# 2017 Annual Report of the Fire Island National Seashore (FIIS) Mosquito Surveillance and Management Program

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## ABSTRACT

The Fire Island National Seashore (FIIS) Mosquito Surveillance and Management Program was first implemented in 1998 in response to public concern over Eastern Equine Encephalitis Virus (EEEV), and continued due to prevalence of West Nile Virus (WNV). WNV has been detected within the park in at least one sample pool (up to 60 mosquitoes) every year between 2000-2006, 2008-2010, 2012, 2015, and 2016. (Table 1). With the collaboration and guidance from Suffolk County Vector Control (SCVC) and Dr. Howard Ginsberg with USGS, it was determined that six traps at these three locations should be maintained as surveillance sites. The mosquito sampling period for 2017 began on August 1st and ended September 11th for a total of seven weeks. This year, in order to help fill a data gap for SCVC we set and collected an additional two traps at the William Floyd Estate. Two types of traps were used: light traps and gravid traps. Typically, light traps yield a significantly greater amount of mosquitoes than the gravid traps. Results and limitations of the 2017 trapping season and plans for the 2018 season are discussed in the document.

# INTRODUCTION

In order for a consistent monitoring program, the Fire Island National Seashore (FIIS) Mosquito Surveillance and Management Program relies on the Mosquito Action Plan and Surveillance Protocols (Protocols) to provide guidance to staff on the proper techniques, data management, and disease response required to maintain an efficient program. This document is updated annually in collaboration with county, state and federal organizations, including Suffolk County Vector Control (SCVC), Suffolk County Department of Health Services and United States Geological Survey (USGS). The Protocols contain specific criteria for varying levels of alert and action, as well as the procedures for handling dead birds, the management of freshwater sources and equipment requirements. This document was updated and circulated to FIIS staff and was the basis of the mosquito program for 2017.

## *Fire Island Mosquito Management History*

Fire Island is a 32-mile long barrier island characterized by saltmarsh, dune grassland, dune shrubland, interdunal swale and forest/shrubland habitat (Klopfer et al. 2002) and is situated off the south shore of Long Island, New York. A unit of the National Park Service (NPS), Fire Island National Seashore (FIIS) comprises 26 miles of this narrow barrier island, plus the historic 613-acre William Floyd Estate (Public Law 89-244, 1965). Created in 1964, FIIS is maintained and operated by the National Park Service, under Department of the Interior regulation and jurisdiction. According to the FIIS Enabling Legislation (Public Law 88-587, 1964), FIIS was established "for the purpose of conserving and preserving for the use of future generations certain relatively unspoiled and undeveloped beaches, dunes, and other natural features…"

Within the boundaries of the park lie the Otis G. Pike High Dune Wilderness Area, park facilities, such as, Sailors Haven and Watch Hill, as well as 17 private communities. All of FIIS falls within the boundaries of Suffolk County, Long Island. At the west end, FIIS is bordered by Robert Moses State Park and on the east end, Smith Point County Park falls within the Park's jurisdictional boundaries, but is managed by Suffolk County (Figure 1).

In 1998, FIIS implemented a mosquito surveillance and management program in response to concerns that Eastern Equine Encephalitis Virus (EEEV), a mosquito-borne virus that could potentially occur within the park and affect public health. When West Nile Virus (WNV) was discovered in the New York region in 1999, mosquito surveillance and management efforts were subsequently expanded within the park to appropriately address this new disease concern.

Long Island has had an established mosquito control program since 1900 and Suffolk County has had its own mosquito control program since 1934. Today, SCVC focuses on mosquito surveillance and source reduction, water management and other environmental controls, larviciding, and adulticiding (SCVC History, 2004). The SCVC regularly controls mosquitoes through pesticide applications throughout Suffolk County, including Smith Point County Park and private communities located within the boundaries of FIIS. SCVC is restricted from using any form of pesticides on the federally owned tracts of Fire Island and the William Floyd Estate as per NPS policies documented in the Protocols. In order to maintain and preserve the environment within FIIS, NPS policy states that mosquito management interventions will be applied in FIIS only if the presence of WNV (and/or EEEV), in or near the park, is strong enough to suggest disease risk to humans and the risk of disease transmission would be substantially lowered by the intervention.

### *Mosquito Monitoring*

In previous years, mosquito trapping at FIIS has started in the first week of June and ended in the beginning of October spanning over roughly 16 weeks. The current trapping has been starting the last week in July/first week in August through the first full week in October, totaling around 10 weeks. The sampling season typically ends in the first week in October due to colder weather and a decrease in human disease risk (visitation to the park declines during that time). October trapping has occurred in prior seasons due to positive detections of WNV toward the end of September and only at targeted locations. At the height of the mosquito program, 18 traps were managed at seven locations. At least two nights of trapping where conducted per week and it was the responsibility of a full-time employee to carry out all trapping and sorting with little involvement in other Natural Resources programs.

Due to re-prioritization of the biological technician's responsibilities in 2013, FIIS Natural Resource Management staff reduced the amount of mosquito surveillance sites and set priority areas for mosquito trapping and deployment times for the 2013 summer season. This change altered the locations and deployment times for mosquito trapping that have been established in the past. In addition to FIIS's limitations, SCVC requested FIIS to decrease trapping times and locations to accommodate their limitations for the 2013 season. With guidance from Dr. Scott Campbell at SCVC and Dr. Howard Ginsberg at USGS, FIIS crafted the 2013 season trapping schedule based on locations and times of year WNV has been detected on Fire Island and the William Floyd Estate (WFE) in the past. This trapping method has been continued through 2017.

Thirteen years of data have been compiled to show when WNV was isolated from trapped mosquitoes for all years combined. From all positive pools, 60% occurred in September, 26% in August, 7% in early October, and 7% in late July. Based on this information the park decided that the 2013 trapping season would begin in the first week of August and end by the first week in October. However, the plan accommodated a response to high numbers of positive WNV pools earlier in the season, such as a possible early start for trapping mosquitoes in the end of July (if advised to do so by SCVC). It was also considered that trapping may also extend into October if pools are positive for WNV at the end of September based on consultation with SCVC and USGS.

The alterations of the 2013 mosquito trapping season was also implemented for all following years. The limitations of SCVC on the number of samples they can receive from FIIS still exist and will continue into the foreseeable future. As such, FIIS, SCVC and USGS re-visited the decisions made in 2013 that determined trapping locations and number of traps. Until SCVC can accommodate more FIIS mosquito samples and/or a need arises to increase trapping, FIIS will maintain the six mosquito traps at three locations; Watch Hill West, Fire Island Pines/ Carrington Tract, and the Village of Saltaire. FIIS is confident that the thirteen years of mosquito data that was analyzed showed that the alterations are appropriate for the mosquito management program and should be maintained in the future.

### *Mosquito Biology*

Approximately 40 mosquito species have been documented in Suffolk County, Long Island (Guirgis 1984). Approximately 25 of these species have been recorded throughout FIIS, with *Aedes sollicitans* (=*Ochlerotatus sollicitans*[1]), *Ae. vexans*, *Culex pipiens*, *Cx. restuans*, and Cx. *salinarius* being the most common. Of these species, the FIIS Mosquito Surveillance and Management Program focuses on mosquitoes of the genus *Culex*, which are known to have a

higher estimated transmission rate (ETR) for WNV than other mosquitoes found in FIIS. In our area, the primary epidemic or bridge vector that is responsible for transmission of WNV to people are *Culex* species (discussed more below).

WNV has been detected in at least 326 native and exotic bird species in the U.S. since 1999 (CDC 2009). Although birds infected with WNV can die or become ill, most infected birds do survive and act as reservoir hosts that continue to circulate the virus in the environment. On Fire Island, WNV is maintained in an enzootic cycle by several *Culex* species, with many bird species acting as reservoir hosts. In addition to mosquito population concerns, FIIS is concerned with finding dead birds specifically crows (*Corvidae* spp), hawks (family *Accipitridae*), and blue jays (*Cyanocitta cristata*) and has developed protocols and a Job Hazard Analysis (JHA) to safely collect and transport dead birds for WNV testing which are found in the Protocols.

The preferred habitats of *Culex* are areas that contain standing freshwater with high organic content (Crans 2004). This could be natural areas such as woodland pools or artificial containers like barrels, discarded tires and wells (Means 1987). The breeding of *Culex* is continuous throughout the summer months. Breeding of *Cx. pipiens* peaks in July and early August (Means 1987); while *Cx. restuans* peaks is in June and early July (Andreadis et al. 2005). These two species are both primarily bird feeders (ornithophagic) that are known to only occasionally bite mammals. *Cx. salinarius* breeds in a wide range of habitats, but is exceptionally abundant in freshwater marshes in Suffolk County (Means 1987). In contrast to *Cx. pipiens* and *Cx. restuans*, however, *Cx. salinarius* also lays eggs in brackish water and has a broader host range, including mammalian species.

*Ae. sollicitans*, commonly known as the eastern saltmarsh or golden saltmarsh mosquito, are also abundant in the saltmarshes of Suffolk County (Means 1979). They are multivoltine breeders (Crans 2004), with adults emerging by mid-May to produce successful generations into late September and even October (Means 1979). Eggs are normally deposited on bare moist soil in saltmarsh depressions which are regularly flooded, particularly by lunar tides, producing broods at approximately two week intervals. Storm tides and heavy rains can also trigger additional broods (Crans 2004). The natural landscape found within FIIS, especially in the Otis G. Pike High Dune Wilderness Area in the eastern portion of Fire Island, supports healthy populations of *Ae. sollicitans*. However, research has found that the Great South Bay acts as a migration barrier for mosquitoes and only a small percentage (< 1% - 6% in differing emergences) of *Ae. sollicitans* produced in the Otis G. Pike High Dune Wilderness Area migrate across to the neighboring communities of Mastic Beach and Shirley (Ginsberg 1986). Moreover, of those that do migrate across the bay, it was suggested that they are primarily newly-emerged mosquitoes (Ginsberg and Rohlf, 1985) and are thus not likely to transport arboviruses across to Long Island. This is based on the understanding that WNV has not been suggested to be transferred transovarially among local mosquito species.

Public health concern have been growing due to the rapidly spreading non-native invasive Asian Tiger mosquito, *Aedes albopictus*, and the established populations of *Ae. albopictus* throughout Long Island and Fire Island (SCVC per. comm and FIIS mosquito surveillance 2012 and 2013). This insect has been shown to be a vector of Dengue Fever, EEEV, capable of transmitting WNV, and a possible (but not confirmed) vector of Zika (Tiawsirisup et al., 2005; Rindfleisch, 1995 (NWS EA); CDC 2017). There has been some recent focus in New York on whether or not *Ae. albopictus* is a competent vector for WNV in our area. As such, FIIS staff assisted SCVC in 2013 and 2014 in monitoring *Ae. albopictus* mosquitoes in the Fire Island Pines, Carrington Tract, and Cherry Grove. This effort supported preliminary studies for *Ae. albopictus* population control by sterilizing males using a microbial biopesticides (MosquitoMate). In 2016, monitoring for *Aedes albopictus* was implemented throughout Fire Island in collaboration with SCVC and Dr. Howie Ginsberg (UGSS). Monitoring these populations will help inform any

potential management efforts in the future. We can essentially confirm (or not) that we have a significant enough population of the suspected vector in any particular region of the park.

## METHODS

### *Trapping Methods and Equipment for Virus Detection*

Two types of traps were used for the collection of mosquitoes: Gravid traps (John W. Hock Company model #1712) and $CO_2$-baited Miniature Light Traps (John W. Hock Company model #512). In all trap locations, light and gravid traps were paired together (within several meters of each other) in order to help facilitate possible future epidemiological research by USGS.

#### *Gravid Trap*

The gravid trap consists of 3.5”-wide PVC tubing that has a basic motor fan secured inside and a net on the top. The fan is powered by a sealed 6-volt battery. Held up vertically by aluminum cross beams, the PVC tubing rests on top of a plastic bin with measurements of 7” x10”x14” (height, width, and length, respectively). The bin contains a fermented mixture of rabbit feed and water, which acts as a high-organic material bait. The fermented mixture amount is adjusted so that the base of each tube sits approximately 1 inch above the surface of the mixture. The trap functions by pulling the mosquitoes up into the net via the PVC tubing, by the force of the fan, as gravid mosquitoes approach the fermented mixture to deposit their eggs (Figure 2A).

The gravid traps are designed to attract and collect gravid (egg-bearing) mosquitoes of species with larvae that thrive in freshwater with high organic content, which in FIIS are predominately *Cx. pipiens* and *Cx. restuans.* However, these traps can occasionally collect non-gravid foraging females of other species, especially those which are typically low-flying such as *Ae. sollicitans*. Gravid *Culex* mosquitoes are the preferred specimens for WNV testing. Gravid mosquitoes have already fed and are therefore more likely to be infected with WNV compared to those mosquitoes that have not yet procured a bloodmeal. For that reason, along with the ecology and biology of *Culex* mosquitoes, it is argued that gravid traps are likely to be more sensitive in detecting WNV and other mosquito-borne diseases than light traps.

#### *Light Trap*

As with the gravid traps, the light trap consists of 3.5”-wide PVC tubing with a basic motor fan run by a sealed 6-volt battery secured inside and a collection container that hangs from the tubing. As bait a 5”x5” cube of dry ice is hung in a canvas bag adjacent to the trap. Carbon dioxide gas given off during sublimation of the dry ice attracts mosquitoes to the vicinity of the trap. Once baited by the dry ice, an incandescent light located at the top of the tubing acts as a focal point and draws the mosquitoes to the suction of the fan, upon which they are pulled inside the bottom of the collection container via the tubing (Figure 2B).

The $CO_2$-baited light traps are designed to attract and collect host-seeking adult female mosquitoes. Research has shown, however, that these traps do not attract all species equally (Lussier et al. 2006). For example, some studies have found that certain bird feeding species were not strongly attracted to $CO_2$. Considerable variation among species has also been found in the degree that mosquitoes are attracted to light (Service 1976). Nonetheless, $CO_2$-baited light traps are generally known to yield larger collections, with a greater diversity of mosquitoes as compared to gravid traps (Lussier et al. 2006). Therefore, this trap may be a slightly stronger gauge for qualitatively measuring species abundance and, to a certain extent, species richness.

***Surveillance Sites***

Surveillance sites were determined in 2013 after analysis of thirteen years of mosquito data. These sites were chosen based on habitat and availability of fresh water resources, positive occurrences of WNV, accessibility, and human health risks.

- **Watch Hill West**: this location has produced the highest number of positive pools of WNV from FIIS's mosquito surveillance program (17 pools in 17 years) (Table 1). In addition, Watch Hill has high visitation throughout the summer season and park staff and concessionaires live at Watch Hill housing during the summer. The high human populations visiting and living at Watch Hill, the incidence of WNV and the habitat for WNV vectors warranted the continued surveillance of mosquitoes for the 2017 season. In addition, Watch Hill has high accessibility for staff via boat or ferry and employee housing provides for easy deployment and collection of traps.
- **Fire Island Pines/ Carrington Tract**: this location has had some incidence of WNV on Fire Island in the past (3 pools in 17 years) (Table 1). The fresh water swamp habitat that is found in this area supports the WNV vectors *Cx. pipiens* and *Cx. restuans*. The incidence of WNV, habitat, and close proximity to two important Fire Island communities (Fire Island Pines and Cherry Grove) warranted mosquito surveillance at this site. Traditionally, Watch Hill and the Fire Island Pine traps were set and collected on the same days, making for easy logistics.
- **Village of Saltaire**: this location has a history of WNV occurrence (6 positive pools in 17 years) (Table 1) making it the second highest site for WNV out of the seven that were historically sampled. The Village of Saltaire has a dense community and high visitation, increasing its human health risk. FIIS works closely with the Village of Saltaire to carry out the mosquito sampling.
- **William Floyd Estate (WFE):** this location has had several occurrences of WNV since the beginning of monitoring efforts. This site is made up of several inland freshwater pools and is surrounded by the densely-populated community of Mastic Beach. This site is particularly important because it will help fill a data gap for SCVC in this area. A total of two traps will be maintained at the William Floyd Estate. A paired light trap and gravid trap will be placed near the visitor entrance. The traps are set and collected by NPS employees but dropped off at the SCVC lab to be sorted and recorded.

The mosquito trapping season began the week of July 31st, 2017 and ended the week of September 11th, 2017 (Table 2). The season began with a total of 6 traps established at 3 surveillance sites (Table 3). Exact locations of each trap were selected based on various factors such as vegetative indicators, proximity to residential communities, the degree of staff and visitor use, visibility of trap (to avoid vandalism), mosquito productivity, canopy cover (for light traps) and either the presence of standing water or indications of water table surfacing (for gravid traps). In addition, historical records of arbovirus prevalence helped determine trapping locations of most concern. Traps were typically set in the afternoon, left overnight and then collected the following morning. Care was taken to not leave the traps out for longer than 16 hours in order to avoid excessive mortality and subsequent degradation of viruses, and damage to morphological characteristics necessary for accurate identification. Weather-permitting, each trap was set once per week and GPS coordinates of each trap location were recorded using a Trimble GeoXT™ (Table 3). Multiple traps were maintained at each of the surveillance sites. Light and gravid traps were paired together within several meters of each other in order to help facilitate possible future epidemiological research. A total of three areas were used as surveillance sites, which were selected in consultation with Dr. Scott Campbell (SCVC) and Dr. Howard S. Ginsberg (USGS).

The sites established from west to east were 1) the Village of Saltaire, 2) Fire Island Pines, and 3) Watch Hill.

Watch Hill is located on federally owned land consisting of a public marina, visitor center, campgrounds, park employee housing and maintained hiking trails and boardwalks. This site is characterized by northern dune shrubland, northern beach grass dune, pitch pine dune woodland, maritime deciduous scrub forest, highbush blueberry shrub forest, beach heath dune, northern salt shrub vegetation. On the bay side (north) there are features of reedgrass marsh, brackish meadow and low and high saltmarsh (Klopfer et al. 2002). Watch Hill is bordered by the community of Davis Park on the west and by the federally-designated Otis G. Pike High Dune Wilderness Area to the east. Two traps were placed at Watch Hill; a paired light trap and gravid trap were set 50 meters east of the Davis Park community border referred to as Watch Hill West (Figure 5). In previous years, after multiple positive WNV detections, a second trap was set later in the season to increase surveillance in the Watch Hill area. This light trap was situated next to employee house unit #2 and was referred to as Watch Hill Residence. Due to the lack of WNV detections in this area in 2017, this second location was not used.

Although one of our surveillance sites is labeled as Fire Island Pines, the traps are located in adjacent federal land. The landscape is predominately characterized by a maritime deciduous forest and maritime holly forest; it also has features of reedgrass marsh, highbush blueberry shrub forest and northern salt shrub (Klopfer et al. 2002). There is also a nearby permanent, freshwater inland pond. This federal tract bisects two strips of privately-owned land: Cherry Grove to the west and Fire Island Pines to the east. The Fire Island Pines site had a paired light trap and gravid trap located approximately 100 meters west of the federal-private lands border in a small tract of federal land unofficially called the Carrington Tract (Figure 4).

The Village of Saltaire is a boardwalk community that is characterized by northern dune shrubland, maritime deciduous scrub forest, and northern beach grass dune vegetation (Klopfer et al. 2002). The village is heavily fragmented by houses, and much of the original vegetation profile has changed. A high percentage of ornamental and exotic plantings occur around houses, and a high abundance of phragmites is present in wetland areas. Saltaire has a high water table and often has standing fresh to brackish water under the boardwalks and houses. This standing water provides excellent breeding areas for several mosquito species, especially *Culex*. Saltaire's surveillance site contained a light trap and a gravid trap separated by several hundred feet. The gravid trap was located on West Ave. at the west end of Saltaire, and the light trap was positioned on Neptune Ave. near the center of Saltaire (Figure 3).

### *Protective Equipment and Other Materials*

Personal protection equipment (PPE) was a necessity for the field work executed for the mosquito program monitoring effort. A white, disposable Tyvek™ suit with a hood and elastic wrists and ankles was worn for protection against ticks and mosquito bites, and a hoop-ring headnet and nitrile and/or gloves were also occasionally worn for mosquito protection. Permethrin, DEET, and/or herbal-based insect repellents were also applied to clothing as extra precautionary measures. Rubber boots were worn when hiking in wet areas and also provided a smooth surface that inhibited ticks from grasping on to clothing.

Dry ice for the light traps was purchased from County-wide Ice Cream in Holtsville, NY. Fresh dry ice was purchased in the beginning of every week for that week's trapping. Dry ice was stored in a dry-ice graded cooler to minimize rate of sublimation.

### *Transportation*

Fire Island is a unique barrier island in that it does not have paved roads along its entirety, making the beach the main access road for full sized and off-road vehicles. The traps located at Saltaire were accessed solely by truck. In this particular area, the interior road is easily accessed to get to the trap locations. A representative from the Village of Saltaire's security team help set and collect the traps each week. After collecting each traps, Saltaire's representation transported them to PMF to be sorted by the Biotech.

The "island traps", Watch Hill and Fire Island Pines, require both boat and beach driving. A boat was used to travel from Patchogue to the Watch Hill Marina, from where a Polaris or Truck would be used to get to each specific trap. This method of transportation was highly weather dependent; therefore, the trapping schedule varied each week according to the forecast. During inclement weather (i.e. small craft advisories and heavy thunderstorms), traps would not be set until the weather cleared up, or not set at all. If the traps were not set at all, incomplete data were recorded for that particular week.

### *Adult Mosquito Sampling and Analysis*

After being established at a particular location, most of the trap equipment remained at that trap site until the end of the season. The only equipment and materials that were removed and reset each week were the batteries, the collection nets, fermented water mixture and dry ice. In cases of damage or malfunction, traps were brought back to the lab for repair and reset the next trapping cycle, or if possible, repaired in the field. Immediately after gathering collection containers in the morning, containers with mosquitoes were placed in a cooler with dry ice to preserve the specimens and keep them immobilized for later analysis.

Analysis of mosquito populations involved determining the total number of mosquitoes caught per trap, and separated into seven taxonomic groups: 1.) *Culex* spp. 2.) *Ae. sollicitans* 3.) *Ae. taeniorhynchus 4.) Ae. vexans* 5.) *Coq. perturbans* and 6.) *Ae. albopictus* 7.) unknown/other. For traps that contained relatively few mosquitoes, all mosquitoes were individually counted to determine the total number caught and the totals of each taxonomic group. For traps that contained high numbers of mosquitoes, *Culex* were separated first than an estimation of the number of mosquitoes was determined. The contents of the entire trap were weighed using an ADAM ACB Plus – 150™ (max: 150g, d=0.005g) digital scale, and the resulting mass was compared to the mass of a known sub-sample size (100 mosquitoes). In order to account for differences in condensation and moisture content between each, a sub-sample size was extracted from each large trap night sample. The following formula was used for this calculation:

*T = (# of mosquitoes in sub-sample) x (mass of all mosquitoes) ÷ mass of sub-sample,* where
*T* = the total number of mosquitoes in a single trap night.

For traps that collected high numbers of mosquitoes, the number of each taxonomic group was also estimated. This was done by determining the proportion of each species in a known, randomly-extracted sub-sample and then multiplying that proportion by the estimated total number of mosquitoes. For example, to estimate the total number of *Ae. sollicitans* in a single trap night the same formula was used: (Solve for X)

$$\frac{X \text{ (Proportion of Ae. sol).}}{\text{Estimate total number in trap night (done by weight)}} = \frac{\text{Number of Ae. sol. In sub-sample}}{\text{100 (sub-sample size)}}$$

Then, solve for $T_{sol}$, where $T_{sol}$ is the estimated number of Ae. sollicitans in a trap night.

$$T_{sol} = X \text{ (Proportion of Ae. sollicitans) } x \text{ Total number in trap night/ } 100$$

Individual *Culex* were always pulled out of traps to form pools. A pool consisted of 10 to 60 mosquitoes of the same species collected from the same trap during the same trap night. Pools were placed in petri dishes, secured with rubber bands and labeled with the type of trap (gravid or light), the trap location, the date set and the contents of the pool (# of mosquitoes and species). Pools were then stored on dry ice until they could be transported to SCVC entomology laboratory. Once there, they were stored at -70°C in a top-loading freezer. Specimen identifications and counts were confirmed by laboratory staff and then later sent to the New York State Department of Health Wadsworth Center in Albany for arbovirus testing. The turnaround time for getting the results of the laboratory testing was approximately two weeks.

***Data***

After the mosquito data was gathered each week, it was entered into an Excel spreadsheet. From this, data tables and graphs (Table 4, Figures 8 and 9) were generated in Excel to depict trends in the mosquito numbers for important species throughout the season. The maps of surveillance sites (Figures 3-5) were created using ArcGIS™ (Geographic Information System).

***Aedes albopictus Monitoring***

The monitoring program consists of installing an array of ovi-traps throughout the park. These are essentially 22 oz cups with water (and organic matter) which attracts container breeding mosquitoes (such as the mosquitoes listed above). Germination paper is placed in each of these cups. There are only 3 species of mosquito eggs that can attach to this paper, two of which are found on Fire Island. They are, *Aedes albopictus* (Asian Tiger mosquito) and *Aedes japonicus* (Asian bush mosquito). Traps are checked once every week, and if eggs are found on the paper they are brought back to lab and reared to larvae. Once they are large enough, which takes about 10 days, we can take a sub-sample and confidently ID the species. This project can help the park determine whether we have a significant population of the suspected vector in any particular region of the park.

The *Aedes albopictus* sites included, from west to east: Lighthouse/Saltaire, Sailor's Haven/Sunken Forest, Carrington Tract/Fire Island Pines, Talisman, Blue Point, Watch Hill, Otis Pike Wilderness Area (east of breach), and the William Floyd Estate. The Lighthouse trap has been permanently moved, after the first week of trapping, to Saltaire. This was done because the site will be maintained by Saltaire, and the ovi-trap will be set up near the gravid trap in this area. Each site is represented on the map below (Figure 6). Figure 7 shows an example of what the traps look like and how they are being set up.

## RESULTS

There were 7 weeks of mosquito trapping from July- September 2017 with 3 gravid traps and 3 light traps maintained throughout the season. The traps set for each week can be found in Table 2. Adult mosquitos and *Culex* were relatively high in numbers throughout all of the light traps this season (Figure 8 and 9).

WNV has been detected at various locations within FIIS every year between 2000-2006, 2008-2010, 2012, 2015, and 2016 (Table 1). In 2017, there were zero positive detections of WNV within our sites.

### *Light Traps*

For 2017, the highest number for adult mosquitoes captured in light traps during one trap night (approx. 16 hours) was 5,544 individuals, on the night of August 8th at the Watch Hill West location (Table 4). The highest number of mosquitoes from the genus *Culex* collected during one trap night was 1337 mosquitoes, collected on September 11th also at the Watch Hill West site (Figure 9). This is a decrease from the 2016 numbers for the highest number of adult mosquitoes and the number of *Culex* captured in a light trap.

### *Gravid Traps*

The highest number of adult mosquitoes captured in a gravid trap was 56 individuals on August 8th at Saltaire (Table 4). The highest yield of *Culex* from a gravid trap in 2017 was 31 mosquitoes on August 8th, from a collection obtained at the Saltaire location (Figure 9). The overall number of *Culex* as well as highest number of adult mosquitoes captured in a gravid trap slightly decreased from the 2016 collections.

## DISCUSSION

### *Site Specific*

There were zero positive pools of WNV identified during the 2017 trapping season at FIIS. Compared to previous years, *Ae. sollicitans* populations were low. Watch Hill traps normally produce high numbers of *Ae. sollicitans* due to the close proximity of salt marshes. However, captures of salt marsh mosquitoes remained low which was anecdotally noticed at other salt marsh locations.

### *Limitations*

A contributing factor to the efficiency of the FIIS mosquito program has always been the travel time to and from trapping sites. The accessibility by boat or vehicle to Fire Island is time consuming and highly dependent on weather. Logistics and weather heavily influence the success and implementation of the mosquito program. Due to weather and tide restrictions, the Fire Island Pines light and gravid traps were not set the week of August 14th. This is shown on figures 6 and 7 as a break in the graphs. There was a slight malfunction with the gravid trap at Saltaire which lead to being unable to set this trap the week of August 28th. Representatives from Saltaire aided in the 2017 trapping season by setting and collecting traps at that site throughout the entirety of the season. This helped eliminate any time constraints that may have occurred if this site was only set by FIIS staff.

### *Mosquito Management on Non-federal Properties*

In 2017, the Village of Bellport Program Fund supported a mosquito control program at Ho Hum Beach on Fire Island with a letter of authorization from FIIS. The application of 1.6 gallons of Cedar safe concentrate was used throughout the season. No data was collected to quantify the

effects of mosquito spraying in this area. The Village of Bellport looks to continue this effort in 2018.

SCVC routinely applied pesticides to many communities within the boundaries of FIIS. A letter of authorization issued by the park to SCVC allows for such mosquito management practices and has been occurring since the late 1990's when FIIS mosquito surveillance program was created. SCVC follows protocols approved by FIIS as well as FIIS's Protocols in order to carry out mosquito management, including pesticide applications. Quantities of pesticides used by SCVC in 2017 can be found in Table 5. A comparison between pesticide use in 2016 and 2017 show SCVC applied less larvicide and adulticides (Table 6).

## CONCLUSION

In summary, in 2017, there were a total of 14 nights of trapping over a 7 week period. 4,817 *Culex* specimens were sent to the New York Department of Health Wadsworth Center in Albany for arbovirus testing. There were zero detections of WNV within our sites, which is a decrease from 2016's one positive detection in Saltaire. The 2017 trapping season was ended two weeks early due to weather. With inclement weather, unsafe field conditions, and lack of positive detections of WNV, FIIS staff along with SCVC and Dr. Howard Ginsberg, it was decided that trapping season could be ended.

Public education efforts consisted of spontaneous informal education programs between staff and visitors/residents during setting or collection of traps. The impromptu education interactions with the public were successful and enjoyable for visitors and residents. Overall, the reduction of the mosquito monitoring program in 2013 was found to be a successful compromise in response to FIIS's sequestration budget. For 2018, mosquito trapping locations will be reevaluated. In addition, formal education efforts will be increased and scheduled farther in advance for RM staff and Interpretation staff to better organize events.

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## TABLES AND FIGURES

Table 1. Locations of positive WNV identification either through mosquito testing or dead bird surveillance by year.

| Year | Location |
|---|---|
| **2000** | Saltaire |
| **2001** | Watch Hill |
| **2002** | Watch Hill West<br>Wilderness |
| **2003** | William Floyd Estate<br>Cherry Grove (from dead bird) |
| **2004** | William Floyd Estate |
| **2005** | Saltaire<br>Lighthouse Tract<br>Sunken Forest<br>Wilderness |
| **2006** | Watch Hill Residence Area |
| **2007** | - |
| **2008** | Fire Island Pines |
| **2009** | Wilderness Visitor Center<br>Sailors Haven |
| **2010** | Fire Island Pines<br>Watch Hill Residence Area |
| **2011** | - |
| **2012** | William Floyd Estate West<br>Watch Hill West |
| **2013** | - |
| **2014** | - |
| **2015** | Watch Hill West (3x)<br>Saltaire (3x) |
| **2016** | Saltaire |
| **2017** | - |

Table 2. Weeks traps were set at each location, L= light trap, G= gravid trap

| | Watch Hill West | | Fire Island Pines | | Saltaire | |
|---|---|---|---|---|---|---|
| | **L** | **G** | **L** | **G** | **L** | **G** |
| **7/31** | X | X | X | X | X | X |
| **8/7** | X | X | X | X | X | X |
| **8/14** | X | X | - | - | X | X |
| **8/21** | X | X | X | X | X | X |
| **8/28** | X | X | X | X | X | - |
| **9/4** | X | X | X | X | X | X |
| **9/11** | X | X | X | X | X | X |
| X = Trap set | | (-) = Not set | | | MAL= malfunction | |

Table 3. Locations of 2016 traps.

| FIIS- trap placement 2016 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Study Area** | **Study Site** | **Site Code** | **Trap Type** | **Trap Code** | **Trap UTMS (18T)** | | **Trap No.** |
| | | | | | **Meters East** | **Meters North** | |
| Saltaire | Saltaire | S | Gravid | S-G | 652207 | 4499954 | 3 |
| | | | Light/CO2 | S-L | 652433 | 4500353 | 4 |
| Fire Island Pines | Fire Island Pines/Carrington Tract | FIP | Gravid | FIP-G | 662471 | 4503094 | 8 |
| | | | Light/CO2 | FIP-L | | | 9 |
| Watch Hill | Watch Hill West | WH-W | Gravid | WH-W-G | 669282 | 4506038 | 10 |
| | | | Light/CO2 | WH-W-L | | | 11 |

Table 4. Highest numbers caught at each location in 2017.

| | Trap Type | Highest Trap Numbers | Date |
|---|---|---|---|
| **Watch Hill** | Light | 5544 | 8- Aug |
| | Gravid | 12 | 8- Aug |
| **Fire Island Pines** | Light | 2014 | 8- Aug |
| | Gravid | 9 | 8- Aug; 21- Aug |
| **Saltaire** | Light | 373 | 8- Aug |
| | Gravid | 56 | 8- Aug |

Table 5. SCVC pesticide use in 2017 within Fire Island communities.

| Larvicide | Atlantique | Cherry Grove | Davis Park | Fair Harbor | FIP | Kismet | Ocean Bay Park | Ocean Beach | POW | Saltaire | Seaview | South Shirley | Summer Club | Water Island |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Altosid Liquid 20% Conc (FL) | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 84.424 | 0 | 0 | 0 | 0 |
| Aquabac 200G (LB) | 0 | 0 | 0 | 31 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 |
| Spheratax SPH 50 (LB) | 0 | 0.0825 | 11.75 | 87.5 | 0 | 15 | 3.75 | 6 | 0 | 321.75 | 15 | 0 | 0 | 0 |
| VectoBac 12AS (FL) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1683.5 | 0 | 0 | 0 | 0 |
| VectoPrime FG (LB) | 0 | 5 | 1 | 15.5 | 0.434 | 0 | 2.25 | 0 | 22 | 172 | 0 | 0 | 0 | 0 |
| **Adulticide** | | | | | | | | | | | | | | |
| Anvil 10 + 10 ULV | 16.5 | 0 | 210 | 0 | 137.5 | 0 | 226.1 | 152 | 195 | 0 | 139.5 | 103.2 | 11.5 | 42.5 |

FIP= Fire Island Pines, OBP= Ocean Bay Park, OB= Ocean Beach, POW= Point O' Woods

Table 6. Pesticide use in communities 2016 vs 2017 by SCVC.

| | 2016 | 2017 |
|---|---|---|
| **Larvicided communities** | 10 | 10 |
| **Adulticided communities** | 9 | 10 |

| Larvicides | 2016 | 2017 |
|---|---|---|
| **Altosid Liquid Larvicide 20% Conc. (FL)** | 80.644 | 84.424 |
| **Altosid XR-G (lb)** | 8 | - |
| **Aquabac 200G (LB)** | 357.797 | 36 |
| **FourStar 90 Day (ea)** | 6 | - |
| **Spheratax SPH 50 (LB)** | 163.211 | 460.8325 |
| **SUSPEND SC (FL)** | 6 | - |
| **SUSPEND POLYZONE (fl)** | 96 | - |
| **VectoBac 12AS- Duplex (FL)** | 1499.136 | 1683.456 |
| **VectoPrime (lb)** | 299.8125 | 218.184 |
| **Adulticide** | | |
| **Anvil 10+10 (FL)** | 1379.25 | 1233.8 |

Figure 1. Map of Fire Island National Seashore with the three trapping sites for disease monitoring.

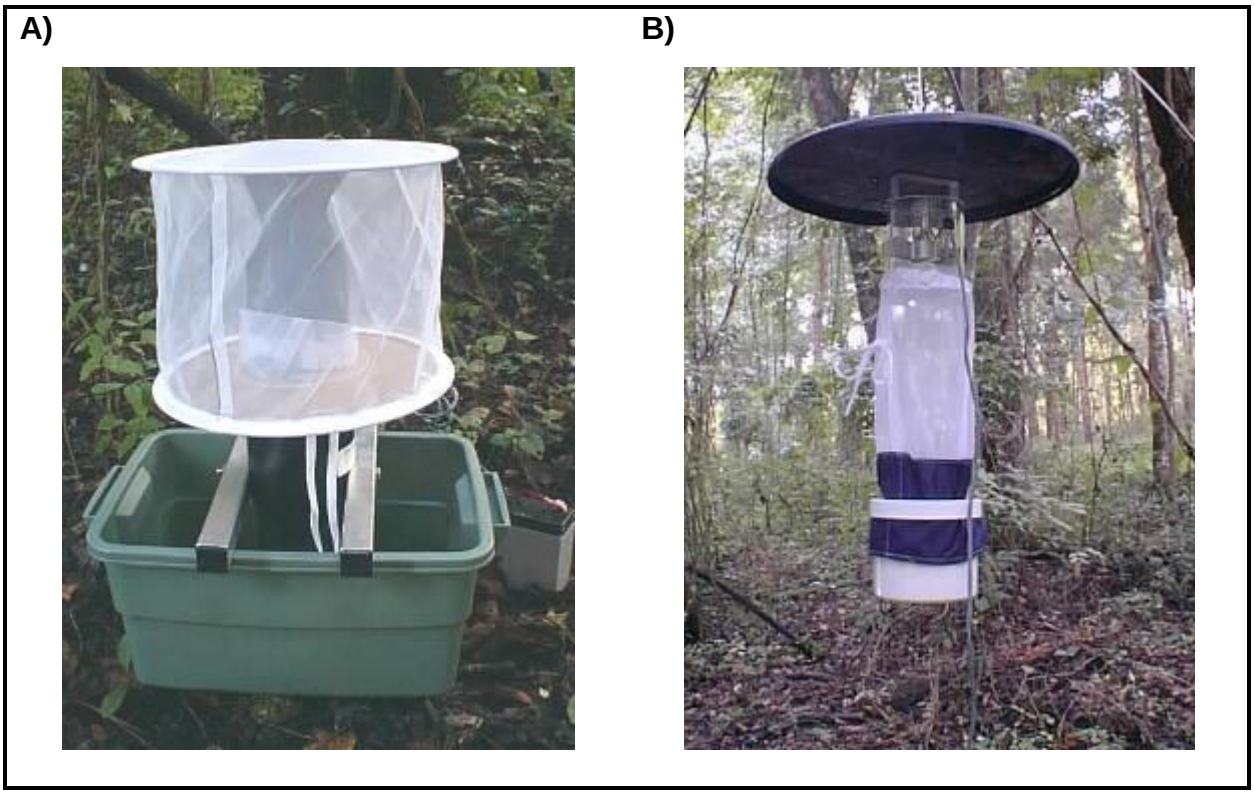


Figure 2. A) Gravid trap with collection net and battery. B) Light trap with collection container.

Figure 3. Map of the Saltaire study site.

Figure 4. Map of the Fire Island Pines study site.

Figure 5. Watch Hill West study site.

Figure 6. Map of *Aedes albopictus* ovi-trap sites.

Figure 7. Image of traps set at Sailors Haven.

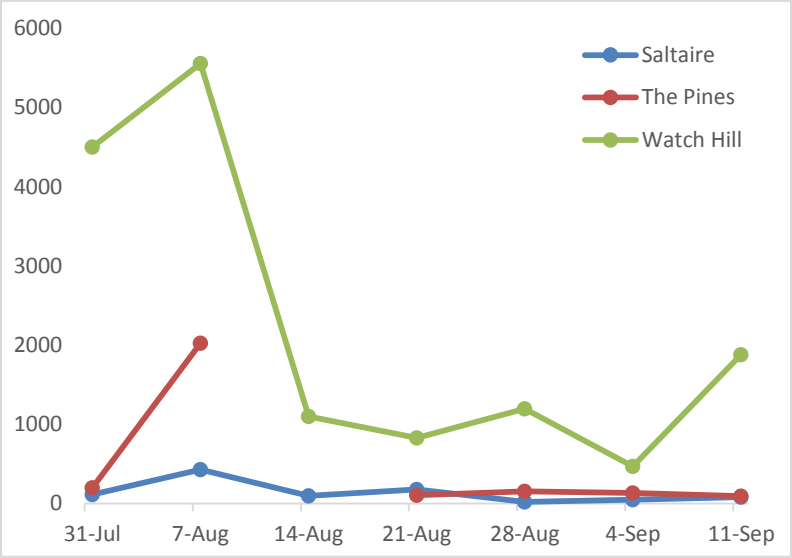


Figure 8. Number of mosquitoes trapped at each location (light and gravid together).

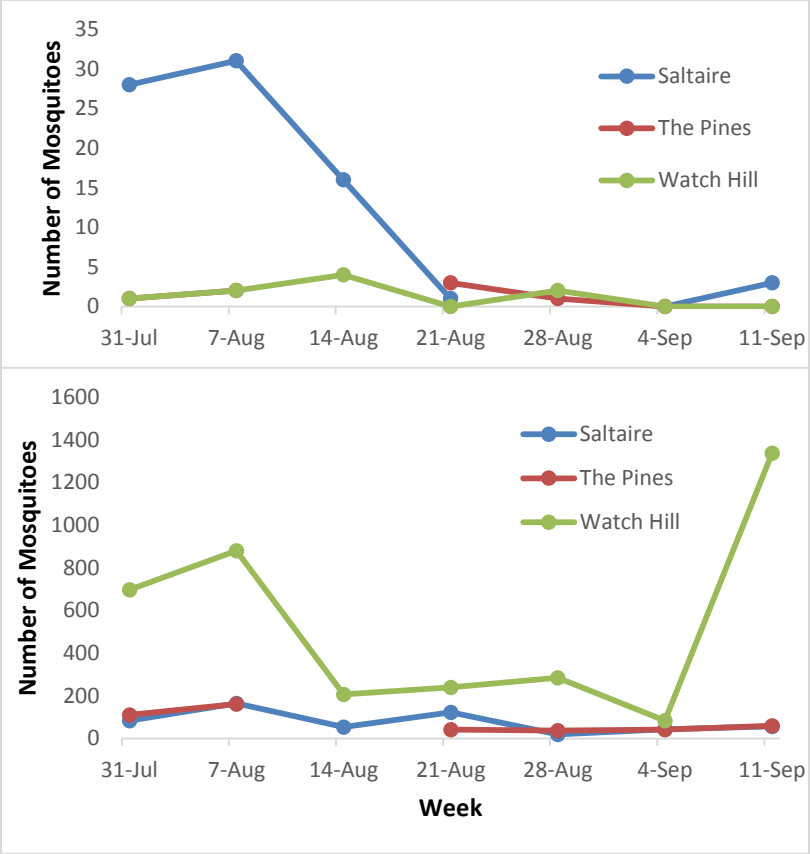


Figure 9. *Culex* captured in gravid traps (top) vs. light traps (bottom).