

ASSATEAGUE ISLAND NATIONAL SEASHORE

2001 Summary Report For Mosquito Monitoring and Management Program

Introduction

Humans do not have a physical response to the first mosquito bites they receive. But eventually, the mosquito's saliva will elicit an allergic response that results in the annoying swell and itch. Some people who are exposed to continuous biting will actually become desensitized, immune from the bite's effects. Unfortunately, mosquitoes cause more human deaths than any other animal due to the transmission of viruses during the imbibing of blood, so there is reason to be curious about the local status of mosquitoes.

Assateague is typical for a mid-Atlantic barrier island, being shaped by periodic overwash events. The overall low topography lends to regular tidal flooding of saltmarshes, and low-lying interior habitat is affected by the near-surface freshwater lens, forming fresh or brackish pools.

These wetlands support an environment perfectly suited for breeding mosquitoes. Assateague Island hosts at least 22 species of mosquito, ranging from saline to fresh to stagnant water species. Active during any warm month, the mosquito population provides a steady supply of protein for the island's foodweb.

The larvae of each mosquito species are tied to specific aquatic growth mediums, so development is often related to rain or tidal events. Except during extreme meteorological patterns, Assateague usually offers an ample assortment of larval habitats.

Adult mosquitoes rely on plant fluids to supply the energy for normal activities. Females also require specific amino acids to build their egg proteins, which is provided when females imbibe the blood of other animals. While mosquito genera have evolved preferences or adaptations for specific groups of animals for blood meals, they will take blood from other animals if the preferred host is not available. Fortunately for the adult mosquitoes on Assateague, if a preferred blood host is not available, the feral horse is always readily accessible.

Mosquitoes have an influence on human visitors to Assateague. During peak visitation, people tend to recreate primarily on the open beach and dune habitats. The dry, breezy nature of the beach is very inhospitable to mosquitoes, so human/mosquito interactions are usually limited.

During the night hours, prevailing winds turn offshore, increasing relative humidity and transporting mosquitoes towards the beach. Visitors who do not leave the island at sunset often need to protect themselves through smoky fires, screened tents, or chemical repellants.

Under circumstances that lead to extremely large hatches, mosquitoes can become a nuisance. When these events occur, visitors and workers are advised to protect themselves through the use of

insect repellants and protective clothing, or to avoid outside activities. Under these conditions, tolerance or avoidance is necessary to deal with these extreme populations of mosquitoes.

National Park Service (NPS) Management Policies (4.4.5) recognize the value that natural organisms, like mosquitoes, play in maintaining a site's ecological integrity and directs that native pests be allowed to function unimpeded. Policy makes a distinction between nuisance pests and pests impacting park resources or operations at a level that requires managed intervention.

One exception for intervention is to “manage a human health hazard when advised to do so by the U.S. Public Health Service which includes the Centers for Disease Control (CDC), or to otherwise protect against a significant threat to human safety”.

Background

Under rare conditions, particular mosquitoes have the potential to transmit certain viruses that pose a health risk to humans. Of particular local interest are Eastern Equine Encephalitis (EEE) and West Nile Virus (WNV).

EEE is a common avian virus that has little to no affect on native bird species. EEE can be successfully transmitted between birds and humans by only two local mosquito species. *Culiseta melanura* is a forest-dwelling ornithophilic species common to the Pocomoke River drainage but not generally found on Assateague. Although it is not unusual for *C. melanura* to be infected with the EEE virus, its affinity for birds and a life cycle tied to Cypress swamps limits the potential risk to people on Assateague Island. *Ochlerotatus sollicitans* (formerly known as *Aedes sollicitans*) the common salt marsh mosquito, is a non-specific browser and a prolific breeder on the island. *O. sollicitans* is not common in bird rookeries where most viremic hosts are located, so it is extremely rare for this species to carry the EEE virus.

WNV was first documented in the Western Hemisphere in 1999 in New York City, and which has spread west as far as Wisconsin, Missouri and Louisiana by the end of 2001. As a new virus, the influence WNV is having on North American fauna is not yet well understood. Many mammalian and avian species have been infected, but only a few like the horse and crow, have shown notable mortality rates.

The current understanding of this virus is that it is being transmitted by mosquitoes primarily in the *Culex* genera, which are mainly bird-feeding mosquitoes. The virus may be amplified by dense populations of commensal birds in urban-interface areas, and then transferred by mosquitoes to migrating birds that transport live virus to other parts of the country. While mosquito testing has not been consistent across the eastern United States, there have been many more positive WNV locations from bird testing than from mosquitoes (see attached CINDI figures). Most human cases have been restricted to urban areas, where *Culex pipiens*, a stagnant water or container breeding mosquito and the House Sparrow may combine to increase the risk of transmission to residents. People with compromised immune systems appear to be most at risk to deleterious effects of WNV.

EEE and WNV are the two mosquito-borne viruses that may present a human health risk on Assateague under rare circumstances. It is noteworthy that the only other island specie known to

have a high infection risk to these diseases is the feral horse. Since the horses occupy prime mosquito habitats and have little recourse but to submit to mosquito feeding, they effectively serve as a natural sentinel host. (Although two species of crow utilize the island for foraging, and are both impacted by WNV, the WNV/crow relationship is not understood well enough to comment on the local significance.)

Assateague Island National Seashore (ASIS) initially addressed mosquito-transmitted viruses during island EEE outbreaks in 1989 & 1990. Those events prompted the development of specific Monitoring Protocols and response procedures (Decision Tree) that have been updated on an annual basis. This report summarizes the results of the ASIS mosquito monitoring program for 2001.

Program Objective

The mosquito monitoring program at ASIS has been developed to provide NPS management with scientifically valid, timely information on which decisions regarding the control of mosquitoes will be based. The primary interest is in assuring protection of human health from the threat of Eastern Equine Encephalitis and West Nile viruses.

The program is structured to permit the monitoring of low to nuisance population levels, and to recognize conditions that trigger increasing levels of monitoring intensity and management actions.

Mosquito Monitoring Program

Study Area

Mosquito observations and collections were made from three sites on Assateague Island: the North Beach Developed Area, Tingles Backcountry Campsite and Green Run Peninsula. These sites were spaced to sample mosquito populations along the length of the island. The trap locations were situated in edge communities to facilitate the capture of both saltmarsh and fresh/brackish water species.

Methods

Pre-monitoring arrangements were made for potential adulticiding if the Intervention response level was reached. The Washington Office of the NPS gave pre-approvals for the mosquito adulticide Trumpet EC, the insecticide recommended by the Maryland Department of Agriculture Mosquito Control Section (MDAMCS).

CDC-style dry ice baited light traps were operated at all sites, from late spring until after peak visitation in the fall. Trapping began earlier than previous seasons to permit early observations from WNV carriers. Unlike the 2000 trapping season when a specific trap was deployed in habitat more conducive for trapping species with a higher potential for carrying WNV, MDAMCS relied only on the ASIS long term monitoring sites.

NPS staff deployed traps on Monday evenings with mosquito collections removed on Tuesday morning. Collections were kept cool and promptly transferred to personnel from the MDAMCS. MDAMCS staff sorted and counted the collections from each trap by species.

Initially, the state was interested in testing only North Beach Mosquitoes, unless conditions or results warranted an expansion of the testing program. Under that protocol, MDAMCS intended to reserve a portion of *O. sollicitans* from North Beach for EEE testing while the remaining mosquitoes of WNV relevance were transferred to the Maryland Department of Health and Mental Hygiene (MDHMH) laboratory in Baltimore by courier. Later in the season, MDHMH elected to begin screening all pools from the ASIS sample sites for three potential viruses: EEE, WNV and St. Louis Encephalitis (SLE). The MDAMCS lab in Salisbury performed no analysis.

The separated trap contents were initially subdivided into pools of up to 50 mosquitoes each, but the size was later reduced to not more than 40. In the event that a trap catch exceeded 500 mosquitoes of a species of interest, a sub-sample of up to 10 pools/species was removed. A weekly summary of trapping results was prepared by MDAMCS and forwarded to ASIS.

Throughout the entire year, ASIS staff observed island feral horses for symptomatic behaviors suggesting a viral infection. Park staff was also advised to report any unusual bird deaths, particularly in the crow populations, to the Maryland Wild Bird Mortality Hotline. Maintenance staff was encouraged to manage outside storage areas in an effort to reduce water-holding materials that could harbor container-breeding species.

Results

Trapping occurred weekly from May 3 through October 3 at North Beach and July 3 through October 3 at the other sites. Initially, MDAMCS was interested in processing only samples from North Beach, which tends to have a higher proportion of non-saltmarsh species. After ASIS expressed concern about the loss of full island coverage and effective monitoring for EEE, the two remaining sites were added to the analysis process in July.

A total of 51 trap-night samples were provided. MDAMCS did prepare and forward a weekly summary of trap contents, but the number of pools submitted for actual testing was not provided. MDAMCS intended to phone report any positive test results.

Samples from the CDC CO₂ baited light traps produced 12 identified species or groups of mosquitoes. These included:

<i>Aedes vexans</i>	<i>Culex salinarius</i>	<i>O. taeniorhynchus</i>
<i>Anopheles br.&cr.complex</i>	<i>Ochlerotatus canadensis</i>	<i>Psorophora ciliata</i>
<i>A. walkeri</i>	<i>O. cantator</i>	<i>P. columbiae</i>
<i>Coquilleltidia perturbans</i>	<i>O. sollicitans</i>	<i>P. howardii</i>

Of the annual trap catch of an estimated 257,038 mosquitoes, 99% was made up of two species: *O. taeniorhynchus* accounted for 80% and *O. sollicitans* 19%.

For the 14-week period when all three sample locations were operational, Green Run produced 43% of the crop, North Beach harbored 35%, while Tingles Island made up 22% of the catch.

There were no positive PCR test results for EEE from *O. sollicitans* pools tested during the 2001 monitoring season. In addition, no samples of *Culiseta melanura* were collected. No horses were observed with conditions suggesting illness or infection.

There were no positive PCR test results for WNV (or SLE) from any mosquitoes or animals on Assateague or elsewhere on Maryland's Eastern Shore in 2001. WNV has yet to be documented on the Delmarva Peninsula south of New Castle County, Delaware (northern-most third of the state).

Discussion

A regional dry spell continued in 2001, with only four rain events measuring over one inch occurring during the May – October 1 period. The lack of freshwater pools may have contributed to the dominance of the two salt/brackish marsh species and the drop in *C. salinarius*, a freshwater species that accounted for 22% of the 2000 catch.

A significant hatch of the salt marsh species occurred during the first half of June, at a time too early to support the other life cycle requirements for the EEE virus. There were no major hatches in July, but four of the five weeks in August were well occupied by foraging adults of both saltmarsh species. After a quiet September, a final hatch at Green Run occurred on October 3. The most significant concentration of the summer occurred at North Beach on August 28 with an estimated night catch of over 46,000 females.

There were seven rather significant (>10,000/trap) mosquito swarms between June 5 and October 3, 2001. Ninety-nine percent of the mosquitoes sampled were comprised of two species with larval preferences for saline to brackish water. This slant for the 'saltmarsh' mosquitoes may have resulted from the low amounts of rainfall experienced during the season, reducing the breeding potential of the fresh or stagnant water species.

Unfortunately for park visitors, both of the saltmarsh species are rather aggressive and based on trap counts, the North Beach area was occupied by a much higher proportion of adult females than what is usually observed.

Elsewhere in the region, EEE was isolated from two successive early August mosquito catches (*Culiseta melanura*) along the Pocomoke River in Worcester County. *C. melanura* is a common species along the Pocomoke drainage, and as the primary vector of EEE in the bird population, it is not uncommon for monitoring to show a few positive results on an annual basis. Most native birds at some point in their lives contract EEE, and although the virus is benign in native birds, each bird is viremic during the initial exposure. An infected bird can potentially fly to the island and expose feeding mosquitoes to the virus, but the series of events leading to an actual transfer remain very remote.

Additionally, a Worcester County (Ocean Pines) Blue Jay being screened for WNV provided a positive result for EEE. The encouraging aspect of the positive bird is that public awareness and timely reporting of sick bird sightings permitted agencies to confirm the actual virus and better understand developing risks.

Several of the mosquito species that are represented on Assateague have been found to harbor WNV DNA in laboratory tests, but the ability of these mosquitoes to actually transmit the virus between hosts has not been concluded. The mosquito species that are currently believed to be the primary transmitter of WNV have not been identified on the island. Although much remains unknown about the life cycle of WNV in North America, if the association between stagnant water breeding mosquitoes and commensal birds plays a significant role in disbursal, natural areas like Assateague will likely play less of a role in human exposure than our urban areas.

Summary Discussion

The interest by public health agencies in learning about the emerging presence of WNV has focused development of monitoring efforts and testing procedures for mosquito monitoring agencies. High interest in Maryland was based on the number of WNV cases in metropolitan and suburban areas in 2000.

The 2001 efforts in Maryland directed all samples to the centralized MDHMH lab, where pools were tested for WNV, EEE and SLE (LaCrosse virus to be added in 2002). This coordinated effort permitted an ongoing statewide assessment of mosquito-borne virus activity. Mosquito control agencies used subsequent positive lab results to direct area abatement programs, although there appears to have been limited assessment of the public health risk.

Due to the workload associated with the wide-scale mosquito sampling throughout the state, MDAMCS was not able to perform parity assessments of ASIS samples. Although the ratio of older female mosquitoes is intuitive on a certain level (time lapse since obvious hatches), ASIS Response Protocols have used the parity level as a decision threshold. That information provides the NPS with a more realistic assessment of risk to people, and a justification for conducting pest control. If the state uses positive PCR test results alone from either mosquito or bird samples to trigger area abatement activities, the NPS may need to adjust its EEE monitoring protocol to better fulfill its management obligations.

The importance of mosquito sampling as the keystone species in the monitoring program is another issue that may need to be addressed in the future. It is highly probable that EEE or WNV on Assateague will be manifested in the horse population before the mosquito samples. This is based on the few mosquito samples actually being tested as compared to the number of horses being exposed to mosquito bites in all habitat types and the horses' susceptibility to both viruses. The U.S. Geologic Service also recognizes that WNV monitoring is much more effective through bird monitoring than by mosquito screening.

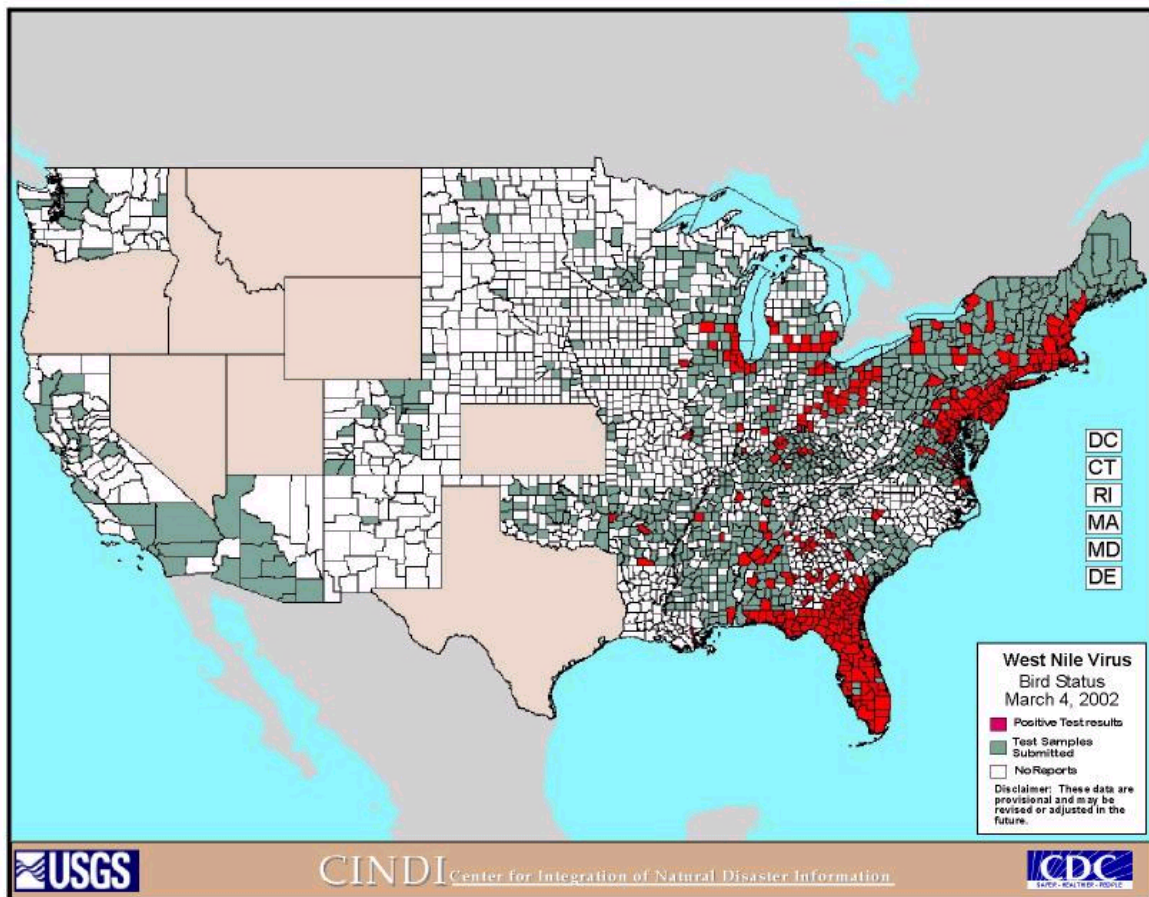
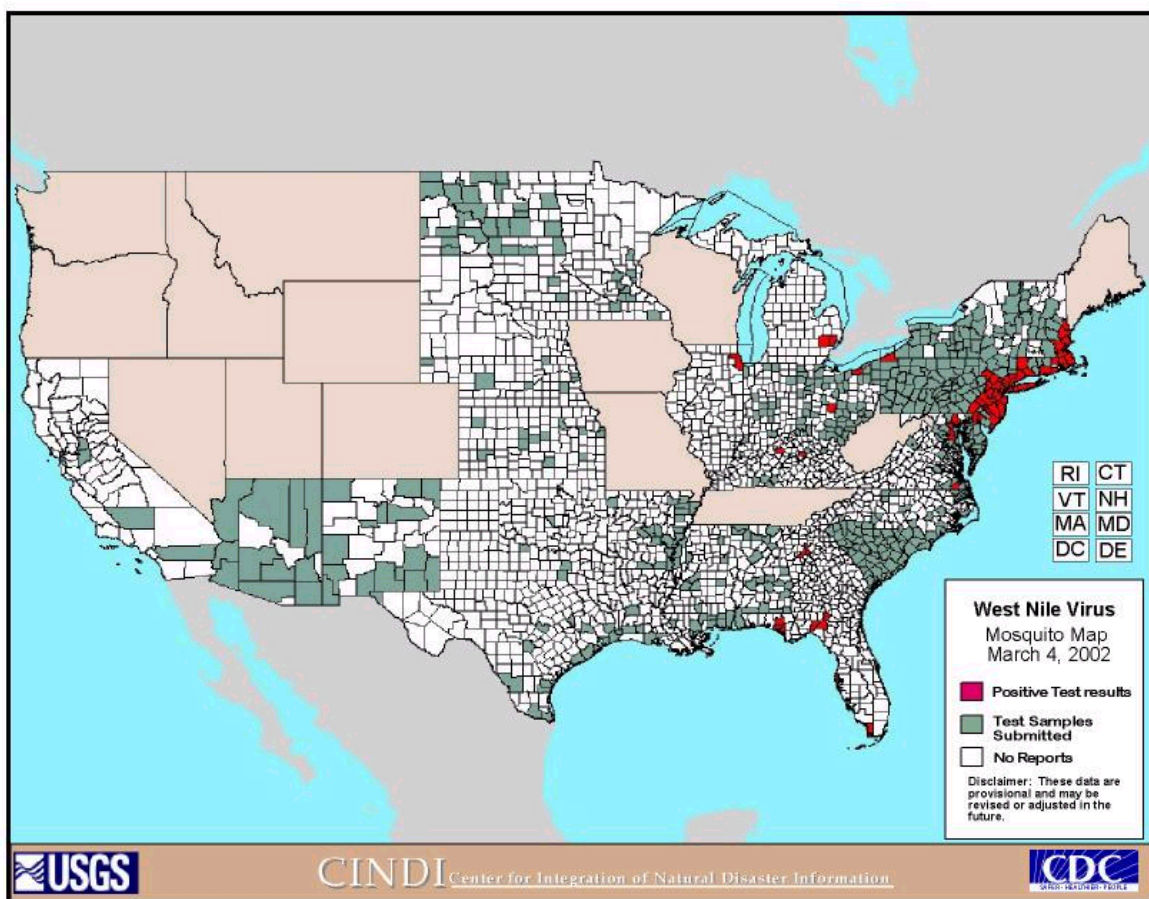
Overall, the Monitoring Program functioned much as it had in recent years. The cooperation with the various state agencies and individuals was essential in processing the island samples and providing the PCR tests. Their support played a critical function in the program's ability to provide accurate, timely information in support of management decisions. Our hats go off to all of the MDAMCS technicians.

Total Trap Counts 14 week sample period	North Beach (23 week period #'s)		Tingles Island		Green Run	
Species	Total	%	Total	%	Total	%
<i>Aedes vexans</i>	400 (1,075)	(1)	7		341	
<i>Anopheles crucians</i> & <i>bradelyi</i>	26 (122)		46		93	
<i>A. walkeri</i>	1 (1)					
<i>Coquilleltidia perturbans</i>	2 (2)					
<i>Culex salinarius</i>	50 (314)		263	1	171	
<i>Ochlerotatus canadensis</i>	5 (8)		5		15	
<i>O. cantator</i>	0 (1,196)	(1)				
<i>O. sollicitans</i>	1,781 (14,764)	2 (14)	11,770	24	31,477	32
<i>O. taeniorhynchus</i>	77,717 (91,537)	97 (84)	37,736	76	66,033	67
<i>Psorophora ciliata</i>	5 (5)				21	
<i>P. columbiae</i>			6		29	
<i>P. howardii</i>					1	

Table: Total season catch by location for each species identified during the 2001 monitoring season.

Species list and larval habitat for Assateague Island mosquitoes.

<i>Aedes albopictus</i>	container	<i>Ochlerotatus atlanticis</i>	flooded woods
<i>Aedes vexans</i>	puddles	<i>Ochlerotatus canadensis</i>	floodwater
<i>Anopheles bradelyi</i>	brackish pools	<i>Ochlerotatus cantator</i>	floodwater
<i>Anopheles crucians</i>	wooded swamps	<i>Ochlerotatus sollicitans</i>	saltmarsh
<i>Anopheles punctipennis</i>	ditches	<i>Ochlerotatus taeniorhynchus</i>	brackish marsh
<i>Anopheles quadrimaculatus</i>	vegetated pools	<i>Ochlerotatus trivittatus?</i>	ditches, container
<i>Anopheles walkeri</i>	vegetated pools	<i>Psorophora ciliata</i>	floodwater
<i>Culex salinarius</i>	grassy ditches	<i>Psorophora columbiae</i>	floodwater
<i>Culisetta inornata</i>	ditches	<i>Psorophora ferox</i>	flooded woods
<i>Culisetta melanura</i>	wooded swamp	<i>Psorophora howardii</i>	floodwater
<i>Coquilleltidia perturbans</i>	vegetated pools	<i>Uranotaenia sapphirina</i>	container



Maps illustrating counties from which positive PCR analysis has been recorded from mosquito samples (above), and birds (below).