEE vector habitats in southern, central and western Maine.[25]

SECTION 9: RECOMMENDATIONS

Based on the considerations outlined in this report and attached plan, and the DACF assessment of the best available science, DACF offers the following recommendations for consideration:

1. **Increase mosquito surveillance.** Because the state does not have an emergency mosquito control role, Maine's ability to prevent MBD relies largely on the ME CDC's disease surveillance program. If the necessary resources can be identified, a more robust monitoring program would allow Maine public health officials to provide more accurate and timely information about the disease threat, thereby allowing the public to take common-sense precautions, such as using repellents and staying indoors when it's most important to do so. Current funding, which comes

with a tenuous future, provides sufficient resources to operate 25 monitoring sites, primarily in York and Cumberland Counties, from July through September. This level of monitoring is grossly inadequate for the purposes of characterizing the severity and the geographic distribution of a mosquito-borne disease threat. **Moreover**, mosquito monitoring offers significant public benefit without any associated risks. DACF and ME CDC agree that if resources can be identified, the single most beneficial improvement that Maine should consider in connection with mosquito-borne disease prevention is enhancement of the mosquito monitoring program.

2. **Provide explicit state authority to DACF to plan and prepare for MBD prevention activities, and to conduct emergency mosquito intervention activities if MBD threat is critical.** Maine citizens and lawmakers have expressed concerns about the potential impacts of pesticide use for controlling mosquitoes. These concerns should not be minimized and state officials must be mindful of the concerns as they consider MDB prevention strategies. However, in the event of a EEE or WNV outbreak, when risks of MBD-caused human and animal fatalities exceed the risks associated with pesticide use, the public interest may be best served by using very limited and precisely targeted ultra-low volume insecticide application to control disease vector mosquitoes. The recent situation in Vermont illustrates the importance of this strategy. Like Maine, Vermont was ill prepared to respond when two people in the same town were killed by EEE in 2012. It took state officials considerable valuable time to obtain the necessary permits, notify the public, develop and approve a contract with an aerial applicator, and conduct the spray operation. Such last minute response increases the likelihood of mistakes, accidents and higher costs. Maine can learn from Vermont's experience by preparing in advance. Such preparation may never be needed, but as with all emergency preparedness, it is much better to be prepared to implement action plans quickly and safely if the emergency arises.

   Currently, no state agency has any explicit statutory authority or responsibility to manage the mosquito-borne disease threat. The responsibility for potential emergency mosquito-control during a disease outbreak falls solely upon municipalities which have limited capacity or expertise, and there is no coordination among communities. The ME CDC presently takes the lead role on MBD in conjunction with its broader disease prevention mandates and because federal public health funding allows for a mosquito-borne disease prevention component. Providing explicit state authority to conduct planning and preparation activities, coupled with authority to conduct emergency intervention activities consistent with legislative policy on use of pesticides, would ensure that the state can respond during a public-health crisis, and that the mosquito-borne disease threat doesn't get lost when state agency resources cannot keep pace with demands. A 2007 New Hampshire Legislative task force reached many of the same conclusions relative to the appropriate state role in preventing MBD.[14]

   If the necessary resources were identified, the following are examples of some activities that would enhance the state's ability to better manage the mosquito-borne disease threat include:
   - Track national research and mosquito monitoring strategies for evolving best practices.
   - Track national research and utilizing in-state resources to identify the lowest risk mosquito control products and strategies.
   - Conduct inter-agency research and planning on the potential for mosquito habitat reduction strategies such as reducing the inadvertent creation of mosquito habitat through construction and road maintenance practices.

- Work with the DEP and other state agencies to investigate potential streamlining of waste discharge licenses required to treat mosquito larvae and for wide-area adult mosquito control activities.
- Explore opportunities to strengthen medical entomology expertise in Maine. Currently there are no medical entomologists at public agencies or universities in Maine.
- Identify and train state agency field staff and develop a plan for utilizing them to assist in an expanded mosquito monitoring program if needed in an MBD outbreak.
- Conduct mock mosquito-borne emergency exercises to identify bottlenecks and weaknesses and improve readiness.
- Develop and maintaining a Geographical Information System database (GIS) of organic farms, fish hatcheries and other sites that should be excluded from a public-health related mosquito-control operation. This database, coupled with in-state capacity to quickly produce digital maps of high risk areas targeted for mosquito control, would enhance the ability of the state to quickly respond if needed.
- Investigate the propriety of entering into mosquito-control contingency contracts in the case of a public-health emergency. Other states have adopted this strategy to eliminate the time-consuming process required for state contract approval and to lock in competitive pricing.

3. **Consider legislation to exempt public health related mosquito control programs from the "Title, Rights and Interest" requirement contained in CMR 06-096, Chapter 2**.This rule requires any governmental agency to demonstrate Title, Rights and Interest in property identified in waste discharge license applications, including public health mosquito control projects. Such a requirement is neither feasible nor useful for a wide-area mosquito control operation if it becomes necessary to address a MBD outbreak.

4. **Provide an opportunity for the Joint Standing Committee on Agriculture, Conservation and Forestry to review the annual Maine MBD surveillance reports prepared by the ME CDC**. This report would keep the Maine Legislature in tune with the evolving disease threat and the state's prevention activities

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State of Maine Department of Agriculture, Conservation and Forestry

Plan to Protect the Public Health from Mosquito-Borne Illness

Pursuant to Resolve 2013, Chapter 13

Presented by the Maine Department of Agriculture, Conservation and Forestry in Cooperation with the Maine Department of Health and Human Services

December 20, 2013

Executive Summary

The threat of mosquito-borne illness is on the rise in Maine and is predicted to increase in the near future. However, the State has a very limited capacity for monitoring threat levels or taking action to reduce those disease threats. Responsibility for managing this public health risk falls primarily to municipalities, most of which lack resources and capacity for monitoring or controlling mosquitoes. Two towns in York County contract with private companies to monitor and control mosquitoes. A few schools rescheduled fall sports games in 2013 to avoid peak mosquito activity when EEE risk was high but the vast majority of Maine's communities are doing very little and are unprepared to address this risk.

Individual landowners can and do purchase and apply pesticides on their properties or they can hire a pest control company to do applications. As mosquito-borne illness threats increase, the potential for pesticide misuse and overuse is also likely to increase. There are more than 1,300 pesticide products, including repellents, currently registered in Maine for use against mosquitoes. The amount and extent to which these pesticides are applied on private properties is not known.

The purpose of this plan is to describe the Maine Department of Agriculture, Conservation and Forestry responsibilities and proposed actions within existing resource levels and authorities, to protect public health from mosquito-borne diseases. Improving Maine's readiness to respond to the increasing threat of mosquito-borne illness will reduce the incidence of serious, sometimes debilitating disease and ultimately save lives.

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About This Plan

This plan was developed by the Maine Department of Agriculture, Conservation and Forestry (DACF) in cooperation with the Maine Department of Health and Human Services, Center for Disease Control and Prevention (ME CDC) as directed by State Legislative Resolve 2013, Chapter 13. The purpose of this plan is to describe the DACF responsibilities and proposed actions, within existing resource levels and authorities and in collaboration with other appropriate agencies and entities, to protect public health from mosquito-borne diseases. This plan addresses specific considerations as directed by the Resolve including 1) ecological and economic impacts of proposed methods for controlling mosquitoes and preventing mosquito breeding, 2) integrated pest management (IPM) techniques, 3) description of the criteria for declaring a mosquito-borne disease public health threat, 4) elements of a response to such a public health threat, and 5) the responsibilities and lines of authority during a public health threat.

This DACF plan is based on a thorough review of information from other states, federal agencies and other reliable sources, as well as scientific research findings including authoritative guidance published by the Association of State and Territorial Health Officials[1] and U.S. Centers for Disease Control and Prevention (US CDC)[2]. This plan complements the State of Maine Arboviral (Mosquito-Borne) Illness Surveillance, Prevention and Response Plan[3] (hereafter referred to as the ME CDC Arboviral Plan) developed and updated annually by ME CDC (appendix 4). Because Resolve 2013, Chapter 13 directs DACF to develop a plan "within existing resources," the Department constructed the DACF plan based on currently existing resources and commitments. Accordingly, it primarily explores opportunities to leverage existing Department expertise to assist ME CDC in its disease prevention efforts. It must be noted that current resource levels and lines of authority significantly limit the State's capabilities to plan, prepare and effectively respond to a mosquito-borne illness outbreak.

Why This Plan is Needed

The threat of mosquito-borne illness is on the rise in Maine and the rest of the continental U.S. There has been a dramatic increase in the prevalence of arboviruses (arthropod-

borne viruses) in the past decade, beginning with the first reported West Nile Virus (WNV) outbreaks in the U.S. in 1999. WNV is now found in all 48 continental states. In the U.S. there were 5,674 human cases of WNV with 286 deaths in 2012 and 2,300 human cases with 105 deaths in 2013. Maine had its first human case of WNV in 2012.

Another mosquito-borne disease, Eastern Equine Encephalitis (EEE), found primarily in the eastern U.S. (including Maine), is rarer but more lethal. In 2008 a fatal case of EEE was diagnosed in a Massachusetts resident who may have acquired the infection while vacationing in Maine. From 2001 to 2012, evidence of EEE infection in animals and mosquitoes was found in 15 of our 16 counties[3]. In 2012, there were 15 human cases in the U.S., including seven cases, three of them fatal, in Massachusetts, and two cases, both fatal, in Vermont. In 2013, six human cases and three deaths have been reported in five states. In Maine EEE killed 15 animals (horses and llamas) in 2009. Three horses and a flock of pheasants died of EEE in Maine in 2013. Although Maine has a limited arbovirus surveillance program, mosquito sampling and testing indicate that both EEE and WNV activity were high in 2012 and 2013.

In states where mosquitoes have been a historical disease threat, regional and/or local governmental authorities administer both local and wide-area mosquito control programs. There are no state-, county- or district-level mosquito control programs in Maine, and there is not an established process for coordinating mosquito surveillance or control efforts among communities. No state or regional agencies have financial resources or authority to conduct mosquito management activities. Public agency involvement is limited to coordinating a minimal mosquito and wildlife surveillance program, tracking reports of mosquito-borne illness in humans and domestic animals, and disseminating public information. Individual towns are responsible for developing, maintaining and financing local mosquito control actions. With increasing prevalence of EEE and WNV, it is imperative that the State of Maine critically review and assess resources, programs and policies for protecting Maine citizens from these public health threats. This plan is intended to describe DACF capabilities, authorities and responsibilities and to assess our preparedness for a rapid and effective response in the event of disease outbreak. Criteria,

response elements and lines of authority for a phased response to increasing arbovirus illness threats are described below and summarized in Table 1.

Integrated Pest Management

Integrated Pest Management (IPM) is a systematic, science-based approach to managing pests, globally recognized as the most effective means of protecting people, our food supply, and other resources from pests while minimizing environmental and economic impacts. When applied to management of mosquitoes, IPM is sometimes referred to as Integrated Vector Management (IVM) or Integrated Mosquito Management (IMM). The key elements of public health IPM are a) education and outreach, b) pest surveillance and threat assessment, c) combinations of pest prevention and control measures when warranted, and d) evaluation of outcomes. The US CDC guidelines[2] highlight the importance of IPM for protecting humans from mosquito-borne illness. This DACF plan, and the ME CDC Arboviral Plan, are based on IPM principles and practices.

Public Health Threat Criteria, Phased Response and Responsibilities

As called for by Resolve 2013, Chapter 13, this plan describes actions DACF will take to protect public health from mosquito-borne illness threats. Table 1 shows the specific steps DACF will take in a phased response to arboviral illness threat levels. The criteria, elements of the proposed phased response, and description of the lines of authority and responsibilities in Table 1 were taken directly from the ME CDC Arboviral Plan. No state entity has explicit authority to declare a 'public health threat', however, as described in the ME CDC Arboviral Plan, 'If risk of outbreak is widespread and covers multiple jurisdictions, ME CDC will confer with local health officials and VBWG to discuss the use of intensive mosquito control methods. A State of Emergency may be declared by the governor pursuant to Title 37-B Chapter 13 Subchapter 2 § 742.' Additional 'critical threat level' criteria described in the ME CDC Arboviral Plan are 1) more than one confirmed human case of EEE or WNV in a community or focal area or, 2) multiple non-human mammal cases of EEE or WNV. Other quantitative measures considered in the

determination of human risk levels include early season positive surveillance indicators, sustained elevated mosquito infection rates, high mosquito abundance in key bridge vector species, surveillance indicators from neighboring areas and other states in our region, and current and predicted weather and seasonal conditions (including time to expected mosquito-killing frosts).

Mosquito and Domestic Animal Surveillance

As described in the ME CDC Arboviral Plan[3], ME CDC is the lead agency for arboviral surveillance in mosquitoes, non-human mammals, birds and human illness cases. Testing of domestic animals and birds showing symptoms of arbovirus disease is conducted under the auspices of the DACF State Veterinarian.

Mosquito Surveillance: ME CDC conducts a small mosquito surveillance program through contracted services provided by Maine Medical Center Research Institute Vector-borne Disease Laboratory (MMCRI) and one or more private pest management companies. MMCRI may enlist additional cooperators to assist in mosquito trapping. In 2013, adult mosquitoes were monitored at just 25 sites located primarily in Cumberland and York counties. The monitoring protocol used by MMCRI is described in Table 2. Adult mosquitoes are collected from traps, sorted, and sent weekly from July through September, to ME CDC Health and Environmental Testing Laboratory (HETL) where they are tested for arboviruses. ME CDC tracks, records and disseminates weekly summaries of surveillance results from July through September and issues a final report at the end of the season. In addition, ME CDC tracks and shares arbovirus surveillance data reported from neighboring states and from US CDC reports.

Maine's current mosquito monitoring program, funded through federal grants to ME CDC, is not adequate for the purposes of characterizing the significance and the geographic distribution of a mosquito-borne disease threat. Nor is it adequate for utilizing mosquito surveillance software developed by US CDC[4] and recommended for use at the county or municipal level to provide predictive indicators associated with elevated human risk. Furthermore, ME CDC monitors adult mosquitoes only. Larval mosquito

surveillance can serve as an early indicator of population density and expected adult emergence time for the different vector species. Surveillance of larval mosquito populations also provides an opportunity for targeted application of lower risk larvicides. Elimination of human-made larval habitats (such as discarded tires and unmaintained backyard pools) has been shown to reduce risk of human illness.

A more robust mosquito monitoring effort is needed to enable Maine public health officials to provide accurate and timely information about the disease threat, thereby allowing the public to take common sense precautions when it's most important. DACF and ME CDC agree that the single most beneficial improvement that Maine should consider in connection with the mosquito-borne disease threat is expansion of the mosquito monitoring program. In the absence of additional funding, creative solutions are needed.

With current resource levels and authorities, DACF has the following capabilities for mosquito surveillance:

- DACF (including Board of Pesticides Control (BPC)) will collaborate with ME CDC and other experts to review and annually update recommended response action thresholds.

- DACF State Entomologist, in collaboration with ME CDC and other experts, will annually review and document planned mosquito and arboviral surveillance protocols.

- DACF will identify appropriate DACF field staff available to augment contracted mosquito surveillance services if needed when disease threat is critical. Note: at present, DACF entomologists are tasked with other responsibilities and are not routinely engaged in mosquito surveillance activities. Mosquito surveillance is done by service providers contracted by the ME CDC. However, DACF field staff could, with some training, be tasked with deployment and operation of mosquito traps if priorities were shifted away from current responsibilities.

- DACF will work with partners to identify resources to train DACF staff to assist with mosquito monitoring, identification and transport if rapid expansion of mosquito surveillance is needed when risk of arboviral illness is critical.

- DACF will collaborate with ME CDC and other organizations (eg. Maine Office of Geographical Information Services (MEGIS) and/or University of Maine Remote Sensing Laboratory) to identify and develop mapping tools to guide optimal placement of additional mosquito surveillance sites if warranted.

- DACF will partner with ME CDC, the Vector-Borne Working Group (VBWG) and other experts to stay abreast of new research findings, and developments in surveillance and management methods and technologies.

Domestic Animal Surveillance. Some domestic mammals and birds are susceptible to arboviruses. Passive surveillance (reporting and testing of animals showing symptoms of arboviral infection) can provide an additional measure of mosquito and arbovirus activity, thus is an important tool for public health protection.

With current resource levels and authorities, DACF has the following capabilities for passive surveillance of domestic animals:

- The DACF State Veterinarian will continue to collaborate with ME CDC HETL and US CDC to facilitate testing of horses and other domestic animals (including farm-raised birds such as emus and pheasants) displaying symptoms consistent with mosquito-borne disease.

- The DACF State Veterinarian will continue to communicate annually with all Maine-licensed veterinarians describing clinical signs of diseases, prevention measures and reporting processes for reportable vector-borne diseases, such as EEE and WNV. The State Veterinarian will continue to encourage vaccination of domestic animals where appropriate, i.e. in species where vaccines are available.

- The DACF State Veterinarian will continue to facilitate collection of appropriate specimens for diagnostic testing of mosquito-borne disease.

Public Education

Public education is a critical component of mosquito IPM. Residents and visitors should be informed about effective personal protection measures such as staying indoors at dawn and dusk, proper dress for outdoor activities and the use of repellents. Residents must also be informed to recognize and drain man-made mosquito breeding habitats such as toys, tarps, bird baths, and clogged gutters.

With current resource levels and authorities, DACF has the following capabilities:

- DACF will continue to collaborate with ME CDC and other partners to promote public education on personal protection and elimination of man-made mosquito breeding habitat. DACF will continue to maintain the DACF website to ensure links to updated ME CDC information and announcements are readily available to the DACF audiences such as farmers, foresters, domestic animal owners, veterinarians, schools, pesticide applicators, visitors and the general public. DACF will continue to distribute ME CDC printed materials, when they are available, at DACF-sponsored events such as the Agricultural Trades Show, and DACF-staffed venues such as state parks.

- DACF will continue to participate with the VBWG, and to collaborate with ME CDC and other partners, in public education activities.

Mosquito Breeding Habitat Reduction

Communities and property owners can reduce the risk of arboviruses by eliminating and draining shallow sources of standing water such as bird baths, ditches, and clogged gutters. Tires used on farms to anchor tarps covering animal feed should be cut or drilled. Education campaigns and community events have been shown to be effective in addressing WNV. This approach is not as effective in reducing habitat of EEE vectors, which breed primarily in natural habitats that cannot be drained without ecological disruption. Research is needed to develop and demonstrate effective and environmentally

sound methods for reducing EEE mosquito habitat. With current resource levels and authorities, DACF has the following capabilities:

- DACF will collaborate with ME CDC and other state agencies to inform farmers, land-owners, land-managers and the general public about recommended habitat reduction methods proven to reduce human risk while minimizing environmental impacts.

- DACF will collaborate with ME CDC, other state agencies and the VBWG to stay abreast of research on effective habitat reduction methods for man-made and natural mosquito breeding sites.

Mosquito Management

Biological Methods. Published research and communication with mosquito managers in other states indicate that effective biological IPM methods for mosquito control are lacking. A pilot program conducted in New Jersey found the use of laboratory-bred copepods as a predator of mosquito larvae to have extremely limited utility, primarily in human-made temporary water sources which can be more effectively eliminated by simply draining or removing them (Mark Mayer, NJ Department of Agriculture, personal communication Sept. 2013). A similar study in New York City showed disappointing results and was abandoned[5]. Relocation of mosquito-eating fish to vector mosquito breeding sites, which are often inaccessible and shallow water around tree roots in maple swamps, is not likely to be feasible or effective. A study showed that stocking dragonflies in Maine wetlands was ineffective in reducing mosquito abundance[6]. This study further showed this practice is likely to result in introduction of non-native species which could negatively impact our ecosystems. However, research may identify effective and practical biological strategies in the future. DACF will stay abreast of developments in this area.

Chemical Control Methods: Although non-chemical methods, such as the elimination of temporary mosquito breeding habitats and public education, are important components of mosquito IPM, it has been demonstrated that well timed and targeted pesticide

applications may be critical to protecting people when mosquito-borne illness threats are high. Public health 'wide area' adulticide applications use trucks or aircraft equipped with ultra-low-volume (ULV) nozzles to apply very small volumes of a pesticide into the air to kill mosquitoes while they are flying. A product often used in our region is Anvil 10+10 applied at 0.62 fluid ounces (0.0036 lbs active ingredient) per acre. This product is regarded as the lowest risk choice for both humans and the environment because it is applied at such low volume and is very short lived.

The EPA has determined that the insecticides labeled nationally for this type of application do not pose unreasonable health risks to humans, wildlife, or the environment when used according to the label. Pesticides have been widely used to control mosquitoes throughout the U.S., providing ample opportunities to assess effectiveness and develop methods for minimizing negative impacts. Communities in Maine's neighboring New England states have found it necessary to occasionally conduct wide area adulticide applications when surveillance showed EEE threat was very high. Planning and preparation to enable the safest wide area use of pesticides if needed in the event of a mosquito-borne disease outbreak will save lives.

With current resource levels and authorities, DACF has the following capabilities:

- DACF will collaborate with the VBWG and other experts to stay informed of proven non-pesticide mosquito management methods as they become available and provide recommendations for their use to municipalities, residents, and property owners and -managers.

- DACF will collaborate with ME CDC and other experts to develop guidance for municipalities and the general public on the use of pesticides for management of mosquitoes. BPC will develop and annually update the list of wide area public health ultra-low-volume mosquito adulticide products registered in Maine. The list will be annotated to highlight strategies to mitigate any environmental impacts or human health risks according to product labels and EPA risk assessments and will reflect any EPA-mandated label changes.

- DACF will collaborate with other agencies and experts to develop recommended protocols to assess impacts and efficacy of adulticide applications.

- DACF BPC will explore opportunities with Maine DEP to facilitate permitting processes allowing treatment of mosquito breeding habitats if needed to reduce threats to human health.

- DACF will develop guidance for municipalities seeking to contract for wide area ground or aerial pesticide applicators to enable swift, effective and targeted pesticide applications aimed at protecting human health and minimizing non-target impacts. This will also include updated lists of licensed applicators.

- DACF will explore opportunities for piggy-backing surveillance and outreach activities such as mosquito monitoring, mapping, wildlife disease surveillance and weather monitoring with existing DACF programs.

- DACF will collaborate with other agencies and non-governmental organizations (NGOs) to develop protocols and processes for identifying exclusion zones, such as organic farms and fish hatcheries, from any planned wide area adulticide applications.

- DACF State Apiculturist will cooperate with any planned wide area mosquito adulticide application operations to mitigate adverse effects on managed honey bee colonies.

- DACF will collaborate with other agencies and NGOs and emergency preparedness and response personnel and programs to develop notification procedures to be used to notify farmers, registered apiaries, municipalities, schools, and the Pesticide Notification Registry list in advance of any planned wide area mosquito adulticide applications.

Assessment and Reporting

Ecological Impacts

Natural resources are an important part of Maine's heritage and economy, so it is essential that methods and materials used for mosquito control be evaluated for possible environmental impacts. If pesticide applications are needed to protect human health, priority should be given to use of methods and materials that minimize risks of unintended ecological impacts.

Biological methods of mosquito control also have the potential for negative ecological impacts. For instance, a study conducted in York County showed that stocking dragonflies purchased from commercial suppliers has the potential for introducing non-native dragonfly species[6], which could be ecologically disruptive. Stocking or relocating fish, copepods, or other mosquito predators carries the same risk.

- DACF will continue to network and collaborate with agencies and programs within Maine and across the U.S. to stay abreast of current research on environmental and ecological impacts of mosquito management methods.

- DACF BPC Toxicologist will evaluate available chemical mosquito management methods and materials for their efficacy and potential ecological and human health impacts. BPC will provide an updated list of approved mosquito control pesticide products and recommendations for their use. Guidance will include methods for assessing efficacy of mosquito management activities and assessing and mitigating ecological impacts.

- DACF will collaborate with other appropriate experts and agencies to develop protocols for assessing efficacy and environmental impacts of any planned wide area mosquito control program.

- DACF will collaborate with ME CDC to provide the Joint Standing Committee on Agriculture, Conservation and Forestry an annual mosquito-borne disease surveillance report including records and assessments of any mosquito management actions taken by the State.

Economic Impacts

In 2013, the towns of York and Kittery, ME spent approximately $50,000 to $70,000 per town for contracted mosquito management services including mosquito surveillance, larviciding and adulticiding (Kimberly Foss, Swamp, Inc. personal communication). The cost of aerial pesticide applications conducted in Vermont in 2012 (20,000 acres) and 2013 (8,500 acres) for control of EEE vector mosquitoes (following two fatal human cases in 2012 and mosquito surveillance showing high disease threat in 2013) was approximately $2 per acre.

There are also economic considerations associated with mosquito-borne illness. For instance, it is estimated that medical costs associated with a single case of EEE ranges from $21,000 for mild, transient illness to as much as $3 million for individuals who suffer permanent neurologic damage[3]. An economic analysis of a WNV outbreak in California showed average WNV-associated medical costs were $19,500 per patient. This study compared the number of WNV cases reported inside versus outside an area treated to control mosquitoes and found that approximately 48 cases of WNV were averted by the spray, resulting in an estimated savings of $702,000 after factoring in the cost of the spray operation[7].

Planning ahead for mosquito management improves efficiency and effectiveness, saving money and avoiding the strain placed on local emergency response staffing, equipment and budgets by an emergency mosquito management response[1].

With Current Resource Levels and Authorities, DACF has the following capabilities:

- DACF will collaborate with other appropriate experts and agencies to develop protocols for assessing efficacy (a measure of cost/benefit) and economic impacts of any planned wide area mosquito control program.

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Table 1. Role of DACF in ME CDC Phased Response Plan for a West Nile Virus (Adapted from State of Maine Arboviral Illness Surveillance, Prevention and Response Plan 2013. DACF roles highlighted).

Risk Category	Probability of Human Outbreak	Definition for a Focal Area*	Recommended Response
1	Remote	All of the following conditions must be met: Prior Year No activity detected in a community or focal area. AND Current Year No current surveillance findings indicating EEE or WNV activity in the focal area.	1. Educational efforts directed to the general public on personal protection, such as use of repellents, and source reduction. DACF disseminates information via websites and DACF-sponsored events and other venues as staff time and resources permits. 2. Routine human and non-human mammal surveillance;. DACF State Veterinarian annually communicates with all ME-licensed veterinarians describing clinical signs of diseases, prevention measures and reporting processes for reportable vector-borne diseases, such as EEE and WNV. DACF Animal Welfare Program assists in outreach to domestic animal owners and municipalities through outreach to animal control officers. 3. Assess local ecology for mosquito abundance. DACF program will assist ME CDC by providing maps, GIS layers and expertise. 4. Consider larval and adult mosquito monitoring with routine collection and testing of mosquitoes. DACF will a develop and maintain a contact list of appropriate field staff who can be tasked with deploying and operating additional mosquito traps if ME CDC determines that disease threat warrants enhanced mosquito surveillance.
2	Low	Prior Year (WNV) Virus activity detected in mosquitoes. Prior 2 Years (EEE) Virus activity detected in mosquitoes during either of both of the past two years. OR Current Year	Incorporates previous category response, plus: 1. Expand community outreach and public education programs focused on risk potential and personal protection, emphasizing source reduction. DACF disseminates information via websites and DACF-sponsored events and other venues as staff time and resources permits. 2. Assess mosquito populations, monitor larval and adult mosquito abundance, submit samples to HETL for virus

* Focal area: May incorporate multiple towns or cities. Designation based on factors including mosquito habitat, current and historic virus activity, timing of current virus activity, current weather and seasonal conditions. Known/suspected location of exposure is used for human and non-human animal cases and not necessarily town of residence.

		EEE or WNV identified in a single mosquito trap location AND No non-human mammal or human cases	testing. 3. Use larvicides at specific sources identified by entomologic survey and targeted at vector species. If appropriate, consider source reduction techniques. DACF BPC will assess currently available mosquito control methods and materials and will provide guidance on use of pesticides, including methods for minimizing environmental impacts to municipalities, land-owners, schools and the general public on selection and use of pesticide products. 4. Enhance surveillance of human and non-human mammal surveillance. State Veterinarian collaborates with ME CDC HETL and US CDC to facilitate testing of horses and other domestic animals displaying symptoms consistent with mosquito-borne disease.
3	Moderate	Prior Year Confirmation of human and/or non-human mammal case(s) OR Sustained EEE or WNV activity in mosquitoes. OR Current Year Multiple EEE or WNV mosquito isolates AND No non-human mammal or human cases.	Incorporates previous category response, plus: 1. Increase larval control, source reduction, and public education emphasizing personal protection measures. 2. Actions to prevent disease may include targeted larviciding at likely vectors, and if current year activity, possibly ground adulticiding targeted at likely bridge vector species. DACF will assess currently available methods and materials and will provide guidance on use of pesticides, including methods for minimizing human and environmental impacts. 3. Enhance human surveillance and activities to further quantify epizootic activity. 4. DACF field staff may be directed to assist ME CDC with supplemental mosquito trapping by deploying and operating mosquito traps using predetermined protocols if needed.
4	High	Current Year Surveillance of increasing EEE or WNV activity in mosquitoes OR A single confirmed non-human mammal case of EEE or WNV OR A single confirmed human case of EEE or WNV.	Incorporates previous category response, plus: 1. Intensify public education on personal protection measures a. Utilize multimedia messages including press releases, local newspaper articles, cable channel interviews, etc. b. Actively seek out high-risk populations (nursing homes, schools, etc.) and educate them on personal protection. DACF School IPM Program assists in outreach to schools c. Issue advisory information on adulticide spraying. DACF assists in 2. Consider intensifying larviciding and/or adulticiding control measures as indicated by surveillance. DACF will intensify guidance and training to local officials on selection and use of pesticides.

			3. ME CDC will confer with local health officials to determine if the risk of disease transmission threatens to cause multiple human cases. If surveillance indicates a continuing risk of human disease and potential for an outbreak, intensified ground-based adult mosquito control may be recommended. DACF will assist ME CDC in evaluating disease surveillance indicators and meteorological information in consideration of the biological and ecological factors influencing human disease threats.
5	Critical	Current Year More than 1 confirmed human case of EEE or WNV in a community or focal area OR Multiple confirmed EEE or WNV non-human mammal cases.	Incorporates previous category response, plus: 1. Continued highly intensified public outreach messages through community leaders and the media emphasizing the urgency of personal protection. DACF will assist with messaging to people engaged in agriculture, conservation and forestry activities and the general public. 2. If risk of outbreak is widespread and covers multiple jurisdictions, ME CDC will confer with local health officials and Vectorborne Work Group to discuss the use of intensive mosquito control methods. A State of Emergency may be declared pursuant to Title 37-B Chapter 13 Subchapter 2 §742. DACF staff will participate in these discussions as members of the Vector-borne Work Group The declaration of an emergency may trigger application of mosquito adulticide. ME CDC may define targeted treatment areas for vector control following the declaration of an emergency. DACF will provide guidance in the selection and use of pesticides. 3. Ground-based adulticide applications may be repeated as necessary to achieve adequate control. DACF will provide guidance in the selection and use of pesticides.

Table 2. Field Methods Used for Mosquito Surveillance in Maine.

Light Trapping Adult mosquitoes are trapped using CDC miniature light traps (John W. Hoch Company, Gainesville, Florida) with a 6-volt lead battery. Approximately 5 pounds of dry ice are hung in an insulated cooler above the trap and vented at the bottom so that CO_2 gas drifted slowly from the cooler over the trap. Traps generally are hung in the late afternoon or early evening and situated so that the trap is always out of direct sunlight. Trap locations are chosen in secure places with habitats likely to have mosquitoes (adjacent to wetland habitat). Traps are retrieved in the early morning hours of the following day. Air temperature is recorded on a field data form at the time of trap placement and retrieval. Mosquitoes remain in the mesh and plastic trap and are stored in a cooler with either wet or dry ice for delivery to the laboratory. Mosquitoes from a trap are assigned an accession number and all collection data entered on a laboratory sheet with that number. Each collection site is geo-referenced with latitude and longitude either by GPS, by locating the site on DeLorme 3-D TopoQuads, or through the use of Google Earth.
Resting Boxes Resting boxes are rectangular wooden boxes measuring approximately 12" x 12" x 12",open on one end and painted flat black on the outside and either red or rust brown on the inside. Boxes are placed on the ground in wooded habitats. Mosquitoes utilizing these boxes as resting sites can be collected, identified and tested for arbovirus and serve as a useful indicator, particularly for EEE vector mosquitoes.
Gravid Trapping Gravid trapping is done with Hoch traps (Gainesville. Florida) powered by a 6-volt lead battery. The trap basin is filled with a standard seven-day hay infusion* to within 2 inches of the bottom of the trap. Traps are placed in the late afternoon or early evening and are collected during the early morning of the next day. They are placed so that they would not be in direct sunlight at any time during the trapping session. Air temperature is recorded at the time of trap placement and collection. Site locations are geo-referenced with latitude and longitude coordinates with a Garmin 12 GPS. Trapped mosquitoes are transported to the laboratory in the nets, in coolers with blue ice packets. **Seven-day hay infusion:* Approximately 2.5 ounces (about one small handful) of hay are submerged in a 5-gallon bucket filled with well water. The bucket is covered and left at ambient temperature for seven days. The resulting infusion is decanted and used in restaurant "bus" tubs and gravid trap basins for attracting gravid *Culex* species mosquitoes.

***Culex* species Egg Raft Collection**

Egg rafts of *Culex* species are collected using a different method. Black restaurant "bus" tubs 19"x15"x7" are placed in sites out of direct sunlight during the late afternoon or early evening and filled with one gallon of seven-day hay infusion. The tubs are inspected the following morning for egg rafts. The total number of egg rafts is recorded. Up to twenty-four egg rafts from each tub are collected into separate wells of polystyrene tissue culture plates with a small amount of infusion, and are covered and carefully transported to the lab. Air temperature and infusion temperatures are recorded at the time the tubs are placed and in the morning when egg rafts are collected. Each plate of egg rafts is assigned an accession number upon arrival at the lab and all collection data are recorded on a data sheet with that accession number. The rafts are kept at room temperature and first instar larvae are inspected to determine the species of *Culex*.

Adult Mosquito Identification

All female mosquitoes captured in light or gravid traps are identified by one person using a binocular dissecting microscope. Staff of the Maine Medical Center research Institute received training in mosquito identification from Drs. Howard Ginsberg and Roger LeBrun at the University of Rhode Island in 2005. Standard dichotomous identification keys for mosquitoes of North America and an unpublished key to the mosquitoes of New Hampshire provided by Dr. John Burger of the University of New Hampshire are utilized to aid in mosquito identification. Mosquitoes are frozen at -20^0C and identified as promptly as possible after collection. All collected mosquitoes that are not sent to the HETL for testing are either pinned as reference specimens or saved in pools by species and accession number for future reference. All environmental data for each trapping and mosquito species identified are entered into a Microsoft Access database for retrieval, manipulation and further study.

Rapid Response Monitoring

Rapid response monitoring is employed after an arbovirus-positive event occurs. This consists of setting multiple CDC mini-light traps with CO2 in the late afternoon, at the site where the positive animal had been found and at several nearby sites where mosquitoes are likely to be trapped. Captured mosquitoes are collected in the early morning and transported to the laboratory in a cooler on blue ice packets. After being briefly exposed to –150C to arrest movement, the mosquitoes are quickly identified alive on pre-chilled plaster of Paris or blue ice packets. Pools of up to 50 mosquitoes of the same species are placed in microcentrifuge tubes and immediately frozen at -70oC. Mosquito pools are then packed on dry ice and shipped overnight by FedEx to the ME CDC HETL for testing.

APPENDIX 1:

RESOURCES USED

APPENDIX 1: RESOURCES USED

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APPENDIX 2:

RESOLVE 2013 CHAPTER 13

APPROVED
MAY 8, 2013
BY GOVERNOR

CHAPTER
13
RESOLVES

STATE OF MAINE

IN THE YEAR OF OUR LORD

TWO THOUSAND AND THIRTEEN

H.P. 201 - L.D. 292

Resolve, Directing the Department of Agriculture, Conservation and Forestry To Develop a Plan for the Protection of the Public Health from Mosquito-borne Diseases

Sec. 1. Department of Agriculture, Conservation and Forestry to develop a plan for the protection of the public health from mosquito-borne diseases. Resolved: That the Department of Agriculture, Conservation and Forestry is directed to develop, within existing resources, a plan for the protection of the public health from mosquito-borne diseases, in cooperation with appropriate personnel from the Department of Health and Human Services and with other state agencies as may be necessary. In developing this plan, the department shall consider, at a minimum, the ecological and economic impacts of proposed methods of controlling mosquitoes and preventing their breeding. These proposed methods must include integrated pest management techniques and other science-based technology that minimizes the risks of pesticide use to humans and the environment. The department shall include in the plan the criteria for declaring a mosquito-borne disease public health threat, the elements of a response to such a threat and a description of the lines of authority and responsibilities during a public health threat; and be it further

Sec. 2. Report. Resolved: That the Department of Agriculture, Conservation and Forestry shall report on its plan for protecting the public health from mosquito-borne diseases to the Joint Standing Committee on Agriculture, Conservation and Forestry by December 15, 2013. The Joint Standing Committee on Agriculture, Conservation and Forestry may report out a bill on the plan for the protection of the public health from mosquito-borne diseases to the Second Regular Session of the 126th Legislature.

APPENDIX 3:

LD 292: AN ACT TO PROTECT THE PUBLIC HEALTH FROM MOSQUITO-BORNE DISEASES

126th MAINE LEGISLATURE

FIRST REGULAR SESSION-2013

Legislative Document **No. 292**

H.P. 201 House of Representatives, February 7, 2013

An Act To Protect the Public Health from Mosquito-borne Diseases

Submitted by the Department of Agriculture, Conservation and Forestry pursuant to Joint Rule 204.

Reference to the Committee on Agriculture, Conservation and Forestry suggested and ordered printed.

Millicent M. MacFarland

MILLICENT M. MacFARLAND
Clerk

Presented by Representative GIFFORD of Lincoln.
Cosponsored by Senator SHERMAN of Aroostook and
Representatives: BLACK of Wilton, CRAY of Palmyra, SAUCIER of Presque Isle.

Be it enacted by the People of the State of Maine as follows:

Sec. 1. 7 MRSA c. 6-A is enacted to read:

CHAPTER 6-A

CONTROL OF MOSQUITOES

§171. Control of mosquitoes for protection of public health; state policy

It is the policy of the State to undertake appropriate activities to reduce disease-carrying mosquito populations that threaten the health of residents of this State. The State shall use a wide array of integrated pest management techniques and other science-based technology in a manner that minimizes the risks of pesticide use to humans and the environment.

§172. Department lead agency; powers of commissioner

The department is the lead agency of the State for carrying out mosquito-control activities as described in this chapter.

The commissioner may use all lawful methods for the control of mosquitoes and the prevention of their breeding, including conducting or contracting for mosquito-control activities and purchasing necessary equipment for the purposes of carrying out this chapter.

§173. Rules

The commissioner may adopt rules to carry out the purposes of this chapter. Rules adopted pursuant to this section are routine technical rules as described in Title 5, chapter 375, subchapter 2-A.

§174. Duties of commissioner

1. Study; plan; arrange cooperation. The commissioner, in cooperation with appropriate personnel from the Department of Health and Human Services, shall, when sufficient money for such purposes is available in the fund, consider and study mosquito-control problems, including mosquito surveillance; coordinate plans for mosquito-control work that may be conducted by private landowners, groups, organizations, municipalities, counties and mosquito-control districts formed pursuant to section 176; and arrange, so far as possible, cooperation among state departments and with federal agencies in conducting mosquito-control operations within the State.

2. Assist with disseminating information. The commissioner, in cooperation with appropriate personnel from the Department of Health and Human Services, shall, when sufficient money for such purposes is available in the fund, assist private landowners, groups, organizations, municipalities, counties and mosquito-control districts formed pursuant to section 176 with disseminating information to the citizens of the State about ways to reduce mosquito populations, to control breeding sites and to protect themselves from mosquito-borne diseases as well as other relevant information.

3. Implement mosquito-control response. In the event that a mosquito-borne disease public health threat is declared by the Commissioner of Health and Human Services pursuant to Title 22, section 1446, the Commissioner of Agriculture, Conservation and Forestry shall consult appropriate state agency plans and personnel and university and private sector experts to determine and implement an effective control response, which must include a wide array of integrated pest management techniques. The availability of funds must also be considered as part of the response planning.

§175. Maine Mosquito Control Fund

The Maine Mosquito Control Fund, referred to in this chapter as "the fund," is established to carry out the purposes of this chapter. The fund consists of any money received as contributions, grants or appropriations from private and public sources. The fund, to be accounted for within the department, must be held separate and apart from all other money, funds and accounts. Any balance remaining in the fund at the end of a fiscal year must be carried forward to the next fiscal year. The department may expend the money available in the fund and make grants to private landowners, groups, organizations, municipalities, counties and mosquito-control districts to carry out the purposes of this chapter.

§176. Mosquito-control districts

For the purposes of preserving and promoting the public health and welfare by providing for coordinated and effective control of mosquitoes, municipalities may cooperate through the creation of mosquito-control districts.

Sec. 2. 22 MRSA c. 257-B is enacted to read:

CHAPTER 257-B

MOSQUITOES

§1446. Mosquito-borne disease public health threat

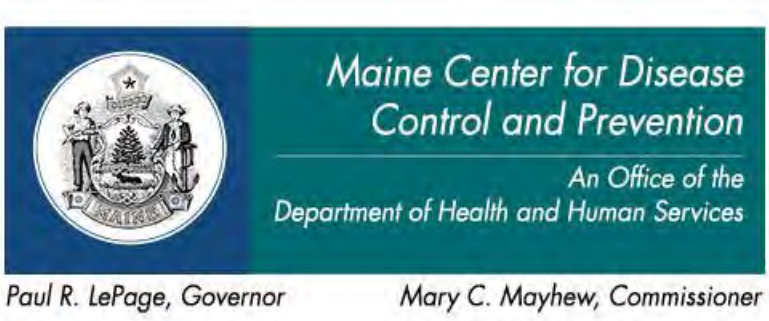
When available surveillance information indicates the likelihood of a potential human disease outbreak arising from mosquito-borne pathogens, the commissioner may declare a mosquito-borne disease public health threat for the purposes of alerting the public and other state, local and federal agencies about the existence of the threat so that appropriate actions may be taken.

SUMMARY

This bill authorizes the Department of Agriculture, Conservation and Forestry to conduct appropriate mosquito-control activities in response to mosquito-borne disease public health threats. In addition, the bill authorizes municipalities to cooperate in controlling mosquitoes through the formation of mosquito-control districts. It establishes the Maine Mosquito Control Fund to provide funding for mosquito-control activities. Finally, the bill authorizes the Commissioner of Health and Human Services to declare a mosquito-borne disease public health threat.

APPENDIX 4:

STATE OF MAINE ARBOVIRAL (MOSQUITO-BORNE) ILLNESS SURVEILLANCE, PREVENTION AND RESPONSE PLAN, 2013



DEPARTMENT OF HEALTH & HUMAN SERVICES

MAINE CDC

State of Maine

Arboviral (Mosquito-Borne) Illness

Surveillance, Prevention and Response Plan

2013 Season

TABLE OF CONTENTS

INTRODUCTION

The 2013 Arboviral (Mosquito-borne) Illness Surveillance, Prevention and Response plan provides surveillance and phased response guidance for both Eastern Equine Encephalitis (EEE) virus and West Nile virus (WNV). The purpose of the plan is to provide guidance on operational aspects of surveillance, prevention and response by the State and local communities to control mosquito-borne disease and encourage proactive preparations for the 2013 season. This plan is the result of analysis and review of surveillance data and response plans for Maine, as well as from other State and federal entities. Maine CDC will continue to seek advice from its partners and collaborators and modify the plan, as appropriate.

The Maine Vector-borne Work Group was formed in 1986 in anticipation of the increased threat posed by the emergence of vector-borne diseases in Maine. The expertise provided by the group works to minimize the risk to Maine residents of being exposed to, and infected with, vector-borne diseases. The State Epidemiologist convenes this Work Group bimonthly to develop and collaborate on a statewide coordinated strategy to reduce the risk of vector-borne (mosquito and tick) diseases in Maine. The work group and its sub-groups meet more frequently as warranted with dialogue and updates continuing throughout the year. Information provided from the Maine Vector-borne Work Group meetings is contained herein and aims to guide proactive community planning and actions to reduce the risk of human disease from EEE virus and WNV. Key objectives contained in this plan provide for the monitoring of trends in EEE virus and WNV in Maine, supporting locally-based mosquito plan development and response, providing timely, detailed and summary information on the distribution and intensity of EEE and WNV virus in the environment, laboratory diagnostic testing of EEE and WNV for humans, horses and other animals, and communicating guidelines, advice and support on activities that effectively reduce the risk of disease. This document will be reviewed at least annually.

I. DISEASE BACKGROUND

The two main mosquito-borne viruses (also known as arboviruses, for **ar**thropod-**bo**rne **viruses**) recognized in Maine and known to cause human and animal disease are Eastern Equine Encephalitis (EEE) virus and West Nile virus (WNV). The first potentially Maine acquired human case of EEE was identified in 2008. The first case of indigenously acquired WNV occurred in 2012. Different types of mosquitoes, with species-specific feeding habits (birds and/or mammals) and habitats (environments where they are found) carry these diseases. These differences are important in developing strategies for controlling the mosquitoes involved.

Infected mammals (e.g., humans, horses) are considered “dead-end” hosts for EEE and WNV. This is because mosquitoes that bite humans or equines infected with EEE or WNV do not pick up enough virus particles to transmit the disease to the next human or animal they bite. Risk of disease in humans is directly related to the amount of exposure to infectious mosquitoes.

A. Eastern Equine Encephalitis Virus

EEE virus is an alphavirus, present in some passerine (perching song birds) bird species found in fresh-water swamp habitats. The virus is transmitted among wild birds in these areas primarily by *Culiseta melanura*, a mosquito species that prefers to feed on birds. EEE virus has a cycle of natural infection among wild bird populations with occasional infections of humans, non-human mammals (most often horses) and large domesticated birds (emus, ostriches, etc). Bridge vectors (i.e., a mosquito species that is indiscriminant and will feed on birds or mammals) are responsible for transferring the EEE virus to humans.

Many people infected with EEE virus will not have symptoms of disease, while others may get only a mild flu-like illness with fever and headache. However, for people with infection of the central nervous system, a sudden high fever, severe headache, and stiff neck can be followed quickly by seizures, coma, and death. The cost of a single human case of EEE has been estimated to range from $21,000 for mild, transient illness, to as much as $3 million for individuals who suffer permanent neurologic damage. Human cases of EEE occur sporadically in the United States. Historically, clusters of human cases have occurred in sequential cycles of 2-3 years, with a hiatus of numerous years between outbreak and high-risk years. Between 1964 and 2012, 285 human cases of EEE were reported in the US, with an average of 6 cases per year. Most of the cases reported were from eastern states, primarily Florida (71 cases), Massachusetts (45 cases), Georgia (28 cases), and New Jersey (20 cases).

EEE activity documented in Maine in the last 5 years includes:

Table 1: EEE Activity in Maine, 2008-2012

	2008	2009	2010	2011	2012
Humans	0*	0	0	0	0
Mosquito Pools	1	2	0	0	0
Horse	1	15	0	0	0
Birds	0	3**	1	0	1***
Other animals	0	1 (llama)	0	0	0

*A fatal case of EEE was diagnosed in a Massachusetts resident who may have acquired the infection while vacationing in Maine
**3 separate flocks diagnosed with EEE
***1 pheasant flock diagnosed with EEE

Updated information on arborviral activity in Maine can be found at http://www.maine.gov/dhhs/mecdc/infectious-disease/epi/vector-borne/index.shtml.

The incidence of EEE infection in humans varies by geographic area. Human EEE disease is more common in areas that support dense populations of passerine birds and have favorable habitats for the larvae of the primary mosquito vector. In Maine, these areas consist mainly of large and mature white cedar and red maple swamps. EEE has never been reported in a Maine resident to date. However, in 2008 there was a fatal case of EEE diagnosed in a Massachusetts resident who may have acquired the infection while vacationing in Maine.

From 2001 to 2012, evidence of EEE infection was found in 15 of the 16 counties in Maine. This evidence was obtained through a combination of EEE seroprevalence studies in animals and regular surveillance activities performed by Maine CDC. Seroprevalence indicates previous exposure to the virus, not active illness. Testing has been performed on samples from deer, moose, bear, wild and domestic turkeys, and a variety of songbirds in conjunction with federal CDC.

Additionally, the likelihood of mosquito exposure is a key factor in determining the risk of human EEE infection. The abundance of specific species of mosquitoes at critical periods during the transmission season, in part determined by groundwater levels and the timing of rainfall during the mosquito season, is important in determining the likelihood of mosquito exposure. The use of personal protective measures (avoidance of mosquitoes, use of repellent) by people reduces their risk of exposure and infection.

B. West Nile Virus

WNV is a flavivirus. Similar to EEE, WNV is also maintained in the environment in a cycle that involves birds, with indiscriminant feeding mosquitoes infecting humans and other mammals. WNV causes sporadic disease in humans, and occasionally results in significant outbreaks. In 2012, 2,734 human cases of WNV neuroinvasive disease (West Nile meningitis and West Nile encephalitis) and 2,653 human cases of WNV fever were reported nationwide to the federal Centers for Disease Control and Prevention (CDC).

WNV activity was first identified in Maine in September 2001. WNV activity documented in Maine in the last 5 years includes:

Table 2: WNV activity in Maine, 2008-2012

	2008	2009	2010	2011	2012
Human	0	0	0	0	1
Mosquito Pools	0	1	1	0	7
Birds*	0	0	0	0	0

*Routine testing for WNV in dead birds was discontinued in 2006

Updated information on arborviral activity in Maine can be found at http://www.maine.gov/dhhs/mecdc/infectious-disease/epi/vector-borne/index.shtml.

An estimated 80% of people who become infected with WNV never develop symptoms attributable to the infection. For those who do develop symptoms: severe symptoms can include high fever, headache, neck stiffness, disorientation, coma, tremors, convulsions, muscle weakness, vision loss, and paralysis. These symptoms may last weeks, and neurological effects may be permanent. Up to 20 percent of the people who become infected will display symptoms of WNV fever, including fever, headache, body aches, and can include swollen lymph glands. Symptoms can last for days to months. People over 50 years of age are at a higher risk of developing serious symptoms of WNV.

West Nile virus activity varies from year to year. When there are a high proportion of infected mosquitoes in a relatively small geographic area the risk of transmission of virus to humans will increase. West Nile virus activity in Maine in 2012 was high, with seven mosquito pools testing positive for virus. Maine also had its first human case of WNV in a Maine resident in 2012. The case was a Cumberland County resident who experienced WNV neruoinvasive disease. The resident fully recovered from the illness. Maine discontinued routine dead bird surveillance in 2006, based on the fact that this form of surveillance is no longer considered a useful indicator for WNV.

II. PROGRAM GOALS

Timely and accurate information provided by Maine CDC may offer an early warning of increased risk of EEE and WNV virus infection of humans or non-human mammals. Based on surveillance information, actions to reduce disease transmission can be implemented early when the impact can be lessened.

Maine CDC Specific Program Priorities

1. Active involvement in and maintenance of the Maine Vector-borne Work Group to provide expertise in proactively minimizing the risk to Maine residents of being exposed to and infected with mosquito-borne diseases.
2. Conducting surveillance including laboratory testing of human clinical specimens, and testing of mosquitoes, horses, and other animals to identify EEE virus and WNV.
3. Tracking trends in incidence and prevalence of EEE virus and WNV infections by geographic area.
4. Advising human and animal medical practitioners on the appropriate procedures for detecting and identifying infections and disease caused by mosquito-borne viruses.
5. Providing information to the public on mosquito-borne disease and disease risk, and how to take precautions to reduce the risk of infection.
6. Providing timely surveillance information to communities to assist in developing and implementing local mosquito control and response plans.
7. Participating in the national Arbovirus surveillance network (ArboNet) coordinated by the federal CDC.

Maine CDC works cooperatively with other state agencies, federal agencies, local communities and selected interest groups to identify and support the use of risk reduction and disease prevention methods that are specific to the cause of the diseases, that use the least intrusive and most appropriate prevention methods, and that support planning and practices that minimize the use of pesticides.

III. PREVENTION AND CONTROL

Ultimately, the key to reducing the risk of arboviral disease is education and outreach to the public regarding the need for mosquito-bite prevention and explaining how people can protect themselves from diseases such as EEE and WNV. The emergent public health threat posed by arboviral illness requires a vigilant outreach effort. As the state public health entity, Maine CDC will continue to take a lead role in providing public education efforts to promote prevention, by working with our partners to maximize the opportunity to alert our residents to the dangers posed by mosquito-borne illness. This will include working with the media, local communities, businesses and special populations such as schools, the homeless and others who spend considerable time outdoors, such as those who hunt and fish.

Maine CDC provides information to the public and communities to guide planning and actions to reduce the risk of human disease from EEE virus and WNV. Individuals can take a number of simple steps that will greatly reduce the risk of mosquito-borne viruses to them, their families, and their communities. Choosing to wear protective clothing (e.g., long pants, long-sleeve shirts), using effective Environmental Protection Agency (EPA) approved repellants, and minimizing opportunities for mosquitoes to breed are all important ways individuals can help prevent the spread of EEE and WNV in Maine. Community efforts, such as public education, mosquito surveillance, and integrated pest management (IPM) measures aimed at mosquito larvae may be necessary to decrease the local risk of EEE virus and WNV.

A. Prevention Through Knowledge

The goal of all mosquito-borne virus public information activities is to provide Maine's residents with helpful, accurate and specific advice and information in order to approach this problem with the appropriate level of caution.

Maine CDC's website includes general background information and surveillance updates as well as links to other informational websites including other state and federal agency sites. Printed materials can be ordered through this website: http://www.maine.gov/dhhs/mecdc/infectious-disease/epi/order-form-wn.shtml.

Epidemiologists from Maine CDC are also willing to conduct trainings and give presentations on arboviral diseases.

B. Prevention Action Steps

1. Preventing Mosquito Breeding Opportunities: By reducing exposure to mosquitoes around their homes and by eliminating mosquito breeding grounds, Maine residents can greatly reduce their risk of mosquito-borne virus exposure. Many species of mosquitoes lay their eggs in standing water. Fresh water swamps and coastal areas provide larval habitat for the mosquito species commonly associated with EEE. Weeds, tall grass, and bushes may provide resting areas for the mosquitoes that are most often associated with WNV.

Maine CDC recommends residents take the following steps to reduce opportunities for mosquito breeding:

- Eliminate artificial sources of standing water around residential and commercial areas by discarding outdoor artificial containers such as tin cans, plastic containers, glass bottles, or similar water-holding containers.
- Remove all discarded tires from your property. The used tire is the most common site for mosquito breeding in the United States.
- Dispose of or drill holes in the bottom of containers left outdoors, such as recycling containers or flowerpots. Drainage holes on the sides of containers will still allow enough water for mosquitoes to breed. Do not overlook containers that have become overgrown by aquatic vegetation.
- Make sure roof gutters drain properly. Clean clogged gutters in the spring and fall and as often as necessary to eliminate standing water.
- Clean and chlorinate swimming pools, outdoor saunas, and hot tubs following disinfectant label directions. If not in use, keep them empty and covered. Do not allow these covers to collect standing water.
- Aerate ornamental pools or stock them with native fish. Water gardens become major mosquito producers if they are allowed to stagnate.
- Turn over wheelbarrows and plastic wading pools when not in use. Both provide breeding sites for domestic mosquitoes.
- Change water in birdbaths at least twice weekly.
- Remind or help neighbors to eliminate mosquito breeding sites on their property.
- Consult with local mosquito control companies licensed by the Maine Board of Pesticides Control (BPC) (go to http://www.maine.gov/agriculture/pesticides/public/mosquito_control_list.htm to see an updated list of licensed companies) for additional solutions to decrease mosquito-breeding activity in nearby areas. Products are available that can be used to reduce mosquito populations (see Mosquito Control Activities below).
- The management of ponds, marshlands, and wetlands is regulated under existing state law and administrative rule. Alteration may require the approval of state and possibly federal agencies. Contact the Maine Department of Environmental Protection (DEP) for further information http://www.maine.gov/dep/index.shtml.

2. Personal Protective Measures: Residents can take simple steps to minimize mosquito bites. Such steps are critical in reducing the risk of EEE and WNV infections. Maine CDC recommends that residents take the following steps to protect themselves, particularly from June to October, when mosquitoes are most active:

- If outside during evening, nighttime and dawn hours, or at any time mosquitoes are actively biting, children and adults should wear protective clothing such as long pants, long-sleeved shirts, and socks, and consider the use of personal repellent.
- EPA approved repellents include: DEET, Picaridin (KBR3023), IR3535, and Oil of Lemon Eucalyptus. The length of time a repellent is effective varies with ingredient and concentration. Always follow the manufacturer's instructions on the label.

- Permethrin is an EPA approved repellent product that can be used on clothing or fabrics. This product should not be applied directly to the skin. Always follow the manufacturer's instructions on the label.
- Do not allow young children to apply repellent themselves and do not apply repellent directly to children. Apply to your own hands and then put it on the child's skin.
- Infants and children should be protected by placing mosquito nets over strollers in the evening, nighttime and dawn hours or at any time mosquitoes are actively biting.
- After returning indoors, wash treated skin with soap and water or bathe. Also, wash treated clothing before wearing again.
- Store repellent out of reach of children.
- For additional information about chemicals contained in repellents, visit the National Pesticide Information Center (NPIC) website at http://npic.orst.edu/repel.html. or contact the Maine BPC at 207-287-2731.
- Make sure that doors and windows have tight-fitting screens. Repair or replace all screens in your home that have tears or holes.
- Vitamin B, ultrasonic devices, incense and bug zappers have not been shown to be effective in preventing mosquito bites.

3. Mosquito Control Activities: The objective of public health mosquito control is to prevent transmission of mosquito-borne disease to humans. Reduction of mosquito species is not carried out by Maine public health agencies. It is important to emphasize that local communities make the final decision regarding mosquito control activities. Communities are responsible for developing, maintaining and financing local mosquito control programs. Maine CDC, the Maine Department of Agriculture, Conservation, and Forestry, the Maine Board of Pesticides Control, and the Maine Department of Environmental Protection are available to provide guidance and recommendations to assist municipalities in plan development and when faced with response decisions.

All discussion regarding pesticide applications discussed in this plan will be in accordance with the principles of Integrated Pest Management (IPM). IPM is a sustainable approach to managing mosquitoes by combining biological, physical and chemical tools in a way that minimizes economic, health and environmental risks. IPM involves preventive control and suppressive control, including:

- Source reduction (remove, cover, drain, fill) of larval habitats that are not environmentally sensitive or protected
- Mechanical control (the use of barriers such as screens to prevent the movement of mosquitoes and the use of traps)
- Chemical / Biological Pesticide control (the use of registered pesticides, according to label directions that act against mosquitoes)

Chemical /Biological pesticide controls can be further divided into the application of products aimed at mosquito larvae (larvicide) and those aimed at adult mosquitoes (adulticide). Larvicide involves the application of chemicals or natural bacteria to surface waters (such as ponds or in storm drains) to kill mosquito larvae. Larviciding is a proactive measure that can be useful in reducing the risk of mosquito-borne disease throughout the season. The intent of a larvicide

program is to control generations of targeted mosquito species before they reach the adult stage, when they are able to transmit diseases such as EEE and WNV. Larvicide programs typically begin in early spring and continue throughout the season, and may help reduce the potential for human exposure to pesticides. These applications require DEP permits when the "waters of the state" are involved (see DEP pesticide Rules section below).

Adulticides involve the application of fine "mists" of pesticide over a relatively broad area to bring about the rapid reduction of adult mosquitoes. Adulticiding occurs in response to current surveillance activity. Adulticiding can quickly reduce existing, biting adult mosquitoes throughout a spray area, but its effects are relatively short lived, raising the possibility of repeat applications. In addition, adulticide spray sites are most likely to be areas of high human population density increasing the potential for human pesticide exposure. Comprehensive mosquito control programs may utilize both of the control methods, larviciding and adulticiding, if indicated by surveillance data.

Pesticides may pose their own risk to the health of humans, animals, plants, and the environment. Thus pesticides are only one component of a coordinated effort to control mosquitoes. Pesticide treatments and other IPM strategies may be appropriate in certain situations, while each strategy alone may not be adequate.

IPM dictates that control efforts should be tied to thresholds. This means simply that a certain defined risk needs to exist before particular control methods are recommended. Different responses may be made as different levels of risk are identified. These levels of risk are discussed under the Phased Response section of this plan. In an ideal IPM program, non-chemical methods should be employed to keep pest levels below the risk level that might trigger a pesticide response, meaning that pesticides are a last, rather than first response to a WNV or EEE problem.

Suggested Options for Mosquito Control Activities

Once a community has identified the need for an organized response to the risk of a mosquito-borne disease, 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. Listed below are suggested options for local mosquito control programs. It is important to remember mosquito control is a year-round activity; many of these activities can be performed during the "off season." Communities interested in developing or enhancing their mosquito control programs should review the document "Public Health Confronts the Mosquito" available at http://www.astho.org/WorkArea/DownloadAsset.aspx?id=2333

- 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.

- Stay up-to-date on statewide and regional virus activity and recommendations by visiting http://www.maine.gov/dhhs/mecdc/infectious-disease/epi/vector-borne/index.shtml.

- Contact insect repellent manufacturers to determine the availability of community or municipal discounts for bulk purchases of repellent products.

- Encourage local reporting to town officials of suspected areas where mosquitoes may be breeding (larval habitats). Such areas may then be evaluated by mosquito control personnel.

- Institute community cleanup programs to eliminate larval habitats from backyards, commercial sites and abandoned premises. Efforts may be aimed at removing, covering, or draining such artificial habitats.

- If needed, develop provisions in the local ordinances to deal with public health nuisances (e.g., unmaintained swimming pools that may serve as mosquito breeding habitat).

- Define the scope of the mosquito control program.
    - Create a clearly defined statement of services or deliverables, and a clear performance evaluation document.
    - Establish what activities will be performed.
    - Determine what resources (equipment, staff, insecticides, etc.) will be needed and what is available.
    - Decide where, when, and how often activities are to occur.
    - Emphasize public education and source reduction, augmented by larval and adult mosquito control, if appropriate.
    - Ensure that all staff are appropriately trained and licensed (see commercial pesticide applicator licensing requirements at http://www.maine.gov/agriculture/pesticides/cert/questions.htm#commercial.)
    - Investigate training opportunities to develop local expertise, such as in mosquito trapping and identification and/or pesticide application.

- Institute basic mosquito population monitoring to define the problem. Monitoring species, abundance, and virus infection rates in adult mosquitoes provides critical early, predictive data for surveillance and control.

- Consider coordinating mosquito control efforts with neighboring jurisdictions.

- Once these decisions have been made, create a community-specific mosquito control plan.

C. Pesticide Control Board Regulations

The use of pesticides in Maine is governed by state law 22MRSA§1471 A-2 and 7MRSA§ 601-625 and by the Administrative Rules of the Board of Pesticides Control, CMR**01-026**. Chapters 10 – 90. These statutes and rules require people applying pesticides, other than homeowners on their own property, hold licenses issued by the Maine Board of Pesticides Control. Municipal employees must be licensed as a commercial pesticide applicator if the use of a pesticide is part

of their official duties, and they may only apply pesticides to municipal properties. Municipal entities needing licenses include municipal and quasi-municipal organizations like Parks and Recreation Departments, Public Works, Cemetery Maintenance, Water & Sewer Districts, Housing Authorities, etc.

The Board of Pesticides Control also requires licensing whenever pesticides are applied in areas open to the public. These areas could include parks, campgrounds, apartment or condominium grounds, common areas of apartment buildings and many other areas. If a municipality hires an outside company to do pest control, that municipality must be sure the applicator company has the appropriate commercial pesticide applicator licenses. We recommend obtaining proof of licensure even before entertaining a bid from an outside pest control company.

Pesticides covered by these rules include insecticides to kill mosquito larvae like *Bacillus thuringiensis* (*var. israelensis*) (Bti), *Bacillus sphaericus* (Bs), methoprene, and temephos, and insecticides to kill adult mosquitoes like malathion, naled and the pyrethroids, or any other pest control products both organic and synthetic.

Pesticide applicator licenses are required to handle and apply even the over-the-counter product varieties, like mosquito dunks or natural and organic products, when applications are performed by government employees or in public areas because of the greater potential for public exposure and the added liabilities resulting from that use. PERSONAL USE OF REPELLENTS DOES NOT REQUIRE A LICENSE

D. Department of Environmental Protection Pesticide Rules

Although certain pesticide products are available for sale in the marketplace to control mosquito larvae, application of these products to any surface waters in Maine is governed through permits obtained from the Maine Department of Environmental Protection. Questions regarding how to apply for such special permits should be directed to the Maine Department of Environmental Protection at 287-7688 (http://www.maine.gov/dep/).

In the event an EEE or WNV threat has been identified, the Commissioner of Health and Human Services may declare a Public Health Emergency and instruct the Department of Environmental Protection to commence the expedited special permit process – that is, provide an application form and other pertinent information to the appropriate town official(s) through the local health officer. The special permit will be issued with the greatest possible speed, preferably within seventy-two (72) hours.

Pesticide Applicator Licenses
A listing of the current Maine licensed pesticide applicators certified to control mosquitoes can be requested from the Maine BPC (287-2731, pesticides@maine.gov or http://www.maine.gov/agriculture/pesticides/public/mosquito_control_list.html.) Successful applications require in-depth knowledge of the community's planned pesticide use for mosquito control. Communities may also decide to license their own staff to apply pesticides. The

licensing process for commercial applicators is described on the BPC website at http://www.maine.gov/agriculture/pesticides/cert/questions.htm#commercial

IV. SURVEILLANCE

Arboviral testing available through Maine's Health and Environmental Testing Laboratory (HETL) is outlined below. All laboratory test results should be considered in conjunction with both clinical symptoms and epidemiologic findings. Human samples must meet a set of minimum requirements in order to be tested (submission form required).

Table 3: Testing services available through HETL

Sample	West Nile virus (WNV)	Eastern Equine (EEE)	St. Louis (SLE)	LaCrosse (LE)	Powassan virus
Human serology (IgM)	X	X	X	X*	X*
Human cerebrospinal fluid (IgM)	X	X	X	X*	
Bird tissue (PCR)	X	X			
Mosquitoes (PCR)	X	X			
Non-Human Mammal tissue (PCR)	X**	X**			
Horse serology (IgM)	***	***			

* = Testing is not performed at HETL, but can be forwarded on to the federal CDC upon request. Federal CDC is also able to perform IgG testing if warranted.
** = A rabies test must be performed on mammal specimens before PCR for WNV/EEE can be done. Animals testing positive for rabies will not be tested for WNV/EEE
*** = Testing is not performed at HETL, but is offered by private laboratories
PCR = polymerase chain reaction

Note: The USDA National Veterinary Services Laboratory (NVSL) or federal CDC Laboratory will be used as a confirmatory reference laboratory for results as needed.

A. Mosquito Surveillance for Eastern equine encephalitis and West Nile virus

Mosquitoes are the best early indicator of human risk for arboviral disease. The objective of a mosquito surveillance program is to determine the presence of arboviruses, including EEE and WNV, in mosquito species common to our area. An effective program begins by targeting mosquito species considered to be important in transmitting disease among birds (primary vector) and transmitting disease from birds to humans (bridge vectors). Monitoring mosquito abundance is accomplished through various surveillance methods including but not limited to measuring larvae (dip counts) and adult mosquitoes (use of light/CO2 baited traps, gravid traps and resting boxes). Results must be evaluated by mosquito species, as each species has unique biological characteristics that should be incorporated into control decisions (see Appendix I). Maine CDC uses a comprehensive and flexible strategy that modifies certain surveillance activities in response to trends in disease risk.

Based on historic and current epidemiology in Maine and the United States, Maine CDC may test only particular mosquito species for EEE virus and WNV. Testing decisions will be based on the most current knowledge and fiscal considerations. Such decisions will be announced to Town Officers and mosquito contractors well in advance. Regardless of testing decisions, communities financing mosquito surveillance are encouraged to utilize surveillance from July 1 through October 1 in order to evaluate the relative abundance of particular mosquito species. Mosquito larvae and adult abundance, arboviral testing results, and coverage of mosquito surveillance efforts play a critical decision-making role in overall need, scope, and method of control.

Activities for mosquito surveillance for the 2013 season will consist of routine and rapid response surveillance.

1. Routine Mosquito Surveillance: Maine CDC is the lead agency responsible for mosquito surveillance activities. Maine CDC will work with its partners in coordinating efforts for appropriate placement of traps, collection, packaging and transport of mosquito specimens.

Routine, fixed long-term trap sites provide the best baseline information for detecting trends in mosquito abundance, virus prevalence and estimating the risk of human infection from EEE and WNV. Maine CDC works together with contract employees to determine long term trap sites. If your town or community has interest in collecting mosquitoes locally for testing, please consult with Maine CDC for more information on collection requirements and testing ability.

2. Rapid Response Mosquito Surveillance: In the case of a positive test of an arbovirus in non-human mammals, mosquitoes, or humans, State sponsored activities may include:

- Notifying city and town municipal officials of positive virus isolation or a confirmed case of a mosquito-borne disease.
- Provide for short-term mosquito surveillance and laboratory specimen preparation in the absence of a local health department surveillance or local mosquito control program in predetermined selected areas.
- Coordinating training and lending expertise to local health officials and state personnel.
- Evaluating current trap locations based on criteria including habitats conducive to mosquito breeding and bridge vector collection, and level of human use (e.g., schools, parks, athletic fields).
- Reviewing and determining the need for expanding trapping in the area surrounding the positive identification.

B. Avian Surveillance for West Nile virus and Eastern Equine Encephalitis

National and local analysis suggests dead bird testing for WNV is becoming less useful for early detection and evaluation of WNV risk. Most birds infected with EEE do not succumb to severe disease and do not provide useful data for disease surveillance and response in Maine. For these reasons, Maine has discontinued wild bird testing. Wild bird surveillance is useful in understanding the ecology of arboviruses, and as such, other agency partners (i.e., MMCRI, Wildlife Services, etc.) may conduct surveillance among wild bird and mammal populations to address specific research questions.

In some circumstances, dead birds may be tested for EEE and WNV by the state if the situation warrants (e.g., unusual large die-offs without a known cause). It is the responsibility of the local community to arrange for the transportation of dead birds to the HETL. Birds must be approved for testing prior to delivery by calling Maine CDC's disease reporting line (1-800-821-5821).

Testing and surveillance of domestic birds (e.g., emus) will follow the procedures listed below for mammal (non-human) surveillance.

C. Mammal (Non-human) Surveillance for Eastern Equine Encephalitis (EEE) virus and West Nile virus (WNV)

Under the auspices of the State Veterinarian, Maine Department of Agriculture, Conservation, and Forestry, HETL may conduct testing of horses and other domestic animals (e.g., llamas, alpacas) that have severe neurological disease suspected of being caused by EEE virus or WNV infection. On an annual basis, a letter from the State Veterinarian (Maine Department of Agriculture) describing the case definition, clinical signs of disease, prevention measures, and reporting process will be sent to all licensed veterinarians in the state of Maine. This serves as a reminder to investigate and report neurological illness in animals. Parameters for the evaluation and testing of ill animals will include the following:

- Domestic animals with neurologic signs will initially be referred to private veterinarians for evaluation.
- Veterinarians wishing clinical consultation or information on encephalitic disease testing procedures should contact the State Veterinarian at the Maine Department of Agriculture, Conservation, and Forestry.
- Necropsy specimens, such as animal heads, must be sent to the Maine HETL for processing.
- The State Veterinarian will assure appropriate collection of specimens for diagnostic testing.

Mammals Submitted for Rabies Testing

Unlike an arbovirus, rabies can be transmitted to humans through the bite of an infected animal. It is important that all mammals with neurological symptoms that have had contact with humans, pets, or domestic animals, and that meet guidelines for rabies testing, be submitted for testing in accordance with HETL guidelines. Animals testing positive for rabies will not be tested for EEE virus and WNV.

D. Human Surveillance

1. Passive surveillance: Maine CDC is the lead agency for the conduct of human case surveillance for arboviral encephalitis, meningitis, and meningoencephalitis. Arboviral testing is available at HETL, and requires a "Human Arboviral Specimen Submission Form." Instructions on submitting samples and the submission form can be found online at

http://www.maine.gov/dhhs/mecdc/public-health-systems/health-and-environmental-testing/micro/submitting_samples.htm.

Health care providers who suspect arboviral disease should submit the following specimens for testing (when possible, serum and CSF should be submitted together) along with the Human Arboviral Specimen Submission Form:

- CSF for testing by IgM Multiplex Immunoassay (MIA). All spinal fluid submission must be accompanied by a corresponding serum sample.

- Sera, both acute and convalescent, for testing by IgM Multiplex Immunoassay (MIA).

Note: Severe neurological disease due to an arboviral infection has occurred in patients of all ages. Year-round transmission is possible in some areas of the country. Therefore, arboviral disease should be considered in persons with unexplained encephalitis and meningitis with consistent travel history.

HETL's normal viral testing protocol for arboviruses includes human serology and cerebrospinal fluid assays for WNV, EEE, and SLE (St. Louis Encephalitis). Testing for LAC (LaCrosse Encephalitis) and Powassan virus is referred to the federal CDC for testing if requested.

Maine CDC promotes human surveillance activities by:

- Alerting Maine hospitals and clinicians about the importance, criteria, and requirements for reporting, along with instructions for submission of appropriate laboratory specimens (CSF, acute and convalescent sera for arboviral encephalitis).

- Providing Maine hospitals, neurologists and infectious disease physicians with clinical and epidemiologic information about human cases of WNV and EEE and criteria for reporting and laboratory testing.

All suspect human cases should be reported to Maine CDC at 1-800-821-5821.

2. Enhanced surveillance: If surveillance data indicate an increased risk of human disease, active surveillance or enhanced passive surveillance may be instituted in high-risk areas. This consists of contacting health care providers and facilities surveying for potential cases. Additionally, death records and other available surveillance systems will be utilized to screen for possible human cases of arboviral encephalitis, meningitis, or meningoencephalitis.

E. Communication of Surveillance Information

1. Routine Information: Arboviral information will be available on Maine CDC's website at http://www.maine.gov/dhhs/mecdc/infectious-disease/epi/vector-borne/index.shtml.

2. Positive EEE Virus & WNV Findings: Maine CDC ensures the rapid and accurate dissemination of positive test results. Following an EEE or WNV positive mosquito pool, bird,

non-human mammal or human, an investigation will be initiated and an epidemiologist will notify the Town Manager or Selectman as well as the district liaison for that area. The Town Manager or Selectman should notify all pertinent local officials, including high-level elected and appointed officials and, as warranted, the municipal Emergency Management Director and Animal Control Officer. Weekly reports are posted to the website during the arboviral season (http://www.maine.gov/dhhs/mecdc/infectious-disease/epi/vector-borne/index.shtml).

3. Press Releases/ Health Alerts: Maine CDC may issues press releases or health alerts to inform the public of conditions that may warrant additional precautions to reduce the risk of disease. The Health Alert Network (HAN) will be utilized by Maine CDC to disseminate information to health care providers in the State. All HANs are posted to http://www.maine.gov/dhhs/mecdc/.

V. RECOMMENDATIONS FOR A PHASED RESPONSE TO EEE VIRUS AND WNV SURVEILLANCE DATA

The recommendations provided here are based on current knowledge of risk and appropriateness of available interventions to reduce the risk for human disease. Multiple factors contribute to the risk of mosquito-transmitted human disease. Decisions on risk reduction measures should be made after consideration of all surveillance information for that area at that time.

Recommendations regarding the EEE and WNV phased response plan (Table 1) incorporates several components presented in the CDC document "Epidemic/Epizootic West Nile virus in the United States: Guidelines for Surveillance Prevention, and Control", 3rd Revision, 2003, as well as results of analyses of surveillance data collected in Maine and throughout the northeastern United States.

Public awareness of what can be done to reduce risk of infection is of utmost importance. The level of EEE virus and WNV activity may occasionally present a potential for increased virus transmission to humans. Typically, risk is expected to be relatively low, and the routine precautions taken by individuals may be sufficient to avoid infection. These guidelines take into consideration the complexity of reducing risk of human disease from EEE virus and WNV infection and form a framework for decision-making. They are not a set of specific prescriptions.

1. Phased Response: General guidelines are provided for an array of situations that are noted in the Surveillance and Response Plan Table (**Table 4**) that follows. Specific situations must be evaluated and options discussed before final decisions on particular actions are made. The assessment of risk from mosquito-borne disease is complex and many factors modify specific risk factors. Maine CDC works with public health districts, community administrators, health officers, and mosquito control contractors to develop the most appropriate prevention activities to reduce the risk of human disease. There is no single indicator that can provide a precise measure of risk, and no single action that can assure prevention of infection.

When recommending the use of mosquito larvicides or adulticides, Maine CDC works to identify and support the use of risk reduction and disease prevention methods that are specific to the cause of disease, that use the least intrusive and most appropriate prevention methods, and that support planning and practices that reduce the use of pesticides. Technical support from the Board of Pesticides Control will be provided upon request. Ultimately, the decision to apply pesticides is left to the community. Communities that would like to consider pesticide use should identify licensed personnel or locate licensed contractors and consult with the Maine Board of Pesticides Control to determine that the pesticide chosen is properly registered for use in Maine.

Historical local surveillance data is critical in making informed decisions regarding risk and appropriate actions. Communities are urged to review and enhance local surveillance activities to aid in decision-making and early detection of arboviral activity.

2. Maine CDC Guidance: Throughout the arboviral season, Maine CDC will monitor activity in an attempt to ascertain risk levels as outlined in the phased response tables of this plan. Risk levels are defined for focal areas. "Focal Areas" may incorporate multiple communities, towns, or cities. Factors considered in the determination of human risk in a focal area include: mosquito habitat, mosquito abundance, current and historic virus activity, timing of recent isolations of virus in mosquitoes, current and predicted weather and seasonal conditions needed to present risk of human disease. Known/suspected location of exposure is used for human and non-human animal cases and not necessarily town of residence.

Table 4: Guidelines for Phased Response to EEE and WNV Surveillance Data

Risk Category	Probability of Human Outbreak	Definition for a Focal Area*	Recommended Response
1	Remote	All of the following conditions must be met: Prior Year No activity detected in a community or focal area. AND Current Year No current surveillance findings indicating EEE or WNV activity in the focal area.	1. Educational efforts directed to the general public on personal protection, such as use of repellents, and source reduction. 2. Routine human and non-human mammal surveillance;. 3. Assess local ecology for mosquito abundance. 4. Consider larval and adult mosquito monitoring with routine collection and testing of mosquitoes.
2	Low	Prior Year (WNV) Virus activity detected in mosquitoes. Prior 2 Years (EEE) Virus activity detected in mosquitoes during either of both of the past two years. OR Current Year EEE or WNV identified in a single mosquito trap location AND No non-human mammal or human cases	Incorporates previous category response, plus: 1. Expand community outreach and public education programs focused on risk potential and personal protection, emphasizing source reduction. 2. Assess mosquito populations, monitor larval and adult mosquito abundance, submit samples to HETL for virus testing. 3. Use larvicides at specific sources identified by entomologic survey and targeted at vector species. If appropriate, consider source reduction techniques. 4. Enhance surveillance of human and non-human mammal surveillance.
3	Moderate	Prior Year Confirmation of human and/or non-human mammal case(s) OR Sustained EEE or WNV activity in mosquitoes. OR Current Year Multiple EEE or WNV mosquito isolates AND No non-human mammal or human cases.	Incorporates previous category response, plus: 1. Increase larval control, source reduction, and public education emphasizing personal protection measures. 2. Actions to prevent disease may include targeted larviciding at likely vectors, and if current year activity, possibly ground adulticiding targeted at likely bridge vector species. 3. Enhance human surveillance and activities to further quantify epizootic activity.

* Focal area: May incorporate multiple towns or cities. Designation based on factors including mosquito habitat, current and historic virus activity, timing of current virus activity, current weather and seasonal conditions. Known/suspected location of exposure is used for human and non-human animal cases and not necessarily town of residence.

4	High	Current Year Surveillance of increasing EEE or WNV activity in mosquitoes OR A single confirmed non-human mammal case of EEE or WNV OR A single confirmed human case of EEE or WNV.	Incorporates previous category response, plus: 1. Intensify public education on personal protection measures a. Utilize multimedia messages including press releases, local newspaper articles, cable channel interviews, etc. b. Actively seek out high-risk populations (nursing homes, schools, etc.) and educate them on personal protection. c. Issue advisory information on adulticide spraying. 2. Consider intensifying larviciding and/or adulticiding control measures as indicated by surveillance. 3. Maine CDC will confer with local health officials to determine if the risk of disease transmission threatens to cause multiple human cases. If surveillance indicates a continuing risk of human disease and potential for an outbreak, intensified ground-based adult mosquito control may be recommended.
5	Critical	Current Year More than 1 confirmed human case of EEE or WNV in a community or focal area OR Multiple confirmed EEE or WNV non-human mammal cases.	Incorporates previous category response, plus: 1. Continued highly intensified public outreach messages through community leaders and the media emphasizing the urgency of personal protection. 2. If risk of outbreak is widespread and covers multiple jurisdictions, Maine CDC will confer with local health officials and Vectorborne Work Group to discuss the use of intensive mosquito control methods. A State of Emergency may be declared pursuant to Title 37-B Chapter 13 Subchapter 2 §742. The declaration of an emergency may trigger application of mosquito adulticide. Maine CDC may define targeted treatment areas for vector control following the declaration of an emergency. 3. Ground-based adulticide applications may be repeated as necessary to achieve adequate control.

APPENDIX I

BIOLOGY, ARBOVIRAL ACTIVITY, AND CONTROL CONCERNS OF SELECTED MAINE MOSQUITO SPECIES

Below is a review of the main products used for mosquito control and descriptions of the principle mosquito species likely responsible for Eastern Equine Encephalitis (EEE) virus and West Nile virus (WNV) transmission in Maine. The unique biological features pertinent to control and prevention of each species are discussed. Information was obtained from federal, state, and local publications (see reference list below) and results from the Maine and other New England state arboviral testing programs.

Control of Mosquitoes in Maine

Deciding which product and method of application to use will depend on environmental conditions, targeted species, and state/local regulations. For information regarding pesticide rules and regulations, contact the Maine BPC at 287-2731. For legal use, larvicide and adulticide products must be registered in the State of Maine. To check registration status, please contact the Maine BPC at 287-2731 or go to http://state.ceris.purdue.edu/doc/me/stateme.html. To gauge the relative risk of larvicides or adulticides go to the BPC web site at http://www.maine.gov/agriculture/pesticides/wnv/index.htm.

Larviciding. Larviciding is a proactive measure that can be useful in reducing the risk of mosquito-borne disease throughout the season and tends to be more effective at reducing mosquito populations than adulticiding. Larviciding occurs in response to larval mosquito surveillance and habitat identification. The intent of a larvicide program is to control generations of targeted mosquito species before they reach the adult stage, when they are able to transmit diseases such as EEE and WNV. Several materials in various formulations are labeled for mosquito larviciding. Items can be classified as bacteriologic, insect growth regulators, surface films, and organophosphates. Most are effective during particular stages of mosquito development, thus timing of application is important.

(1) Bacteriologic Control: *Bacillus thuringiensis israelensis* (*Bti*) and *Bacillus sphaericus* (*Bs*) are naturally occurring bacteria used as larvicides. When ingested by mosquito larvae, they alter gut permeability killing the larvae. They are believed to pose a minimal risk to non-target species.
(2) Insect Growth Regulators: Methoprene (e.g., Altosid) mimics the action of a mosquito growth-regulating hormone and prevents the larvae from maturing into adults. It has low toxicity to birds and fish.
(3) Surface Films: Petroleum derivatives (e.g., Golden Bear Oil) produce a thin film on the surface of the water that prevents the transfer of oxygen causing the mosquito larvae/pupae to drown. Ethoxylated Alcohols (e.g., Agnique) produce a thin surface film, making it difficult for mosquito larvae, pupae, and emerging adult to attach to the water's surface, causing them to drown. The window of opportunity for use of these agents is limited by the mosquito life cycle, especially when dealing with species that require little or no surface contact for breathing. These

agents also prevent the natural transfer of oxygen into the water body. There are potential impacts to non-target species that rest on the water surface.
(4) Organophosphates: Temephos is the only organophosphate with larvicidal use and inhibits nerve signal transmission. Although it presents relatively low risk to birds and terrestrial species, available information suggests that it is more toxic to aquatic invertebrates than alternative larvicides.

Adulticiding. Adulticide involves the application of fine "mists" of pesticide over a relatively broad area to bring about the rapid knockdown of adult mosquitoes. Adulticiding occurs in response to current adult mosquito surveillance activity. Adulticiding can quickly reduce existing, biting adult mosquitoes throughout a spray area, but its effects are relatively short lived, raising the possibility of repeat applications. In addition, adulticide spray sites are most likely to be areas of high human population density.

Mosquito adulticides are dispersed either by truck-mounted equipment, backpack, or from aircraft. Barrier treatments, using compounds with residual characteristics, may also be used. Adulticides labeled for mosquito control include natural pyrethrins, synthetic pyrethroids, and organophosphates. Insecticide selection and timing of application should be based on the distribution and behavior of the target mosquito species.

- Pyrethrum: A derivative from chrysanthemum flowers that has a relatively low toxicity.
- Synthetic pyrethroids: Synthetic chemical pesticides (e.g. Permethrin, Resmethrin and Sumithrin aka D-phenothrin) that act in a similar manner to pyrethrins. They are relatively low in toxicity. Most break down rapidly in sunlight. Pyrethroids used in mosquito control are typically mixed with a synergist compound, such as Piperonyl Butoxide, which enhances the effectiveness of the active ingredient to kill adult mosquitoes on contact.
- Organophosphates: Organic compounds (e.g., Malathion and Naled) that function as nerve toxins, with the purpose of killing adult mosquitoes. There is potential for acute, and chronic risks to freshwater invertebrates and possibly other species.

Pesticides may pose their own risk to the health of humans, animals, plants, and the environment. Thus pesticides are only one component of a coordinated effort to control mosquitoes.

MAINE MOSQUITO SPECIES OF CONCERN FOR EEE AND WNV

There are 45 mosquito species present in Maine, however less than half of these are considered to be likely vectors for EEE and WNV. Given the short history of arboviral surveillance in Maine, it is difficult to know the specific role each mosquito species plays in EEE and WNV disease transmission. In general, species are identified as vectors based on their local abundance, demonstrated vector competence in the laboratory, and frequent infection with the virus as documented by arboviral surveillance programs. Based on these criteria, the following species are considered to be vectors of concern for EEE and/or WNV in Maine or the surrounding region:

- EEE virus: *Aedes vexans, Aedes cinerus, Coquillettidia perturbans, Culex salinarius, Culex pipiens, Culex restuans,Culiseta melanura Culiseta morsitans,Culiseta inornata,Ochlerotatus*

canadensis, Ochlerotatus japonicus, Ochlerotatus triseriatus, Ochlerotatus sollicitans, Psorophora ferox

- WNV: *Anopheles punctipennis, Anopheles walkeri, Aedes vexans, Aedes cinerus, Coquillettidia perturbans, Culex pipiens, Culex restuans, Culex salinarius, Culesita melanura, Ochlerotatus canadensis, Ochlerotatus cantator. Ochlerotatus japonicus, Ochlerotatus sollicitans, Ochlerotatus triseriatus*

Information pertaining to the biology and specific control concerns for these species is provided below.

Aedes cinerus

Larval habitat: Wooded snowmelt pools, semi-permanent bogs and swamps. There are several generations per year.
Overwintering stage: Egg.
Host preference: Mammals. Adults readily bite humans.
Biting times: Dusk to dawn and daytime in wooded areas. Adults rest in shaded areas and will bite if disturbed.
Flight range: 100 to 1000 feet.
Virus isolations: Maine WNV. New Hampshire EEE and WNV. Isolations have been found in other northeastern states.
Maine surveillance: Collected throughout the arboviral season (June-October) from all counties in which surveillance occurred.

Aedes vexans

Larval habitat**:** A floodwater species found in a wide variety of temporary freshwater pools and depression areas (e.g., flooded fields, retention ponds, roadside puddles). There are several generations per year.
Overwintering stage**:** Egg.
Host preference: Mammals. Adults are aggressive human biters. This species will also feed on birds.
Biting times: Dusk to dawn; may also bite during the day.
Flight range: 1-5 miles; some sources cite flight ranges > 15 miles.
Virus isolations: New Hampshire EEE, Maine WNV. Isolations have been found in other northeastern states.
Maine surveillance: Collected throughout the arboviral season (June-October) from all counties in which surveillance occurred.
Control concerns: Thought to be an important bridge vector (able to transmit virus from a bird to a mammal) of EEE and possibly WNV. At warm temperatures (i.e., 77F), larval development is rapid, 4-6 days, followed by a short pupal stage (2 days); this process is longer at cooler temperatures. Hence, the window for effective larval/pupal control is narrow.

Anopheles punctipennis

Larval habitat: Confined bodies of water with aquatic vegetative edges and artificial containers. There are several generations per year.
Overwintering stage: Adult.
Host preference: Birds and Mammals. Major summer pest.
Biting times: Dusk to dawn and daytime. Adults rest in shaded areas and will bite if disturbed.
Flight range: 1 to 2 miles.
Virus isolations: New Hampshire WNV. WNV Isolations have been found in other northeastern states.
Maine surveillance: Collected throughout the arboviral season (June-October) from all counties in which surveillance occurred.

Anopheles walkeri

Larval habitat: Confined bodies of water with aquatic vegetative edges. There are several generations per year.
Overwintering stage: Egg.
Host preference: Mammals.
Biting times: Dusk to dawn and daytime. Adults rest in shaded areas and will bite if disturbed.
Flight range: 1 to 2 miles.
Virus isolations: New Hampshire WNV.
Maine surveillance: Collected throughout the arboviral season (June-October) from all counties in which surveillance occurred. Usually collected during spring and early summer.

Coquillettidia perturbans

Larval Habitat: Permanent bodies of water with muddy substrates and abundant emergent vegetation (e.g., cattails). This species has only one generation per year.
Overwintering stage: Larvae.
Host preference: Birds and mammals. This species readily enters houses and bites humans.
Biting times: Adults readily bite humans in the early morning, at dusk, and in the evening. Adults rest in shaded vegetation during the day and will bite if disturbed.
Flight range: 1-5 miles.
Virus isolations: New Hampshire EEE. EEE and WNV isolations have been found in other northeastern states.
Maine Surveillance: Collected throughout the arboviral season (June-October) from all counties in which surveillance occurred.
Control concerns: This species is an important bridge vector of EEE. Larvae and pupae obtain air by attaching themselves to the roots and stems of emergent plants. When disturbed, they detach and burrow in the mud making them difficult to monitor and control. Larvicides, such as *Bti* and Temephos, might not satisfactorily control this species.

Culex pipiens

Larval habitat: Artificial containers (e.g., catch basins, flower pots, discarded tires) and stagnant, temporary pools with a high organic content. There are several generations per year.
Overwintering stage: Adults overwinter in damp, protected human-made structures.
Host preference: Birds and occasionally mammals.
Biting times: From dusk to dawn. Adults can be found during the day in dark, damp shelters.
Flight range: ¼ - ½ mile.
Virus isolations: Maine EEE and WNV, New Hampshire EEE and WNV. Isolations have been found in other northeastern states.
Maine surveillance: Collected throughout the arboviral season (June-October) from all counties in which surveillance occurred.
Control concerns: This species is an important primary vector for WNV, amplifying WNV in the bird population.

Culex restuans

Larval habitat: Natural and artificial containers (e.g., tree holes, catch basins), woodland and temporary pools. There are several generations per year.
Overwintering stage: Adults overwinter in well-protected natural and manmade enclosures.
Host preference: Birds and occasionally mammals, including humans.
Biting times: Dusk to dawn.
Flight range: 1-2 miles.
Virus isolations: Maine WNV, New Hampshire EEE and WNV. Isolations have been found in other northeastern states.
Maine surveillance: Collected throughout the arboviral season (June-October) from all counties in which surveillance occurred.
Control concerns: This species is an important primary vector for WNV, amplifying WNV in the bird population.

Culex salinarius

Larval habitat: Brackish salt marshes and freshwater wetlands; occasionally collected from artificial containers (e.g., catch basins, discarded tires). There are several generations per year.
Overwintering stage: Adults overwinter in natural and man-made structures.
Host preference: Birds, mammals, reptiles, and amphibians. Adults readily attack humans, often entering houses.
Biting times: Dusk to dawn. Adults can be found during the day in cool, shaded sites.
Flight range: ¼ - 5 miles.
Virus isolations: New Hampshire EEE and WNV. Isolations have been found in other northeastern states.
Maine surveillance: Collected throughout the arboviral season (June-October).
Control concerns: This species is thought to be a bridge vector for EEE and possibly WNV.

Culiseta inornata

Larval habitat: Wooded snowmelt pools, marshes, bogs, swamps. There are several generations per year.
Overwintering stage: Adult
Host preference: Mammals (humans).
Biting times: Dusk to dawn.
Virus isolations: Maine EEE. EEE and WNV isolations have been found in other states.
Maine surveillance: Collected throughout the arboviral season (June-October) in southern coastal areas.

Culiseta melanura

Larval habitat: Underground aquatic crypts or sheltered bodies of water among tree roots in acidic Red maple and Atlantic White Cedar swamps. There are several generations per year.
Overwintering stage: Larvae.
Host preference: Almost exclusively birds, rarely mammals (humans).
Biting times: Dusk to dawn.
Flight range: Sources vary from ½ - 5 miles.
Virus isolations: Maine and New Hampshire both EEE and WNV. Isolations have been found in other northeastern states.
Maine surveillance: Collected throughout the arboviral season (June-October) from all counties in which surveillance occurred.
Control concerns: *Culiseta melanura* is an important primary vector for EEE, amplifying EEE in the bird population. There may be multiple adult emergence peaks during the season, depending on temperature and rainfall conditions. Crypts where larvae develop are not interconnected and often have only small openings making them difficult to treat.

Culiseta morsitans

Larval habitat: Permanent and semi-permanent bogs, swamps, tree root cavities, and boggy margins of lakes. One generation per year.
Overwintering stage: Egg.
Host preference: Almost exclusively birds, rarely mammals (humans).
Virus isolations: New Hampshire EEE. EEE and WNV isolations have been found in other northeastern states.
Maine surveillance: Collected throughout the arboviral season (June-October) from all counties in which surveillance occurred.
Control concerns: This species can be an important primary vector for EEE, amplifying EEE in the bird population.

Ochlerotatus canadensis

Larval habitat: Temporary leaf-lined woodland pools, drainage ditches, and freshwater swamps. It has one large generation in late spring, and then a partial second generation in late summer, depending on the amount of rainfall.

Overwintering stage: Egg.
Host preference: Mammals, birds, reptiles, and amphibians. Adults readily bite humans.
Biting times: Dusk to dawn. Adults rest in shaded areas and will bite if disturbed.
Flight range: Up to ¼ mile.
Virus isolations: Maine WNV, New Hampshire EEE and WNV. Isolations have been found in other northeastern states.
Maine surveillance: Collected throughout the arboviral season (June-October) from all counties in which surveillance occurred.
Control concerns: Possibly a bridge vector for EEE, especially during intense viral activity. Control of this species is difficult because the water bodies in which it breeds are isolated from each other.

Ochlerotatus cantator

Larval habitat: Temporary saline and brackish pools in coastal salt marshes. There are several generations per year.
Overwintering stage: Egg.
Host preference: Mammals (humans), birds.
Biting times: Dusk to dawn and during the day. Adults rest on vegetation during the day and will actively bite if disturbed.
Flight range: 5-40 miles.
Virus isolations: Maine WNV. EEE and WNV isolations have been found in other northeastern states.
Maine surveillance: Collected throughout the arboviral season (June-October).
Control concerns: This species may be a bridge vector of EEE and WNV.

Ochlerotatus japonicus

Larval habitat: Natural and artificial containers including tree holes, catch basins, bird baths, and discarded tires. There are several generations per year.
Overwintering stage: Egg.
Host preference: Birds and mammals.
Biting times: Dusk through dawn and during the day.
Flight range: Less than 1 mile.
Virus isolation in Maine: Maine and New Hampshire WNV. EEE and WNV isolations have been found in other northeastern states.
Maine surveillance: Collected throughout the arboviral season (June-October) from all counties in which surveillance occurred.
Control concerns: This species may be a bridge vector of EEE and WNV. As this species is relatively new to New England, better guidance will be provided pending accumulation of more information about its role in EEE and WNV transmission.

Ochlerotatus sollicitans

Larval habitat: Temporary saline pools in coastal salt marshes. There are several generations per year.

Overwintering stage: Egg.
Host preference: Almost exclusively mammals, rarely birds.
Biting times: Dusk to dawn and during the day. Adults rest on vegetation during the day but will bite if disturbed.
Flight range: 5-40 miles.
Virus isolations: Maine WNV. WNV isolations have been found in other northeastern states.
Maine surveillance: Collected throughout the arboviral season (June-October).
Control concerns: This species may be a bridge vector for EEE.

Ochlerotatus triseriatus

Larval habitat: Tree holes, catch basins, tires, buckets, gutters, other natural and artificial containers. There is one generation per year.
Overwintering stage: Egg.
Host preference: Mammals, birds and reptiles.
Biting times: Dusk to dawn. Adults rest on vegetation and containers during the day but will bite if disturbed.
Flight range: ½ to 1 mile.
Virus isolations: New Hampshire EEE and WNV. Isolations have been found in other northeastern states.
Maine surveillance: Collected throughout the arboviral season (June-October).

Psorophora ferox

Larval habitat: Wooded temporary ground pools, flood-water areas. There is one generation per year.
Overwintering stage: Egg.
Host preference: Mammals (humans).
Biting times: Dusk to dawn. Adults rest on vegetation in wooded areas during the day and will bite if disturbed.
Flight range: Up to 1 mile.
Virus isolations: New Hampshire EEE. EEE and WNV isolations have been found in other northeastern states.
Maine surveillance: Collected throughout the arboviral season (July-October).

Appendix II

Mosquito Testing at Maine Department of Health and Human Services, 2013

Please find below information pertaining to mosquito testing through Maine's Health and Environmental Testing Laboratory (HETL) during 2012. Mosquitoes will be tested for Eastern Equine Encephalitis (EEE) virus and West Nile virus (WNV).

1. Mosquito pools may contain a maximum of 50 mosquitoes. Please be careful not to exceed the 50-mosquito pool size, as there may not be remaining space for adding the necessary reagents. HETL will REJECT for testing any pools that they cannot process due to excessive pool size. These pools will be held at HETL.

2. Please be sure to include detailed information on trap location. Trap location may be used for GIS mapping as well as analyzing location-specific changes over time. Both uses require detailed address information to ensure consistent results and tracking.

3. The mosquito season will begin on July 1, 2013 and go through October 1, 2013. Testing will be performed in the following manner:

a. Phase I - July 1 through October 1, 2013 or first Maine EEE or WNV detection (dates pertain to date of collection):

i. *Cs. melanura, Cx. pipiens, Cx. restuans,* and *Cx. pipiens/restuans:* Only these species will be tested. Any pool size may be submitted for testing but pool size cannot exceed 50 mosquitoes. As soon as EEE or WNV is detected in Maine, mosquito submissions will follow phase II.

ii. Other mosquito species: During the mosquito season, please discard (or hold internally if interested) any mosquitoes that are not *Cs. melanura, Cx. pipiens, Cx. restuans,* or *Cx. pipiens/restuans*. Other mosquito species may be tested on a case by case basis, as resources and time allow. As soon as EEE or WNV is detected in Maine, mosquito submissions will follow phase II.

b. Phase II - First Maine EEE or WNV detection through October 1, 2013 (dates pertain to date of collection):

i. If presence of either EEE or WNV detected in Maine, the testing criteria will be reevaluated and additional species may be tested.

ii. Other mosquito pools not meeting the above criteria: Other mosquito species may be tested on a case by case basis, as resources and time allow. Otherwise, please discard (or hold internally if interested) any mosquitoes that do not meet the above criteria.

RESOURCES

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The Commonwealth of Massachusetts Department of Food and Agriculture. 1998. Generic Environmental Impact Report (GEIR) for the Massachusetts Mosquito Control Projects, available at: http://www.mass.gov/agr/mosquito/geir_docs/GEIR_FULL_TEXT.pdf

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Maine Vector-borne Work Group

Chair: Stephen Sears, Maine Center for Disease Control and Prevention (Maine CDC)

Adams, Justin	Municipal Pest Management
Aherne, Jim	Maine Organic Farmers and Gardeners Association
Campbell, Polly	Nurse, Augusta, Maine
Camuso, Judy	Maine Department of Inland Fisheries and Wildlife
Dill, Jim	Maine Cooperative Extension
Donahue, Charlene	Maine Forest Service
Dube, Nancy	Maine Department of Education
Elias, Susan	Maine Medical Center Research Institute
Fish, Gary	Maine Board of Pesticides Control
Forbes, John	United States Department of Agriculture Wildlife Services
Foss, Kimberly	Municipal Pest Management
Hicks, Lebelle	Maine Board of Pesticides Control
Jennings, Henry	Maine Board of Pesticides Control
Juris, Sherrie	Atlantic Pest Solutions
Kantar, Lee	Maine Department of Inland Fisheries and Wildlife
Keenan, Patrick	Biodiversity Research Institute
Kirby, Clay	Maine Cooperative Extension
Lacombe, Eleanor	Maine Medical Center Research Institute
Lichtenwalner, Anne	University of Maine, Animal Health Laboratory
Lubelczyk, Charles	Maine Medical Center Research Institute
McCutchan, Thomas	Maine Insectary Services
McEvoy, Elizabeth O.	Maine Department of Agriculture, Conservation, and Forestry
Morrison, Mike	Municipal Pest Management
Murray, Kathy	Maine Department of Agriculture, Conservation, and Forestry
Pote, Ken	Maine CDC
Rand, Peter	Maine Medical Center Research Institute
Ravana, Kyle	Maine Department of Inland Fisheries and Wildlife
Ridky, Chip	United States Department of Agriculture
Robinson, Sara	Maine CDC
Saunders, Megan	Maine CDC
St. Amand, Ted	Atlantic Pest Solutions
Sites, Anne	Maine CDC
Smith, Rob	Maine Medical Center Research Institute
Storch, Dick	University of Maine, Environmental Services
Stratton, Robert D.	Maine Department of Inland Fisheries and Wildlife
Struble, Dave	Maine Forest Service
Sullivan, Kelsey	Maine Department of Inland Fisheries and Wildlife
Szantyr, Beatrice	Physician, Lincoln, Maine
Tsomides, Leon	Maine Department of Environmental Protection
Walsh, Michele	Maine Department of Agriculture, Conservation, and Forestry
Webber, Lori	Maine CDC

APPENDIX 5:

A RAPID HEALTH IMPACT ASSESSMENT ON THE HUMAN HEALTH RISKS OF EMERGENCY ADULTICIDING USING PYRETHROID INSECTICIDES FOR THE PREVENTION OF MOSQUITO-BORNE DISEASES IN MAINE

A Rapid Health Impact Assessment on the Human Health Risks of Emergency Adulticiding Using Pyrethroid Insecticides for the Prevention of Mosquito-borne Diseases in Maine

Megan Saunders, MSPH
Maine Center for Disease Control and Prevention (Maine CDC)
University of Southern Maine (USM)

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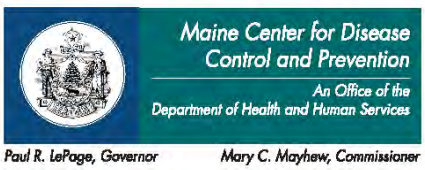

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List of Abbreviations:

BPC	Board of Pesticides Control
CDC	Center(s) for Disease Control and Prevention
DHHS	Department of Health and Human Services
DACF	Department of Agriculture, Conservation and Forestry
ED	Emergency departments
EEE	Eastern equine encephalitis
EPA	Environmental Protection Agency
HIA	Health Impact Assessment
PBO	Piperonyl butoxide
ULV	Ultra-low volume
US	United States
WNV	West Nile virus

Executive Summary

L. D. 292

In 2013, Maine's Department of Agriculture, Conservation and Forestry introduced a bill to the 126th Maine State Legislature entitled "An act to protect the public health from mosquito-borne diseases." The bill was put to resolve, directing the Department of Agriculture, Conservation and Forestry to develop a plan for the protection of the public health from mosquito-borne diseases. This resolve allowed for an opportunity to examine the health effects of the policy, specifically the human health risks associated with the insecticides used in emergency mosquito-control operations.

Methodology

The study employed the steps of Health Impact Assessment (HIA) as outlined by the United States Centers for Disease Control and Prevention. HIA is used to examine the health effects that may be associated with specific policies and to help promote decisions based on the actions that are most beneficial for human health[1]. This HIA was performed in a rapid format, which employed a literature review as its main information gathering technique.

Main Findings

In the event that all other options for mosquito control have been exhausted when confronted with a mosquito-borne public health emergency, it would be beneficial for human health to perform aerial insecticide applications in designated high-risk areas. The pesticides that would be used, specifically synthetic pyrethroids, do not appear to have any significant risk to human health when applied using the recommended concentrations. Should emergency mosquito-control applications commence, communications to the public should be focused on avoiding exposures to the insecticides and monitoring for adverse health effects associated with applications should be monitored by Maine CDC.

I. Introduction

Health Impact Assessment (HIA) is a tool used to help objectively evaluate the potential health effects of a project or policy before it is implemented. The goal of HIA is to provide guidance to policy makers on the decisions that may be made so as to promote outcomes that are beneficial to a population's health[1]. HIA also helps to identify appropriate actions to manage said health effects[2]. The purpose of this HIA is to address one of the health impacts related to the resolve of L. D. 292, directing the Department of Agriculture, Conservation and Forestry (DACF) to develop a plan for the protection of the public health from mosquito-borne diseases (Appendix A). The resolve directs the DACF to consider integrated pest management (IPM) strategies that minimize the risks of pesticide use to humans and the environment; however one of the strongest oppositions to the original bill was that emergency pesticide use would pose significant health risks to the population of Maine. Maine Center for Disease Control and Prevention (Maine CDC) became involved with the lawmaking process, along with DACF and the Maine Board of Pesticides Control (Maine BPC), for the reason that it performs surveillance for arboviral diseases, such as Eastern equine encephalitis (EEE) and West Nile virus (WNV), in the state. Maine CDC would be the agency advising the Commissioner of Health and Human Services to declare a state of public health emergency, allowing for emergency response to an arboviral threat – including the use of emergency adulticiding (the process of using aerial pesticide applications to control adult mosquito populations). This HIA addresses the possible human health risks associated with pesticide exposures from mosquito-control operations.

II. Methods

A. Health Impact Assessments

The conduction of a HIA typically consists of 5 major steps[1, 3, 4]:

- Screening – identifying plans, projects or policies for which a HIA would be useful.
- Scoping – identifying which health effects to consider.
- Assessment – using available resources to judge the magnitude and direction of potential health impacts.
- Reporting – presenting results to stakeholders and decision-makers.
- Monitoring – Tracking the effects of the HIA and decisions on the policy involved.

This report will cover the first four steps of the HIA (screening, scoping, assessment, and reporting). Monitoring will occur following the completion of this report.

B. Screening

In 2012, Maine experienced its first case of locally acquired WNV neruoinvasive disease in a Maine resident, as well as having multiple mosquito pools test positive for WNV and a flock of pheasants test positive for EEE[5]. This made 2012 the most active arboviral year in Maine since 2009 when the state experienced a large scale EEE outbreak which killed numerous horses, pheasants and a llama[6]. In response to the increased arboviral activity Maine BPC (an agency within the Maine DACF) realized that currently Maine is unprepared to respond to a mosquito-borne disease threat and proposed a bill entitled "An Act to Protect the Public Health from Mosquito-borne Diseases" (L.D. 292). This bill proposed changes to the duties of the Commissioner of Agriculture, Conservation and Forestry, including studying, planning, and arranging cooperation related to mosquito-control operations in conjunction with appropriate personnel from the Department of Health and Human Services (DHHS), assisting with disseminating information, and implementing mosquito-control response in the event that the Commissioner of Health and Human Services declares a mosquito-borne disease public health threat. Maine CDC is the agency within DHHS that performs mosquito-borne disease surveillance and members of the Division of Infectious Disease would be the personnel advising the Commissioner of Health and Human Services that a public health threat is imminent. The initial bill was put to resolve (Appendix B), asking members from the DACF to convene and develop a physical plan to protect the public health from mosquito-borne diseases, in cooperation with appropriate personnel from DHHS. Many potential health impacts of the plan were discussed within the Maine State Legislature's Committee on Agriculture, Conservation and Forestry and following the sessions it was decided that there was potential for a HIA to be conducted related to the resolve of L.D. 292.

C. Key Stakeholders

The key stakeholders in this HIA are as follows:

- Maine DACF
    - Maine BPC
- Maine DHHS
    - Maine CDC
- The 126th Maine State Legislature
    - Representing the public interest

D. Scoping

The HIA was scoped using a policy pathway to outline the direct impacts and the intermediate and health outcomes related to the policy (Appendix C). This pathway was then focused on a specific statement indicating that the proposed methods examined in the plan "must include IPM techniques and other science-based technology that minimize the risks of pesticide use to humans" (Appendix D). This was then further refined to look at a specific health outcome: the potential for acute human health risks due to pesticide exposure (Appendix E). Other health outcomes were considered; however during the public hearings and work sessions that occurred related to L.D. 292 it was noted that human health risks due to pesticide exposures were the health outcomes of most concern to the population.

Following the choice of the health outcome to be examined by the HIA, it was decided that the best form of HIA to be applied would be the rapid HIA. The methodology for the HIA was decided to be in the form of a literature review.

After discussion with Maine BPC, and examination of current public health mosquito control practices in New England, it was determined that in the event of a public health threat requiring aerial pesticide applications, that a class of pesticides known as pyrethroids would be the logical products to use in a public health response. Pyrethroids are synthetic chemical insecticides that are widely used for controlling various insects. Some examples of synthetic pyrethroids commonly used in mosquito control operations are permethrin, resmethrin, and d-phenothrin (Sumithrin®), and are usually mixed with a synergist such as piperonyl butoxide (PBO) which enhances the effects of the pyrethroids[7]. The products that would be considered by Maine BPC for use in a public health threat or emergency are Anvil ®,10+10 (Sumithrin® + PBO) which is currently registered in Maine, or Duet® (Sumithrin®+ prallethrin + PBO) which is currently not registered in Maine. Based on the choice of insecticides that would be used in response to a mosquito-borne public health threat or emergency, the literature review was focused on studies done on pyrethroids and mosquito control operations in the United States, as well as risk assessments for pyrethroids. The logic behind this decision is based on the fact that outside of the United States, some pyrethroids are used in malaria control operations, whose methods differ from those used for domestic arboviral control programs.

E. Literature Review

Systematic literature searches were undertaken using PubMed, a biomedical literature search engine powered by the US National Library of Medicine and the National Institutes of Health. Multiple word combinations were searched to ensure that the literature was fairly represented. The following combinations were used:

- Aerial mosquito spraying USA human health
- D-phenothrin human health
- Emergency mosquito spraying
- Human health risks pesticide application mosquito control
- Aerial pesticide application West Nile virus
- ULV pyrethroid exposures
- Human health risks WNV insecticides
- Mosquito control pyrethrin human health risks
- Aerial spraying for mosquitoes

Following each search, the articles were reviewed to ensure that only the relevant literature was included in the final literature compilation. The results were also restricted to English language articles.

Sixteen review articles formed the final literature base for the rapid HIA assessing the human health risks of emergency adulticiding for the prevention of mosquito-borne diseases. Of these, twelve were considered highly relevant and four were considered moderately relevant. The moderately relevant articles discussed risk tradeoffs between mosquito-borne disease and pesticide exposures[8, 9], organophosphates exposures and aerial mosquito control operations[10], and health effects associated with chronic pesticide exposures due to agriculture and mosquito control operations [11]. The highly relevant articles discussed acute health effects of pyrethroid insecticides used in mosquito-control[12-23].

III. Results

A. Media and Risk Perception

Since the early 1900s, United States communities and governments have organized mosquito-control programs to protect the public from the vectors that spread diseases such as EEE and WNV. These control programs include surveillance activities, source reduction, larval control strategies and both ground and aerial applications of insecticides to control adult mosquitoes[24]. When WNV emerged in the United States in 1999[25], the relative risks of illness versus insecticide use were introduced into the public eye[8, 9]. During the first year of the outbreak, the risk of WNV to human health was viewed as a higher risk than the use of pesticides; however during the second year of the outbreak the media shifted their interest to the potentially harmful effects of pesticides[8]. The print media was able to influence the public's viewpoint on risk through the use of qualitative statements regarding mortality and morbidity for both WNV and pesticide use[9]. The more accurate and quantitative the information presented by the press, the better the public is prepared to make informed decisions regarding the risks associated with mosquito-borne diseases and pesticide use[9].

B. Pyrethroid Insecticides and Application Methods

Insecticides used to control adult mosquitoes are known as adulticides. The United States Environmental Protection Agency (US EPA) is in charge of registering different products for this use[26]. Two common groups of adulticides used to control mosquitoes during disease outbreaks or epidemics are organophosphates and pyrethroids[8, 9, 10, 11, 12, 15, 16, 17, 26]. There are both organophosphate and pyrethroid insecticides registered for use in Maine[27]; however based on current nationwide practices, in the event of a mosquito-borne disease outbreak a pyrethroid control product (specifically d-phenothrin (sumithrin®))would be used[7]. Pyrethroid insecticides are synthetic versions of a naturally occurring pesticide known as pyrethrin, which naturally occurs in chrysanthemums[7, 28]. Sumithrin® is registered to control mosquitoes over both agricultural and non-agricultural areas[7]. These insecticides are applied by a process known as ultra-low volume (ULV) sprays. ULV applications are performed either by truck mounted sprayers or by aircraft, and dispense very fine aerosolized droplets that stay aloft and kill flying mosquitoes on contact[7, 28]. These applications also use very small concentrations of the insecticide compared to the size of the area being treated to reduce risks to both people and the environment[28]. The US EPA conducts risk assessments for all pesticides that they register. In these risk assessments they use very conservative estimates of concentrations. Based on the most recent risk assessment for pyrethrins and pyrethroids, it was determined that the cumulative risks from existing pyrethroid uses are below the US EPA's level of concern[29]. Similarly, according the United States Centers for Disease Control and prevention (US CDC), aggressive and timely use of adulticides will reduce the incidence of human disease and assist in reducing the abundance of disease vectors[19, 30].

C. Health Effects of Pyrethroid Insecticides

Pesticides and their effects on health and the environment have been topics of public concern since Rachel Carson published *Silent Spring* in 1962. The book addressed the organochlorine pesticide DDT which had severe repercussions to human health and negative environmental impacts, which led to its use being discontinued in the United States[31]. Other pesticides with fewer health effects and environmental effects, such as organophosphates and pyrethroids, are now used in mosquito control operations in the United States[26]. The use of pyrethroids has increased over the past decade with the declining use of organophosphate pesticides, which are more acutely toxic to birds and mammals than the pyrethroids[32]. When used according to the specifications listed on their labels, pyrethroids pose minimal risks to humans and the environment[7].

As the use of pesticides and their human health effects are a continued topic of interest in today's society, especially with persistent WNV transmission in the United States, a number of risk assessments have been performed to investigate the potential for acute health effects due to the use of insecticides in mosquito control operations[17, 19, 20]. In 2005, Peterson et al. performed a human health risk assessment that looked at the effects of insecticides used in mosquito management and the effects of WNV on human health. Using conservative assumptions for exposures, it was determined that none of the concentrations of active ingredients used in ULV applications from truck mounted sprayers exceeded the acceptable daily exposure limits for both acute and subchronic exposures[17]. The lowest acute and lowest subchronic risk quotients were to phenothrin for both adults and infants, meaning that the calculated potential exposures did not exceed or equal the acceptable daily exposure limits for the active ingredients involved. Similarly, with the conservative estimates for their models, actual exposures to the adulticides distributed by ULV methods would likely be less than the calculated risks[17]. In another study evaluating the efficacy and human health risks of aerial ULV applications of pyrethrins and PBO, it was shown that the risk quotients for one truck mounted ULV application are approximately ten times greater than those estimated for three aerial ULV applications, in part because pesticide deposition on the ground is lower after aerial ULV applications compared to truck applications[20]. Overall the risk assessments both show that acute human health risks from exposures to pyrethroids are below the US EPA's levels of concern, so the benefits of the pesticide applications likely exceed the risks. The risk of infection with a mosquito-borne disease was also determined to be greater than the health risks associated with ULV insecticide applications[17, 20]. In a study based out of Sacramento, California it was determined that without aerial ULV adulticide applications, it was likely that more residents would have been infected with WNV – thus the applications prevented increased mortality and morbidity associated with the mosquito-borne illness[19].

Exposures to high concentrations of pyrethroids are known to have acute effects on the dermal, gastrointestinal, and nervous systems[7, 12, 18, 22, 33]; however the public concern for respiratory effects such as asthma exacerbation due to mosquito control operations has increased since the introduction of WNV to the United States[14, 34]. A number of studies have been conducted looking at acute insecticide related illness associated with mosquito control operations[12, 14, 15, 16, 22, 23]. In a study looking at nine states with pesticide poisoning surveillance programs, the majority of persons identified with acute

pesticide related illness had low to moderate illness severity associated with either respiratory or neurologic dysfunction. Out of the 133 cases identified from 1999 to 2002, 37 of the cases were reported as being associated with pyrethroid exposures, while the majority of the remaining cases were associated with organophosphate exposures. Overall, the study showed that the risks of acute pesticide-related illnesses associated with mosquito control operations was low for persons living in areas where the insecticides were applied[12]. In another study looking at the effects of large scale ULV applications of various pesticides used in emergency mosquito-control operations in Mississippi, North Carolina, and Virginia, health officials looked at urine pesticide metabolite concentrations to see if persons with exposures had higher concentrations. The findings indicated that the ULV applications of mosquito control products did not lead to increased urine pesticide metabolite concentrations, and therefore did not contribute to substantial or increased human pesticide exposures[15].

Multiple studies have been conducted looking at ULV mosquito control applications and emergency department (ED) visits[14, 16, 22, 23]. Two studies looked at the effects of pesticide spraying on ED asthma visits in New York City as part of the WNV virus response in 1999[16] and 2000[14]. Both studies looked at the rates of visits for asthma on days with spray events and days without spray events, and found that there was no increase in ED visit rates for asthma[14, 16]. The study in looking at the rates of ED asthma visits in 1999 also found that there was no increase in the severity of asthma seen in the ED post pesticide application[16]. These studies suggest that respiratory effects of ULV pyrethroid applications are minimal. A recent study out of California examined the correlation between aerial ULV pyrethrin applications and ED visits in Sacramento, and found that exposures to aerially applied insecticides was not associated with clusters of respiratory, gastrointestinal, skin, eye, or neurologic complaints in the ED[22]. In a study describing the 2012 WNV epidemic in Dallas, Texas, the daily incidence of ED visits for skin rashes and acute respiratory distress was analyzed for a two month period encompassing the month prior to and week following an eight day aerial insecticide treatment period. There was not an upward shift in visits on or following the application days and it was found that aerial pyrethroid applications were not associated with increases in ED visits for asthma or skin rash[23]. Similarly, following an increase in concern over respiratory effects of pyrethrins and pyrethroids the US EPA conducted a review of the registered products to identify any emerging trends associated with these products. They found that there does not appear to be any clear association between pyrethrin and pyrethroid exposures and allergic or asthma responses[34].

The volume of literature examining other health effects of pyrethroid insecticides is significantly sparser; however three articles examining dermal exposures[21], dietary risks[18], and hormonal effects[13] of pyrethroid insecticides were found in the review. In a study examining dermal exposures due to ULV applications for mosquito control, it was found that, similar to the results of other risk assessments[17, 20], the estimated exposures were below the regulatory levels of concern posing little risk to human health[21]. Mosquito-control products may be applied over agricultural crops in the event of a mosquito-borne disease outbreak, which may increase the possibility of ingesting pesticide products. A dietary risk assessment for resmethrin was conducted to explore dietary exposures to this pyrethroid in 2006[18]. It was found that the likelihood of detectable pesticide residues on crops due to aerial mosquito-control applications would be low, especially when compared to residues left in the environment due to

traditional agricultural application practices[18]. The investigators also calculated margins of safety from possible reproductive and/or teratogenic effects due to acute dietary exposures to resmethrin using results from animal toxicity studies and found that the margins of safety for all age groups were adequate to protect human health[18]. Finally, there have been concerns of pyrethroids having effects on the endocrine system[8, 13]. In a study that examined *d*-phenothrin's (sumithrin®) effects on estrogenic and (anti-) androgenic activities, it was found that *d*-phenothrin exhibits no adverse estrogenic or (anti-) androgenic effects, implying that exposures to this pyrethroid pose little risk for endocrine disruption[13]. Finally, in a long term exposure study looking at chronic exposures to agricultural pesticides, it was found that there was weak evidence of increased risk for breast cancer associated with less persistent current-use pesticides, but the association could be due to chance[11]. There was also a lack of a persistent pattern observed in odds ratios for proximity to mosquito control operations and breast cancer risk[11]. The less persistent current-use pesticides were defined as those which were not persistent organochlorines and applied after 1975; therefore they could include organophosphates, pyrethroids, or other pesticide categories[11].

IV. Conclusions and Recommendations

The literature consistently shows that when used at recommended concentrations for ULV applications, pyrethroid insecticides pose very low risks to human health. It also shows that when applied aerially, the risk to human health is lower than when applied by truck mounted sprayers. The products that have been suggested for use in Maine by the Maine BPC in the case of a mosquito-borne public health emergency have active ingredients that are the least acutely toxic of the pyrethroids (d-phenothrin (sumithrin®), further reducing the potential risk for adverse human health effects due to pesticide exposures. Finally, in epidemic arboviral transmission settings, it has been consistently determined that the risk to human health from mosquito-borne diseases is greater than the risk of acute pesticide poisoning.

In the event of aerial mosquito-control applications becoming necessary in Maine there are a number of ways to help reduce the public's risk of exposure to the insecticides used in these operations. Applications should be timed to minimize the public's contact with the insecticides. Communication to the public about the operations needs to be the performing agencies' first priority. The agencies should notify the public about when, where and why the insecticides will be applied and how to reduce the likelihood of exposures in a timely manner. Efforts should be made to ensure that the information reaches everyone in the spray zone, and multiple methods of communication should be utilized including print, radio, and television. An informational hotline might be a useful tool to provide information to the public about their concerns, should applications be required. The hotline should be a joint effort between Maine CDC and Maine BPC.

Following any large-scale mosquito-control applications, Maine CDC should implement a system to monitor for any adverse health effects related to insecticide exposures. Currently, very few states have state-monitored pesticide poisoning surveillance systems[12], and Maine currently does not have a system in place. Two potential ways of monitoring for increased pesticide poisoning events following public health mosquito-control operations would be to either use the Northern New England Poison Center (NNEPC)'s call system or using Maine CDC's syndromic surveillance system. If the NNEPC were to be used, a baseline for numbers of calls related to acute pesticide poisoning would need to be established prior to the applications. Any calls on the night of the pesticide application and day following the application received by NNEPC should be logged. These calls would then need to be relayed to Maine CDC and Maine BPC to be examined for any deviations from the normal number of calls received by NNEPC. The limitations to this are that it may not distinguish between agricultural, home pesticide exposures and exposures due to mosquito control applications. If a syndromic surveillance system were to be used to monitor adverse health effects associated with pesticides, the first step would be to create a list of chief complaints associated with pesticide poisoning which could then be used to form a syndrome for surveillance purposes. This syndrome could then be monitored through ED's in the areas surrounding the spray area following the applications. Once again, a baseline for the syndrome being examined would need to be determined. One limitation to this monitoring strategy would be that the more non-specific or common the chief complaints used, the less useful the system would be in

identifying adverse health events. Another limitation to this strategy is that currently Maine CDC's syndromic surveillance system does not capture data for all hospitals. If the application event occurred in an area without connected EDs, it would be difficult to monitor for any adverse health events.

In conclusion, in the event of a mosquito-borne public health emergency requiring emergency mosquito-control operations Maine CDC and Maine BPC should work together to reduce human exposures to insecticides, use products that have consistently been found to be at very low risk for human health effects, and monitor for any adverse health effects related to insecticide exposures in the population.

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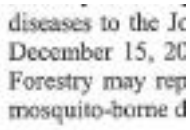
VI. Appendices

Appendix A: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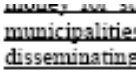
Appendix B:



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Appendix C:

State Mosquito Policy Pathway as Related to L.D. 292

Policy

- **Department of Agriculture, Conservation and Forestry to Develop a Plan for the Protection of the Public Health from Mosquito-borne Diseases (LD 292)**
  - In developing this plan the department shall consider at a minimum, the ecological and economic impacts of proposed methods of controlling mosquitoes and preventing their breeding
  - Proposed methods must include IPM techniques and other science-based technology that minimize the risks of pesticide use to humans and the environment
  - Plan must include criteria for declaring a mosquito-borne disease threat , the elements of a response to such a threat and a description of the lines of authority and responsibilities during a public health threat

Direct Impact

- **Organization of Response Efforts**
- **Description of State's Authority**
- **Coordination of State Organizations' Efforts**
  - Different Agencies' Roles
- **Determination of Mosquito Control Districts**
- **Definition of Trigger for a Mosquito-borne Public Health Emergency**
- **Arboviral Surveillance**
- **Use of IPM strategies**
  - Larviciding
  - Habitat Modification
  - Biocontrol Exploration
  - Emergency Adulticiding

- Signifies a change

Intermediate Outcomes

- **Outdoor activities**
- **Farming practices**
- **Town planning**
- **Air pollution**
- **Invasive species**
- **Mosquito activity & presence**
- **Environmental changes**
  - Water quality
  - Water retention
  - Greenspaces & visual quality
- **Pesticide use**
- **Economic impacts**
  - Agricultural practices
  - Food purchasing & eating habits

- Signifies a change

Health Outcomes

- **Vector-borne disease**
- **Respiratory diseases**
- **Chronic diseases**
- **Pesticide exposures**
  - Respiratory, gastrointestinal, and dermal conditions
- **Physical activity**
- **Mental health**
  - Stress
- **Nutrition**

- Signifies a change

*__Bold__ indicates an encompassing category within the impacts and outcomes

Appendix D:

Health Impact Assessment Focus Pathway as Related to L.D. 292

Policy	Direct Impact	Intermediate Outcomes	Health Outcomes

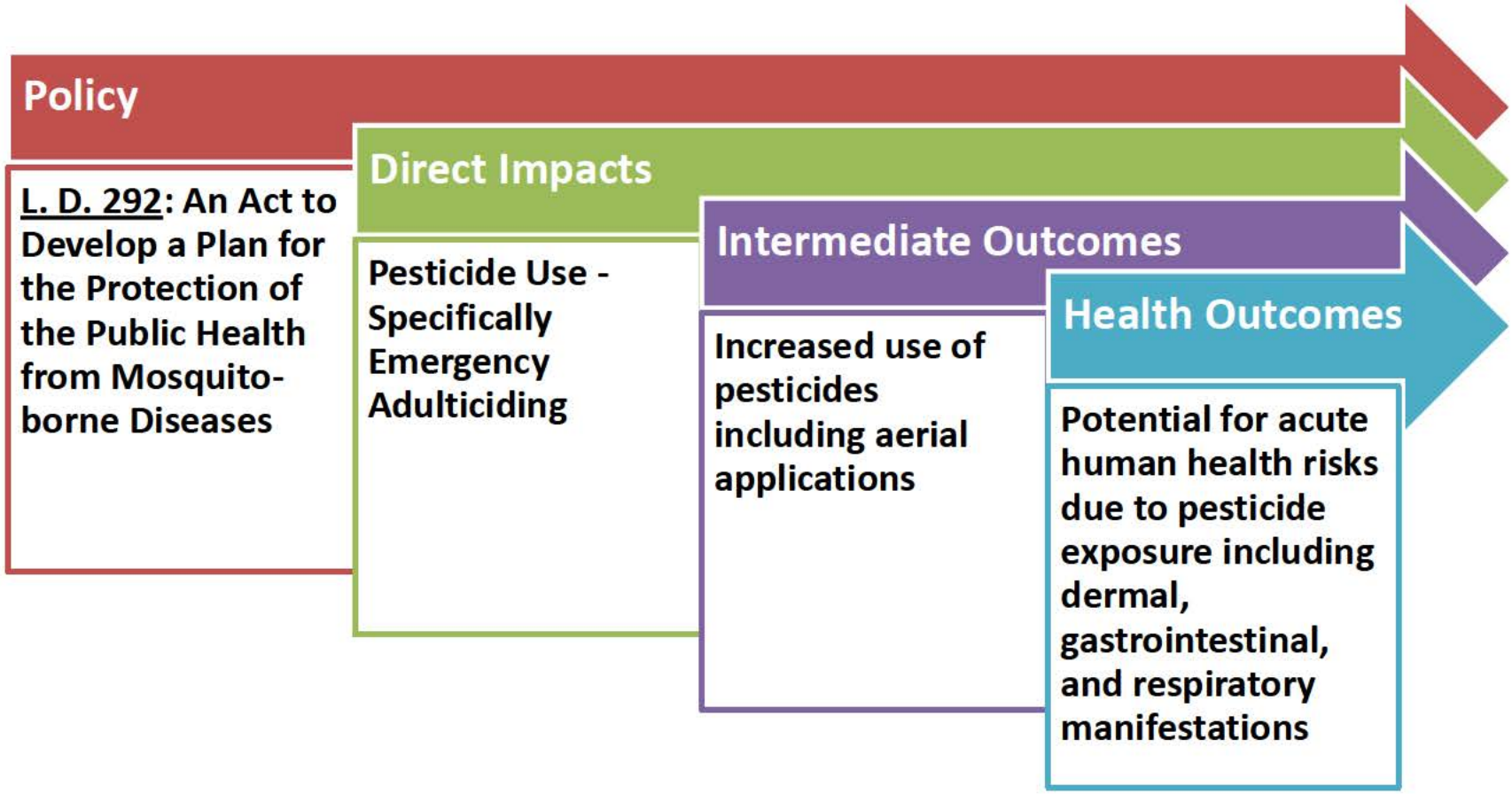
• **Department of Agriculture, Conservation and Forestry to Develop a Plan for the Protection of the Public Health from Mosquito-borne Diseases (LD 292)**
  • Proposed methods must include IPM techniques and other science-based technology that minimize the risks of pesticide use to humans and the environment
	• **Increased use of IPM strategies**
	  • Larviciding
	  • Habitat Modification
	  • Biocontrol
	  • Adulticiding (Use of Pesticides)
	  • Routine
	  • Emergency
		• **Increased use of pesticides**
		  • Aerial applications
		• **Decrease mosquito activity**
		  • Decrease likelihood of EEE & WNV transmission to humans
		• **Decrease presence of mosquitoes**
		  • Decrease likelihood of EEE & WNV transmission to humans
		• **Decreased air quality**
		• **Increased presence of pesticide residue on crops**
			• **Decrease number of human cases of EEE & WNV**
			• **Prevent human cases of EEE & WNV**
			• **Potential for human health risks due to exposure to pesticides**
			  • Acute
			  • Dermal
			  • Gastrointestinal
			  • Respiratory
			  • Chronic

*__Bold__ indicates an encompassing category

**Underlined indicates the topic of interest for the Health Impact Assessment

Appendix E:

Health Determinant Pathway: L. D. 292



APPENDIX 6:

STATUS OF PRODUCTS REGISTERED FOR USE AS WIDE-AREA PUBLIC HEALTH MOSQUITO ADULTICIDES IN MAINE, 2013 and REVIEW OF EPA'S MOST RECENT PUBLIC HEALTH AND ENVIRONMENTAL RISK ASSESSMENTS

Report on the Status of Products Registered for use as Wide Area Public Health Mosquito Adulticides in Maine-2013

And

Summary of EPA's Most Recent Public Health and Environmental Risk Assessments

Lebelle Hicks PhD DABT
Pesticides Toxicologist
Maine Board of Pesticides Control
December 20, 2013

MOSQUITO WIDE AREA PUBLIC HEALTH ADULTICIDES IN MAINE 2013

BACKGROUND

The pesticides registered for use for mosquito control in Maine include:

Adulticides, products which kill adult mosquitoes, ten of which are discussed below

Repellents, products used on human skin, human gear and animals to repel adult mosquitoes

Aquatic larvicides, products added to water at breeding sites to prevent the development of the mosquitoes, these include the biological insecticides, the insect growth regulator methoprene and monomolecular films which mechanically control the larvae

Non-aquatic larvicides, insect growth regulators which are labelled for use indoors, outdoors and on animals

Of the 1,322 products registered for use on mosquitoes in Maine -2013, 1,125 of these products contain at least one adulticide and approximately 30 have specific directions for use in wide area public health uses (NSPIRS 2013). This review is limited to a subset of these products which are registered for use in public health wide area mosquito control projects used to address an outbreak of either Eastern Equine Encephalitis (EEE) or West Nile Virus (WNV). Since the labels are legal documents and are approved by EPA in accordance with their risk assessments, human health and environmental, the label statements limiting the areas of use and specifics of applications go a long way to limiting exposure while providing efficacy in control of adult mosquitoes.

There are two chemical classes of insecticides, pyrethrins-pyrethroids-PBO (including etofenprox, permethrin. piperonyl butoxide (PBO) (synergist), permethrin, phenothrin, prallethrin, pyrethrins and resmethrin) and the organophosphates (chlorpyrifos, malathion and naled). The synergist PBO is found in all but two of the pyrethroid-pyrethrin products and is not in the organophosphate products. A synergist increases the activity of the pyrethroid-pyrethrin insecticides while having no insecticidal efficacy of its own.

HUMAN RISK ASSESSMENT

The human health risks are evaluated by comparing the most sensitive endpoint in lab animals, to expected environmental exposures. The standard measure of human health risk is the 'margin of exposure' (MOE). The MOE is the ratio of the most sensitive toxicity result from the animal study to the expected exposure dose resulting from the use in question. A pesticide product with a higher calculated MOE has a lower risk to humans. EPA has established chemical specific 'levels of concern' (LOC) for short (1 to 7 days) and intermediate (1 to 6 months) term exposures. Risks higher than the LOC are deemed acceptable. Human health risks are evaluated for toddlers for exposure following an application via incidental oral route (putting hands or objects in mouth after playing on grass, or eating grass) and dermal (skin) exposure and inhalation, and for adults via skin and inhalation routes (EPA 2012c).

With regard to the pyrethrins-pyrethroids and piperonyl butoxide (PBO), with the exception of prallethrin (a component of Duet EPA# 1021-1795-8329) the MOE exceed EPA's LOC by approximately ten to over a million times for both aerial and ground applications at the maximum use rate for public health adult mosquito control. EPA has yet to finalize the human health risk assessment for prallethrin. The human health risk associated with the use of these materials is exceedingly low. Mosquito adulticides are applied by ultra-low-volume equipment by air or by ground. For the adulticide products containing pyrethrins-pyrethroids-PBO, risks from aerial applications by ultra-low-volume are lower and efficacy against mosquitoes is better than those made by ground ultra-low-volume.

Given the low risks from exposure to the pyrethrins- pyrethroids-PBO, any could be used in a wide area public health adulticiding program. The phenothrin-PBO containing product, Anvil 10+10 (EPA# 1021-1688-8329) has been used in other states, because of its very low application rate (0.0036lbs ai/A), its low risk to humans, its allowed use over agricultural areas (40 CFR 180.647) and the tolerances in all raw agricultural commodities as a result of mosquito adulticiding.

The three organophosphates, chlorpyrifos, malathion and naled, registered for wide area adult mosquito control have lower margins of exposure (higher risk to people) than do the pyrethrins-pyrethroids-PBO compounds. However, with the exception of chlorpyrifos at 0.01 lb ai/A, the risk of inhalation exposure in both toddlers and adults is higher (the MOE is lower) than EPA's levels of concern for these applications. For air applications of the organophosphate pesticide naled, the calculated risks to toddlers range from 54 times higher than the level of concern for oral exposure to approximately 240 times higher for dermal exposure (EPA 2002a, EPA 2006a). Similar to phenothrin, there is a universal tolerance on agricultural products intended for human consumption for naled residues following wide area mosquito adulticiding applications (40CFR180.215). Among organophosphates, naled and malathion, are considered the lowest risk, effective pesticides and are often used in the southern and mid-western U.S. for wide area mosquito control.

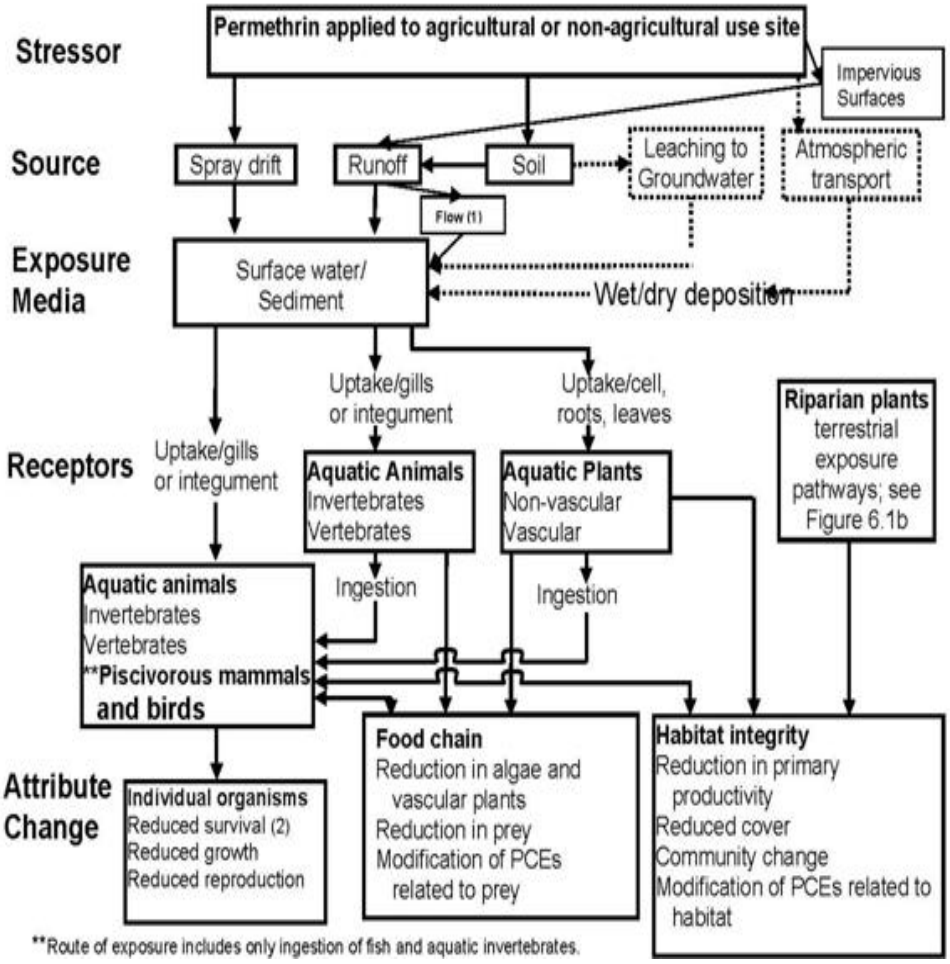
The potential for pesticides to cause an increase in cancer rates in the human population is considered in EPA risk assessments. The cancer potentials for the adulticides are categorized as "not likely" or "no evidence" for phenothrin, and naled, "not likely at low doses" for etofenprox and pyrethrins, suggestive or possible for PBO and malathion, and likely for permethrin and resmethrin (EPA 2012a). However, the cancer risks from exposure to permethrin following ultra-low-volume ULV applications is 3 orders of magnitude (1,000 times) lower than EPA's acceptable risk level of 1 in a million by ground and eleven orders of magnitude lower, when the application is done by air (EPA 2009d). The residential cancer risks following mosquito adulticiding with permethrin both by air and ground are lower than EPA's acceptable risk level 1 in a million (EPA 2006f).

Allergy reactions as a result of insecticide exposure, including asthma exacerbations are difficult to predict. Because of this, the message to the public if a municipal adulticiding application were to occur, would include, persons with allergies, take extra care (stay inside, close windows etc.) to reduce exposure.

Environmental Risk Assessment

Because of the wide variety of ecological niches and species occupying those niches, assessing risks to organisms in the environment is much more complicated (Figure 1) than human health assessments.

Figure 1 Aquatic Conceptual Model of Exposure pathways for Permethrin (EPA 2011h)



Laboratory species are used to determine the critical toxicology value and exposure is estimated using a combination of modeling and environmental sampling. Unlike the human health process, the environmental risks are evaluated using the risk quotient method; estimated environmental concentration divided by the toxicity factor. In this case the lower the risk quotient, the lower the risks. The levels of concern (LOC) used by EPA have been established for acute (short term exposure, LOC = 0.5), chronic (long term exposure, LOC = 1).

Fish and aquatic invertebrates lack the metabolic capability of the mammalian liver and lack the protective barrier found in humans or other mammals, therefore they are generally more sensitive to insecticides. This is reflected in both the toxicity of the insecticides as wells as the risks. Exposure to birds and wild mammals is estimated using the T-REX model (EPA 2012b). The risks to birds and

wild-mammals parallels the risks to humans. Because there was no toxicity seen in the animal studies, EPA did not perform risk assessments for etofenprox (EPA 2009a) and phenothrin (d-phenothrin; Sumithrin[tm]) (EPA 2008f).The other pyrethrins-pyrethroids and PBO risks are within EPA's level of concern of acute and chronic exposures at rates used for mosquito control (EPA 2005g, EPA 2006i, EPA 2006b, EPA 2006d, EPA 2010b, EPA 2011h, EPA 2011i, EPA 2012h, EPA 2012i). The risk quotients for the organophosphates for birds and mammals are generally higher (more risky) than the pyrethrins-pyrethroids-PBO compounds (EPA 2008d, EPA 2008e, EPA 2008g, EPA 2009g) . They are still within EPA's level of concern for acute and chronic exposure.

The data currently in the EPA reviews indicate that the highest risks from ultra-low-volume mosquito adulticiding applications are to freshwater and marine invertebrates living in the water column and to those dwelling in the sediment. The toxicity of the pyrethrins and pyrethroids to sediment dwelling invertebrates is an area of active research. EPA has issued data-call-ins for the pyrethrins and most of the pyrethroids.

EPA's aquatic risk assessments rely on modeling for estimating environmental exposure. The assumptions are for multiple aerial applications 25 to 50 per year with intervals ranging from 1 day (EPA 2011h) to 7 days (EPA 2012h). They also assume that temperature is 85^{o} F and the relative humidity is 90%. Most of the ultra-low-volume mosquito adulticide labels require a temperature of above 50^{o} F. Given the climate in Maine and our relatively short warm season permitting mosquito development, and the fact that EEE and WNV are often not detected in mosquitoes until late in the season, the likelihood of more than one or two applications per year is low.

CONCLUSIONS

Adult mosquito control is only one part of a comprehensive IPM approach that includes education to promote the use of repellents and staying indoors when risk is high, and when possible, eliminating standing water where mosquitoes breed, or treating mosquito breeding habitats with lower risk larvicides. However, the use of adulticides can be a lower risk and necessary means for protecting communities when the risk of WNV or EEE reaches critical levels. When risks of mosquito borne illness are high and mosquito habitat reduction and larval control are infeasible and/or insufficient to reduce adult mosquito populations, aerial or ground-based applications of insecticides are often a necessary component of an integrated mosquito management program (CDC 2003).

The overview of mosquito products and the label review are appended for consultation. The risk assessment information (100+ pages) is compiled and will be made available at your request.

SECTION 1. SCOPE; UNIVERSE OF PESTICIDE PRODUCTS REGISTERED FOR USE ON MOSQUITOES IN MAINE 2013 AND PESTICIDE PRODUCTS LABELED FOR USE AS PUBLIC HEALTH MOSQUITO ADULTICIDES

The 53 active ingredients in the 1,322 products currently registered in Maine with mosquito control on their labels. The active ingredients are summarized in Table 1.1. These products have been grouped as to function: adulticide, aquatic larvicides, insect growth regulators, repellents, and products with multiple uses. When a product has two or more active ingredients in the same group, adulticide, larvicide or repellent, that is consider a single group. For example a product with two pyrethroids would be considered an adulticide, a product with one pyrethroid and an insect growth regulator would be considered a multi-use-product. One thousand one hundred and twenty five of the mosquito products registered in Maine-2013 contain at least one adulticide, 206 products contain at least one insect growth regulator (for purposes this classification products containing methoprene with non-aquatic uses are grouped with the IGRs and aquatic uses are grouped with the aquatic larvicides), 163 contain at least one repellent and 47 are aquatic larvicides. Three hundred and sixty five of these products contain one of two synergists, either PBO (piperonyl butoxide) or MGK 264 (N-Octyl bicycloheptene dicarboximide).

In addition to the active ingredients, pesticide products contain "inert" or "other" ingredients. These ingredients are present to increase the activity of the active ingredient, but they have no pesticidal action against the target pest. A review of the inert ingredients in the public health adulticides, could be undertaken, but was beyond the scope of the current project.

The products included in the current review were limited to the adulticide products with specific directions for wide area public health uses and include pyrethrins, five synthetic pyrethroids (etofenprox, permethrin, phenothrin, prallethrin and resmethrin) and three organophosphates (chlorpyrifos, malathion and naled) (Table 2.1). Future reviews of the other types of mosquito products may be done.

The most common active ingredients in mosquito products are: permethrin is also found in over 300 products, the synergist, PBO (over 300 products) and pyrethrins (over 200 products). These three active ingredients are found in the public health products listed in Table 2.1. Permethrin has uses on human gear, indoor, outdoor and direct uses on animals. PBO and pyrethrins have a variety of indoor, outdoor and direct uses on animal (NSPIRS 2013).

Table 1.1 Overview of Mosquito Products Registered in Maine in 2013; The Active Ingredients in Bold are found in the Public Health Wide Area Mosquito Products			
Type	**# Products**	**Active Ingredients**	**Notes**
Biological larvicides	32	Bti-Bs	Microbial disruptors of insect midgut membranes (IRAC 2013)
Repellents	179	DEET	These repellents are registered for use on human skin and are recommended by the federal CDC as mosquito repellents.
		IR3535	
		Oil of Lemon Eucalyptus	
		Picaridin	
		PMD	
		MGK 326 Repellent (Dipropyl isocinchomeronate) is registered for use on human gear in products with indoor and outdoor uses. BPG (Butoxypolypropylene glycol) is found in combination with other repellents pyrethroids and synergist. Registered for agricultural use on livestock. Linalool is registered in impregnated materials (candles torches etc.) to repel mosquitoes outdoors. The linalool products also have indoor uses. Other repellents: Oil of Eucalyptus (can be used on skin), Metofluthrin, Oil of Citronella	
Synergists	455	**PBO (piperonyl butoxide)**	PBO used in most of the pyrethrin-pyrethroid products used in public health wide area projects.
		MGK 264 (N-Octyl bicycloheptene dicarboximide)	MGK 264 is found in a dozen products with human skin and gear on their labels and numerous indoor outdoor and animals use products.
Insect Growth Regulators	258	Methoprene	Methoprene is a juvenile hormone analogue (IRAC 2013) and is found in aquatic larvicide 12 products; the non-aquatic uses of methoprene are on cats and dogs for flea and tick control
		Pyriproxyfen	Pyriproxyfen is a juvenile hormone analogue (IRAC 2013). The primary uses of pyriproxyfen are on cats and dogs for flea and tick control

Table 1.1 Overview of Mosquito Products Registered in Maine in 2013; The Active Ingredients in Bold are found in the Public Health Wide Area Mosquito Products			
Type	**# Products**	**Active Ingredients**	**Notes**
Neonicotinoids	38	Acetamiprid, Dinotefuran, Imidacloprid	These compounds activate the insect nicotinic acetylcholine receptor (nAChR) (IRAC 2013).
Organophosphates	39	**Chlorpyrifos, Malathion, Naled**	Organophosphate insecticides act by irreversibly inhibiting the enzyme acetylcholinesterase in the nervous system (IRAC 2013).. These may be used in public health wide area projects.
		DDVP, Tetrachlorvinphos	Six impregnated strips containing 18.6% DDVP.and one DDVP/ tetrachlorvinphos are registered for agricultural uses. DDVP is also found as a metabolite of naled
		Temephos	Temephos is an aquatic larvicide.
Carbamates	10	Carbaryl	Carbamate insecticides act by reversibly inhibiting the enzyme acetylcholinesterase in the nervous system (IRAC 2013
Pyrethrins - Pyrethroids	1181	**Ethofenprox, Permethrin, Phenothrin, Prallethrin, Pyrethrins, Resmethrin**	Pyrethrins and pyrethroids act by modulating the sodium channels in neurons (IRAC 2013). Ethofenprox, Permethrin, Phenothrin, Prallethrin, Pyrethrins, or Resmethrin may be used in public health wide area projects. All of the public health products contain the synergist PBO except for the etofenprox products.
		Other pyrethroids: Allethrins-d and d-trans, Bifenthrin, Bioallethrin-s, Cyfluthrins, Cyhalothrins, Cypermethrins, Deltamethrin, Esfenvalerate, Fluvalinate, Tetramethrin	
Others	148	2-Phenylethyl propionate, d-Limonene, Fipronil, Mineral oil, NEEM, POE isooctadecanol, Soap, Spinosad, Triethylene glycol	Includes two aquatic larvicides with mechanical means of control; mineral oil and POE isooctadecanol. Fipronil acts by blocking the GABA gated chloride channels in nerves. Spinosad acts as a nACh allosteric activator (IRAC 2013)

SECTION 2. TYPICAL ADULTICIDE PRODUCTS LABELED FOR WIDE AREA PUBLIC HEALTH ULV USES

In an effort to summarize the potential for human and environmental hazards associated with public health mosquito abatement programs, a product search was conducted for Maine 2013 registration, followed by a search for active federal registrations for public health mosquito adulticide products. The search terms included: adult mosquito, and aerial or ultra-low volume (ULV) (NSPIR 2013). There were approximately 30 products identified by the search, with the language on their labels specifying:

> *"For use only by federal, state, tribal, or local government officials responsible for public health or vector control, or by persons certified in the appropriate category or otherwise authorized by the state or tribal lead pesticide regulatory agency to perform adult mosquito control applications, or by persons under their direct supervision"*

The EPA registration numbers (EPA#) for the selected public health wide area mosquito adulticide products registered in Maine in 2013 containing synthetic pyrethroids, pyrethrins and PBO, their diluents, are found in Table 2.1. Similar information for the organophosphate containing products is found in Table 2.2.

The review is based on selected products because the number of products could change, with the Maine registration of a federally registered product. The federal search identified 108 products, 27 of which are currently registered Maine. Of the remaining 84 products, 78 have the same mosquito adulticide active ingredients and similar formulations as those registered in Maine-2013. The other six products, may be registered in Maine -2013, but do not have public health mosquito control uses on their labels. Four of these contain the active ingredients carbaryl (one home owner; three agricultural products), 2 contain the synthetic pyrethroid, lambda cyhalothrin. Wide area mosquito adulticiding public health uses are not on these federal labels (Bayer 2009, Tessendro-Kerley 2012, Tessendro-Kerley 2013, Loveland Chemical 2011, Syngenta 2010, LG Lifesciences 2009).

The maximum use rates in pounds pyrethroid-pyrethrins and PBO active ingredient per acre (lbs ai/A) are presented in Table 2.3. The organophosphate active ingredient maximum use rates are found in Table 2.4. The use rates for malathion are 0.23 lbs ai/A by air and 0.11 lbs ai/A by ground (Table 2.4.). Use rates for the synthetic pyrethroids, pyrethrins and the organophosphates chlorpyrifos and naled are the same for both aerial and ground ultra-low volume (ULV) applications.

Table 2.1 Typical Public Health Adult Mosquito Products Containing Pyrethroids-Pyrethrins-Piperonyl Butoxide (PBO) Registered in Maine for 2013 sorted by Active Ingredient (NSPIRS 2013) [a]				
Active ingredients	**Percent Active Ingredients**	**Diluent**	**EPA REG #**	**References**
Etofenprox	4% Etofenprox	Ready to use	2724-807	Wellmark 2010a, Wellmark 2010b,
	20% Etofenprox	Oil	2724-791	Wellmark 2009a, Wellmark 2009b,
Permethrin-PBO	2% Permethrin, 2% PBO [b]	Ready to use	73748-3	Univar 2013a, Univar 2013b
	< 5% Permethrin, < 5% PBO	Oil	655-898	Prentiss 2012a, Prentiss 2012b
	20% Permethrin, 20% PBO	Water	432-796	Bayer [c] 2013a, Bayer 2013b
	20.6% Permethrin, 20.6% PBO	Oil or Water	53883-274	Control Solutions 2010a, Control Solutions 2010b,
	> 30 % Permethrin, > 30% PBO	Oil	73748-5	Univar 2013g, Univar 2013h
Phenothrin-PBO	10% Phenothrin[d], 10% PBO	Oil	1021-1688-8329 [h]	Clarke [e] 2013a, Clarke 2009
Phenothrin- Prallethrin-PBO	5% Phenothrin [d], 1% Prallethrin, 5% PBO	Oil	1021-1795-8329 [h]	Clarke 2013b, Clarke 2008
Pyrethrins-PBO	5 to 12% Pyrethrins, 25 to 60% PBO	Oil	1021-1199	MGK [f] 2013a, MGK 2013b
Resmethrin-PBO	4.14 to 18% Resmethrin, 12.42 to 54% PBO	Oil	432-716	Bayer 2012a, Bayer 2012b

a) Selection of a product for label review does not constitute an endorsement
b) PBO = Piperonyl butoxide, pesticide synergist
c) Bayer = Bayer Environmental EPA Company number 432
d) Phenothrin = Sumithrin

e) The company number for these products is McLaughlin Gormley King (MGK) company number, 1021, the product number varies with the product and 8329 is the company number for the distributer, Clarke Mosquito Products
f) MGK = McLaughlin Gormley King

Table 2.2. Selected Public Health Adult Mosquito Products Containing Organophosphate Insecticides Registered in Maine for 2013 (NSPIRS 2013, Label) [a]				
EPA REG #	**Active Ingredients**	**Diluent**	**lbs ai/gal**	**References**
53883-251	19.36% Chlorpyrifos [b]	Oil	1.5	Control Solutions 2009a, Control Solutions 2010d
67760-34	96.5% Malathion	Oil	9.9	Cheminova 2011a, Cheminova 2011b,
5481-479	62% Naled	Water	7.5	AMVAC 20012a, AMVAC 20012b
5481-481	78% Naled	None	10.8	AMVAC 2010a, AMVAC 2010b
5481-480	87.4% Naled	Oil	13.2	AMVAC 2009a, AMVAC 2009b

a) Selection of a product for label review does not constitute an endorsement
b) There are a number of other chlorpyrifos containing products registered for public health mosquito adulticide use (NSPIRS 2013)

Table 2.3 Use Rates for Active Ingredients (lbs ai/A and lbs ai/A/year) for Public Health Adult Mosquito Products Containing Pyrethroids-Pyrethrins and PBO			
Active Ingredients	**Rate (lbs ai/A)**	**Annual Rate (lbs ai/A/year)**	**Reference**
Etofenprox	0.007	0.18	Wellmark2010a, EPA 2009a
Permethrin	0.007	0.18	Bayer 2011f, EPA 2009c
Phenothrin (Sumithrin)	0.0036	1	MGK 2012a, EPA 2007, EPA 2008
PBO	0.08	2	EPA 2004b
Prallethrin	0.0008	0.02	Clarke Mosquito 2013b
Pyrethrins	0.008	0.2	MGK 2013a, EPA 2006b
Resmethrin	0.007	0.2	Bayer 2012a

Table 2.4 Use Rates for Active Ingredients (lbs ai/A and lbs ai/A/year) for Public Health Adult Mosquito Products Containing Pyrethroids-Pyrethrins and PBO			
Active Ingredients	**Rate (lbs ai/A)**	**Annual Rate (lbs ai/A/year)**	**Reference**
Chlorpyrifos	0.01	0.26	Control Solutions 2009a, Control Solutions 2009b
Malathion (air)	0.23	Not more than 3 times in any one week. More frequent treatments may be to control mosquito-borne diseases in animals or humans	Cheminova 2011a, EPA 2004a, EPA 2009b
Malathion (ground)	0.11		
Naled (air and ground)	0.1	10.73	AMVAC 20012a, AMVAC 20012b

SECTION 3. LABEL REVIEW

Pesticide labels are legal documents. The statement "**It is a violation of Federal Law to use this product in a manner inconsistent with its labeling"** is required on all pesticide labels (EPA 2007 to 2012). The pesticide product label language requirements are spelled out in the EPA Label Review Manual found at: http://www.epa.gov/oppfead1/labeling/lrm/ (EPA 2007 to 2012). These statements are required based on the toxicity databases for the technical grade active ingredient and the pesticide end use product (active and inert ingredients).

For the public health mosquito adulticide the label sections summarized below are signal words, hazards to humans and domestic animals and personal protective equipment. EPA assigns mammalian toxicity categories for the technical grade active ingredients (TGAI) and the end use products offered for sale and use based on acute toxicity data. The criteria for EPA's toxicity categories are set in 40CFR156.62 and the relationship with required label language are found in Appendix II.

SIGNAL WORDS, HAZARDS TO HUMANS AND DOMESTIC ANIMALS

PYRETHROIDS- PYRETHRINS-PBO PRODUCTS

Signal Words

Etofenprox, Permethrin-PBO, Phenothrin (Sumithrin [tm])-PBO, Phenothrin (Sumithrin [tm])-PBO-Prallethrin, Pyrethrins-PBO, Resmethrin-PBO

All of the wide area public health mosquito adulticide products containing pyrethrins, pyrethroids and PBO have "caution" signal words indicating low risks to mammals from acute exposure.

Hazards to humans and domestic animal

Etofenprox, Permethrin-PBO, Phenothrin-PBO, (Anvil 10 +10-oil based), Pyrethrins-PBO, Resmethrin-PBO, have warnings for moderate eye irritation. Anvil 10 + 10 (EPA# 1021-1688-8239) also has a warning for moderate eye irritation

Phenothrin-PBO (Aqua Anvil-water based), Phenothrin (Sumithrin [tm])-PBO-Prallethrin (Duet-oil based and Aqua Duet-water based) have no eye warnings.

Personal Protective Equipment

In Table 2.1, the Pyrethrins-Pyrethroids-PBO containing products are primarily permethrin-BPO at a variety of concentrations. There are two products with etofenprox as the sole active ingredient, two phenothrin (Sumithrin [tm])-PBO products, two phenothrin (Sumithrin [tm])-PBO-prallethrin products, three pyrethrins-PBO products and two Resmethrin-PBO containing products. The personal protective equipment statements are found below.

Etofenprox containing products have no personal protective equipment requirements on the labels of the two mosquito adulticide product labels.

Ten of the eleven permethrin-PBO containing products registered for use in Maine 2013 have labels approved by EPA in 2011, 2012 and 2013 with the following personal protective equipment requirements:

"Mixers, loaders, applicators and other handlers must wear:

- Long-sleeved shirt and long pants,
- Shoes plus socks,
- Chemical-resistant gloves for all handlers except for applicators using motorized ground equipment, pilots, and flaggers
- Chemical-resistant apron for mixers/loaders, persons cleaning equipment, and persons exposed to the concentrate"

The other permethrin product, PBO/Permethrin 20:20, (EPA# 53883-274), has no PPE requirements and the label was approved in 2010. Since the RED for permethrin was issued in 2009 (EPA 2009c), most likely the next iteration of this label would incorporate the PPE requirements from the RED.

Anvil 10 + 10 (EPA# 1021-1688-8329), hydrocarbon based, Multicide® Mosquito Adulticiding Concentrate 2705 (EPA# 1021-1688) requires applicators, mixers and loaders to wear: long-sleeve shirt and pants, shoes and socks, and chemical resistant gloves made of barrier laminate nitrile rubber, neoprene rubber or viton.

Aqua Anvil, water based (EPA# 1021-1807-8329)*:* Multicide® Mosquito Adulticiding Concentrate 2807 (EPA# 1021-1807) labels require applicators mixers and loaders wear: long-sleeve shirt and pants and shoes and socks.

Duet (EPA#1021-1795-8329) petroleum base, Multicide Fogging Concentrate 2798 (EPA# 1021-1795) and Aqua Duet (EPA#1021-2562-8329), Multicide Fogging Concentrate 2922 (EPA# 1021-2562) labels require applicators mixers and loaders wear: long-sleeve shirt and pants and shoes and socks.

Two resmethrin products registered in Maine 2013 for adult mosquito control in public health settings are SCOURGE® Insecticide with resmethrin/piperonyl butoxide 18% + 54% MF FORMULA II (EPA# 432-667) and SCOURGE® Insecticide with SBP-1382/Piperonyl Butoxide 4%+12% MF FII (EPA# 432-716).

The personal protective equipment requirements from both labels are:

- Long-sleeved shirt and long pants
- Shoes plus socks
- Chemical-resistant gloves for all handlers except applicators.

The Scourge product label for product with the higher concentrations, (EPA# 432-667), chemical resistant gloves are require for all applicators except applicators using motorized ground equipment pilots and flaggers.

Organophosphates

Signal Words

The organophosphate products containing chlorpyrifos and malathion also have "caution" signal word. The naled containing products have "danger" signal words due to irreversible corrosive effects on the skin and eyes.

Hazards to humans and domestic animal

Chlorpyrifos and Malathion

Technical grade chlorpyrifos is more acutely toxic than technical grade malathion (Table B). The adulticide products are a soluble concentrate containing 19.36% chlorpyrifos (1.5 lbs/gal) product and a ready to use 96.5% malathion (9.9 lbs/gal) product. Both the chlorpyrifos product and the malathion product labels have "caution" as the signal word. The different human and domestic animal hazard sections reflect the differences in potency.

Chlorpyrifos

CSI 1.5 (EPA# 53883-251) human and domestic animal hazard section reads:

"Harmful if swallowed. Avoid contact with skin or clothing. Wash thoroughly with soap and water after handling and before eating, drinking, chewing gum, using tobacco, or using the toilet. Prolonged or frequently repeated skin contact may cause allergic reactions in some individuals (Control Solutions 2009a, Control Solutions 2009b)."

The Fyfanon (EPA# 67760-34) malathion containing product label states:

"Harmful by swallowing, inhalation or skin contact. Avoid contact with skin. Avoid breathing spray mist" (Cheminova 2011a, Cheminova 2011b.)"

Naled

All of the naled containing products registered for use as public health mosquito adulticides are classified **RESTRICTED USE PESTICIDE DUE TO EYE AND SKIN CORROSIVITY HAZARD** and have **DANGER** signal words because of corrosiveness to eyes and skin.

Human health hazard statements include:

- "Causes irreversible eye and skin damage.

- Causes skin bums.
- May be fatal if swallowed.
- Harmful if inhaled or absorbed through the skin.
- Do not get in eyes, on skin, or on clothing.
- Do not breathe vapor or spray mist.
- Prolonged or frequently repeated skin contact may cause allergic reactions in some individuals (AMVAC 2009a, AMVAC 2010a, AMVAC 20012a.)"

Personal Protective Equipment Requirements

The organophosphate containing products include one chlorpyrifos, one malathion and three naled products. The personal protective equipment statements are found below.

Chlorpyrifos

CFI 1.5 containing 19.36% chlorpyrifos (1.5 lbs/gal) (EPA# 53883-251) has the following directions for personal protective equipment:

> "Personal Protective Equipment (PPE): All mixers and loaders involved in ground application must wear coveralls over long-sleeved shirt and long pants, shoes plus socks, chemical-resistant gloves, and a NIOSH-approved dust mist filtering respirator with MSHAINIOSH approval number prefix TC21C or a NIOSH-approved respirator with any R, P, of HE filter. Applicators involved in ground ULV application must use an enclosed cab as described in the

Engineering Controls Section of this label and must wear long-sleeved shirt and long pants, shoes plus socks, and chemical-resistant gloves. Aerial applicators and pilots must use an enclosed cockpit and wear long-sleeved shirt, long pants, shoes, and socks (Control Solutions 2009a, Control Solutions 2009b.)"

Malathion

Fyfanon ULV containing 96.5% malathion (9.9 lbs/gal) (EPA# 53883-34) label directions for personal protective equipment are:

"For all formulations and use patterns - mixers, loaders, applicators, flaggers, and other handlers must wear:

- Long-sleeved shirt and long pants
- Chemical-resistant gloves
- Shoes plus socks (Cheminova 2011a, Cheminova 2011b)"

Naled

Personal protective equipment from the naled product labels read:

"If engineering controls are in use:

- Protective eye wear (goggles, face shield, or safety glasses)
- Long-sleeved shirt and long pants
- Socks plus shoes
- Chemical-resistant gloves (barrier laminate, butyl rubber, nitrile rubber, or viton, selection category E) and apron when mixing or loading. See engineering controls for additional requirements

In the absence of engineering controls:

- Protective eye wear (goggles, face shield, or safety glasses)
- Coveralls over long-sleeve shirt and long pants
- Chemical-resistant gloves
- Chemical-resistant footwear plus socks
- Chemical-resistant apron if exposed to the concentrate • Chemical-resistant headgear for overhead exposure
- A respirator with an organic-vapor removing cartridge with a prefilter approved for pesticides (AMVAC 2009a, AMVAC 2010a, AMVAC 20012a.)"

ENVIRONMENTAL HAZARD STATEMENTS

PYRETHROIDS- PYRETHRINS-PBO CONTAINING PRODUCTS

The environmental hazard statement from Zenivex E20 (EPA#2724-791) containing 20% etofenprox label states:

"**This pesticide is toxic to aquatic organisms, including fish and aquatic invertebrates**. Runoff from treated areas or deposition into bodies of water may be hazardous to fish and other aquatic organisms. Do not apply over bodies (of water (lakes, rivers, permanent streams, natural ponds, commercial fish ponds, swamps, marshes or estuaries), **except when necessary to target areas where adult mosquitoes are present,** and weather conditions will facilitate movement of applied material away from water in order to minimize incidental deposition into the water body. Do not contaminate bodies of water when disposing of equipment rinsate or washwasters. [Emphasis added].

This product is highly toxic to bees exposed to direct treatment on blooming crops or weeds. Time applications to provide the maximum possible interval between treatment and the next period of bee activity. Do not apply to blooming crops or weeds when bees are visiting the treatment area, **except when applications are 'made to prevent or control a threat to public and/or animal health determined by a state, tribal, or local health or vector control agency on the basis of documented evidence of disease-'causing agents in vector mosquitoes or the occurrence of mosquito-borne disease in animal or human populations**, or if specifically approved by the state or tribe during a natural disaster recovery effort (Wellmark 2010c, Wellmark 2010d.)" [e**mphasis added]**.

Similar extensive environmental hazard warnings are found on all of the pyrethrins-pyrethroid-PBO have warnings similar or identical to the Zenivex E20 (EPA# 2724-791) (Wellmark 2010c, Wellmark 2010d.)"
In addition, the two Scourge products containing resmethrin and PBO are classified as restricted use products because of acute toxicity to fish (Bayer 2012a, Bayer 2012b, Bayer 2012c, Bayer 2012d). The restricted use classification means that certification and licensing are needed to purchase and use the products.

ORGANOPHOSPHATE CONTAINING PRODUCTS

Pyrofos 1.5 ULV Vector Control Insecticide containing 19.36% chlorpyrifos (1.5 lbs/gal) (EPA# 53883-251) has the following environmental hazard statements:

> "This pesticide is toxic to fish, aquatic invertebrates, small mammals and birds. Runoff from treated areas or deposition of spray droplets into a body of water may be hazardous to fish and aquatic invertebrates. Do not apply over bodies of water (lakes, rivers, permanent streams, natural ponds, commercial fish ponds, swamps, marshes or estuaries) ~ **except when necessary to target areas where adult mosquitoes are present, (emphasis added)** and weather conditions weather facilitate movement of applied material beyond the body of water in order to minimize incidental deposition into the water body. Do not contaminate bodies of water when disposing of equipment rinsate or wash waters.
>
> This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treated area**, except 'When applications are made to prevent or control a threat to public and/or animal health determined by a state, or local health or vector control agency on the basis of documented evidence of disease causing agents in vector mosquitoes, or the occurrence of mosquito-borne disease in animal or human populations, or if specifically approved by the state or tribe during a natural disaster recovery effort (emphasis added)** (Control Solutions 2009a, Control Solutions 2009b**)**."

The environmental hazard section of the Fyfanon ULV containing malathion read much the same as the synthetic pyrethroids:

> "This pesticide is toxic to aquatic organisms, including fish and invertebrates. Use care when applying in or to an area which is adjacent to any body of water, and do not apply when weather conditions favor drift from target area. Poorly draining soils and soils with shallow water tables are more prone to produce runoff that contains this product. When applying as a wide area mosquito adulticide, before making the first application in a season, it is advisable to consult with the state or tribal agency charged with primary responsibility for pesticide regulation to determine if other regulatory requirements exist.
>
> This product is highly toxic to bees exposed to direct treatment on blooming crops or weeds. Do not apply or allow to drift onto blooming crops or weeds while bees are actively visiting the treatment area, **except when applications are made to prevent or control a threat to public**

and/or animal health determined by a state, tribal or local public health or vector control agency on the basis of documented evidence of disease causing agents in vector mosquitoes or the occurrence of mosquito-borne disease in animal or human populations, or if specifically approved by the state or tribe during a natural disaster recovery effort (emphasis added).

When applying as a wide area mosquito adulticide, do not apply over bodies of water (lakes, rivers, permanent streams, natural ponds, commercial fish ponds, swamps, marshes or estuaries), except when necessary to target areas where adult mosquitoes are present, and weather conditions will facilitate movement of applied material away from the water in order to minimize incidental deposition into the water body. Do not discharge effluent containing this product into lakes, streams, ponds, estuaries, oceans, or other waters unless in accordance with the requirements of a National Pollutant Discharge Elimination System (NPDES) permit and the permitting authority has been notified in writing prior to discharge. Do not discharge effluent containing this product to sewer systems without previously notifying the local sewage treatment plant authority. For guidance contact your State Water Board or Regional Office of the EPA (Cheminova 2011a, Cheminova 2011b.)"

Another consideration not found on other public health mosquito products is: "undiluted spray droplets of Fyfanon ULV Mosquito will permanently damage vehicle paint finishes unless the aircraft used for the ultra-low volume application meets all of the specifications listed under AERIAL APPLICATION (Cheminova 2011a, Cheminova 2011b).

Regarding non-target toxicity the naled labels read:

"This pesticide is toxic to fish, aquatic invertebrates, and wildlife. Runoff from treated areas or deposition of spray droplets into a body of water may be hazardous to fish and aquatic invertebrates. Before making the first application in a season, consult with the primary State agency responsible for regulating the pesticides to determine if permits are required or regulatory mandates exist. Do not apply over bodies of water (e.g., lakes, swamps, rivers, permanent streams, natural ponds, commercial fish ponds, marshes or estuaries), **except when necessary to target areas where adult mosquitoes are present (emphasis added),** and weather conditions will facilitate movement of applied material away from the water in order to minimize incidental deposition into the water body. Do not contaminate bodies of water when disposing of equipment washwaters or rinsate (AMVAC 2009a, AMVAC 2010a, AMVAC 20012a).

This product is highly toxic to bees exposed to direct treatment on blooming crops or weeds. To minimize hazard to bees, it is recommended that the product is not applied more than two hours after sunrise or two hours before sunset, limiting application to times when bees are least active. Do not apply this product or allow it to drift to blooming crops or weeds while bees are visiting the treatment area, except when applications are made to prevent or control a threat to public and/or animal health determined by a state, tribal or local health or vector control agency on the basis of documented evidence of disease causing agents in vector mosquitoes or the occurrence of mosquito-borne disease in animal or human populations, or if specifically approved by the state or the tribe during a: natural disaster recovery effort (AMVAC 2009a, AMVAC 2010a, AMVAC 20012a).

LABEL LANGUAGE FOR USE OVER FARMS AND AGRICULTURAL AREAS

PYRETHROIDS- PYRETHRINS-PBO PRODUCTS

Depending on the existence of US food or feed tolerances (Appendix III), the label language for the pyrethrins-pyrethroid containing adulticides is different.

Piperonyl butoxide (PBO), is present in all of the pyrethrins-pyrethroid products with the exception of the etofenprox products. PBO is exempt from tolerance on raw agricultural commodities when used according to good agricultural practice (40CFR180.905).

There are no tolerances for etofenprox in raw agricultural commodities with the exception of rice (40CFR180.620). Etofenprox containing products have label directions to "Cover exposed drinking water in corrals, feedlots, swine lots cropland or any exposed drinking water" and "do not spray or allow drift onto pastureland, cropland or potable water sources. Given the "cover drinking water" sources for livestock and "do not spray or allow drift" statements on the etofenprox labels, food residues resulting from public health mosquito applications should not be an issue.

Permethrin has many tolerances in raw agricultural commodities (40 CFR180.378) these are for the commodities listed on the permethrin product labels. Permethrin-PBO products, in one form or another have the following label language, "Do not spray this product on or allow it to drift onto cropland (other than crops listed) or potable water supplies (followed by the list of commodities which have tolerances for permethrin and PBO residues). In the treatment of corrals feedlots animal confinements/houses swine lots poultry ranges and zoos cover any exposed drinking water drinking fountains and animal feed before application.

Phenothrin has a universal tolerance 0.01 ppm for raw agricultural commodities (40CFR180.647) and PBO is exempt from tolerance (40CFR180.905). Prallethrin only has a universal tolerance for uses in food and feed establishments and no tolerances on raw agricultural commodities (40CFR180.545). Anvil 10 + 10, oil based and Aqua Anvil, water-based, have the following statement regarding use over agricultural areas: "May be applied over agricultural areas for the control of adult mosquitoes within or adjacent to the treatment areas" Because of the presence of prallethrin and the lack of tolerances, the Duet and Aqua Duet, Phenothrin-PBO-Prallethrin have the following statement regard agricultural areas: "Do not spray this product on or allow it to drift onto rangeland cropland poultry ranges or potable water supplies In treatment of corrals feed lots swine lots and zoos cover any exposed drinking water drinking water fountains and animal feed before application"

Pyrethrins are exempt from tolerance on raw agricultural commodities (40CFR180.905).

Pyrethrins-PBO product labels state: "This concentrate may be diluted or used as supplied for mosquito control programs involving residential, industrial, recreational and agricultural areas where adult mosquitoes are present in annoying numbers in vegetation surrounding swamps, marshes, overgrown waste areas, roadsides and pastures. Use in agricultural areas should be in such a manner as to avoid residues in excess of established tolerances for pyrethrins and PBO on crops or commodities"

Similar to prallethrin, resmethrin has a universal tolerance for uses in food and feed establishments and no tolerances on raw agricultural commodities (40CFR180.525.). Given the site limitations on the resmethrin containing product labels, food residues resulting from public health mosquito applications should not be an issue. The two Scourge products containing resmethrin and PBO labels state: "Scourge is designed for application as an Ultra-Low Volume (ULV) aerosol to control adult mosquitoes and flies in residential industrial urban recreational areas and other areas where the labeled pests are a problem.

ORGANOPHOSPHATE CONTAINING PRODUCTS

There are at least 80 tolerances (40CFR180.342) for chlorpyrifos, given the non-crop-land statement on the chlorpyrifos label, food residues resulting from public health mosquito applications should not be an issue. Chlorpyrifos containing product, CSI 1.5 ULV (EPA# 53883-251) is designed for application either as a thermal fog or as an ultra-low volume (ULV) non-thermal aerosol (cold fog) to control adult mosquitoes in: "Outdoor residential and recreational areas and other non-cropland areas where these insects are a problem"

Malathion has tolerances in over 150 commodities (40CFR180.111). Given the site limitations on the malathion containing product label, food residues resulting from public health mosquito applications should not be an issue. Aerial Applications for Fyfanon ULV are limited to "Rangeland, Pasture, and Other Uncultivated Non-Agricultural Areas (Wastelands, Roadsides). There are no such limits on ground applications.

There are 38 tolerances for naled. In addition, a universal tolerance of 0.5 part per million is established for the pesticide naled in or on all raw agricultural commodities, except those otherwise listed in this section, from use of the pesticide for area pest (mosquito and fly) control (40CFR180.215). Two of the three products containing naled have mosquito (and nuisance fly) uses only, Dibrom Concentrate (EPA# 5481-480) and Trumpet EC (EPA# 5481-481). The third product, Dibrom 8 Emulsive (EPA# 5481-479) has the mosquito, nuisance fly and agricultural uses on its label. The two products with no agricultural uses on their labels have the following directions regarding use over agricultural areas:

> "It is not necessary to avoid farm buildings, dairy barns, pastures, feed or forage areas. Use in agricultural areas must be in a manner as to ensure that residues do not exceed the established federal tolerance for the active ingredient in or on raw agricultural commodities resulting from use for wide area pest control. Treat shrubbery and vegetation where mosquitoes may be present. Shrubbery and vegetation around stagnant pools, marshy areas, swamps, residential areas, municipalities, woodlands, pastures, farm buildings and feedlots may be treated."

The product with both agricultural and mosquito/ nuisance fly uses, Dibrom 8 Emulsive (EPA# 5481-479) in the section on controlling mosquitos reads:

> "It is not necessary to avoid farm buildings. Make applications during peak of infestation and repeat as necessary. See crop recommendation for use limitations near harvest. Treat shrubbery and

vegetation where mosquitoes may rest. Shrubbery and vegetation around stagnant pools, marshy areas, ponds and shorelines may be treated.

References

40CRF180.215, 2013, Tolerances for Naled

40CRF180.647, 2013, Tolerances for Phenothrin (Sumithrin)

AMVAC 2009a, Dibrom Concentrate, EPA# 5481-480, containing 87.4% naled, EPA Label

AMVAC 2009b, Dibrom Concentrate, EPA# 5481-480, containing 87.4% naled, ME-2013 Label

AMVAC 2010a, Trumpet EC Insecticide, EPA# 5481-481, containing 78% naled, EPA Label

AMVAC 2010b, Trumpet EC Insecticide, EPA# 5481-481, containing 78% naled, ME-2013 Label

AMVAC 2012a, Dibrom 8 Emulsive, EPA# 5481-479, containing 62%, naled, EPA Label

AMVAC 2012b, Dibrom 8 Emulsive, EPA# 5481-479, containing 62%, naled, ME-2013 Label

Bayer CropSciences 2009, Sevin Brand RP4 Carbaryl Insecticide, EPA# 264-335, containing 43% Carbaryl EPA Label

Bayer Environmental Services 2011a, Aqua-Permanone, EPA# 432-796, containing 20% permethrin-20% PBO, EPA Label

Bayer Environmental Services 2011b, Aqua-Reslin, EPA# 432-796, containing 20% permethrin-20% PBO, ME-2013 Label

Bayer Environmental Services 2011c, Omen 30-30 ULV, EPA# 432-1235, containing 30% permethrin-30% PBO, EPA Label

Bayer Environmental Services 2011d, Permanone 30-30, EPA# 432-1235, containing 30% permethrin-30% PBO, ME-2013 Label

Bayer Environmental Services 2011e, Permanone Insecticide Concentrate, EPA# 432-1250, containing 31.28% permethrin-66% PBO, EPA Label

Bayer Environmental Services 2011f, Permanone 31-66, EPA# 432-1250, containing 31.28% permethrin-66% PBO, ME-2013 Label

Bayer Environmental Services 2011g, Pyrenone Crop Spray, EPA# 432-1033, EPA Label

Bayer Environmental Services 2012a, Scourge Insecticide w/ Resmethrin/Piperonyl Butoxide 4%+12% MF FII, EPA# 432-716, containing 4.14% resmethrin-12.42% PBO, EPA Label

Bayer Environmental Services 2012b, Scourge Insecticide w/ Resmethrin/Piperonyl Butoxide 4%+12% MF FII, EPA# 432-716, containing 4.14% resmethrin-12.42% PBO ME-2013 Label

Bayer Environmental Services 2012c, Scourge Insecticide w/ Resmethrin/Piperonyl Butoxide 18% + 54% MF FII, EPA# 432-667, containing 18% resmethrin-54% PBO, EPA Label

Bayer Environmental Services 2012d, Scourge Insecticide w/ Resmethrin/Piperonyl Butoxide 18% + 54% MF FII, EPA# 432-667, containing 18% resmethrin-54% PBO, ME-2013 Label

Centers for Disease Control and Prevention (CDC) 2003, Epidemic/Epizootic West Nile Virus in the United States: Guidelines for Surveillance, Prevention and Control

Cheminova 2011a, Fyfanon ULV Mosquito Insecticide, EPA# 67760-34, containing 96.5% malathion, EPA Label

Cheminova 2011b, Fyfanon ULV Mosquito Insecticide, EPA# 67760-34, containing 96.5% malathion, ME-2013 Label

Clarke Mosquito Control 2013a, Anvil 10+10 ULV, EPA# 1021-1688-8329, containing 10% sumithrin (phenothrin)-10% PBO, ME-2013 Label

Clarke Mosquito Control 2013b, Duet EPA# 1021-1795-8329, containing 1% Prallethrin 5% sumithrin (phenothrin)-5% PBO, ME-2013 label

Clarke Mosquito Control 2013c, Aqua Anvil Water Based Adulticide, EPA# 1021-1807-8329, containing 10% sumithrin (phenothrin)-10% PBO, Label from Clarke mosquito Website: http://www.clarke.com/index.php?option=com_content&view=category&layout=blog&id=47&Itemid=126

Clarke Mosquito Control 2013d, Aqua Duet, EPA# 1021-2562, containing 1% Prallethrin 5% sumithrin (phenothrin)-5% PBO, Label from Clarke mosquito Website: http://www.clarke.com/index.php?option=com_content&view=category&layout=blog&id=47&Itemid=126

Control Solutions 2009a, Pyrofos, EPA# 53883-251, containing 19.36% chlorpyrifos (1.5 lbs/gal) EPA Label

Control Solutions 2010e Pyrofos, EPA# 53883-251, containing 19.36% chlorpyrifos (1.5 lbs/gal) ME-2013 Label

Control Solutions 2010a, PBO/Permethrin 20:20, EPA# 53883-274, containing 20.6% permethrin-20.6% PBO, EPA Label

Control Solutions 2010b, Vector-Flex 20:20, EPA# 53883-274, containing 20.6% permethrin,-20.6% PBO, ME-2013 Label

Direct AG Source 2013, Permethrin 3.2 AG, EPA# 83222-3, containing 36.8% Permethrin [3.2 lbs/gal] EPA Label

Dow AgroSciences 2012, Dursban 50W in Water Soluble Packet,s EPA# 62719-72, Wettable Powder in Water Soluble bags Containing 50% Chlorpyrifos EPA Label

EPA 2002a, 2006a, Interim Re-registration Eligibility Decision for Naled; Finalized in 2006

EPA 2005g, Screening Ecological Risk Assessment for the Re-registration of Piperonyl Butoxide Insecticide Synergist

EPA 2006b, Revised Pyrethrins RED Chapter after Additional 60-Day Comment Period Phase 5

EPA 2006d, Re-registration Eligibility Decision (RED) for Resmethrin

EPA 2006f, Revised Occupational and Residential Exposure Assessment and Recommendations for the Re-registration Eligibility Decision (RED) for Resmethrin

EPA 2006i, The Agency Revised Risk Assessment for the Registration Eligibility Decision for Permethrin Following Public comments, Phase III

EPA 2006j,Glyphosate Human Health Risk Assessment for Proposed Use on Indian Mulberry and mended Use on Pea, Dry. PC Code: 417300, Petition No: 5E6987, DP Num: 321992, Decision No. 360557.

EPA 2008d, EFED Registration Review-Preliminary Problem Formulation for the Ecological Risk Assessment of Naled

EPA 2008e, EFED Registration Review – Preliminary Problem Formulation for Ecological Risk and Environmental Fate, Endangered Species and Drinking Water Assessments Chlorpyrifos (PC Code 059101; DP Barcode D355212)

EPA 2008f, EFED Preliminary Environmental Fate And Effects Assessment Science Chapter for the Re-registration Eligibility Deciscion of D-phenothrin (Sumithrin)

EPA 2008g, Risks of Naled Use to Federally Threatened California Red Legged Frog *(Rana aurora drayonii)*

EPA 2009a, Environmental Fate and Ecological Risk Assessment for Etofenprox New Uses on Rice and Vector Control

EPA 2009d, Permethrin: Sixth Revision of the HED Chapter of the Re-registration Eligibility Decision Document (RED)

EPA 2009g, Registration Review Preliminary Problem Formulation for the Ecological Risk, Environmental Fate and Endangered Species Assessments for Malathion (PC code 057701; DP Barcode D359863)

EPA 2010b, EFED Registration Review Problem Formulation for Piperonyl Butoxide

EPA 2011h, EFED Registration Review Preliminary Problem Formulation for Permethrin

EPA 2011i, EFED Registration Review Preliminary Problem Formulation for Pyrethrins

EPA 2012a, Chemicals Evaluated for Carcinogenic Potential, Office of Pesticides Programs 2012

EPA 2012b, Use's Guide to T-REX Version 1.5

EPA 2012c, Standard Operating Procedures for Residential Pesticide Exposure Assessment

EPA 2012h, EFED Registration Review: Preliminary Problem Formulation for Environmental Fate, Ecological Risk, Endangered Species, and Drinking Water Exposure Assessment for Prallethrin

EPA 2012i, EFED Registration Review:Preliminary Problem Formulation for Resmethrin

LG Lifesciences 2009, Lamdastar 1 CS-PCO, EPA# 71532-27, containing 12% lambda cyhalothrin Fed Label

Loveland Chemical 2011, Carbaryl 4L, EPA# 34704-447, containing 43% Carbaryl EPA-Label

McLaughlin Gromley King 2012a, Pyrocide Mosquito Adulticiding Concentrate for ULV Fogging 7395, EPA# 1021-1570, containing 12% pyrethrins-60% PBO, ME-2013 Label

McLaughlin Gromley King 2012b, Pyrocide Mosquito Adulticiding Concentrate for ULV Fogging 7395, EPA# 1021-1570, containing 12% pyrethrins-60% PBO, EPA Label 2012

McLaughlin Gromley King 2012c, Multicide Mosquito Adulticiding Concentrate for ULV Fogging 2705, EPA# 1021-1688, containing 10% sumithrin (phenothrin)-10% PBO, EPA-2012 Label

McLaughlin Gromley King 2012d, Multicide Mosquito Adulticiding Concentrate for ULV Fogging 2795, EPA# 1021-1795, containing 1% Prallethrin 5% sumithrin (phenothrin)-5% PBO, EPA-2012 Label

McLaughlin Gromley King 2012c, Multicide Mosquito Adulticiding Concentrate for ULV Fogging 2705, EPA# 1021-1807, containing 10% sumithrin (phenothrin)-10% PBO, EPA-2012 Label

McLaughlin Gromley King 2012d, Multicide Mosquito Adulticiding Concentrate for ULV Fogging 2795, EPA# 1021-2562, containing 1% Prallethrin 5% sumithrin (phenothrin)-5% PBO, EPA-2012 Label

McLaughlin Gromley King 2013a, Pyrocide Fogging Formula 7067, EPA# 1021-1199, containing 5% pyrethrins-25% PBO, EPA Label

McLaughlin Gromley King 2013b, Pyrocide Fogging Formula 7067, EPA# 1021-1199, containing 5% pyrethrins -25% PBO, ME-2013 Label

McLaughlin Gromley King 2013c, Pyrocide Mosquito Adulticiding Concentrate for ULV Fogging 7396, EPA# 1021-1569, containing 5% pyrethrins-25% PBO, EPA Label

McLaughlin Gromley King 2013d, Pyrocide Mosquito Adulticiding Concentrate for ULV Fogging 7396, EPA# 1021-1569, containing 5-pyrethrins-,25% PBO, ME-2013 Label

NuFarm Americas 2012, ATERA GC 2+1 SC Insecticide, EPA# 228-557, containing 21.99% [2 lbs/gal] imidacloprid and bifnenthrin 10.654% [1 lb./gal]

Prentiss 2012a, Prentox Perm-X UL 4-4, EPA# 655-898, containing 4% permethrin-4% PBO, EPA Label

Prentiss 2012b, Prentox Perm-X UL 4-4, EPA# 655-898, containing 4% permethrin-4% PBO, ME-2013 Label

Prentiss 2012c, Prentox Perm-X UL 30-30, EPA# 655-811, containing 30% permethrin, 30% PBO, EPA Label

Prentiss 2012d, Prentox Perm-X UL 30-30, EPA# 655-811, containing 30% permethrin-30% PBO, ME-2013 Label

Prentiss 2012e, Prentox Perm-X UL 31-66, EPA# 655-812, containing 31% permethrin-66% PBO, EPA Label

Prentiss 2012f, Prentox Perm-X UL 31-66, EPA# 655-812, containing 31% permethrin-66% PBO, ME-2013 Label

Syngenta 2010, Demand Pest Tabs, EPA# 100-1082, containing 10% lambda-cyhalothrin, EPA Label

Tessendro-Kerley 2012 Sevin Brand 4F Carbaryl Insecticide, PA# 61842-38, containing 43% Carbaryl, EPA-Label

Tessendro-Kerley 2013 Sevin Brand 85 Sprayable Carbaryl Insecticide, EPA# 61842-33, containing 85% Carbaryl, EPA-Label

United Phosphorous 2012, Up-Cyde Pro 2 0 EC Termiticide/lnsecticide (EPA # 70506-19) EPA Label

Univar Environmental Services 2013a, Masterline Kontrol 2-2, EPA# 73748-3, containing 2% permethrin-2% PBO, EPA Label

Univar Environmental Services 2013b, Masterline Kontrol 2-2, EPA# 73748-3, containing 2% permethrin-2% PBO, ME-2013 Label

Univar Environmental Services 2013c, Masterline Kontrol 4-4, EPA# 73748-4, containing 4.6% permethrin-4.6% PBO, EPA Label

Univar Environmental Services 2013d, Masterline Kontrol 4-4, EPA# 73748-4, containing 4.6% permethrin-4.6% PBO, EPA Label

Univar Environmental Services 2013e, Masterline Aqua Kontrol Concentrate, EPA# 73748-1, containing 20% permethrin-20% PBO, ME-2103 Label

Univar Environmental Services 2013f, Masterline Aqua Kontrol Concentrate, EPA# 73748-1, containing 20% permethrin-20% PBO, EPA Label

Univar Environmental Services 2013g, Masterline 30-30, EPA# 73748-5, containing 30% permethrin-30% PBO, ME-2103 Label

Univar Environmental Services 2013f, Masterline 30-30, EPA# 73748-5, containing 30% permethrin-30% PBO, EPA Label

Wellmark International 2010c, Zenivex E20, EPA# 2724-791, containing 20% etofenprox, EPA Label

Wellmark International 2010d, Zenivex E20, EPA# 2724-791, containing 20% etofenprox, ME-2013 Label

Wellmark International 2010a, Zenivex E4 RTU, EPA# 2724-807, containing 4% etofenprox, EPA Label

Wellmark International 2010b, Zenivex E4 RTU, EPA# 2724-807, containing 4% etofenprox, ME-2013 Label