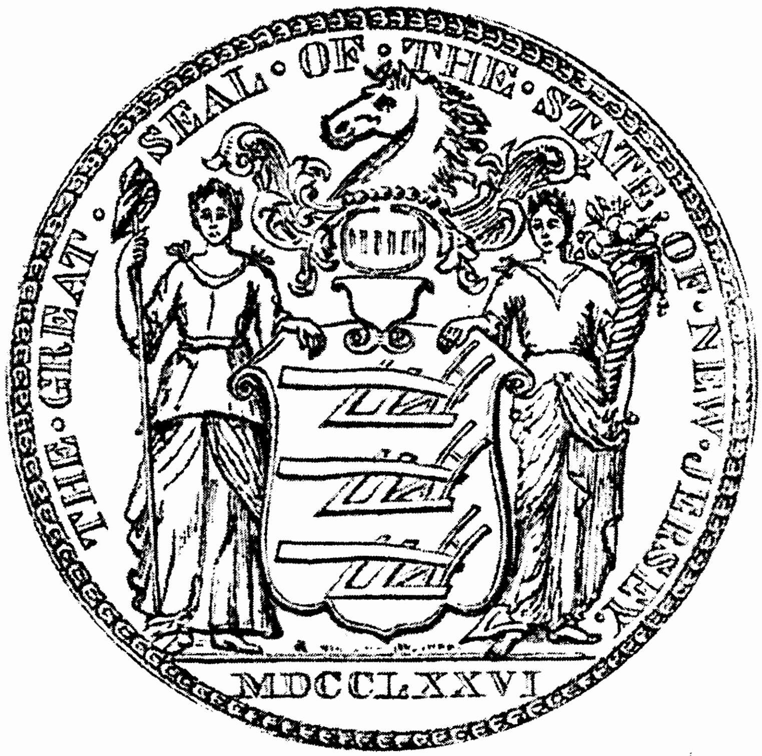
FIFTY SIXTH ANNUAL REPORT

OF THE

STATE MOSQUITO CONTROL COMMISSION

OF THE

STATE OF NEW JERSEY



For the Fiscal Year commencing July 1, 2011 and ending June 30, 2012

FIFTY SIXTH ANNUAL REPORT

NEW JERSEY STATE MOSQUITO CONTROL COMMISSION

2012

STATE OF NEW JERSEY
CHRIS CHRISTIE, GOVERNOR

N.J. DEPARTMENT OF ENVIRONMENTAL PROTECTION
BOB MARTIN, COMMISSIONER

Report prepared by the Office of
Mosquito Control Coordination,
N.J. Department of Environmental Protection
Robert Kent, Administrator
Claudia O'Malley, Principal Biologist
Steven Csorgo, Jr., Assistant Biologist
Kimberly Johnson, Secretary

State of New Jersey

CHRIS CHRISTIE
Governor

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STATE MOSQUITO CONTROL COMMISSION
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KIM GUADAGNO
Lt. Governor

BOB MARTIN
Commissioner

To: The Honorable Chris Christie, Governor
The Honorable Kim Guadagno, Lt. Governor
and members of the Senate and the
General Assembly of the State of New Jersey

In accordance with the provisions of Title 26 Chapter 9:12.6, we are pleased to submit the Fifty Sixth Annual Report of the State Mosquito Control Commission for the Fiscal Year covering the period from July 1, 2011 through June 30, 2012.

Respectfully,

John Sarnas, M.A., H.O., Chairman
Howard Emerson, H.O., Vice Chairman
Kenneth Bruder, Ph.D.
George Shivery,
John Surmay, R.Ph., H.O.
George Van Orden, Ph.D., H.O.
Mark Mayer, M.S.
Anthony Petrongolo, M.S.
Shereen Semple, M.S.
Mark Robson, Ph.D., M.P.H.

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MEMBERS OF THE STATE MOSQUITO CONTROL COMMISSION

John Sarnas, M.A., H.O., Chairman	Hudson County
Howard Emerson, Vice Chairman	Camden County
Kenneth W. Bruder, Ph.D.	Ocean County
George Shivery	Gloucester County
John Surmay, R.Ph., H.O.	Union County
George Van Orden, Ph.D., H.O.	Morris County
Bob Martin, Commissioner Ex Officio	N.J. Department of Environmental Protection
Mary E. O'Dowd, M.P.H. Commissioner Ex Officio	N.J. Department of Health & Senior Services
Douglas Fisher, Ph.D. Ex Officio	N.J. Department of Agriculture
Robert Goodman, Ph.D.	N.J. Agricultural Experiment Station, Rutgers University
Robert Kent, Secretary	N.J. Department of Environmental Protection

The following individuals served as representatives for the various ex officio members during the year:

Shereen Semple, M.S.	N.J. Department of Health & Senior Services
Anthony Petrongolo, M.S.	N.J. Department of Environmental Protection
Mark Mayer, M.S.	N.J. Department of Agriculture
Mark Robson, Ph.D., M.P.H.	N.J. Agricultural Experiment Station, Rutgers University

COMMISSION ACTIVITIES AND HIGHLIGHTS DURING FISCAL YEAR 2012

During the fiscal year 2011-2012, the State Mosquito Control Commission continued to monitor and address those issues, activities and legislation of importance to the mosquito control interests in New Jersey. Official meetings of the New Jersey State Mosquito Control Commission were held monthly during the year on the following dates and at the following locations:

DATE	LOCATION
July 19, 2011	Cape May Department of Mosquito Control, Cape May Court House, NJ.
August 16, 2011	NJ Division of Fish & Wildlife, Hackettstown, N.J.
September 21, 2011	NJ Agricultural Experiment Station, New Brunswick, N.J.
October 19, 2011	Office of Mosquito Control Coordination, DEP, Trenton, N.J.
November 16, 2011	City of Elizabeth "Steve Sampson Multi-Purpose Building" Elizabeth, NJ
December 2011	No Meeting Scheduled
January 17, 2012	Office of Mosquito Control Coordination, DEP, Trenton, N.J.
February 21, 2012	Office of Mosquito Control Coordination, DEP, Trenton, N.J.
March 20, 2012	Public Health Environmental & Agricultural Laboratories, Ewing, NJ
April 17, 2012	Meeting Cancelled
May 15, 2012	Office of Mosquito Control Coordination DEP, Trenton. NJ
June 19, 2012	Assunpink Wildlife Management Robbinsville, N.J.

In addition to the regularly scheduled meetings, the commissioners participated in numerous committee meetings and conferences with local, state and federal officials regarding mosquito control related matters. All business meetings were announced and held in compliance with the Open Public Meeting Law. P.L. 1975. C231.

The following six reports detail major issues that were anticipated and addressed. The first three: Equipment Use, Mosquito Airspray and Biological Control were managed by the staff of the Office of Mosquito Control Coordination within NJ-DEP. By way of this work and through other contact with the county mosquito control agencies; this office kept the Commission informed of the mosquito problems throughout the state. The other three reports are based on Professional Services contracted with Rutgers, the State University of NJ.

Also included in this report is that of a surveillance-related professional service contract for "Quality Control and Assurance." The work commenced last fiscal year and was engaged to assure consistent, quality sampling and preparation of mosquitoes by the county agencies when they submit mosquitoes to the state laboratory for disease testing. That report appears in this document.

State Equipment Use Program

The State Mosquito Control Commission's Equipment Use Program annually assigns a variety of surveillance, research or operational mosquito control equipment to any of the New Jersey mosquito control agencies on an as-needed basis. The equipment is used and maintained under the terms of the Department of Environmental Protection's Equipment Use Agreement and the State Mosquito Control Commission's 'Guidelines for the Use and Repair of State-Owned Equipment'. During fiscal year 2012, the State Commission had in its inventory 124 pieces of equipment available to the mosquito control community through this program (Table 1). Twenty of the twenty-one county mosquito control agencies in New Jersey, as well as the New Jersey Agricultural Experiment Station at Rutgers University, the New Jersey Department of Agriculture's Division of Animal Health, the New Jersey Department of Environmental Protection's Division of Fish and Wildlife, and the Office of Mosquito Control Coordination utilized this equipment during the fiscal year.

Three new pieces of equipment were obtained in fiscal year 2012. A 2012 Load Rite boat trailer was purchased at a cost of $1,199.00. This trailer replaced SMCC #67, a 1998 boat trailer assigned to the Ocean County Mosquito Extermination Commission. Daily launching in salt water had taken its toll – the side rails, axle, and suspension of the trailer were rusted out and were no longer repairable. As a result, the 1998 trailer was declared surplus, disposed of, and replaced. SMCC #43, a 2002 Ford Ranger pickup truck, was replaced with a 2012 GMC Canyon pickup truck at a cost of $15,175.00. This vehicle is used to pick up mosquito specimens for virus testing from the northern New Jersey mosquito control agencies and transport them to the Department of Health's Public Health and Environmental Laboratory in Ewing throughout the mosquito breeding season. SMCC #43 had been assigned to the Morris County Mosquito Extermination Commission; the Warren County Mosquito Control Commission has assumed the operation of the northern courier route, and this vehicle assignment was subsequently transferred to Warren County. $20,513.00 was expended to replace SMCC #98, a 2002 Ford Ranger four wheel drive pickup truck assigned to the Principal Biologist within the NJDEP Office of Mosquito Control Coordination. The replacement vehicle is a four wheel drive 2012 Ford Escape.

A total of $30,579.23 was disbursed for repairs to three pieces of state-owned equipment. This included $4,000.00 for repairs to SMCC #2, a 1987 hydraulic rotary excavator assigned to the Ocean County Mosquito Extermination Commission. This work had not been completed as of the end of fiscal year 2012. $20,000.00 was expended to augment funds encumbered in fiscal year 2011 for extensive repairs to SMCC #3, a 1995 hydraulic rotary excavator assigned to the Atlantic County Office of Mosquito Control. These included the purchase of new track chain, repairs to the rear engine fuel system, and repairing, sandblasting, and painting the pontoons. As was the case with SMCC #2, the repairs had also not been completed by the end of the fiscal year. $6,579.23 was required for repairs to SMCC #5, a 2003 long-reach hydraulic excavator assigned to the Morris County Mosquito Extermination Commission. Not included in the repair total was $2,020.00 for the purchase of a new atomizing head for SMCC #128, a 2008 turbine sprayer assigned to the Hudson Regional Health Commission Mosquito Control Program.

Six pieces of equipment in the state's inventory were transferred during the course of the fiscal year; three of these transfers were on a temporary basis. SMCC #31, a 2003 dissecting microscope and fiber optic illuminator, was surrendered by the Mercer County Division of Mosquito Control in fiscal year 2011. Likewise, the New Jersey Agricultural Experiment Station had surrendered SMCC #27, a 1994 ultra-low temperature freezer in fiscal year 2011. Both pieces of equipment were requested by and transferred to the Ocean County Mosquito Extermination Commission during the course of fiscal year 2012. The Mercer County Division of Mosquito Control also surrendered SMCC #107, a 2002 ultra-low temperature freezer; this was subsequently requested by and transferred to the Department of Agriculture's Division of Animal Health. SMCC #99 and 100, a 2002 all-terrain vehicle and trailer assigned to the Sussex County Office of Mosquito Control, was temporarily transferred to the Morris County Mosquito Extermination Commission. Morris County had been using the Marsh Master II to access a water management project; however, the U.S. Fish and Wildlife Service needed this piece of equipment, leaving Morris County with no reliable way to transport personnel to the project site. In the spirit of interagency cooperation, the Sussex County Office of Mosquito Control graciously agreed to the temporary transfer of the all-terrain vehicle and trailer to Morris County, in order that work on the water management project could continue. Similarly, SMCC #7, a 2003 low ground pressure hydraulic excavator assigned to Salem County Mosquito Control, was temporarily transferred to the Monmouth County Mosquito Extermination Commission so work on one of that county's water management projects could be accomplished before permit timing restrictions went into effect. The excavator was returned to Salem County prior to the end of the fiscal year. The New Jersey Agricultural Experiment Station also surrendered SMCC #46, 47, and 48, one 1977 compound microscope and two 1977 dissecting microscopes. Reassignment of this equipment had not been made by the close of the fiscal year.

Two pieces of state-owned equipment were surrendered and disposed of in fiscal year 2012, both assigned to the Sussex County Office of Mosquito Control. The first, SMCC #$30, was a 1995 insecticide sprayer which was no longer operational and for which replacement parts were no longer available. The second, SMCC #86A, was a 2006 insecticide sprayer variable flow control. Sussex County no longer had a use for this equipment, and the manufacturer was also no longer maintaining product support for this model, since it was superseded by newer technology. Both pieces of equipment were offered to the county mosquito control agencies; no interest was shown nor was any request made, so the equipment was declared surplus and disposed of.

Table State Mosquito Control Commission Equipment

No.	Type of Equipment	Location
1	1992 Amphibious Hydraulic Rotary Excavator	Cape May
2	1987 Amphibious Hydraulic Rotary Excavator	Ocean
3	1995 Amphibious Hydraulic Rotary Excavator	Atlantic
4	2007 Amphibious Tracked Vehicle	State
5	2003 Long-Reach Hydraulic Excavator	Essex/Morris
6	2003 Low Ground Pressure Hydraulic Excavator	Warren
7	2003 Low Ground Pressure Hydraulic Excavator	Salem
8	1992 Long-Reach Hydraulic Excavator	Cape May
9		Vacant
10	1995 Amphibious Long-Reach Hydraulic Excavator	Salem
11	1986 Hydraulic Excavator	Div. Fish & Wildlife
12	2003 Low Ground Pressure Hydraulic Excavator	Cumberland
13	2002 Hydraulic Excavator	Atlantic
14	2002 All-Terrain Vehicle	Ocean
15	2002 All-Terrain Vehicle Trailer	Ocean
16	1983 Tracked Vehicle	Essex
17	1985 Widetrack Bulldozer/Backhoe	Salem
18	1972 17 Foot Boat	Atlantic
19	2002 Outboard Motor	Atlantic
20	2002 Boat Trailer	Atlantic
21	1988 13 Foot Boat	Burlington
22	1988 Boat Trailer	Burlington
23	2002 Outboard Motor	Burlington
24	1988 Stereo Microscope w/optics	Warren
25	2008 U.L.V. Machine	Warren
25	2008 Spray Recording /Vehicle Monitoring System	Warren
26	2008 U.L.V. Machine	Passaic
26	2008 Spray Recording /Vehicle Monitoring System	Passaic
27	1994 Ultra Low Temperature Freezer	Ocean
28	1995 U.L.V. Machine	Salem
28	2007 Variable Flow Control	Salem
29	1995 U.L.V. Machine	Cumberland
30		Vacant
31	2003 Stereo Microscope w/optics	Ocean
32	1995 Turbine Sprayer	Cumberland
33	1995 U.L.V. Machine	Gloucester
34	1981 Phase-Contrast Microscope	Hudson
34	1981 Power Pak	Hudson
34	1981 Camera	Hudson
35		Vacant

36	2004 Incubator	Rutgers
37	1987 Stereo Microscope w/optics	Camden
38	1987 Stereo Microscope w/optics	Hudson
39	1992 U.L.V. Machine	Cumberland
40		Vacant
41	1988 Biosafety Cabinet	Rutgers
42	1977 Flatbed Truck	Sussex
43	2012 2WD Pickup Truck w/cap	Warren
44	1987 20-Ton Trailer	Salem
45	1976 Compound Microscope	State
46	1977 Compound Microscope	State
47	1977 Stereo Microscope	State
48	1977 Stereo Microscope	State
49	1980 Bulldozer/Backhoe	Warren
50	1980 Rotary Ditcher Attachment	Salem
51	2005 Tabletop Autoclave	Hunterdon
52	1984 Stereo Microscope w/optics	Monmouth
53		Vacant
54	2002 4x4 Pickup Truck w/cap	State
55	1985 Hydraulic Excavator	Essex
56	1988 6" Water Pump	Cape May
57	1989 Stereo Microscope w/optics	Atlantic
58	1989 All-Terrain Vehicle	Salem
59	1989 All-Terrain Vehicle Trailer	Salem
60	1990 Stereo Microscope w/optics	Sussex
61	1990 20-Ton Trailer	Warren
62	1996 All-Terrain Vehicle	Monmouth
63	1996 All-Terrain Vehicle Trailer	Monmouth
64	1997 Turbine Sprayer	Gloucester
65	1997 17 Foot Boat	Ocean
66	2007 Outboard Motor	Ocean
67	2012 Boat Trailer	Ocean
68	2000 Stereo Microscope w/optics	Hunterdon
69	2007 U.L.V. Machine	Hunterdon
69	2007 Spray Recording /Vehicle Monitoring System	Hunterdon
70	2007 U.L.V. Machine	Burlington
70	2007 Spray Recording /Vehicle Monitoring System	Burlington
71	2007 U.L.V. Machine	Essex
71	2007 Spray Recording /Vehicle Monitoring System	Essex
72		Vacant
73	2007 U.L.V. Machine	Atlantic
73	2007 Spray Recording /Vehicle Monitoring System	Atlantic
74	2007 U.L.V. Machine	Hunterdon
74	2007 Spray Recording /Vehicle Monitoring System	Hunterdon
75	2000 U.L.V. Machine	Gloucester
76	2001 Power Sprayer	Hunterdon

77	2000 U.L.V. Machine	Salem
78	2001 Ultra Low Temperature Freezer	Bergen
79	2001 Ultra Low Temperature Freezer	Middlesex
80	2001 Ultra Low Temperature Freezer	Monmouth
81	2001 Ultra Low Temperature Freezer	Morris
82	2001 Ultra Low Temperature Freezer	Salem
83	2001 Ultra Low Temperature Freezer	Warren
84	2001 Ultra Low Temperature Freezer	Camden
85	2001 Ultra Low Temperature Freezer	Sussex
86	2001 U.L.V. Machine	Sussex
87	2001 Insecticide Applicator	Sussex
88	2004 Power Sprayer	Essex
89	2001 4x4 Pickup Truck w/cap	Atlantic
90	2002 17 Foot Boat	Ocean
91	2002 Outboard Motor	Ocean
92	2002 Boat Trailer	Ocean
93	2002 All-Terrain Vehicle	Gloucester
94	2002 All-Terrain Vehicle Trailer	Gloucester
95	2002 All-Terrain Vehicle	Essex
96	2002 All-Terrain Vehicle	Hunterdon
97	2002 All-Terrain Vehicle Trailer	Hunterdon
98	2012 4x4 Sport Utility Vehicle	State
99	2002 All-Terrain Vehicle	Sussex
100	2002 All-Terrain Vehicle Trailer	Sussex
101	2002 Acoustic Storm Drain System	Sussex
102	2002 Ultra Low Temperature Freezer	Rutgers
103	2002 All-Terrain Vehicle	Bergen
104	2002 All-Terrain Vehicle Trailer	Bergen
105	2002 U.L.V. Machine	Salem
106	2002 Ultra Low Temperature Freezer	Burlington
107	2002 Ultra Low Temperature Freezer	Dept. of Agriculture
108	2002 U.L.V. Machine	Cumberland
109	2002 U.L.V. Machine	Essex
110	2002 All-Terrain Vehicle	Union
111	2003 All-Terrain Vehicle Trailer	Union
112	2003 Microplate Reader	Rutgers
113	2003 Microplate Washer	Rutgers
114	2003 All-Terrain Vehicle	Mercer
115	2003 All-Terrain Vehicle Trailer	Mercer
116	2002 All-Terrain Vehicle	Ocean
117	2003 All-Terrain Vehicle Trailer	Ocean
118	2003 All-Terrain Vehicle	Cumberland
119	2004 All-Terrain Vehicle Trailer	Cumberland
120	2003 All-Terrain Vehicle	Hudson
121	2004 All-Terrain Vehicle Trailer	Hudson
122	2004 Ultra Low Temperature Freezer	Gloucester

123	2004 Ultra Low Temperature Freezer	Essex
124	2004 Ultra Low Temperature Freezer	Passaic
125	2004 Ultra Low Temperature Freezer	Cumberland
126	2004 Ultra Low Temperature Freezer	Union
127	2004 Ultra Low Temperature Freezer	Hudson
128	2008 Turbine Sprayer	Hudson
129	2007 Turbine Sprayer Trailer	Hudson
130	2009 Amphibious Tracked Vehicle Trailer	State

Program Director: Claudia O'Malley, Office of Mosquito Control Coordination, Department of Environmental Protection.

State Airspray Program

Fiscal year 2012 began, as in all years past, with the mosquito control season well underway. Twenty-three insecticide applications were performed in five counties, treating a total of 32,993 acres (Table 2). Although the program's primary focus continues to be the control of larval mosquitoes, two of the applications made were for adult mosquito control. Both took place in Cumberland County, to control high population levels of *Aedes sollicitans* resulting from coastal flooding brought on by Hurricane Irene. Of the twenty-one aerial larvicide applications, 86% were made to the Atlantic coastal salt marshes and the Delaware Bayshore salt hay farms, where mosquito production is mainly influenced by monthly tidal cycles. The remaining 14% of the aerial larvicide applications were made to upland targets, where precipitation is the major factor affecting mosquito production. In addition to the twenty-one larvicide operations and two adulticide operations, program aircraft were also utilized for one surveillance flight, which was conducted in Atlantic County.

Aircraft available to the program included two single-engine, turbine Air Tractor AT-602s for high payload applications of both liquid and granular insecticide formulations, two Cessna Skylanes for observation flights, and seven Bell Jet Ranger rotary-wing aircraft for both granular larvicide applications and survey work. Additionally, four Grumman Ag Cats were also available for the application of both liquid and granular insecticide formulations; however, the highly efficient Air Tractor AT-602 was the sole aircraft used for fixed-wing applications this fiscal year.

The insecticides used in the larval control operations included temephos in a 5% granular formulation, and *Bacillus thuringiensis* var. *israelensis* in both granular and aqueous suspension formulations. Malathion was used for both adulticide applications.

Since fiscal year 1996, state aid has been provided to those Airspray Program counties that make insecticide applications for mosquito control to state-owned land within their corporate borders. This aid is made in the form of in-kind replacement of the insecticides applied. During fiscal year 2012, Cape May County was reimbursed with 6,840 pounds of Vectobac GS, and Ocean County was reimbursed with 1,320 gallons of Vectobac 12AS and 2,775 pounds of Abate 5BG.

Finally, Table 3 outlines the actual monetary cost of the state aid provided to those counties that participated in the State Airspray Program during fiscal year 2012.

Table 2 State Airspray Program acreage treated in FY2012 by mode and county.

County	Larviciding Acreage	Adulticiding Acreage	Total Acreage
Atlantic	13,376	- 0 -	13,376
Cumberland	4,613	8,733	13,346
Essex	2,240	- 0 -	2,240
Morris	2,435	- 0 -	2,435
Ocean	1,596	- 0 -	1,596
State Total	**24,260**	**8,733**	**32,993**

Table 3 State Airspray Program FY2012 expenditures by participating county.

County	Aircraft	Insecticides	Total
Atlantic	$109,336.40	$96,045.23	$205,381.63
Cumberland	$61,900.50	$41,960.60	$103,861.10
Essex*	$32,175.00	- 0 -	$32,175.00
Morris*	$44,752.50	- 0 -	$44,752.50
Ocean	$13,948.00	$39,325.44	$53,273.44

* In the case of upland operations, insecticide is provided by the county.

Program Director: Claudia O'Malley, Office of Mosquito Control Coordination, Department of Environmental Protection.

State Biological Control Program

The Biological Control Program continued to play an important role in the State Mosquito Control Commission's integrated pest management approach to mosquito control efforts in fiscal year 2012. The Commission maintained fiscal support of the program, and continued to make available five species of mosquito-eating fish to the county mosquito control agencies. These fish are used within the county programs as an alternative to the use of insecticides.

The Commission renewed the Memorandum of Agreement with the New Jersey Division of Fish and Wildlife that has been in effect for the past twenty years. The agreement provides for the development, maintenance and provision of fishery stocks at the Charles O. Hayford Fish Hatchery at Hackettstown. Bureau of Freshwater Fisheries personnel once again raised stocks of fish for release into known mosquito production sites throughout New Jersey. The difficulties with overwintering *Gambusia affinis* experienced during fiscal years 2007, 2008 and 2009 were not, thankfully, evidenced this fiscal year. As a result, an ample supply of fish was available for use by the county mosquito control agencies throughout the mosquito breeding season.

The Office of Mosquito Control Coordination and the participating county mosquito control agencies continue to enjoy an excellent relationship with Bureau of Freshwater Fisheries personnel, who provide invaluable assistance with this program. This work would not be possible without their cooperation and considerable expertise. All stocking is performed strictly in accordance with the guidelines and policy outlined in the Department of Environmental Protection document "How to Use the State Bio-Control Program for Mosquito Control in New Jersey". In fiscal year 2012 a total of 150,100 fish were stocked through the Biological Control Program in twelve New Jersey counties (Table 4). Species stocked included the Mosquitofish, *Gambusia affinis*, and the Fathead Minnow, *Pimephales promelas*. A total of 3,226,574 fish have been provided to the New Jersey county mosquito control agencies through the State Mosquito Control Commission's Biological Control Program since its inception in 1992, all at no cost to the participating counties.

The Commission also renewed its Memorandum of Agreement with the New Jersey Department of Agriculture's Phillip Alampi Beneficial Insect Rearing Laboratory, ensuring that the cyclopoid copepod project could continue through fiscal year 2012. Department of Agriculture staff continue to ensure that an ample supply of the native New Jersey copepod *Macrocyclops albidus* are available to those counties that choose to participate in this program. As is the case with the mosquitofish program, without the dedication of the staff at the Beneficial Insect Rearing Laboratory, this work would not be possible. In fiscal year 2012, 60,000 copepods were distributed among the following six counties: Bergen, Burlington, Cape May, Morris, Ocean and Passaic. Once again, various types of artificial containers were the habitat types into which these mosquito predators were introduced. It was discovered that marginal control results were achieved using lower stocking rates, so the practice of "super stocking" was initiated in two of the participating counties. In Burlington County, abandoned tires were stocked with 250 and 500 copepods per tire, instead of the original rate of 50 copepods per tire. In Ocean County, an approximately 96 cu. ft. stormwater management facility outflow structure was stocked with 10,000 copepods. The control achieved in both counties was quite encouraging, and the practice of stocking with higher numbers of copepods earlier in the season will be continued in future endeavors.

Table 4 Mosquitofish stocking by county and species during FY2012.

County	Species	Number of Fish
Bergen	*Gambusia*	20,000
Camden	*Gambusia*	7,000
Cape May	*Gambusia*	10,000
Cumberland	*Gambusia* Fathead minnows	14,000 7,500
Gloucester	*Gambusia* Fathead minnows	6,000 4,300
Monmouth	*Gambusia*	10,000
Morris	*Gambusia*	16,000
Ocean	*Gambusia*	10,000
Passaic	Fathead minnows	3,450
Salem	*Gambusia*	5,400
	Fathead minnows	2,100
Sussex	Fathead minnows	100
Warren	*Gambusia* Fathead minnows	8,000 26,250
Total		**150,100**

Program Director: Claudia O'Malley, Office of Mosquito Control Coordination, Department of Environmental Protection.

Monitoring the Efficacy of Insecticides for Mosquito Control in New Jersey

Toxicities of spinosad to *Aedes sollicitans* larvae from Ocean, Atlantic, Cape May and Cumberland counties are reported here. The toxicities remain in the single digit range and vary insignificantly between the years 2008, 2009, and 2010. Toxicities of Bti to *Aedes sollicitans* larvae were essentially the same as in previous years with small differences in the data falling well within normal variation. Bti is generally less toxic to mosquito larvae than spinosad. It takes 9 – 17 times more of Bti to achieve the same control as with spinosad. Toxicities of temephos at the LC_{50} level to the larvae were, like those of spinosad, in the single digit range. The variation at the LC_{90} level looks greater than it probably is due to less precision in the discriminating dose data from 2008 and 2009 than in the full-range LC_{50} toxicity bioassays. Toxicities of methoprene to the larvae were difficult to obtain. (The compound is quite toxic to the larvae – single digit LC_{50} values for Ocean and Atlantic counties, but increasingly troublesome to work with, probably due to some formulation problem.) This progress report shows the details of: collection of *Aedes sollicitans* host-seeking females; toxicity data for Bti, spinosad, temephos, and methoprene to mosquito larvae from eggs from females collected in south New Jersey field sites May through October, 2010; and data for etofenprox and prallethrin toxicities to larvae from Ocean County.

Host-seeking Ae. *sollicitans* females were collected in four locations in New Jersey: West Creek in Ocean County, Brigantine Island in Atlantic County, Sutton Lane in Cape May County, and East Point Lighthouse in Cumberland County. Nineteen collecting trips were under taken, with the last trip for the season on October 29, 2010.

The female mosquitoes were brought back to the Headlee lab in New Brunswick and fed cattle blood, purchased from the Carteret Abattoir, with a Hemotek apparatus. After 4 feedings, the mosquitoes were left in the collecting cages supplied with a paper towel soaked with a 10% sugar solution for 2 or 3 days. They were then transferred to glass shell vials (2 females per vial) containing a moistened cotton ball and sealed with a piece of fabric screen (bridal tulle) through which they could drink a 10% sugar solution placed on top in a saturated paper towel. During transfer, whilst holding them in the glass transfer tube, each female was identified by inspection with a dissecting microscope. Females that were not *Ae. sollicitans* were discarded. The egg-containing shell vials were stored at room temperature for 3 weeks to allow development of the embryo and the serosal cuticle. After that, the vials were stored in plastic baskets with a wet paper towel on top and wrapped in a plastic bag. The baskets were stored at 24°C in a Percival environmental incubator set at a 16/8 day/night cycle, and the moisture level in the vials was monitored and adjusted weekly to 80 – 85%RH to avoid drying out of the eggs. The numbers of vials with eggs from each field site are shown in Table 5.

As Table 5 shows, far from all collected females actually laid eggs. The number of eggs in each vial was highly variable, ranging from fewer than 10 to well over 100. Not every egg hatched. There are variations in each step of this series of events. This variability necessitates many collecting trips. This year, the number of eggs from Cape May and Cumberland Counties proved insufficient to obtain good solid data for insecticide response experiments.

Table 5. Summary of female *Ae. sollicitans* wild-caught at each field site in 2009.

County	Number of vials with eggs	Percent vials with eggs
Ocean	**358**	**55**
Atlantic	**301**	**62**
Cape May	**85**	**57**
Cumberland	**93**	**79**

All assays were performed exactly as described in prior annual reports. As in the previous year, this year's report includes "fold ratios" (FR) of toxicity of the insecticides between the years 2010 and 2009. The FR between years can indicate a trend, or lack thereof, in the physiological response in the larvae to an insecticide based on either a change in detoxification capacity or in molecular target site sensitivity, or both. A difference up to 3 – 4-fold can easily be the result of normal biological variation (if you look at any financial graph you will see similar variability in numbers). A larger and consistent difference should prompt close scrutiny of the population and how it is controlled as it could indicate incipient resistance evolution.

Toxicity of spinosad to *Aedes sollicitans* larvae.

A sample of spinosad marketed as Natular®, which is a 20.6% mixture of spinosyn A (major component) and spinosyn D in wintergreen oil (methyl salicylate) supplied by Clarke Mosquito Control Products, Inc., Roselle, IL, was used.

Mortality produced by spinosad was assessed after 3 days of incubation based on the progressive mortality observed and described in the 2008 Final Report for this project.

The 3-day mortalities from spinosad treatment to larvae from females collected in 2008, 2009, and 2010 are shown in Table 6.

Table 6. LC_{50} (ppb) with 95% confidence limits 3 days after treatment with spinosad in *Ae. sollicitans* larvae.

County	2008	2009	2010	FR (09/08)	FR (10/09)
Ocean	**2.4 (2.1 – 2.6)**	**5.4 (4.1 – 6.6)**	**3.2 (2.9 – 3.5)**	**2.2**	**0.6**
Atlantic	**1.5 (1.3 – 1.7)**	**5.8 (5.2 – 6.5)**	**1.8 (1.5 – 2;2)**	**3.3**	**0.3**
Cape May	**1.4 (1.2 – 1.7)**	**3.4 (3.0 – 3.8)**	**2.4 (2.0 – 2.9)**	**2.4**	**0.7**
Cumberland	**1.7 (1.3 – 2.2)**	**6.9 (6.3 – 7.4)**	**1.8 (1.5 – 2.1)**	**4.1**	**0.6**

All data in Table 6 are solid; the FR values between 2010 and 2009 data show increased toxicity in 2010 as opposed to decreased toxicity between the years 2009 and 2008. This is most likely due to normal biological variation. Several more years' worth of data are needed to determine any hard trend.

The toxicity of spinosad to *Ae. sollicitans* larvae is very high. By comparing the LC_{50} data for Bti and spinosad from 2010, it is clear that spinosad is more toxic than Bti: for Ocean, Atlantic, and Cape May counties, the difference is 9-fold in favor of spinosad; for Cumberland County, it is 17-fold in favor of spinosad. Bti is likely more expensive than spinosad. New Jersey *Ae. sollicitans* larvae are not resistant to spinosad and it should be perfectly feasible to rotate this insecticide with Bti.

Table 7 shows the LC_{50} (same as in Table 6) and LC_{90} data for spinosad to the mosquito larvae in 2010 (95% confidence limits) (ppb)

County	LC_{50}	LC_{90}	Slope
Ocean	**3.2 (2.9 – 3.5)**	**5.9 (5.2 – 6.6)**	**4.8**
Atlantic	**1.8 (1.5 – 2;2)**	**3.6 (2.9 – 5.3)**	**4.3**
Cape May	**2.4 (2.0 – 2.9)**	**4.9 (3.8 – 7.8)**	**4.0**
Cumberland	**1.8 (1.5 – 2.1)**	**3.7 (3.0 – 5.0)**	**4.1**

The slope of a regression line is taken to indicate the level of genetic heterogeneity/homogeneity of the population under study. The slopes of these regression lines indicate populations of average ("normal") genetic homogeneity. If plotted out, all these lines will have a slope of 45 degrees, more or less.

Toxicities of Bti to *Aedes sollicitans* larvae.

The Bti preparation was a sample of VectoBac®, donated by the Hunterdon County Mosquito Control Agency, containing 11.61% active ingredient representing 1200 international toxic units per mg. There is no direct relationship between potency and the percent active ingredient by weight. It is unclear exactly what the 'active ingredient' really is. The toxic principle of Bti is a large, 144 kD protein, the δ-endotoxin, not the item quantified in this formulation.

The assays were performed as described in the 2009 final report. The LC_{50} from 2008, 2009, and 2010 are shown in Table 8.

Table 8. Mortalities of 4th instar larvae of *Ae. sollicitans* in 2008, 2009, and 2010 (95% lower - upper confidence limits of the LC_{50} value) 24 hours after treatment with Bti.

County	2008 LC_{50} (ppb)	2009 LC_{50} (ppb)	2010 LC_{50} (ppb)	FR (09/08)	FR (10/09)
Ocean	**21.6 (18.2 – 5.2)**	**15.2 (13.5 – 7.3)**	**27.5 (24.6 – 32)**	**0.7**	**1.8**
Atlantic	**21.6 (18.9 – 24.9)**	**26.4 (23.4 – 30.4)**	**17.8 (14.9 – 21.4)**	**1.2**	**0.7**
Cape May	**16.8 (14.8 – 19.1)**	**19.9 (16.5 – 24.6)**	**23.2 (20.7 – 26.4)**	**1.2**	**1.2**
Cumberland	**24.2 (21.7 – 27.4)**	**39.5 (32.8 – 49.3)**	**33.7 (30.2 – 37.8)**	**1.6**	**0.9**

All data in Table 8 are solid. The variation in toxicity between the 3 years, 2008, 2009, and 2010 is insignificant, well within normal biological variation (all FR values are less than 2) indicating that Bti continues to be an excellent insecticide to use for the control of NJ salt marsh mosquitoes. To safeguard against resistance evolution to this valuable control agent it would be prudent to rotate it with spinosad (or even temephos as long as it's available) from time to time.

Table 9 shows the LC_{50} (same as in Table 8) and LC_{90} data for Bti to the mosquito larvae in 2010 (95% confidence limits) (ppb)

County	LC_{50}	LC_{90}	Slope
Ocean	**27.5 (24.6 – 32)**	**54.7 (46.3 – 68.9)**	**4.3**
Atlantic	**17.8 (14.9 – 21.4)**	**42.9 (33 – 66)**	**3.3**
Cape May	**23.2 (20.7 – 26.4)**	**48.8 (40.4 – 63.8)**	**3.9**
Cumberland	**33.7 (30.2 – 37.8)**	**58.5 (50.3 – 72.8)**	**5.3**

As before, the slope of a regression line is taken to indicate the genetic heterogeneity/homogeneity of the population under study. The slope data for Bti toxicity to the mosquito larvae indicate that the population from Cumberland County is slightly more genetically homogeneous (possibly more stressed with Bti) than the other populations and that the population from Atlantic County is slightly more genetically heterogeneous than other populations (less Bti stress). Considering that *Ae. sollicitans* is a strong flyer (has been recovered up to 50 miles from origin, personal communication with M. Romanowski), the level of homogeneity of any of the 4 south NJ *Ae. sollicitans* population can be expected to change depending on how the adult mosquitoes move between the 4 field sites; they are all within the range of adult flight capacity.

Toxicities of temephos to *Aedes sollicitans* larvae.

Analytical grade, >99% pure, temephos (Abate®) was purchased from Chem Service, West Chester, PA. Temephos toxicity (dead larvae) was assessed 24 hours after application. The value of monitoring temephos toxicity is at least 2-fold: temephos is a remarkably effective mosquito larvicide and may be needed in the future if other control agents should fail, and being detoxified in *Ae. sollicitans* exclusively by carboxylesterases, temephos toxicities provide information about the condition of this defense mechanism in the mosquito larvae. Carboxylesterases are also responsible for the detoxification of pyrethroids, especially synergized pyrethroids.

Table 10. Toxicity data for temephos to 4th instar larvae of *Ae. sollicitans* from females collected in Ocean, Atlantic, Cape May, and Cumberland Counties in 2010. (95% confidence limits, when available) (ppb)

County	LC_{50}	LC_{90}	Slope	Approximate LC_{90} for 2008	Approximate LC_{90} for 2009
Ocean	**4 (3.6 – 4.4)**	**7.6 (6.7 – 8.9)**	**4.6**	**10**	**14**
Atlantic	**2.9 (2.5 – 3.2)**	**8.2 (6.8 – 10.5)**	**2.8**	**10**	**60**
Cape May	**4 (2.6 – 5.4)**	**11 (7.7 – 26)**	**2.9**	**8**	**13**
Cumberland	**2 (1.7 – 2.2)**	**3.9 (3.3 – 5.1)**	**4.2**	**19**	**10**

The data in Table 10 are solid; they are better for Ocean and Atlantic Counties than for Cape May and Cumberland counties due to insufficient supplies of larvae from the latter counties. Because of lacking LC_{50} data for recent years when only discriminating dose data were sought, FR values would be largely meaningless. It is, however, obvious that temephos is an extraordinarily effective mosquito larvicide. The low slope values for Atlantic and Cape May counties indicate quite flat regression lines, which, in turn, indicate heterogeneous populations, perhaps a result of diminished use of temephos (lower selection pressure) in these counties in recent years.

Toxicity of methoprene to *Aedes sollicitans* larvae.

The methoprene (Altosid®) was purchased from Chem Service, Inc., West Chester, PA. It was a racemic mixture of the R and S forms, containing mostly the S (bioactive) form.

The methoprene toxicity test was performed as described in the 2009 report for this project.

A full-range LC_{50} was attempted with populations from the 4 field sites. This succeeded only for the populations from Ocean, Atlantic, and Cumberland counties. There are no data at all available for Cape May larvae due to insufficient numbers of eggs as well as to lacking basic equipment, *viz.*, a temperature-controlled bench-top incubator (previously, these monitoring experiments were performed in 1987. The mortalities obtained in 2010 are shown in Table 10.

Table 11. Toxicity data for methoprene to 4th instar larvae of *Ae. sollicitans* from females collected in Ocean, Atlantic, and Cumberland Counties in 2010. (95% confidence limits when available) (ppb)

County	LC_{50}	LC_{90}	Slope	Approximate LC_{90} for 2008	Approximate LC_{90} for 2009
Ocean	**1.3 (0.8 – 1.8)**	**29.5 (17.2 – 73.7)**	**0.9**	**36**	**15**
Atlantic	**5.3 (3.3 – 7.5)**	**81.9 (46.3 – 226.6)**	**1.1**	**50**	**15**
Cape May	**NA**	**NA**	**NA**	**25**	**15**
Cumberland	**13.2 (7 – 26.2)**	**362 (105.2 – 14,013)***	**0.9**	**50**	**15**

The data in Table 10 are best regarded as preliminary. Although methoprene is probably considerably toxic to *Ae. sollicitans* larvae, it was very difficult to obtain data that were even close to reasonable, in light of previous experimental data with these populations. Perusal of the LC_{90} (form 2010) and the approximate LC_{90} data from previous years, indicates a significantly decreased toxicity, especially for Cumberland County mosquitoes. Methoprene is, at best, capricious to use, and it takes a real effort to obtain consistent and reliable data with this compound, even in bench-top *in vivo* toxicity bioassays with stringently controlled conditions. Because of lacking LC_{50} data for recent years, when only discriminating dose data were sought, FR values would be largely meaningless. The slope values for the three regression lines indicate extremely flat lines; it was difficult to discern a true dose-mortality relationship with methoprene.

<u>Experiments with other insecticidal compounds.</u>

The recently introduced ether-pyrethroid adulticide **etofenprox** (ZENIVEX E20®) is toxic also to mosquito larvae. A preliminary LC_{50} of 3 ppb was obtained with mosquito larvae from females collected in Ocean County in 2009. This compound is not yet registered for use as a larvicide in New Jersey. When this compound is used as an adulticide in the vicinities of salt marshes, it will likely affect any larval populations present, as well. An **LC_{50} of 17.9 (15.9 – 20.8) ppb** was obtained with larvae from females collected in Ocean County in 2010. The value is solid; the toxicity is comparable to that of Bti. The **LC_{90} was 42.5 (35.6 – 54) ppb** and the slope of the regression line was 3.4 indicating "normal" genetic heterogeneity in the population.

Prallethrin, a recently introduced pyrethroid is formulated with another (old) pyrethroid, d-phenothrin and the synergist piperonyl butoxide, as Duet®, which is used on an observational basis in NJ for adulticiding. In experiments with prallethrin alone with larvae from females collected in Ocean County in 2010, an **LC_{50} of 20.9 (18.9 – 23.4) ppb** and an **LC_{90} of 30.8 (26.8 – 39.1) ppb** were obtained. The toxicity of this compound is also in the range of Bti toxicity. The slope for this regression line was 7.6, i.e., very steep, indicating a highly homogeneous population. This could very well be an effect of extensive use of other piperonyl butoxide-synergized pyrethroids exerting selection pressure. They are all detoxified by cytochrome P450 and carboxylesterases and they all have the same molecular target site, the axonal sodium channel.

Conclusion.

The overall conclusion based on the data presented above is that *Aedes sollicitans* larvae in the southern New Jersey salt marshes are still easily controlled with the insecticides monitored. This should be true also for methoprene, which, however, tends to be increasingly difficult to use. This is probably rather related to a formulation problem than to physiological resistance in the mosquito larvae.

Despite practical problems and lack of operating support, it is imperative that the available control agents be used in rotation every year to avoid potential resistance evolution in some situations. To do otherwise is destructive not only to the enduring effectiveness of the materials but also to the ecology and biology of the environment. Rotation of insecticides is one method accepted as part of IPM strategies. Another important option is the use of mixtures of insecticidal compounds (as opposed to simply synergized insecticides) as is routinely practiced in drug treatment of infectious diseases. This option is currently impossible (except perhaps by surreptitious use of several insecticides in a really short time period) with pesticides due to lack of research of pesticide interactions *in situ* and the ensuing lack of EPA-approved products. Yet another possibility is the use of refugia where sensitive populations can survive and, presumably, exit from to "dilute" resistant population gene pools.

Despite diminishing options for insecticides to use, and diminishing resources to use them with, there are likely many compounds already on the market for other types of control that could be registered for use in mosquito control if the required information were available. With such new possibilities, as well as with established mosquito control insecticides it is important to understand how the mosquito responds, as the mosquito remains the key factor.

Project Director: L.B. Brattsten, Rutgers University.

Surveillance for the Mosquito Vectors of Eastern Equine encephalitis and West Nile virus in New Jersey

Introduction

The NJ State Mosquito Control Commission (SMCC) has monitored potential vectors of mosquito-borne encephalitis in New Jersey since 1975 with a vector surveillance program designed to keep health related agencies aware of the potential for human involvement. Eastern equine encephalitis (EEE) was an original target for investigation because of its impact on coastal resorts in the southern portion of the state. West Nile virus (WNV) was added to the program in 2000 following an outbreak in New York City the previous year. In 2009, Saint Louis encephalitis and La Cross encephalitis surveillance were added. This program functions as a cooperative effort that includes the NJ Department of Environmental Protection, the NJ Department of Health, the NJ Agricultural Experiment Station at Rutgers and the 21 county mosquito control agencies in the state. The goal is a disease surveillance effort that provides mosquito control with information to target vector populations for the prevention of human disease. This report documents the results of virus surveillance efforts during the 2011 encephalitis season.

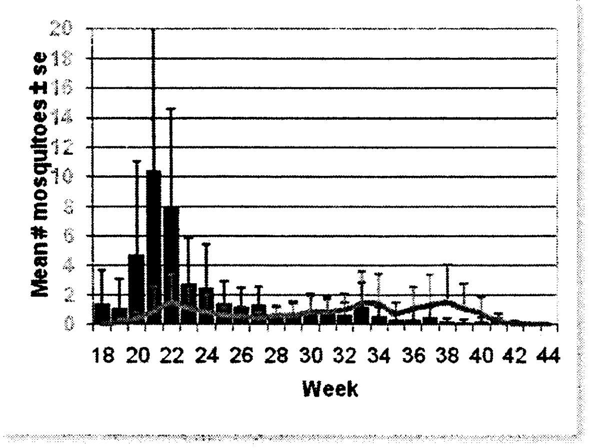
Methodology of EEE Surveillance

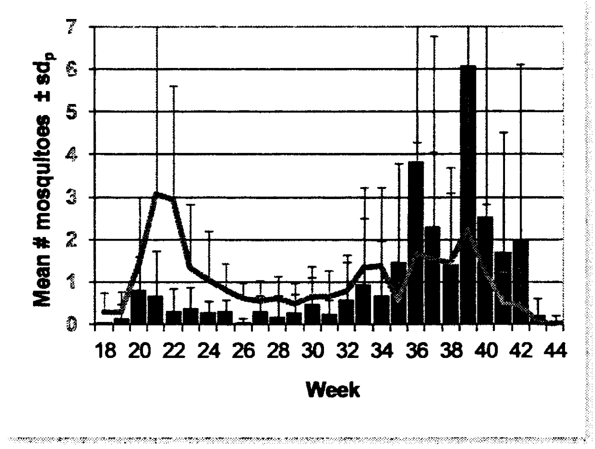
The mosquito, *Culiseta melanura*, is monitored from late May to about mid-October as the primary indicator of EEE virus in southern New Jersey. This ornithophilic mosquito transmits virus to birds as part of the amplification and transmission cycle and can be used to monitor virus levels as the season progresses. Weekly collections of *Cs. melanura* were made from resting boxes at seven permanent study sites by teams of field staff from four county mosquito control agencies: Atlantic, Cape May, Monmouth and Ocean counties. The mosquitoes collected were frozen on dry ice at the collection site and transported to county labs for further processing. The frozen specimens were sorted on chill tables to maintain the cold chain and were identified to species, pooled and submitted weekly to the Public Health Environmental and Agricultural Labs (PHEAL) of the Department of Health in Trenton or to the Cape May labs at the Cape May County Department of Mosquito Control for virus testing. Positive pools were detected by Taqman RT-PCR. Information was summarized and distributed weekly to mosquito control and public health agencies through the website http://vectorbio.rutgers.edu/surveillance.php . The resting box collection sites for 2011 included:, Centerton in Salem County, Corbin City in Atlantic County, Dennisville in Cape May County, Glassboro in Gloucester County, Green Bank in Burlington County, Turkey Swamp in Monmouth County and Winslow in Camden County.

Results of EEE Surveillance in 2011

In 2010, *Culiseta melanura* populations in the Pinelands were higher than historical trends, but decreased as the season progressed and fall populations were lower than average. This set up for the potential of low spring populations in 2011 as the second generation of the previous year contribute to the overwintering larval population that emerges the following spring. Indeed, the 2011 spring populations began at low levels (Figure 1). However, halfway through the season, *Cs. melanura* populations recovered and the second generation was in greater number in comparison to historical trends than the first generation. Part of this pattern may be attributed to climatic patterns. According to the State Climatologist's Office, 2011 had several unique features with regard to weather. The first half of the year was unusually warm from February to June, ending up as the 14th warmest first half of the year since 1895. A very mild winter may have allowed a higher overwintering survival rate for larvae. This was balanced by a state in which the northern half was wetter than normal and the southern half was drier than normal. Ground water may have continued to be lower in the southern portions of the state as was the case the previous year. As *Cs. melanura* overwinter in spaces surrounding tree roots of cedar swamps, lower ground water levels may affect available habitat and consequently overwintering survival. The second feature that was highly unusual about 2011 weather patterns was the landfall through New Jersey of Tropical Storm Irene. This storm precipitated the largest coastal evacuation in New Jersey history and resulted in the greatest amount of rainfall and subsequent flooding recorded. This occurred during Week 35 and the increase in *Cs. melanura* population is clearly seen afterward.

Figure 1. Populations of *Culiseta melanura* in two years of light trapping in southern New Jersey pinelands during 2010 (left) and 2011 (right). This bivoltine species overwinters as larvae. The size of the overwintering population, partially determined by the fall population of the first year, can contribute to the size of the population that emerges the following spring.



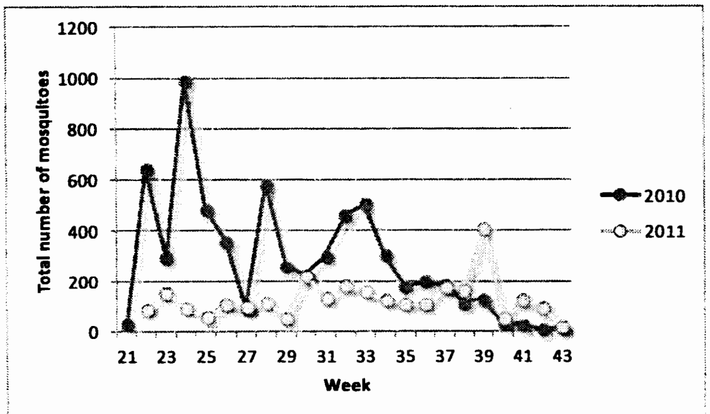


In 2010, EEE activity was detected in 21 mosquito pools including 19 from *Cs. melanura* and 2 from *Culex erraticus*. This occurred after a very active 2009 year that produced over 100 positive pools from several different species. In 2011, no positive pools of EEE were detected from any mosquito species at any of the sites in New Jersey. Nine years earlier, in 2002, no detections also occurred. Table II show the number of pools and total mosquitoes collected at the traditional resting box sites. Figure 2 illustrates that during the year, more mosquitoes were collected from the sites in 2010 than in 2011, until after Tropical Storm Irene passed late in the season. This reflects the patterns seen in Figure 1.

Table 12. Total number of *Culiseta melanura* sampled for EEE by site in 2010 and 2011.

Site Name	Coastal or Inland	Total Pools 2010	Total Mosquitoes 2010	Total Pools 2011	Total Mosquitoes 2011
Corbin City	Coastal	20	369	33	208
Dennisville	Coastal	26	725	20	229
Green Bank	Coastal	22	251	32	136
Centerton	Inland	40	1617	31	987
Glassboro	Inland	19	513	23	136
Turkey Swamp	Inland	66	763	61	444
Winslow	Inland	51	2179	24	503
Statewide		**252**	**6417**	**224**	**2989**

Figure 2. Total number of mosquitoes collected per week at the 7 traditional resting box sites for 2010 and 2011.



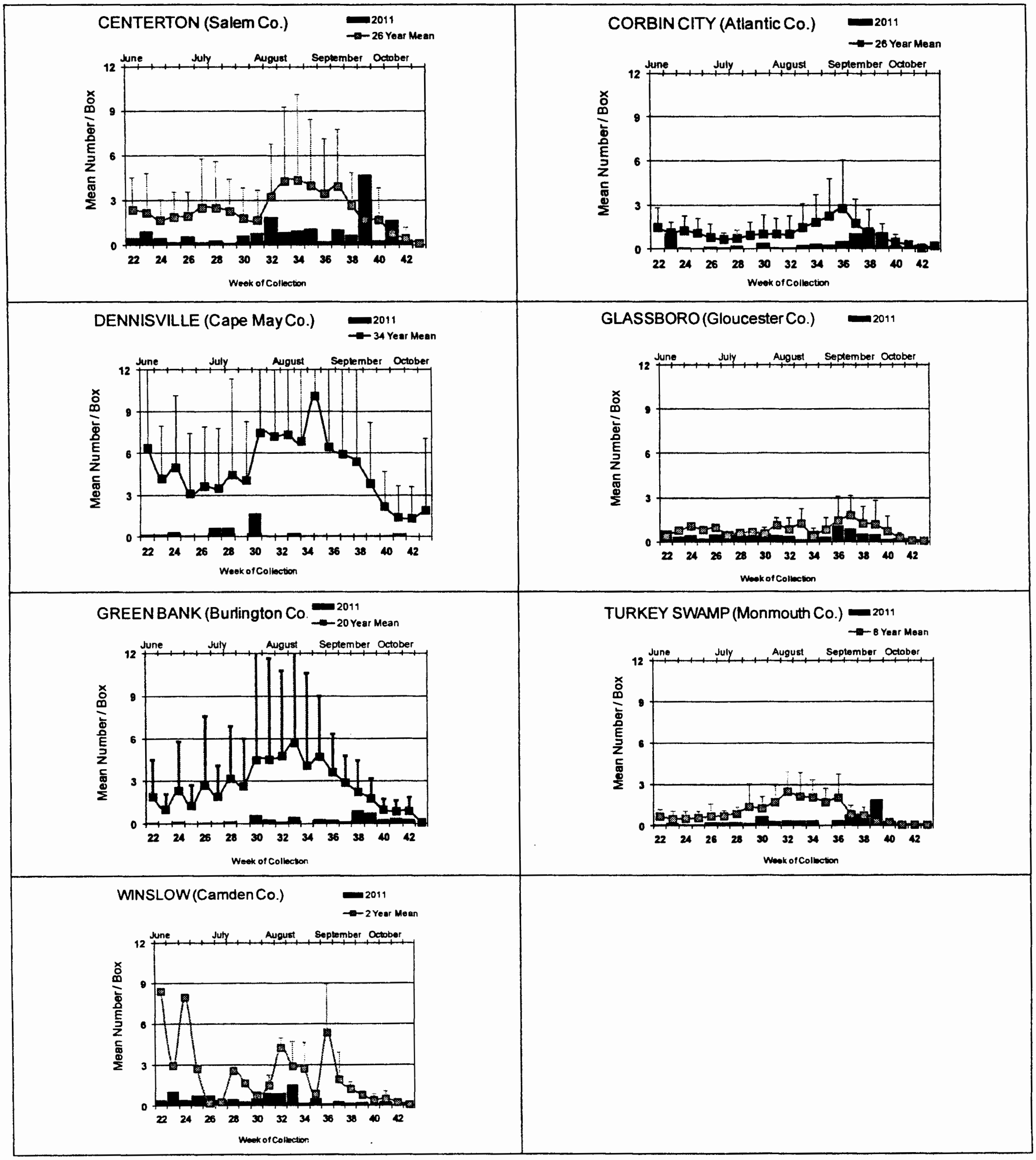
Counties often set out their own traps after the first positive EEE pool is detected, or as part of an ongoing surveillance. Counties caught *Cs. melanura* in a variety of traps, including CO2 traps, gravid and resting boxes but like the traditional resting box sites, no positive pools were detected. Table 12 also shows a similar pattern as Table 11 with higher numbers sampled in 2010 than in 2011.

Table 13. Total number of *Cs. melanura* caught at non-traditional sites, by county and trap for 2010 and 2011. Data from 2010 show only same trap types as used.

County/Trap Type	Total Pools 2010	Total Mosquitoes 2010	Total Pools 2011	Total Mosquitoes 2011
Burlington	70	2582	92	2265
CO2 Trap	84	197	91	2264
Gravid			1	1
Cape May	171	2130	96	435
CO2 Trap	3	40	1	13
Gravid	84	197	53	101
Resting Box	84	1893	42	321
Cumberland	24	509	39	325
CO2 Trap			5	37
Gravid	2	2	1	1
Resting Box	22	507	33	287
Gloucester	95	1516	141	852
Resting Box	95	1516	141	852
Monmouth			2	11
CO2 Trap			1	6
Gravid			1	5
Ocean	37	232	44	125
CO2 Trap	18	147	21	55
Gravid	7	9	7	8
Resting Box	12	76	16	62
Salem	1	1	8	28
Backpack Aspirator	1	1	1	3
Gravid			7	25
Sussex	6	12	1	14
CO2 Trap	6	12	1	14
Grand Total	**419**	**7022**	**423**	**4055**

Figure 3 further illustrates the very low populations that were found at the traditional resting box sites. It is possible that due to the low numbers caught at these and other sites in New Jersey were at a level below the threshold for detection of EEE activity in *Cs. melanura*. There was activity, however, in the state that was demonstrated by a horse case that had no travel history associated with it (see below).

Figure 3. Population levels of *Cs. melanura* at the seven traditional monitoring sites. 2011. Population levels are in black bars, historical trends (between 1 and 30 years) are in blue (coastal sites) or green lines (inland sites) with error bars.



In addition to *Cs. melanura*, other species were sampled for the presence of EEE. Table 14 indicates that no species were found to be infected with EEE, indicating that virus circulation was likely limited.

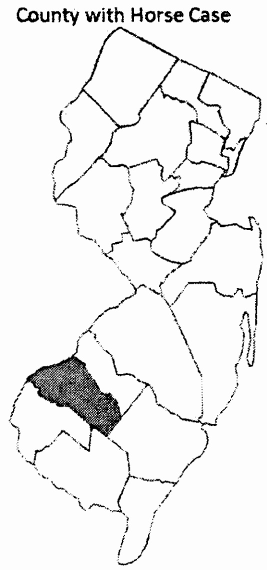
Table 14. Total non-*Cs. melanura* species tested for EEE.

Species	Total Pools	Total Mosquitoes
Aedes albopictus	62	504
Aedes atlanticus	6	60
Aedes atropalpus	3	4
Aedes canadensis canadensis	50	2022
Aedes cantator	51	249
Aedes grossbecki	1	3
Aedes japonicus	29	103
Aedes mitchellae	2	29
Aedes sollicitans	40	241
Aedes sticticus	2	30
Aedes taeniorhynchus	22	411
Aedes tibaulti	1	1
Aedes triseriatus	18	96
Aedes trivittatus	1	7
Aedes vexans	26	854
Anopheles barberi	2	2
Anopheles bradleyi	103	1083
Anopheles crucians	7	75
Anopheles punctipennis	55	403
Anopheles quadrimaculatus	46	330
Coquillettidia perturbans	90	1362
Culex erraticus	233	9332
Culex pipiens	603	4397
Culex restuans	54	152
Culex salinarius	194	1226
Culex spp.	384	12530
Culex territans	4	24
Culiseta inornata	1	1
Psorophora ciliata	1	35
Psorophora columbiae	7	148
Psorophora ferox	9	119
Psorophora howardii	4	35
Uranotaenia sapphirina	4	83
Grand Total	2115	35951

Horse and Human Involvement with EEE:
Although no positive pools from any mosquito species were found in 2011, one horse developed EEE. This 3 year old male horse from Gloucester County showed onset of symptoms on 10 October and was later euthanized. Increased county surveillance to detect positive mosquitoes around this site did not result in any positives (Figure 4). In 2011, there were 67 horse cases in the US with 34 of them occurring in Wisconsin. Activity in horses, as with mosquitoes, was considerably less than in 2010, when there were 249 horse cases in the US (yet only 1 in New Jersey).

There were no human cases.

Figure 4. County with single horse case.



Methodology of WNV Surveillance

New Jersey's WNV surveillance program relies on county initiative to conduct meaningful surveillance within their county borders. Counties have various approaches to monitoring West Nile virus activity, ranging from focusing on the enzootic vector, *Culex pipiens* (primarily through the submission of Mixed *Culex* pools) to the submission of a wide range of potential bridge vectors. In 2011, mosquitoes were sampled through a variety of traps, chilled and transported to county control agencies for identification and pooling. Pools were submitted weekly to the PHEAL facility in Trenton or to the Cape May labs at the Cape May County Department of Mosquito Control for WNV virus testing. Positive pools were detected by Taqman RT-PCR. Information from the investigation was summarized and distributed weekly through the website http://vectorbio.rutgers.edu/surveillance.php .

Results of WNV Surveillance in 2011

During the 2010 mosquito season, a total of 192,250 specimens were tested in 10,442 pools from 38 species. This is an increase of about 35,500 mosquitoes and 2,985 pools. Results from the surveillance effort produced 532 WNV positive pools. All of New Jersey's 21 county mosquito control agencies participated in the state program during 2011. Table 14 indicates species results. The majority of positive pools came from *Culex* species, either mixed pools or species-identified, with *Culex pipiens*, the enzootic vector of WNV showing the highest degree of infection at 4.221 mosquitoes/1000 of the three mixed species. This rate is about half of what it was in 2010, a very active year. As has usually been the pattern, *Culex restuans* was the second most infected species, with an MFIR value of 2.614. *Culex salinarius* had only one infected pool (and was sampled at a lower rate) with an MFIR of 0.406. And as in previous years, the mixed *Culex* pool had an MFIR value much closer to the value for *Culex pipiens* and it is likely that *Cx. pipiens* contributes proportionally to the overall Mixed *Culex* pools. *Culiseta melanura*, another ornithophilic species, was also positive, with an MFIR value of 1.700.

Table 15. Mosquitoes tested for West Nile in New Jersey during 2011.

Species	Total pools	Total mosquitoes	Positive pools	MFIR
Aedes albopictus	1282	8122	6	0.739
Aedes atlanticus	18	140		
Aedes atropalpus	3	4		
Aedes aurifer	1	2		
Aedes canadensis canadensis	207	5462		
Aedes cantator	81	426		
Aedes cinereus	3	5		
Aedes grossbecki	3	8		
Aedes japonicus	695	3917	3	0.766
Aedes mitchellae	3	30		
Aedes sollicitans	63	376		
Aedes sticticus	9	89		
Aedes stimulans	5	47		
Aedes taeniorhynchus	71	1262		
Aedes thibaulti	1	1		
Aedes triseriatus	349	774		
Aedes trivittatus	50	479		
Aedes vexans	253	2571		
Anopheles barberi	7	7		
Anopheles bradleyi	137	1729	1	0.578
Anopheles crucians	8	77		
Anopheles punctipennis	147	605		
Anopheles quadrimaculatus	191	967		
Anopheles walkeri	2	14		
Coquillettidia perturbans	138	1729		
Culex erraticus	266	10028		
Culex pipiens	1265	19188	81	4.221
Culex restuans	890	4590	12	2.614
Culex salinarius	244	2462	1	0.406
Culex spp.	3262	118295	415	3.508
Culex territans	7	27		
Culiseta inornata	3	4		
Culiseta melanura	627	7057	12	1.700
Orthopodomyia signifera	8	8		

Psorophora ciliata	6	63		
Psorophora columbiae	23	253		
Psorophora ferox	86	1247	1	0.802
Psorophora howardii	6	42		
Uranotaenia sapphirina	22	143		
Statewide	**10442**	**192250**	**532**	**2.767**

Table 15 also lists infection rates in potential bridge vectors. WNV was detected in *Aedes albopictus, Ae. japonicus, Anopheles bradleyi, Culex salinarius* and *Psorophora ferox*. *Ae.* albopictus and *Ae. japonicus* are competent vector of WNV and have appeared infected nearly every year since the emergence of WNV in New Jersey. *An. bradleyi* populations along the coast and the Delaware Bayshore regions were significantly high in 2011 and the single infected pool likely represents an incidental infection. All MFIRs for these species were less than 1.000.

While counties (Table 16) tended to maintain their collection patterns from one year to the next, counties varied on what they collected, likely based upon many factors. In the past several years, the number of pools submitted by counties for detecting WNV continued to play a significant role, with more pools likely to detect WNV activity. Last year, the trend was not observed. In 2011, again there was no relationship between total pools sampled and MFIR values (Spearman's r = -0.298, df=19, p>0.05) nor between total mosquitoes sampled and MFIR (Spearman's r = -0.139, df=19, p>0.05).

Table 16. Cumulative infection rates in each county in the 2011 season.

County	Total pools	Total mosquitoes	Positive pools	MFIR
Atlantic	236	6211	4	0.644
Bergen	200	13401	108	8.059
Burlington	766	21797	35	1.606
Camden	283	6635	19	2.864
Cape May	3331	25236	4	0.159
Cumberland	269	4216		0.000
Essex	550	7837	16	2.042
Gloucester	807	13302	49	3.684
Hudson	214	11230	37	3.295
Hunterdon	250	11462	39	3.403
Mercer	369	4702	44	9.358
Middlesex	246	8693	55	6.327
Monmouth	499	4271	7	1.639
Morris	230	7695	25	3.249
Ocean	577	6429	10	1.555
Passaic	124	2244	4	1.783
Salem	324	3684	2	0.543
Somerset	227	3095	17	5.493
Sussex	401	9897	25	2.526
Union	176	4832	17	3.518
Warren	363	15381	15	0.975
Grand Total	**10442**	**192250**	**532**	**2.767**

Out of the 264 avian carcasses sent to PHEAL, 123 were found suitable for testing (Table 17). Infection rates remained high for American Crows but dropped for both Blue Jays and Fish Crows. No raptors were positive. Submission of dead birds has varied considerably over the recent years as either the public does not report birds (surveillance fatigue, misinformation) or that the counties do not submit birds regardless of the requests of PHEL for continued participation. Counties submitting dead birds were Atlantic, Burlington, Cape May, Cumberland, Gloucester, Mercer, Monmouth, Morris, Ocean, Salem, Sussex, Union and Warren counties.

Table 17. Birds tested at PHEAL in 2011 for the presence of WNV and their corresponding infection rates.

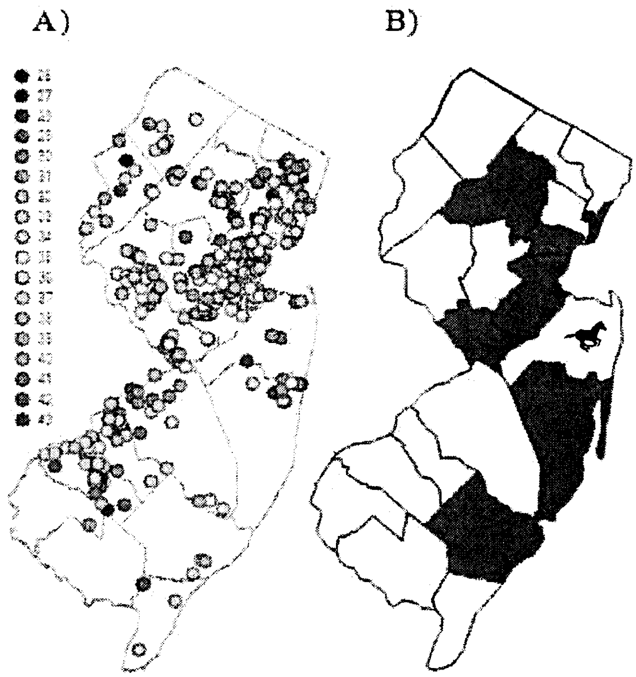
Species	Negative	Positive	Tested	IR
American crow *Corvus brachyrhynchos*	3	15	18	0.833
Blue Jay *Cyanocitta cristata*	7	8	15	0.533
Fish crow *Corvus ossifragus*	17	8	25	0.320
Raptor	5		5	0.000
Other	45	4	49	0.082
Unidentified crow *Corvus*	4	7	11	0.636
All Birds	**81**	**42**	**123**	**0.341**

Horse and Human Involvement

In 2011 there was a single horse case from Monmouth County reported late in the season. Date of onset was 10 Sep and there was no vaccination or travel history reported. The 11 year old mare recovered.

Seven human cases of WNV fever or neuroinvasive disease were detected in New Jersey. The cases occurred through the Suburban Corridor where the bulk of positive mosquito pools also occurred and down the coastal areas of human habitation (Figure 5 A/B). The onset of the first case occurred on 20 July in Mercer County and the last case occurred in the beginning of October.

Figure 5. A) Location of positive WNV pools through CDC week, B) Counties with human and horse cases. Each county had a single human case marked in red; horse icon denotes Monmouth County (not exact location).



Methodology and Results of St. Louis Encephalitis (SLE) Surveillance

New Jersey selectively tested for St. Louis encephalitis virus (SLE) in 2010. SLE has had previous activity in New Jersey, most notably in 1964 and 1975 (CDC's SLE **website**), the latter prompting the vector surveillance reporting by Rutgers. SLE is a flavivirus and has a similar transmission pattern to West Nile, with *Culex* species as the predominant vectors. Between 1964 and 2008, New Jersey has experienced 131 cases. Fatality rates are from 5-15% (CDC.gov website).

No pools tested positive for 2011 (Table 18).

Table 18. Mosquito species by county tested for SLE in 2010 through RT-PCR at NJDHHS PHEL.

	Pools	Mosquitoes
Burlington	702	21383
Aedes albopictus	39	458
Aedes atlanticus	6	60
Aedes atropalpus	3	4
Aedes canadensis canadensis	44	2008
Aedes cantator	3	72
Aedes grossbecki	1	3
Aedes japonicus	17	79
Aedes mitchellae	2	29
Aedes sollicitans	7	129
Aedes sticticus	2	30
Aedes taeniorhynchus	9	69
Aedes triseriatus	14	91
Aedes trivittatus	1	7
Aedes vexans	23	850
Anopheles bradleyi	15	461
Anopheles crucians	7	75
Anopheles punctipennis	9	38
Anopheles quadrimaculatus	1	5
Coquillettidia perturbans	29	805
Culex erraticus	13	534
Culex pipiens	25	351
Culex restuans	13	70
Culex salinarius	27	314
Culex spp.	274	12136

Culex territans	3	23
Culiseta inornata	1	1
Culiseta melanura	92	2265
Psorophora ciliata	1	35
Psorophora columbiae	7	148
Psorophora ferox	7	117
Psorophora howardii	4	35
Uranotaenia sapphirina	3	81
Camden	259	6132
Aedes albopictus	55	332
Aedes japonicus	33	73
Aedes triseriatus	4	8
Aedes vexans	1	1
Anopheles punctipennis	3	3
Anopheles quadrimaculatus	1	2
Culex erraticus	2	7
Culex pipiens	3	135
Culex spp.	157	5571
Cumberland	1	1
Aedes triseriatus	1	1
Essex	550	7837
Aedes albopictus	112	516
Aedes canadensis canadensis	2	8
Aedes grossbecki	2	5
Aedes japonicus	86	711
Aedes sticticus	1	21
Aedes stimulans	4	46
Aedes triseriatus	43	110
Aedes vexans	31	127
Anopheles punctipennis	4	5
Culex spp.	261	6269
Psorophora ferox	4	19
Hudson	199	10456
Culex spp.	199	10456
Grand Total	**1711**	**45809**

Methodology and Results of La Crosse Encephalitis (LAC) Surveillance

New Jersey selectively tested for La Crosse (LAC) virus this year. New Jersey has had 3 cases of this encephalitic disease since 1964 (see CDC's LAC website). The mortality is low but like other encephalitides, LAC can have both personal (lasting neurological sequelae) and economic impacts. LAC is a bunyavirus with a transmission cycle involving mosquitoes such as *Aedes triseriatus* and small mammals such as squirrels and chipmunks. LAC can infect *Aedes albopictus* with transovarial transmission also demonstrated (Tesh and Gubler 1975 Laboratory studies of transovarial transmission of La Crosse and other arboviruses by *Aedes albopictus* and *Culex fatigans.* American Journal of Tropical Medicine and Hygiene 24(5):876-880).

There were no positive pools detected in 2011 (Table 19).

Table 19. Mosquito species by county tested for LAC in 2011 through RT-PCR at NJDHHS PHEL.

		Pools	Mosquitoes
Cape May		135	201
	Aedes japonicus	1	1
	Aedes triseriatus	134	200
Cumberland		16	30
	Aedes triseriatus	16	30
Salem		9	18
	Aedes triseriatus	9	18
Warren		1	9
	Aedes triseriatus	1	9
Grand Total		**161**	**258**

Results of Vector Surveillance in the season of 2012 (to June 30, 2012)

As a result of the biological basis of disease epidemiology, vector surveillance for any one year runs within the calendar year. Funding, however, occurs on a fiscal year cycle. This section reports the vector surveillance work done from 1 January to 30 June, 2012. For the full weekly report of week 26, see:
http://www.rci.rutgers.edu/~vbcenter/reports/vector/2012week26.pdf

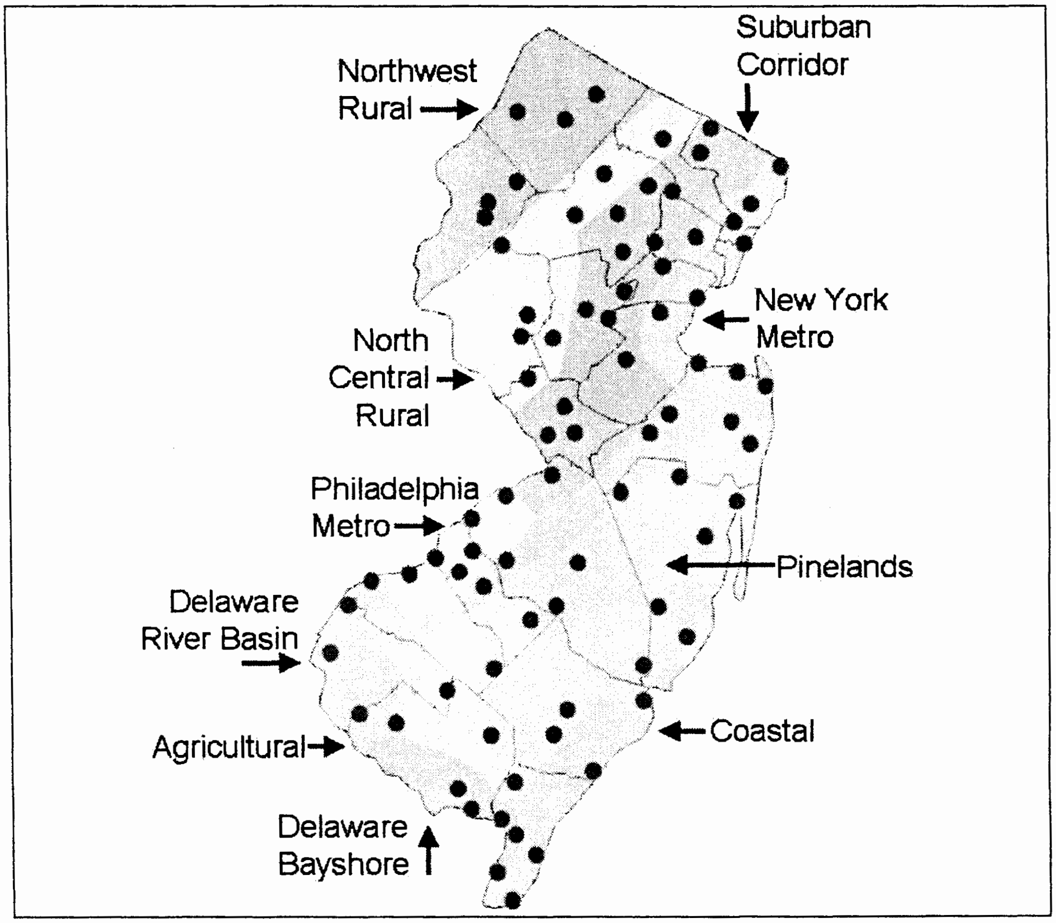
EEE: Though June 2012, there were no detectable positive pools of *Cs. melanura*, either collected at the traditional resting box sites or at other sites submitted by the counties. To date, 121 pools of 3439 *Cs. melanura* mosquitoes had been tested. Of these only 15 pools of 403 mosquitoes from the traditional resting box sites had been tested. During that time, the Cape May Lab had been offline and testing resumed in July 2012. An additional 2470 *Cs. melanura* mosquitoes caught prior to 30 June 2012 at the traditional resting box sites were tested and found to be negative. Nineteen additional mosquito species were also tested, forming 216 pools from 6139 mosquitoes, all of which were negative. One horse from Burlington County was reported with EEE onset of 25 May. This horse is the earliest reported case in New Jersey. The horse was reported as vaccinated two weeks prior to symptom onset. There were no positive mosquitoes trapped in Burlington County. This case should be treated with caution as source of the virus is unknown. There were no human cases.

WNV: Testing began earlier this year due to a number of circumstances including activity in adjacent state (Pennsylvania) and early mosquito activity. Through June 2012, there had been 56,464 mosquitoes tested in 1,843 pools from 26 species. Positive pools were first detected in *Culex* species, *Cx. pipiens,* and *Cs. melanura* from Gloucester County on 17 May. By the end of June, positive pools were detected in *Aedes japonicus* (1 pool), *Cx. pipiens* (5), *Cx. restuans* (1), *Culex* species (31) and *Cs. melanura* (1). Bird testing also began earlier than the usual 15 April, with a positive crow detected out of Morris County collected 9 April. Two additional crows were also found positive out of 41 birds tested. No horse or human cases were reported to date.

SLE: No detectable SLE was found in the 482 pools of the nineteen species tested, comprised of 15869 mosquitoes. No human cases were reported.

LAC: No detectable LAC was found in the 4 pools of *Ae. triseriatus* tested, comprised of 20 mosquitoes. No human cases were reported.

NEW JERSEY STATE ADULT MOSQUITO SURVEILLANCE



Purpose: Data from 76 New Jersey light traps contributed by county mosquito control agencies are used to calculate trends in mosquito populations for species of nuisance or health concerns.

Calculations are based on regional distributions, with emphasis on mosquito habitat and land use. Trends will allow a statewide evaluation of changing mosquito populations, in response to control and/or changes in habitat.

The State Surveillance Program Overview

In New Jersey, county-level mosquito control agencies use New Jersey light traps to monitor certain nuisance and health-risk mosquito species. Agencies have many years worth of experience in the placement, use, and interpretation of light traps and their data as monitoring mosquito populations is an essential part of an integrated pest management approach. But county agencies are limited to county data, and a landscape-wide view of changing mosquito trends is not available. The purpose of this program is to cover that gap and provide information of nuisance and health-risk mosquito populations on a regional level.

The 2011 Season: Nineteen of the 21 county mosquito control agencies participated in this program during the season. During 2011, 44 mosquito species were identified out of the 234,045 individual mosquitoes caught in the statewide surveillance light trap network throughout New Jersey. The total number of mosquitoes trapped was moderate on the range from recent years (between 100,000 and 300,000 individuals). Species with less than 10 individuals trapped (not included in the total number caught, but included in species number totals) for the entire season included *Aedes abserratus, Ae. atlanticus, Ae. atropalpus, Ae. communis, Ae. excrucians, Ae. mitchellae, Ae. thibaulti, Anopheles barberi, An. earlei, Culiseta inornata, Cs. minnesotae, Cs. morsitans, Orthopodomyia signifera, Psorophora cyanescens* and *Ps. howardii.*

The Delaware Bayshore region collected more mosquitoes than any other region, with a significant increase in both *An. bradleyi* and *Culex* Mix. However, the Agricultural and Pinelands regions collected a wider variety of mosquitoes than did other regions (Table 20, Figures 9-18), although total number of mosquitoes in those regions were considerably less. As with last year, neither the number of species nor the number of mosquitoes caught in each region correlated with the number of traps ($r = 0.50$, $df = 8$, $p > 0.05$; $r = 0.07$, $df = 8$, $p > 0.05$, respectively) such that those with fewer traps caught neither fewer species nor fewer number of mosquitoes. There was also no correlation between the number of species caught and total number of mosquitoes present ($r = 0.28$, $df = 8$, $p > 0.05$).

Table 20. Number of county traps used in each region with the number of mosquito species identified in the traps.

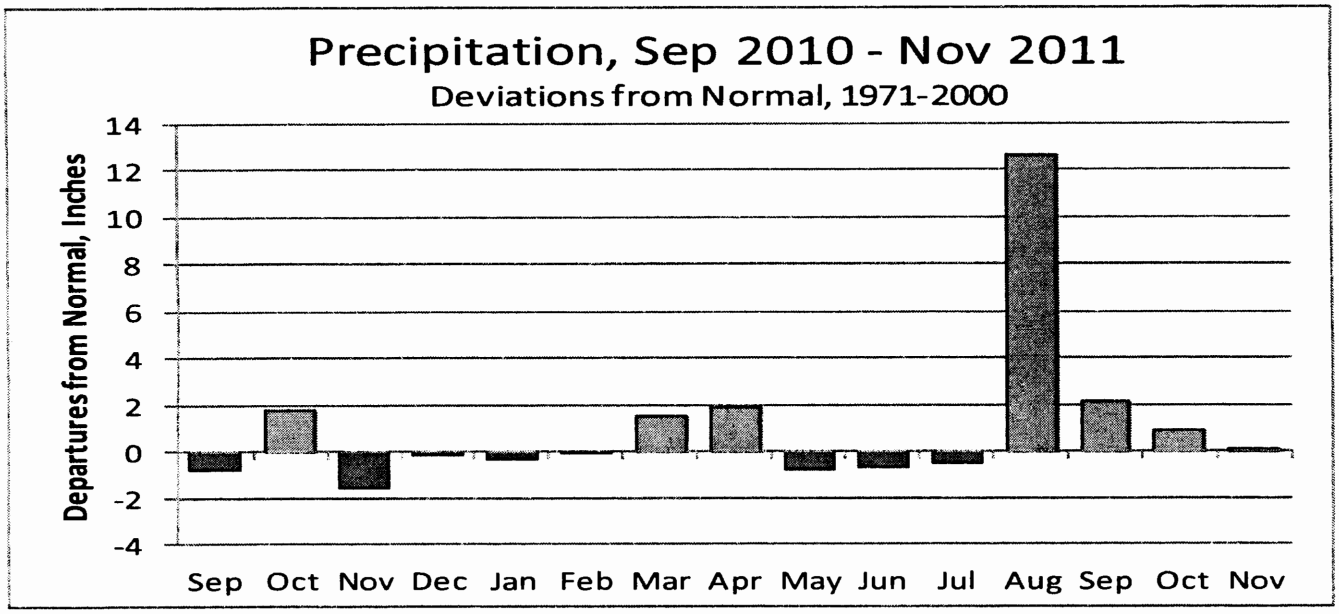
Region	***Number of Traps***	***Number of Species***	***Number of Mosquitoes***
Agricultural	6	33	8,771
Coastal	9	32	38,302
Delaware Bayshore	5	25	61,685
Delaware River Basin	2	19	4,493
New York Metro	10	28	17,231
North Central Rural	7	20	1,503
Northwestern Rural	6	30	42,385
Philadelphia Metro	4	26	17,005
Pinelands	10	33	16,422
Suburban	17	30	26,248
Statewide Total	76	36*	234,045

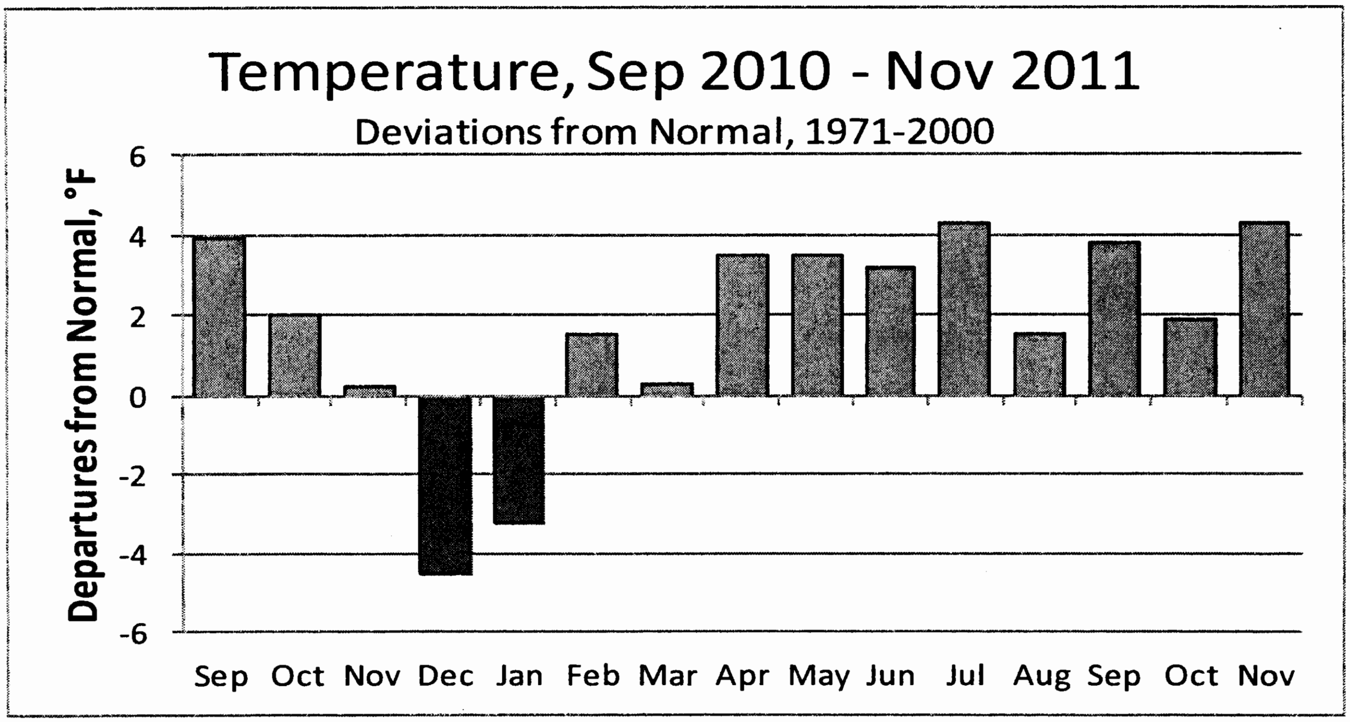
*not including the least common species.

The most abundant species caught statewide were *Aedes vexans,* the *Culex* Mixed (including *Cx. pipiens, Cx. salinarius* and *Cx. restuans*), *Anopheles bradleyi, Ae. sollicitans* and *Ae. cantator* (Figure 18) . Mixed *Culex* populations were in greatest number in the New York Metropolitan, North Central Rural and the Pinelands regions (Figures 13, 14 & 17). *Ae. vexans* was the predominant species, most commonly caught in light traps in the Agricultural, Delaware River Basin, Northwestern Rural, Philadelphia Metropolitan and the Suburban Corridor. *Ae. sollicitans* was dominant in the Coastal region and *An. bradleyi* in the Delaware Bayshore.

Weather effects: The Office of the New Jersey State Climatologist recorded the monthly temperature and precipitation departures against averages from 1971 – 2000 and noted extremes from data going back to 1895. With the advent of Hurricane Irene, considerable rainfall was recorded resulting in the wettest year since 19895. In addition, 2011 had the third warmest months recorded for an eleven month period. This last factor resulted in mosquitoes being present late into the season despite an early snowfall. Although mosquitoes were not as abundant as in 2003, populations recovered easily from the previous drought year of 2010.

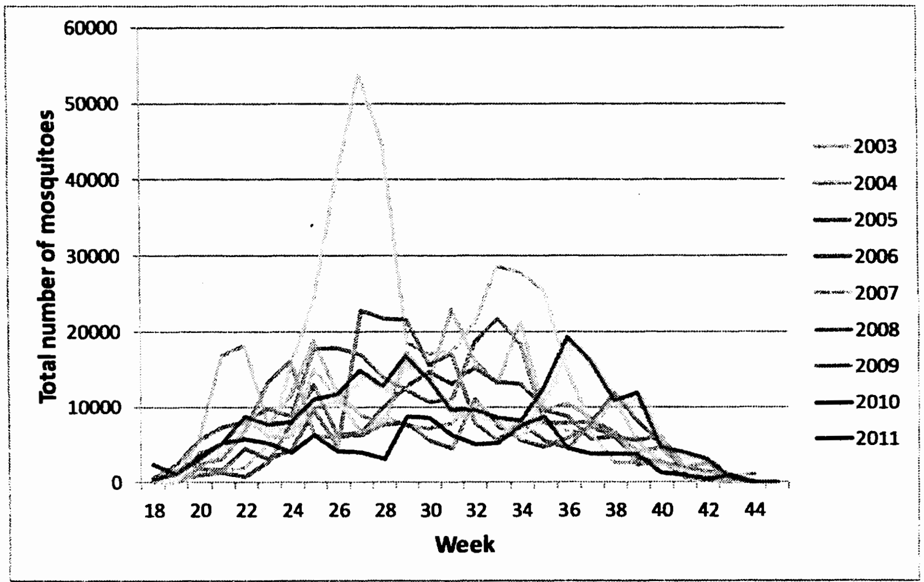
Figure 6. Monthly temperature and precipitation departures from normal, Office of the New Jersey State Climatologist.





The population increase after the landfall of Hurricane Irene is evident in Figure 7. Also note the relatively increased numbers of mosquitoes at the end of the season.

Figure 7. Weekly total mosquitoes collected in statewide light trap program from 2003-2011.



An online calibration class is offered to any county that wished to learn about the proper maintenance and calibration of light traps (http://www.rci.rutgers.edu/~vbcenter/video/ovi.htm). Cleaned and calibrated traps confer compatibility of the datasets.

Top Ten and Species Summary Figures:

Figure 8 are the cumulative totals statewide and for each region for 2011. Figures 19-45 are the species summaries for those species that have 500 or more individuals caught, or are of public-health interest. They are listed alphabetically, with information on how they are classified according to life cycle types [Crans 2004 A Classification System for Mosquito Life Cycles: Life Cycle Types for Mosquitoes of the Northeastern United States] Journal of Vector Ecology pp1-10.) and written summary.

Figures 8. Cumulative totals for light trap species statewide and Top Ten for each region, 2011.

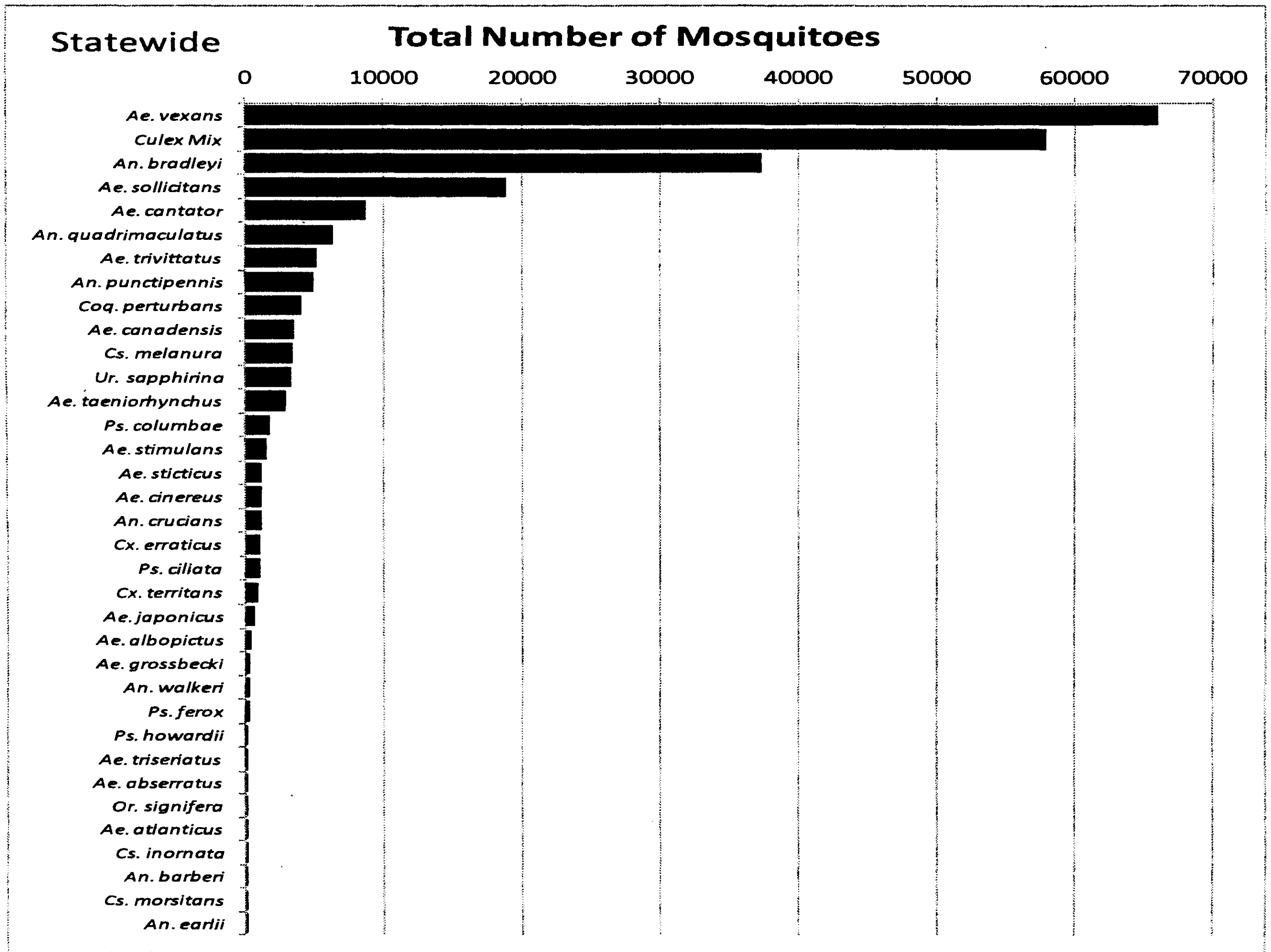


Figure 9.

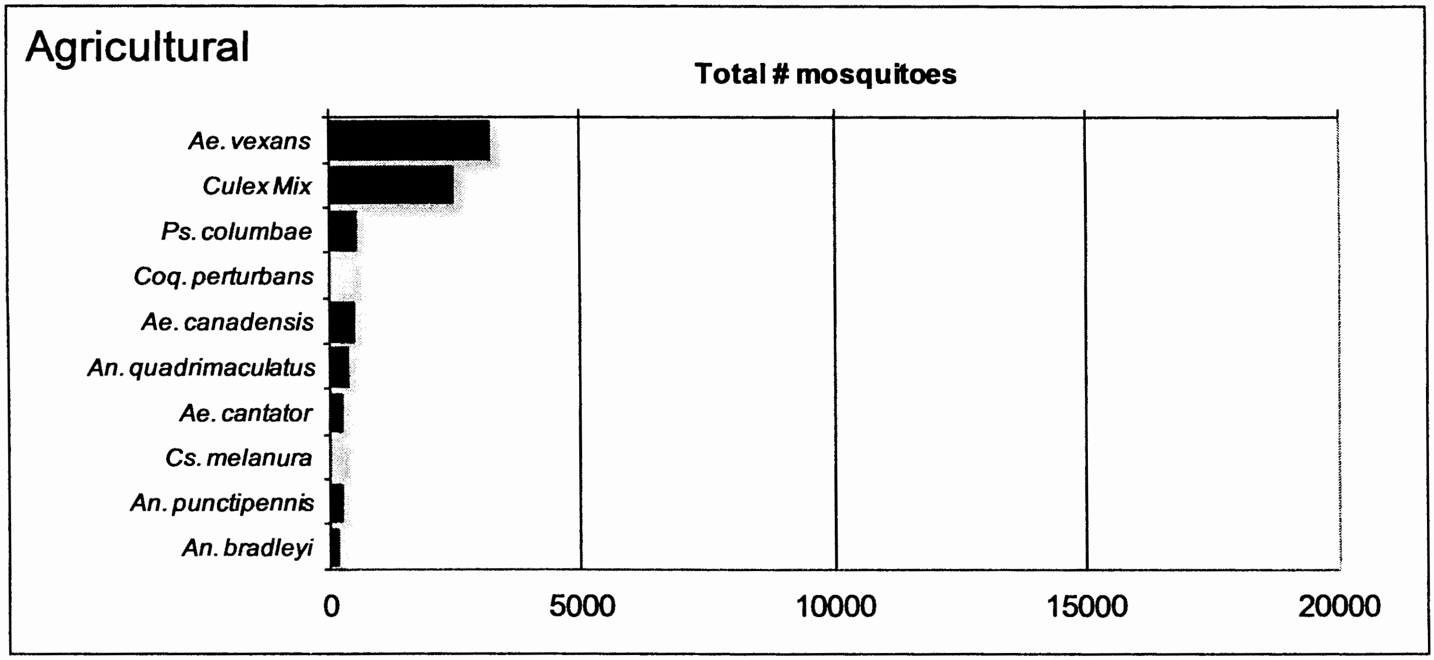


Figure 10 .

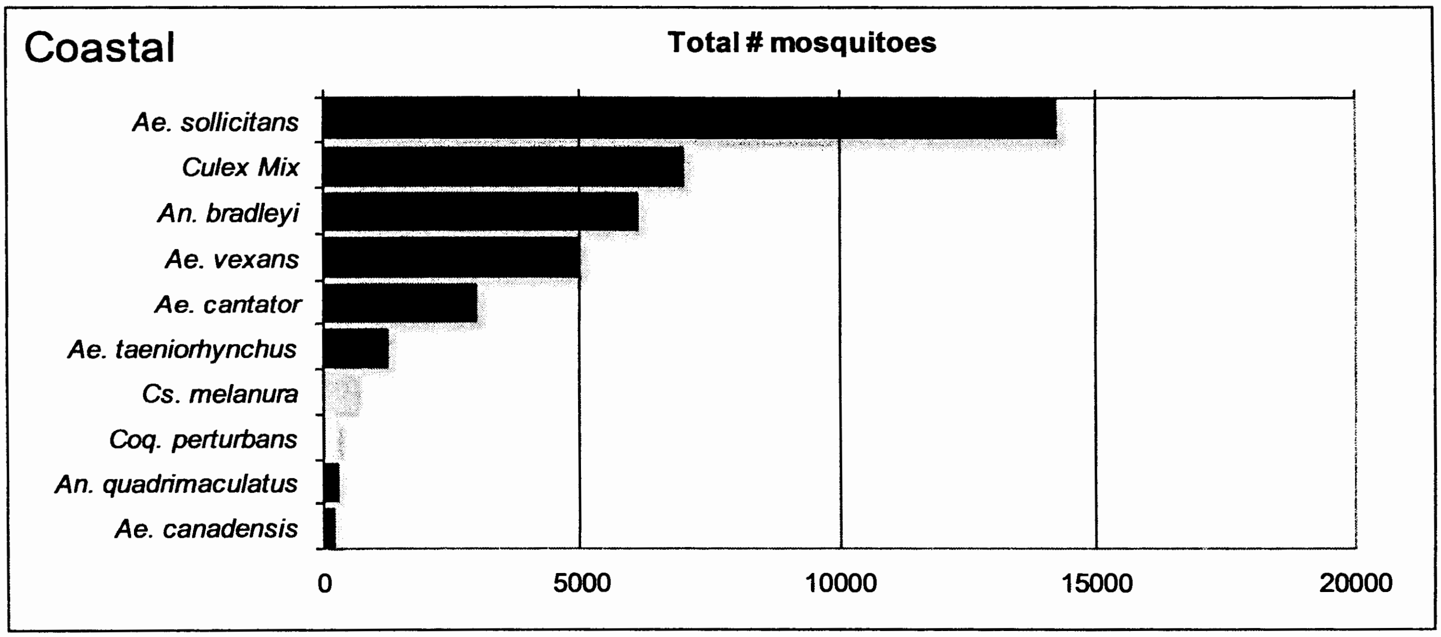


Figure 11.

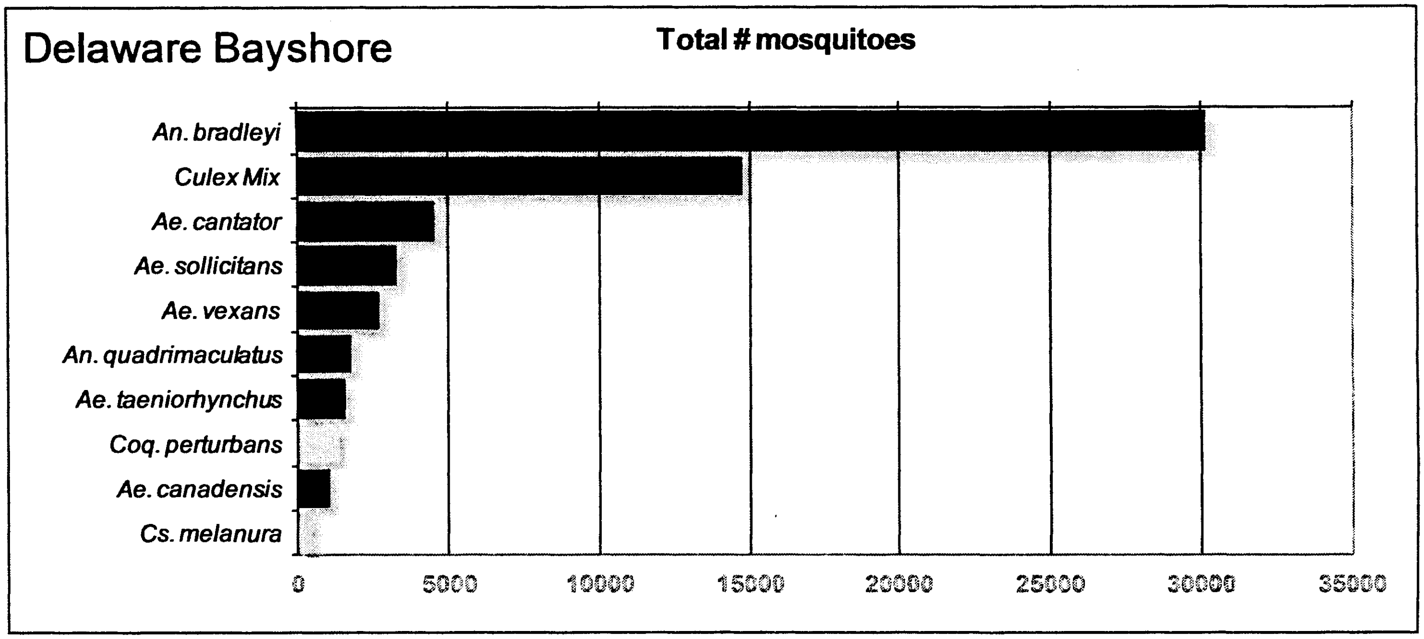


Figure 12.

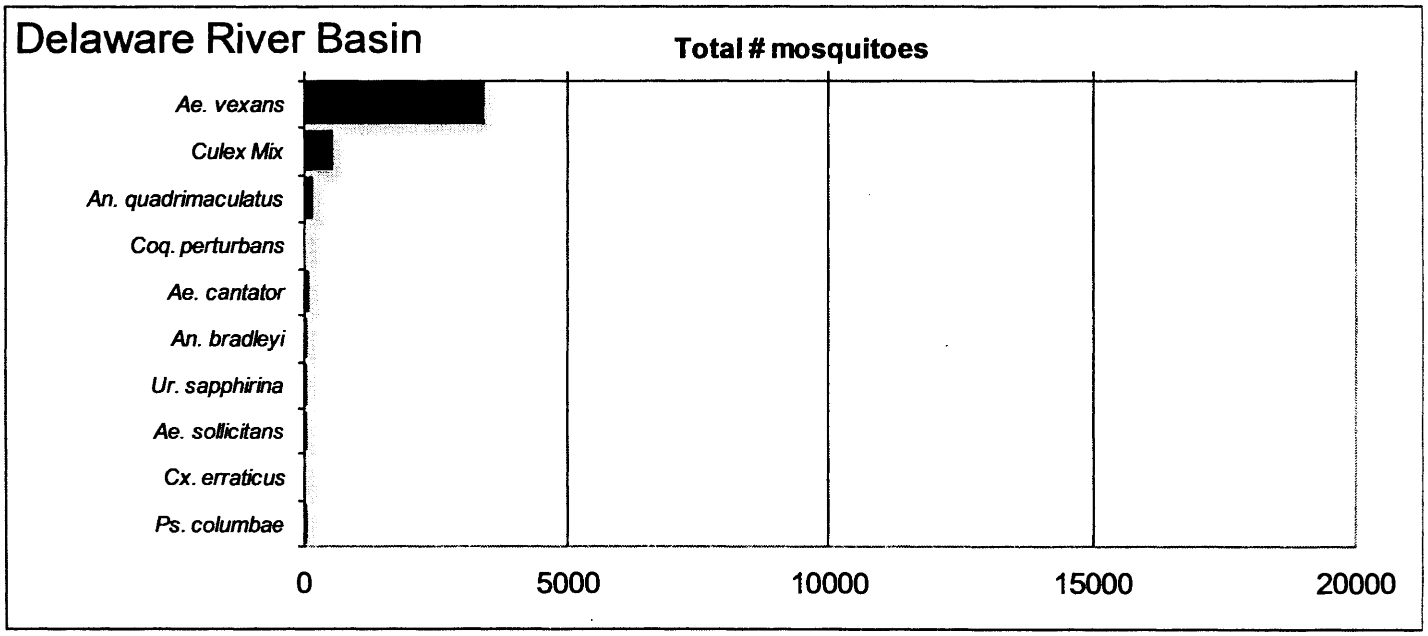


Figure 13.

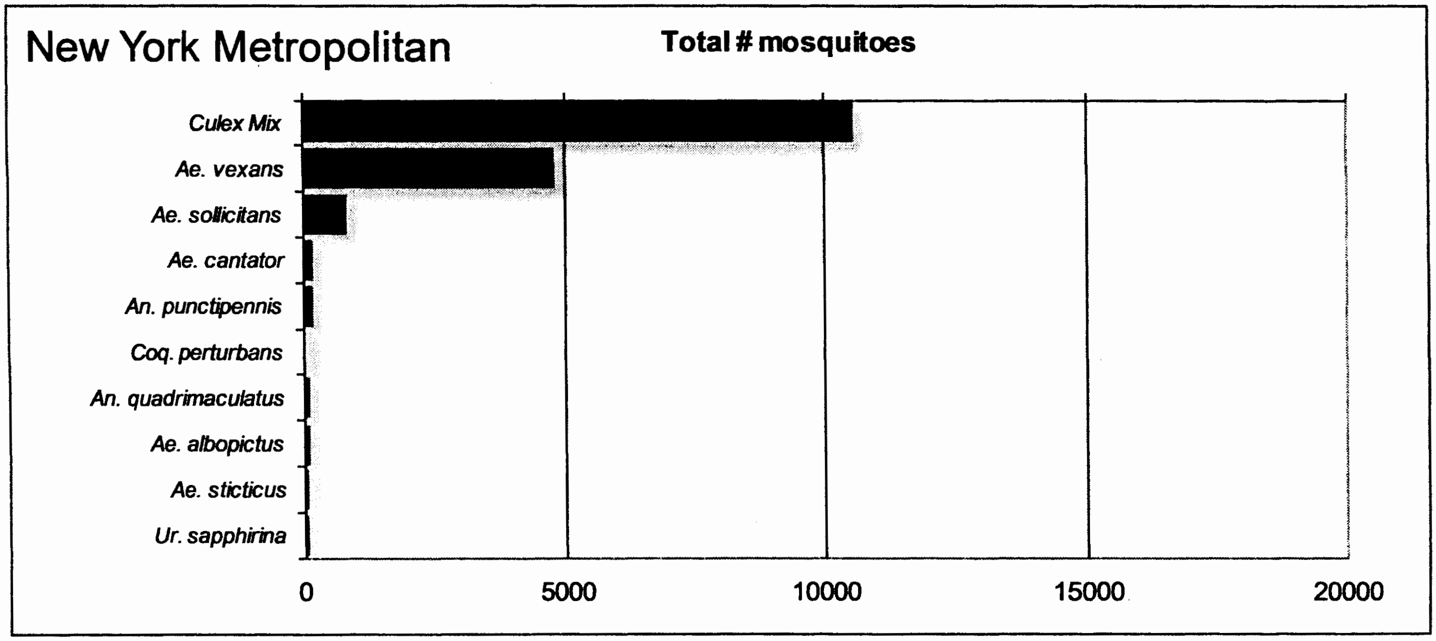


Figure 14.

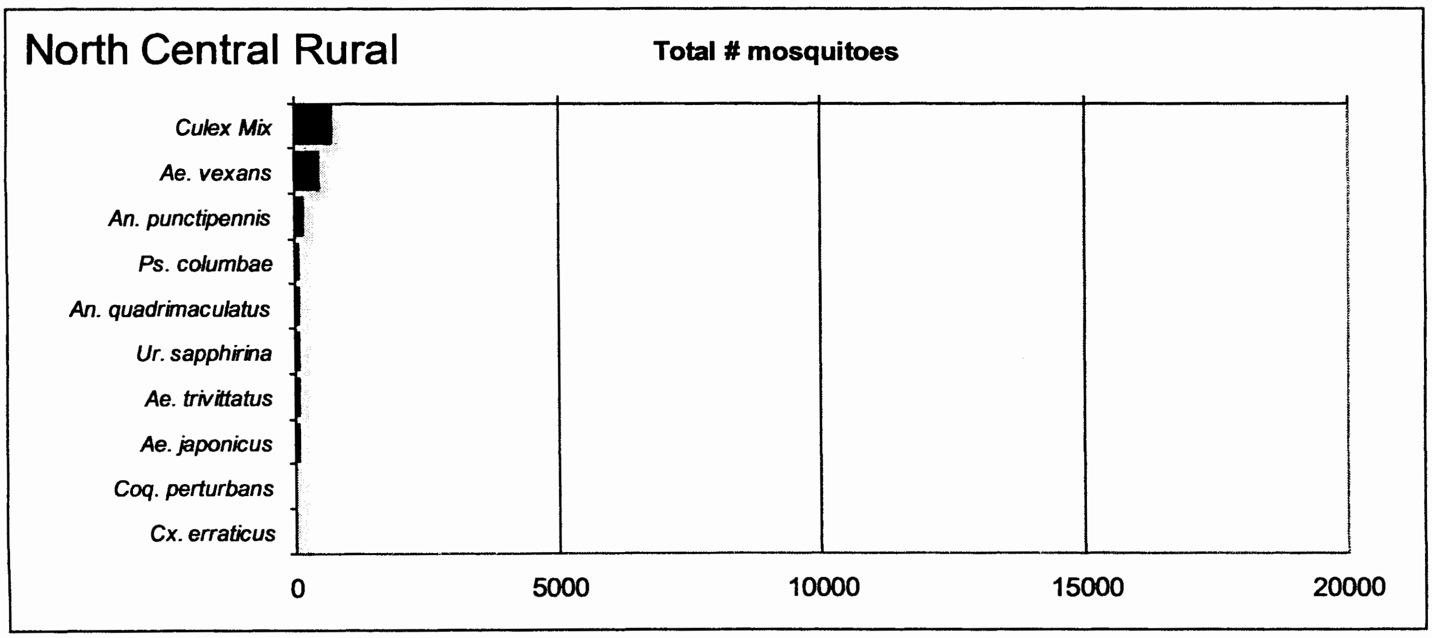


Figure 15.

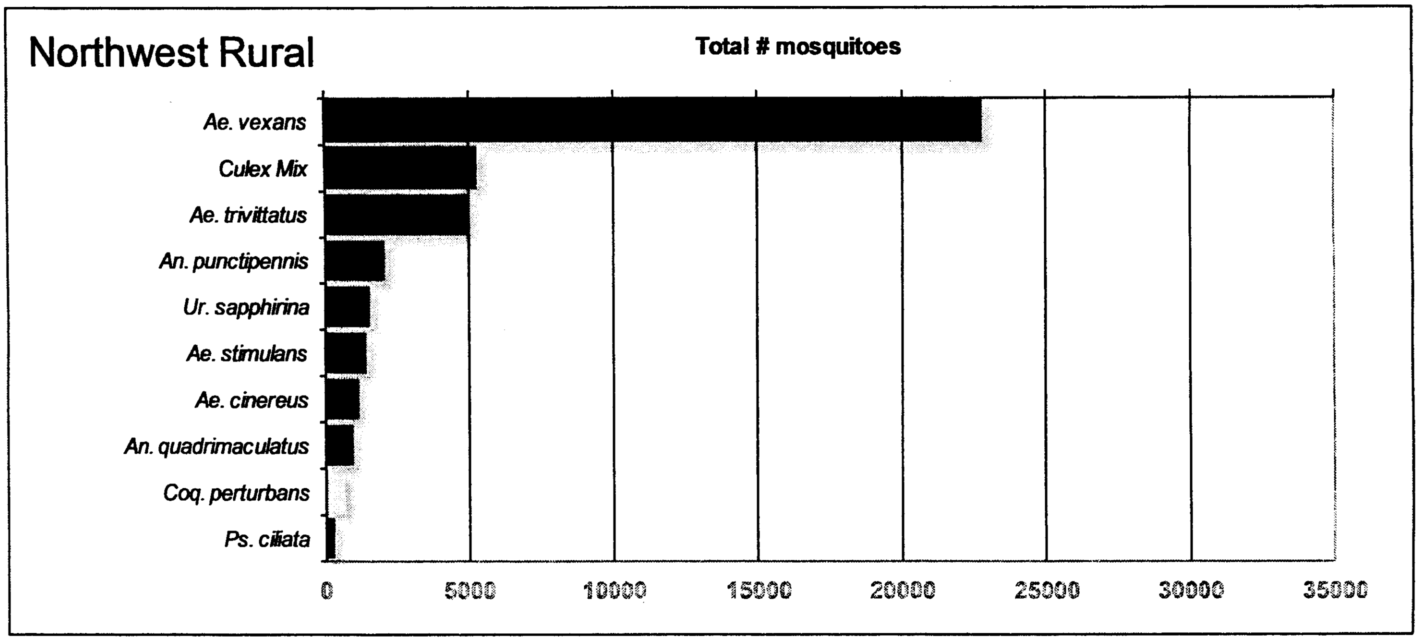


Figure 16.

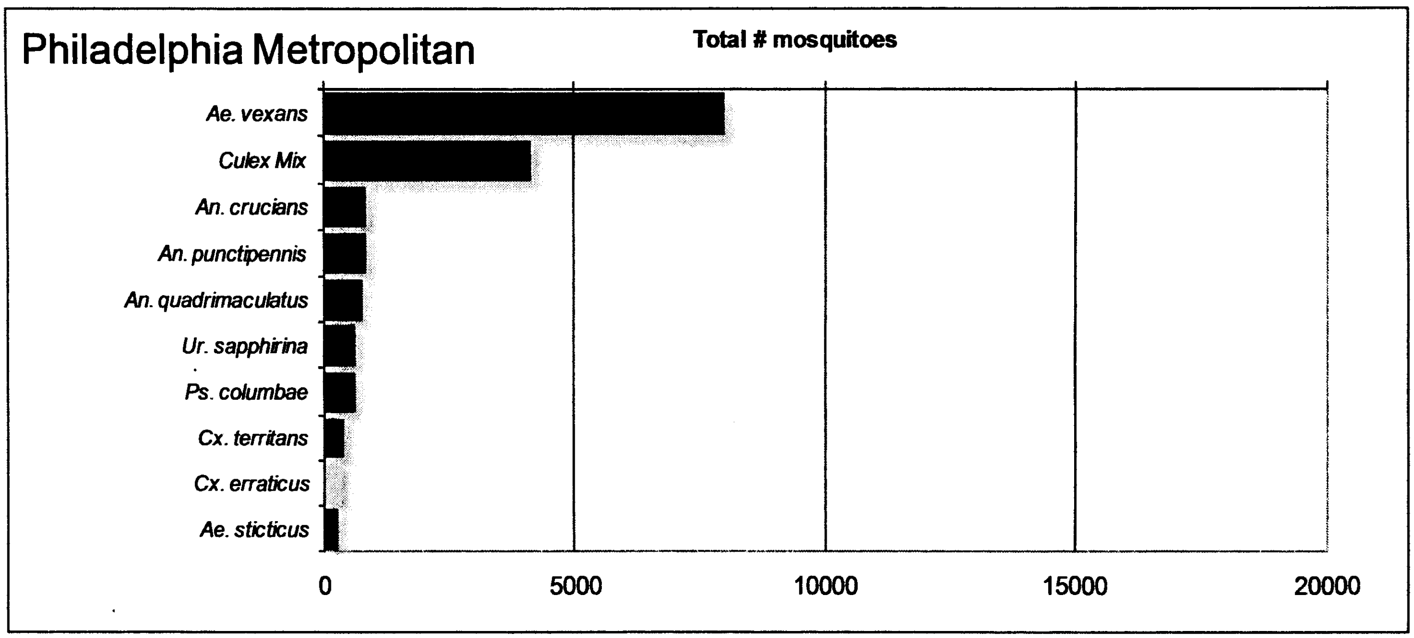


Figure 17.

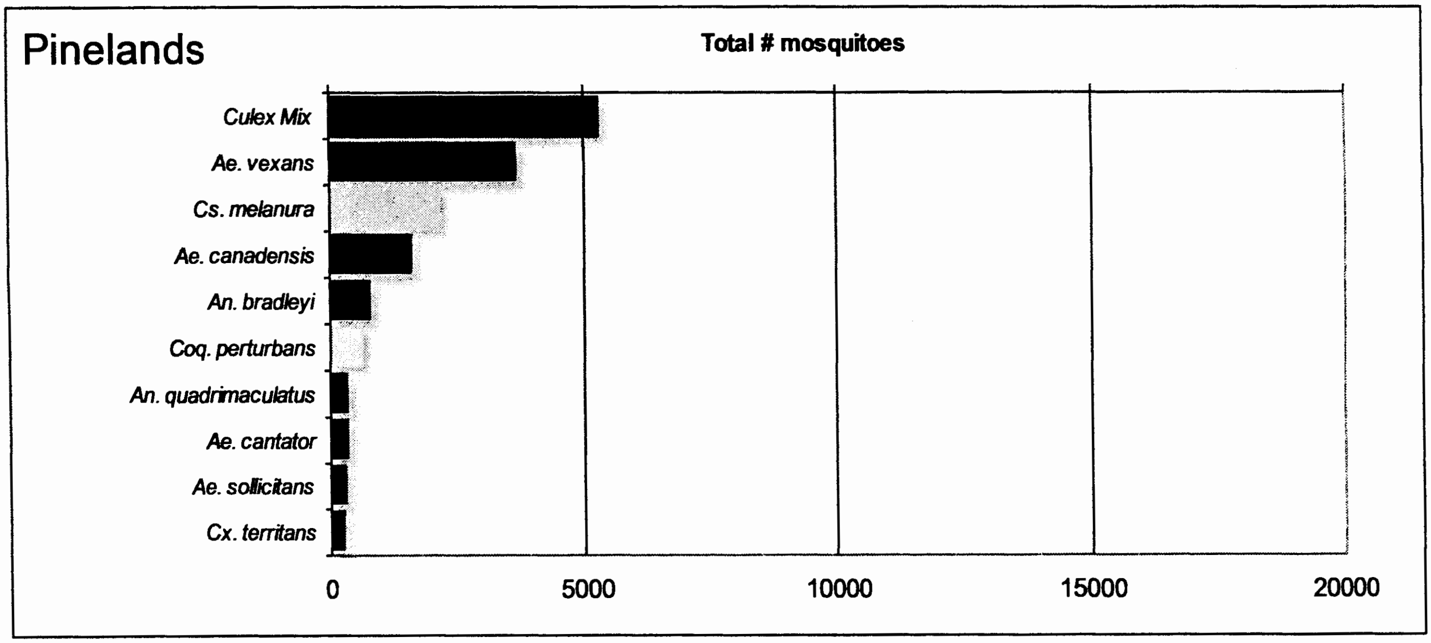


Figure 18.

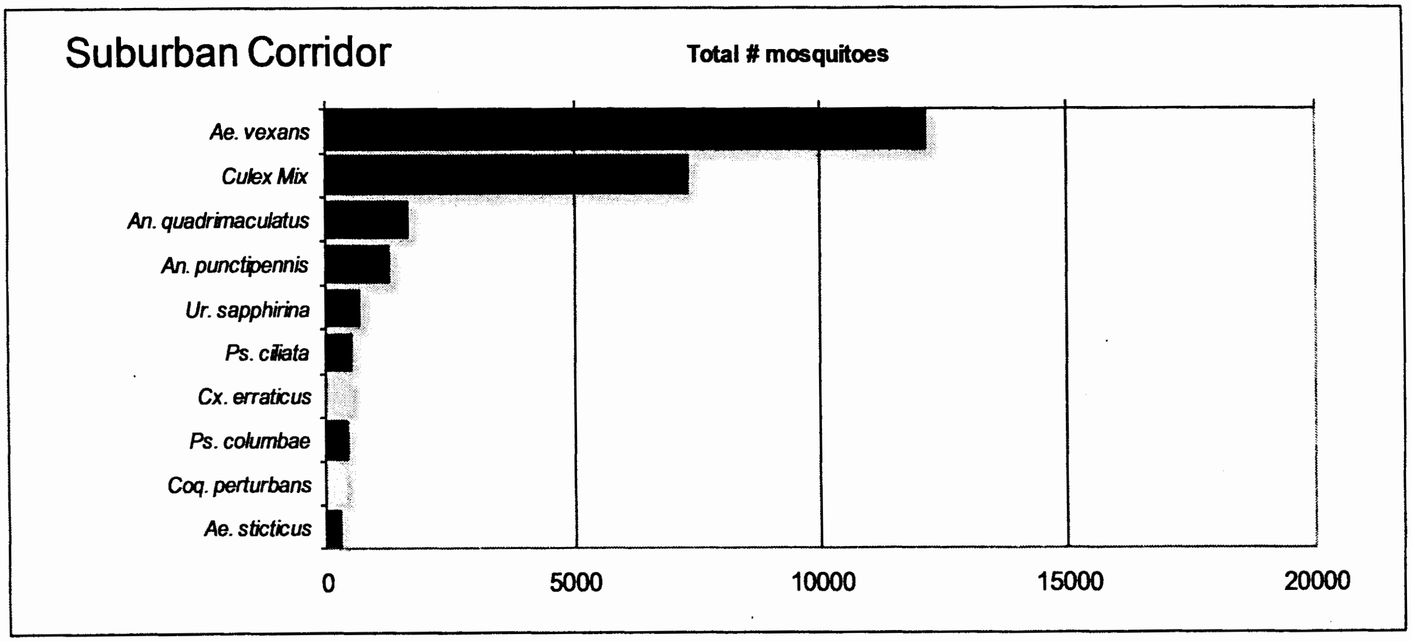
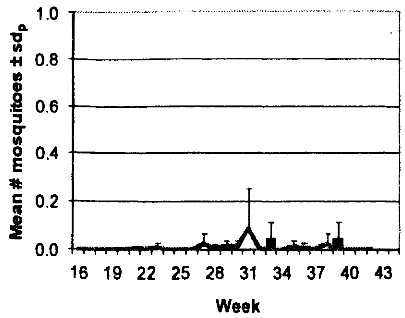


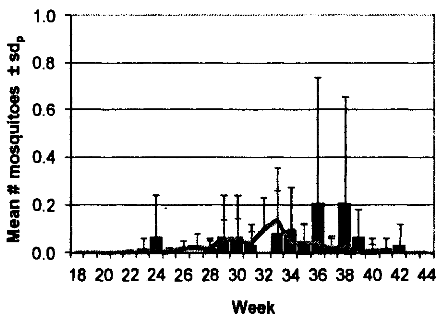
Figure 19.

Aedes albopictus – Multivoltine Aedine (*Aedes triseriatus* Type)

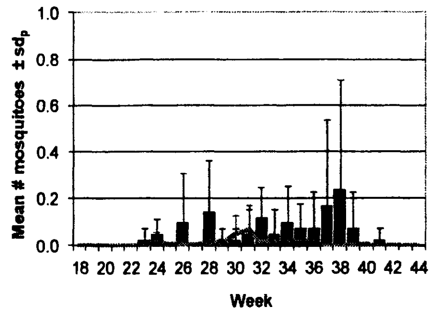
Agricultural



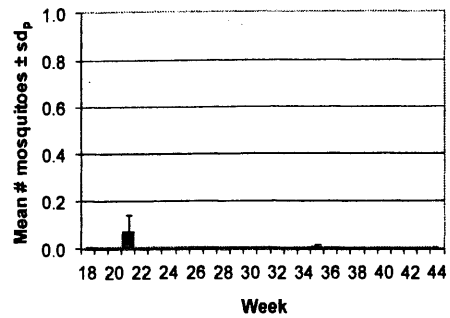
Coastal



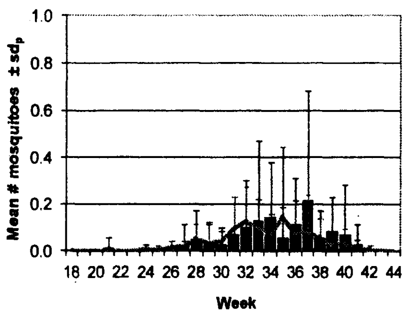
Delaware Bayshore



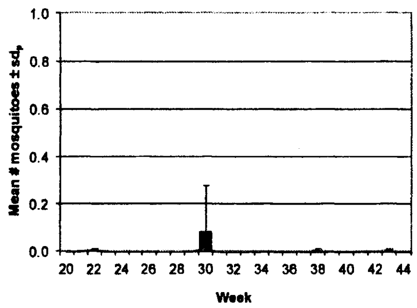
Delaware River Basin



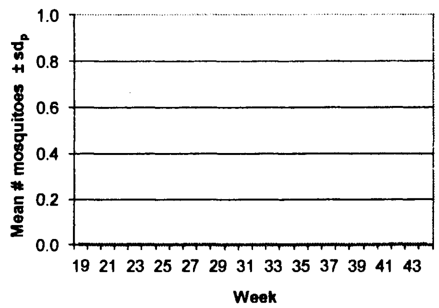
New York Metro



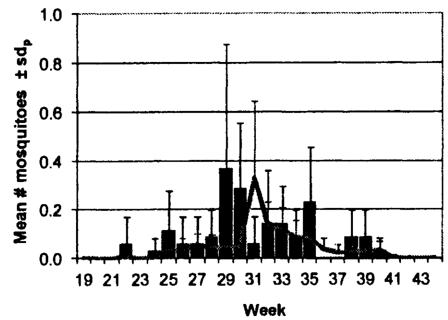
North Central Rural



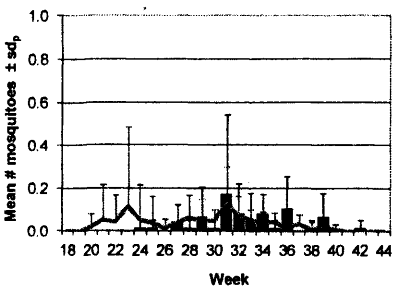
Northwestern Rural



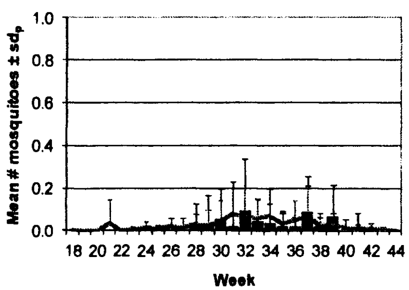
Philadelphia Metro



Pinelands



Suburban Corridor

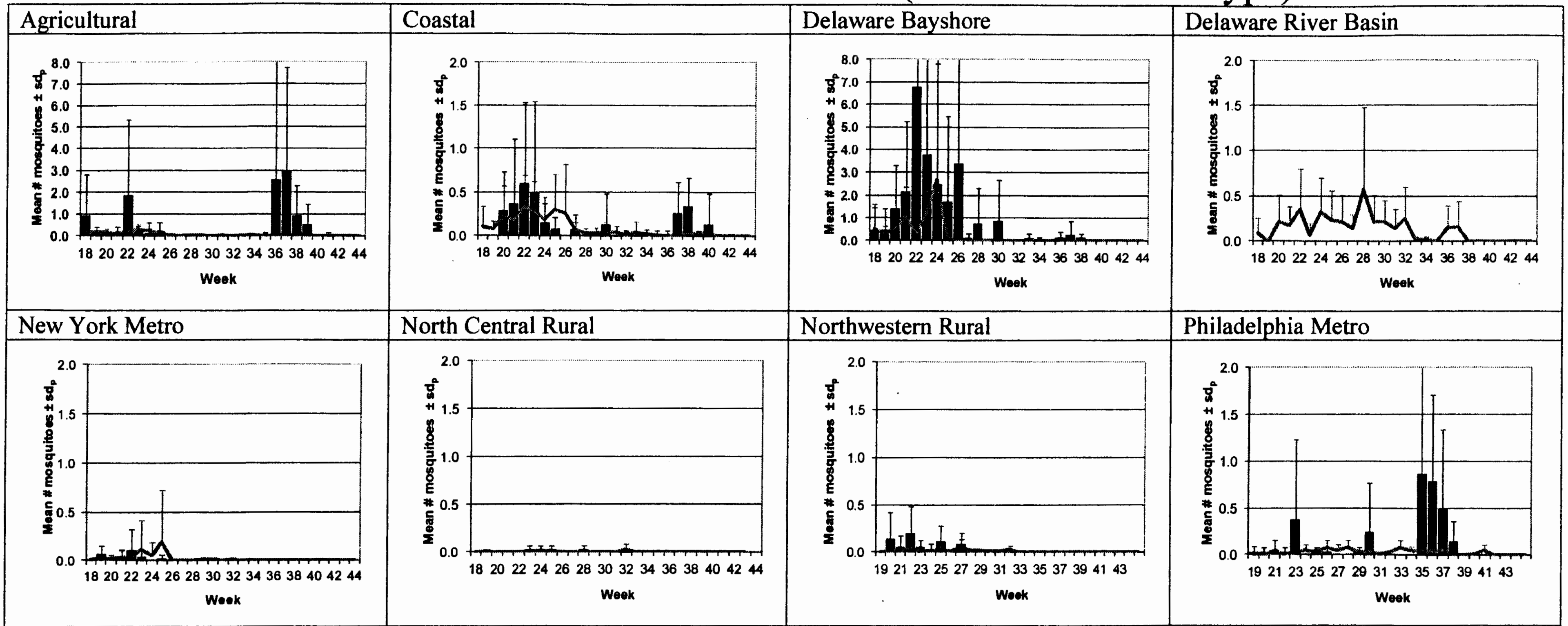


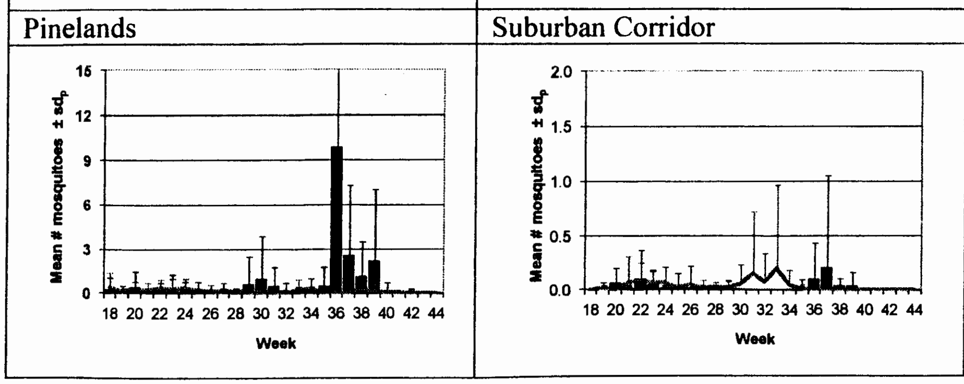
Comments

Aedes albopictus made its first appearance in New Jersey in 1995, ten years after the initial US invasion in Texas. In New Jersey, all counties but those in the Northwestern Rural region have reported populations, some with significant numbers. In 2011, the Coastal, Delaware Bayshore, and Philadelphia Metropolitan regions experienced above average numbers of this persistent biter. This species is making up a significant portion of the complaints to mosquito control agencies and this trend is likely to grow.

Figure 20.

Aedes canadensis – Univoltine Aedine (*Aedes canadensis* Type)





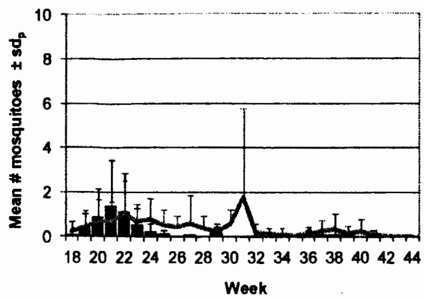
Comments

Aedes canadensis canadensis experienced higher than historical trends in the Agricultural, Delaware Bayshore, Philadelphia Metropolitan and Pineland regions but was noticeably absent from the Delaware River Basin. This species is an early season univoltine mosquito found throughout New Jersey, often with a late season emergence. These later waves of *Ae. canadensis* are not a second generation but the result of later emergences from eggs that failed to hatch from earlier flooding. If flooding events are greater than events that initiated the spring emergence, then the smaller, late season emergence will occur. The large emergences that occurred most notably for the Agricultural, Coastal, Philadelphia Metro, Pinelands and the Suburban Corridor regions resulted from rains dropped by Hurricane Irene.

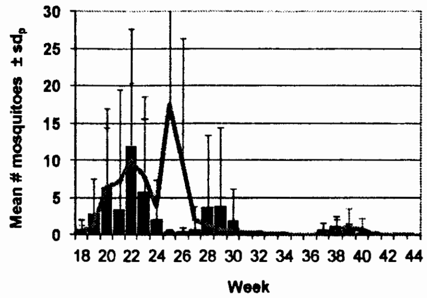
Figure 21.

Aedes cantator – Multivoltine Aedine (*Aedes sollicitans* Type)

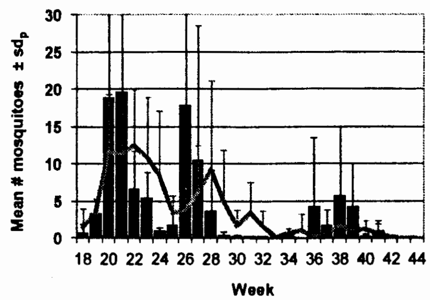
Agricultural



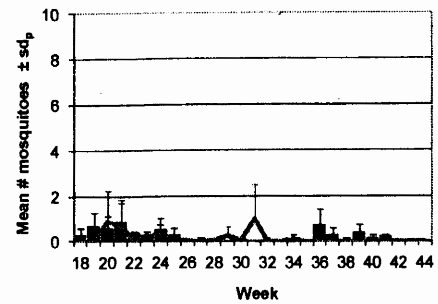
Coastal



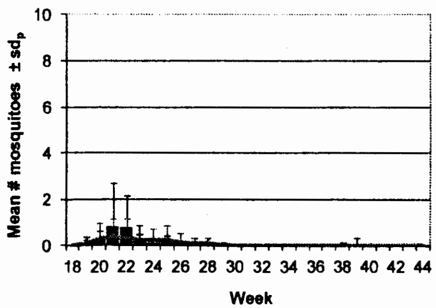
Delaware Bayshore



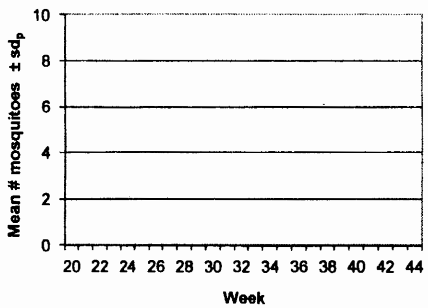
Delaware River Basin



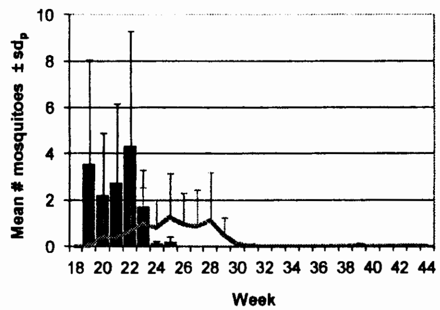
New York Metro



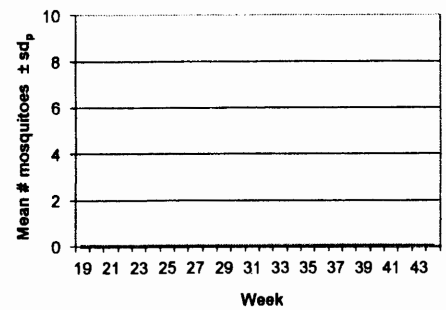
North Central Rural



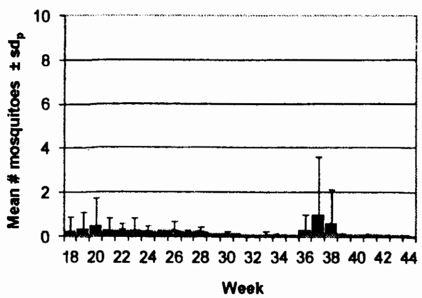
Northwestern Rural



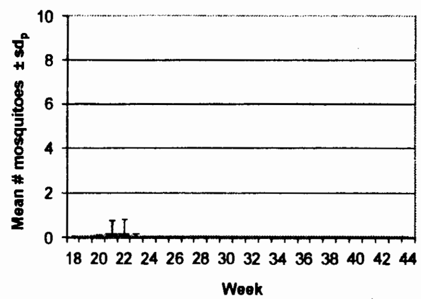
Philadelphia Metro



Pinelands



Suburban Corridor



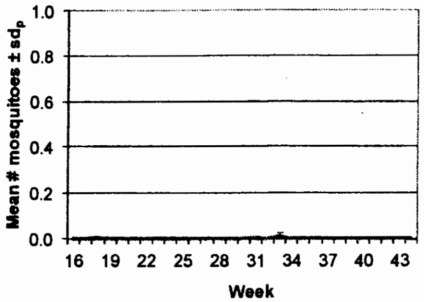
Comments

Aedes cantator is a facultative salt marsh floodwater species that can exploit both natural and anthropogenic sources of saline habitat. Their significant presence in the Coastal and Delaware Bayshore regions is obvious. In the Northwestern region, however, might be puzzlement until the habitat is understood: a textile factory contributes habitat through the use of saline waters to help set the dye in fabrics. In this region for 2010, *Ae. cantator* emerged earlier than historical trends suggest and this shift also appears for the Delaware Bayshore region.

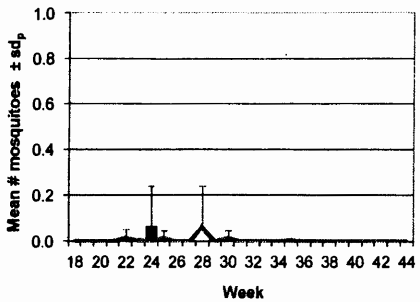
Figure 22.

Aedes cinereus – Univoltine Aedine (*Aedes canadensis* Type)

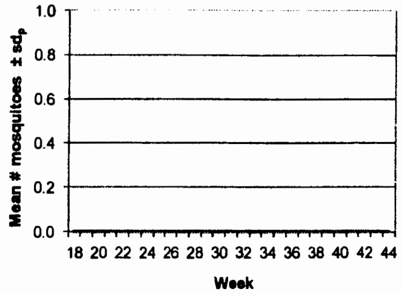
Agricultural



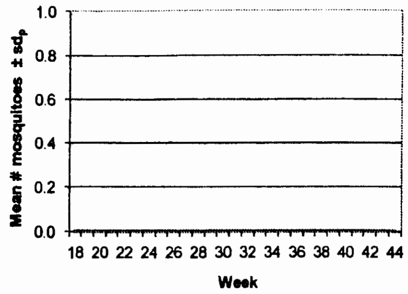
Coastal



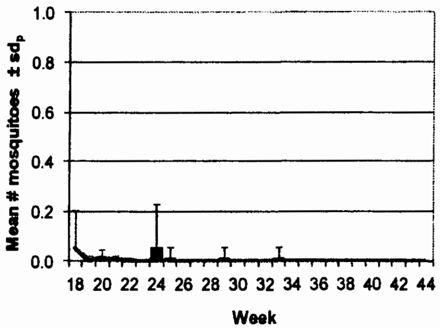
Delaware Bayshore



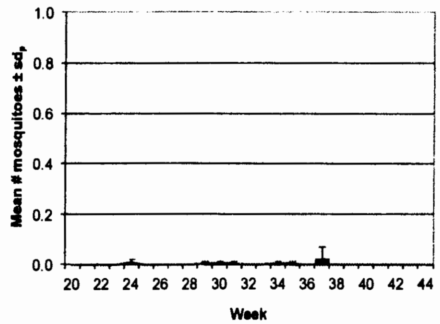
Delaware River Basin



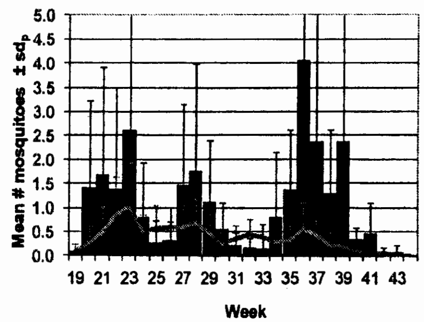
New York Metro



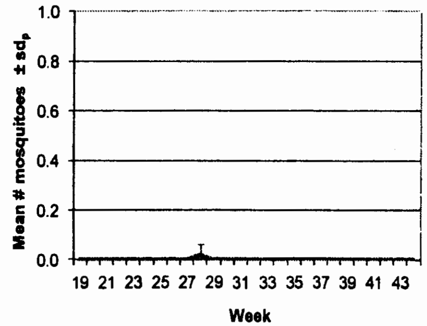
North Central Rural



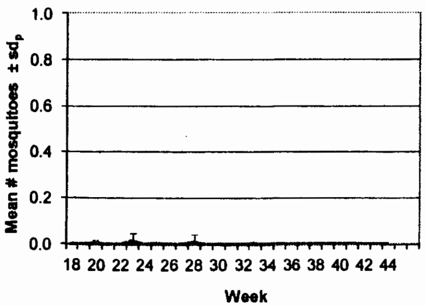
Northwestern Rural



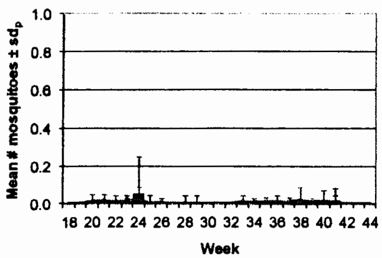
Philadelphia Metro



Pinelands



Suburban Corridor



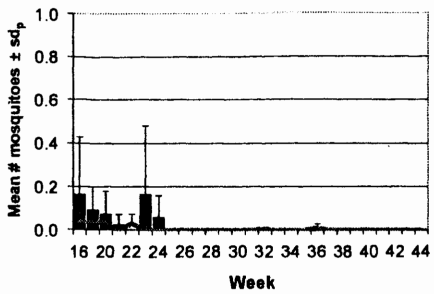
Comments

Aedes cinereus is a cold tolerant species that appear early in the season, but like *Ae. canadensis*, later emergences can also occur from eggs that had not previously hatched. *Ae. cinereus*, with a range that extends into Canada and up through Alaska, may be limited by heat. For the past several years, the Northwestern Rural region has experienced abundances well above historical values and 2010 was not different.

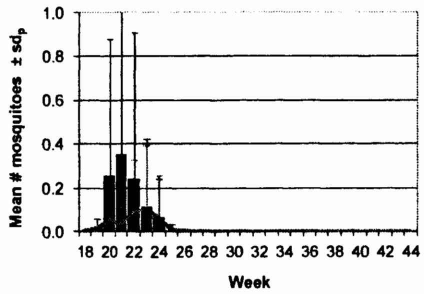
Figure 23.

Aedes grossbecki – Univoltine *Aedine* (*Ae. stimulans* Type)

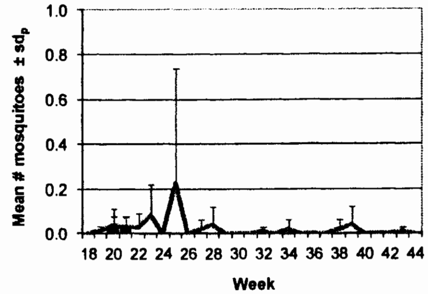
Agricultural



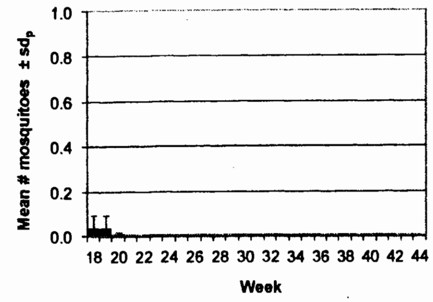
Coastal



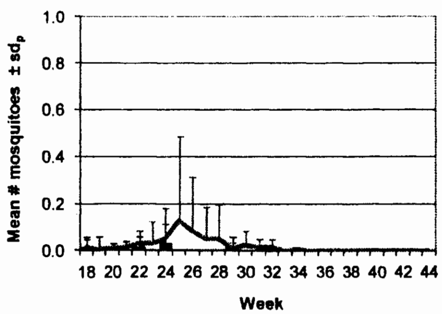
Delaware Bayshore



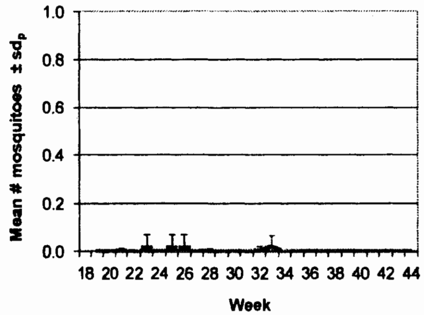
Delaware River Basin



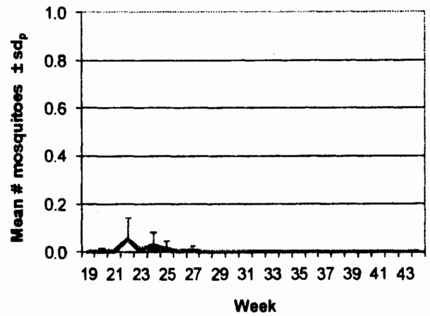
New York Metro



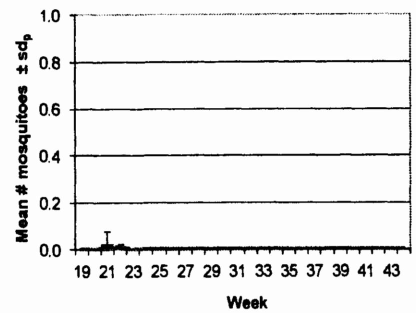
North Central Rural



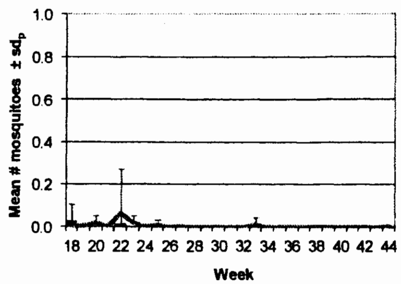
Northwestern Rural



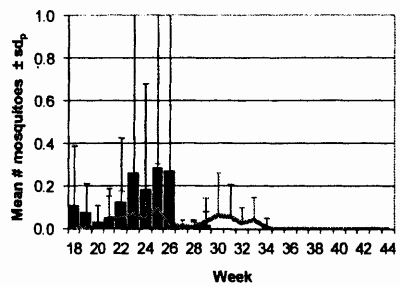
Philadelphia Metro



Pinelands



Suburban Corridor



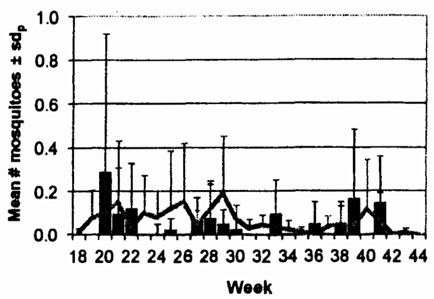
Comments

Aedes grossbecki is an early to mid-season mosquito, is found in all regions of New Jersey. This species is considered a "minor" pest because although it may have a noticeable bite, its overall numbers tend to be low with a muted distribution. The large larvae can be found in woodland pools with waters rich in leave leached tannins. Emergences can occur prior to the use of light traps, as can be seen in the Agricultural region. Higher numbers were observed in the Coastal region and Suburban Corridor.

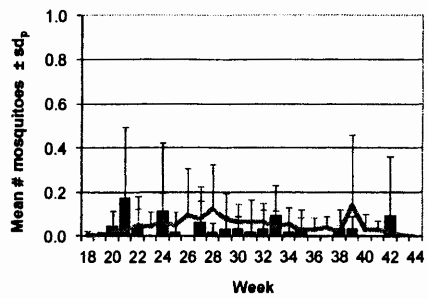
Figure 24.

Aedes japonicus – Multivoltine Aedine (*Aedes triseriatus* Type)

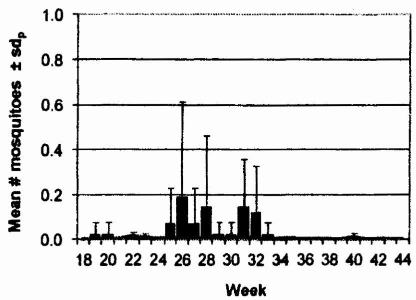
Agricultural



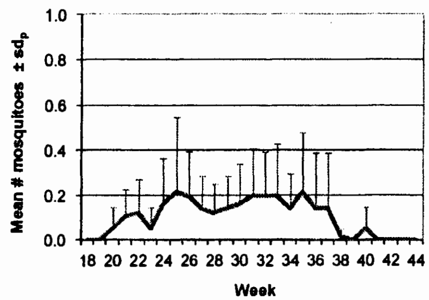
Coastal



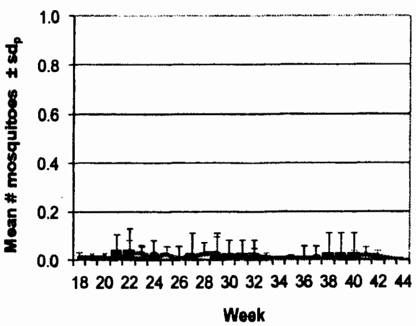
Delaware Bayshore



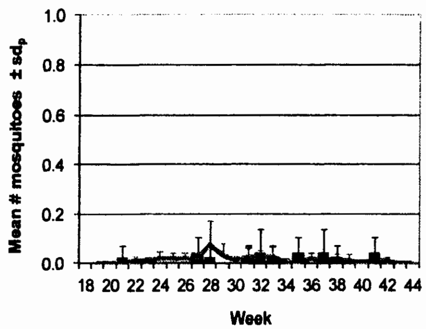
Delaware River Basin



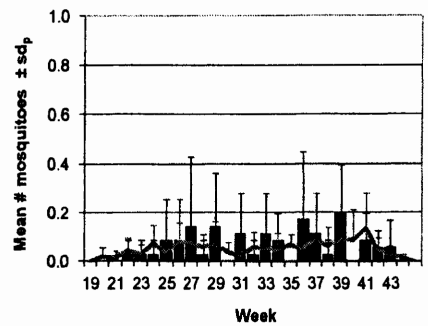
New York Metro



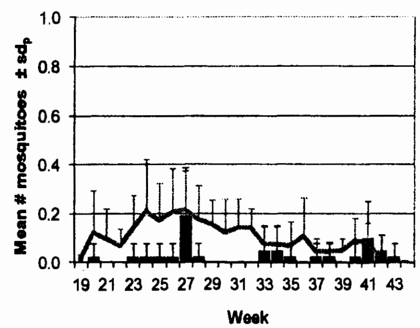
North Central Rural



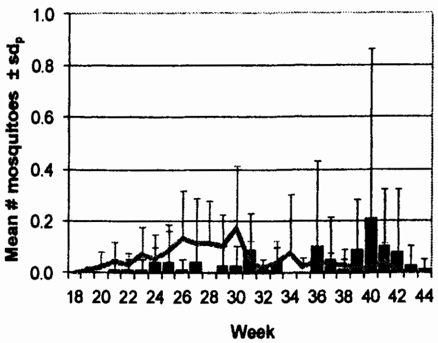
Northwestern Rural



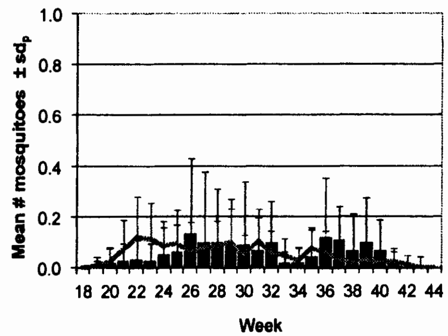
Philadelphia Metro



Pinelands



Suburban Corridor



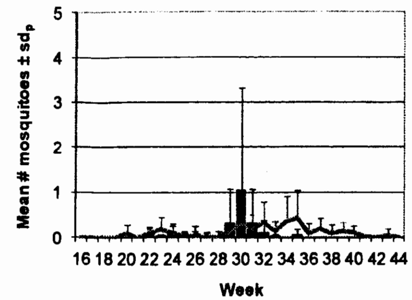
Comments

Aedes japonicus, a cold-tolerant invasive species, was at about historical levels for most regions. Populations were noticeably higher in the Delaware Bayshore regions, but absent from the Delaware River Basin where previous numbers had been significant. Numbers were also low in the Philadelphia Metropolitan region. This species is very competent for West Nile virus transmission, and is usually found positive for mosquito pools submitted in the Vector surveillance program.

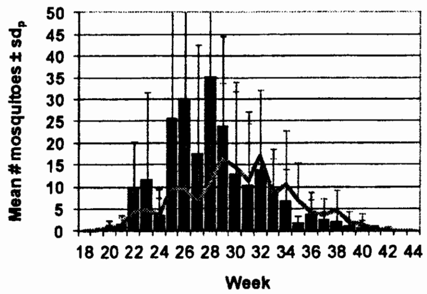
Figure 25.

Aedes sollicitans – Multivoltine Aedine (*Aedes sollicitans* Type)

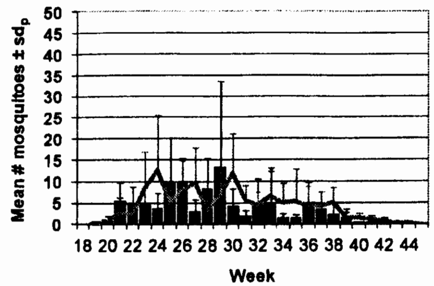
Agricultural



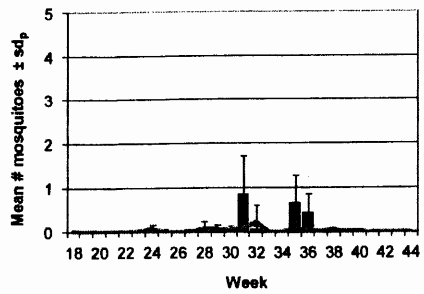
Coastal



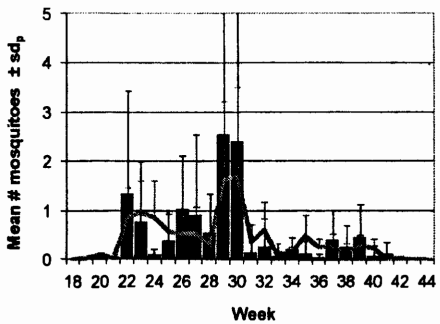
Delaware Bayshore



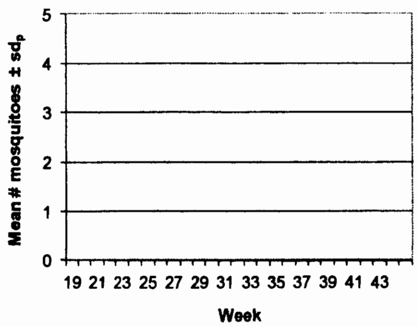
Delaware River Basin



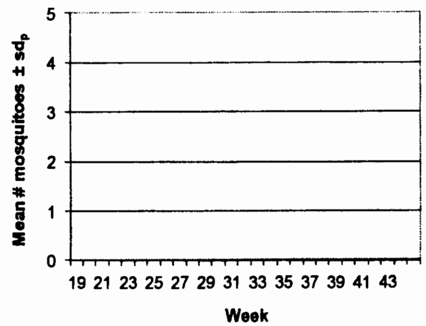
New York Metro



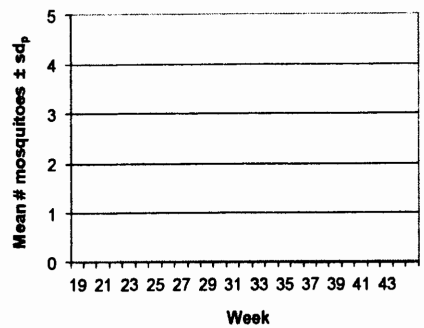
North Central Rural



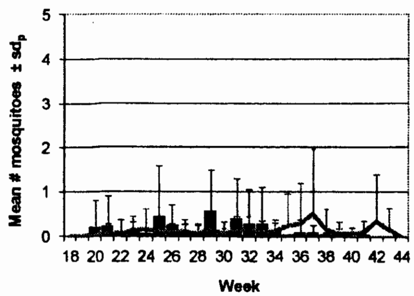
Northwestern Rural



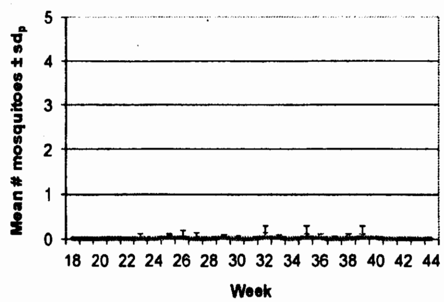
Philadelphia Metro



Pinelands



Suburban Corridor



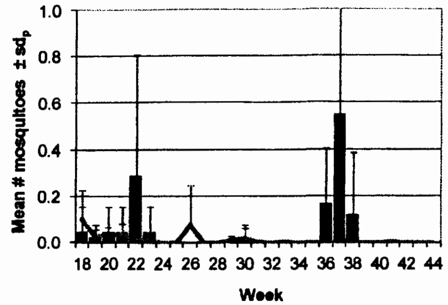
Comments

Aedes sollicitans is a long-distance migrant can generate nuisance complaints far from its natal habitat, particularly when population levels are high. A salt floodwater species, greatest abundance is found in the Coastal and Delaware Bayshore regions with smaller populations in the New York Metropolitan region. This year, higher numbers occurred earlier in the season in the Coastal region but not in the Delaware Bayshore. This species may contribute to the coastal cases of eastern equine encephalitis.

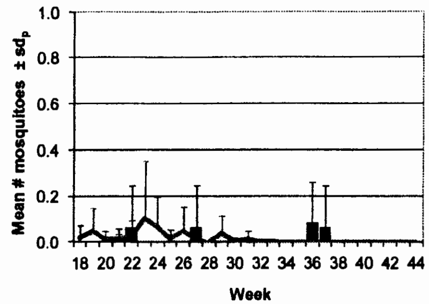
Figure 26.

Aedes sticticus – Univoltine Aedine (*Aedes canadensis* Type)

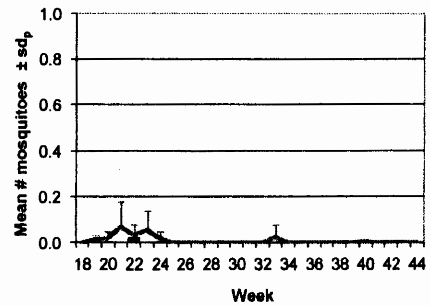
Agricultural



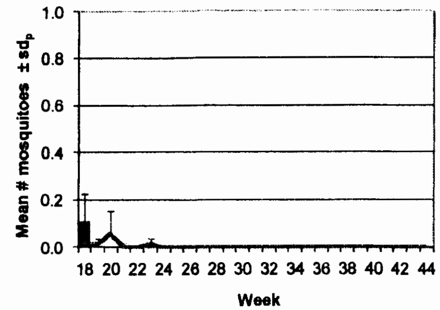
Coastal



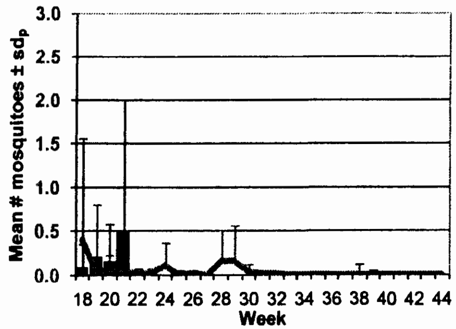
Delaware Bayshore



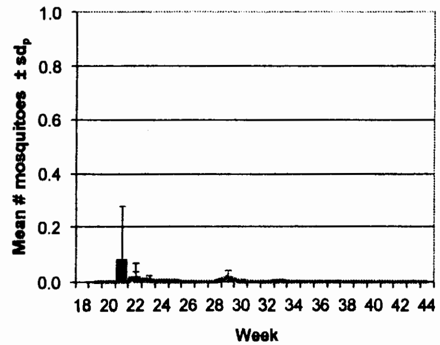
Delaware River Basin



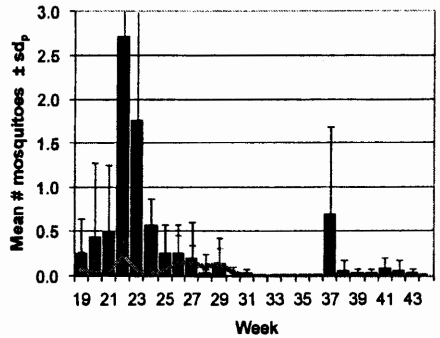
New York Metro



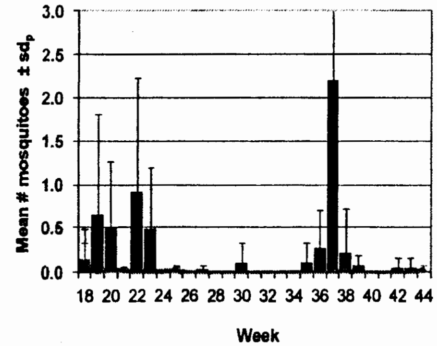
North Central Rural



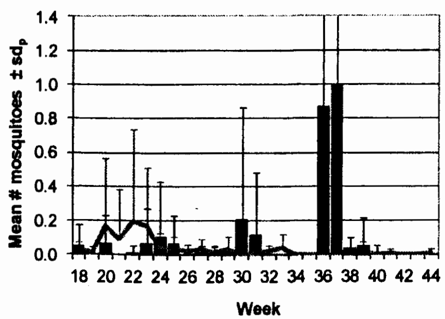
Northwestern Rural



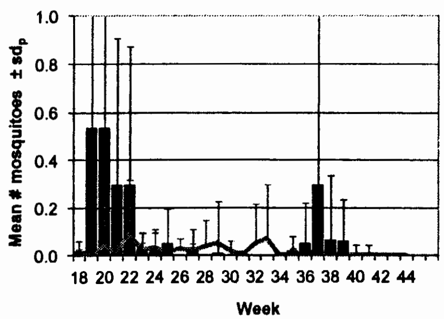
Philadelphia Metro



Pinelands



Suburban Corridor



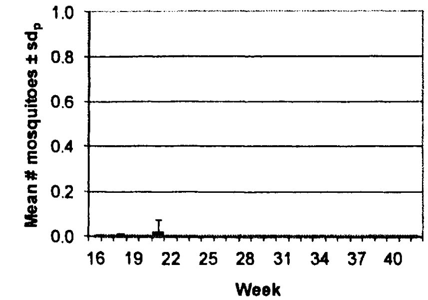
Comments

Aedes sticticus is a univoltine aedine mosquito with re-occurrence patterns similar to *Aedes canadensis*. After an initial spring emergence from shaded woodland pools located in floodplains, an additional emergence will come from other pools located slightly elevated (i.e., near the edge of the floodplain) when these areas become flooded later during the summer. In 2011, this pattern was particularly noticeable in the Agricultural, Northwestern Rural, Philadelphia Metropolitan, Pinelands and Suburban Corridor, with elevated populations seen in those regions after flooding by Hurricane Irene.

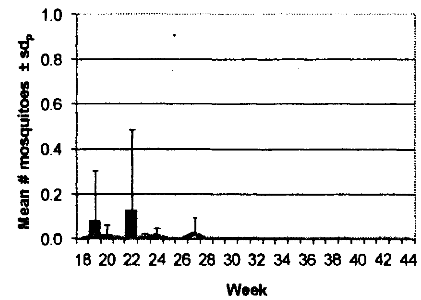
Figure 27.

Aedes stimulans – Univoltine *Aedine* (*Ae. stimulans* Type)

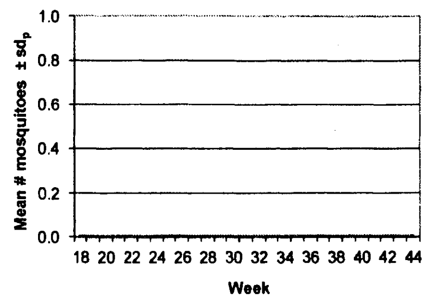
Agricultural



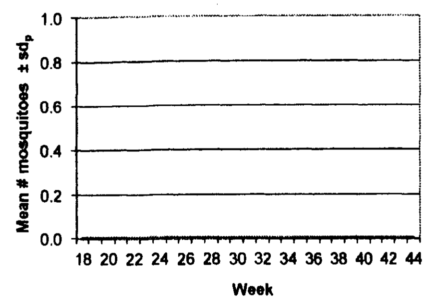
Coastal



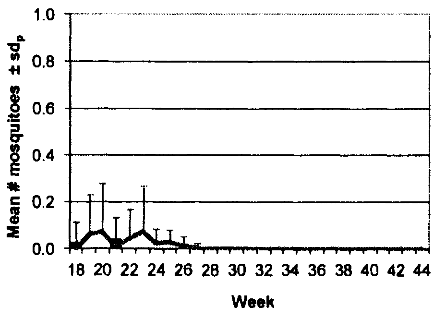
Delaware Bayshore



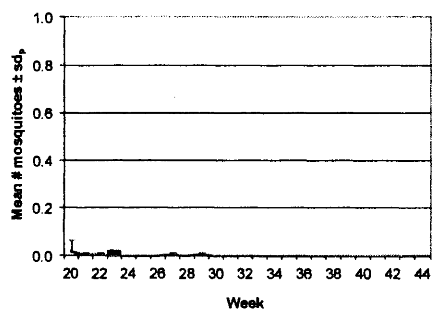
Delaware River Basin



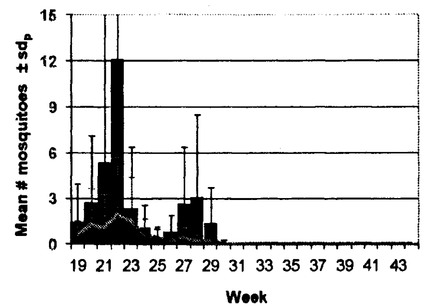
New York Metro



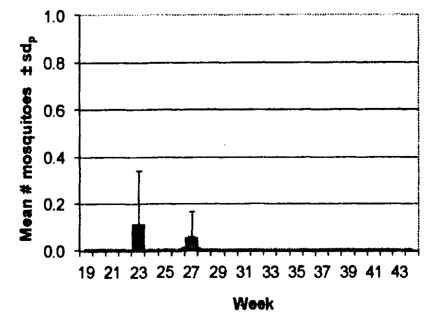
North Central Rural



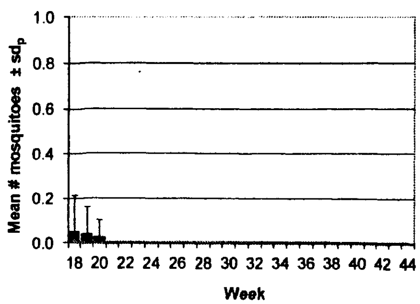
Northwestern Rural



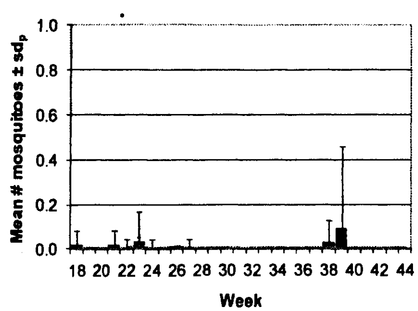
Philadelphia Metro



Pinelands



Suburban Corridor



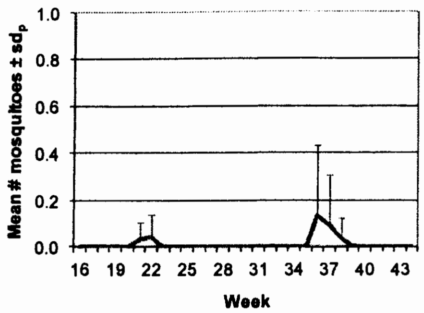
Comments

The snowpool mosquito, *Aedes stimulans* is appropriately named as it is found in woodland pools of the northeastern US and southwestern Canada. An early emergence is forced when surrounding woodland trees develop leaves and subsequently drain the pools. Thus, it may be on the wing before this surveillance program begins. Populations in the Northwestern Rural were above historical trends in 2011, but did not show the historical abundance previously seen a year ago in the New York Metropolitan region.

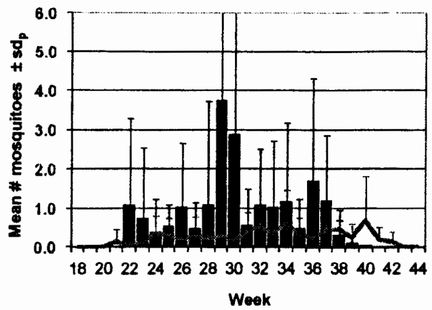
Figure 28.

Aedes taeniorhynchus – Multivoltine Aedine (*Aedes sollicitans* Type)

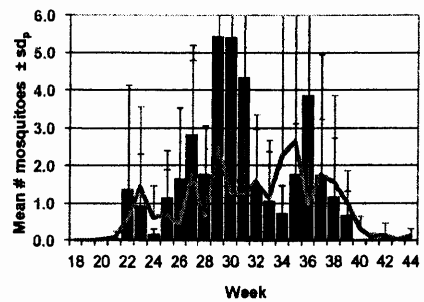
Agricultural



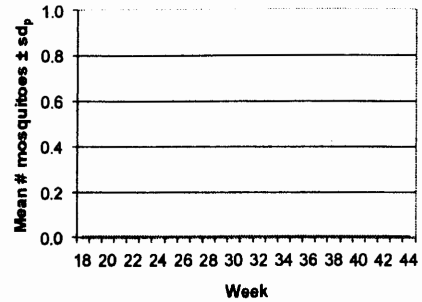
Coastal



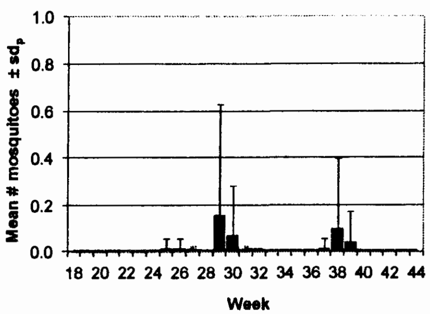
Delaware Bayshore



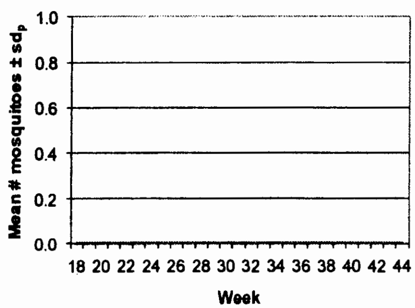
Delaware River Basin



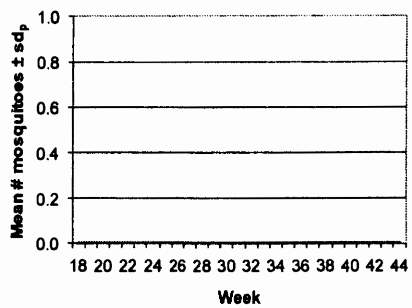
New York Metro



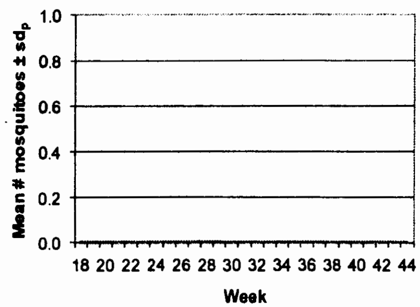
North Central Rural



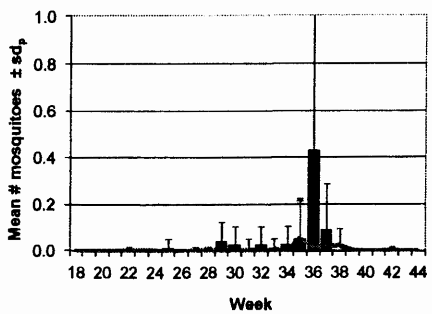
Northwestern Rural



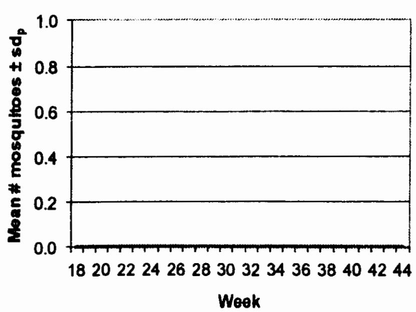
Philadelphia Metro



Pinelands



Suburban Corridor



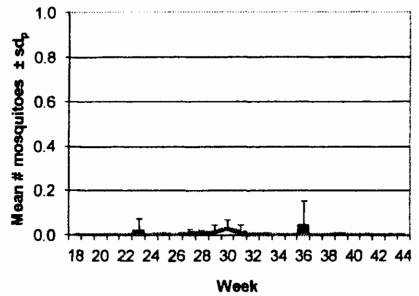
Comments

Aedes taeniorhynchus is a floodwater species found primarily in coastal salt water habitats. Migration flights are not as long as *Ae. sollicitans* and it is most abundant in the Delaware Bayshore. It is, however, a persistent biter and can generate complaints when found. Fortunately, *Ae. taeniorhynchus* is not an efficient vector or either EEE or WNV. In 2011, the populations in the Delaware Bayshore and the Coastal regions were above historical trends. Smaller numbers appeared in the New York Metropolitan region but not in the Agricultural region.

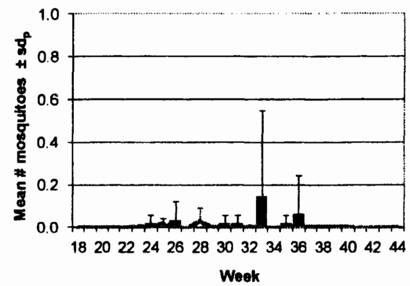
Figure 29.

Aedes triseriatus – Multivoltine Aedine (*Aedes triseriatus* Type)

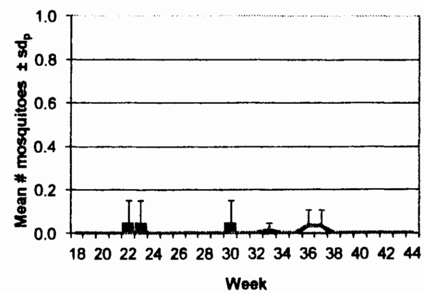
Agricultural



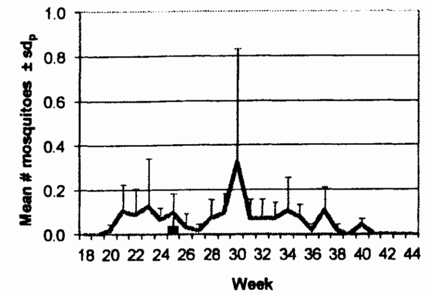
Coastal



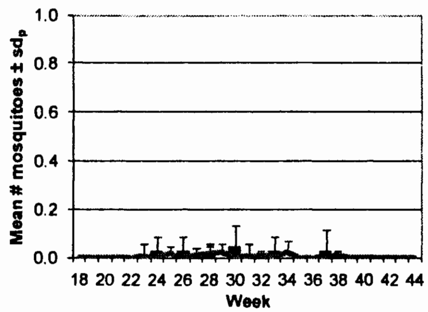
Delaware Bayshore



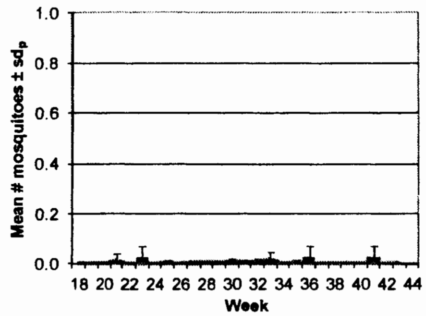
Delaware River Basin



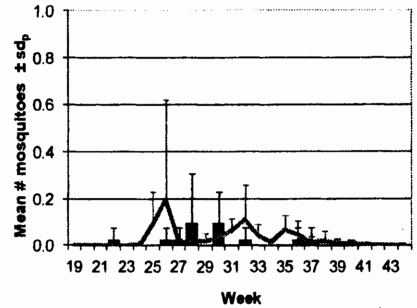
New York Metro



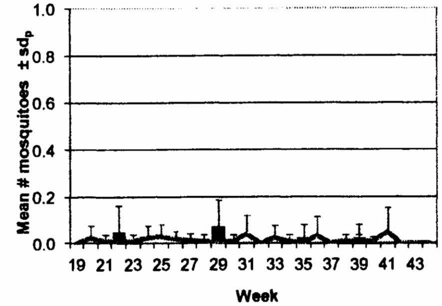
North Central Rural



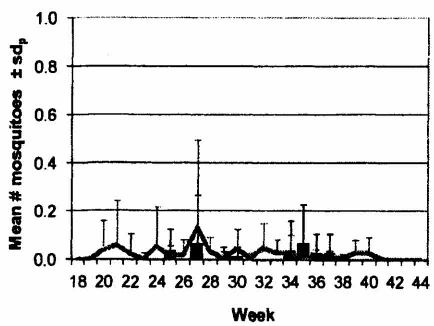
Northwestern Rural



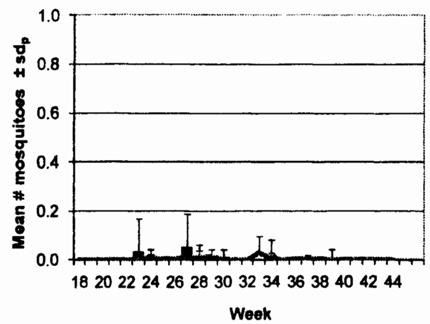
Philadelphia Metro



Pinelands



Suburban Corridor



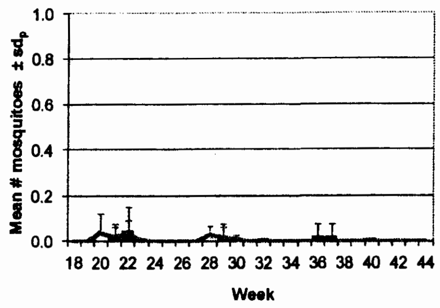
Comments

Aedes triseriatus, the Eastern Treehole mosquito, is a known vector of La Crosse encephalitis virus. Transmission to the following year is through overwintering eggs (vertical transmission) that develop into infected adults. Amplification is through small vertebrates such as chipmunks and tree squirrels. The CDC reports 3 known cases of La Crosse in New Jersey, all occurring during the mid 1970's. This species is not well attracted to light traps. As in previous years, numbers of *Ae. triseriatus* are variable compared to historical trends, with increases seen in the Coastal and Delaware Bayshore regions and fewer in the Delaware River Basin.

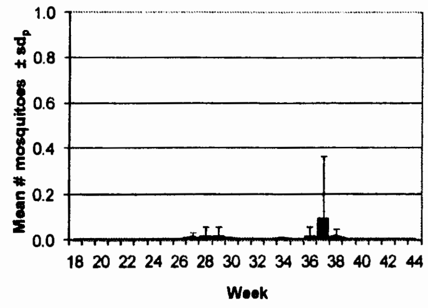
Figure 30.

Aedes trivittatus – Multivoltine *Aedine* (*Ae. vexans* Type)

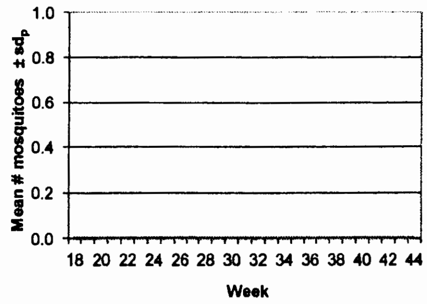
Agricultural



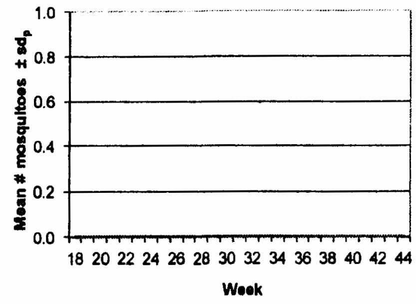
Coastal



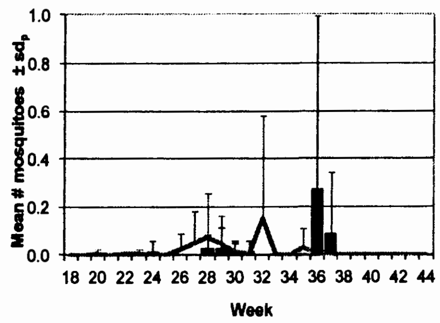
Delaware Bayshore



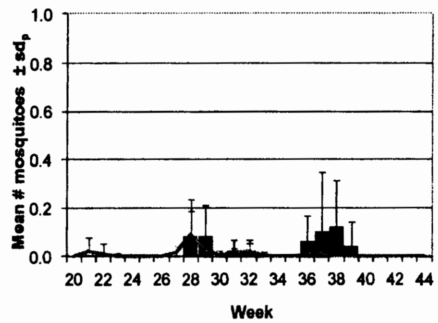
Delaware River Basin



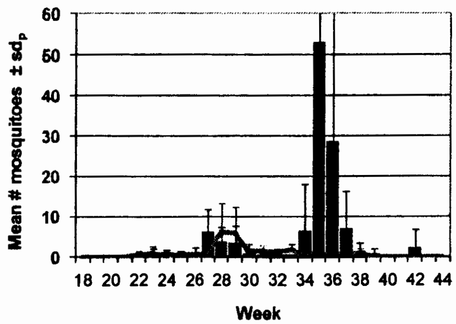
New York Metro



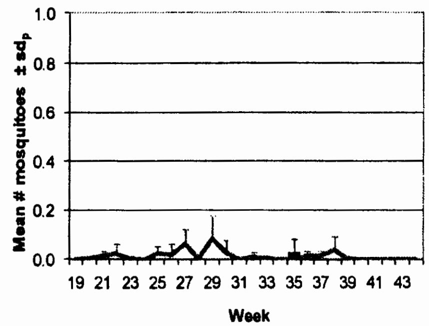
North Central Rural



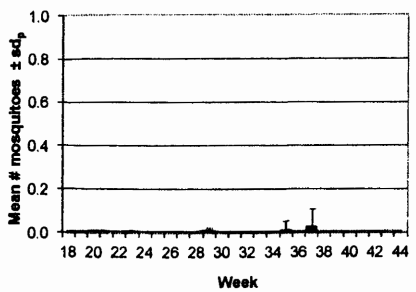
Northwestern Rural



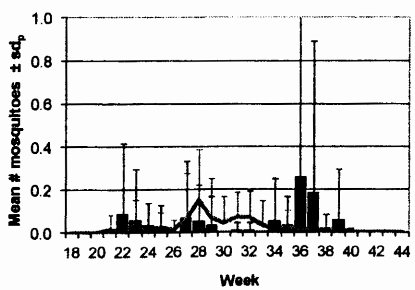
Philadelphia Metro



Pinelands



Suburban Corridor



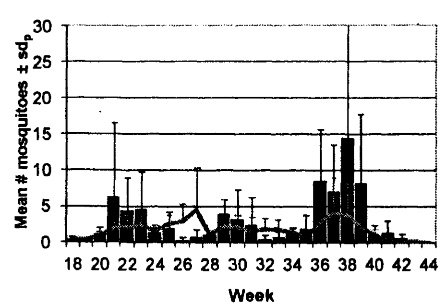
Comments

Aedes trivitattus, a multivoltine floodwater species, can generate a number of complaints from residents after flooding events. This aggressive, persistent biter is most abundant in the Northwestern Rural region where this year a very significant emergence occurred. Not surprisingly, this area is also the source of another multivoltine floodwater species, *Aedes vexans*. Other regions where higher than average emergences occurred were the Coastal, New York Metropolitan, North Central Rural regions and the Suburban Corridor – all affected by flooding after Hurricane Irene passed through New Jersey.

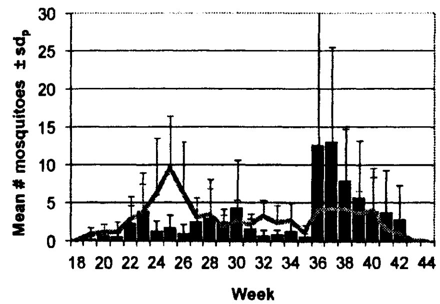
Figure 31.

Aedes vexans – Multivoltine *Aedine* (*Ae. vexans* Type)

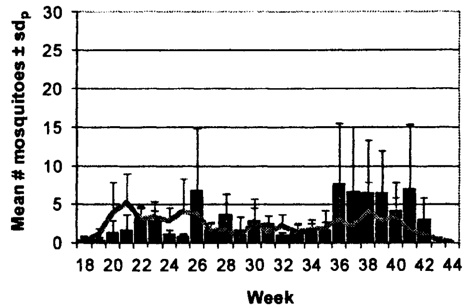
Agricultural



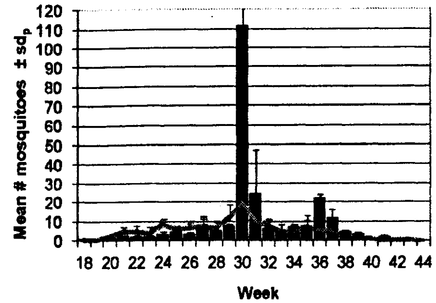
Coastal



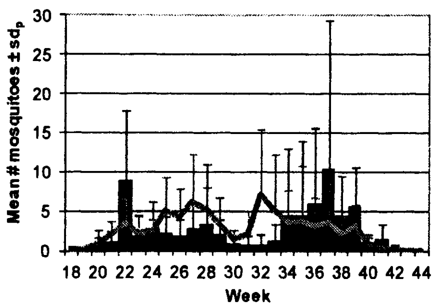
Delaware Bayshore



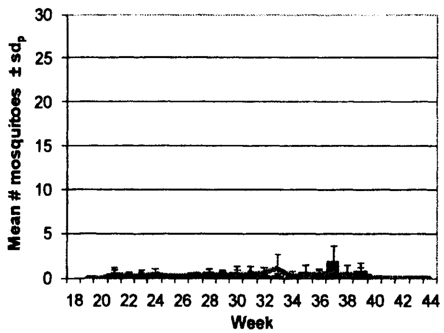
Delaware River Basin



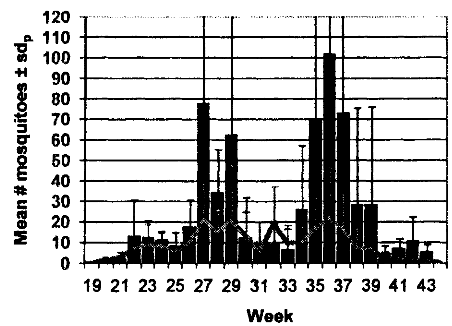
New York Metro



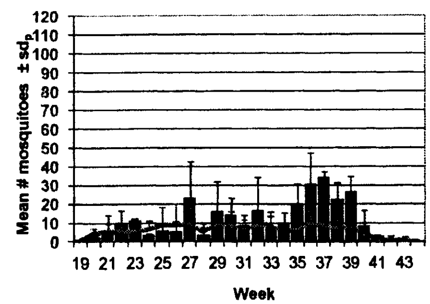
North Central Rural



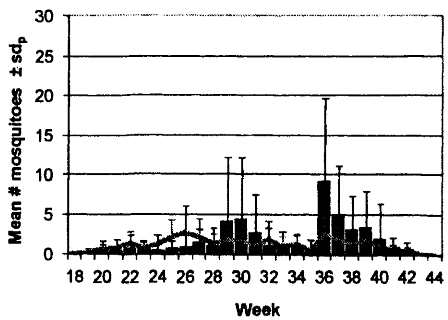
Northwestern Rural



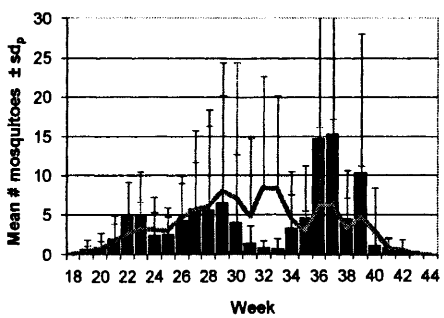
Philadelphia Metro



Pinelands



Suburban Corridor



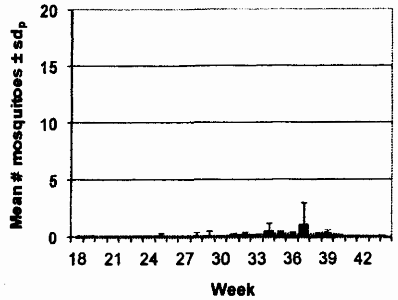
Comments

Aedes vexans is the model for the fresh floodwater mosquito that produces multiple generations a year. Populations are very dependent on local conditions, although some areas can be influenced by distant conditions, such as floodwater from streams that overflow banks despite no local rains. This condition is found in the Northwestern Rural region, where three rivers meet and flood after rains from upstate New York flow into New Jersey. Not surprisingly, populations were elevated there, particularly after flooding from significant rains dropped by Hurricane Irene. Those rains also produced emergences from most other regions.

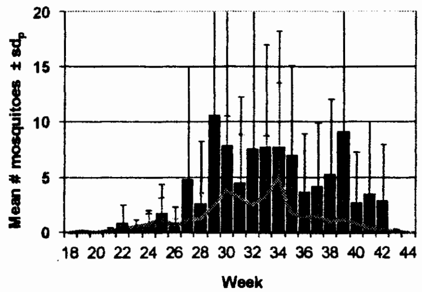
Figure 32.

Anopheles bradleyi – *Culex/Anopheles* (*Cx. salinarius* Type)

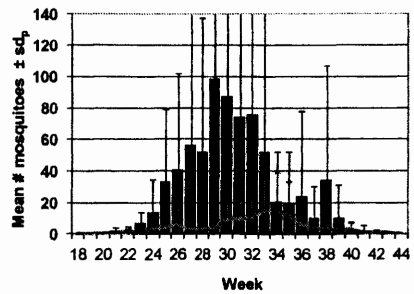
Agricultural



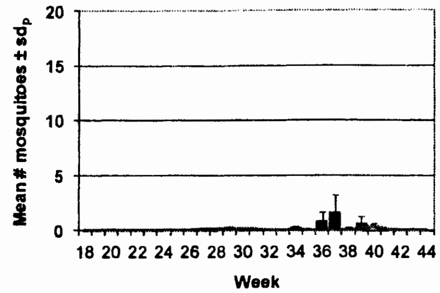
Coastal



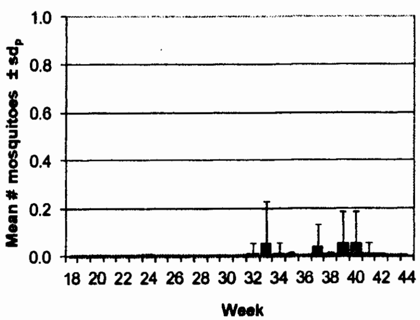
Delaware Bayshore



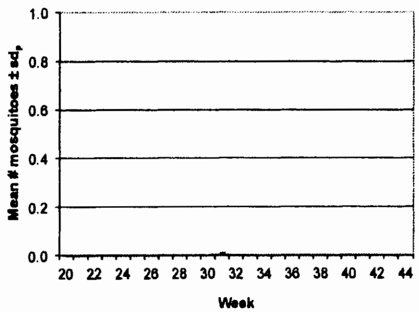
Delaware River Basin



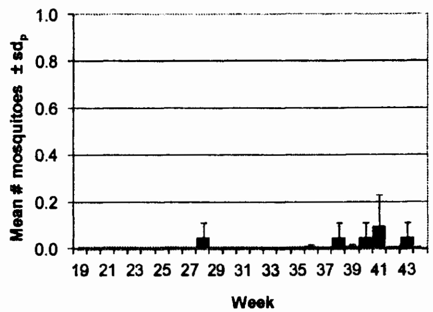
New York Metro



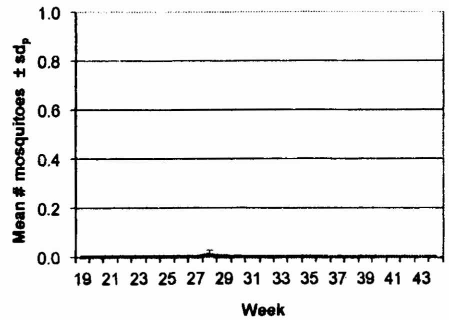
North Central Rural



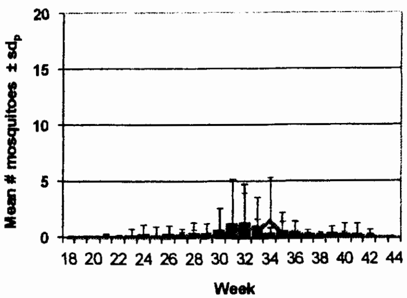
Northwestern Rural



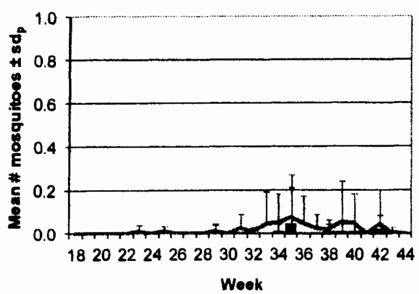
Philadelphia Metro



Pinelands



Suburban Corridor



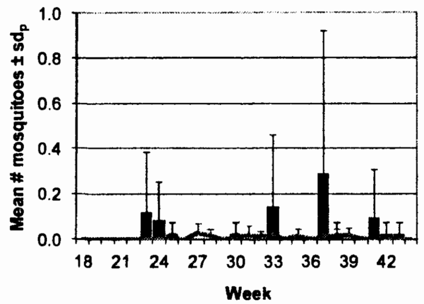
Comments

Anopheles bradleyi is a salt tolerant floodwater species that exploits more brackish water areas near salt marshes. Its largest populations are found in the Coastal and Delaware Bayshore, but surprisingly not in the Delaware River Basin, where dredge spoil impoundments have produced significant populations in earlier years (Slaff and Crans 1982). In 2011, abundances were significantly above historical trends in their typical habitats of the Coastal and Delaware Bayshore regions. Also, appearances were seen in the Agricultural, Delaware River Basin, New York Metropolitan and Northwestern Rural regions.

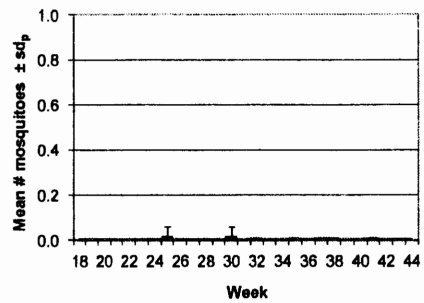
Figure 33.

Anopheles crucians – Unique (*Cs. melanura* Type)

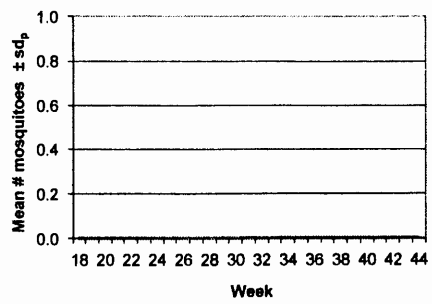
Agricultural



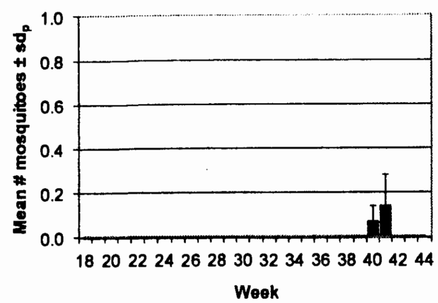
Coastal



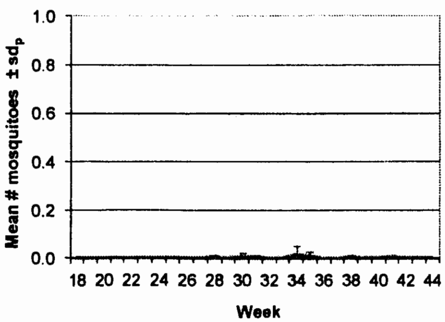
Delaware Bayshore



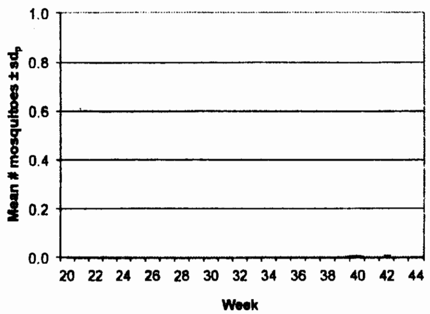
Delaware River Basin



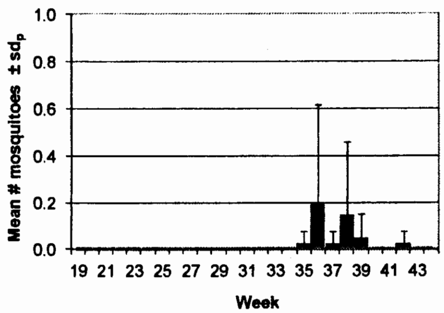
New York Metro



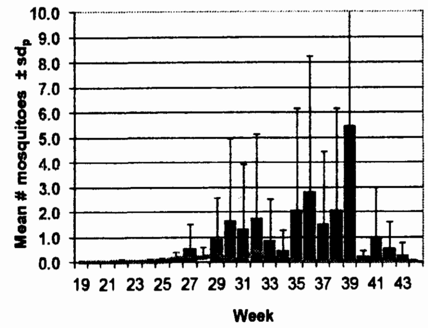
North Central Rural



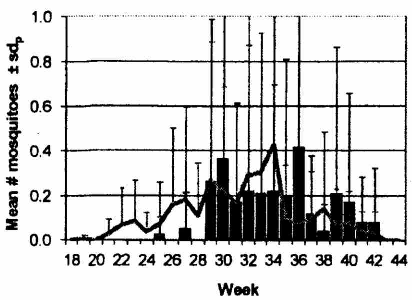
Northwestern Rural



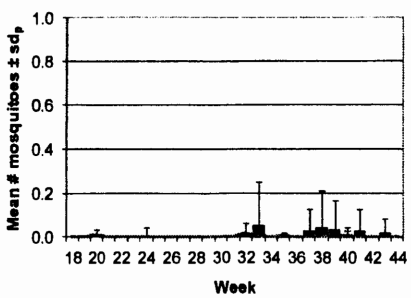
Philadelphia Metro



Pinelands



Suburban Corridor



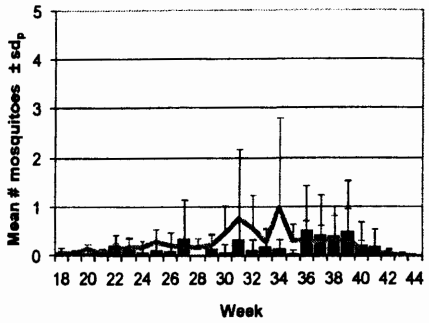
Comments

This is the second year that abundances in the Pinelands and Philadelphia Metro regions to include this species into the final report. *An. crucians* is similar to *Cs. melanura* with overwintering larvae that likely spend time burrowed in bottom sediment. It can apparently exploit habitats with varying amounts of mineral salts not tolerated by other species. Numbers were also reported, but at lower levels, in the Agricultural, Delaware River Basin, Northwestern Rural regions and the Suburban Corridor.

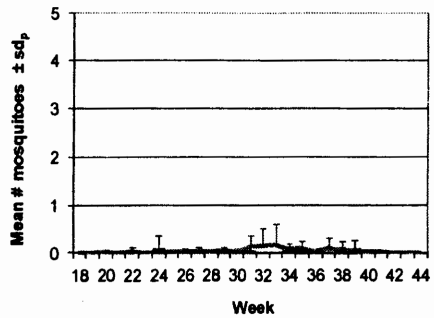
Figure 34.

Anopheles punctipennis – *Culex/Anopheles* (*Cx pipiens* Type)

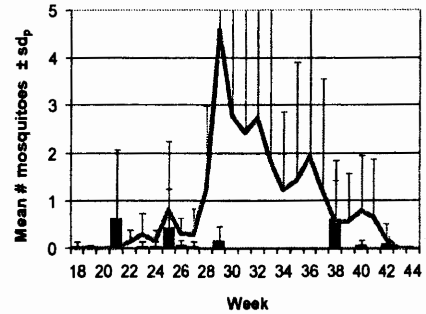
Agricultural



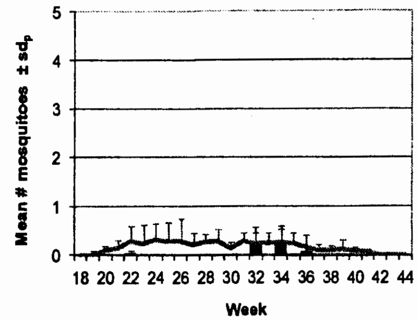
Coastal



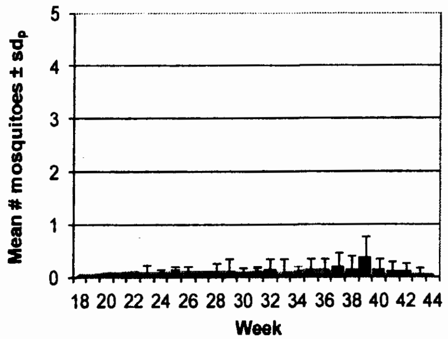
Delaware Bayshore



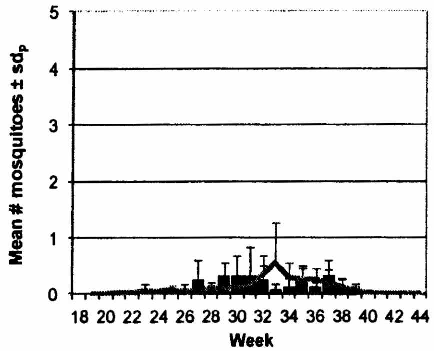
Delaware River Basin



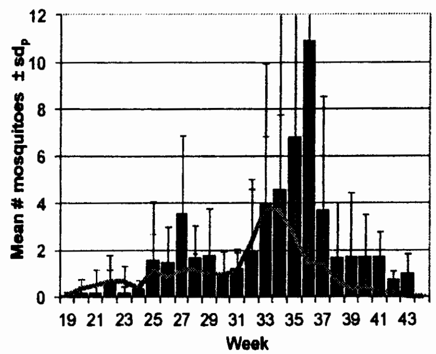
New York Metro



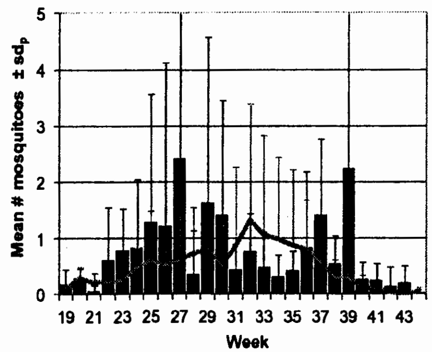
North Central Rural



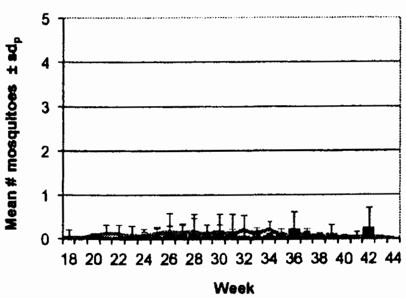
Northwestern Rural



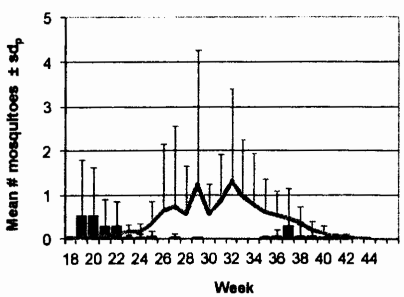
Philadelphia Metro



Pinelands



Suburban Corridor



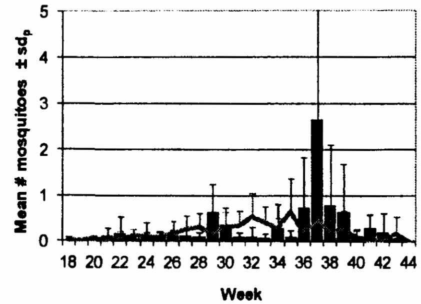
Comments

Anopheles punctipennis is present in every region of New Jersey, with highest populations found in the Northwestern Rural region. In 2011, abundances were again high there, with late-season numbers well above historical trends. Abundances were also high in the Philadelphia Metropolitan region, whereas mid-season numbers were notably lacking in the Delaware Bashore, Delaware River Basin and the Suburban Corridor.

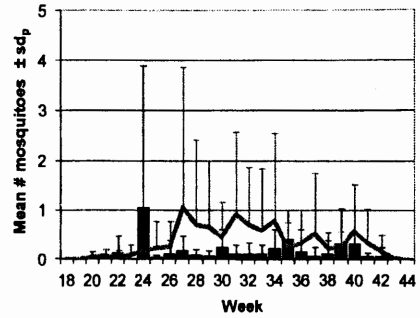
Figure 35.

Anopheles quadrimaculatus – *Culex/Anopheles* (*An. quadrimaculatus* Type)

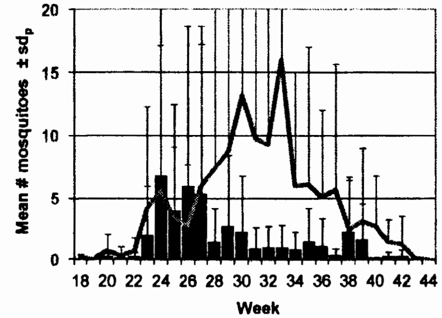
Agricultural



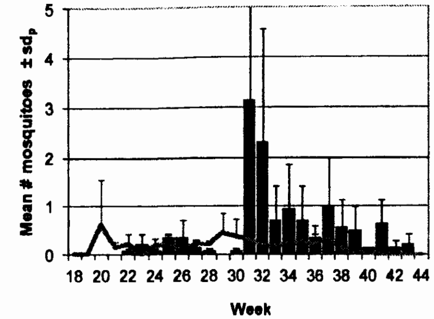
Coastal



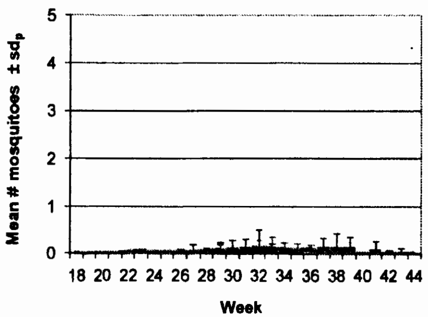
Delaware Bayshore



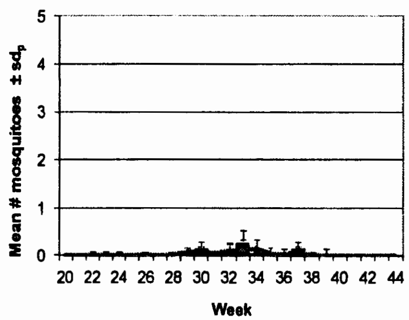
Delaware River Basin



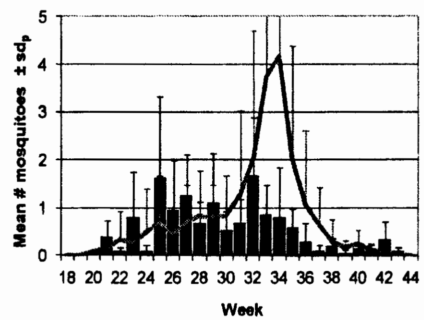
New York Metro



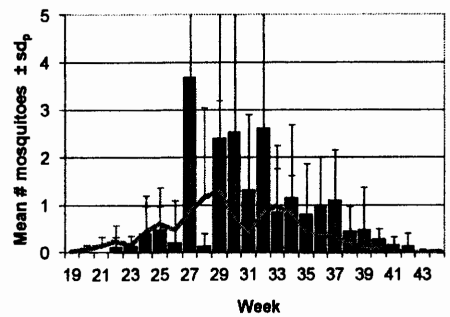
North Central Rural



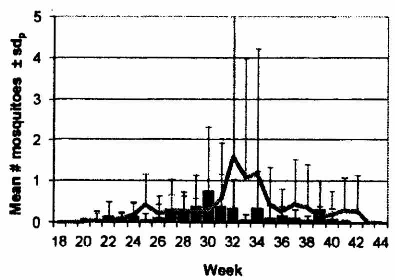
Northwestern Rural



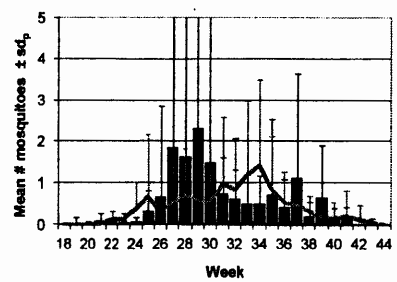
Philadelphia Metro



Pinelands



Suburban Corridor



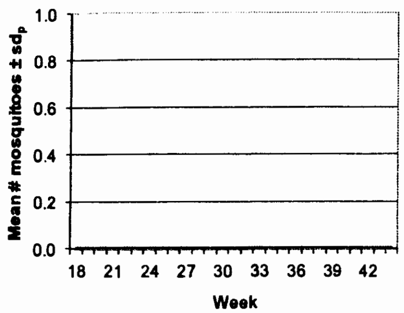
Comments

Anopheles quadrimaculatus is the type species for multivoltine mosquitoes that lay non-desiccant resistant eggs on clean water and that overwinters as adult females. In the past, *An. quadrimaculatus* has been a significant vector of malaria in New Jersey. In 2011, *An. quadrimaculatus* showed a variable response in New Jersey, with above-historical abundances in the Agricultural, Delaware River Basin, Philadelphia Metro and Suburban Corridor, while depressed populations occurred in the Delaware Bayshore and in, to a lesser extent, the Northwestern Rural region.

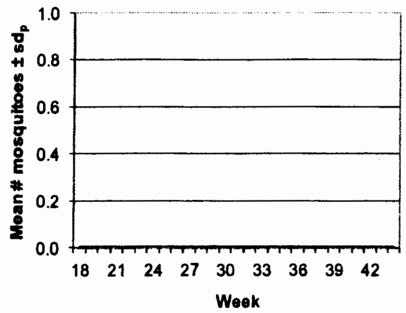
Figure 36.

Anopheles walkeri – Monotypic (*An. walkeri* Type)

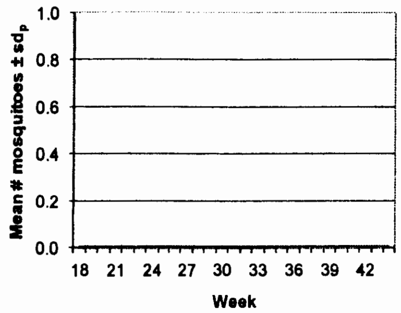
Agricultural



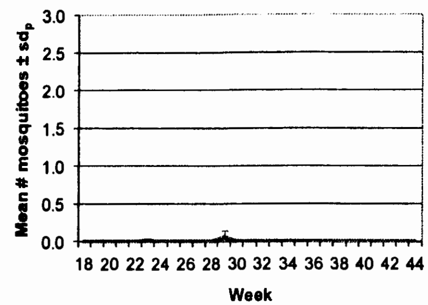
Coastal



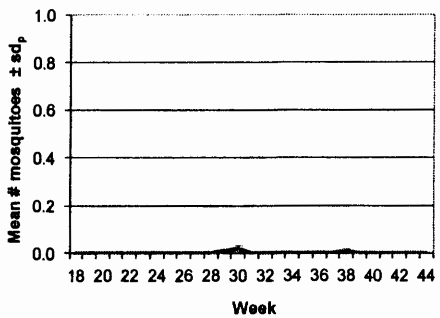
Delaware Bayshore



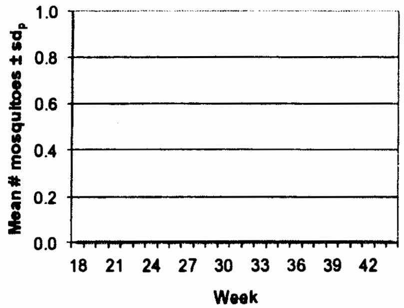
Delaware River Basin



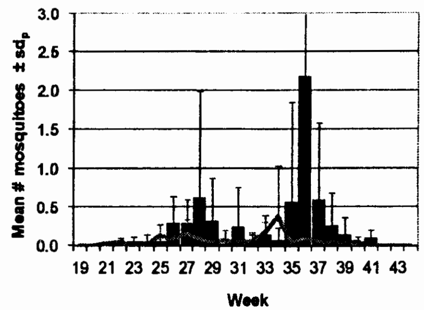
New York Metro



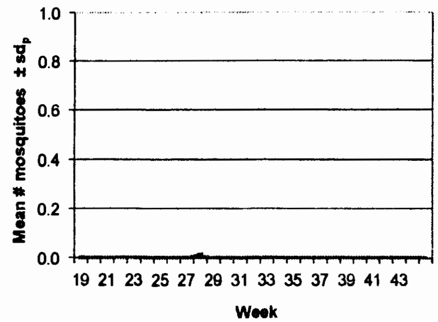
North Central Rural



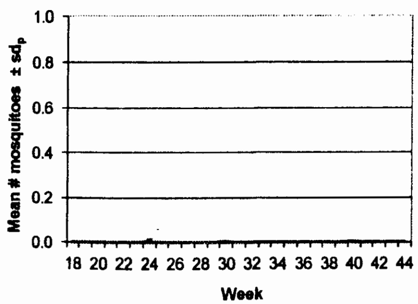
Northwestern Rural



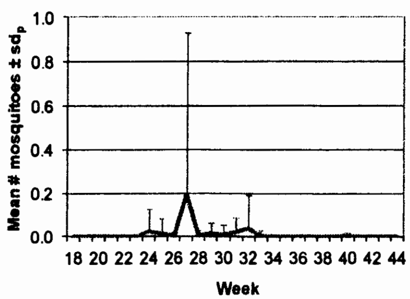
Philadelphia Metro



Pinelands



Suburban Corridor



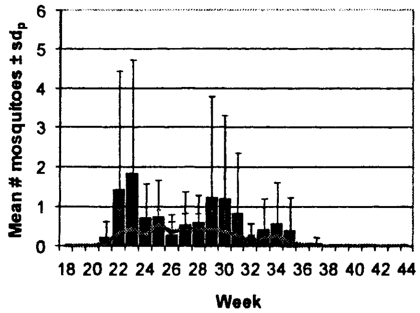
Comments

Anopheles walkeri is the only anopheline to overwinter as an egg and is thus given its own life cycle classification (Crans 2004). As in previous years, populations in the Suburban Corridor were generally absent. However, in the adjacent Northwestern Rural region, this species flourished, with abundances well above the historical trends for the last five years.

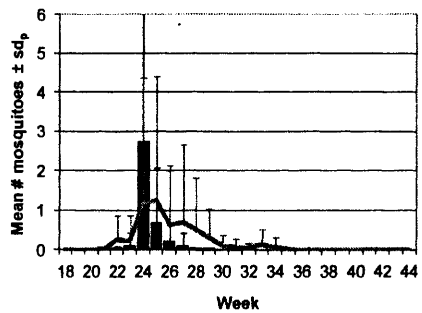
Figure 37.

Coquillettidia perturbans – Miscellaneous Group

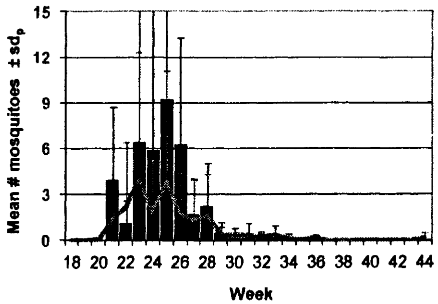
Agricultural



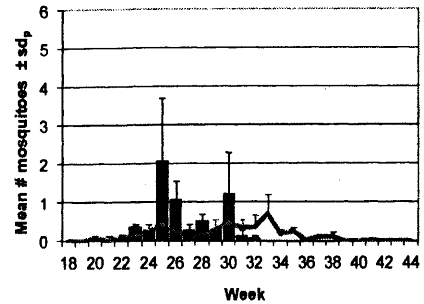
Coastal



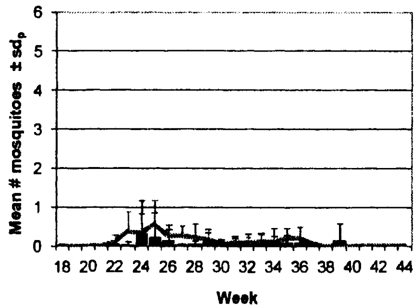
Delaware Bayshore



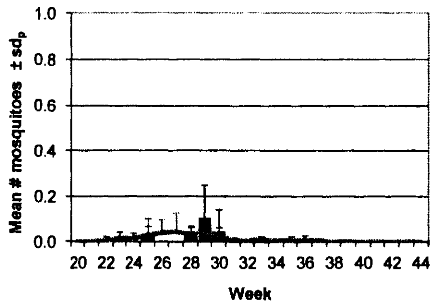
Delaware River Basin



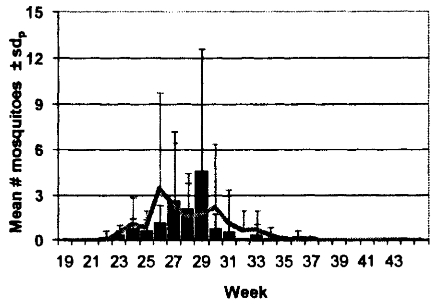
New York Metro



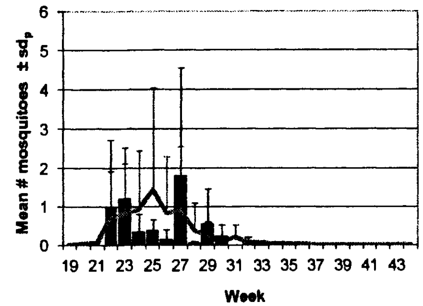
North Central Rural



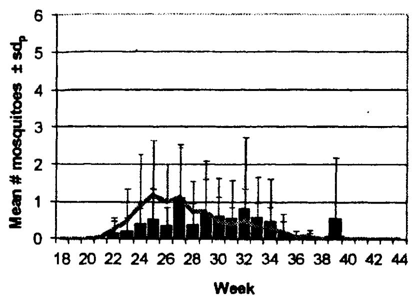
Northwestern Rural



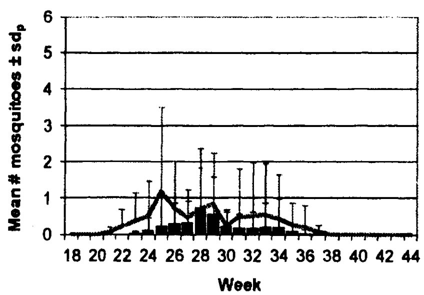
Philadelphia Metro



Pinelands



Suburban Corridor



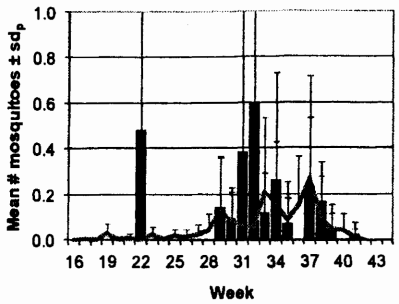
Comments

Coquillettidia perturbans, a suspected vector of inland EEE cases, spends its larval time attached to plants and gaining oxygen through the piercing of the plant phloem. This exploitation of plants makes this species more difficult to control. In 2011, populations of *Coq. perturbans* were elevated in the Agricultural, Delaware Bayshore and Delaware River Basin while populations elsewhere were around historical trends.

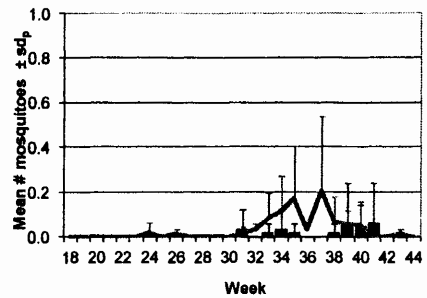
Figure 38.

Culex erraticus – *Culex/Anopheles* (*An. quadrimaculatus* Type)

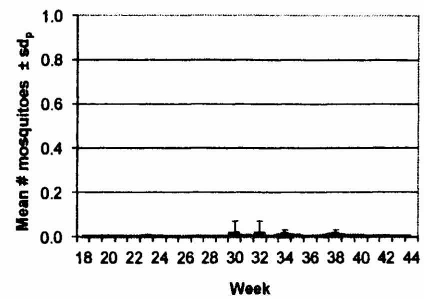
Agricultural



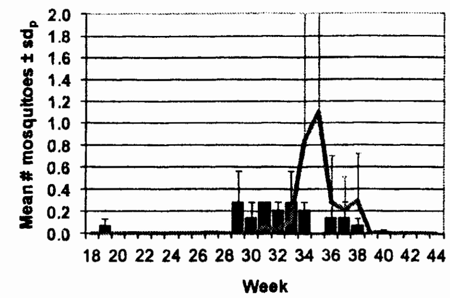
Coastal



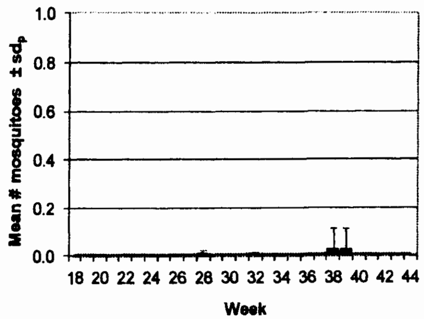
Delaware Bayshore



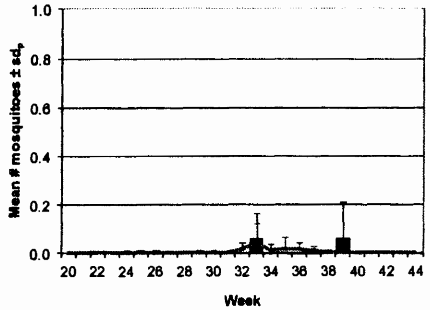
Delaware River Basin



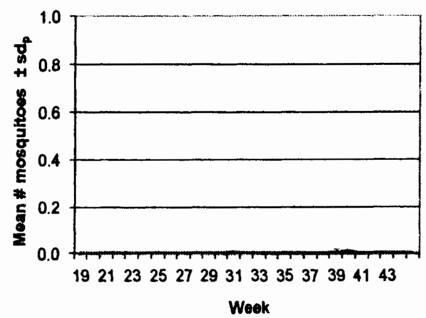
New York Metro



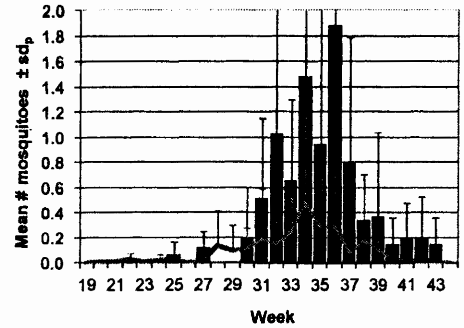
North Central Rural



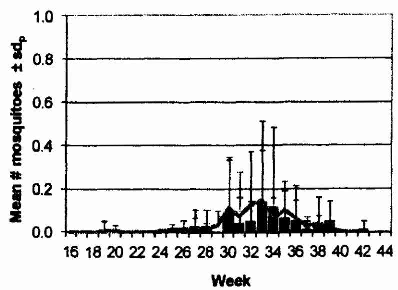
Northwestern Rural



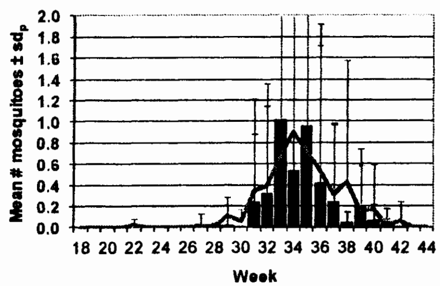
Philadelphia Metro



Pinelands



Suburban Corridor



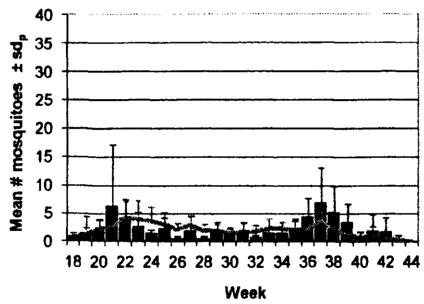
Comments

Culex erraticus was first detected in New Jersey in the late 1960's. For most of the years since then, this mosquito has been thought of as rare. Recently, populations have begun to show up more frequently in traps seen before as well as being seen for the first time in other areas. Catholic in its diet, *Cx. erraticus* has been implicated in the amplification and transmission cycle of eastern equine encephalitis. Populations in 2011 were elevated in the Agricultural and Philadelphia Metropolitan regions.

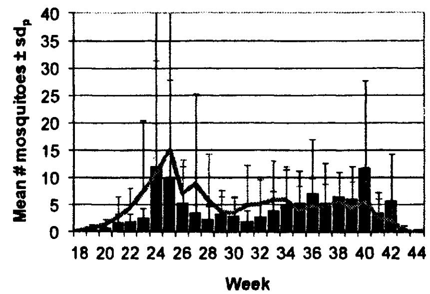
Figure 39.

Mixed *Culex* spp. – Culex/Anopheles (*Cx pipiens/salinarius* Type)

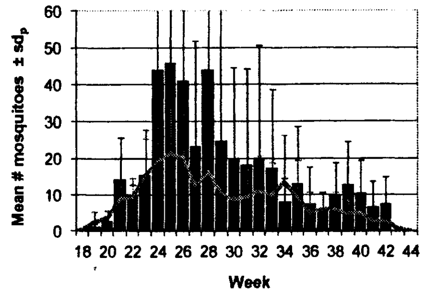
Agricultural



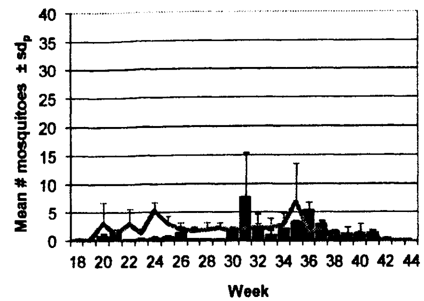
Coastal



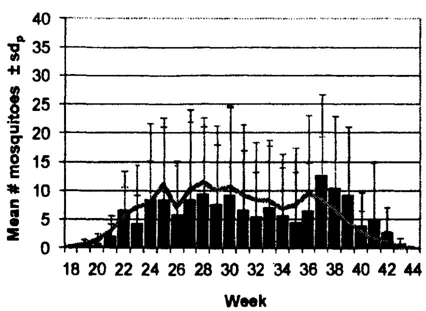
Delaware Bayshore



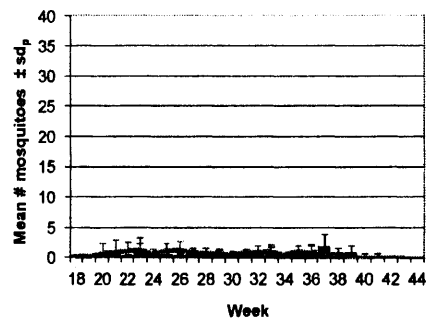
Delaware River Basin



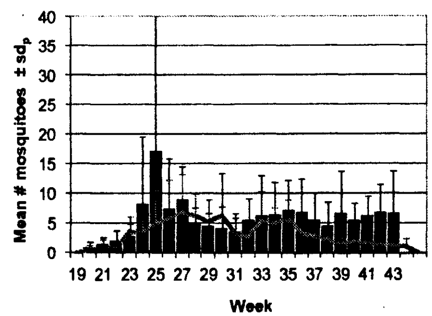
New York Metro



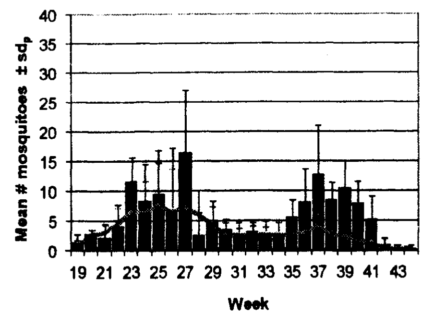
North Central Rural



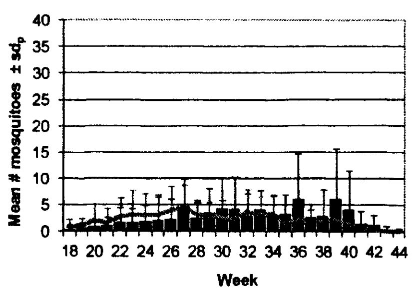
Northwestern Rural



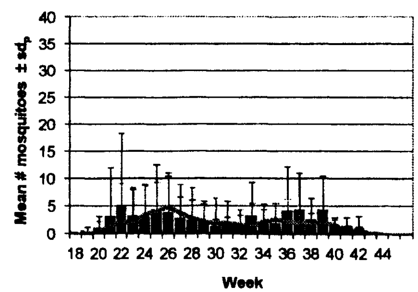
Philadelphia Metro



Pinelands



Suburban Corridor



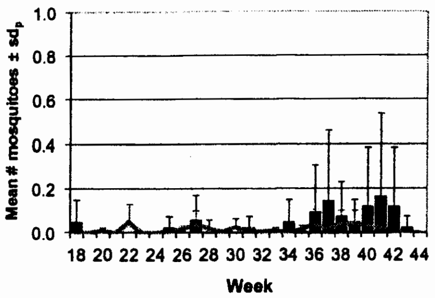
Comments

Mixed *Culex spp.* (including *Culex pipiens, Cx. restuans* and *Cx. salinarius*) are consolidated into one group as individuals from the three species can be difficult to distinguish after going through a light trap. Two of these (*Cx. pipiens* and *Cx. restuans*) are primarily bird feeders, although they may change their diet to include mammals as the summer ends. This is the primary enzootic vector for West Nile virus in the northeast US. Populations in 2011 were elevated above historical trends in the Delaware Bayshore, Northwestern Rural and the Philadelphia Metropolitan regions.

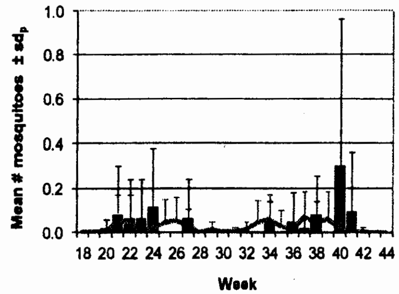
Figure 40.

Culex territans – *Culex/Anopheles* (*An. quadrimaculatus* Type)

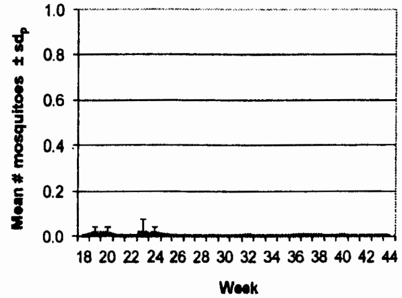
Agricultural



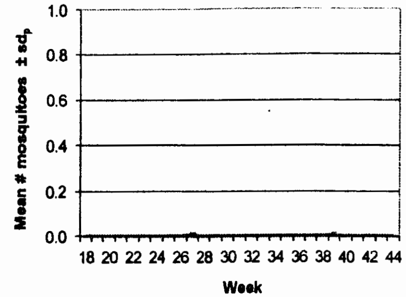
Coastal



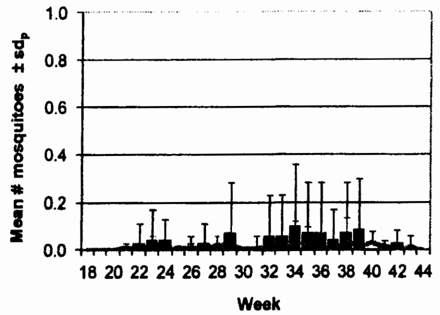
Delaware Bayshore



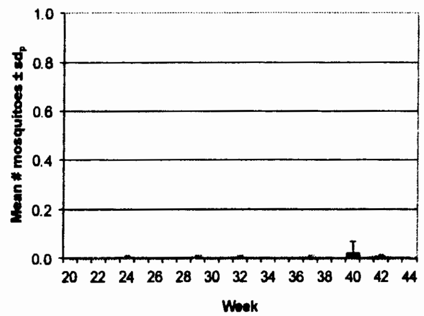
Delaware River Basin



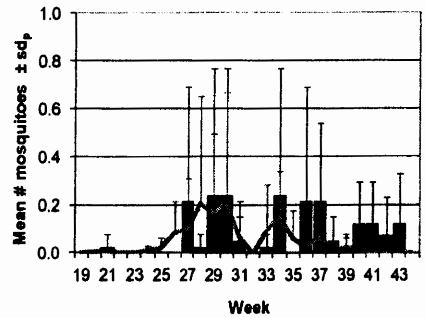
New York Metro



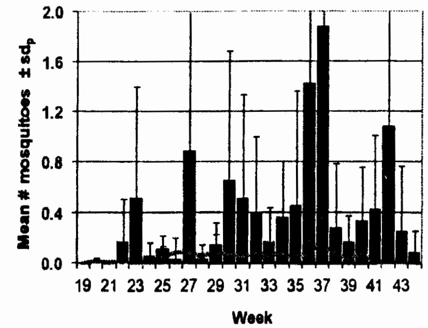
North Central Rural



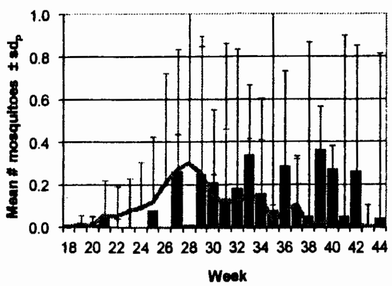
Northwestern Rural



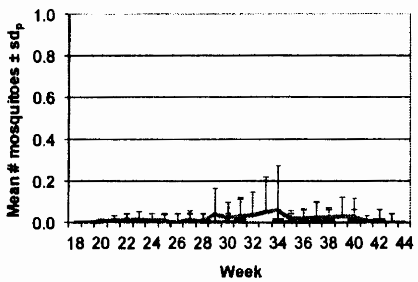
Philadelphia Metro



Pinelands



Suburban Corridor

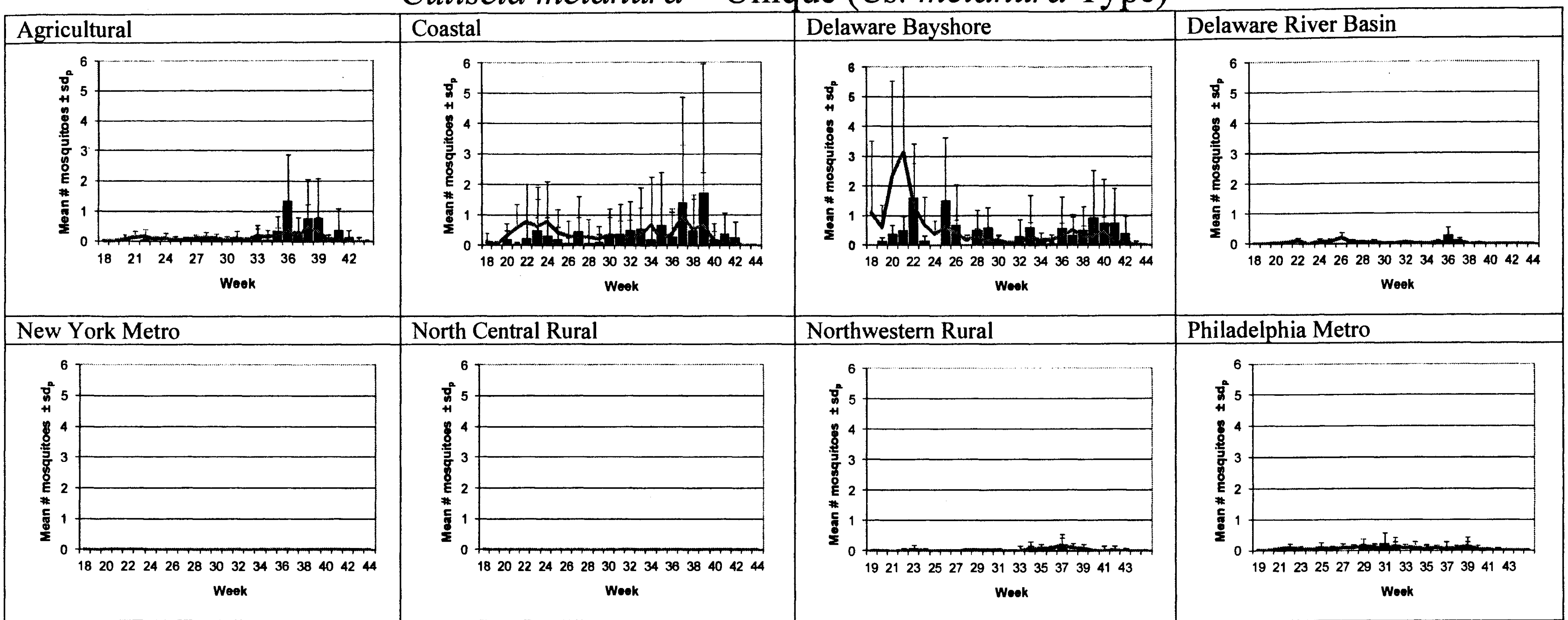


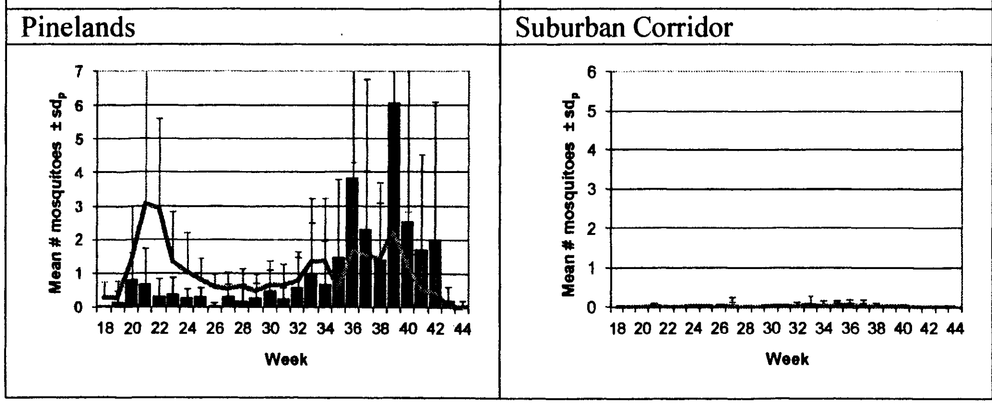
Comments

Culex territans is a specialized frog-feeder with cold tolerance that allows it to be present when early-season frogs appear. This means that a portion of the population is not likely recorded in the light traps as they have already appeared and disappeared before the traps were turned on. As with other *Culex*, females overwinter in protected hibernaculae. This species is found throughout most of New Jersey. In 2011, the Philadelphia Metropolitan region experienced a significant increase above historical trends. Agricultural, Coastal, Northwestern Rural and the Pinelands also saw late season increases of *Cx. territans.*

Figure 41.

Culiseta melanura – Unique (*Cs. melanura* Type)





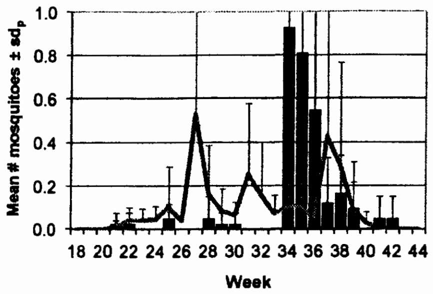
Comments

Culiseta melanura is the enzootic vector of eastern equine encephalitis virus. This species overwinters as larvae in the acidic waters of peat bogs, usually safely inside crypts formed at the base of trees. This makes larval control of them particularly difficult. Historical values of the Pinelands clearly show the second generation where most EEE amplification occurs that develops during the second half of the season. In 2011, populations of *Cs. melanura* followed typical patterns, with an elevated population in the Pinelands, suggesting that the 2012 season may begin with elevated populations should the water table remain to promote overwintering larval survival.

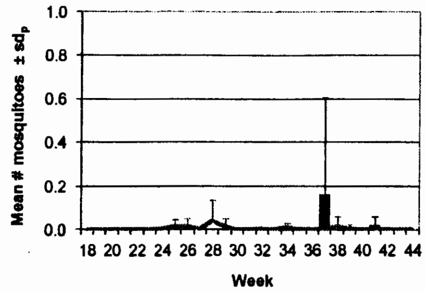
Figure 42.

Psorophora ciliata – Multivoltine Aedine (Ae. vexans Type)

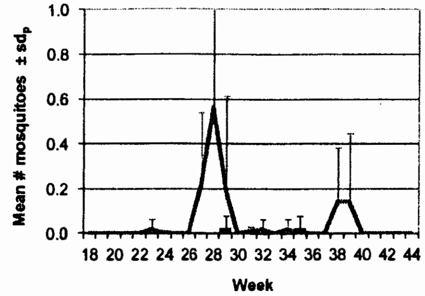
Agricultural



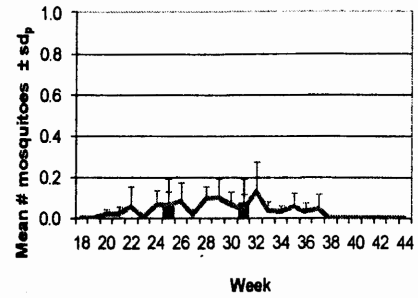
Coastal



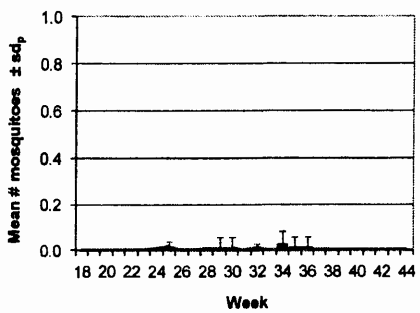
Delaware Bayshore



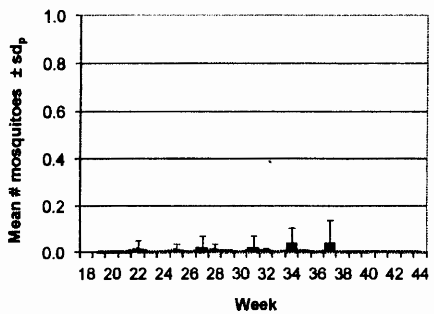
Delaware River Basin



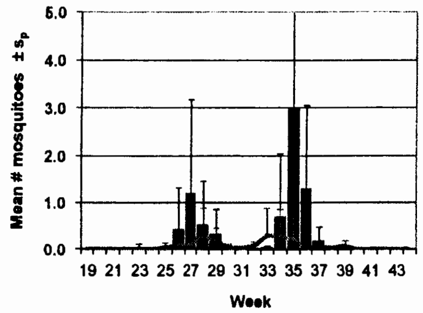
New York Metro



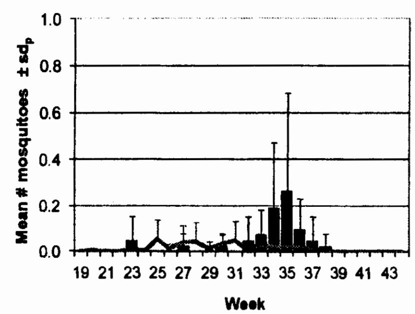
North Central Rural



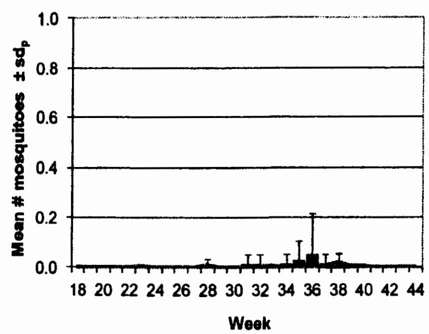
Northwestern Rural



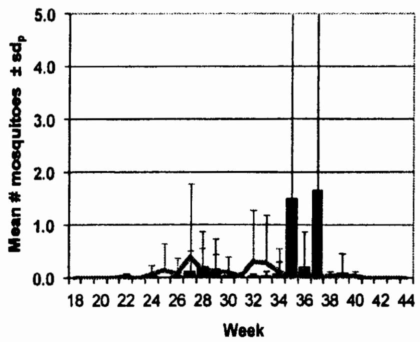
Philadelphia Metro



Pinelands



Suburban Corridor

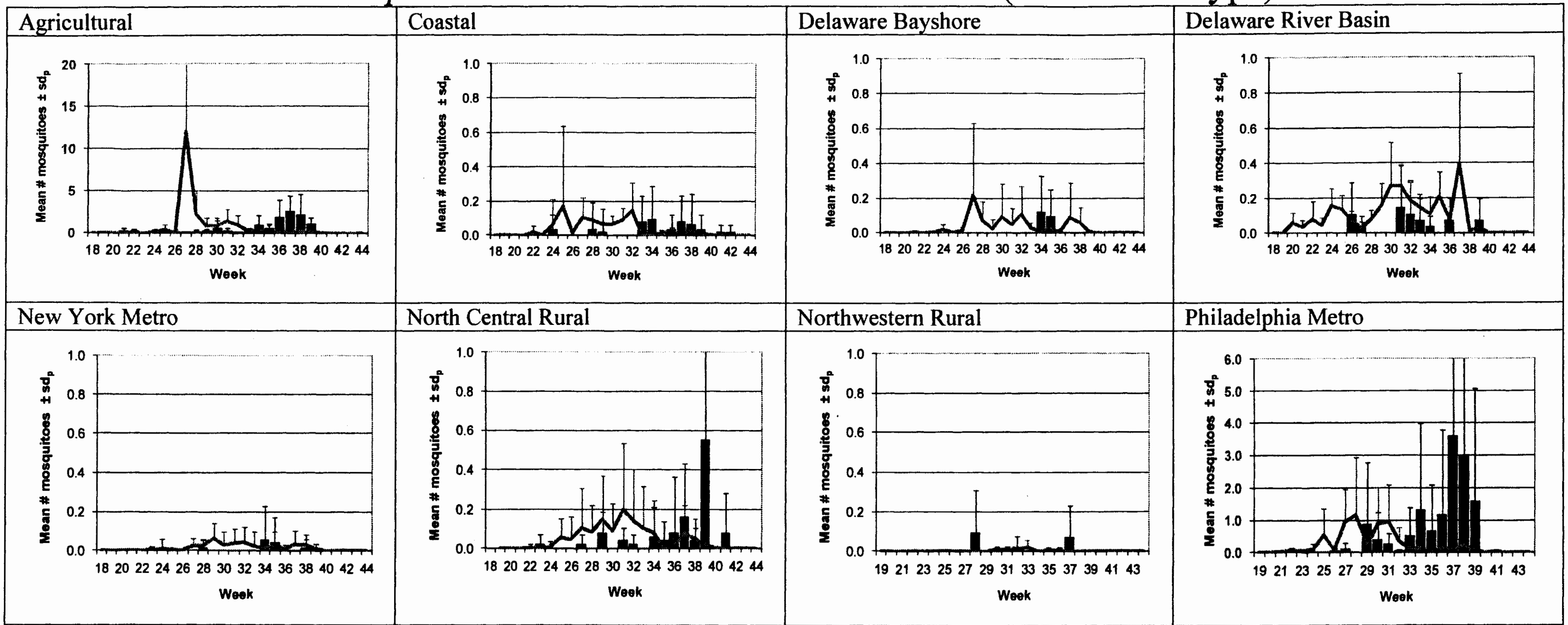


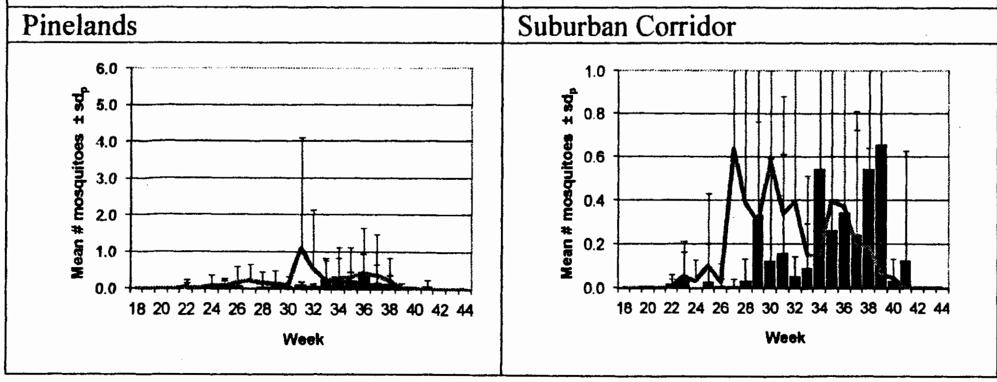
Comments

Psorophora ciliata is a large floodwater mosquito that preys upon smaller mosquitoes such as *Psorophora columbiae* as larvae. Hurricane Irene dropped significant amounts of water that resulted in large emergences in the Agricultural, Northwestern Rural, Philadelphia Metropolitan regions and the Suburban Corridor. Smaller emergences were also seen in the Coastal and Pineland regions.

Figure 43.

Psorophora columbiae – Multivoltine Aedine (*Ae. vexans* Type)





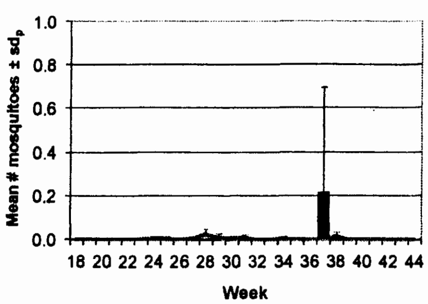
Comments

Psorophora columbiae is a smaller psorophoran that is preyed upon by its larger brethren. All the psorophorans are floodwater mosquitoes in New Jersey. As such, and as one of the food sources for the larger psorophorans, the population size of this mosquito as well as rain events can regulate the larger psorophorans. As with *Ps. ciliata*, rains from Hurricane Irene resulted in emergences in the Agricultural, Northwestern Rural, Philadelphia Metropolitan and the Suburban Corridor regions.

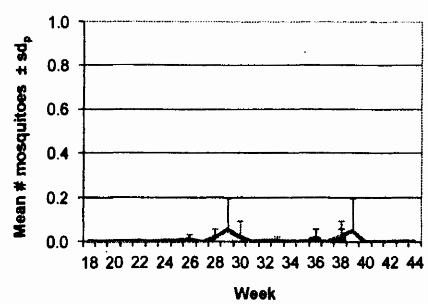
Figure 44.

Psorophora ferox – Multivoltine Aedine (*Ae. vexans* Type)

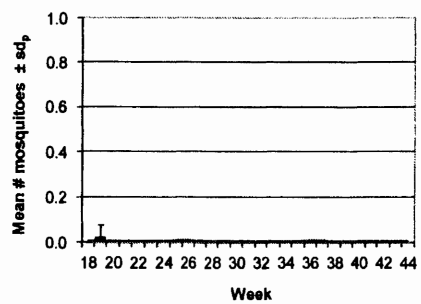
Agricultural



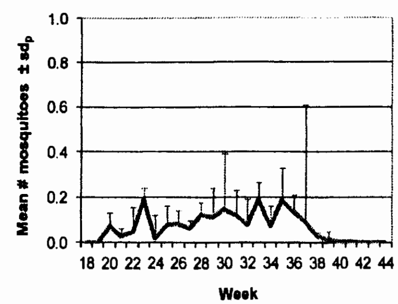
Coastal



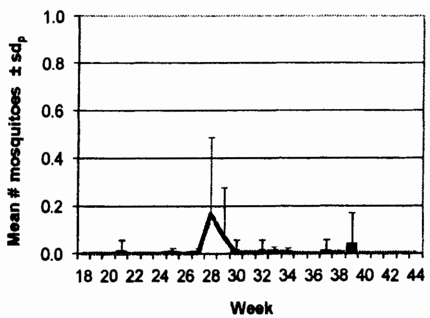
Delaware Bayshore



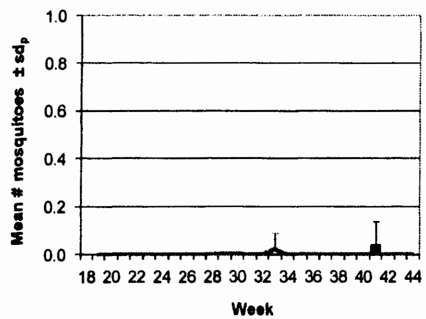
Delaware River Basin



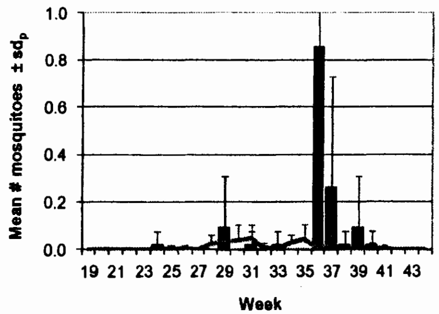
New York Metro



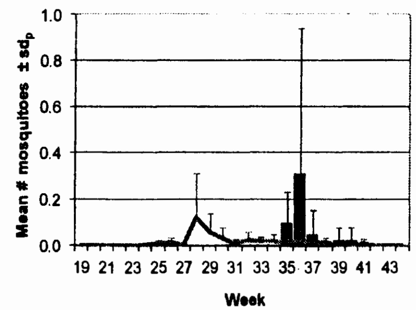
North Central Rural



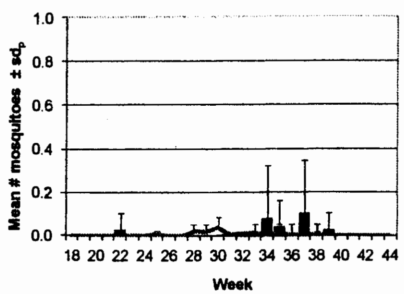
Northwestern Rural



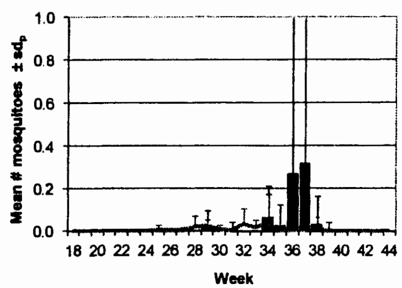
Philadelphia Metro



Pinelands



Suburban Corridor



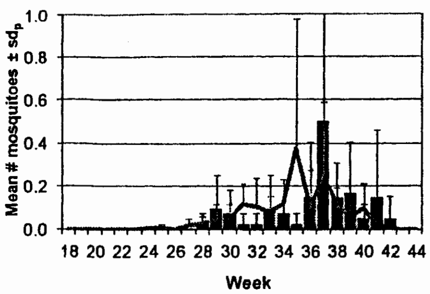
Comments

Psorophora ferox is a large floodwater mosquito that produces predatory larvae as well as a fierce bite as an adult. They can attack when disturbed at their resting site. Emergences of this species occurred after the significant rainfall from Hurricane Irene in the Agricultural, Northwestern Rural, Philadelphia Metropolitan, Pinelands and the Suburban Corridor. *Ps. ferox* was absent from the Delaware River basin after having been recorded there in relatively large numbers in previous years.

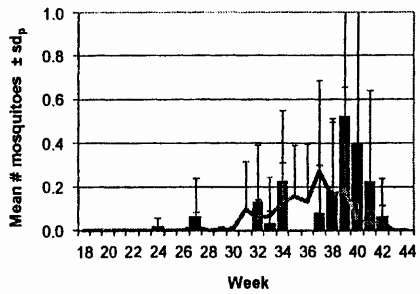
Figure 45.

Uranotaenia sapphirina – Culex/Anopheles (An. quadrimaculatus Type)

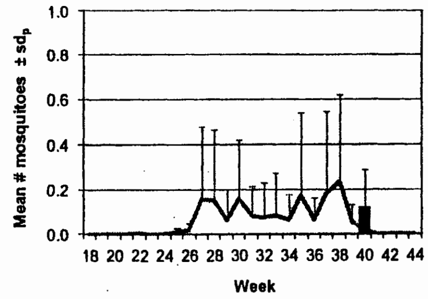
Agricultural



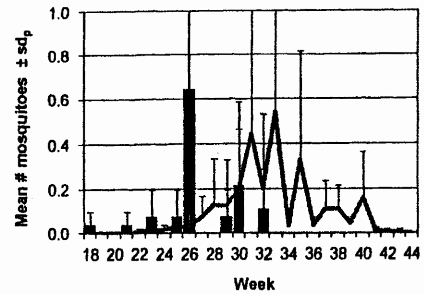
Coastal



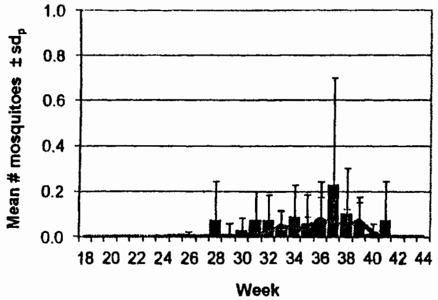
Delaware Bayshore



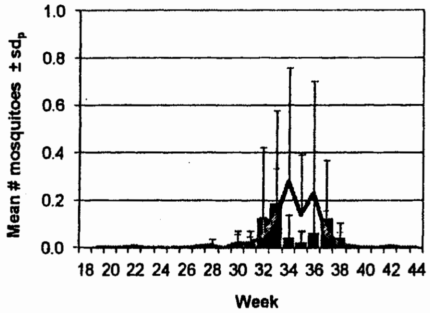
Delaware River Basin



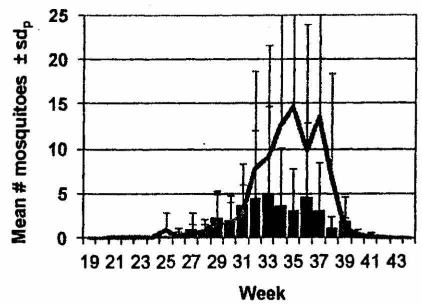
New York Metro



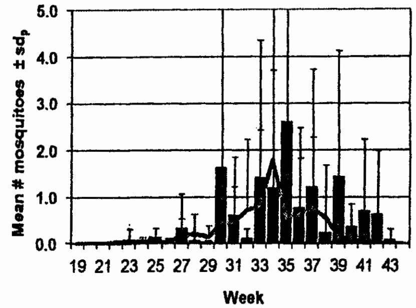
North Central Rural



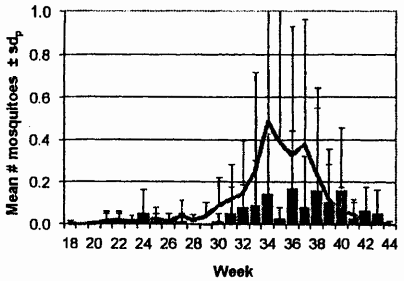
Northwestern Rural



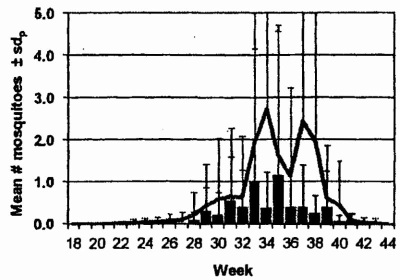
Philadelphia Metro



Pinelands



Suburban Corridor



Comments

This small mosquito is generally considered not to be a health threat, although eastern equine encephalitis and West Nile viruses have been detected in them in the US. Although it is found throughout New Jersey and is often recorded in the light traps of this program and can overwinter near anthropogenic sources, this mosquito apparently bites few humans. Typically, populations will build up then slowly decline. In 2011, populations, while present in all regions, appeared depressed in several: Delaware Bayshore, Delaware River Basin, North Central Rural, Northwestern Rural, Pineland and the Suburban Corridor. The Agricultural, Coastal and Philadelphia Metropolitan regions also appeared shifted toward a later build-up.

The 2012 season (to 30 June).

Although the mosquito season in New Jersey runs within a calendar year, funding for this program run the fiscal year of 1 July through 30 June. This section reports the results of surveillance from 1 January 2012 through 30 June, 2012. The weekly report that includes the end of the fiscal year can be seen here:
http://www.rci.rutgers.edu/~vbcenter/reports/mospop/2012week26.pdf

Aedes vexans populations were reported as well above historical trends in the Delaware Bayshore, Delaware River Basin and the North Central Rural regions. The actual averages for the North Central Rural region was considerably lower that for the two other regions but still significantly higher than historical averages. Regions such as the Coastal and New York Metropolitan reported less abundance than had been seen in the 5 previous years. Overall, *Ae. vexans* ranked 2nd in total light trap catches for the traps used in this program to the end of June 2012. This number was still less than 1/3rd the number of the first ranked species, *Culex* Mix. Of the 10 regions, *Ae. vexans* ranked 1st in only the Delaware River Basin, followed closely by *Culex* Mix.

Culex Mix abundances were higher in the Delaware Bayshore, the Northwest Rural and the New York Metropolitan regions during the last week of June 2012. Most regions reported *Culex* populations up to the end of June as approximating historical trends, although there was a slight decline in numbers for the Pinelands during June. This was the number one ranked species statewide, ranking first in all but the Delaware River Basin (*Aedes vexans*) or the Pinelands (*Culiseta melanura*).

Coquillettidia perturbans populations were significantly higher than historical averages during the final week of June 2012 in the Delaware Bayshore and North Central Rural regions. This species showed spikes of higher populations earlier in the season in the Coastal and Delaware River Basin as well as several times in the North Central Rural region.

Aedes sollicitans populations were only higher than historical trends in the Delaware River Basin – an area not generally noted for significant populations for this species. In the Coastal and Delaware Bayshore, prime *Ae. sollicitans* habitat, numbers were only at historical levels during peak emergence, but fell away during other times, clearly showing clean peaks in population change. This species has not been recorded in the North Central Rural, Northwestern Rural or Philadelphia Metropolitan regions during the past 5 years.

Culiseta melanura spiked well above historical trends in several regions (Agricultural, Coastal, Delaware Bayshore and the Philadelphia Metropolitan regions) early in the year. In the Pinelands and Northwestern Rural regions, populations reflected historical trends. There were few *Cs. melanura* in the Delaware River Basin light traps. It should be noted that the light traps in this program suggested higher *melanura* populations than did the resting box numbers in the Vector Surveillance program. Generally, the reverse pattern is observed, with more of this species caught in resting boxes. One factor that may be involved in these recent patterns is local habitat change, with some resting box habitats becoming more light-infused by canopies opening up.

By the end of the fiscal year, 44,322 mosquitoes representing 32 species had been caught in the light traps in this program.

Surveillance Data Standardization and Assurance Pilot 2010-2011

Surveillance, or population monitoring, is a critical component in any effort designed to control biological organisms. The importance of tracking mosquito numbers as part of an integrated management program has long been recognized (Metcalf & Novak 1994). Without such knowledge, control strategies may be improperly applied, reducing the efficiency of mosquito abatement efforts, wasting resources and potentially causing adverse environmental and human health outcomes.

The role of surveillance in New Jersey mosquito control efforts has been recognized for many years. As a result, the Agricultural Experiment Station developed the ground breaking standard for measuring mosquito populations, the New Jersey light trap, in the early 1930s (Headlee 1945). Mosquito control professionals in New Jersey continued to pioneer the use of consistent and standardized methods for monitoring these insects (O'Malley 1989, Reinert 1989). This has enabled mosquito control professionals to implement efficient and targeted control measures and has also allowed them to detect the arrival of new species such as *Aedes japonicas, Aedes albopictus* and *Culex tarsalis.* Establishment of a comprehensive program to monitor the presence of West Nile virus has proven invaluable in minimizing this dangerous mosquito-borne virus in the state.

Although mosquito control programs in New Jersey employ a number of methods to measure population levels of these insects, there have been no recent, comprehensive reviews to determine how consistently the various surveillance techniques are currently employed. With the advent of new mosquito species, new diseases, and increased oversight by regulators, taxpayers and politicians, a review of mosquito surveillance practices was undertaken.

<u>Design and Implementation of the survey</u>

In the initial proposal, surveillance practices of 4 mosquito control programs were to be reviewed. The goal was to see how these agencies were carrying out mosquito monitoring and then work with them on areas of potential improvement. This approach was abandoned after a short time for a number of reasons, the most notable being a sample size that was insufficient to provide a useful overview of local mosquito surveillance programs. Instead, a broad overview of mosquito sampling in 10-15 control programs was planned, with more detailed efforts deferred for future years of the project.

Gathering objective, comparative information on current mosquito surveillance activities by local abatement agencies was the priority of this project. As such, a questionnaire was developed that allowed project staff to ask consistent questions of each control program with the option to discuss additional facets that might not be covered by the survey. The questionnaire is shown in Appendix 1.

Participants were sought via the monthly mosquito control directors' meeting and by follow up contact with the control agencies. Initial progress was slow, but intensified outreach resulted in the inclusion of additional programs. Assurance was provided regarding the general nature of the project to allay concerns about targeted criticism of any individual agency. Information was gathered in an on-site meeting with the agency director or biologist, or both. At that time an overview of the facilities was also obtained by the project coordinator. Lengthy discussions with local professionals were deemed essential in eliciting detailed information that might not show up by simply answering the questionnaire. A map indicating the location of the agencies is shown in Fig. 47.

Results

A summary of the information obtained can be seen in Table 19. The 14 programs are listed in the order they were visited, with Salem, Ocean and Warren Counties being the first 3 seen in March and April of 2011, while Essex, Bergen and Passaic were the final 3, completed in November and December, 2011.

All of the mosquito control programs have one or more staffers who have completed the Rutgers mosquito identification certification short course. Personnel from one agency have not yet taken the final certification test, however.

Given the varied level of local funding, there is a correspondingly wide range of personnel involved in mosquito control and surveillance. In addition, these programs deal with a wide variety of mosquito species and human populations, resulting in subsequently different responses. As seen in Table 19, employee levels range from 4-20,(mean of 10) with inspection employees, those who conduct surveillance activities, ranging from 2-11(mean of 6).

NJ light traps, long the mainstay of consistent monitoring for local mosquito populations, range from 0-28 (mean of 12). Also noted in the table are other methods used to track mosquito numbers, such as dry ice baited traps (CDC, ABC or EVS), which ranged from 0 – 22.5/week (mean of 7/week) and gravid traps, which are used to monitor and collect specimens for West Nile virus activity. The latter ranged from 2.5-25, mean of 13.

The number of species tested for virus is shown, and ranged from 1-29, with a mean of 13.

Discussion

As seen in Table 20, there is substantial variability in the total number of employees and those who do inspection within mosquito control districts. Much of this difference is due to the budget levels set by the local government, but some is a result of generally modest mosquito nuisance or disease levels in the area. In several cases, the numbers shown represent a dramatic decrease of the past few years as budget constraints following the recession of 2008 rippled through county government.

The importance of having professionals involved in mosquito monitoring is seen in the certification levels of identification specialists. This program, pioneered at Rutgers University, reveals an ongoing commitment to ensuring there is a trained workforce involved. The course to certify mosquito identification specialists is offered routinely as needed. As a result, there is a justifiably high level of confidence in the accuracy of mosquito identification and submission for virus testing.

Light Traps

Light trap numbers differ substantially by county. Although used primarily for tracking annual trends in mosquito numbers rather than for providing rapid feedback on control efforts, the light trap is still an important tool for determining the type and relative level of mosquitoes found locally. Every agency that operates light traps has calibrated them within the last 1-2 years to ensure they are operating as specified. A network of light traps is used to gather statewide data on mosquito levels, and these results are reported in the NJ State Mosquito Surveillance program. Staffers from Rutgers University have reviewed the placement and calibration training for the traps.

Because light traps consist of just a bulb, fan and killing container, they offer unmatched consistency in gauging mosquito population levels. They are relatively easy to operate and run day after day without the need for attention. Light traps detected the presence of several invasive species in New Jersey, including *Culex tarsalis* (Crans et al. 1979), which did not become established here and *Ae. japonicus* (Peyton et al. 1999) and *Ae. albopictus* (Crans et al. 1996), which did.

Despite the above qualities, running a light trap route does require a great deal of time. Some agencies visit each trap daily to empty the collections, and even those that do so less often expend considerable resources in the gathering, sorting and identification of samples from this device. As a result, a network of 5-15 traps would probably suffice for most situations. Operating more than that is labor intensive and would be unlikely to detect more discrete population changes. Rather than having employees make frequent rounds to empty the traps, agencies might consider enlisting the assistance of the local homeowner for this purpose. An entire week of samples could then be picked up in a single trip.

Gravid Traps

The use of gravid traps became essential with the establishment of West Nile virus in the US in 1999. These devices use polluted water, usually a grass or hay infusion, to attract the common house mosquito or related species, which are then pulled into a net via a battery operated fan. There are several types of gravid traps, and these vary substantially in their ability to collect house mosquitoes (Kesavaraju et al. 2011). Because the main purpose is to collect mosquitoes for virus submission, this variance isn't critical. Other factors also lead to differing numbers, including the age and composition of the attractant water, the level of the fan intake above the water and the age and condition of the batteries and motor.

Given the non-random, or clumped distribution of WNV in a given area, running sufficient numbers of these is very important. Unless sampling is broad enough in scope, an area that has WNV present may be missed. Another factor, however, is collecting large enough numbers locally to find the virus, since the percentage of infected mosquitoes tends to be low, especially early in the summer. As a result, at least 6 traps should be run each week, and these should be rotated throughout the county to detect the pockets where WNV may be developing. A combination of several fixed sampling sites that are based on prior WNV isolations and additional random locations is more likely to pinpoint where the disease may be lurking. If the traps are operated for several nights in the same area, they should at least be moved a few hundred yards to increase the chance of finding viral hot spots. Some agencies operated rather low numbers of this device, or left them in a single, fixed location for long periods of time.

The species of mosquitoes submitted for virus testing is also important. Where WNV is the primary concern, the house mosquito (*Culex pipiens*) and related species are most important in both amplifying the disease in birds and then acting as the "bridge" vector to incidental hosts such as horses and humans (Savage et al. 2007, Jones et al. 2011) As such, testing for WNV on an operational level should focus primarily on *Culex* species. There is little evidence that other mosquito species are involved in WNV transmission and testing them wastes valuable resources (time and the expense to run the tests, for example). Many agencies appear to be testing mosquitoes that are unlikely to be a WNV threat.

Some sections of NJ are at risk for eastern equine encephalitis (EEE), and in those areas, testing of other mosquito species is critical. Resting boxes are used to collect *Culiseta* melanura, the enzootic vector of EEE, and dry ice baited traps are used to capture other mosquitoes that may transfer the disease to horses or humans. Additional species can also be sampled for Lacrosse virus or St. Louis encephalitis, but the latter disease is also best detected by testing the house mosquito alone.

Carbon Dioxide Baited Traps and Landing Rates

Traps supplemented by carbon dioxide (dry ice) are used routinely by 11 of the queried agencies. These are an excellent resource for detecting and quantifying some of the most serious nuisance mosquitoes, particularly those in the genera *Aedes* and *Psorophora*. In many cases, these are used to replace landing rate counts.

Although the traps provide very accurate and similar information to landing rate data (Slaff et al. 1983), they are also rather labor intensive, requiring time to set, retrieve and sort. In many cases, a quick landing rate assessment will provide information that is as useful as the carbon dioxide baited traps with much less labor. Numerous landing rate samples can be made over a broad geographic area, while traps are much more limited in their range.

Several agencies indicated that they used these devices due to concerns for employee safety while conducting landing rates, but employee risk can be mitigated by wearing protective clothing and conducting very brief landing rates. Landing rates should be discontinued if there is a localized risk of disease transmission, however.

Given the ascent of the Asian Tiger mosquito, the use of landing rates provides an accurate and rapid tool for determining the presence and relative population levels of this important pest. There are several baited traps that offer excellent and consistent data on their population levels, but with the widespread nature of the species, sampling sufficient areas with traps is often improbable. Landing rates offer an excellent means for keeping track of *Ae. albopictus*.

Larval Surveillance

Monitoring mosquito larvae is critical because this life stage is often the most logical target for control efforts. They are usually found in well-defined habitats that do not change much over time, and reducing larval numbers effectively stops the mosquito life cycle before they threaten with annoyance or disease. In addition, they are best sampled using the very simple dipper. An excellent resource regarding the proper sampling of mosquito larvae can be found in O'Malley (1989).

Although relatively simple, carrying out surveys for mosquito larvae can be time consuming and challenging. Developing maps of important larval habitats can take years, although the recent advent of GIS systems can speed the process. There are, however, 2 agencies that rely on the experience of employees to properly locate and sample larval habitat. While adequate with seasoned personnel involved, they are vulnerable in the face of employee turnover. At least 2 other mosquito control programs can offer assistance in quickly establishing a larval mapping system, and their advice should be sought to extend that knowledge to the agencies in need.

Monitoring and controlling the larval stage of container mosquitoes is more challenging due to the widespread, cryptic nature of this source. Sources are often randomly dispersed and hidden on numerous properties, making them difficult to discover. Although challenging, finding and eliminating as many of these as possible can be productive. One agency reviewed has assigned an employee to scour neighborhoods searching for and removing this type of habitat. As noted, this is an extremely time consuming activity, and results of such work are often only temporary. The use of service requests and landing rates are important in identifying and controlling sites that produce *Ae. albopictus*.

<u>Other Observations of Interest</u>

There were numerous details observed beyond the information contained in the questionnaires. Here are a few that are notable:

An agency that has excellent laboratory protocols for processing samples to be tested for WNV. Any equipment is sterilized in alcohol between every sample, the chill table and other surfaces are wiped down between samples, and everything to be re-used is sterilized in an autoclave. All programs should learn and follow their practices.

A few agencies have implemented an Access database for managing information, but one in particular has a template that could be helpful to other control programs.

Several districts routinely print out tables and graphs of population trends, which are then hung up in the laboratory area for ready access. Employees can quickly review current and past trends of mosquito numbers and disease risk. This is a practice that should be more widespread.

At least 3 districts suggested the practice of superpooling (Sutherland & Nasci 2007) to better monitor WNV activity, particularly early in the summer. This makes use of drawing a subsample from numerous "slurried" mosquito pools, so several hundred mosquitoes can be tested in a single PCR run. If they come back positive, the subsamples can be tested individually if desired. Superpooling greatly increases the chances of finding virus activity by processing many more specimens.

Many of the control programs are not regularly represented at the mosquito control directors' meetings (the Associated Executives of Mosquito Control Work in New Jersey). This results in reduced communication between mosquito control professionals. With many creative minds employed in this field, routine interaction and discussion is imperative. The rapid incorporation of new ideas and improved operations would be possible if personnel learn more about the practices of their colleagues.

As more mosquito control programs are placed under the direction of other programs (Public Works, Health, Parks, etc.), there has been a reduction in top management understanding the process and importance of surveillance in the abatement structure. The critical nature of tracking mosquito numbers is not always clear to these managers, and interaction between them and the staff who collect such information is often inadequate. As a result, there is a reduction in the efficiency of their mosquito surveillance and control strategies.

Future Plans

A review of at least 4 additional mosquito control programs would be helpful. If possible, all 21 counties would be interviewed, providing more comprehensive information on mosquito surveillance operations throughout New Jersey.

Frequent interaction with a few agencies would be undertaken during 2012-13. These would be programs with the greatest need, where routine discussions and visits are likely to be helpful. In addition, fostering better communication between all mosquito control districts will be accomplished by holding at least 2 day long surveillance sessions.

Acknowledgements

We gratefully thank the following mosquito control programs for their participation, listed in the order they were interviewed: Salem, Ocean, Warren, Mercer, Hunterdon, Atlantic, Cumberland, Burlington, Camden, Gloucester, Hudson, Essex, Bergen and Passaic. The guidance and assistance of Robert B. Kent are of special note, and we thank him for his patience in seeing this project through.

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Project Directors: Marc Slaff, Ph.D. Coordinator Lisa Reed, Ph.D., Co-Principal Investigator Mark Robson, Ph.D. Principal Investigator.

Appendix 1- Questionnaire for Surveillance Data Standardization and Assurance Pilot

SURVEILLANCE PILOT PROJECT, 2010-2011

AGENCY INFORMATION

COUNTY-

NAME OF PROGRAM-

DIRECTOR-

ORGANIZATIONAL PLACEMENT
(Division, Department, Commission, etc., governing agency you report to)-

EMPLOYEES- Number, job titles, etc. Organization chart if available.

BUDGET- Operating, capital-

MOSQUITO SURVEILLANCE, LIGHT TRAPS:

1. Certified identification specialist? Y__ N__
2. Number of light traps? ____
3. Number of traps in State Surveillance network? ____
4. Light traps calibrated? Y __ N__, year if yes? ____
5. Frequency of light trap pickup and sample processing?
6. Most important species in county (top 5-10):
7. Usefulness/Use of NJLT data (pre- and post- control measurements, historical record, habitat location, etc.):
8. Data tabulation/record keeping method/analysis (if any):
9. Lab facilities (describe):

MOSQUITO SURVEILLANCE, LARVAL:

1. Number of field inspectors, full time/seasonal? _____/_____

2. Location, general description and size of major habitats?

MOSQUITO SURVEILLANCE, LARVAL: (Continued)

3. Routine or occasional identification of larvae?

4. Use of larval samples in monitoring effectiveness of control efforts (pre- and post-sampling, etc.):

5. Data tabulation/record keeping/analysis of larval data?

MOSQUITO SURVEILLANCE, DISEASE:

1. Mosquito-borne diseases in your county (WNV, EEE, other)/ # human cases in past 3 years? _____

2. Sampling methods used to monitor (gravid traps, ABC+CO2, CDC+CO2, landing rates, resting boxes, etc.):

3. Avg. # weekly collections by above methods (e.g., 4 GT/wk., 2 ABC+CO2/wk., etc.)

4. Procedure for processing collections for testing (returned to lab in cooler, refrigerated or frozen, identified on chill table, stored in REVCO, etc.).

5. Species submitted for testing?

6. Use of results in intervention (e.g., intensify larval surveys, press releases, additional surveillance, adulticiding, etc.):

MOSQUITO SURVEILLANCE, OTHER:

1. Importance of service requests, response?

2. Use of landing/bite counts? Training of staff for standardization? Action threshold?

3. Other surveillance tools? GIS, spreadsheets, statistical analysis (total collections, means, graphs, etc.)?

ADDITIONAL NOTES (use other side if needed):

Figure 47. Counties that participated (in dark gray) in the mosquito surveillance pilot project

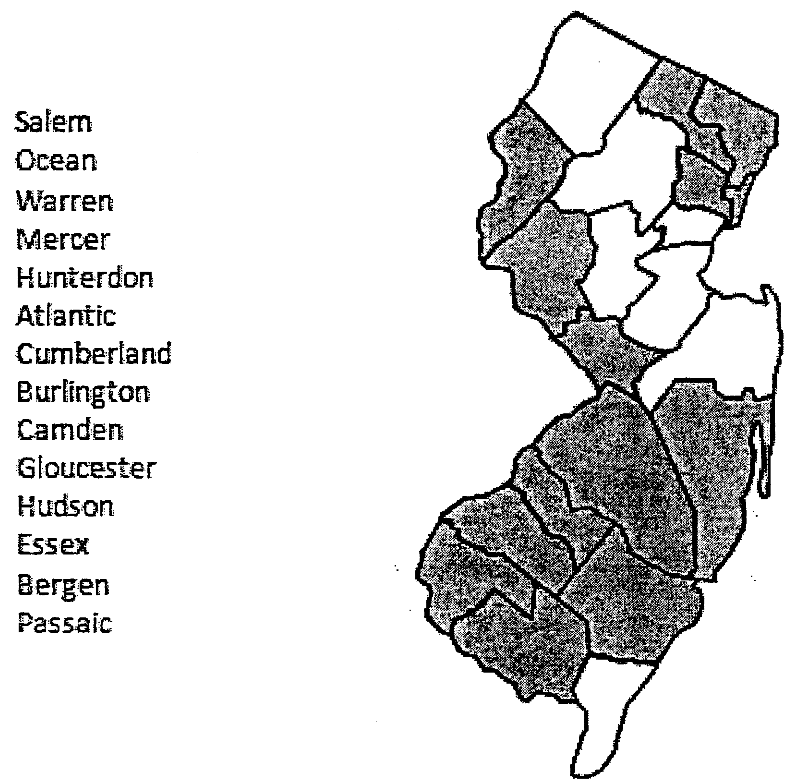

Table 20 - Summary of County Mosquito Surveillance Information

County	Employees	Inspection	# Certified	Light Traps	Gravid	Dry Ice	Resting Box	Sp. Tested
Salem	9	7	2	19	2.5	2.5		19
Ocean	15	5	3	28	6	6	50	22
Warren	7	4	3	7	9	9		16
Hunterdon	4	2	2	6	45	22.5		1
Atlantic	12	9	2	19	4	4	25	20
Cumberland	6	3	2	15	4	4	10	22
Burlington	11	10	1	14	10	7		29
Mercer	10	7	2	13	20	12		10
Camden	5	4	1	8	10	0		9
Gloucester	7	5	1	6	14	4	150+	10
Hudson	5	4	2	10	15	0		1
Essex	14	7	3	12	12	6		11
Bergen	20	11	2	5	20	3		6
Passaic	14	6	0	0	8	0		9
AVG.	**10**	**6**	**2**	**12**	**13**	**6**		**13**
MIN.	**4**	**2**	**0**	**0**	**2.5**	**0**		**1**
MAX.	**20**	**11**	**3**	**28**	**45**	**22.5**		**29**

FINANCIAL STATEMENT
NJ STATE MOSQUITO CONTROL COMMISSION
END-OF-YEAR
(FY 2011-12)

FY '12 STATE MOSQUITO CONTROL, RESEARCH,	**$,1,346,000.00**
ADMINISTRATION AND OPERATIONS APPROPRIATION	
Office of Mosquito Control Coordination	($292,351.32)
Carry-forward	$33,328.22
STATE MOSQUITO CONTROL COMMISSION	**$1,086,976.90**

PROGRAMS/SERVICES	**ALLOCATED**	**EXPENDED**	**BALANCE**
Administration	$ 3,000.00	$ 2,316.30	$ 683.70
Toll Free Number ($186.52) AMCA Sustain. Memb. ($500.00) Legal Ads ($160.08)1 NJMCA Proceedings ($120.00) Coffee and Danish- ($77.01)2 D.A.G. Charges 2 Qtr. ($783.20) Travel-J. Sarnas- ($332.32)3 Travel- H. Emerson- ($157.17)4			
State Airspray Program	$ 542,457.983	$ 542,457.98	$ 0.00
Insecticides ($45,096.48) Insecticides ($15,032.16) Insecticides ($30,064.32) Insecticides ($4,128.00) Insecticides ($7,340.85) Aircraft ($350,000.00)			

Drum truck ($233.85)
Insecticides ($8,823.60)
Insecticides ($37,580.40)
Insecticides ($17,094.00)
Insecticides (30,064.32)

Equipment Repairs/ Purchases	$ 69,309.92	$ 69,309.92	$ 0.00

Rot. Ex. repair – Ocean ($ 4,000.00)
Trailer rplcmnt. – Ocean ($ 1,199.00)
Freezer transfer - RU/Ocean ($740.06)
Vehicle rplcmnt. - State ($20,513.00)
Rot. Ex. rep. - Atlantic ($20,000.00)
Hyd. Ex. rep.- Morris Co.($18,000.00)
Resting Boxes-($710.00)
Transport Tubs-copepods ($4,147.86)

Education and Information	$ 200.00	$ 200.00	$ 0.00

NJMCA Exhibitor fee- ($200.00)

Memoranda-of-Agreement			
DH/SS PHEL	$ 180,000.00	$ 180,000.00	$ 0.00
Cape May Laboratory	$ 61,000.00	$ 61,000.00	$ 0.00
Bio-Control, Fish	$ 25,000.00	$ 25,000.00	$ 0.00
Bio-Control, Copepods	$ 35,000.00	$ 35,000.00	$ 0.00
Courier, North	$ 8,000.00	$ 8.000.00	$ 0.00
Courier, South	$ 9,500.00	$ 9,500.00	$ 0.00
Professional Services			
Vector Surveillance	$ 49,001.00	$ 49,001.00	$ 0.00
Statewide Surveillance	$ 37,000.00	$ 37,000.00	$ 0.00
QA/QC Surveillance	$ 0.00	$ 0.00	$ 0.00
Efficacy of Insecticides	$ 67,508.00	$ 67,508.00	$ 0.00
TOTAL	**$ 1,086,976.90**	**$ 1,086,293.20**	**$ 683.70**

COMMISSION-SUPPORTED PUBLICATIONS AND PRESENTATIONS

JULY 1, 2011 – JUNE 30, 2012

Presentations

Johnson, B., K. Munafo, N. Tsipoura, M. Robson, J. Ehrenfeld, M. Sukhdeo, 2012. New Jersey Mosquito Control Association, Atlantic City, New Jersey. : "The Rules of Mosquito and Bird Communities on the Prevalence of West Nile Virus in Urban Wetlands and Residential Habitants."

Kent, R. 2011. Northern Mosquito Control Association, Plymouth, Massachusetts: *"Copepods: A Not-So-New-Bio-Control Agent for New Jersey.*

Kent, R. 2012. New Jersey mosquito Control Associations, Atlantic City, New Jersey: *"The New Jersey State Mosquito Commission and the N.J. office of Mosquito Control Coordination, 2011 Report."*

Reed, L. 2011. Northeastern Mosquito Control Association, Plymouth, Massachusetts: *Vector and Mosquito Population Surveillance in New Jersey, 2011.*

Reed, L. 2012. New Jersey Mosquito Control Association, Atlantic City, New Jersey: *Vector and Mosquito Population Surveillance in New Jersey, 2011.*

Slaff, M., R. Kent, L. Reed, M. Robinson. 2012 New Jersey Mosquito Control Association, Atlantic City, NJ: "An Overview of Mosquito Surveillance Practices in New Jersey.

Publications

Reed, L. NJMCA proceedings: New Jersey Vector Surveillance Program, 2012 (*in print*)