

ASSATEAGUE ISLAND NATIONAL SEASHORE

2000 Summary Report For Mosquito Monitoring and Management Program

Introduction

Although ocean beaches and feral horses are the most noted natural resources on Assateague Island, many island users would also list the biting insects, particularly mosquitoes, as a memorable feature.

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 14 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 ecological foodweb.

The larvae of each mosquito species are tied to specific aquatic growth mediums, so development is tied 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. It is apparent from years of horse monitoring that although biting flies can drive horses wild, mosquitoes apparently have little effect on horse behavior. It is not uncommon to see horses that appear dusty gray, literally coated with blood-seeking mosquitoes, following large hatches.

Mosquitoes have a limited 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 not noteworthy.

During the night hours, the wind normally turns offshore, increasing relative humidity and transporting mosquitoes towards the beach. Visitors who do not leave the island at sunset 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 nuisance levels 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. It makes an exception 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”.

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

EEE is a common avian virus that has little to no effect 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. *Aedes sollicitans*, the common salt marsh mosquito, is a non-specific browser and a prolific breeder on the island. *A. 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, initially in New York City, and then later in several nearby states including Maryland. 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 harbored and amplified primarily in birds, notably introduced Old World species, and being transmitted by mosquitoes in the *Culex* genera, particularly *Culex pipiens*. While *Culex* are primarily bird-feeding mosquitoes, *C. pipiens* breeds in small bodies of stagnant water commonly found in urban and suburban environments where humans are an abundant, optional host.

EEE and WNV are the two mosquito-borne viruses that are likely to present a human health risk on Assateague. It is noteworthy that the only other island species 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 mosquito/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 2000.

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.

EEE 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 three 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. The Tingles and Green Run sites were also immediately adjacent to high marshes with frequently flooded depressions that were used to monitor mosquito larvae.

Methods

Three CDC, dry ice baited, light traps were to be operated at all three sites from early June until the middle of September, unless conditions warrant extension of that period. 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 Maryland Department of Agriculture Mosquito Control Section (MDAMCS).

MDAMCS staff sorted and counted the collections from each trap by species. If Intensified Surveillance had been initiated (Stage 2 of the above mentioned decision tree), additional sorting as per the following occurred:

A subsample of the sorted *A. sollicitans* (by trap) was assessed for parity. If >10% of the subsample was found to be parous, then the entire original sample was subdivided into pools of 50 mosquitoes each. These pools, along with all specimens of *Culiseta melanura*, (pooled by trap) were to be transmitted to the Maryland Animal Health Laboratory in Salisbury for processing and analysis. Both live and freshly dead specimens were used.

Following the onset of Intensified Surveillance, the Salisbury lab conducted the Polymerase Chain Reaction assay (PCR) to detect the presence of EEE. This analysis was conducted on all *A. sollicitans* and *Culiseta* specimens collected.

A weekly summary of monitoring and analysis activity was prepared by MDAMCS.

Throughout the entire period when mosquito populations were evident, park staff observed the feral horses for symptomatic behaviors suggesting a viral infection.

Results

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 MDAMCS.

Trapping occurred at all three locations weekly from June 1 through October 23, 2000. Samples were recovered from all traps except for the Green Run location on September 6, when high tides prevented access to the site. The NPS only received catch success data for samples through September 12, for a total of 48 trap-nights.

Although the *A. sollicitans* trap counts, female parity rate and key initiation date conditions had not been reached, MDAMCS elected to begin PCR testing of pools at the onset of the season's trapping efforts. Trap counts of 1,000+ *A. sollicitans* were observed at two sites on June 13, but the first 1,000+ counts in July occurred on the 11th. By protocol, the move from Routine to Intensified Surveillance, triggering the onset of PCR testing, would not have occurred until a parity rate exceeding 10% of the female population was observed following the July 11th hatch.

There were no positive PCR test results for EEE from *A. sollicitans* pools tested during the 2000 monitoring season. In addition, no samples of *Culiseta melanura* were collected. No horses were observed with conditions suggesting illness or infection. For these reasons, there was no justification to move into a Public Awareness response level.

Samples from the CDC CO₂ baited light traps produced 10 identified species or groups of mosquitoes. These included:

<i>Aedes canadensis</i>	<i>Anopheles complex</i>
<i>A. cantator</i>	<i>A. quadrimaculatus</i>
<i>A. sollicitans</i>	<i>Culex salinarius</i>
<i>A. taeniorhynchus</i>	<i>Psorophora ciliata</i>
<i>A. vexans</i>	<i>P. ferox</i>

Of the annual trap catch of an estimated 279,594 mosquitoes, 95% was made up of three species: *A. sollicitans* accounted for 59%, *C. salinarius* 22 % and *A. taeniorhynchus* 14% of the catch.

By location, Green Run produced the most abundant crop, accounting for 45% of the total, with Tingles and North Beach providing 30% and 25% respectively.

Discussion

Mosquito hatches were most prominent on June 13, July 11, August 1, 8, 15, and September 12. Each of these events was preceded by a rain event measuring over one inch accumulation two weeks prior to the hatch, and a tidal flooding event that occurred one week prior to hatch.

Without site specific rain accumulation, tidal penetration and puddle salinity, cause and effect relationships between breeding pool development and hatches could not be developed. Season-long flooding events were noted throughout the island, so in general, 2000 was a terrific year for mosquito breeding weather conditions.

WNV Monitoring Program

Study Area

A single monitoring site was selected in 2000 to provide initial surveillance for WNV. The site, North Beach Maintenance Yard, is located in an upland shrub edge believed to better represent typical *Culex* habitat on the island. The trap site was approximately 200 meters from the North Beach Developed Area EEE Monitoring site.

Methods

Samples were collected through the combination of a CDC dry ice baited light trap, a gravid trap intended to sample gravid *Culex* species, and a caged sentinel flock of four chickens to provide avian-host blood samples. Weekly trapping and biweekly chicken testing occurred from June through September or until favorable conditions lapsed.

MDAMCS staffs were responsible for all activities associated with the WNV monitoring program. *Culex* samples were processed and tested for WNV through PCR assay. A weekly summary of monitoring and analysis activity was to be prepared by MDAMCS and forwarded to the NPS.

Throughout the entire period when mosquito populations were evident, park staff observed the 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.

Results

Sentinel chickens were placed on the island in late May. Chickens were bled on a schedule throughout the summer and into the fall. Subsequent information from controlled experiments suggested that chickens were not an effective sentinel species for WNV monitoring purposes. The flock was removed from the island in September after a raccoon successfully entered the coop and killed some of the birds.

The gravid trap was used to sample females from May 24 through October 24, 2000, with a total of 24 weekly observations. There was a season total of 84 gravid mosquitoes observed in the trap, with only 24 *C. salinarius*.

The CDC trap was operated from May 30 through October 24, 2000. A total of 21 trap nights were sampled. A total of 11,995 mosquitoes were captured, of which, 4,399 (37%) were *C. salinarius*. The other primary species sampled were *A. sollicitans* (35%), and *A. taeniorhynchus* (22%).

There were no positive PCR test results for WNV from *C. salinarius* or chicken blood tested from this site during the 2000 monitoring season. In addition, no samples of the primary target species *C. pipiens* were collected. No horses were observed with conditions suggesting illness or infection, and there were no island reports of unusual bird mortality.

Samples from the combined CDC and gravid traps produced 11 identified species or groups of mosquitoes. These included:

<i>Aedes cantator</i>	<i>Anopheles complex</i>
<i>A. sollicitans</i>	<i>A. quadrimaculatus</i>
<i>A. taeniorhynchus</i>	<i>Culex salinarius</i>
<i>A. vexans</i>	<i>Culisetta inornata</i>
<i>A. albopictus</i>	<i>Psorophora ciliata</i>
	<i>P. columbiae</i>

Discussion

The gravid trap yielded a relatively small number of female mosquitoes, and was not very effective for monitoring mosquitoes at this location.

The CDC trap catch contained a higher proportion of *Culex* as compared to traps located at the fresh/salt marsh interface for EEE monitoring. Ninety-four percent of the sample was made up of the same three species as the EEE marsh interface trapsites, although the catch was consistently and occasionally dramatically, lower than the other monitoring sites. The pattern of WNV-CDC trap catches did mirror those from the EEE monitoring program, although the highest catch rates just barely reached over 1,000 individuals.

The WNV trap site did capture samples of some of the more uncommon mosquito species on the island, and included the first documentation of *A. albopictus*, the exotic ‘tiger’ mosquito that has become firmly established throughout stagnant water habitats of North America.

Summary Discussion

A combination of heavy rains and periodic tidal events are thought to have supported some very significant mosquito hatches in 2000, including an early July hatch that resulted in the second highest trap catch on record.

While conditions remained favorable for mosquito reproduction and survival throughout the summer, and EEE outbreaks were reported along the Southeast U.S. coast up to the mouth of the Chesapeake Bay, there was no evidence of the virus on Assateague or elsewhere on the Eastern Shore.

Despite significant hatches on at least a monthly basis, NPS staff did not receive public feedback indicating that visitors were experiencing conditions that were more problematic than during less-

prolific summer seasons. On the other hand, park staff who ventured into prime wetland habitat were in awe by such a sublime manifestation. Had wind patterns favored the west, it is likely that few visitors would have appreciated the mosquitoes' ecological value.

The EEE 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.

The transfer of analysis data back to the park continued to be plagued by periodic lapses. The point of disconnect along the information flow is not clear. While PCR test results appear to be processed in a timely manner and verbal confirmation available on request by the park, the confirmation of counts and test results are often late, and, for the final month of trapping in 2000, never received by the park.

Late or missing data is unfortunate during a quiet season. A break in information transfer in the event of a viral emergence would seriously undermine the continuity of the program, the confidence that the health community has placed on the Program, and the ability for NPS managers to make sound decisions in balancing environmental and health threats.

It would also be useful for the partners to clarify the need for, and intended use of, data on larval dip counts and wetland flooding. Dip counts are usually performed in designated areas, but can vary depending on the presence of puddles. Flooding information is recorded for the dip count site if the site has been recently flooded. If not, the observer checks other marshes in the general vicinity and notes a positive response if any area appears at a distance to have been recently flooded.

The degree of wetland flooding undoubtedly has an impact on larvae development. But, it is also recognized that wetland conditions change very rapidly, potentially enhancing or eliminating a larvae cohort. Marsh flooding is a factor of many influences. It is evident that even a slight wind building a fetch from a particular direction could flood marshes with one aspect while leaving adjacent marshes dry. It may be possible to find 'probable' supportive larval habitat from many locations on the island on any day. Without a more robust observation and dip count effort, biased observations invalidate any relationship between larval dip counts, flood conditions and hatches. It would also be inaccurate to interpret watershed-wide population changes on such spot checks.

For WNV, the partners should review the use of sentinel hosts, gravid traps, and other monitoring methods. In addition, it would be beneficial to learn what species of mosquito are capable of successfully transmitting WNV between hosts to direct any additional monitoring efforts.

The catch of *A. albopictus* is worth noting from a management perspective. Recognizing that the tiger mosquito is a fierce biter that is active during the daytime, the NPS should anticipate an increase in complaints from the public should a population become firmly established.

The fact that the tiger mosquito was caught within the maintenance storage yard should not come as a surprise, due to the number of potential stagnant catches at that location. Park staff should

espouse better housekeeping to minimize breeding opportunities.

Past ditching and diking throughout the island has left a number of inaccessible stagnant waterholes. Although reclamation is not likely in the immediate future, the park should insure that management practices minimize water impediments around construction sites and permit natural forces to influence old restrictive structures throughout the island whenever or wherever possible.