TECHNICAL BULLETIN OF THE FLORIDA MOSQUITO CONTROL ASSOCIATION

VOLUME 4 2003

Florida Mosquito Control Association, Inc.
Organized in 1922

The Florida Mosquito Control Association, Inc. is a non-profit, technical, scientific and educational association of the mosquito control, medical public health and military biologists, entomologists, engineers, and laypersons who are interested in the biology and control of mosquitoes or other arthropods of public health importance.

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FOREWORD

This issue of the Technical Bulletin of the Florida Mosquito Control Association includes information developed at a workshop held on April 3-4, 2002 at the University of Florida's Indian River Research and Education Center in Fort Pierce, Florida. The workshop was organized and coordinated by Faculty of the Florida Medical Entomology Laboratory, University of Florida, Institute of Food and Agricultural Sciences in Vero Beach, Florida. Over 100 Florida mosquito control and health department professionals, with attendees from 3 other states, met to specifically assess the challenges facing mosquito control to mitigate the impact of West Nile virus in Florida.

The objective of the workshop was to provide an update on West Nile virus in North America, expectations for Florida, and to provide an outline of mosquito control strategies to reduce the impact of West Nile virus in Florida. Participants were split into 5 different groups and appointed one leader for the discussion, a recorder to take notes, and a reporter to present the results of the discussions to the larger group. The workshop provided an interactive discussion that resulted in this document stating Florida mosquito control plans to reduce the impact of West Nile virus in the State. Immediate feedback from the attendees was that the format of the workshop was very beneficial.

As a follow-up to the first workshop, the Florida Medical Entomology Laboratory organized a similar forum during the 2003 Spring Meeting of the Florida Mosquito Control Association. It was held May 20-21, 2003 and was also conducted at the University of Florida's Indian River Research and Education Center in Fort Pierce. A summary of that session follows the results from the first workshop in this document.

We thank 1) Velma Spencer and Robin Kostoyeo of the Indian River Research and Education Center for their assistance in facilitating both meetings; 2) the Florida Mosquito Control Association for allowing time during the Spring Meeting; and 3) all of the participants, speakers, moderators, recorders, and reporters for bringing their expertise to the group and making these workshops a success.

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Florida Mosquito Control Response to the Challenge of West Nile Virus

Results of two workshops of
Florida Mosquito Control Professionals

April 3-4, 2002 and May 20-21, 2003

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West Nile virus represents a serious threat to the public health and well being of Florida's citizens and visitors, is a threat to Florida's horse industry, and it threatens Florida's tourist industry. In July 2001 West Nile virus was detected for the first time in Florida. It was first detected in north Florida followed by other regions in the state, including the Keys in extreme southern Florida. Although Florida escaped a large-scale epidemic of substantial numbers of human cases, there were 12 human cases and almost 500 West Nile horse cases during 2001 demonstrating that Florida residents, visitors, and their domestic animals are certainly at risk from this mosquito-borne virus.

West Nile virus is new to Florida and represents a significant challenge to those faced with the responsibility to protect Florida's citizens from this disease. Florida mosquito control professionals in particular have a significant role to play in mitigating the potential impact of West Nile virus in the state. A successful mosquito control program can reduce human exposure to West Nile virus infected mosquitoes and therefore reduce the chances of West Nile infection.

The workshop addressed issues and challenges within the following five major areas:

1. Surveillance
2. Identifying Vector Species as Targets for Mosquito Control
3. Larviciding
4. Adulticiding
5. Media and Personal Protection

The following outline represents a summary of the workshop proceedings. It is organized following the issues and challenges discussed in each major area. Each area addressed the following:

1. Identify the three high priority objectives in the specific area that will result in mosquito control being able to reduce the risk of West Nile infection in humans.
2. Identify the strategies that mosquito control can use to reach the identified priority objectives.
3. Identify the impediments facing mosquito control in implementing the identified strategies.
4. Identify ways to overcome impediments to mosquito control strategies to mitigate the impact of West Nile virus.

SURVEILLANCE ISSUES

J.F. Day, J. Burgess, D.A. Focks, D. Shroyer

Arboviral surveillance using non-human indicators is a critical, proactive component in the risk assessment for human arboviral infection. Without an active surveillance program, human cases may be the first indication of an arboviral transmission event. It is these human cases that a well-designed surveillance program attempts to predict. In the case of a widespread human epidemic, the early identification of arboviral amplification and transmission can reduce the number of human cases by using a media-driven educational warning campaign designed to inform the general public about how, when, and where arboviral transmission is likely to occur.

The design of a surveillance program in many ways dictates its utility. For example, a surveillance program relying solely on reports of arboviral-positive horses will likely be ineffective for predicting human cases in the same geographical area. This is because there is generally a long lag time associated with confirming presumptive or suspected horse cases. In many instances confirmed positive horses are reported at the County level weeks, or even months, after they were infected by a mosquito bite. Attempts to mount a control effort this long after the actual transmission events are futile. In addition, because horses are exposed to many more mosquito bites than are humans, horses tend to be a more sensitive indicator of viral transmission and there can be widespread transmission to horses without a serious threat to humans in the same region.

The best surveillance programs are those that integrate a large amount of surveillance data into a single program (Day and Lewis 1992). The extent of arboviral transmission depends on the interaction of 3 distinct biological cycles; those of the virus, the vector and vertebrate amplification host. These cycles are sometimes brought into synchrony by specific environmental conditions (Day 2001). Because arboviral transmission cycles are so complex, several different surveillance programs, each using different indicators, may be required to gain a true picture of the risk of arboviral transmission. The surveillance programs must measure the geographic and temporal distribution of the virus, the vector, the population dynamics of the amplification hosts, and the environmental conditions that cause vector mosquitoes and amplification hosts to interact. The rapid transmission of virus between vector mosquitoes and vertebrate amplification hosts is what places humans at risk of arboviral infection.

I. High priority objectives for surveillance.

1. Perfect an ability to measure virus amplification and transmission in real-time.
2. Develop the capability of accurately pinpointing local viral transmission zones for control purposes.
3. Establish and implement statewide arboviral surveillance protocols.

II. Strategies to meet high priority surveillance objectives.

1. Perfect an ability to measure virus amplification and transmission in real-time.

Arboviral amplification and transmission occur in Florida following a known sequence of events, which unfold in more or less the same manner year after year. To be transmitted to any significant degree, arboviruses must be amplified between arthropod vectors and vertebrate amplification hosts. Because sufficient numbers of vectors and vertebrate amplification hosts are not abundant and do not overlap throughout the entire year, the annual St. Louis encephalitis arboviral cycle in Florida can be divided into four equal phases (Day and Curtis 1999). January-March marks the arboviral maintenance phases where viruses are transmitted at low levels through the

Florida winter, which also includes the dry season. Vector abundance is at its lowest during the maintenance phase and wild birds are widely dispersed. Migrant birds have left the state and resident birds are often observed in large roving winter flocks. This makes arboviral transmission difficult to document during the winter months in Florida. The arboviral cycle for eastern equine encephalitis does not follow the same pattern as St. Louis encephalitis, and it is too soon to recognize a pattern for West Nile in Florida.

The most important period in determining the risk of human epidemics in Florida is April through June, which marks the arboviral amplification phase. This period coincides with the primary avian nesting season in Florida. It is during this period that newly hatched, highly susceptible nestling birds are available to amplify arboviruses. If high vector populations coincide with exceptional avian abundance, arboviral amplification will likely occur (Day and Stark 1999). The third phase of the annual arboviral cycle occurs between July and September and is identified as the early transmission phase. During years when amplification is particularly efficient, this phase is extremely important in terms of predicating a potential human epidemic (Day and Stark 2000). Human cases usually first appear in late July. Large numbers of human cases generally appear in August and September. The final phase is late transmission, which occurs between October and December. This phase marks the end of epidemic transmission. Amplification is no longer occurring and how quickly an epidemic ends depends on how rapidly previously infected mosquitoes die. Florida epidemics generally peak in September or October and the number of new human cases quickly declines following the epidemic peak. Sporadic human cases often appear in November and December. The duration and intensity of an epidemic depends mainly on events which occur during the amplification phase of the annual arboviral transmission cycle. In order to perfect the near real-time measurement of virus amplification and transmission, surveillance efforts have to focus on the amplification and early transmission phases of the annual arboviral cycles (Day and Lewis 1992).

Sentinel chickens provide the cheapest, most efficient, and time proven method of monitoring arboviral transmission in Florida to predict the risk of a significant outbreak of arboviral disease in the human population (Day 1991). Sentinel chicken seroconversion data were essential for the early recognition of the 1990 St. Louis encephalitis epidemic in south Florida. Sentinel chicken flocks are maintained by local agencies throughout Florida. In many Florida counties, especially those in the Panhandle and north central parts of the state, sentinel chicken flocks are not used. It is essential that funding be secured to expand, maintain, and improve the existing sentinel chicken surveillance program throughout Florida.

In many programs, sentinel chickens have traditionally been placed in the field in May or June and removed in December. With the arrival of West Nile virus in Florida it has become increasingly important to maintain sentinel chicken flocks in the field throughout the year. Each sentinel chicken should be bled weekly and positive chickens should be removed from the flock and replaced with a negative bird as soon as results for the first positive blood sample are reported.

The following represents the most common Florida practices for using sentinel chickens to evaluate arboviral transmission. The presence of hemagglutination (HI) antibody is used as the initial arboviral screen in sentinel chickens. Routinely, chickens are bled on Monday, serum is submitted for testing on Wednesday, and results are available on Friday. Sera are tested for HI antibody to eastern equine encephalitis and flaviviruses (St. Louis encephalitis/West Nile viruses). The flavivirus-positive serum samples must be identified to specific virus using either an ELISA IgM or a Plaque Reduction Neutralization Test. This adds one to two weeks to the testing procedure. It would be helpful if techniques could be developed to reduce the reporting turn around time, especially for the ELISA confirmations of West Nile/St. Louis encephalitis hemagglutination antibody results. It may be beneficial to assume that all flavivirus HI positive samples are real until proven otherwise and to base control decisions on the first reported HI results[1].

Florida sentinel chicken surveillance generally utilizes flocks of 6-8 birds each, placed at locations where exposure to mosquitoes is likely. The number of flocks placed in the field by the different mosquito control agencies varies from 4-18. Seroconversion rates in these flocks measure the magnitude of arbovirus transmission. Researchers at the Florida Medical Entomology Laboratory (FMEL), and in California, have demonstrated that the placement of individual chicken sentinels in traps designed to collect biting mosquitoes is a useful method to identify transmitting mosquitoes and to quantify the frequency of mosquito transmission in an area (Reeves et al. 1961; Rutledge et al. 2003). Individual birds are placed in the trap for a single night. All mosquitoes biting each bird are collected and stored. Birds that seroconvert, demonstrating a transmission event on that night, indicate which mosquitoes should be processed to identify the transmitting mosquito and quantify the frequency of mosquito transmission.

Equine surveillance has proven valuable in tracking the movement and transmission of eastern equine encephalitis and West Nile viruses. The availability of eastern equine encephalitis and West Nile vaccinations complicates the equine arboviral detection program, especially when serology is used to identify suspected cases. However, not all horses are vaccinated and not all vaccinated horses are protected. Mortality and morbidity of unvaccinated horses caused by eastern equine encephalitis and West Nile viruses still provides an indication of active transmission zones as long as this information becomes available to Mosquito Control and Public Health workers within a reasonable time (10 da) of the onset of symptoms in the infected horse.

Arboviral detection based on positive mosquito pools has been used to track the spread of West Nile virus and to confirm the presence of arboviruses in specific geographical areas. The use of mosquito pools for arboviral surveillance has several shortcomings: 1) the low mosquito infection rates commonly observed during inter-epidemic periods, and occasionally even during epidemics, are difficult and expensive to detect using pools of 50 field-collected mosquitoes; 2) positive PCR results are sometimes obtained in the absence of live virus, suggesting that the positive mosquito may never have contacted live virus, or that these mosquitoes once contained live virus that had subsequently died; 3) mosquito pools need to be handled and prepared under biologically safe conditions due to the potential hazard caused by viral aerosols; 4) positive mosquito pools do not separate mosquitoes capable of transmitting virus from those that are incapable of viral transmission.

New diagnostic technologies for mosquito pool analysis are becoming readily available and allow bench top analysis of mosquito pools at the mosquito control agency level. In addition to the shortcomings listed above, these new diagnostic techniques also have their own shortcomings: 1) they are expensive and 2) there is no quality control to assure the validity of the results generated under diverse laboratory conditions.

Wild bird surveillance has been used to document the presence of an arbovirus in a particular geographical area and to track changes in arboviral transmission. Dead birds were used in the northeast USA during 1999 to track the movement, or geographic spread, of West Nile virus. In many instances, dead wild birds have been the first indication that West Nile has entered a new area of North America. Wild bird serology was used to document amplification during the 1990 Florida St. Louis encephalitis epidemic (Day and Stark 1999). Wild avian serology and bird mortality are both primarily viral <u>detection</u> tools. In the absence of knowledge of the bird's exact age and travel history, little can be said about where and when it was infected. Arboviral positive juvenile birds provide more exact temporal and geographical information about virus transmission. However, birds must be accurately aged and positive data need to be reported in a timely manner. Once established, long-term annual baseline avian serological and mortality data sets may be valuable in measuring the amplification of mosquito-borne

[1] A relatively large percentage of the HI positive samples from 2002 and 2003 were not confirmed with the IgM ELISA; therefore, until this issue can be resolved, it is not considered beneficial to make control decisions based on the first results.

viruses. However, there is a possibility that the clinical impact of West Nile virus on wild avian populations may attenuate. This will result in fewer avian deaths due to West Nile virus.

Human surveillance is used to track the course of an epidemic. By the time human cases are confirmed and reported it is generally too late to mount an effective vector control effort. Therefore, human surveillance is unlikely to play a role in arboviral surveillance, the goal of which is to mitigate the number of human cases. The timely and direct reporting of early suspected human cases to local Mosquito Control and Public Health Officials, especially during the amplification and transmission phases of an epidemic, is necessary to help coordinate proactive vector control efforts. Press releases reporting confirmed human cases are an inefficient, insufficient, and inappropriate means of communication with local surveillance and control personnel.

2. Develop the capability of accurately pinpointing local viral transmission zones for control purposes.

The maintenance and transmission of many mosquito-borne viruses is often extremely focal, both in time and space. The identification of these focal transmission hot spots requires an effective, efficient, and proper arboviral surveillance program as outlined above. Pinpointing local viral transmission zones requires the integration of surveillance data into meaningful and readily accessible information. Surveillance data need to be collected to establish long-term baseline information to compare with current data sets. For example, in many Florida counties sentinel chicken seroconversion data for eastern equine encephalitis and St. Louis encephalitis viruses have been collected for more than 25 years, allowing comparison of current surveillance results with the baseline data set. In many Florida counties we know exactly what to expect, relative to sentinel chicken seroconversion rates, during any month of the year. A deviation above the monthly baseline value may be indicative of a possible epidemic threat within the surveillance region especially during June and July. Likewise, baseline data sets can be built for vector and avian amplification host populations and local meteorological conditions including rainfall and temperature.

The first step to identifying local and regional arboviral transmission zones is the collection and rapid analysis of local surveillance data and the comparison of these data to long-term baseline data sets. In addition, the collection and integration of local land use, soil type, avian population, human population, habitat types, and vector population data into a Geographical Information System (GIS) format will help identify, track, and document arboviral transmission zones. The integration of real-time weather data into the GIS format will help with the prediction of vector population emergences and movement patterns. Finally, surveillance data, GIS maps and local meteorological conditions can be formatted into a real-time local map that identifies the current risk of arboviral transmission.

3. Establish and implement statewide arboviral surveillance protocols.

Information flow is always a problem during medical emergencies. Rumors and misinformation abounds, especially when fear of the epidemic adds to the chaos. A single point of contact for directing the information flow regarding current arboviral transmission in Florida may help to alleviate the unfortunate conditions that often surround reports of arboviral-positive sentinel chickens, horses, and humans in Florida.

There is little standardization relative to vector surveillance methodologies in the state. A powerful statement can be made for the value of surveillance standardization by viewing the structure of the Florida Sentinel Chicken Surveillance Program where there is a high degree of standardization across programs that cover the entire state. Within these county-level programs, sentinel chickens are maintained according to a standardized protocol. Blood samples are collected, analyzed and documented in a way that is easily reported and interpreted. We feel that a similar program focusing on vector surveillance will be equally valuable. This may be done by standardizing vector collection methods and counts and then linking these in real-time with viral transmission indices including sentinel chicken seroconversion rates, wild bird abundance and infection rate, and mosquito infection rates. In addition to standardizing surveillance protocols, the establishment of a risk assessment team capable of obtaining, integrating, analyzing, interpreting, and making recommendations on all pertinent arboviral transmission data would greatly benefit arboviral risk assessment in Florida. The Florida surveillance programs require a solid, sustainable funding base to support statewide arboviral surveillance. This must include a credible commitment of state funds for surveillance personnel and infrastructure at the local level where surveillance data are gathered and maintained. Aside from laboratory services provided by the Florida Department of Health, virtually all surveillance expenditures and support are currently derived from local funds. This has resulted in different and variable vector surveillance methods throughout the state with the resulting difficulties in readily interpreting vector findings and comparing the arboviral transmission conditions between localities.

III. Impediments to meeting high priority surveillance objectives.

1. Perfection of near real-time measurement of virus amplification and transmission.

A limited resource base is the major impediment to an effective, efficient, and proper statewide arboviral surveillance program in Florida. Financial commitment to the program on the state and local levels is a prerequisite to its success. The best model for a successful integrated arboviral surveillance program is the already existing Florida Sentinel Chicken Surveillance program where chickens are placed in the field, maintained, and periodically bled by local personnel and sera are analyzed and reported at the state level. A similar cooperative agreement for a statewide integrated arboviral surveillance program involving the monitoring and reporting of vector population dynamics, vertebrate amplification host population structure and environmental conditions that predispose an area to an arboviral epidemic would greatly enhance the programs that already exist in Florida.

2. Develop the capability of accurately pinpointing local viral transmission zones for control purposes.

The establishment of a statewide arboviral surveillance program that is standardized and compatible between various programs is a necessary prerequisite for accurately pinpointing arboviral transmission zones. Once local data are collected, GIS technology will allow the construction of local risk maps to help evaluate the status of arboviral transmission to humans. Problems with current GIS systems include the steep learning curve and the startup expense associated with these programs. There is currently a lack of appreciation for the power of GIS data integration programs and how GIS programs can be used to map and assess the risk of real-time arboviral transmission on the local level.

3. Establish and implement statewide arboviral surveillance protocols.

There are currently limited resources and funding to support local arboviral surveillance programs. Funding sources and long-term surveillance plans and goals need to be established on the state and local levels. There is currently a poor understanding of surveillance issues by state legislators. Education efforts need to be undertaken to stress the importance of long-term arboviral surveillance programs to the Florida economy and the health and well-being of Florida residents and their domestic animals. Recent reductions in the Florida Department of Agriculture and Consumer Services (DACS) Bureau of Entomology and Department of Health (DOH) Epidemiology Sections is clearly movement in the wrong direction, resulting in even fewer resources to protect Florida's citizens and economy from the impact of an arboviral disease epidemic. There is also a lack of facilities and programs to train Florida's public health workers, mosquito control professionals and medical entomologists. These trends need to be reversed if Florida is to escape the massive arboviral epidemics that were experienced throughout the mid-west during 2002.

IV. Overcoming the impediments to meeting high priory surveillance objectives.

1. Perfection of near real-time measurement of virus amplification and transmission.

It is important to increase public awareness of the need for integrated arboviral surveillance throughout Florida. It is important that public health and mosquito control professionals educate the public about the importance of this issue. Public Service Announcements can also be used to educate the public about the effectiveness of well-run arboviral surveillance programs. Success of the existing Florida Sentinel Chicken Surveillance Program can be used as an example of the value of early warning to mitigating an impending arboviral epidemic emergency. It is important to effectively communicate the costs and benefits associated with local and statewide arboviral surveillance programs. It is also important to establish a single, apolitical position to coordinate and disseminate surveillance data and information to all cooperating agencies in a timely manner.

There must be an increase in State and Federal funding for local arbovirus surveillance programs. The entire state of Florida will benefit from a coordinated and well-run integrated arboviral surveillance program. It may be possible to link Florida arboviral surveillance programs to new and existing Emerging Infectious Disease initiatives as well as to Bioterrorism initiatives at the Federal level as well as to existing arboviral surveillance programs and other Southeastern states.

2. Develop the capability of accurately pinpointing local viral transmission zones for control purposes.

It is important to increase Local, State, and Federal funding for projects designed to measure and assess the real-time risk of arboviral transmission. The initiation of local pilot projects to demonstrate the utility of GIS risk assessment for real-time arboviral transmission may help to educate local and state legislators about the importance of arboviral surveillance.

3. Establish and implement statewide arboviral surveillance protocols.

An increase in funding is a requisite for the establishment of statewide arbovirus surveillance protocols. Funding sources must be established to support local surveillance programs and the statewide support network that will help to analyze and disseminate the surveillance results. There should be an increase of funding for the Florida DOH Tampa Laboratory so that this support unit can continue to analyze sentinel chicken, wild bird, and mosquito samples in a timely manner. There should also be an increase in state funding for the local Florida sentinel chicken surveillance programs, mosquito surveillance, and the integration of surveillance data into GIS risk maps on the local level. Such funding is essential to establish a single source Florida training program that will serve to train public health and mosquito control professionals in the variety of surveillance tools that they will require. The statewide training program is essential to ensure that information collected by local organizations can be readily interpreted and will be useful in assessing risk throughout the state. Finally, funding should be made available to establish a Florida Professional Arboviral Risk Assessment Team. The currently existing Arboviral Partners Committee, which is organized by the Florida Department of Health, may serve as a template for the Risk Assessment Team.

Potential sources of funding include an increase in the mandated waste tire money to establish a funding base dedicated to the Florida arboviral surveillance program. Money may also be made available through additional legislative mandates. Finally, it is critically important that a Public Health Medical Entomology Training Facility is established to train public health and mosquito control workers in Florida.

V. Concluding remarks.

Forecasting the risk of human arboviral infection in Florida depends on the implementation of an effective, efficient, and proper integrated arboviral surveillance program throughout the state. The purpose of this program will be to monitor the abundance and activity patterns of vector-borne arboviruses, arboviral vectors, known vertebrate amplification hosts, and the environmental conditions that predispose a region of the state to vector-borne disease epidemics. Without an integrated arboviral surveillance program, Florida will remain at very great risk from arboviral epidemics that may have a devastating impact on public health and the Florida economy. Such epidemics have the potential of claiming hundreds or even thousands of victims. Florida can ill afford the adverse publicity associated with such an epidemic. The impact of such an epidemic on tourism and the Florida economy will be devastating. The only way to avoid the impact of a major arboviral epidemic is to recognize warning signs long before human cases appear. The only way to recognize the warning signs is to institute a statewide integrated arboviral surveillance program that is effective, efficient, and proper. Failure to do so will result in an inability to mitigate the consequences of a future arboviral outbreak. The West Nile virus situation in the U. S. during 2002 does not forebode well for Florida. A future arboviral epidemic with 1000's of human cases is likely to occur in South Florida.

IDENTIFYING VECTOR SPECIES AS TARGETS FOR VECTOR CONTROL

G. F. O'Meara, R. Betts, T. P. Breaud, L. J. Hribar, E. Schreiber

To apply efficient, effective and appropriate mosquito control measures to combat outbreaks of West Nile virus in Florida, it is essential to know the major vector(s) transmitting this pathogen to humans and other organisms. Unfortunately, at the present, insufficient information is available for definitely identifying the primary and secondary vectors of West Nile virus. During 2001, West Nile virus was detected at numerous locations throughout Florida, with human cases occurring in northern Jefferson County near the FL-GA state line and in southernmost part of state – the Florida Keys.

Efforts to identify the enzootic and the epizootic/epidemic vectors of West Nile virus in the United States have been focused primarily on (1) the laboratory based studies assessing vector competence (Turell et al. 2001a; 2001b) and (2) the examination of field collected mosquitoes to determine what species had encountered West Nile virus (O'Leary et al. 2002). Although these studies have provided some valuable clues as to what mosquito species might be involved in West Nile virus transmission, vector incrimination beyond the speculation stage will require additional information on mosquito host feeding patterns, seasonal abundance, field transmission rates, and adult female longevity and dispersal under various environmental conditions. Vector species for West Nile virus in Florida may differ from those found in other parts of the United States, and even within Florida vector species many vary seasonally and geographically.

I. High priority objectives for identifying vector species.

1. Increase the opportunities for training in proper mosquito identification techniques.
2. Investigate potential sibling/cryptic species.
3. Obtain better understanding of the bionomics of the likely suspects.
4. Collaboration and cooperation between research labs and all agencies.
5. Increase research on biology of suspected vectors.

II. Strategies to meet high priority objectives for identifying vector species.

Only a few of the 77 species that comprise Florida's mosquito fauna are likely to play a major role in the transmission of West Nile virus. Thus, the participants in this workshop session considered the most likely suspects – namely members of the subgenus, *Culex* (*Culex*). Four members of this group (*Cx. nigripalpus, Cx. quinquefasciatus, Cx. restuans* and *Cx. salinarius*) are widely distributed throughout the state (Darsie and Morris 2000).

1. Increase the opportunities for training in proper mosquito identification techniques.

Identifying to species adult Culex (Culex) captured in various types of traps is not easy, particularly when many of the mosquitoes have lost a large portion of their body scales. Hence, records of mosquito monitoring activities often include data on the number Culex (Culex) or Culex spp. collected. A large number of the mosquito pools designated as West Nile virus positive in West Nile virus surveillance programs conducted in the United States since 1999 have been mixtures of two or more Culex (Culex) species or have been pools of Culex mosquitoes (species unknown). This problem could be alleviated if more individuals had the opportunity to obtain training in mosquito identification. The Florida Mosquito Control Association, the Florida Medical Entomology Lab, Florida Dept. of Agriculture and Consumer Services and the John A. Mulrennan, Sr., Public Health Entomology Research and Education Center offer courses in mosquito identification, ranging from the introductory to the advanced level.

Improved protocols for collecting mosquitoes might lessen the frequency of so-called “rubbed specimens” (those that are missing scales and other markers characteristic for a species). However, Culex (Culex) generally are long-lived mosquitoes, a feature that enhances their capacity for serving as vectors for certain pathogens, and scale loss is just part of the aging process. Very accurate genetic techniques have been developed for distinguishing Culex (Culex), but these methods are too costly and time consuming for routine monitoring activities which must process large numbers of mosquitoes on a daily or weekly basis (Crabtree et al. 1995).

2. Investigate potential cryptic/sibling species.

Very few studies have examined Florida *Culex* (*Culex*) for the occurrence of sibling species (i.e., species that are morphologically similar but genetically distinct) or for other types of genetic differences among populations. Sibling species have been detected in other Florida mosquitoes, notably the *Anopheles quadrimaculatus* and *Anopheles crucians* complexes (Reinert et al. 1997; Kreutzer and Kitzmiller 1971). Climatic conditions, which differ considerably between north and south Florida, undoubtedly are important factors limiting distribution of some mosquito species, and they also may contribute to the establishment and maintenance of genetic differences among populations that impact vector potential. Nearly one-half of the mosquito species occurring in Florida are restricted in their distribution to either the northern part of the state (temperate species) or the southern part of the state (tropical or subtropical species) (Darsie and Morris 2000). For species with statewide distributions, populations often vary geographically in terms of seasonal patterns of abundance, reproductive biology, and other traits that influence the mosquito’s ability to serve as a vector (O’Meara and Evans 1973). Studies which attempt to identify the vectors of West Nile virus in Florida should not assume that all populations of a species are similar in terms of their vector potential.

3. Obtain better understanding of the bionomics of the likely suspects.

West Nile virus and St. Louis encephalitis virus have similar transmission cycles with birds serving as the amplification hosts and other vertebrates, including humans, being primarily dead end hosts. The primary enzootic and epizootic/epidemic vectors of St. Louis encephalitis virus are *Cx. nigripalpus* in Florida and *Cx. quinquefasciatus* elsewhere in the southeastern United States. Both species might play a similar role in the transmission of West Nile virus. By contrast, in the northeastern United States none of the mosquito species currently suspected as important enzootic vectors of West Nile virus is considered an epizootic or epidemic vector of West Nile virus.

Many of the characteristics that make *Cx. nigripalpus* a major vector of St. Louis encephalitis virus also make it a likely candidate for being the primary vector of West Nile virus in Florida[2]. *Culex nigripalpus* occurs in a wide range of aquatic habitats, which vary considerably in size, water quality conditions and permanency (Provost 1969). No other mosquito species in Florida is able to invade and to thrive in so many different types of aquatic habitats. Immature *Cx. nigripalpus* frequently are more abundant in anaerobic, highly nutrient-rich wastewater lagoons than *Cx. quinquefasciatus*, the quintessential wastewater mosquito throughout much of the southern United States (O’Meara and Evans 1983). *Culex nigripalpus* is also a common mosquito in less nutrient-rich systems, including ponds, lakes and borrow pits (in areas with emergent or floating vegetation), stormwater drainage and retention swales, and drainage and irrigation furrows in citrus groves. Water accumulations in artificial and natural containers may harbor *Cx. nigripalpus* larvae, especially when leaf litter and other types of organic debris are present. In south and central Florida, *Cx. nigripalpus* populations are reproductively active year round; however, activity slows noticeably in the winter and early spring; albeit during this period larvae can be collected

[2] Indeed in 2002 and 2003, *Cx. nigripalpus* was the predominant West Nile infected species in Florida.

readily in bay swamps and permanent/semi-permanent aquatic habitats.

Adult *Cx. nigripalpus* can be extremely abundant in both rural and urban settings throughout peninsular Florida with peak production normally following periods of heavy rainfall, which greatly increase the availability of aquatic habitats for this mosquito. It is very difficult to accurately assess the longevity of female *Cx nigripalpus* under field conditions, which typically vary spatially and temporarily. Yet, the fact that *Cx. nigripalpus* is the major vector of St. Louis encephalitis virus in Florida indicates that this mosquito probably has sufficient longevity to be a vector of West Nile virus.

During periods of drought or minimal rainfall, *Cx. nigripalpus* females remain in woodlands and related habitats, a trait which enhances longevity and vector potential (Shaman et al. 2002). Once the drought is broken by heavy rainfall events, the rise in relative humidity stimulates flight activity and the dispersal of females to other habitats (Dow and Gerrish 1970; Day and Curtis 1994).

Female *Cx. nigripalpus* obtain blood meals from a wide range of hosts with avian sources predominating during the drier months and mammals during the rainy season (Edman and Taylor 1968; Edman 1974). This shift in host feeding pattern is a key factor contributing to the ability of *Cx. nigripalpus* to serve as both the enzootic and epidemic vector of St. Louis encephalitis virus in Florida, and this trait would also enhance this mosquito's potential for vectoring West Nile virus. Generally, one blood meal is sufficient for the production of an egg batch by a *Cx. nigripalpus* female; but multiple blood feeding episodes within a single ovarian cycle, another trait that increases vector potential, may occur occasionally (Anderson and Brust 1995).

As *Cx. nigripalpus* search for sugar sources, blood sources, oviposition sites and resting sites, they may fly several miles from their larval habitat during their adult life span (Nayar et al. 1980). The distribution of these resources and the suitability of conditions for flight are the main factors regulating the overall dispersal of this mosquito (Day and van Handel 1988). Certainly, in terms of dispersal capacity, *Cx. nigripalpus* ranks among the more highly mobile Florida mosquito species.

Most laboratory studies on *Cx. nigripalpus* have used the same colony strain, which originated from material collected in the Vero Beach area. Establishing a laboratory colony of *Cx. nigripalpus* is a very difficult task. Undoubtedly, this factor has discouraged scientists from comparing populations for differences in behavioral, physiological and other traits. Given the wide distribution of this mosquito in the Americas, it is likely that there is a considerable amount of geographical variation within this species. Most field studies on *Cx. nigripalpus* have been conducted in south-central Florida; hence, much less is known about the bionomics of this mosquito in the northernmost and southernmost sections of the state.

Also on the short list of Florida mosquito species likely to play a major role in West Nile virus transmission is *Culex quinquefasciatus*[3], which possesses many of the same characteristics that contribute to the vector potential of *Cx. nigripalpus*. The southern house mosquito, *Cx. quinquefasciatus*, feeds on both birds and mammals, occurs throughout the state and can be extremely common at least near its larval habitats, which often have been made available by human activities. Seasonal patterns of abundance of *Cx. quinquefasciatus* differ significantly from those of *Cx. nigripalpus*. In peninsular Florida, *Cx. quinquefasciatus* populations typically reach peak abundance in the late winter and spring. *Cx. quinquefasciatus* is much more dependent upon nutrient-rich aquatic habitats than is *Cx. nigripalpus*.

The arrival of the rainy season, which in central and south Florida normally begins in late spring, usually initiates a major expansion in the occurrence of ephemeral aquatic habitats that favor the production of *Cx. nigripalpus* but not *Cx. quinquefasciatus*. Heavy rainfall events may dilute eutrophic aquatic habitats making them unsuitable for *Cx. quinquefasciatus*; however, even in animal waste lagoons, where the nutrient loads are essentially unaffected by rainfall, the abundance of

[3] In 2002 and 2003, *Cx. quinquefasciatus* were detected in Florida with West Nile virus.

immature *Cx. quinquefasciatus* normally drops precipitously in the summer and fall (O'Meara and Evans 1983).

On the other hand, drought conditions, especially in the spring, may greatly enhance the production of *Cx. quinquefasciatus* as nutrient load increases with decreases in water volume. Under these conditions, small lakes and ponds may become ideal aquatic habitats for *Cx. quinquefasciatus*. *Culex nigripalpus* is primarily a subtropical species that thrives under warm, humid conditions. The duration of these conditions in Florida generally decreases with increasing latitude so that *Cx. nigripalpus* has the shortest season of peak activity in north Florida. Here, *Cx. quinquefasciatus* might serve as the primary vector of West Nile virus early in the year with *Cx. nigripalpus* taking over this role later in the year.

In a recent study conducted in the lower Florida Keys, Hribar et al. (2001) found immature *Cx. quinquefasciatus* much more frequently than immature *Cx. nigripalpus* in various types of artificial containers. Sampling was conducted on three Islands (Big Coppitt, Stock and Key West) from late winter until early summer. It would be informative to determine if the predominance of *Cx. quinquefasciatus* over *Cx. nigripalpus* in artificial containers persists throughout the year. Container size affects the oviposition behavior of gravid *Cx. nigripalpus* females, which are much more likely to select larger containers over smaller ones (O'Meara et al. 1989).

Improvements in wastewater treatment and disposal procedures, implemented in Florida during the last 10-15 years, have helped to alleviate some of the mosquito problems associated with nutrient-rich aquatic systems. Many small "package plant" sewage treatment systems, which served residential subdivisions, trailer parks, schools and other facilities, have been eliminated as regional municipally operated systems have expanded. Effluent from old package plant sewage treatment systems usually flowed into a nearby small holding pond, and because these systems typically were poorly maintained, these ponds invariably produced large numbers of mosquitoes, especially the wastewater specialists - *Cx. nigripalpus* and *Cx. quinquefasciatus* (Carlson 1982). By contrast, now a large portion of the effluent from regional sewage treatment facilities is recycled or disposed of in a manner that usually does not generate a severe mosquito problem. Code enforcement of the on-site treatment operations has also improved in recent years. Septic ditches, used for wastewater disposal in some southern states, are not allowed in Florida. There still is, however, a substantial need to further reduce the levels of mosquito production from wastewater systems, but the overall trend is in the right direction.

To comply with state and federal regulations on stormwater runoff from urban and suburban areas, many communities have, or are in the process of implementing, treatment practices to reduce the adverse impact of stormwater runoff on streams, rivers, lakes and estuaries. Far too often stormwater treatment systems are installed and operated without adequately considering their impact on mosquito production. Dry retention systems (those that dry out between storms), one of the more popular stormwater treatment techniques with environmental agencies, frequently are a favorable site for mosquito production when they are installed in low-lying areas with high water tables. In these locations, dry retention systems invariably become waterlogged during the rainy season, providing suitable aquatic habitats for *Cx. nigripalpus* and other mosquito species.

Of the numerous mosquito species that have been evaluated for their ability to serve as a West Nile virus vector, *Cx. restuans* and *Cx. salinarius* have the highest relative vector competence rating (http://www.cdc.gov/ncidod/dvbid/westnile/conf/march_2002.htm). In the northeastern United States more mosquito pools of *Cx. restuans* and *Cx. salinarius* have been detected with West Nile virus than any other species, with the exception of *Cx. pipiens*. Based on these findings and information on the distribution, abundance and host blood feeding patterns, *Cx. restuans* ranks high on the list of potential enzootic vectors of West Nile virus, whereas *Cx. salinarius* could be an excellent epizootic/epidemic vector of this pathogen. Although populations of *Cx. salinarius* and *Cx. restuans* can at times be extremely abundant in the northernmost parts of Florida, they generally are less common and have a shorter season of adult activity in the southern part of the state. Geographical differences in species abundance and distribution are most pronounced in *Cx. restuans*, which is relatively uncommon and has a very brief period of peak activity throughout much of south Florida. Consequently, on a statewide basis, *Cx. salinarius* would appear to have a greater potential for vectoring West Nile virus than *Cx. restuans*.

Culiseta melanura, the enzootic vector of eastern equine encephalitis virus, also may play a role as an enzootic vector of West Nile virus, but its impact would be limited to foci in and near the mosquito's highly specialized aquatic habitat. In surveillance programs conducted in the United States during 2001 more than two dozen pools of *Cs. melanura* tested positive for West Nile virus. Additional studies are needed to (a) determine if West Nile virus infected *Cs. melanura* are capable of transmitting this virus to vertebrates and (b) evaluate the role this swamp-inhabiting mosquito might play in the epidemiology of West Nile virus in Florida.

From field collections taken in Florida during 2001, more than 40 mosquito pools were identified as West Nile virus positive (i.e. either for the virus or for viral RNA). Most of the West Nile virus positive pools were from north Florida, particularly Jefferson County, but several came from Monroe County in the southernmost part of the state. The significance of data derived from the analysis of mosquito pools is difficult to assess without additional information on how many pools were tested, when and where the mosquitoes were collected, and how they were processed. Moreover, just because a mosquito is infected with West Nile virus, does not mean that it is capable of transmitting this virus to vertebrates (Rutledge et al. 2003). Before a mosquito species is classified as a vector of West Nile virus, we need to know the relationship between infection rates and transmission rates under various field conditions.

4. Collaboration and cooperation between research labs and all agencies.

Advancements in knowledge concerning the vectors of West Nile virus in Florida can be achieved most effectively by means of long-term collaborative/ cooperative endeavors, involving research laboratories, mosquito control agencies, DACS, DOH and various other state and federal agencies. Without an extensive statewide West Nile virus surveillance program that provides pertinent and timely information on virus activity and amplification trends, it will be difficult to assess accurately what roles various mosquito species play in transmitting West Nile virus to birds or mammals.

Florida mosquito control agencies, through their mosquito monitoring activities, have amassed a considerable amount of data on the distribution and relative abundance of potential West Nile virus vectors. Most mosquito control agencies currently maintain their mosquito collection records in easily accessible electronic format. Analyses and comparisons of these mosquito collection records from different climatic regions within Florida could provide some valuable insights as to why the importance of certain mosquito species as potential West Nile virus vectors may vary regionally. This endeavor also might provide a basis for developing improved methods for monitoring the distribution and abundance of suspected vectors of West Nile virus.

5. Increase research on the biology of suspected vectors

The highest priority should be given to experiments that are designed to identify the mosquito species that are transmitting West Nile virus to birds and mammals. We need more studies like the one conducted by the FMEL's rapid response team during the summer of 2001 in Jefferson County, FL, which clearly demonstrated the transmission of West Nile virus to a sentinel chicken by *Cx. nigripalpus* (Rutledge et al. 2003). This study also found that a large percentage of the West Nile virus infected mosquitoes were not capable of transmitting this virus to a vertebrate host. Additional studies are needed to determine why the capacity for transmitting West Nile virus varies among West Nile virus infected mosquitoes.

Adult longevity greatly influences the ability of a mosquito species to serve as a vector of West

Nile virus and other arboviruses. A mosquito species might have all the other attributes necessary for being a good vector; however, without sufficient longevity it will be unable to play a major role as a vector. Measuring longevity under field conditions is a difficult task, with investigators typically dependent upon indirect methods for assessing adult age. Although several studies have examined longevity in populations of *Culex nigripalpus* and *Cx*. *quinquefasciatus*, our understanding of how this trait is influenced by environmental factors, such as temperature, relative humidity, rainfall, etc., is still quite incomplete. Therefore, high priority should be given to research designed to accurately measure mosquito longevity under a variety of field conditions.

III. Impediments to meeting high priority goals of identifying vector species.

Will interest and funding for research on potential West Nile virus vectors wane as the newness of the West Nile virus invasion of Florida wears off? Meeting the goals listed above will require long-term commitments to interagency cooperation and adequate funding for multi-year research projects. If the year-to-year incidence of human West Nile virus infections in Florida follows a pattern similar to that of human St. Louis encephalitis virus infections, where major outbreaks occur only occasionally, then sustaining interest and commitments will be difficult.

The chances for major increases in funding from federal, state or local sources are not favorable. During the initial phase of the West Nile virus invasion, the CDC provided funds that were used primarily for improving laboratory diagnostic capabilities. Since September 11, 2001, priorities for CDC have changed drastically with much greater emphasis being placed on protecting citizens from the threat of bioterrorism. In recent years, state funding for mosquito control and research has not kept up with inflation. Although additional funding for mosquito control was included in the budget approved by the 2002 Florida legislature, the Governor vetoed this item[4]. At the local level, many mosquito control units are inadequately funded; a condition that is unlikely to change in the near future. Personnel from local mosquito control units frequently perform the tasks of maintaining sentinel chicken flocks and collecting blood samples with reimbursement from the state usually covering only a portion of the costs associated with these activities. Current budgetary limitations preclude any meaningful expansion in the overall sentinel chicken program.

Concern about the adverse impact of West Nile virus on Florida’s economy, which is heavily dependent on tourism and the influx of retirees, has fostered efforts to downplay the health risks of West Nile virus infections in humans. On the other hand, exaggerations of danger of West Nile virus are not uncommon, particularly in some advertisements for mosquito control products. Amid the confusion caused by these different messages, it is not easy to develop and to promote a more balanced and accurate message about the public health impact of West Nile virus, what mosquito control is doing to reduce this impact and why additional information on vector species will make mosquito control operations even more effective.

Not only is West Nile virus widely distributed throughout Florida, but transmission of this virus to vertebrates seems to be occurring throughout the year even in the northernmost sections of the state (http://www.doh.state.fl.us). These findings strongly suggest that more than one species of mosquito may be involved in the transmission of West Nile virus, with vector species varying seasonally and geographically. Year to year variations in climatic conditions might further complicate efforts to identify vector species. Obviously, short-term studies conducted in just one or two locations will furnish at best a very incomplete assessment of the vectors of West Nile virus in Florida.

[4] Additional state funds in support of emergency mosquito control operations were included in the 2003 state budget, though none was earmarked to expand surveillance or research.

IV. Overcoming the impediments to meeting high priority objectives of identifying vector species.

Opportunities for mosquito control staff to attend the Florida Mosquito Control Association's (FMCA) Dodd Short Course Program and training programs offered by FMEL, Public Health Entomology Research and Education Center (PHEREC), Florida Department of Agriculture and Consumer Services (FDACS) and other organizations should be expanded. New training programs should be developed which utilize interactive, long-distance delivery methods and user-friendly, web-based resources. Shifting educational materials from print to electronic formats would reduce distribution costs, increase accessibility and offer new opportunities for updating the content.

Interagency cooperation and the sharing of expertise and resources will be essential for success in developing, funding and implementing long-term research directed at the identification of West Nile virus vectors. Activities that would foster this cooperation and collaboration include the convening of interagency workshops on West Nile virus and the establishment of committees by the Florida Coordinating Council for Mosquito Control and the Florida Mosquito Control Association to deal with issues related to the control of West Nile virus and other arboviruses in Florida.

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LARVAL MOSQUITO CONTROL

C. R. Rutledge, F. Clarke, A. Curtis, S. Sackett

Control of mosquitoes in the larval stage is a necessary and efficient tool in Integrated Pest Management (IPM) of mosquitoes. As with the other tools in IPM, an active mosquito surveillance program is critical for effective control of mosquitoes in the larval stage. The distribution of mosquito larvae in any given larval habitat is limited to the boundaries of the water source. During the immature stage, mosquitoes are relatively immobile; remaining more concentrated than they are in the adult stage. This aspect of the larval stage allows the most efficient opportunity for chemical/biological control since one application in a confined area has the potential to prevent an entire brood from emerging as adults.

Controlling mosquitoes in the larval stage can be accomplished by 2 methods, source reduction and larviciding. Source reduction is a means of permanent control that involves physically modifying, improving the quality, or removing a water source for larval mosquito development. Examples of source reduction include used tire removal, constructing and maintaining channels and ditches, impounding water, and aquatic weed removal. Larviciding involves the application of pesticides to the water where mosquitoes are developing to kill mosquito larvae (stomach toxins, contact pesticides) or prevent them from emerging as adults (surface control agents, insect growth regulators, and natural agents).

The following is a discussion of larval control strategies developed by participants in the workshop that describes an ideal response to West Nile virus by Florida's Mosquito Control agencies. It should be noted that the response relies on a thorough mosquito surveillance system that is already in operation.

I. High priority objectives for larval mosquito control.

1. Develop an inventory of larval developmental sites by species.
2. Maintain on-going larval surveillance and control.
3. Target control to areas known as developmental sites for vectors of West Nile to interrupt the amplification phase.

II. Strategies to meet high priority objectives for larval mosquito control.

1. Develop an inventory of larval developmental sites by species.

To minimize the impact of West Nile virus in Florida, mosquito control agencies should have an established, on-going larval surveillance program. There should be an inventory of known larval developmental sites within the county (those that are not considered appropriate for source reduction) that includes the site location, a description of the habitat, seasonality of flooding, property owner information, and the mosquito species that are known to occur there.

High risk areas need to be identified on a regular basis as new data are generated by other components of the surveillance/mosquito control IPM program (i.e., sentinel chicken reports, biting counts, etc.) Considering the information that we currently have about the transmission cycle of West Nile, areas of risk should include water sources where the suspected *Culex* vectors of West Nile virus are known to develop, water sources that are potential larval production sites based on the characteristics of the water, known nesting sites for birds, human habitations, and mosquito adult numbers and species. Locations for each of these variables can be entered into a mapping program (GIS, Arc View) and overlaid to show the areas of highest risk. These areas should be the first targets for continued larval surveillance and larviciding efforts.

After risk areas have been determined, a decision must be made on whether or not to larvicide or implement quick source reduction measures. The decision will be based on the target species and the predominant stage of the larvae (1st, 2nd, 3rd, 4th-instar, pupae). Experience with local species within a district is critical. Other information that should be used when making this decision is the cost of the larvicide, the application equipment, the total area to be covered, the effectiveness of the product in a given water source, manpower available, public perception, and risk to public health based on arbovirus activity in a region.

2. Maintain on-going larval surveillance and control.

Once the inventory is in place, and sites that are not appropriate for source reduction are determined, sampling at the sites should be done at regular intervals to estimate the population density and to aid in the decision of whether or not to larvicide. The mosquito instar and species in the sample and the water conditions (brackish, polluted, rain, etc.) should be identified immediately. Various products and formulations of larvicides are available for specific mosquito species and water conditions. The decision to larvicide needs to be made quickly; the appropriate technique for a particular larval stage must be used whether the product is a biological, an organophosphate, an oil, or any new technology available. Late fourth-instar larvae and pupae are not susceptible to some larvicides.

If application of commercially available larvicides is not warranted, there are other techniques that can be used to control this life stage of the mosquito. Natural control agents or surface control agents may be appropriate. Natural control agents that are currently available include predacious fish, predacious mosquito larvae, and copepods. Other natural agents that once seemed promising, the fungus *Lagenidium giganteum*, nematodes, protozoans, and algae, have produced mixed results in the field and problems with storage. At this time, these agents need additional development and would not be appropriate to use in response to West Nile virus control. Surface control agents available in Florida include a monomolecular surface film, some surfactants, and several oils.

Habitats that have later stage larvae should be given priority. Given the amount of manpower available, a threshold should be established that acknowledges that there is a possibility that larviciding may have to be suspended if it is physically impossible to treat all of the high-risk sites before the mosquito larvae reach a stage where they stop feeding or otherwise not affected by the product.

The next step is to determine the best methodologies for specific areas. Factors to consider include environmental sensitivity of the water source, size of the area to be treated, accessibility of sites, seasonality, the age of the larvae, whether or not pupae are present, and the level of alert determined by the Health Department. Timing of application is also important; larviciding won't affect mosquito infection rates for at least 5 days, and transmission to humans for 15 days or more, depending on the temperature.

Larval control of some species, especially those that inhabit containers, is best approached through public education by encouraging people to empty water-holding containers and to clean up yards and vacant lots.

3. Target control to areas known to produce vectors of West Nile to interrupt the amplification phase.

With an inventory of larval developmental habitats and potentially high risk areas in place, mosquito control can target those areas during the time of year when virus amplification occurs, that is, April – June. During this phase, adult mosquitoes and birds come into contact with one another and begin building and increasing the amount of arbovirus circulating in a given habitat. By reducing the number of larvae of vector species early in the year, there will be fewer adults around to feed on infected birds. This could interrupt or minimize the amplification process, thereby having an impact on reducing West Nile transmission.

III. Impediments to meeting high priority larval mosquito control goals.

1. Develop an inventory of larval developmental sites by species.

Impediments include lack of manpower to look for sites; lack of training in mosquito identification; inaccessibility of some sites due to difficulty in getting to the site (rough terrain, locked gates, etc.); or the site being on state-owned lands where mosquito professionals are not allowed to work.

2. Maintain on-going larval surveillance and control.

Impediments to continuation of a larval surveillance program include budget reductions that may lead to reductions in staff or to decisions to abandon the program; public perception that mosquito control agencies are not doing their job if they aren't out driving the spray truck; and inaccessibility of sites.

Impediments to larval control include reluctance on the part of homeowners to clean up their property; discovery of larvae at an advanced stage when some products will not be effective; and problems with effectiveness of the product used.

3. Target control to areas known to produce vectors of West Nile to interrupt the amplification phase.

The main impediment to targeted control of the vector species is the lack of information on the specific vectors. Once the vectors have been determined, then it is a matter of concentrating on their known larval habitat preferences, proper timing, and determining the appropriate technology to use.

IV. Overcoming the impediments to meeting high priority larval mosquito control goals.

1. Develop an inventory of larval developmental sites by species.

Mosquito control agencies should recognize the importance of training offered by the Florida Mosquito Control Association, Florida DACS, and the two Universities (FMEL/UF; PHEREC/FL A&M), and send their employees to training on a regular basis. There are several opportunities every year, in addition to special training at a district or lab when requested.

Directors and managers of mosquito control programs should make sure that their commissioners understand the importance of larval surveillance. Continual reminders of this throughout the year can be important when budgets are being revised and/or cut. Mosquito control managers can demonstrate to their commissioners how efficient and effective larviciding can be when it is part of an IPM program. This could also support requests for ATV's for those areas that are logistically difficult to monitor.

Mosquito control personnel should work with the private land owners early in their program to develop a positive working relationship. The benefits of allowing larval surveillance on their land should be explained to land owners prior to requesting permission to enter their property. Once a relationship is established, access to the property should not be a problem.

For state-owned lands, wildlife refuges, agricultural areas, and privately owned areas that may be inaccessible because of fences, gates, or extensive acreage, communication with land managers and owners should be established as soon as larval sites are determined. It is important to work with them to provide information to them concerning potential vectors that are produced on their property, and to maintain communication throughout the year so that relationships are established prior to any medical emergency. They should maintain this dialogue during an emergency situation.

2. Maintain on-going larval surveillance and control.

Public perception about larviciding is a sensitive issue. Many Florida citizens have become accustomed to seeing a spray truck driving in their area for mosquito control. Because larviciding utilizes different technology and different application sites, it may appear that mosquito control is not doing anything about the mosquitoes in an area. This misconception can be addressed through educational programs, Public Service Announcements, and newspaper articles. The message should be consistent and is best delivered in a proactive manner. Educational and public relation programs should begin prior to the mosquito season. Frequent communication with local journalists is important and should and be stepped up during a medical alert or emergency.

Again, to prevent budget cuts that might affect larval surveillance and control programs, directors and managers of mosquito control programs should make sure that their commissioners understand the importance of larval surveillance. Because larval surveillance is not highly visible, continual reminders and demonstrations of how important it is are necessary. The impact of larval control should be mentioned at Board Meetings, in public, and during educational programs.

Mosquito managers need clear definitions of alerts and emergencies from the Health Department. Some prior notice that a press release is going to be issued for a Medical Alert or Medical Emergency would be extremely beneficial to mosquito control directors. With a clear definition of alerts and emergencies, and some advance notice, mosquito managers can to go to their commissioners with this information if there is a need to increase the larviciding budget.

For homeowners who are reluctant to empty their containers or clean up their property, during a Medical Emergency it may be necessary to obtain assistance from other agencies and code enforcement to ensure that water holding containers are removed.

Maintenance of biological material for larval control is time-consuming, expensive, and should be established early in a larviciding program. Some products have a short shelf life, which must be monitored. Native fish should be introduced into areas that are not likely to dry up, and in water that is suitable for the fish. It should be understood that biological control is not always feasible. The first-time use of fish should not be considered during a medical emergency.

3. Target control to areas known to produce vectors of West Nile to interrupt the amplification phase.

To understand more about the habits of the West Nile vectors, research support for the University labs is necessary, either through direct funding of projects by the mosquito control agency, or letters of support to Florida DACS for funding specific project proposals that relate to West Nile vector research.

The method of larval control depends on the species targeted and the stage of the larvae. Areas that produce large numbers of mosquitoes, such as salt-marsh species, may require a source reduction method that includes constructing drainage ditches or impounding water. Some of these areas may be too large, and therefore too expensive, to treat with a larvicide. New technology with ULV is being developed and may be considered in such large areas.

If it is late in the season and cool weather is expected, it may not be necessary to treat larvae. If larviciding is the preferred control method, an increase in the frequency of sampling may be necessary to avoid missing the susceptible larval stages.

ADULT MOSQUITO CONTROL

C. C. Lord, D. Carlson, F. Jones, M. D. Latham

Adult mosquito control is a critical part of protecting the public from mosquito-borne disease. Not only is it the last option for control of populations which cannot be managed at the larval stage, it is the only way to directly impact *infected* vectors. However, control of mosquitoes in the adult stage is difficult, expensive, and has the potential for non-target impacts. Hence, it is critical that adult mosquito control be precisely targeted towards specific vector species to have the largest impact possible on virus transmission.

I. High priority objectives for adult mosquito control to reduce the impact of West Nile virus in Florida.

1. Define and implement a targeted control strategy towards the specific vector(s).
2. Ensure that an effective adult mosquito control program is available in all areas of the state.
3. Define appropriate triggers for proactive adult mosquito control to minimize disease transmission.

II. Strategies to achieve high priority objectives for adult mosquito control.

Strategies were developed from extensive discussion considering topics including whether or not control of certain species is attainable, standard practices which can be used for control, and variations on treatment protocols which are useful under some conditions.

1. Define and implement a targeted control strategy towards the specific vector(s).

To define targeted control strategies against West Nile virus vectors, we need to ensure that the treatment uses an appropriate and effective chemical. The chemical needs to be delivered using an appropriate system, whether ground or air, for the particular mosquito species and geographic area of interest. The treatment must be tailored to the biology of the mosquito, including delivery at the appropriate time of day for the activity pattern of that species. Treatment area must be considered; generally treatment of larger areas will provide more effective control, but will also be more expensive and can make it difficult to avoid no-spray zones. It was suggested that repetitive applications are usually most effective for treatment of vectors with non-synchronous behavior such as *Culex nigripalpus*. Finally, evaluation techniques are required, such as pre- and post-treatment surveillance programs, to determine treatment efficacy and monitor movement of mosquitoes into the treatment area.

2. Ensure that an effective adult mosquito control program is available in all areas of the state.

To mitigate the impact of West Nile virus in Florida, it is necessary that all counties have access to effective adult mosquito control. To accomplish this, local governments, programs, towns, or cities should have a plan or mechanism in place for adult mosquito control if needed during a West Nile virus outbreak. Assistance from the State should be available to local areas in evaluating treatment efficacy. Finally, meaningful health alert criteria should be in place and lines of communication established with health authorities.

3. Define appropriate triggers for proactive adult mosquito control to minimize disease transmission.

Effective adult mosquito control also depends on identifying appropriate triggers for proactive treatment. Ideally, these triggers are easily monitored, relevant to mosquito populations and disease transmission, and allow for treatment before the problem becomes unmanageable. These triggers need to be identified for particular species and areas and cannot be determined broadly. However, the working group suggests consideration of a number of factors that may indicate a mosquito population and infection level that warrants treatment. These factors are:

- the size of the vector mosquito population
- current surveillance results (e.g. sentinel chicken seroconversions to West Nile virus)
- horse cases of West Nile virus encephalitis
- weather conditions which may increase mosquito populations or human-vector contact
- human cases of West Nile virus encephalitis
- juvenile birds positive for West Nile virus in the area (*juvenile* birds positive for West Nile virus indicate that it is more likely they acquired the virus recently and locally)
- complaint calls (as an indication of mosquito populations).

III. Impediments to meeting the objectives of adult mosquito control.

1. Define and implement a targeted control strategy towards the specific vector(s).

Impediments can come from a variety of sources, ranging from our current state of knowledge to funding and political considerations. The most important and obvious impediment to defining targeted adult mosquito control strategies is in identifying the vector species and understanding its biology. In addition, we lack knowledge about the virus, its epidemiology and differences between regions or populations of vectors and hosts.

Once the vector species are identified, the question of whether that species can be controlled by adulticiding, and how this varies over habitats and regions must be considered. Basic data on susceptibility of different species to available adulticides will address this issue. However, these data are needed from field studies as well as laboratory assays as susceptibility may vary with varying geography and environmental conditions.

Other impediments are the lack of alternatives to chemical spraying, costs of developing and registering new chemistries, and problems with re-registration of existing chemical products. There are a limited number of adulticides registered for mosquito control, and this number may decline if re-registration of existing products is not supported.

2. Ensure that an effective adult control program is available in all areas of the state.

The major impediments to achieving this are political and economic interests at state, federal and local levels. In some areas, there is a local lack of interest or concern about mosquitoes and mosquito-borne diseases and hence no local mandate for funding mosquito control programs.

3. Define appropriate triggers for proactive adult mosquito control to minimize disease transmission.

A problem in defining triggers for adulticiding is balancing the conflicts between the perceived needs of two classes of individuals. Some individuals would prefer to see treatment to try to reduce even low levels of risk, while others prefer treatment only under high risk, or no treatment under any conditions. These conflicts can result from individual perceptions of risk from disease or exposure to insecticides, variation in knowledge and understanding of the actual risks and factors which increase or decrease risk, differences in individual circumstances such as children, pets or livestock and their risk of disease or exposure to insecticide, concerns about environmental impacts, and actual or perceived contact with mosquitoes. Risk assessment may be based on incorrect or unscientific information.

Economics and local restrictions, such as environmentally sensitive lands, flight restrictions, non-target organisms and chemically sensitive individuals also can impede adult mosquito control.

IV. Overcoming the impediments to meeting high priority adult mosquito control goals.

1. Define and implement a targeted control strategy towards the specific vector(s).

To overcome the obstacles of identifying the West Nile vector species and understanding their biology and epidemiological importance, we recommend supporting research with personnel, equipment and funding. Supporting research funding through political activities will also aid in funding critical studies.

To overcome the impediments concerning the mosquito control products, the working group suggests support of research and development of new products. It is important to keep an open mind to alternatives to chemical sprays, and support funding for research on these alternatives. Currently, we lack viable alternatives for adult mosquito control. When alternatives are available, education and communication on the efficacy of alternative treatments, both within the mosquito control community and between the community and the public or other agencies are necessary. This will improve our ability to use both current chemical sprays and any alternative strategies developed, effectively.

2. Ensure that an effective adult control program is available in all areas of the state.

Mitigation of these impediments is best addressed by supporting funding of mosquito control programs at all levels and actively participating in public education. Education about mosquitoes and disease transmission, along with what can be expected from a mosquito control program, may encourage communities to fund local programs or participate in state or regional programs. Equipment upgrades may be needed to make appropriate technology available. Pre and post treatment surveillance protocols will enable local determination of the effectiveness of adulticiding.

Education is a key mechanism for overcoming these impediments. Education of the public and county commissioners on the need for mosquito control, the impact on disease prevention, and realistic achievements may improve mosquito control district (MCD) budgets. Starting dialogues with local land managers early and educating them about mosquito control may mitigate conflicts with environmentally sensitive lands and allow mechanisms to be put in place for adult mosquito control during health alerts. This dialogue will also educate the mosquito control manager on the land managers concerns. Cooperation should be encouraged between land managers and mosquito control agencies. Efforts to promote or mandate cooperation between agencies, MCDs and local land managers should be supported.

3. Define appropriate triggers for proactive adult mosquito control to minimize disease transmission.

Impediments to this include determining what these triggers are for different vector species. This is related to previously mentioned issues, in that determining appropriate triggers for adult control depends upon a good understanding of the species involved and their biology. The best way for mosquito control agencies to overcome this impediment and define triggers is to encourage and support research.

As with any risk management protocol, control of adult mosquitoes must balance the rights and varied desires of individuals with protection of the community from disease. Public education is the best method to mitigate the effects of these conflicts on mosquito control agencies and their ability to use adulticiding to protect the community. Educating the public on assessing risks, safety of chemicals used in treatment, operational methods, and the local ecology of mosquitoes and disease may allow better understanding of the issue and more acceptance of the need for adult control. Enhanced communication between different stakeholders (mosquito control, health practitioners, land managers, livestock owners, etc.) will also improve understanding and enable more efficient and effective control. It may be useful for mosquito control to work with state and county health authorities and to consider using public health laws to allow adult control during medical alerts.

Economics may also impede adult control operations; mosquito control district budgets may not allow for equipment and chemicals needed, particularly during emergency situations. Again, public education can be an effective means to mitigate this impediment. In this case, the message should be directed towards the level of service possible under budgetary limits. In this way, the taxpayers funding mosquito control operations will have a realistic understanding of what can be achieved, and what funding levels are necessary if they desire higher levels of service.

Media perception can help or hinder a mosquito control district's ability to mitigate the impact of West Nile virus through adult mosquito control. It is essential that mosquito control provide an appropriate response to events such as West Nile virus positive birds, mosquitoes or human or equine cases in a county. Over-reacting will damage credibility and make it more difficult to generate the response needed during a true emergency. On the other hand, downplaying a real threat will also negatively impact credibility. Press releases should be used to guide the media, providing answers to frequent questions and giving the message in a strong, easily quoted format.

V. Summary

Adult mosquito control may be critical in reducing the impact of West Nile virus on Florida. Once human and horse cases are present in an area, adult mosquito control is the best way to reduce the population of *infected* mosquitoes. Strategies for controlling adult mosquitoes include developing targeted control strategies for each species needed, ensuring appropriate adult mosquito control is available in all areas, and defining appropriate triggers for proactive adult control. There are impediments along the path to achieving these objectives, but many of the difficulties can be mitigated by supporting research (with time, personnel and logistical support, along with political support for state and federal funding) and education of the public, elected officials and media.

MEDIA/PERSONAL PROTECTION

J. R. Rey, J. Gill, E. Hunter

Communicating the status of West Nile virus transmission in Florida and recommended protection procedures to the public and the media is one of the most important and difficult responsibilities of agencies involved in health and mosquito control activities in the State. The major complicating factor is that many agencies are expected to have a message, and many of these agencies do not have the timely data that are absolutely necessary to generate such messages. Existing background data on the disease and mosquito species responsible for virus transmission and amplification cycles are disseminated in a variety of formats and locations. This situation makes it difficult for individual agencies to refer inquiries for such information to an appropriate source.

I. High priority objectives for media and personal protection to reduce the impact of West Nile virus in Florida.

1. Deliver a unified and accurate message about real risk to the press/public.
2. Establish pathways and procedures to facilitate communication by various agencies with the public/press and among themselves.
3. Deliver a targeted and timely message.

II. Strategies to achieve high priority objectives for media and personal protection.

1. Deliver a unified and accurate message about real risk to the press/public.

The most important issue is to develop a **S**ingle **O**verriding **C**ommunication **M**essage (SOCM) coming from all mosquito control agencies and health departments. Associated with this is the need to clearly define conditions under which certain types of messages will be issued, what the content of these messages will be, and the agencies responsible for deciding that a public message is necessary.

When issuing health risk alerts to the public, it is important that risk be put in perspective without diminishing its importance. The report must be balanced in the sense that it informs the public that a certain risk exists without creating undue alarm. The message should clearly differentiate between sporadic vs. epidemic events, and help the public and the press understand the difference in terms of human or animal risk. All parties involved must understand the possible impacts that an official public health warning can have in terms of economic losses and disruption of personal or community events. However, we must always guard against giving false assurances; there is no such thing as “no risk.”

The content of the message is equally important. The language must be appropriate for the general public without technical/scientific jargon. The message should be succinct and to the point. Information should be limited to the critical information at the time. Background information should be available to the general public, but should not be part of a public health message unless it is absolutely necessary for understanding of the message. A worthwhile exercise may be to develop templates for different situations that define three main points that must be emphasized about each situation.

One of the most constructive actions that can be taken to prevent the spread of arboviral diseases is to foster a public “buy-in” of personal/community responsibility for disease prevention. Thus, one of our major goals is to empower the public to take personal protection measures that are both effective and appropriate for a given situation. The primary message should be that although disease risk cannot be eliminated, it can be minimized with involvement of the community. An aggressive and coordinated public education campaign to teach the public the facts and importance of personal protection must be an integral part of this effort.

2. Establish pathways and procedures to facilitate communication by various agencies with the public and press and among themselves.

To attain this objective, the following must be clearly defined:

- relevant information
- information needs of different agencies
- information stewardship
- responsibility for information interpretation and release
- information flow pathways
- information outlets

A necessary starting point for this exercise is to develop an all-inclusive list of agencies and institutions with health-related public information roles. Included among these are:

- mosquito control agencies
- county health offices
- animal services (county/State)
- county commissioners and planners
- Florida DACS
- U.S. Fish & Wildlife Service
- research institutions
- Cooperative Extension Service
- schools and universities
- State Health Department
- CDC

A decision needs to be made on how to include agencies that are not directly involved in public health issues, but that nevertheless may have information needs above and beyond those of the general public. Examples of these are tourism boards, large outdoor facility operators, and others. Options range from providing these entities with information on who to contact for their information needs, to making them a permanent part of the information flow pathways.

A key factor in establishing effective communications pathways among agencies is mutual respect and understanding of the missions and responsibilities of the different agencies. This not only includes the recognition that some agencies must maintain stewardship over certain types of information, but also that other agencies must have access (in the broad sense) to some of this information in order to fulfill their missions and goals.

Once a consensus is reached on the desirable content of public health messages, and the conditions that will trigger different types of messages, the responsibilities for interpretation and release of the information can be addressed. The simplest approach would be a top-down system, where certain types of messages originate only at the State level. The criteria for inclusion in this category may be severity of threat, geographic area involved, or timing (e.g. first isolation of West Nile virus of the season). However, it is likely that for this to work, additional information must be concurrently made available to local agencies to help them expand and interpret the message locally (local callers, local press, etc.). Note that this does not necessarily imply one-way flow of information. For example, State agencies may need data on local mosquito populations, weather patterns, etc., to properly evaluate a given situation. Other messages may have a more local origin depending upon criteria defined *a priori*.

Not all information needs are related to official public health messages. Many agencies routinely need data or other types of information that are beyond their capabilities to generate. Additionally, some may be producing information at great expense and effort when the same or closely related data are available from other sources. This type of information flow is, perhaps, the most difficult to organize because agency perceptions of their needs and responsibilities may vary widely, even among the same type of agencies. Again, all parties involved must produce a clearly defined list of their information needs and capabilities so that proper information flow pathways can be designed as a joint effort of all parties involved.

The envisioned network must clearly delineate the location(s) of the different types of information identified previously, the frequency with which new information is generated, the expected time lags between production and availability, and the modes of access to this information by those who need it. It is assumed here that those responsible for surveillance programs (dead birds, sentinel chickens, etc.) will be part of this network. It is important to assure that everyone involved is capable of staying in the loop and that agencies with similar information needs coordinate their efforts to minimize complexity and overhead. It is also important that information sharing occur regularly, even during non-event times to maintain the integrity of the network. When disseminating this information, group members should strictly stick to their area of responsibility/expertise; know when to defer, and to whom.

There are many options for the internal transfer of data and other information among the group. Included among these are electronic mailing lists, direct e-mail, internal web pages accessible only to group members, conference calls, regularly-scheduled meetings of representatives from the stakeholder network, and many others.

3. Deliver a targeted and timely message.

Two factors are critical to achieve this objective: (1) messages must be issued proactively, as soon as the information is available, and (2) messages must be released in a manner accessible to the target audience. It is highly desirable that agencies in the network be given some advance notice that a public health message is imminent and of its content. However, this must not result in unreasonable delays in the release of the message. The acceptable lags will, of course, vary with the content and urgency of the messages, and can be established ahead of time. Reaching the above goal will be facilitated by sticking to previously established protocols, promoting effective inter-agency communication, establishing media contacts ahead of time, and by maintaining up to date internal contact information lists with no more than one contact per agency (some agencies may share a single contact individual).

In summary, the major tasks necessary to achieve the above goals depend heavily upon coordination, organization, and cooperation among agencies. This will not happen on its own. It is anticipated that an agency or individual will have to take the lead to start the process, and that several face to face meetings plus considerable communications via other means will be necessary to achieve the stated goals.

III. Impediments to meeting high priority objectives of media and personal protection.

1. Deliver a unified and accurate message about real risk to the press/public.

The major obstacle to achieving this goal is a lack of coordination and communication. Very few of the agencies listed have regular lines of communications open with other agencies and when communication does occur, it is usually at the general public level. Major factors contributing to this situation are lack of knowledge on the types of information that are available from different agencies, lack of knowledge on who to contact to access the information, and lack of guidelines for the data stewards on what agencies should be handled differently than the general public.

Secondly, there are no guidelines for message content and timing under different circumstances. Thus, some agencies that are intimately involved in health related issues often find out about relevant situations after it has been reported in the press. As a result, they are caught unprepared for questions from citizens and legislators and for pre-publication inquiries by the press.

There is quite a bit of general (background) information on West Nile virus, mosquitoes, life cycles, seasonality, etc., but this information is scattered among a multitude of sources and media, including internal reports, web pages, fact sheets and others. It is imperative that this information be centralized or, at least, indexed so that agencies and the general public can access it. Additionally, there is a lot that we don't know about West Nile virus and its transmission, and these gaps in our knowledge are rarely identified in the general literature. As a result, the public is often left with the notion that we are "hiding something" thus fomenting unreasonable insecurity, if not paranoia in some citizens.

2. Establish pathways and procedures to facilitate communication by various agencies with the public/press and among themselves.

It is clear that lack of a road map for information flow and dissemination is by far, the most important obstacle to effective communications among agencies and with the public/press. The major complicating factor is the large number of agencies involved (each with its own mission), bureaucracy, data capabilities, data needs, responsibilities for external communications (both actual and perceived), and involvement. Establishment of effective and efficient information flow pathways will be a difficult process that will require the cooperation of all agencies involved.

3. Deliver a targeted and timely message.

This objective is a desirable end-product of our information dissemination efforts. As such, impediments to the previous two objectives apply equally to this one. Additionally, we are presently hindered by the lack of an overall plan that includes criteria, timing, content, delivery methods, target audiences, and responsibility for the release of public information.

IV. Overcoming impediments to meeting media/personal protection objectives.

1. Deliver a unified and accurate message about real risk to the press/public.

The essential step is to establish a coordinating entity that will define the content, timing and responsibility for the release of different types of messages. It must be understood that these definitions will not be all-inclusive as it is impossible to anticipate all scenarios where release of information to the press and public will be necessary and/or desirable. The group must consider, however, establishing a protocol for regular release of information on the status of West Nile virus in the State, even during non-event times.

An effort should also be made to link all relevant web-based information services and make this information available to the public. Included among these web sites are:

- Florida DOH
  http://www.doh.state.fl.us
- FMEL
  http://fmel.ifas.ufl.edu
- Encephalitis Information System
  http://eis.ifas.ufl.edu
- Florida DACS
  http://www.doacs.fl.us
- IFAS
  http://ifas.ufl.edu
- UF Extension/EDIS
  http://edis.ifas.ufl.edu
- PHEREC/FAMU
  http://www.pherec.org/DECS/arbovirus
- CDC
  http://www.cdc.gov
- Local web pages (city, county, mosquito control agencies, etc.).

It is important that public health alerts and the mechanisms for their release be clearly defined. This involves questions on who issues them, what do they mean, how is the public expected to react, what are the criteria for issuing them, and how are they issued and withdrawn.

It is also important to develop and catalog general information materials suitable for the general public and to distribute and publicize their availability. Desirable information to be propagated via this media include terminology and definitions; physician and veterinarian education materials; background information on West Nile, mosquitoes and personal protection; instructions on specimen handling; FAQs; reference compilations; and lists of contacts for the public.

Educational material on personal protection should also be developed and disseminated. These can include fact sheets, mass media spots, slide/PowerPoint presentations, web based information, and many others. Targeted versions (language, age) of these are very desirable. In most cases, however, the need for materials targeted to a specific group will have to be established at the local level. Some subjects that must be included in this campaign include:

- rationale for personal protection
- promote screen repairs
- appropriate clothing
- times and seasons
- expose gimmick products and myths
- repellents - which, how and when
- DEET - use and precautions
- animal vs. human protection
- sporadic vs. epidemic events

2. Establish pathways and procedures to facilitate communication by various agencies with the public/press and among themselves.

All parties involved should hold a preliminary meeting to establish procedures for defining communication pathways for the transfer of relevant information among agencies. At this meeting, a detailed, but modifiable conceptual scheme for information transfer should be designed to properly fulfill the objective of delivering an appropriate message. Individuals, groups, or agencies should then be assigned the task of outlining the procedures necessary to implement the conceptual plan. The following issues must be considered:

- agencies involved
- agency information needs and capabilities
- agency information infrastructure
- information flow pathways
- definition of types of public health messages
- criteria and timing of messages
- routine information exchange between agencies
- background information
- relevant contacts (for each agency, who is responsible for what)

Even though there are a large number of agencies involved, and many possible scenarios where information must, or should, be made available relatively quickly, the information transfer plan does not necessarily have to be a complex and cumbersome one. The difficult aspect of this endeavor is to define and link information types, information needs, and types of messages with agency needs and capabilities. Once this is done, current information technologies should make the actual process relatively simple and inexpensive. We emphasize here that the goal is not a high-tech, state of the art (expensive) information system.

However, some agencies may have to make modest investments in information infrastructure to take advantage of the system. Unwillingness by some agencies to acquire basic information transfer capabilities should not stand in the way of implementation of the plan. Additional meetings may be necessary to discuss implementation of the plan.

3. Deliver a targeted and timely message.

The final link in the overall information transfer strategy is the development of a marketing and education plan for dissemination of the desired information. Many of the steps outlined above are prerequisites for this plan to be effective. Foremost among these are the definition of information release responsibilities, and of message content and timing. The plan should strive to use West Nile virus as an opportunity to promote what different agencies do for Florida citizens and visitors. Additionally, the plan should define strategies for coordinating press releases among agencies and for making everyone aware of new general interest information available from individual agencies, or from third-party sources. The plan should also make provisions for distribution of coordinated information using a variety of media. Some possibilities include:

- television
- radio
- newspaper
- minority and community publications
- public signs
- special interest groups (e.g., horse owners groups)
- church publications
- health departments
- utility bill inserts
- homeowners associations
- school programs
- video broadcasts
- Cooperative Extension Service
- business partners (e.g., manufacturers, merchants, waste management)
- web sites (FMEL, DOH, DACS, IFAS)

V. Conclusion.

A great deal of coordination and inter-agency cooperation will be necessary to create an efficient public information network for Florida. Most, if not all, of the data necessary to keep Florida citizens and visitors informed about the status of West Nile virus and other arboviruses in the State are already available. The challenge will be to develop, refine and improve a system that interprets, distributes, and releases the necessary information with minimum delay and expense.

Recommendations

The workshop participants identified several priority needs to enhance Florida's ability to mitigate the impact of a West Nile virus epidemic. Florida mosquito control can play a prominent, if not primary, lead role in protecting public health. However, this will require public support. The major recommendations to the State and local governments are:

1. Improve West Nile surveillance programs, strategies, and interpretation capabilities.
2. Increase research on vectors and control to address local issues.
3. Increase training and workshops to develop expertise in mosquito-borne diseases, mosquito control, and public health issues related to mosquito-borne disease.
4. Improve communications and coordination among all agencies and levels of government.
5. Provide a template and a unified message that is appropriate to the real risk to humans.

The issues and recommendations discussed at the workshops lay out a plan for Florida's future. Investments are needed to move forward on this public need. We hope that Florida's government and public officials will recognize the need to protect public health and work in partnership to direct appropriate resources that will indeed improve public health in Florida.

INTRODUCTION TO THE SECOND WORKSHOP

C. R. Rutledge

The second West Nile Workshop sponsored by the UF/IFAS Florida Medical Entomology Laboratory was conducted during the Spring 2003 annual meeting of the Florida Mosquito Control Association in Ft. Pierce, Florida, at the Indian River Research and Education Center. The format was similar to the first workshop; but was completed in a half day. Participants were separated by four Florida geographic regions. Groups picked their discussion leader, recorder, and reporter. All groups were asked to respond to the same questions with answers appropriate to their region. The goals were to demonstrate the possibility of measuring real time arboviral transmission risk in Florida and to determine what the different regions feel they need to improve their surveillance programs.

The group was presented with current data for each region on sentinel chicken seroconversions, rainfall, and risk maps for eastern equine encephalitis and West Nile by Dr. Jonathan Day[5]. Dr. Day described the weather and sentinel chicken activity patterns that lead to the 1990 St. Louis encephalitis epidemic in Florida. He also showed how water table depth modeling was used to develop a signature pattern that represents high risk of St. Louis encephalitis epidemics and indicated how it could be used to predict risk in the future, if the data were available real time rather than historical.

The questions addressed by all groups were:

1) Where are we? Interpret the meaning of the information provided by J. F. Day relative to the current status of West Nile in the region. Provide a risk assessment for West Nile.

2) What are the regional mosquito control units doing operationally in response to the current status of West Nile? What will mosquito control units do in the future? What are the plans? Groups were instructed not to assess but to focus on what is currently being done and any plans for what will be done.

The following is a summary of the data presented to the group and their responses after working with colleagues to determine their needs to improve arboviral surveillance programs.

[5] At the time, sentinel seroconversion data indicated that there was essentially no risk for SLE transmission.

Epidemic Template; Update on Rainfall and Arboviral Surveillance for the East Coast, West Coast, and Panhandle of Florida

J. F. Day

Background information provided to participants

Annual dynamics of arboviral transmission in Florida:

January - March: Maintenance

April - June: Amplification (dry season and bird nesting phase)

July - September: Early transmission

October - December: Late transmission

Amplification

Large population of susceptible wild birds: good reproductive year

1:200 infected mosquitoes (1:1000 during epidemic)

>1" rainfall = epic rainfall

Deviation from normal rainfall is important.

Temperature is not as critical unless increasing warmth which will reduce extrinsic/intrinsic incubation period (temperatures more important during maintenance)

Abundance of mosquitoes is not as important as increased rainfall (epic events) followed by drought.

Water table depth (WTD) important because water in wells is not accurate (increased well water being brought in).

Summary of Rainfall by Region

Panhandle	Wash (wet and dry)
North	Drought (Jan) and wetting
Central	Drought (Jan-Mar) Recent wetting (2 Epic rainfall events)
South	Wash (drought and wetting)

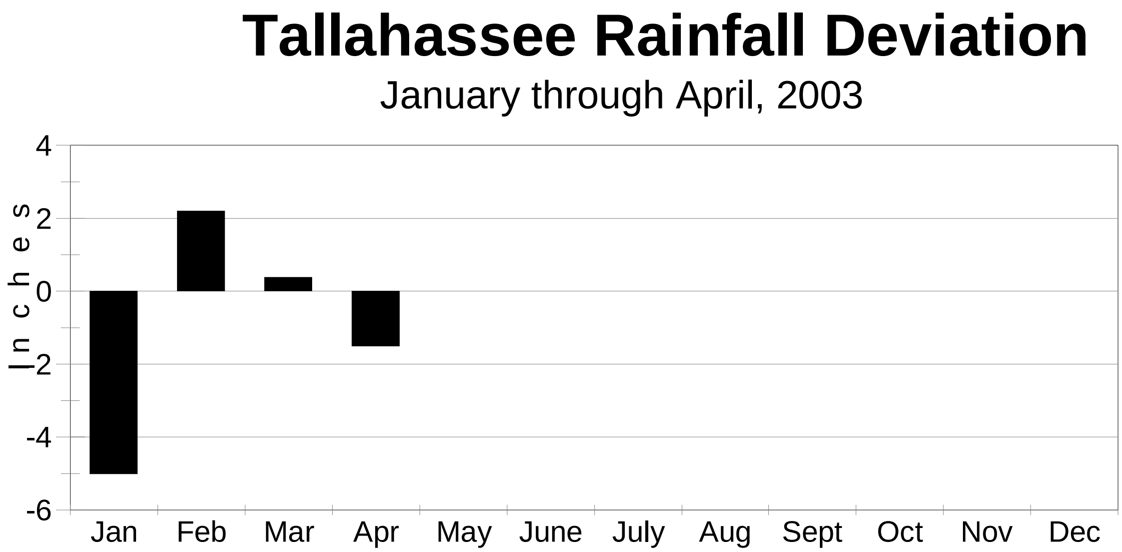
Sentinel chicken seroconversions by region

	St. Louis encephalitis	West Nile	Eastern equine encephalitis
Panhandle	0	2	2
North	0	8 (4*)	15
Central	0	13 (30*)	7
South	0	2	0

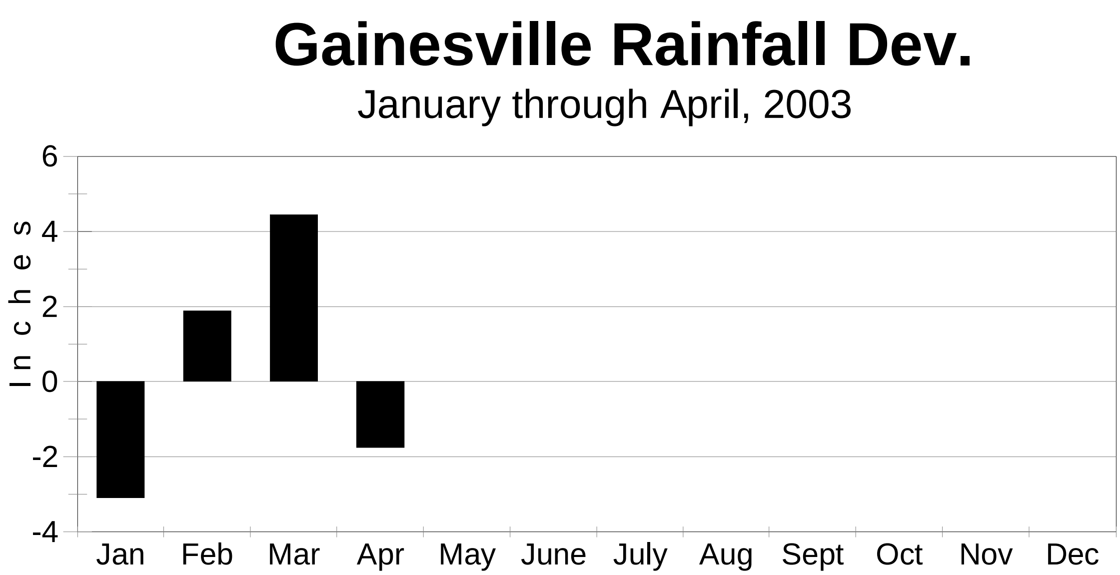
*Late April/May seroconversions; Early seroconversions (May, June, and July) = increased human risk

Rainfall deviation from normal; by region

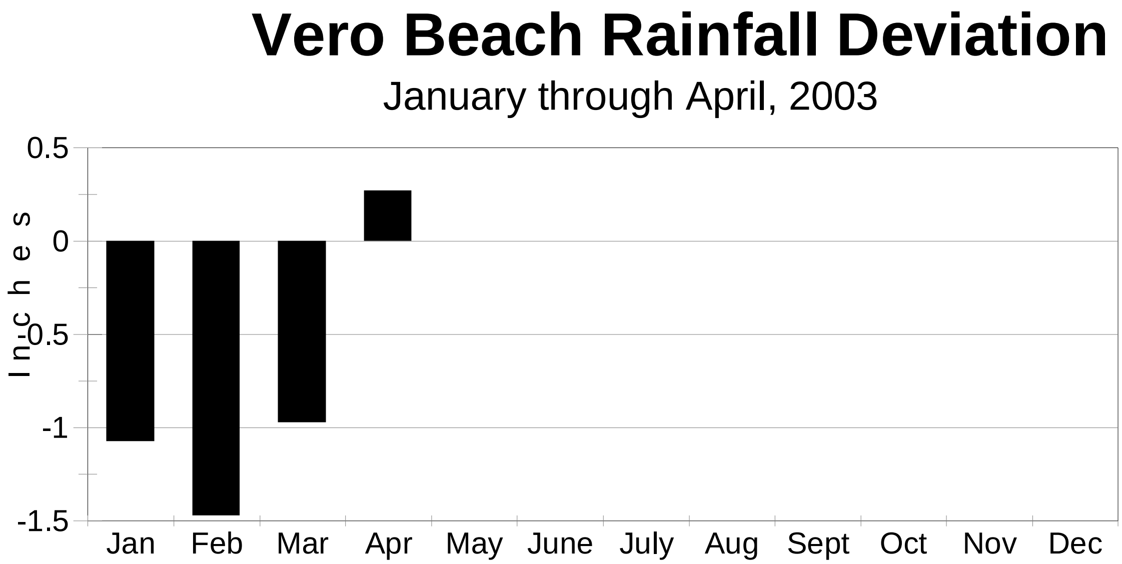
Panhandle:



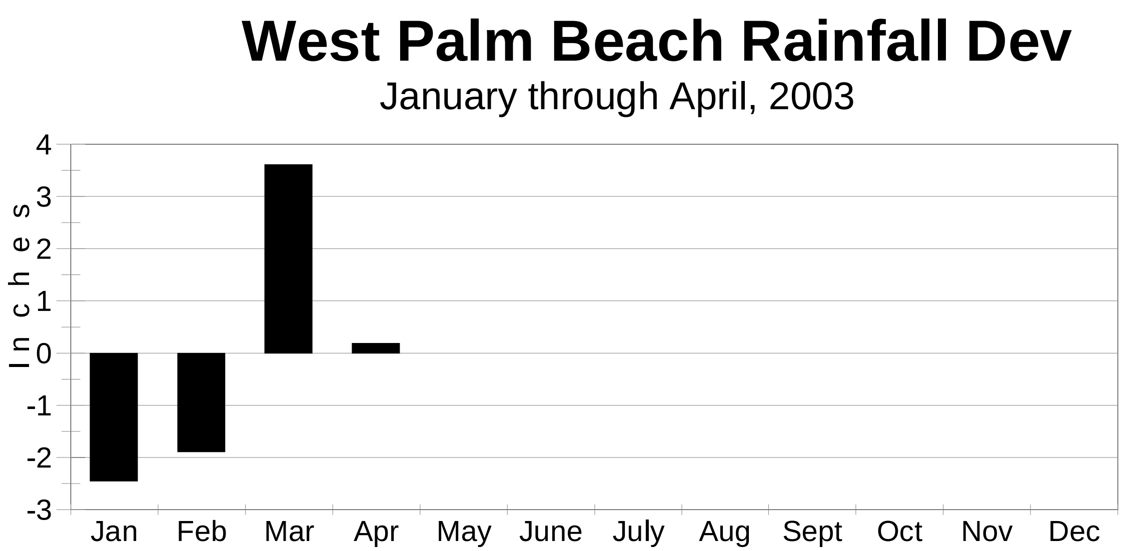
North:



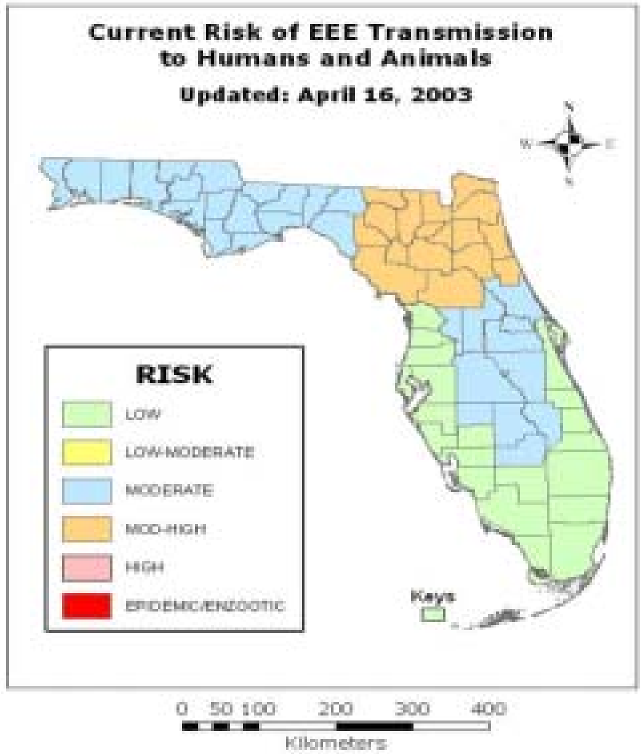
Central:



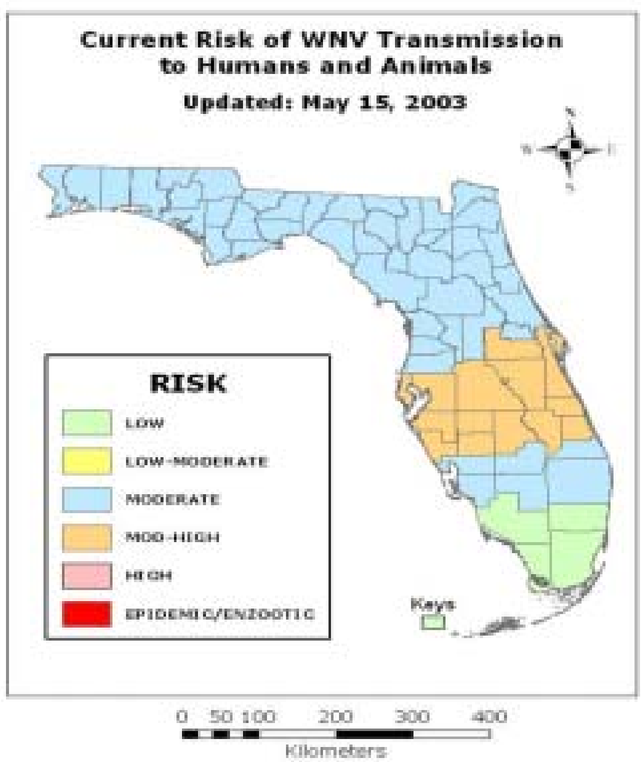
South:



Risk maps from the FMEL Encephalitis Information System for eastern equine encephalitis



Risk maps from the FMEL Encephalitis Information System for West Nile



WHERE ARE WE?

J. David, J. Stivers, and J. Ruff

Where are we? Interpret the meaning of the information provided by J. F. Day relative to the current status of West Nile in the region. Provide a risk assessment for West Nile.

Panhandle/North Florida

Considered three zones within the panhandle: East, Central, and West.

East: High Cx. nigripalpus populations; drought; moderate risk for West Nile

Central: Low Cx. nigripalpus populations; drought; low-moderate risk for West Nile

West: Low Cx. nigripalpus populations; drought; low-moderate risk for West Nile

West Coast

No one working on wild birds – susceptibility of bird populations is unknown

Wet winter, no extended drought

9 + sentinel chickens in Lee County; others not in field yet

Variation in rainfall for all areas

Concern about quality control of samples sent to Health Department. Some samples were sitting in truck all day.

East Coast

Most have sentinels out. Some positives.

Drought until recently

Still waiting for activity

Low-moderate mosquito populations

Is serology reliable?

Consensus of the participants was that most were not pleased with the information they currently have to make risk assessment for their county. Improved surveillance and improved ability to interpret surveillance information at the local level was stated as a high priority need.

WHAT ADDITIONAL INFORMATION IS NEEDED TO FURTHER CLARIFY THE CURRENT STATUS?

J. David, J. Stivers, J. Ruff

What additional information is needed to further clarify the current status? What information would improve the ability to provide better risk assessment in the region and to determine operations?

East Coast

- More reliable indicators of human risk
- Better understanding of local level of transmission
- More background to evaluate information we have on hand
- Fire index data
- More permanent and quality support for State Lab
- Wild bird data (dynamics)
- FMEL, enhance information on emerging information or current research
- Better way to share local rainfall/sentinel data

West Coast

- Define vector/vectors
- Wild birds: do we have naïve birds? If so, what species are they?
- Information from health department on human cases to find out their locations
- Rainfall information
- Web-based clearinghouse for information to view the latest current research based information
- Specifics for horse information
- A place to send people for information

Panhandle/North

- System to map rainfall locally
- Integrated database to include all sentinels, rainfall, vector populations
- Predict when vectors will increase
- Quick method to determine transmission and protocol to protect workers
- Better communication through health department and animal veterinarian industry
- Primary and secondary vectors – what are they?

Specific County Needs:

- Flagler: Basic biology/bionomics of various mosquito species.
- Brevard: Faster turnaround time on lab results.
- Osceola: Rainfall data, faster turnaround time on lab results.
- Indian River: Permanent enhancements for State lab for quality and quantity. Not federal, but State funds; not just during years that it's "nice" to have them around.
- Martin: FMEL lab continued support
- St. Lucie County: Ornithology: more information on bird populations
- Broward: Information sharing (rainfall, mosquito populations)
- Monroe: Funding for Tampa lab; funding for FMEL; groundwater table data.

Dr. D. Dame: Must know vectors for different regions

General comments:

-Reliable indicator of human risk

-How do you assess the data you have? What do the chickens mean?

-Measure of TRANSMISSION

-Accuracy of test results/information

-No guidance from health department on mosquito testing with VecTest.

-Is the VecTest useful?

-One week to 1.5 weeks to get lab results back is too long to wait

-Real-time modeled ground water table data would be useful.

Summary

C. R. Rutledge

As this volume of the Technical Bulletin goes to press, Florida is experiencing sporadic transmission of eastern equine encephalitis virus and West Nile virus to humans and horses. As of August 2003, there appears to be focal transmission of West Nile virus with human cases occurring in Broward, Collier, Dade, Escambia, Lee, Okaloosa, and Santa Rosa Counties. Is this the level of West Nile virus transmission and human cases that Florida will see every year? Are we going to see a major epidemic with human case numbers like those in Colorado (>300 as of August 2003)? Will West Nile follow the same seasonal patterns as St. Louis encephalitis in Florida?

We were fortunate to have the opportunity to bring various agencies together early in the history of West Nile in Florida to discuss issues that have impact on human health. Some of the issues that were consistently raised during both workshops were: 1) the need to have lab results quickly within days of submission; 2) the need for one group/agency to be the point source for surveillance data (chicken, mosquito, horse, and human); 3) the need for easy access to surveillance data from neighboring counties; 4) the need for a much greater research effort on the vector species that is tailored to local issues; and 5) the need for better communication between health departments and mosquito control agencies. The Florida experts on mosquito control consistently emphasized the need for the pubic to invest in resources that will greatly improve mosquito control. Florida is capable of improving surveillance, targeting vectors, and reducing human risk.

The needs have been articulated. The ideas to move forward are on the table now. But it is not enough to just identify them. Florida must act on these ideas if we are to move out of the identification phase and on to the action phase.

Experts in the State of Florida have a rich history with surveillance for St. Louis encephalitis and can apply their expertise to this new pathogen, West Nile virus. Florida can lead the nation in not just collecting surveillance data, but also, interpretation of that data to make informed, proactive decisions about mosquito control activities that will protect public health with effective, efficient, and environmentally proper mosquito control.

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APPENDIX A.
AGENCIES REPRESENTED AT THE FIRST WORKSHOP

Beaufort County Mosquito Control District	Beaufort, South Carolina
Pinellas County Mosquito Control District	Clearwater, Florida
ADAPCO, Inc.	Sanford, FL
Anastasia Mosquito Control District	St. Augustine, FL
Beach Mosquito Control District	Panama City Beach, FL
Chatham County Mosquito Control	Savannah, GA
Citrus County Mosquito Control	Homosassa Springs, FL
City of Jacksonville Mosquito Control Division	Jacksonville, FL
City of Winter Springs	Winter Springs, Fl
Clarke Mosquito Control	Kissimmee, FL
Clay County Mosquito Control	Green Cove Springs, FL
Collier Mosquito Control District	Naples, FL
Dept. of Agriculture and Consumer Sciences	Tallahassee, FL
East Flagler Mosquito Control District	Palm Coast, FL
East Volusia Mosquito Control District	Daytona Beach, FL
Escambia County Mosquito & Rodent Management Div.	Pensacola, FL
Florida A & M/PHEREC	Panama City, FL
Florida Department of Environmental Protection	Tallahassee, FL
Florida Department of Health, Environmental Division	Largo, FL
Florida Department of Health, Pinellas County	St. Petersburg, FL
Florida Department of Health, Okaloosa County	Ft. Walton Beach, FL
Florida Keys Mosquito Control District	Key West, FL
Florida Medical Entomology Laboratory	Vero Beach, FL
Glynn County Mosquito Control	Brunswick, GA
Hernando County Mosquito Control	Brooksville, FL
Hillsborough County Public Works/Mosquito Control	Tampa, FL
Indian River County Health Department	Vero Beach, FL
Indian River Mosquito Control District	Vero Beach, FL
Infectious Disease Analysis	Gainesville, FL
Lake County Mosquito/Aquatic Plant Management	Tavares, FL
Lee County Mosquito Control District	Ft. Myers, FL
Manatee County Mosquito Control District	Palmetto, FL
Marion County Health Department	Ocala, FL
Martin County Mosquito Control	Stuart, FL
Miami Dade County Health Department	Miami, FL
New Orleans Mosquito and Termite Control Board	New Orleans, LA
Navy Disease Vector Ecology & Control Center	Jacksonville, FL
Okaloosa County Mosquito Control	Ft. Walton Beach, FL
Orange County Health Department	Orlando, FL
Orange County Mosquito Control Division	Orlando, FL
Osceola County Mosquito Control	St. Cloud, FL
Pasco County Mosquito Control	Odessa, FL
Pinellas County Mosquito Control	Clearwater, FL
Reedy Creek Improvement District	Lake Buena Vista, FL
Sarasota County Mosquito Control District	Sarasota, FL
South Walton Mosquito Control District	Santa Rosa Beach, FL
St. Lucie County Mosquito Control District	Ft. Pierce, FL
Sumter County Mosquito Control	Bushnell, FL
Taylor County Mosquito Control	Perry, FL
Town of Jupiter Public Works	Jupiter, FL
USDA – ARS, CMAVE	Gainesville, FL
U. S. Fish and Wildlife Service	Atlanta, GA
U.S. Fish and Wildlife Service	St. Marks, FL
U.S. Fish and Wildlife Service	Tittusville, FL
University of Florida	Gainesville, FL
University of South Florida	Hudson, FL
Valent Biosciences Corporation	

APPENDIX B.
WORKSHOP ATTENDEES

David C. Arnold	Beaufort County MCD
Sue Bartlett	Pinellas County Mosquito Control
John Beidler	Indian River Mosquito Control District
Bob Betts	Anastasia Mosquito Control District
Charmont Bonner	Hillsborough County Public Works/MC
John D. Boone	Anastasia Mosquito Control District
Tom Breaud	Orange County Mosquito Control Division
Brenda Brennan	USF-Tropical Public Health
Wade Brennan	Sarasota County MCD
Tim Bubb	Osceola County Mosquito Control
James H. Burgess	Lee County MCD
James Burnett	USFWS - St. Marks National Wildlife Refuge
Alicia Camps, MD	Miami-Dade County Health Department
Doug Carlson	Indian River Mosquito Control District
Marah Clark	City of Jacksonville, Mosquito Control Division
Frank Clarke	Clarke Mosquito Control
Evelyn Cook	Escambia County Mosquito & Rodent Mgt. Div
Eric Cotsenmoyer	Lake County Mosquito/Aquatic Plant Mgt
Alan Curtis	Indian River Mosquito Control District
Gary D'Andrea	South Walton County Mosqutio Control Dist
Richard Darsie	UF/IFAS/FMEL
James R. David	St. Lucie County Mosquito Control District
Jimmy J. Davis	Okaloosa County Mosquito Control
Jon Day	UF/IFAS/FMEL
Aissa E. Doumbouya	UF-Dept. of Entomology and Nematology
Kennith E. Dyer	Clay County Mosquito Control
Eric Elbert	Reedy Creek Improvement District
LT James English	Navy Disease Vector Ecology & Control Center
Trey English	Glynn County Mosquito Control
Marc Epstein	USFWS - Merritt Island NWR
Kim Feagley	Pasco County MC
Dana A. Focks	Infectious Disease Analysis
Jack French	Pasco County MCD
Robert L. Frommer	Manatee County MCD
Bruce M. Furlow	Escambia County Mosquito & Rodent Mgt. Div
Edsel M. Fussell	Florida Keys MCD
Dr. Julia Gill	FL DOH, Pinellas CHD
Gayle Guidash	Pinellas County Health Dept., Env. Div
Donnie Helmly	Anastasia Mosquito Control District
Alan Hill	City of Winter Springs
Lou Hinds	USFWS
Jon Hornby	Lee County MCD
Larry Hribar	Florida Keys MCD
Guangye Hu	Hernando County Mosquito Control
Ed Hunter	Beach MCD
Tommy Hurst	Sumter County Mosquito Control
Terry Johnson	Osceola County Mosquito Control
Flo Jones	Citrus County Mosquito Control
Bill Kellner	Citrus County Mosquito Control
Dan Kline	CMAVE, USDA-ARS
Jean L. Kline	Indian River County Health Dept
Ray Kuhn	Town of Jupiter Public Works
Dana Land	Pinellas County Mosquito Control
Mark D. Latham	Manatee County MCD
Gene Lemire	Martin County Mosquito Control
Henry B. Lewandoski	Chatham County Mosquito Control

Cynthia Lord	UF/IFAS/FMEL
Cliff McGowan	Glynn County Mosquito Control
Gerardo Medrano	East Flagler MCD
Harry Moody	East Flagler MCD
David Mook	St. Lucie County Mosquito Control District
Tom Moore	Marion County Health Department
Bruce Morgan	East Volusia Mosquito Control District
George O'Meara	UF/IFAS/FMEL
Nancy Page	Pinellas County Mosquito Control
Linton Pahl	Hernando County Mosquito Control
Allen Peck	Pinellas County Mosquito Control
Jorge Rey	UF/IFAS/FMEL
Lyman Roberts	Sarasota County MCD
Jim Robinson	Pasco County MC
Terry J. Robinson	Okaloosa County Mosquito Control
Donald Roy	Hillsborough County Public Works/MC
Candace Royals	Valent Biosciences Corp.
Roxanne Rutledge	UF/IFAS/FMEL
Steve Sackett	New Orleans Mosquito & Termite Control Board
John S. Sanders	Escambia County Mosquito & Rodent Mgt. Div
Eric Schreiber	Sarasota County MCD
Hank Shane	Florida Keys MCD
John Singer	Taylor County Mosquito Control
Jack Shoup	Town of Jupiter Public Works
Donald Shroyer	Indian River Mosquito Control District
Jennifer Simpson	DACS-Bureau of Entomology & Pest Control
Michael Smith	Anastasia Mosquito Control District
Robert B. Smith	FL Dept. of Health, Okaloosa County
Mike Spoto	Florida Keys MCD
LT Frederick M. Stell	Navy Disease Vector Ecology & Control Center
Jeff Stivers	Collier Mosquito Control District
Jason Stuck	Pinellas County Mosquito Control
Walter Tabachnick	UF/IFAS/FMEL
Freddie Thomas	Anastasia Mosquito Control District
Bill L. Toth, MPH	Orange County Health Department
Doug Wassmer	Pasco County MC
Herschel S. Wiley, Jr.	Sumter County Mosquito Control
Derek Wright	ADAPCO, Inc.
He Zhong	PHEREC/FAMU