

ASSATEAGUE ISLAND NATIONAL SEASHORE

2002 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 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 bird-feeding species common to the Pocomoke River swamp but rarely 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*, 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 is a virus that has historically been confined to northern Africa and Europe. It was first documented in the Western Hemisphere in 1999 in New York City. By late 2002, it had spread across North America to the Gulf of Mexico, Pacific coast and to central Canada. 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 stagnant-water breeding mosquitoes, primarily of 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 (figure 1). Most human cases have been restricted to urban areas, where *Culex pipiens*, a stagnant water or container breeding mosquito and commensal birds 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 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 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 2002.

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 population levels of the primary island species, 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 span 15 kilometers to provide mosquito population samples along the length of the island. The trap locations were situated in edge communities to facilitate the capture of both saltmarsh and 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. 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. Those species that have a potential to transmit virus with a human health risk were sub-sampled.

Those subsamples were pooled into groups of up to 40 individual mosquitoes. A maximum of 400 mosquitoes (10 pools) per species per trap location were reserved for viral testing. A weekly summary of trapping results was prepared by MDAMCS and forwarded to ASIS.

Pools from Assateague were joined with pools collected from other county sites and transferred to the Maryland Department of Health and Mental Hygiene (MDHMH) laboratory in Baltimore by courier. MDHMH screened the submitted pools from the ASIS sample sites for four potential viruses: EEE, WNV, La Crosse (LCE) and St. Louis Encephalitis (SLE).

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 28 through October 8 at all three sites for a total of 20 trap-nights and 60 samples. 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 10 identified species of mosquitoes, and three individual mosquitoes that could not be speciated. These included:

<i>Aedes vexans</i>	<i>Ochlerotatus canadensis</i>	<i>Psorophora ciliata</i>
<i>Anopheles br.&cr.complex</i>	<i>O. cantator</i>	<i>P. ferox</i>
<i>Culiseta inornata</i>	<i>O. sollicitans</i>	
<i>Culex salinarius</i>	<i>O. taeniorhynchus</i>	

Of the total annual trap catch of an estimated 382,062 mosquitoes, 99% was made up of two species: *O. taeniorhynchus* accounted for 63% and *O. sollicitans* 36%.

For the 2002 season, North Beach produced 42% of the crop, Green Run harbored 39%, while Tingles Island made up 19% of the catch. Although the proportion of *taeniorhynchus* and *sollicitans* varied per trap site, together they accounted for 99% of the sample at each site (Figure 2).

Throughout the season, the rise and fall of hatches for *O. taeniorhynchus* and *sollicitans* mirrored each other. Although *sollicitans* has the ability to withstand higher salinity environments, the rain or tidal events that supported mosquito reproduction apparently favored both species' habitats equally.

Initially, the species of interest included *O. sollicitans* and *Culex* species. Observations elsewhere suggested that many species of mosquito may have the potential to serve as a competent vector for WNV, so most mosquito species were subjected to PCR screening.

There were no positive PCR test results for EEE from *O. sollicitans* pools tested during the 2002 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/LCE) from any mosquitoes or animals on Assateague 2002.

Discussion

Following several years of drought conditions, the summer of 2002 experienced more normal rainfall amounts. However, unlike average summers that experience frequent, wide spread afternoon thundershowers, 2002 had a pattern of relatively dry periods punctuated by storms with significant rainfall amounts.

During the 20 week sample period 92% (11.2") of the total rainfall (12.2") fell during the passage of six low pressure fronts. Those events, some of which occurred over a several day period, dropped from 1.1 to 3 inches of precipitation each.

The mosquito samples collected each Monday suggested hatches some 7-10 days following each of these rainfall events, with the exception for the last significant rainfall in late September after which numbers did not rise. There were five weeks when at least one trap site held between 10,000-100,000 mosquitoes, seven weeks with catches between 1,000-10,000, and eight weeks when all traps held less than 1,000 mosquitoes. The lowest trap catch was 15 and the highest was 86,500.

Elsewhere in the region, there were no reports of EEE activity on the peninsula, but WNV was reported throughout Maryland including all Delmarva counties surrounding Assateague Island. As reported throughout North America, most WNV activity was concentrated in urban/suburban areas.

Some 7206 pools of Maryland mosquitoes were evaluated for the presence of virus. Worcester county contributed the second highest number of pools (1355) primarily due to the large samples collected from Assateague Island. (Anne Arundel had 1366 pools and Prince George's had 1307.) Only 46 pools provided positive WNV results, of which 87% were provided by three urban areas (Howard, Prince George's and Baltimore counties).

Birds, not mosquitoes, provided the overwhelming evidence of WNV in Maryland. Of 739 positive PCR test results for WNV in Maryland in 2002, 675 were from dead birds, 46 from mosquito pools, 13 from human cases and 5 were domestic animals. Figure # shows the by-county occurrence of positive birds resulting from tests on dead birds. Although dead birds appear to provide a more realistic assessment of WNC presence (675 positive results from a total of 1054 birds sampled), the logistics and cost of collecting and processing birds has strained the state's assessment program. Early indications are that the state will not conduct state-wide bird assessments for WNV in 2003.

A more local view of the positive WNV results is presented on the chart below. The number of positive cases is significantly less than the predominantly developed communities off of the peninsula, but they still indicate a presence of the virus.

Locations	Worcester C.	Wicomico C.	Dorchester C.	Sussex C	Accomac C.
Positive WNV	MD	MD	MD	DE	VA
Mosquito pools	0	0	0	0	0
Birds	4	5	3	20	4
Domestic animals	0	0	1	0	0
Humans	0	0	0	0	0

The mosquito species responsible for transmitting the WNV continues to point primarily to stagnant-water breeding species, and remains less certain for many other Genera. In 2002, the 7206 pools represented some 115494 mosquitoes of over 40 species. Of the 46 positive pools, 44 were in the Genera Culex, and two were from Aedes albopictus, the exotic Tiger mosquito. Of the Culex, one positive pool was reportedly from C. salinarius, which usually accounts for less than 1% of the samples from Assateague Island.

One pool of *O. sollicitans* was reported by MDHMH as having an ‘indeterminate’ result for WNV. *O. sollicitans* is the species on Assateague capable of transmitting EEE. It has also been found to harbor and transmit WNV under laboratory conditions, but it’s competency to transmit live virus or to serve as a host under natural conditions is not consistently agreed to by the various public health organizations. As the second most-abundant species on the island, there is a level of angst in not knowing it’s potential role in WNV ecology.

Summary Discussion

In 2002, all Maryland mosquito pools and suspicious animal deaths were directed to the MDHMH lab, where PCR assay’s were conducted for WNV, EEE, SLE and LCE. This coordinated effort permitted a statewide assessment of mosquito-borne virus activity.

The changes in the state program to facilitate the monitoring of WNV has required some modification to the NPS program. The change did permit the park to submit a full complement of samples for analysis of four arboviruses, but also removed the process of conducting parity on late-season samples to assess a vector’s potential to transmit virus (based on cohort age).

Broad-scale testing of essentially all island species increased the pool size from ASIS, resulting in a county-sample size that matched the number of pools tested from the counties with the highest actual infection rates. By not understanding the actual competency of *O. sollicitans* and *taeniorhynchus*, the NPS samples increased the work load and lab costs for both MDAMCS and MDHMH.

Mosquito control agencies used subsequent positive lab results to direct area abatement programs, although there appears to have been limited assessment of 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 because only older mosquitoes can harbor active virus. 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 – Biological Resources Division also recognizes that WNV monitoring is much more effective through bird monitoring than by mosquito screening, although mosquito monitoring can provide supportive information on species, abundance and age.

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	North Beach		Tingles Island		Green Run	
Species	Total	%	Total	%	Total	%
<i>Aedes vexans</i>	459	0.3	16		0	
<i>A. species</i>	2		0		0	
<i>Anopheles crucians</i> & <i>bradelyi</i>	22		12		251	0.2
<i>Culiseta inornata</i>	0		0		1	
<i>Culex salinarius</i>	748	0.5	419	0.6	977	0.7
<i>C. species</i>	0		0		1	
<i>Ochlerotatus canadensis</i>	4		0		0	
<i>O. cantator</i>	277	0.2	12		180	0.1
<i>O. sollicitans</i>	44,485	27.7	23,845	33.2	69,029	46.1
<i>O. taeniorhynchus</i>	114,287	71.3	47,529	66.1	79,192	52.9
<i>Psorophora ciliata</i>	81		35		89	
<i>P. ferox</i>	18		2		0	

Table 1: Total season catch by location for each species identified during the 2002 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>Culiseta inornata</i>	ditches	<i>Psorophora ferox</i>	flooded woods
<i>Culiseta melanura</i>	wooded swamp	<i>Psorophora howardii</i>	floodwater
<i>Coquillettidia perturbans</i>	vegetated pools	<i>Uranotaenia sapphirina</i>	container

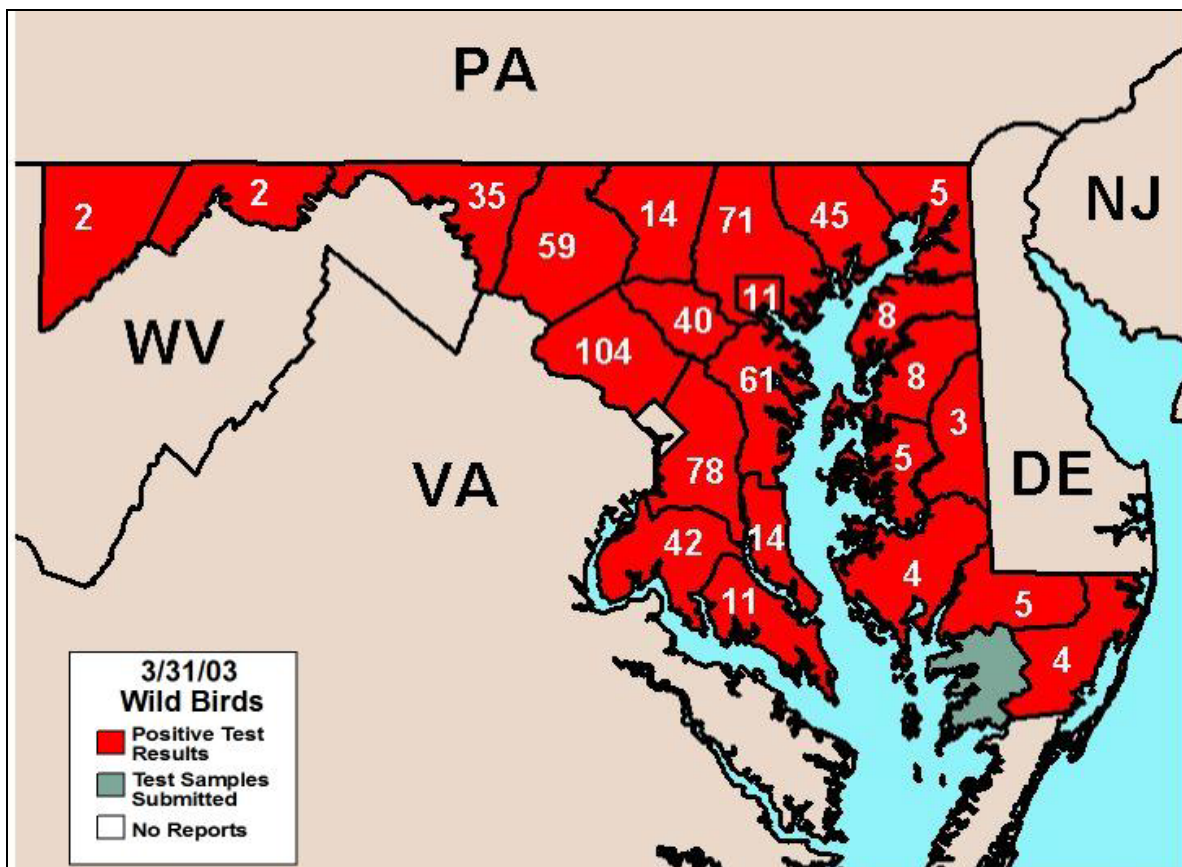


Figure 1. By-county results of West Nile virus infected birds recovered in Maryland during the 2002 sample season. Adopted from the Centers for Disease Control CINDI summary report for 2002.

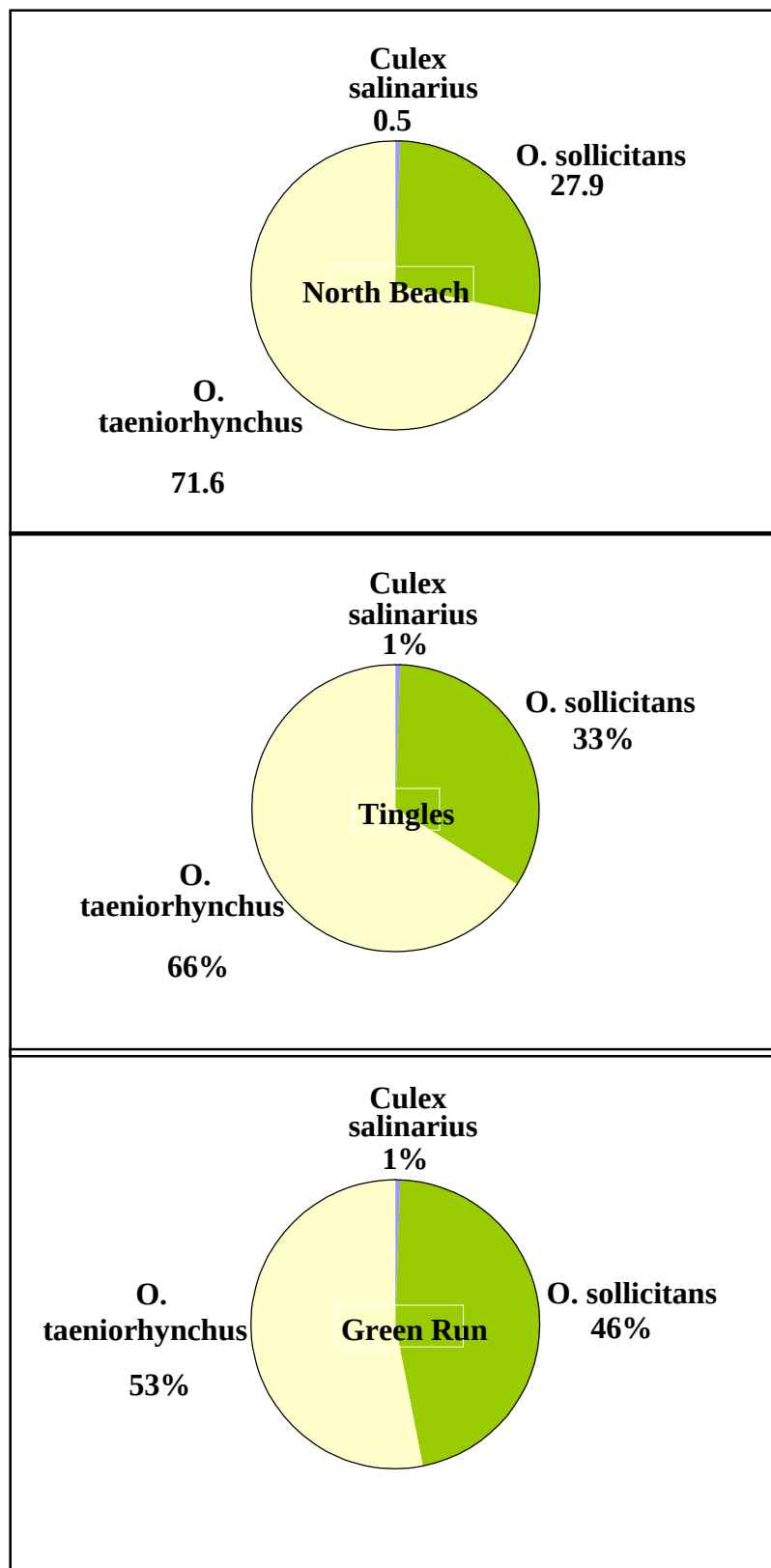


Figure 2. Proportion of mosquito species captured from three Assateague Island trap sites in 2002.

