Suffolk County Vector Control & Wetlands Management Long Term Plan & Environmental Impact Statement

TASK 12: EARLY ACTION PROJECTS CAGED FISH EXPERIMENT

WATER SAMPLING REPORT

Submitted to:

Suffolk County Department of Public Works
Suffolk County Department of Health Services
Suffolk County, New York

Submitted by:

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SUFFOLK COUNTY VECTOR CONTROL AND WETLANDS MANAGEMENT LONG - TERM PLAN AND ENVIRONMENTAL IMPACT STATEMENT

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This report was prepared by the United States Geological Survey (USGS), and was reviewed and edited by Cashin Associates, P.C. (CA).

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LIST OF ABBREVIATIONS AND ACRONYMS

CA	Cashin Associates, P.C.
EWI	Equal Width Incremental
PBO	Piperonyl Butoxide
QA/QC	Quality Assurance and Quality Control
SCDHS	Suffolk County Department of Health Services
SCVC	Suffolk County Vector Control
USGS	Unites States Geological Survey
WNV	West Nile Virus
WNWR	Wertheim National Wildlife Refuge

ABSTRACT

A three year sampling program conducted by the United States Geological Survey (USGS) in Suffolk County, NY, gives evidence that insecticides (particularly methoprene and resmethrin) decrease in concentration over time, once applied to surface waters. A total of 73 samples were analyzed for six pesticides - methoprene, methoprene acid, resmethrin, sumithrin, malathion, and piperonyl butoxide (PBO). The synergist, PBO, was most frequently detected, with a median concentration of 61 ng/L. Methoprene had the highest median concentration (216 ng/L) and resmethrin had the lowest median concentration (29 ng/L). The difference in concentrations observed could be the result of differential transport on land or in the air, tidal fluctuations, or the differential preservation of the synergist PBO and pyrethroid (resmethrin) in surface waters. Sumithrin and malathion were not applied and never detected in the samples.

INTRODUCTION

The West Nile Virus (WNV) has emerged as a public health threat throughout Long Island. The principal vector is mosquitoes that breed throughout Long Island (Figure 1). The WNV causes infections in humans and animals. Possible symptoms include fever, headache, body aches, skin rash, and swollen lymph glands. In some cases (< 1%) people may develop meningitis or encephalitis. WNV is primarily transmitted to humans through mosquito bites.

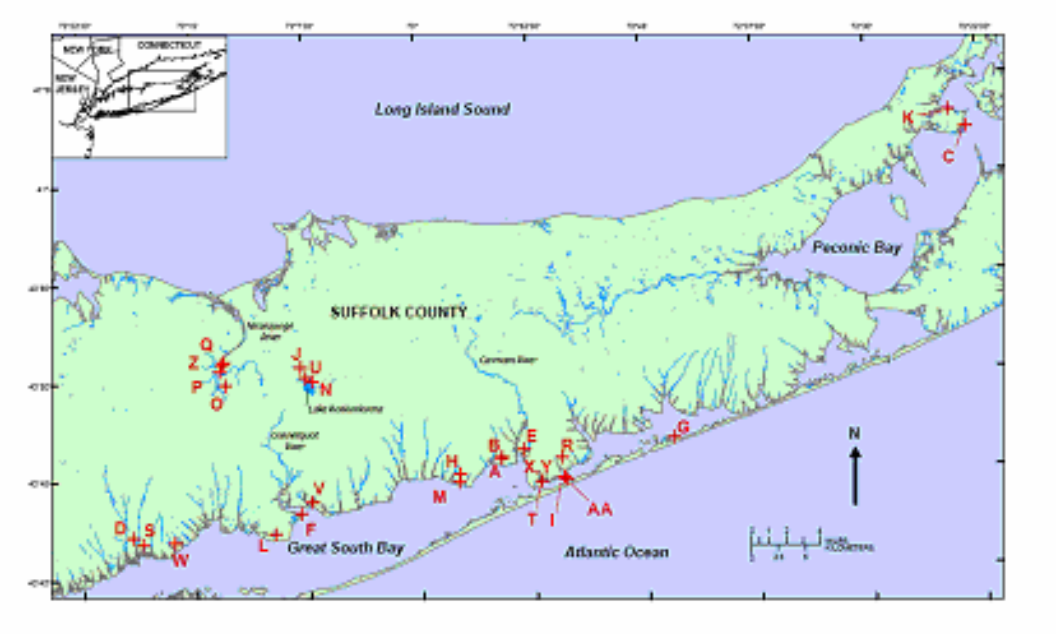


Figure 1. Locations of sampling sites in Suffolk County, N.Y., 2002-04.

WNV was first detected in mosquitoes within Suffolk County in 2000 by the Suffolk County Department of Health Services (SCDHS). In response of the public health concern the USGS, in cooperation with the SCDHS, began a 3-year study in 2002 to sample surface waters from selected area wetlands for insecticides that were sprayed seasonally by truck or by helicopter as part of a Suffolk County Vector Control (SCVC) program. The surface-water-monitoring study was conducted as part of a larger USGS study to develop analytical methods for detection of synthetic organic compounds at extremely low concentrations (as low as 5 nanograms per liter) in environmental waters. The 3-year sampling program was designed to provide data for

- an environmental-risk assessment (conducted by Suffolk County) of the insecticides used to control mosquito populations suspected to carry the WNV, and
- to aid in the development of spray-management guidelines to ensure that harmful amounts of these compounds do not reach unintended waters.

The following is a report on the samples collected between the summers of 2002 – 2004. An analysis and some explanation of the data are presented in tables and graphs.

APPROACH AND METHODS

Water samples were collected in June, July, and August of 2002, 2003, and 2004. Sample collection in the late spring and early summer followed the application of the larvicide methoprene (an insect-growth regulator) for treatment of the waterborne mosquito larvae. Sample collection during the middle and late summer followed applications of spray, mainly Scourge™, which targeted adult mosquitoes and contains the pyrethroid resmethrin and the synergist PBO. Sumithrin and malathion were not applied for the control of mosquitoes during the 2002-04 sampling season.

Sampling localities were chosen through a review of Suffolk County insecticide-application plans and public announcements of local spraying events released by SCVC. Final site selection was based on a USGS reconnaissance of potential sampling locations, and sampling was conducted without informing the SCVC to ensure unbiased insecticide applications, except in the field season of 2004, when the USGS and SCVC were interested in collaborating with local universities (SUNY Stony Brook and Southampton College) to compare results.

Samples were collected by techniques described in the USGS National Field Manual for the Collection of Water-Quality Data (1997-2004). Some sites were sampled more than once after spraying to measure the changes in the insecticide concentration over time (Table 1) and whether storm runoff or tidal flooding and the subsequent drainage could transport insecticides to unintended waters.

Physical properties of the water sampled (temperature, specific conductance, pH, and dissolved oxygen concentration) were measured, and 2- to 4-liter samples were collected at each site. Samples were collected at the water surface, where the sprayed insecticide is first deposited, and additional samples were collected at a 6-inch depth ("point" samples) at some sites to provide data for related studies. Some stream-water samples were collected through an equal-width-incremental (EWI) method, which obtains a representative sample for the entire cross section of a stream, where conditions were appropriate.

Most of the sampling sites were shallow; therefore, surface ("grab") samples were collected at nearly every location. Grab samples are the easiest to obtain and also minimize the potential for sample contamination because the sampler does not descend far or disturb the natural stratification of the water column.

The first sample collection occurred during the summer of 2002 at 13 sites. All samples were "grab" samples and were collected within 60 minutes (except Sites L and V) after a spray application. The 2003 season included sample collection at 14 sites, generally once before a spray application, and once within six hours thereafter. The 2004 sampling was done at two locations during August and included collection of additional samples at four specified time intervals after the spray application. Samples were collected at the surface and at a depth of 6 inches below the surface in an effort to plot the decrease in insecticide concentration over the next 5 days. As the study developed, the sample intervals were varied to investigate the fate and transport of the applied insecticide concentration.

All water samples were collected in dark-glass bottles and filtered into 1-liter dark-glass bottles to prevent the breakdown of the insecticides through photochemical degradation. All samples were filtered within 3 hours of collection through a baked glass filter with a 0.7-micrometer pore diameter. Samples were placed on ice and shipped overnight to the USGS organic compound research laboratory in Lawrence, Kansas. Each sample was analyzed for six insecticides—malathion, methoprene, methoprene acid (except in 2004), PBO, resmethrin, and sumithrin. Each of the six insecticides is typically used in the control of mosquitoes and is applied at different times of the year. The laboratory tests for all six as a standard analyzing technique, even though only one major insecticide is applied per spray event. Malathion is an adulticide used domestically and commercially to control insects. Methoprene is an insect growth regulator while resmethrin and sumithrin are pyrethroids. Pyrethroids are extracts from pyrethrum (Chrysanthemum) flowers that are used as an insecticide. Methoprene acid is a by-product of methoprene and is not applied directly as a pesticide. PBO, a synergist, is often found in some combination with resmethrin or sumithrin. Laboratory analyses were conducted as described in Zimmerman and others (2001).

Samples were collected at each field site before an insecticide application as a basis for comparison with post-application samples. Field blank samples consisting of deionized water were collected in 2003 and 2004 for quality-assurance and quality-control (QA/QC) purposes. Field-blank sample preparation consisted of pouring the deionized water into dark-brown glass bottles (same as the sample bottles) at the field site 30 minutes after insecticide application. The pre-application and field-blank samples were prepared for laboratory analysis in the same manner as the post-application samples collected (filtered, iced, and shipped).

A list of the laboratory and field results from the 2002-2004 study is given in table 1. These data are also available in the USGS annual reports (U.S. Geological Survey, 2002, 2003, and 2004). A statistical summary of the detected pesticides is presented as box plot in figure 3. Analytical results from sequential replicate samples in 2003 and further analysis of these insecticides are given in Zulkosky and others (written commun., 2005).

Pesticide Concentrations Before and After the Spray Applications

Analyses of the 73 samples collected at all 27 sites are described below. The most frequent detections of the applied insecticides at each site were in samples collected within 1 hour after the application (Table 1). None of the six compounds were detected in any of the pre-application or field blank samples. The following goes into detail of a few study areas of interest for each sample year.

2002 Sampling in the Lake Ronkonkoma area – Resmethrin

All samples collected in 2002 were grab samples (interface/surface) obtained after an insecticide application. Detection of the applied insecticide occurred in those samples collected at Sites J, U, and N (Figure 1) within the hour after application (Table 1).

The application and effectiveness of Scourge^{TM} (resmethrin and PBO mixture) in Nesconset, north of Lake Ronkonkoma, was of particular interest during the summer of 2002 because the

WNV was detected in both birds and mosquitoes. Three sites were chosen to monitor the applied strength of the insecticide and to monitor whether or not it was reaching unintended water, i.e. Lake Ronkonkoma. A sample was collected at each site 30 minutes after the spray event. Both resmethrin and PBO were detected at two sites (J and U, Figure 1), while the third site (Site N) did not detect any analytes at the minimum detection limit. SCVC reported the spray event to be effective in reducing the number of potentially infected mosquitoes by 85% (oral commun., 2004).

A. Site location, sample-collection data, tide conditions, and pesticide-application data.

Site code	Station name	Latitiude	Longitude	Sample-collection date	Sample-collection time	Tide or current	Type of sample	Spray time or duration	Spray method	Pesticide used
A	Beaver Dam Creek at Fireplace Neck	40º 45' 51	072º 55' 07	06/03/03	1230	flowing in	Grab	1245	helicopter	Methoprene
					1250	flowing in	Grab			
B	Beaver Dam Cr near Fireplace Neck	40º 45' 56	072º 55' 06	08/20/03	1855	flowing in	Grab	1900 - 2300	helicopter	Resmithrin
					2315	flowing out	Grab			
C	Cedar Beach Creek at Bayview	41º 02' 13	072º 23' 41	08/27/03	1850	flowing in	Grab	1830	helicopter	Resmithrin
D	Carl's Creek at Park Avenue at Babylon	40° 42' 07	073° 19' 42	08/26/02	2015	flowing out	Grab	1900 - 2300	helicopter	Resmithrin
E	Carmans River at Brookhaven	40° 46' 18	072° 53' 37	06/18/02	1400	flowing in	Grab	1330 - 1355	helicopter	Methoprene
				06/17/03	1336	flowing in	Grab	1440 - 1450	helicopter	Methoprene
					1515	flowing in	Grab			
					1600	high tide	Grab			
					1718	flowing out	Grab			
				07/29/03	1840	n/r	Grab	1235 - 1300	helicopter	Methoprene
F	Connetquot River at mouth at Great River	40º 43' 14	073º 08' 29	06/10/03	0850	n/r	Grab	0845	helicopter	Methoprene
				06/24/03	0730	n/r	Grab	0740 - 0745	helicopter	Methoprene
					0750	n/r	Grab			
				08/03/04	0735	flowing in	Grab	0645 - 0655 (8/3)	helicopter	Methoprene
					0736	flowing in	Point			
					0850	flowing in	Point			
				08/04/04	0645	flowing out	Point			
				08/05/04	0645	flowing out	Point			
				08/07/04	0645	slack	Point			
G	Dune Road near Shinnecock E. County Park	40° 46' 43	072° 43' 36	07/16/02	0700	flowing in	Grab	0635 - 0654	helicopter	Methoprene
H	Dunton Lake at Bellport	40º 45' 07	072º 57' 55	07/15/03	1915	nontidal	Grab	1900 - 2300	truck	Resmithrin
					2300	nontidal	Grab			
I	End of Cranberry Lane at Mastic	40° 44' 45	072° 50' 51	07/31/02	2100	n/r	Grab	2000	truck	Resmithrin
J	Gibbs Pond at Nesconset	40° 50' 41	073° 08' 23	08/19/02	2045	slack	Grab	2000 - 2300	helicopter	Resmithrin

K	Goose Creek at Bayview	41º 03' 05	072º 24' 50	08/27/03	1610	flowing out	Grab	2007	helicopter	Resmithrin
					2025	flowing in	Grab			
L	Heckscher State Park at East Islip	40° 42' 15	073° 10' 14	07/24/02	0930	flowing out	Grab	1130 - 1145 (7/23)	helicopter	Resmithrin
M	Hedges Creek at mouth at Bellport	40º 44' 40	072º 57' 59	07/15/03	1825	flowing out	EWI	1900 - 2300	truck	Resmithrin
				07/16/03	0600	flowing in	EWI			
N	Lk Ronkonkoma County Park by Portion Rd	40° 49' 59	073° 07' 38	08/16/02	2157	slack	Grab	2000 - 2300	truck	Resmithrin
				08/19/02	2030	slack	Grab	2000 - 2300	helicopter	Resmithrin
O	New Mill Pond near Hauppauge	40º 49' 51	073º 13' 23	08/26/03	2020	nontidal	Grab	2010	helicopter	Resmithrin
P	New Mill Pond near Smithtown	40º 50' 30	073º 13' 43	08/26/03	2025	slack	Grab	2015	helicopter	Resmithrin
Q	Nissequoge River near Smithtown	40º 50' 58	073º 13' 29	08/26/03	1816	nontidal	EWI	2020	helicopter	Resmithrin
					2030	nontidal	EWI			
R	Pattersquash Creek at Mastic Beach	40° 45' 49	072° 51' 06	09/10/02	2200	nontidal	Grab	1900 - 2300	truck	Resmithrin
				06/25/03	1920	nontidal	Grab	1900 - 2300	truck	Resmithrin
					2205	nontidal	Grab			
				08/18/04	2200	nontidal	Grab	1935 -1945	helicopter	Resmithrin
S	Sampawam's Creek S. of Hawley's Pond	40° 41' 48	073° 19' 04	08/26/02	2030	flowing out	Grab	1900 - 2300	helicopter	Resmithrin
T	Shirley Boat Basin at Shirley	40º 44' 38	072º 52' 28	06/10/03	1630	n/r	Grab	1605 - 1620	helicopter	Methoprene
U	Spectacle Pond at Nesconset	40° 50' 09	073° 08' 04	08/19/02	2050	slack	Grab	2000 - 2300	helicopter	Resmithrin
V	Thorn Lane at Oakdale	40° 43' 49	073° 07' 45	07/02/02	1312	flowing in	Grab	0900	helicopter	Methoprene
W	Trues Creek S. on Pine Lake at W. Islip	40° 41' 52	073° 16' 56	08/26/02	2235	flowing out	Grab	1900 - 2300	helicopter	Resmithrin
X	Unchachoque Creek at Shirley	40° 44' 55	072° 52' 05	08/25/04	1940	flowing out	Grab	1900 - 1910	helicopter	Resmithrin
Y	Unchachoque Creek ditch at Shirley	40° 44' 55	072° 52' 04	08/03/04	1115	flowing in	Grab	1210 - 1220 (8/3)	helicopter	Methoprene
					1116	flowing in	Point			
					1250	slack	Grab			
					1251	slack	Point			
					1425	flowing out	Point			
				08/04/04	1215	slack	Point			
				08/05/04	1215	flowing out	Point			
				08/07/04	1215	flowing in	Point			

				08/18/04	1630	flowing in	Grab	1935 - 1945 (8/18)	helicopter	Resmithrin
					1631	flowing in	Point			
					2000	flowing in	Grab			
					2001	flowing in	Point			
					2130	flowing in	Point			
				08/19/04	0430	flowing out	Point			
				08/20/04	2015	flowing out	Point			
				08/22/04	2015	flowing out	Point			
				08/25/04	1745	slack	Grab	1900 -1910 (8/25)	helicopter	Resmithrin
					1746	slack	Point			
					1940	flowing out	Grab			
					1941	flowing out	Point			
					2110	flowing out	Point			
				08/26/04	0430	flowing out	Point			
				08/27/04	1940	flowing out	Point			
				08/29/04	1940	slack	Point			
Z	Vail Pond at Smithtown	40º 50' 54	073º 13' 38	08/26/03	2030	nontidal	Grab	2020	helicopter	Resmithrin
AA	Violet Rd. near Cranberry Dr. at Moriches Bay	40° 44' 51	072° 50' 58	09/10/02	2030	n/r	Grab	1900 - 2300	truck	Resmithrin

B. Field water-quality data and lab concentrations of pesticides in samples

Site code	Station name	Water temp. °C	Specific conductance (µS/cm)	pH	Dissolved oxygen con-centration (mg/L)	Concentration in 0.7-µm glass filtered (replicates are in parentheses)					
						Malathion	Methoprene	Methoprene acid	Piperol butoxide (PBO)	Resmethrin	Sumithrin
A	Beaver Dam Creek at Fireplace Neck	19.9	19580	6.4	12.2	< 5 ng/L	< 5 ng/L	< 20 ng/L	< 5 ng/L	< 5 ng/L	< 5 ng/L
		--	--	--	--	< 5 ng/L	< 5 ng/L	< 20 ng/L	< 5 ng/L	< 5 ng/L	< 5 ng/L
B	Beaver Dam Creek near Fireplace Neck	27.1	1886	8.0	13.3	n/r	n/r	n/r	n/r	n/r	n/r
		24.8	1115	7.9	14.4	< 5 ng/L	< 5 ng/L	< 20 ng/L	506 ng/L	< 5 ng/L	< 5 ng/L
C	Cedar Beach Creek at Bayview	27.5	42320	6.7	6.5	< 5 ng/L	< 5 ng/L	< 20 ng/L	40 ng/L	< 5 ng/L	< 5 ng/L
D	Carl's Creek at Park Avenue	22.7	178	6.3	6.6	< 5 ng/L	< 5 ng/L	< 0.015 µg/L	41 ng/L	18 ng/L	< 5 ng/L

	at Babylon										
E	Carmans River at Brookhaven	24.1	1050	7.1	0.3	< 5 ng/L	631 ng/L	1.71 µg/L	< 5 ng/L	< 5 ng/L	< 5 ng/L
		23.5	10680	7.0	8.8	< 5 ng/L	< 5 ng/L	< 20 ng/L	< 5 ng/L	< 5 ng/L	< 5 ng/L
		24.9	10930	6.9	9.3	< 5 ng/L	9030 ng/L	< 20 ng/L	< 5 ng/L	< 5 ng/L	< 5 ng/L
		25.0	10300	7.0	8.9	< 5 ng/L	39 ng/L	n/a	< 5 ng/L	< 5 ng/L	< 5 ng/L
		23.6	98300	6.7	8.0	< 5 ng/L	846 ng/L	< 20 ng/L	< 5 ng/L	< 5 ng/L	< 5 ng/L
		--	--	--	--	< 5 ng/L	< 5 ng/L	< 20 ng/L	< 5 ng/L	< 5 ng/L	< 5 ng/L
F	Connetquot River at mouth at Great River	17.9	26180	6.9	6.4	< 5 ng/L	< 5 ng/L	< 20 ng/L	< 5 ng/L	< 5 ng/L	< 5 ng/L
		21.6	30060	7.8	8.7	< 5 ng/L	< 5 ng/L	< 20 ng/L	< 5 ng/L	< 5 ng/L	< 5 ng/L
		--	--	--	--	< 5 ng/L	< 5 ng/L	< 20 ng/L	< 5 ng/L	< 5 ng/L	< 5 ng/L
		25.0	3820	6.7	2.3	< 5 ng/L	216 ng/L	n/a	< 5 ng/L	< 5 ng/L	< 5 ng/L
		25.0	3820	6.7	2.3	< 5 ng/L	82 ng/L	n/a	< 5 ng/L	< 5 ng/L	< 5 ng/L
		26.1	3837	7.4	6.7	< 5 ng/L	< 5 ng/L	n/a	< 5 ng/L	< 5 ng/L	< 5 ng/L
		24.5	39560	6.6	2.6	< 5 ng/L	< 5 ng/L	n/a	< 5 ng/L	< 5 ng/L	< 5 ng/L
		23.8	38600	6.5	1.5	< 5 ng/L	< 5 ng/L	n/a	< 5 ng/L	< 5 ng/L	< 5 ng/L
		19.2	38820	6.5	3.1	< 5 ng/L	< 5 ng/L	n/a	< 5 ng/L	< 5 ng/L	< 5 ng/L
G	Dune Road nr Shinnecock E. County Park	19.0	1260	6.2	--	< 0.20 µg/L	< 0.20 µg/L	< 0.015 µg/L	< 0.20 µg/L	< 0.20 µg/L	< 0.20 µg/L
H	Dunton Lake at Bellport	24.3	216	6.7	11.4	< 5 ng/L	< 5 ng/L	< 20 ng/L	< 5 ng/L	< 5 ng/L	< 5 ng/L
		--	--	--	--	< 5 ng/L	< 5 ng/L	< 20 ng/L	< 5 ng/L	< 5 ng/L	< 5 ng/L
I	End of Cranberry Lane at Mastic	--	--	--	--	< 5 ng/L	< 5 ng/L	< 0.015 µg/L	< 5 ng/L	< 5 ng/L	< 5 ng/L
J	Gibbs Pond at Nesconset	30.3	228	7.5	12.0	< 5 ng/L	< 5 ng/L	< 0.015 µg/L	6910 ng/L	76 ng/L	< 5 ng/L
K	Goose Creek at Bayview	25.7	43760	7.8	9.3	< 5 ng/L	< 5 ng/L	< 20 ng/L	< 5 ng/L	< 5 ng/L	< 5 ng/L
		--	--	--	--	< 5 ng/L	< 5 ng/L	< 20 ng/L	< 5 ng/L	< 5 ng/L	< 5 ng/L
L	Heckscher State Park at East Islip	23.9	3208	6.7	0.9	< 5 ng/L	< 5 ng/L	< 0.015 µg/L	< 5 ng/L	< 5 ng/L	< 5 ng/L
M	Hedges Creek at mouth at Bellport	29.7	12740	6.8	6.9	< 5 ng/L	< 5 ng/L	< 20 ng/L	< 5 ng/L	< 5 ng/L	< 5 ng/L
		22.5	17690	6.7	5.8	< 5 ng/L	< 5 ng/L	< 20 ng/L	< 5 ng/L	< 5 ng/L	< 5 ng/L
N	Lake Ronkonkoma County Park by Portion Rd	28.2	263	6.3	2.7	< 5 ng/L	< 5 ng/L	< 0.015 µg/L	< 5 ng/L	< 5 ng/L	< 5 ng/L
		29.0	276	6.4	3.8	< 5 ng/L	< 5 ng/L	< 0.015 µg/L	< 5 ng/L	< 5 ng/L	< 5 ng/L
O	New Mill Pond near Hauppauge	--	--	--	--	< 5 ng/L	< 5 ng/L	< 20 ng/L	20 ng/L	< 5 ng/L	< 5 ng/L
P	New Mill	--	--	--	--	< 5 ng/L	< 5 ng/L	< 20 ng/L	691 ng/L	< 5 ng/L	< 5 ng/L

	Pond near Smithtown										
	Nissequoge River near										
Q	Smithtown	20.9	193	7.0	8.7	< 5 ng/L	< 5 ng/L	< 20 ng/L	< 5 ng/L	< 5 ng/L	< 5 ng/L
		--	--	--	--	< 5 ng/L	< 5 ng/L	< 20 ng/L	153 ng/L	6 ng/L	< 5 ng/L
	Pattersquash Creek at										
R	Mastic Beach	17.0	189	6.5	6.0	< 5 ng/L	< 5 ng/L	< 0.015 µg/L	5 ng/L	< 5 ng/L	< 5 ng/L
		14.8	230	5.9	5.2	< 5 ng/L	< 5 ng/L	< 20 ng/L	8 ng/L / (7 ng/L)	< 5 ng/L	< 5 ng/L
		14.5	233	6.1	5.6	< 5 ng/L	< 5 ng/L	< 20 ng/L	17 ng/L / (11 ng/L)	< 5 ng/L	< 5 ng/L
		15.8	226	6.2	7.2	< 5 ng/L	< 5 ng/L	< 5 ng/L	117 ng/L	12 ng/L	< 5 ng/L
	Sampawam's Creek S. of Hawley's										
S	Pond	22.3	200	6.2	5.9	< 5 ng/L	< 5 ng/L	< 0.015 µg/L	35 ng/L	< 5 ng/L	< 5 ng/L
	Shirley Boat Basin at										
T	Shirley	22.5	31270	8.1	12.9	< 5 ng/L	< 5 ng/L	< 20 ng/L	< 5 ng/L	< 5 ng/L	< 5 ng/L
	Spectacle Pond at										
U	Nesconset	26.8	265	6.6	2.7	< 5 ng/L	< 5 ng/L	< 0.015 µg/L	343 ng/L	21 ng/L	< 5 ng/L
	Thorn Lane at										
V	Oakdale	28.0	3598	8.2	0.1	< 5 ng/L	< 5 ng/L	< 0.015 µg/L	< 5 ng/L	< 5 ng/L	< 5 ng/L
	Trues Creek S. on Pine Lake at W.										
W	Islip	23.4	167	6.1	9.4	< 5 ng/L	< 5 ng/L	< 0.015 µg/L	13400 ng/L	293 ng/L	< 5 ng/L
	Unchachoque Creek at										
X	Shirley	--	--	--	--	< 5 ng/L	< 5 ng/L	< 5 ng/L	16 ng/L	< 5 ng/L	< 5 ng/L
	Unchachoque Creek ditch at										
Y	Shirley	27.6	38870	7.4	10.5	< 5 ng/L	< 5 ng/L	n/a	< 5 ng/L	< 5 ng/L	< 5 ng/L
		27.6	38870	7.4	10.5	< 5 ng/L	10 ng/L	n/a	< 5 ng/L	< 5 ng/L	< 5 ng/L
		28.1	38650	6.3	7.3	< 5 ng/L	< 5 ng/L	n/a	< 5 ng/L	< 5 ng/L	< 5 ng/L
		28.1	38650	6.3	7.3	< 5 ng/L	< 5 ng/L	n/a	< 5 ng/L	< 5 ng/L	< 5 ng/L
		28.3	38720	6.8	5.4	< 5 ng/L	< 5 ng/L	n/a	< 5 ng/L	< 5 ng/L	< 5 ng/L
		29.1	38450	7.7	12.7	< 5 ng/L	< 5 ng/L	n/a	< 5 ng/L	< 5 ng/L	< 5 ng/L
		25.3	38700	7.5	9.0	< 5 ng/L	< 5 ng/L	n/a	< 5 ng/L	< 5 ng/L	< 5 ng/L
		23.8	41300	7.8	10.0	< 5 ng/L	< 5 ng/L	n/a	< 5 ng/L	< 5 ng/L	< 5 ng/L
		24.5	32300	9.6	1.9	< 5 ng/L	< 5 ng/L	n/a	< 5 ng/L	< 5 ng/L	< 5 ng/L
		24.5	32300	9.6	1.9	< 5 ng/L	< 5 ng/L	n/a	< 5 ng/L	< 5 ng/L	< 5 ng/L
		24.6	36280	7.9	11.3	< 5 ng/L	< 5 ng/L	n/a	59800 ng/L	270 ng/L	< 5 ng/L
		24.6	36280	7.9	11.3	< 5 ng/L	< 5 ng/L	n/a	1310 ng/L	< 5 ng/L	< 5 ng/L
		24.7	37060	8.2	12.4	< 5 ng/L	< 5 ng/L	n/a	457 ng/L	38 ng/L	< 5 ng/L
		22.3	33260	5.0	2.4	< 5 ng/L	< 5 ng/L	n/a	61 ng/L	< 5 ng/L	< 5 ng/L
		25.2	33310	6.5	0.9	< 5 ng/L	< 5 ng/L	n/a	6 ng/L	< 5 ng/L	< 5 ng/L
		24.8	32600	6.5	3.2	< 5 ng/L	< 5 ng/L	n/a	< 5 ng/L	< 5 ng/L	< 5 ng/L

		25.7	34880	8.1	14.5	< 5 ng/L	< 5 ng/L	n/a	< 5 ng/L	< 5 ng/L	< 5 ng/L
		25.7	34880	8.1	14.5	< 5 ng/L	< 5 ng/L	n/a	< 5 ng/L	< 5 ng/L	< 5 ng/L
		23.9	31700	7.6	12.8	< 5 ng/L	< 5 ng/L	n/a	12 ng/L	< 5 ng/L	< 5 ng/L
		23.9	31700	7.6	12.8	< 5 ng/L	< 5 ng/L	n/a	15 ng/L	< 5 ng/L	< 5 ng/L
		23.6	32380	7.4	9.9	< 5 ng/L	< 5 ng/L	n/a	28 ng/L	< 5 ng/L	< 5 ng/L
		20.5	27210	6.7	6.9	< 5 ng/L	< 5 ng/L	n/a	113 ng/L	< 5 ng/L	< 5 ng/L
		27.6	35810	8.1	12.0	< 5 ng/L	< 5 ng/L	n/a	<5 ng/L	< 5 ng/L	< 5 ng/L
		27.6	37380	8.0	10.1	< 5 ng/L	< 5 ng/L	n/a	< 5 ng/L	< 5 ng/L	< 5 ng/L
Z	Vail Pond at Smithtown, NY	--	--	--	--	< 5 ng/L	< 5 ng/L	< 20 ng/L	774 ng/L	< 5 ng/L	< 5 ng/L
AA	Violet Rd. near Cranberry Dr. at Moriches Bay	24.7	4409	7.7	7.0	< 5 ng/L	< 5 ng/L	< 0.015 µg/L	< 5 ng/L	< 5 ng/L	< 5 ng/L

Table 1. Summary of results from 27 pesticide-sampling sites in Suffolk County, N.Y., 2002-04.

[Locations are shown by site code in fig. 1. °C, degrees Celsius; ? S/cm, microsiemens per centimeter; mg/L, milligrams per liter; ng/L, nanograms per liter; ?g/L, micrograms per liter; ? m, micrometer. n/r, no record. n/a, not analyzed.]

2003 Sampling at Carmans River - Methoprene

The effect of tidal drainage on the concentration of methoprene in stream water was evaluated at the Wertheim National Wildlife Refuge (WNWR) at Carmans River (Site E; Figure 1) during the summer of 2003. Methoprene was applied by helicopter at the rate of 0.013 lb/acre (oral commun., Suffolk County Vector Control, 2004). Four water samples were collected—one about 50 minutes before the application, and three at specified time increments after the application (Table 2).

Minutes before or after application	Sample-collection time	Concentration (nanograms per liter)
50 before	1336	<5
25 after	1515	9030
70 after	1600	39
148 after	1718	846

Table 2. Concentration of methoprene in water samples from Carmans River (Site E) Suffolk County, N.Y., before and after application during June 2003.
[Location is shown in fig. 1.]

As expected, no methoprene was detected in the sample collected before the application, and the highest concentration (9,030 ng/L) was found in the first sample collected after spraying. The concentration in the final sample (846 ng/L) was considerably higher than that in the preceding sample (39 ng/L), which was collected during high tide at 1600 hours, about 70 minutes after the application, whereas the final sample (846 ng/L) was collected during a falling tide, about 2.5 hours after the application. This change in tidal conditions could explain the anomaly, in that the low concentration could have been the result of dilution by the high tide, whereas the last sample, with a higher concentration of 846 ng/L (Table 2), was the result of water draining from the marsh during the ebb tide.

2004 Sampling at Connetquot River (Methoprene) and Unchachoque Creek (Resmethrin and PBO)

Only two sites were sampled during the 2004 summer spray season—Connetquot River in Great River (Site F) and Unchachoque Creek in Shirley (Sites X and Y, respectively) (Figure 1).

Connetquot River

No pre-application sample was collected at Connetquot River due to time constraints. Methoprene was detected in the samples obtained from the surface and from a 6-inch depth below the surface, which were collected 30 minutes after the application (216 ng/L and 82 ng/L, respectively), but not in the two successive samples (Table 1).

Unchachoque Creek.

Three applications were sprayed at Unchachoque Creek (Figure 1; Sites X and Y) - one of methoprene, and two of resmethrin (PBO was applied with resmethrin). Grab samples were collected from a manmade ditch (Figure 2) dug in the 1930s as part of a mosquito-control program in Long Island's estuarine marshes. The ditch is tidally affected; that is, it becomes partially filled and then drains completely with the normal tidal cycle.

Figure 2

Figure 2. Locations of sampling sites at an artificial ditch at Unchachoque Creek in Shirley, N.Y. (Location is shown in Figure 1.)

Samples were collected once before each application, then four times thereafter (Table 3). The post-application samples were collected over several days to provide a representative sampling for use by co-operating research efforts with local universities referred to earlier. Pre-application samples were collected from the water surface and at the 6-inch depth, as were the samples

collected 30 minutes after the application.

Date (August 2004)	Sampling time	Time elapsed	Sample type*	Direction of tide or current	Concentration, in ng/L	
					Resmethrin	PBO
18	1630	--	Grab	flowing in	< 5	<5
	1631	--	Point	flowing in	<5	<5
spray time:1940	1930	--	Field blank	n/a	<5	<5
	2000	20 min	Grab	flowing in	270	59800
	2001	21 min	Point	flowing in	<5	1310
	2130	1 hr 50 min	Point	flowing in	38	457
19	0430	8 hrs 50 min	Point	flowing out	<5	61
20	2015	48 hrs 35 min	Point	flowing out	<5	6
22	2015	96 hrs 35 min	Point	flowing out	<5	<5
25	1745	--	Grab	slack	<5	<5
	1746	--	Point	slack	<5	<5
spray time:1905	1940	35 min	Grab	flowing out	<5	12
	1941	36 min	Point	flowing out	<5	15
	1942	37 min	Field blank	n/a	<5	<5
	2110	2 hrs 5 min	Point	flowing out	<5	28
26	0430	9 hrs 25 min	Point	flowing out	<5	113
27	1940	47 hrs 25 min	Point	flowing out	<5	<5
29	1940	95 hrs 25 min	Point	slack	<5	<5

*Grab sample, from water surface. Point sample, from 6 inches below water surface.

Table 3. Concentrations of resmethrin and piperonyl butoxide (PBO) in ditch water at Unchachoque Creek (Site Y), Suffolk County, N.Y., August 18-29, 2004.

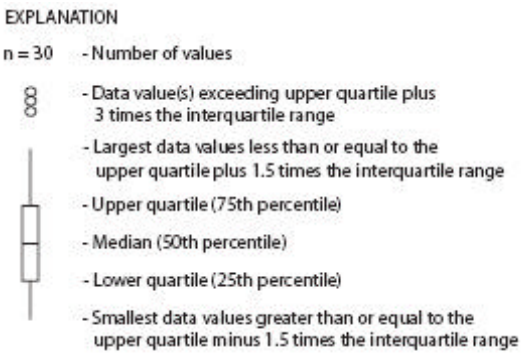
[n/a, not applicable. ng/L, nanograms per liter. Location is shown in Figure 1.]

As expected, no insecticides were detected in samples collected before the application. Methoprene was only detected in the sample collected immediately after application. Resmethrin and PBO concentration continually decreased over time from the initial application on August 18th (Table 3). Concentrations of resmethrin in the post-application samples collected from the August 25th spray application showed a pattern similar to methoprene concentrations in the Carmans River samples from 2003 (Table 2). Resmethrin and PBO concentrations also followed a typical exponential decrease through time after the application, which could be a result of mixing (tidal influence and/or runoff over time) within the marsh.

Statistical Summary

The use of sensitive analytical techniques in this study allowed detection of the applied insecticides in many of the locations sampled directly after spraying. A statistical summary presented in Figure 3 includes only those samples with detections; non-detects were omitted. Of all the samples, PBO was the most frequently detected. Methoprene had the highest median concentration (216 ng/L) after an application, followed by PBO (61 ng/L) and resmethrin (29 ng/L) (fig. 3; table 1). Sumithrin and malathion were not detected in any of the samples are there for are not presented.

Figure 3, explanation



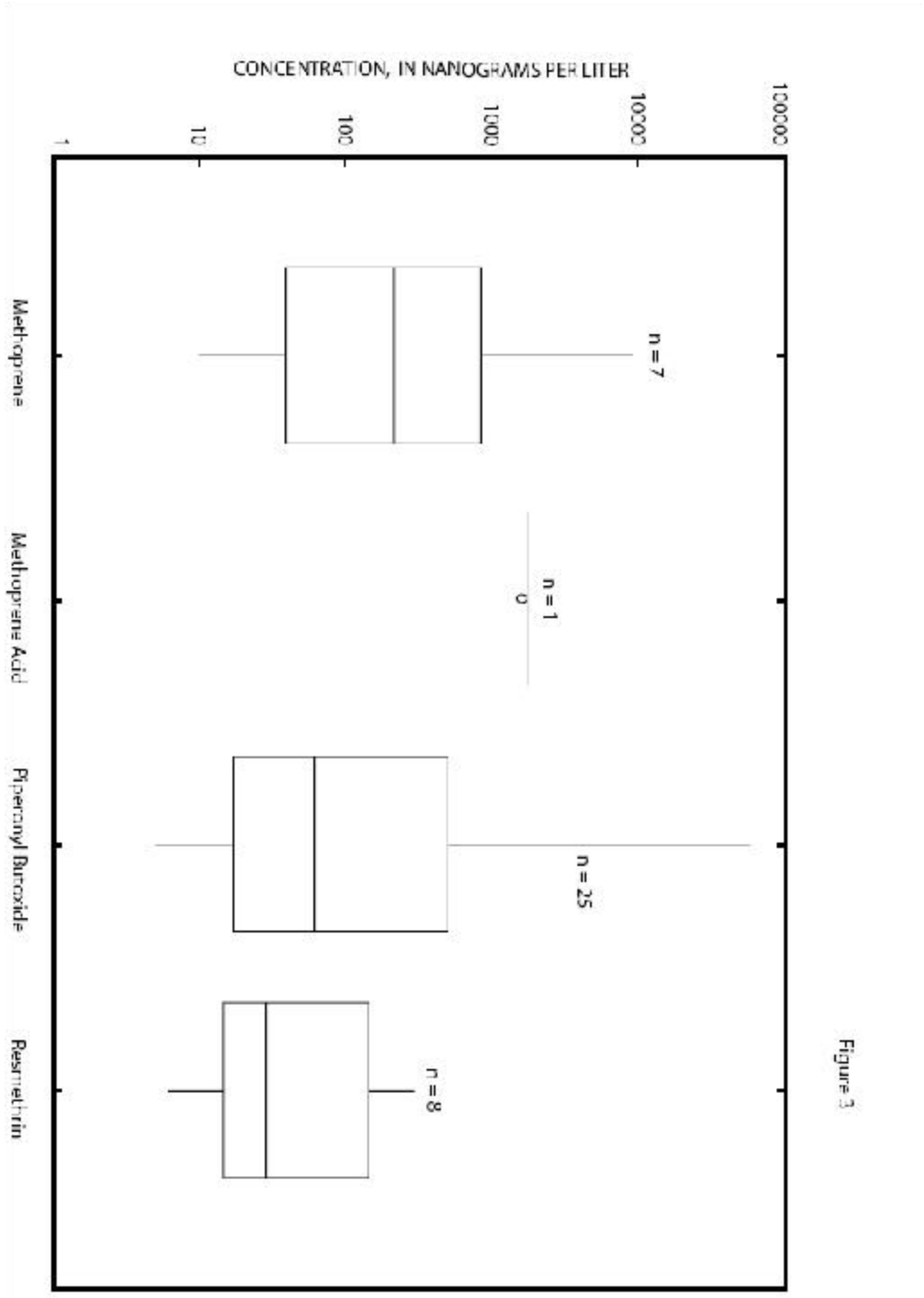


Figure 3. Box plot of detected concentrations for four pesticides in water samples from 15 surface water sites in Suffolk County, N.Y., 2002-04.

The ratio of resmethrin to PBO in the environmental samples was greater than the ratio in the parent mixture (Scourge^{TM}) (1:3). This would indicate either differential transport of the two compounds to surface waters, or differential preservation in surface waters. Differences in transport could occur either in the air after application, or through drainage of the marsh, as a result of tidal flow or by storm runoff. Differences in preservation could result from the propensity of resmethrin to be lost preferentially to the more soluble PBO. Pyrethroids probably are lost rapidly from surface waters through a variety of processes, including photochemical transformation and adsorption to particles and sediments (Clark and others, 1989; Rand, 2002).

Two different application processes allowed for a comparison between successful detections. Detection of resmethrin and PBO after applications by truck and helicopter are shown as bar charts in figure 4. PBO was detected in 38 percent of samples collected after an application by truck, and in 85 percent of samples collected after an application by helicopter. Resmethrin was detected only in samples collected after an application by helicopter.

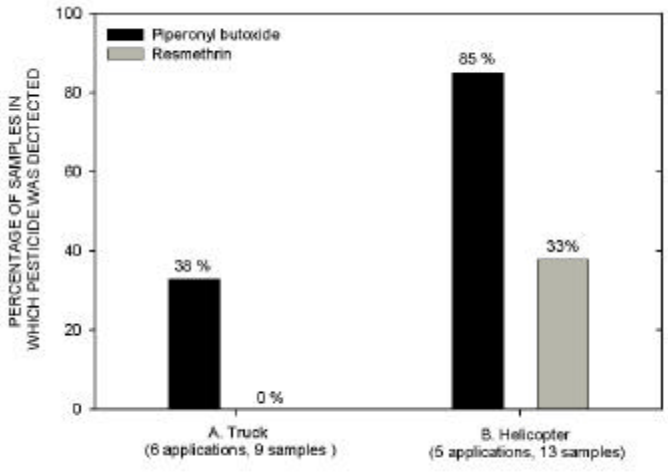


Figure 4. Percentage of samples containing piperonyl butoxide (PBO) and resmethrin after spray application at 25 sites by (A) truck, and (B) helicopter, Suffolk County, N.Y., 2002-03.

SUMMARY

The highest concentrations of insecticide were detected in surface waters in salt marsh areas where samples were collected within the first hour after an application. In every sample, the

concentration ratio of preserved PBO exceeded the amount of resmethrin. The difference could be the result of differential transport on land or in the air, or the differential preservation of the synergist PBO and pyrethroid (resmethrin) in surface waters. An evaluation of samples collected at varying times after initial insecticide application concludes that the insecticide concentration decreases within the environment over time. In some instances, the insecticide concentration increased several hours after the spray application then later decreased. It is possible that the varying concentrations over time are a result of tidal influence and estuarine mixing.

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