Report on the Diversity and Distribution of Mosquito Species (Diptera:Culicidae) Trapped in 2002 in York, Cumberland and Knox Counties, Maine

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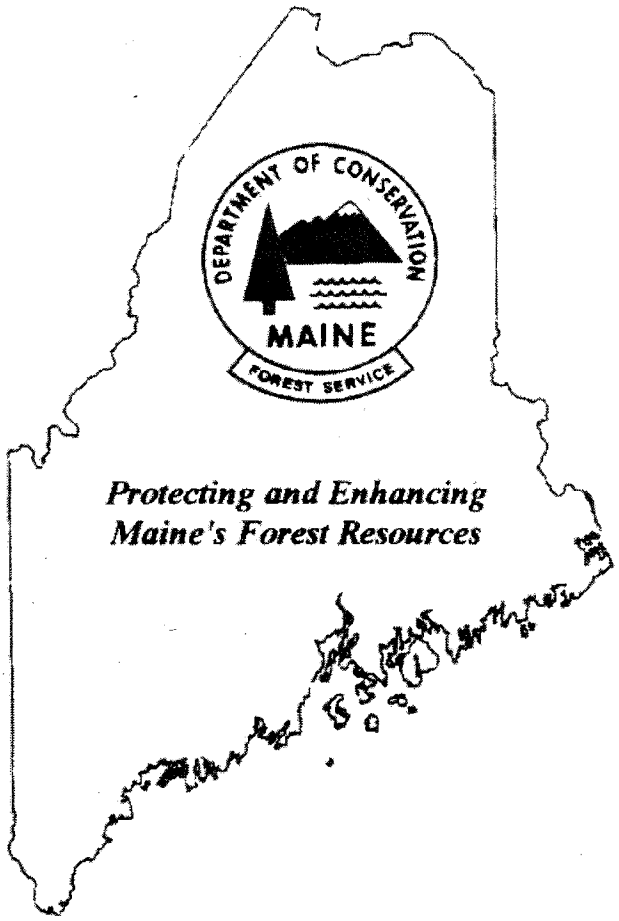

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Introduction

The first recognized human case of West Nile virus (WNv) in the Western Hemisphere occurred during the summer of 1999 in the borough of Queens, in New York City. (CDC, 1999). Sixty-two serious illnesses and seven deaths in the New York area were attributed to the virus that year (Nash, 2001). During 2000, twelve states on the east coast and the District of Columbia, reported epizootic activity in birds and/or mosquito pools. Despite the apparent spread of the virus, there were only two WNv related human deaths in 2000, those occurred in residents of New York and New Jersey (Marfin, 2001). In 2001, epizootic activity expanded to 27 states and the District of Columbia. It caused 64 serious illnesses in ten states and ten of those people died (CDC, 2002).

The first evidence of the presence of West Nile virus in Maine was dead crows found on August 29th, 2001 in Sabattus and Portland. Both birds tested positive for viral RNA by reverse transcriptase polymerase chain reaction (RT-PCR). A total of seven WNv positive birds were found between the end of August and the end of September that year (Maine Bureau of Health).

None of the mosquito pools collected in the state from June to September 2001 was positive for virus by RT-PCR or Vero cell culture and there were no known human illnesses in the state attributed to infection with WNv. A complete report of WNv mosquito surveillance activities in Maine in 2001 is available as Technical Report No. 43 of the Forest Service of the Maine Department of Conservation.

In 2002, as part of the operational plan of Maine's West Nile virus working group, staff of the Vector-borne Disease Laboratory of the Maine Medical Center Research Institute conducted mosquito surveillance in the southern portion of the state. The primary focus was to continue a faunistic study of the diversity and density of species of female mosquitoes trapped in locations near population centers and to have a seasonal comparison to data collected the previous year at several sites. In addition, all collected specimens were tested for WNv RNA by RT- PCR and Vero cell culture at the state Health and Environmental Testing Laboratory (HETL) in Augusta.

As in 2001, collection of *Culex* species mosquito egg rafts would be used to monitor the relative abundance of *Culex pipiens* and *Culex restuans*, the species considered to be the primary enzootic vectors of WNv in New York in previous years (Apperson, 02).

Additional rapid response trapping was planned in the event that a cluster of WNv-positive birds was found in an area not covered by scheduled mosquito trapping. All adult mosquitoes captured would be immediately identified to species and sent to the HETL for testing.

Methods

Study site locations

Eight sites were selected for biweekly mosquito collections from May through September. Study sites were chosen from those that had been trapped by this group in 2001 (Holman, 2001) and from those studied by the Maine Forest Service Insect and Disease Laboratory personnel, in Portland, that same year (Foss, 2001). The sites were specifically chosen based on mosquito data collected the previous year. The aim was to do frequent mosquito monitoring throughout the entire breeding season in areas known to support mosquito species implicated in the maintenance of the epizootic and also near urban/ suburban centers in southern Maine. The trapping efforts would thereby be concentrated in the areas of highest presumed human risk.

Light trapping

Adult mosquitoes were trapped with CDC miniature light traps (John Hoch Company, Gainesville, Florida) using dry ice as an attractant. The traps were placed and mosquitoes were collected as described previously (Holman, 2001). Each collection site was geo-referenced with latitude and longitude with a Garmin GPS 12 (Garmin Corp., Olathe, Kansas).

Adult Mosquito Identification

Female mosquitoes were either frozen at $\leq 20^{\circ}C$ or cold-shocked before identification. Mosquitoes were identified on a cold surface with a binocular dissecting microscope and pooled by site and individual species. Standard dichotomous identification keys for mosquitoes of North America were used (Darsie and Ward, 1981; Wood et. al., 1979; Means, 1979 &1987) as well as an unpublished key to the mosquitoes of New Hampshire provided by Dr. John Burger of the University of New Hampshire.

Mosquito pools were stored at $-20^{\circ}C$ and shipped approximately weekly on dry ice by overnight FedEx to the HETL for testing. Mosquitoes were submitted for testing in pools of ≤ 50 mosquitoes of a single species from one trapping site. Occasionally, mosquitoes were pinned as voucher specimens, and are housed in Portland, at the Vector-borne Disease Laboratory of the Maine Medical Center Research Institute.

Culex species egg raft collection

Gravid *Culex* females were attracted with a hay infusion at each trapping site as detailed previously (Holman, 2001). After enumeration of deposited egg rafts, a sample of rafts were collected at each site and held in the laboratory until larvae hatched. First instar larvae were identified to species using the protocol of Reiter (1986).

Rapid Response Monitoring

Additional trapping was instituted in the vicinity of multiple WNv positive birds in South Portland and Portland during the month of October. Trapping included both CDC mini-light traps and *Culex* egg raft collection.

Systematics

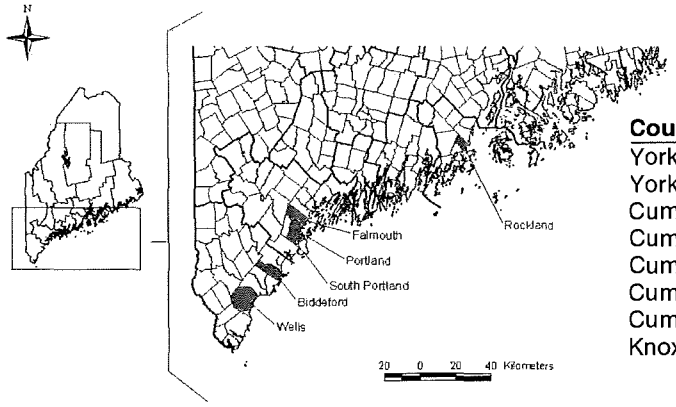
In 2000, the subgenus *Ochlerotatus* of the genus *Aedes* was elevated to the generic level (Reinert, 2000). This resulted in a name change for the majority of mosquito species found in Maine. This new naming convention is used in this report. *Aedes cinereus* and *Aedes vexans* are the only species found in the state that remain in the *Aedes* genus. The rest of the species formerly classified as *Aedes,* are now designated *Ochlerotatus* followed by the same species name.

Results

Sites

Eight southern Maine sites were selected for monitoring in 2002.

Fig. 1. Mosquito trapping locations

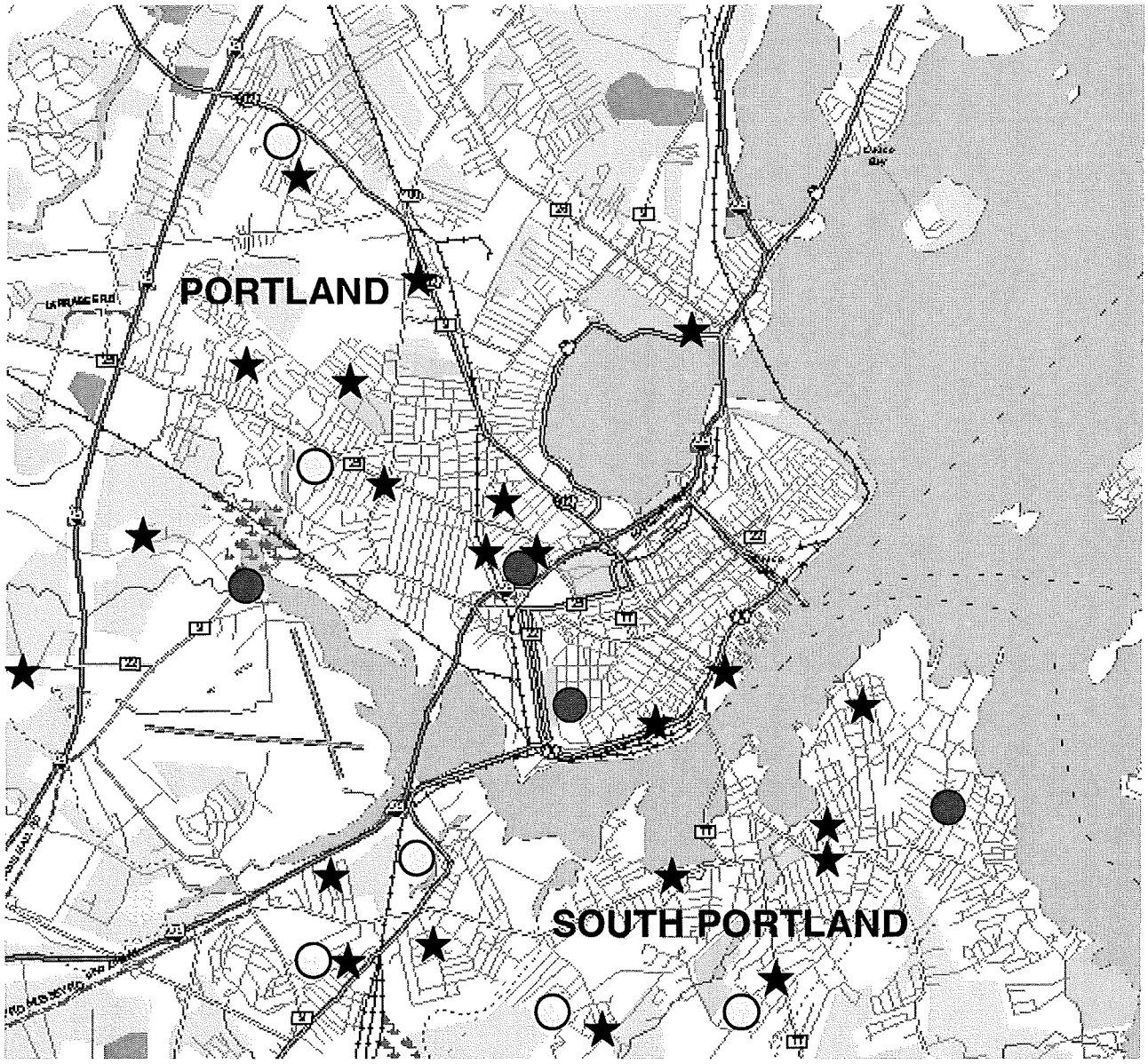


County	Street Address	Town	Zip
York	Laudholm Farm Rd.	Wells	04090
York	371 Hill St.	Biddeford	04005
Cumberland	31 Elsmere St.	South Portland	04106
Cumberland	15 Chamberlain Ave.	Portland	04102
Cumberland	1258 Westbrook St.	Portland	04102
Cumberland	44 Bowdoin Street	Portland.	04102
Cumberland	251 US Route 1	Falmouth	04105
Knox	156 Limerock Street	Rockland	04841

Each site was trapped between 10 and 15 times, with collections of both adult females and *Culex* egg rafts. Trapping was continued into October when the weather remained unseasonably warm, and WNv–positive crows were being submitted in substantial numbers. A total of 101 trap nights occurred at these sites.

An additional seven sites were established in October in response to apparent clusters of positive crows. Rapid-response trapping sites were established in the Rosemont and Riverton neighborhoods in Portland, 4 sites were established in the Thornton Heights and Pleasantdale neighborhoods in South Portland and one site was trapped in Camden. Each of these sites was trapped between one and three times. There was a total of 14 trap nights for the rapid-response surveys. Figure 2 shows the approximate location of WNv-positive crows found in Portland and South Portland as well as the locations of both scheduled and rapid-response trapping sites.

Fig. 2. Mosquito trapping sites and approximate location of West Nile virus-infected dead birds in Portland and South Portland, Maine 2002



★ Approximate location of a dead bird that tested positive for West Nile virus

● Location of an established mosquito trapping site for 2002 season

○ Location of an additional trapping site added in the vicinity of positive birds

Trapping continued at both scheduled and rapid-response sites until mosquitoes were no longer being captured. The last trapping date was October 18th.

Appendix A lists county, town, address, latitude, longitude, and habitat description for each site trapped this season.

Female mosquitoes captured

A total of 115 CDC mini-light traps were set. Twenty-two (19%) traps did not capture any mosquitoes although mosquitoes were trapped at those sites at other times. Empty traps were found primarily in early May and mid- to late October. The mean number of mosquitoes captured in the remaining ninety-three traps was 30, the median number was 12, and the maximum number was 370 female mosquitoes in one trap in Wells on July 8th.

The trap with the highest number of species trapped (11 species) was set on the night of August 7th in Rockland.

A total of 2,786 female mosquitoes were trapped comprising twenty-four species. Table 1 lists the total number of each species trapped, percent of total, and first and last date of capture.

Eight species that were collected in very small numbers by this group last season but were not captured in 2002 are included on this list. The species not captured this year were the following: *Anopheles walkeri, Culex territans, Culiseta minnesotae, Ochlerotatus intrudens, Ochlerotatus punctor, Ochlerotatus sticticus, Ochlerotatus trivittatus, and Psorophora ferox.*

Table 2 lists the total number of each species captured at each of the eight scheduled trapping sites from May through October.

Fig. 3 shows the total numbers of *Culex restuans* and *Culex pipiens* female mosquitoes collected each month at the eight scheduled sites during the entire season. A total of 83 *Cx. pipiens* females were trapped. The total number of *Cx. restuans* captured was 164. Fifty-one *Culex* mosquitoes that could not be definitively identified to either species due to loss of scales are not included in Fig. 3. These mosquitoes are included in Tables 1 and 2 as *Cx. pipiens/restuans* complex. *Cx. pipiens* females were not found at the sites in Wells, Biddeford, Falmouth or Rockland but small numbers of *Cx. restuans* were trapped at each of those sites. The three sites that had the highest numbers of *Cx. pipiens* and *Cx. restuans* were in relatively urban settings in Portland (Chamberlain Street and Bowdoin Street), and at Elsmere Street in South Portland. *Cx. restuans* collections peaked in July and August while the peak of *Cx. pipiens* captures was in August and September.

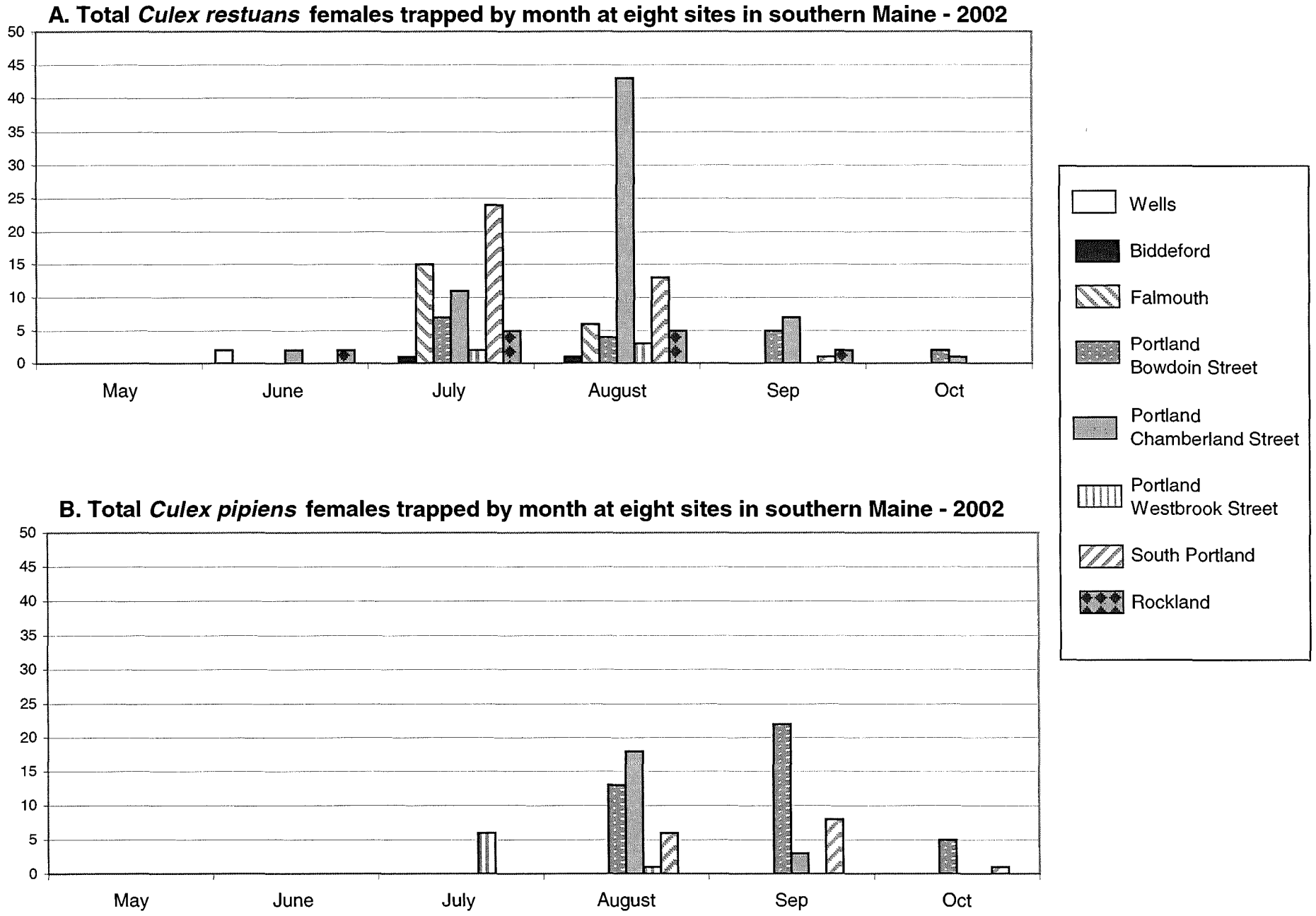
Table 1. Female mosquitoes trapped in CDC mini-light traps with CO_2 in southern Maine, May – October 2002

SPECIES	Total #	% Total	First Date	Last Date
Aedes cinereus	9	0.32	6/26/02	8/7/02
Aedes vexans	242	8.69	6/11/02	10/10/02
Anopheles punctipennis	34	1.22	6/3/02	10/10/02
Anopheles quadrimaculatus	1	0.04	9/5/02	9/5/02
Anopheles walkeri	0	0.00		
Coquillettidia perturbans	242	8.69	6/25/02	9/26/02
Culex pipiens	83	2.98	7/24/02	10/18/02
Culex pipiens/restuans complex	51	1.83	5/8/02	8/26/02
Culex restuans	164	5.89	6/10/02	10/9/02
Culex salinarius	414	14.86	5/30/02	10/18/02
Culex territans	0	0.00		
Culiseta minnesotae	0	0.00		
Culiseta morsitans	21	0.75	7/10/02	10/9/02
Ochlerotatus abserratus	10	0.36	5/30/02	6/27/02
Ochlerotatus atropalpus	2	0.07	7/30/02	9/9/02
Ochlerotatus canadensis	137	4.92	5/29/02	7/30/02
Ochlerotatus cantator	806	28.93	5/29/02	10/18/02
Ochlerotatus communis	5	0.18	6/3/02	7/8/02
Ochlerotatus diantaeus	1	0.04	6/19/02	6/19/02
Ochlerotatus excrucians	71	2.55	5/30/02	8/7/02
Ochlerotatus fitchii	1	0.04	6/10/02	6/10/02
Ochlerotatus intrudens	0	0.00		
Ochlerotatus japonicus	3	0.11	7/30/02	10/2/02
Ochlerotatus provocans	11	0.39	5/16/02	6/19/02
Ochlerotatus punctor	0	0.00		
Ochlerotatus sollicitans	409	14.68	6/10/02	10/9/02
Ochlerotatus sticticus	0	0.00		
Ochlerotatus stimulans	41	1.47	5/30/02	8/7/02
Ochlerotatus taeniorhynchus	1	0.04	8/26/02	8/26/02
Ochlerotatus triseriatus	25	0.90	7/2/02	10/2/02
Ochlerotatus trivittatus	0	0.00		
Psorophora ferox	0	0.00		
Uranotaenia sapphirina	2	0.07	8/29/02	10/4/02
TOTAL	2786			

Table 2. Total number of each species of female mosquitoes captured in CDC mini-light traps at sites in southern Maine, May - October 2002

	Wells	Biddeford	Portland Westbrook	Portland Chamberlanc	Portland Bowdoin	So Portland	Falmouth	Rockland
Aedes cinereus	2	2		3			1	1
Aedes vexans	9	6	75	19	39	5	5	73
Anopheles punctipennis		5	11	1	1	2	13	1
Anopheles quadrimaculatus						1		
Anopheles walkeri								
Coquillettidia perturbans	81	43	36	20	7	2	16	37
Culex pipiens			7	21	40	15		
Culex restuans	2	2	5	64	18	38	21	14
Culex pipiens/restuans complex			12	22	4	9		4
Culex salinarius	206	13	121	4	16	12	23	18
Culex territans								
Culiseta minnisotae								
Culiseta morsitans				1				20
Ochleratatus abserratus	2	2		1			2	3
Ochleratatus atropalpus		2						
Ochleratatus canadensis	2	31	2	2	1		92	7
Ochleratatus cantator	130	4	191	16	36	38	27	359
Ochleratatus communis	1						4	
Ochleratatus diantaeus							1	
Ochleratatus excrucians		3					1	67
Ochleratatus fitchii		1						
Ochleratatus intrudens								
Ochleratatus japonicus		1					2	
Ochleratatus provocans	1						10	
Ochleratatus punctor								
Ochleratatus sollicitans	256	3	123	2	3	7		8
Ochleratatus sticticus								
Ochleratatus stimulans							1	40
Ochleratatus taeniorhynchus			1					
Ochleratatus triseriatus		7			1		13	4
Ochleratatus trivittatus								
Psorophora ferox								
Uranotaenia sapphirina		2						
Total	692	127	584	176	166	129	232	656

Fig. 3: *Culex pipiens* and *Culex restuans* females captured in CDC mini-light traps with CO_2



About half of the total trapping for the season (57 traps) was conducted during the two-month period from August 18th to October 18th, when positive crows were being found in southern Maine. Approximately 21% of total female mosquitoes collected were captured during that period. Table 3 presents the numbers of each species found in each trap during the period when positive crows were being submitted to the state laboratory. The species captured most frequently during that time period, in order, are as follows: *Oc. cantator, Oc. sollicitans, Cx. salinarius, Cx. pipiens, Culex restuans, and Aedes vexans.*

Culex egg raft collections

Culex egg rafts were collected at the same time as light-trapping at every site. At most sites, no egg rafts were deposited until mid to late June.

Figure 4A graphs total numbers of *Culex* egg rafts collected at each scheduled site each month. The peak of egg raft collections was in July. On July 9th, 215 egg rafts were deposited at the Westbrook Street site. Light traps at that site never captured more than a total of 14 female *Cx. pipiens* and *Cx. restuans* combined.

No egg rafts were found at the Wells site. Only *Cx. restuans* larvae hatched from egg rafts found at the Biddeford, Falmouth and Portland-Bowdoin Street sites.

Figure 4B shows the total number of each species from a subset of egg rafts collected and hatched each month at the four sites where *Cx. pipiens* egg rafts were found. The percent of egg rafts at these sites that hatched into *Cx. pipiens* larvae increased steadily throughout the summer. In June 6% of egg rafts produced *Cx pipiens*; the percentage rose to 7.6%, 26.4% and 87.5% respectively in July, August and September.

Testing of mosquito pools for West Nile virus

Three hundred and seventy-six (376) female mosquito pools were shipped to the HETL for testing for the presence of West Nile virus RNA by RT-PCR and Vero cell culture. Testing was negative for presence of virus in all pools except one. The one positive pool contained five *Oc. sollicitans* collected in a trap set on the evening of October 4th at the Laudholm Farm site in Wells.

Rapid-response monitoring

The fourteen trapping nights at sites for rapid-response to positive crows found in the vicinity trapped a total of 24 mosquitoes; all were negative for WNv. Four species of mosquitoes were captured, those were; 11 *Ae. vexans*, 7 *Oc. sollicitans*, 5 *Oc. cantator,* and 1 *Cx. salinarius.*

Discussion

The number of adult female mosquitoes captured was about 50% less than in 2001. Some of the decrease in mosquito numbers is probably attributable to

Table 3. Female mosquitoes captured in each CDC mini-light trap set at southern Maine sites from August 18 - October 18, 2002

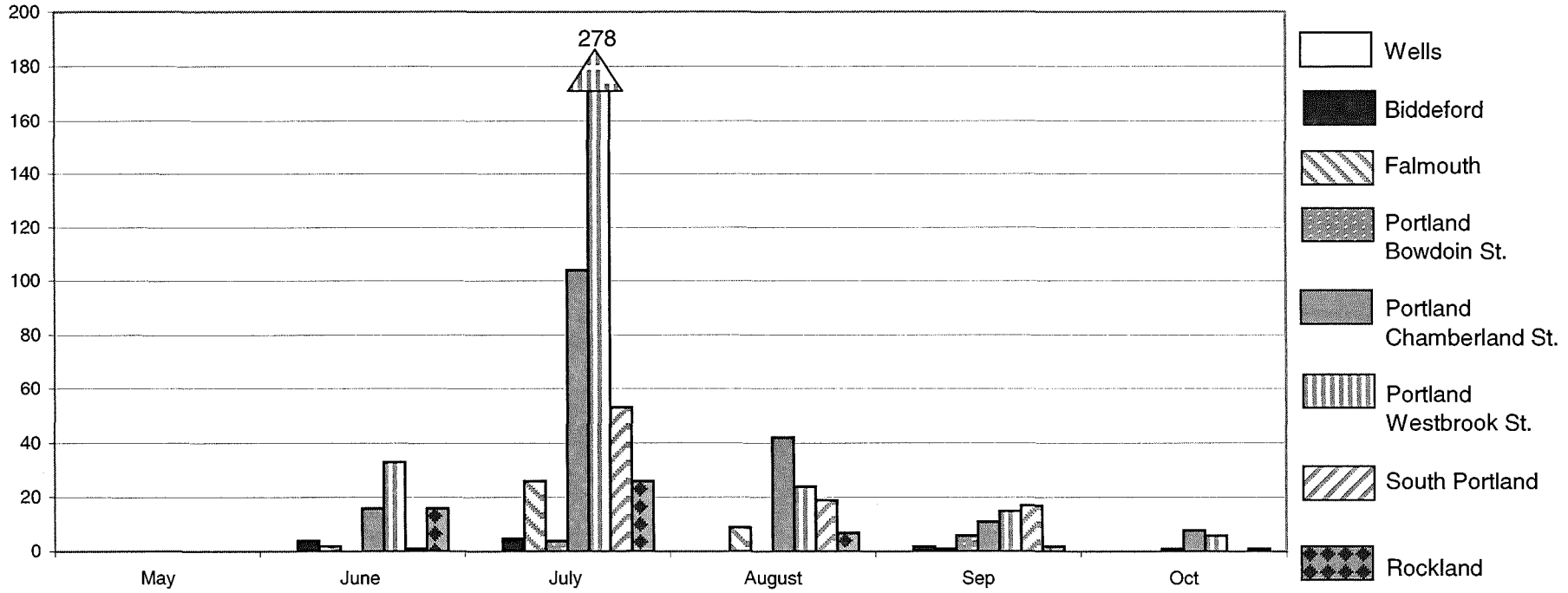
Site	Pool .	Date	Ae vexans	An punctipennis	An quadrimaculatus	Cq perturbans	Cx pipiens	Cx restuans	Cx pip/rest complex	Cx salinarius	Cs morsitans	Oc atropalpus	Oc cantator	Oc japonicus	Oc sollicitans	Oc taeniorhyncus	Oc triseriatus	Ur sapphirina	Total
Biddeford - Trans	M-02-123	8/29/2002	0	1	0	0	0	1	0	2	0	0	0	0	0		0	1	5
Biddeford - Trans	M-02-137	9/9/2002	0	0	0	0	0	0	0	0	0	1	0	1	0		1	0	3
Biddeford - Trans	M-02-183	9/24/2002	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0
Biddeford - Trans	M-02-221	10/4/2002	0	0	0	0	0	0	0	0	0	0	0	0	0		0	1	1
Camden - Oak	M-02-197	10/2/2002	2	0	0	0	0	0	0	0	0	0	0	0	0		0	0	2
Falmouth - Rt1	M-02-127	8/25/2002	0	0	0	0	0	1	0	0	0	0	0	0	0		0	0	1
Falmouth - Rt1	M-02-135	9/5/2002	0	0	0	0	0	0	0	0	0	0	0	0	0		1	0	1
Falmouth - Rt1	M-02-155	9/18/2002	1	0	0	0	0	0	0	0	0	0	0	0	0		0	0	1
Falmouth - Rt1	M-02-165	9/26/2002	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0
Falmouth - Rt1	M-02-181	10/2/2002	2	0	0	0	0	0	0	1	0	0	0	1	0		2	0	6
Falmouth - Rt1	M-02-211	########	0	0	0	0	0	0	0	0	0	0	1	0	0		0	0	1
Port - Belfort	M-02-179	10/2/2002	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0
Port - Belfort	M-02-207	########	3	0	0	0	0	0	0	0	0	0	1	0	0		0	0	4
Port - Belfort	M-02-219	########	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0
Port - Bowdoin	M-02-131	9/5/2002	1	0	0	0	18	4	0	3	0	0	6	0	1		0	0	33
Port - Bowdoin	M-02-151	9/18/2002	0	0	0	0	4	1	0	2	0	0	0	0	0		0	0	7
Port - Bowdoin	M-02-159	9/26/2002	0	0	0	0	0	0	0	1	0	0	1	0	0		0	0	2
Port - Bowdoin	M-02-177	10/2/2002	14	0	0	0	1	2	0	2	0	0	6	0	1		0	0	26
Port - Bowdoin	M-02-209	########	4	1	0	0	3	0	0	0	0	0	1	0	0		0	0	9
Port - Bowdoin	M-02-231	########	0	0	0	0	1	0	0	2	0	0	1	0	0		0	0	4
Port - Chamberlain	M-02-119	8/26/2002	1	0	0	0	18	34	20	0	0	0	0	0	0		0	0	73
Port - Chamberlain	M-02-143	9/9/2002	2	1	0	0	0	3	0	0	0	0	0	0	0		0	0	6
Port - Chamberlain	M-02-147	9/17/2002	0	0	0	0	2	4	0	0	0	0	0	0	0		0	0	6
Port - Chamberlain	M-02-161	9/27/2002	0	0	0	0	1	0	0	0	0	0	0	0	1		0	0	2
Port - Chamberlain	M-02-167	10/1/2002	1	0	0	0	0	0	0	0	0	0	3	0	1		0	0	5
Port - Chamberlain	M-02-199	10/9/2002	0	0	0	0	0	1	0	0	1	0	0	0	0		0	0	2
Port - Chamberlain	M-02-227	########	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0
Port - Hastings	M-02-201	10/9/2002	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0
Port - Westbrook	M-02-121	8/26/2002	0	2	0	0	0	0	0	12	0	0	5	0	14	1	0	0	34

Table 3. Female mosquitoes captured in each CDC mini-light trap set at southern Maine sites from August 18 - October 18, 2002

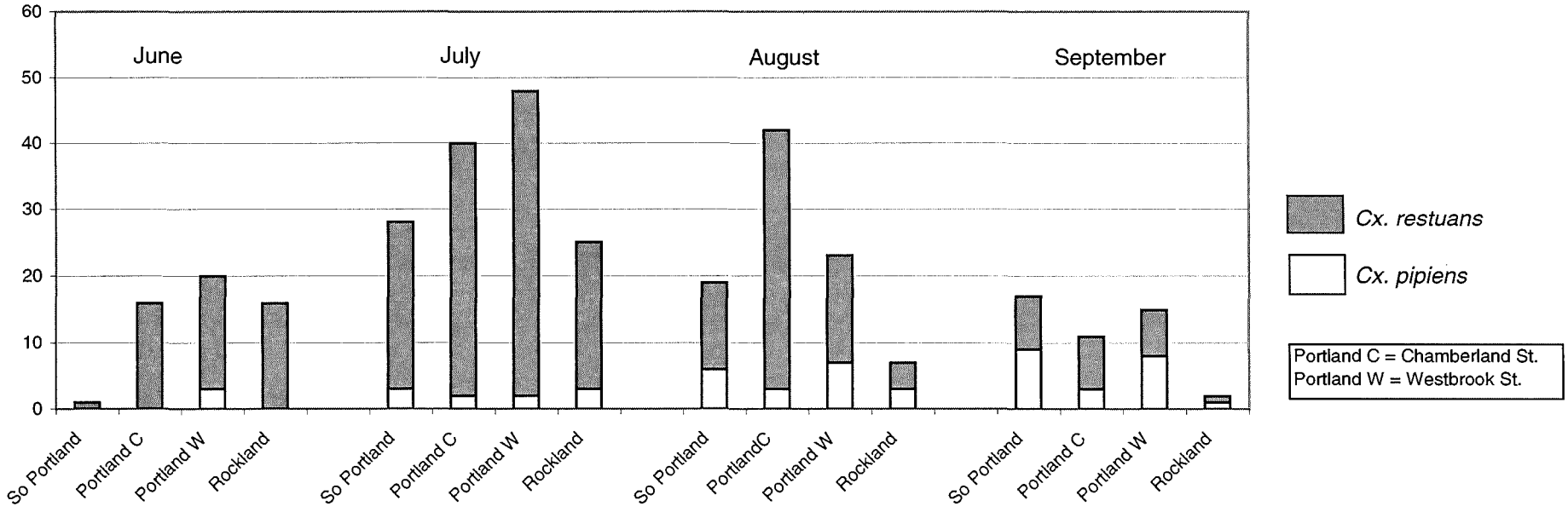
Site	Pool .	Date	Ae vexans	An punctipennis	An quadrimaculatus	Cq perturbans	Cx pipiens	Cx restuans	Cx pip/rest complex	Cx salinarius	Cs morsitans	Oc atropalpus	Oc cantator	Oc japonicus	Oc sollicitans	Oc taeniorhyncus	Oc triseriatus	Ur sapphirina	Total
Port - Westbrook	M-02-141	9/9/2002	1	1	0	1	0	0	0	8	0	0	3	0	4		0	0	18
Port - Westbrook	M-02-149	9/17/2002	4	0	0	0	0	0	0	3	0	0	1	0	1		0	0	9
Port - Westbrook	M-02-163	9/26/2002	3	0	0	1	0	0	0	7	0	0	19	0	54		0	0	84
Port - Westbrook	M-02-169	10/1/2002	2	0	0	0	0	0	0	5	0	0	71	0	19		0	0	97
Port - Westbrook	M-02-203	10/9/2002	4	0	0	0	0	0	0	1	0	0	6	0	2		0	0	13
Port - Westbrook	M-02-225	########	0	0	0	0	0	0	0	1	0	0	0	0	0		0	0	1
Rockland - Lime	M-02-129	8/28/2002	0	1	0	0	0	0	0	3	5	0	9	0	4		0	0	22
Rockland - Lime	M-02-145	9/10/2002	0	0	0	0	0	2	0	3	0	0	13	0	0		1	0	19
Rockland - Lime	M-02-195	10/2/2002	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0
South Port - Calvary	M-02-173	10/1/2002	1	0	0	0	0	0	0	1	0	0	0	0	3		0	0	5
South Port - Calvary	M-02-191	10/8/2002	1	0	0	0	0	0	0	0	0	0	0	0	0		0	0	1
South Port - Elsmere	M-02-133	9/5/2002	0	0	1	0	7	1	0	1	0	0	1	0	0		0	0	11
South Port - Elsmere	M-02-153	9/18/2002	1	0	0	0	1	0	0	2	0	0	0	0	0		0	0	4
South Port - Elsmere	M-02-157	9/26/2002	0	0	0	0	0	0	0	0	0	0	2	0	0		0	0	2
South Port - Elsmere	M-02-171	10/1/2002	0	0	0	0	1	0	0	0	0	0	5	0	2		0	0	8
South Port - Elsmere	M-02-205	########	1	0	0	0	0	0	0	0	0	0	1	0	0		0	0	2
South Port - Elsmere	M-02-229	########	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0
South Port - Keswick	M-02-175	10/1/2002	0	0	0	0	0	0	0	0	0	0	1	0	3		0	0	4
South Port - Keswick	M-02-189	10/8/2002	3	0	0	0	0	0	0	0	0	0	0	0	0		0	0	3
South Port - Keswick	M-02-213	########	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0
South Port - Ledgefield	M-02-187	10/8/2002	1	0	0	0	0	0	0	0	0	0	1	0	0		0	0	2
South Port - Ledgefield	M-02-215	########	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0
South Port - Sylvan	M-02-193	10/8/2002	0	0	0	0	0	0	0	0	0	0	2	0	1		0	0	3
South Port - Sylvan	M-02-217	########	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0
Wells - LF	M-02-125	8/29/2002	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0
Wells - LF	M-02-139	9/9/2002	0	0	0	0	0	0	0	2	0	0	1	0	7		0	0	10
Wells - LF	M-02-185	9/24/2002	0	0	0	0	0	0	0	3	0	0	0	0	23		0	0	26
Wells - LF	M-02-223	10/4/2002	0	0	0	0	0	0	0	0	0	0	0	0	5		0	0	5
		Total	53	7	1	2	57	54	20	65	6	1	161	2	146	1	5	2	583

Fig. 4

A. Total *Culex* species egg rafts collected at eight sites in southern Maine - 2002



B. *Cx. pipiens* vs. *Cx. restuans* larvae hatched from egg rafts collected at four urban sites in southern Maine - 2002



moving traps away from forested and rural habitats and into urban and suburban locations. For example, sites that produced extremely large numbers of *Cq. perturbans* in 2001 were not trapped in 2002. "Snow pool" mosquitoes are species of the *Ochlerotatus* and *Aedes* genera that normally are the first to hatch in the spring and produce just one generation per year (Jamnback, 1969). Snow pool breeders (*Oc. canadensis*, *Ae. cinereus, Oc. provocans*, *Oc. communis*, *Oc. stimulans*, and *Oc. fitchii)* were trapped far less frequently in 2002 than in 2001 despite an increased trapping effort in May and early June. This may have been due to unfavorable weather conditions in the late winter.

Despite changed location of some trapping sites, an expanded trapping schedule and differences in weather between 2001 and 2002, the species of mosquitoes found most frequently in light trap collections remained essentially the same as those found in 2001.

Although a total of twenty-four species of mosquitoes were captured, five species comprised 76% of the total captured. Those relatively abundant species are *Oc. cantator* (28.9%), *Cx. salinarius* (14.9%), *Oc. sollicitans* (14.7%), *Cq. perturbans* (8.7%) and *Ae. vexans* (8.7%). These same five species accounted for 57% of the female captures in 2001.

Culex pipiens/restuans complex mosquitoes combined, accounted for 10.7% of the adult females captured this year compared to a little over 4% in 2001. Most were captured at the Portland and South Portland sites, as expected due to their preference of urban habitats and small niches of dirty water for larval development (Means,87). These species have been shown to be moderately competent vectors of WN virus in laboratory studies (Turell, 01), and have been implicated as the species of greatest importance in the northeastern United States for maintaining the enzootic in birds (Apperson,02).

Culex egg raft data and adult female *Culex* mosquito data at the same site did not always correlate well. Two sites were of particular interest. At the Westbrook Street site in Portland, only a combined total of 24 *Cx. pipiens* and *restuans* females were caught in CDC mini-light traps during the entire season, half of those could not be identifed to species. However, the Westbrook Street site produced the largest number of total egg rafts (356). The Bowdoin Street site in Portland had the converse situation; sixty-two adult female *Cx. pipiens* or *Cx. restuans* were trapped, but only a total of eleven egg rafts were deposited. Apparently, trapping data is a very crude way to get an idea of actual mosquito density. Trapping success at each site may be partially due to the relative availability and attractiveness of natural hosts for adult mosquitoes and nutrient-rich niches for egg raft deposition for gravid females.

Based on the 2002 data, six species of mosquitoes could be implicated as potentially important vectors in the maintenance of a WNv enzootic in southern Maine. Each of these species are known to feed on birds, represented a

significant percent of total captures during the season, was frequently captured after mid-August when the first WNv-positive birds were identified in southern Maine, and was captured in urban rapid-response trapping in October. The species that met those criteria were: *Culex pipiens, Cx. restuans, Cx. salinarius, Oc. cantator, Oc. sollicitans* and *Ae. vexans.*

West Nile virus has been isolated from all of the above listed species of mosquitoes during the past two years in other states (Turell, 01). However, presence of viral RNA in a mosquito pool does not mean that the species is a competent vector of the virus. Turell et al have done laboratory studies on the vectorial competence of several mosquito species for West Nile virus. Of the species listed above, *Cx. salinarius* is the only one that was determined to be an efficient vector of WN virus. *Ae. vexans, Cx. pipiens* and *Cx. restuans* appeared to be moderately competent vectors and *Oc. cantator and Oc. sollicitans* were considered inefficient laboratory vectors of WNv. Ambient temperature can have a direct effect on the ability of a mosquito to be a competent vector of virus. It has been shown that infection rates of *Cx. pipiens* fed on viremic chickens and then held at 30°C is significantly higher than with ones held at lower temperatures (Dohm, 02).

Oc. japonicus was trapped in York and Cumberland Counties in 2001 and 2002. This species is considered to be a very competent vector of WNv (Turell, 01). Although only recently introduced into the U.S. it has spread rapidly (Andreadis 01, Falco 02). If *Oc. japonicus* should become established in Maine, it could play an important role in the maintenance of the WN virus enzootic and possibly also serve as another potential bridge vector to humans of Wnv and perhaps other arboviruses.

Two consecutive seasons of bird and mosquito testing have provided some important surveillance data on the presence of West Nile virus in Maine. However, most questions about West Nile virus remain unanswered both here and across the United States.

- Will West Nile virus become an increasing problem each year or will outbreaks be sporadic as occurs in Europe?
- What role, if any, does climate play in the spread of the virus?
- What are the effects of infection in species of birds other than corvids?
- What will the eventual public health impact of WNv be in Maine?
- Which mosquito species are the most important in this state for maintaining infection in birds?
- What are the important bridge vector species?
- Do mosquito abatement programs work?
- What is the best way to monitor human risk?

Clearly, there is much more work to be done before we will begin to answer the many questions about West Nile virus in Maine and the rest of the country.

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Appendix A: Locations and Descriptions of Mosquito Trapping Sites in Southern Maine - 2002

Site	County	Town	Address	Latitude(North)	Longitude(West)	Description
Biddeford - Trans	York	Biddeford	Transfer Station	43.4752	-70.4675	Biddeford Solid Waste Facility. Many old tires provide ideal breeding conditions. There are numerous areas at the facility that could also be used for breeding. The facility is located south of Route 9, near several schools and the city's airport. Larvae collected from tire piles here in 2001.
Camden - Oak	Knox	Camden	22 Oak Street	44.2063	-69.0770	Residential neighborhood less than 1/2 mile from Camden Harbor and Route 1 business district. Nearby wetland created by new houses filling and blocking drainage. Standing water at edge of lots and in front of the houses. Trap is hanging from willow tree on edge of brushy wetlands
Falmouth - Rt. 1	Cumberland	Falmouth	Behind Shaws	43.7251	-70.2287	This site is in the woods behind the shopping center at Bucknam Road on Route 1. The traps were located a short distance into the woods behind Shaw's delivery platform at an place where water drains across the parking lot into the woods. There is an illegal trash dump on the edge of the woods. This site was selected because until 2001, there was a large population of European house sparrows that lived under the eaves of the building.
Port - Belfort	Cumberland	Portland	17 Belfort St	43.6962	-70.3070	This site is in the Riverton section of Portland. It is a couple of hundred feet from Forest Avenue on a residential street of small (approx. 1/8 acre) lots. The backyard has several large mature trees as do the adjoining backyards. The trap is hung in a large maple tree. Beyond the next street (Verrill) to the west is a large partially wooded parcel of land where the Riverton school is located.
Port - Bowdoin	Cumberland	Portland	44 Bowdoin St.	43.6465	-70.2743	This site is in Portland's West End. It was studied in 2001and is reported in the Maine Department of Conservation Technical Report #42 as site #3. The manicured backyard backs up to Vaughn Street cemetary and the resident attests to a large mosquito population. The trap was hung in different locations in the backyard. Egg rafts were collected near the house.

Appendix A: Locations and Descriptions of Mosquito Trapping Sites in Southern Maine - 2002

Site	County	Town	Address	Latitude(North)	Longitude(West)	Description
Port - Chamberlain	Cumberland	Portland	15 Chamberlain	43.6610	-70.2758	This site is the USM Co-operative Extension office in the Oakdale neighborhood near the University of Southern Maine campus. The yard is very small with overhanging shrubs and a rock wall. The trap was hung from a large forsythia bush and egg rafts were collected beneath the same bush. This site was reported as site #4 in 2001 in Technical Report #42 of the Maine Dept. of Conservation.
Port - Hastings	Cumberland	Portland	39 Hastings Street	43.6682	-70.3045	This site was monitored during the summer of 2001 by Kim Foss. It was used by this group as a rapid response site to WN virus-positive crows in 2001 and 2002. The house is in an urban Portland residential neighborhood of well-maintained properties near Capisic Pond. The trap was hung from the back of a gardening shed in the backyard over a compost heap. A hedge separates this yard from the ones beside and behind it.
Port - Westbrook	Cumberland	Portland	1258 Westbrook Street	43.6571	-70.3119	A WN virus-positive crow was found on this site on August 30, 2001 by the homeowner. This is in the closely-built historic Stroudwater section of Portland and the backyard borders the Stroudwater River just above the dam. Ducks and geese were often seen in the backyard. A light trap was hung from a beech tree in the backyard and the tub for egg raft collection was placed in ornamental vegetation along a fence.
Rockland - Lime	Knox	Rockland	156 Limerock Street	44.1048	-69.1188	Residential District less than 1/2 mile from Rockland Harbor, 1/4 mile from Main Street business district, 1/2 mile from old quarries of standing water. Neatly kept houses. Trap was on edge of brush in backyard in a small maple tree near an intermittent brook.
South Port - Calvary	Cumberland	South Portland	1461 Broadway	43.6318	-70.2932	This site was established as a rapid-response site to positive crows in the Thornton Heights and Cash Corner neighborhoods of South Portland. It is in Calvary Cemetary, at the end of Holy Redeemer Road, near the intersection with St. Andrew. The traps were placed at the end of a line of poplars and blue spruce overlooking Calvary Pond in the "Holy Innocents" section of the cemetary.

Appendix A: Locations and Descriptions of Mosquito Trapping Sites in Southern Maine - 2002

Site	County	Town	Address	Latitude(North)	Longitude(West)	Description
South Port - Elsmere	Cumberland	South Portland	31 Elsmere St.	43.6380	-70.2313	This site is in a residential neighborhood in the Willard Square neighborhood. There is a deep (about 1/4 acre) backyard with lawn and gardens and a compost heap. The trap was hung in a large apple tree in the back of the property. The egg raft tub was placed next to a black plastic compost bin and shed.
South Port - Keswick	Cumberland	South Portland	119 Keswick St	43.6252	-70.3061	This site is in the Thornton Heights area of South Portland and was established as a rapid-response site. Three positive crows were found in the Thornton Heights/Cash Corner vicinity. The backyard is half lawn half woods. The woods are about 25 feet deep to a fence that borders school property. The trap hangs from a broken limb on a maple tree approximately 4 feet into the woods, the egg raft tub is beneath.
South Port - Ledgefield	Cumberland	South Portland	37 Ledgefield Circle	43.6209	-70.2772	This rapid-response site is located in a relatively new sub-division which backs up to woods (Broadview Park). The beige two-story house is the second on right after Kahill Court. The trap is hung in a tree in the woods bordering the backyard behind a large stone.
South Port - Sylvan	Cumberland	South Portland	14 Sylvan Road	43.6215	-70.2554	This site is in the South Portland Heights area. The house is across the street from Hinckley Park. The trap was placed in the backyard in one of several large hemlocks, the egg raft tub was placed beneath.
Wells - LF	York	Wells	Laudholm Farm	43.3400	-70.5517	Wells National Estuarine Research Reserve at Laudholm Farm located in a mixed hardwood stand. It is placed along a popular trail and is adjacent to an area known for raptor and crow activity on the Reserve. Nearby are many vernal pools and areas for mosquito breeding.

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