Preliminary Survey of Mosquito Species (Diptera: Culicidae) with a Focus on Larval Habitats in Androscoggin County and Additional Larval Data for Portland, Maine during 2002

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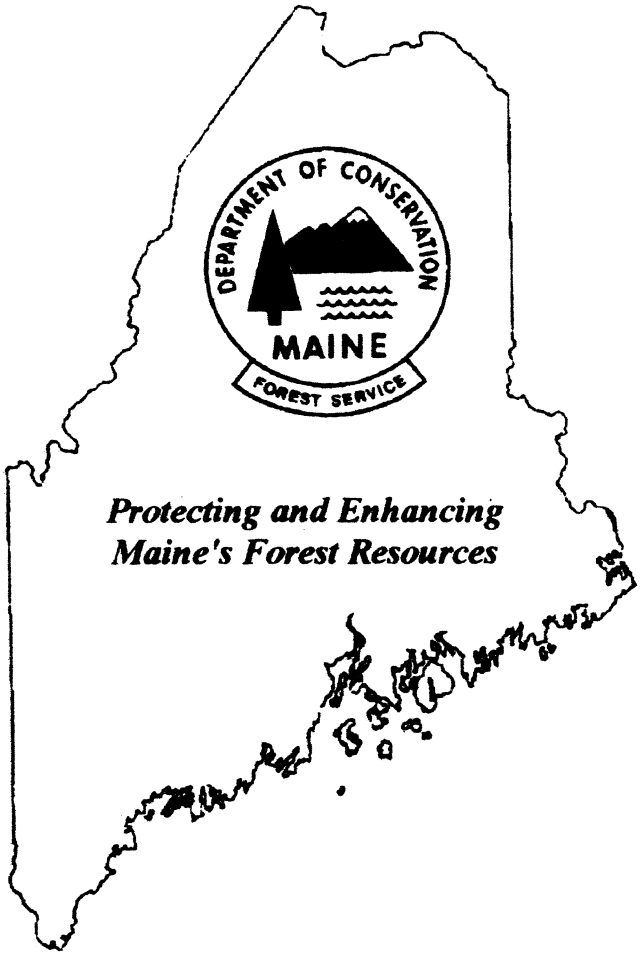

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MAINE DEPARTMENT OF CONSERVATION
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Abstract

In September of 2001, a single American crow (*Corvus brachyrhynchos*), from Sabattus, Maine, was among those birds which tested positive for West Nile Virus (WNV). This event prompted an extension of the 2001 mosquito surveillance protocol in that area and pointed out the need to better understand the nature of mosquito populations in areas of the state other than Portland. As a result, a second concerted effort was undertaken in the spring of 2002, by the Maine Department of Conservation, Forest Service, Forest Health and Monitoring Division, to focus primarily on a large urban area of Androscoggin County, Maine. This project, with sites in Lewiston, Auburn and Sabattus, Maine, involved assessing adult mosquito populations, determining species seasonality, collecting and identifying mosquito larvae, and delineating larval habitats in urban and adjacent rural locations.

CDC CO_2 traps and artificial breeding containers were placed: at an annual winter crow roost; along migratory bird routes; in strategic locations within the urban area; and at the location of the 2001 positive crow. Adult mosquitoes were collected on a weekly basis and identified, pooled, and tested for WNV at the Maine Health and Environmental Testing Laboratory. None of the mosquito specimens sent tested positive for the virus. Of the 41 mosquito species currently listed from Maine, a total of 32 mosquito species were collected from the Androscoggin County area. Larvae of seventeen species were also collected from various natural and artificially created habitats. Larvae of the introduced *Ochlerotatus japonicus* were initially discovered in a tree hole in Lewiston, Maine as early as May and lasting until the first heavy frost. From July to October, *Oc. japonicus* larvae were also collected from artificial containers.

Although most of our efforts were focused on Androscoggin County we also assisted, as time allowed, with mosquito identifications and population assessments in Orono, Bass Harbor, Cranberry Isle and in catch basins in Portland, Maine. Ten catch basins in Portland were selected, characterized and sampled for larvae, once every month from July through October 2002. Mosquito larvae were collected and adults observed in all but one of the catch basins. The species identified from these basins were *Culex pipiens, Cx. restuans* and *Cx. salinarius*. It was interesting that no *Oc. japonicus* were collected during the 2002 season.

As a result of our studies in 2002 we continue to gain a better understanding of mosquito bionomics especially with regard to habitat specificity and species seasonality.

Acknowledgements

Special thanks to the Lewiston Fire Department, Auburn Police Department, owners of Bell Farms, Susan Hayward, Steward for Thorncrag Bird Sanctuary, Lewiston Recreation Department and the residents of Lewiston, Auburn and Sabattus, Maine for allowing continued access to their property for this survey. Thanks to the City of Auburn for donating city zoning and street maps and Auburn Parks and Recreation Department for additional security at trap locations, Elm, Ice and Oil in Falmouth, Maine for continuously supplying dry ice, Lewiston Veterinary Hospital for temporarily storing frozen adult mosquito pools, and Uniship Courier Services for transporting frozen specimens to Augusta for testing.

This project was funded through a special grant from the Centers for Disease Control (CDC) with support from the Maine Department of Conservation, Forest Service, Forest Health and Monitoring Division.

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Introduction

Maine Mosquitoes- Background

Of the four families of biting flies common to Maine, the mosquitoes (*Diptera: Culicidae*) are probably second to only the black flies for their widespread voracious biting habits. In spite of their infamy, there are many unanswered questions as to their distribution and habits. Aside from isolated accounts, the first real discussion of various Maine mosquito species was by Edith Patch in 1906. Johnson in 1925 and again in 1927 listed species primarily for the Mount Desert Island area and Shaw updated this in 1959. The Johnson lists later evolved into the Proctor Lists (1938, 1946), which are considered the most intensive Maine insect surveys, but only for the Mount Desert Island area. In 1938, Frank Lathrop extended observations of species to the rest of Maine in his limited list of mosquito species. James L. Bean in 1946 produced the first detailed Maine State list including some bionomic information. Ivan McDaniel brought the list of Maine mosquito species up to 1973 and included information on pest and disease vector status (McDaniel, 1975). Further concerns about mosquitoes as vectors of disease, such as the WNV in Maine, have stimulated further faunistic work as discussed herein.

Androscoggin County Mosquito Surveillance Project, 2002

In the spring of 2001, an intensive mosquito survey program was initiated in Portland, Maine. Portland was chosen based on the high risk factor for vector related incidence because human population in this part of the state is large and is in close proximity to migratory bird flyways and where WNV has already been identified. This program was conducted to establish baseline faunistics of mosquito species, population densities and to locate and assess potential breeding sites in the Greater Portland area in conjunction with Centers for Disease Control (CDC) West Nile Virus (WNV) protocol. Along with identification of species, seasonal distributions and identification of larval habitats were also assessed (Foss and Dearborn 2001).

In 2002, as a result of a positive crow in Sabattus, Maine, a second mosquito survey program was initiated to assess adult mosquito populations, determine species seasonality, collect and identify mosquito larvae, and delineate larval habitats in the urban and rural locations of Lewiston, Auburn and Sabattus, Maine. Because crows thrive in cities and suburban areas where they live in close association with humans it was crucial to focus on these areas for future disease management strategies. Before the onset of this project, 40 mosquito species were listed as occurring in Maine (Foss and Dearborn 2001). The addition of *Culiseta minnesotae* in 2002 brings the total to 41.

Mosquito Larvae Collected in Portland, Maine from Selected Catch Basins

In the spring of 2002, a request was made by the Maine Department of Health to sample catch basins in the Portland area to determine if they were major potential breeding sites for *Culex* and *Ochlerotatus* mosquito larvae. Since these areas can hold water for extended periods of time, they provide a suitable habitat for mosquitoes. With the assistance of David Petersen, Senior Wastewater Technician for the Portland Public Works Department, ten catch basins were randomly chosen (two from each of the five 2001 Portland sampling sites) and were sampled once per month, from July through October.

Materials

11 CDC miniature CO_2 light traps
11 blue plastic ½ gal. insulated water containers with string and clips for dry ice
500 lbs dry ice (CO_2)
18, 24 well microplates with covers
50/50 Isopropyl (rubbing) alcohol 70%/water
1 large plastic cooler with lid
3 CDC gravid traps model 1712, JW Hock Co.
1 spare parts bag for traps
2 bags of large plastic petri dishes with covers
Hay infusion (1 lb hay per 30 gal water, fermented for 1 week)
Leaf infusion (1 lb dry oak and maple per 30 gal water, fermented for 1 week)
Oakton pH10 series meter
4 large 5 gal. plastic pickle buckets
11 black plastic 7x12x17 restaurant bus pans
Biohazard bags for pooled mosquitoes
2 4x6" flat pieces of marble
3 black 5 gal. buckets
1 battery operated insect aspirator*
Larval forceps and microslide tool sets
Glass vials with screw caps
1 large white plastic larval tray
1 small white plastic larval tray
1 larval dipper with extendable handle
Latex gloves
2 BioQuip mosquito breeding containers
1 pocket thermometer
cotton
1 GPS unit
11 6V batteries for CDC traps
2 battery chargers
eyedroppers for larvae
1 vial tray
glass micro vials
1 L. deionized water for rinsing pH probe

* The use of mouth aspirators should be discouraged when dealing with vector related species due to the risk of contracting disease. The battery operated insect aspirator is an appropriate alternative for projects such as these.

Methods

The methods used in 2002 were similar to those used in 2001 in Portland, Maine (Foss and Dearborn, 2001 revised version). The fieldwork for this project started in Androscoggin County, Maine on May 14, 2002 and ceased on October 15, 2002. Eight sites were selected for intensive sampling: three in Auburn, one in Sabattus and four in Lewiston. CDC CO_2 light traps and hay infusion containers for egg raft and larval sampling were placed at each site. Three locations contained two CO_2 traps; with one trap used for species identification and the other trap used to pool adults for virus testing. These three locations also contained leaf infusion containers placed directly next to the hay infusion containers. The selection of trapping sites was based on security, crow flyways, roosts and geographic distribution of traps. There were eighteen

additional preexisting larval dipping sites, both natural and artificial in urban and rural areas, which were also monitored weekly.

The fieldwork took place on Monday and Tuesday of every week for twenty-three weeks. Monday morning work consisted of picking up the dry ice, setting up CO_2 traps, recharging infusion containers at the chosen sites and some larval dipping. Tuesday work consisted of collecting, counting and freezing mosquito specimens found in the traps, and collecting larvae from additional sites. The traps were collected in the same order as they were set, allowing for approximately 24-hours of collection time. Date, time, air and water temperatures, water pH and current weather conditions were recorded on both days on a field data sheet. Traps were always cleaned to remove any insect parts and scales that might be left. The last three days of the week consisted of sorting and identifying the adult, larval and egg raft specimens collected. Processing specimens on a weekly basis ensured that the mosquitoes were in excellent condition and they were not backlogged. Batteries were fully recharged and hay/leaf Infusions were prepared for fermentation on Monday nights for the following weeks trapping session.

Adult mosquito pools were kept frozen and immediately delivered for virus testing, on a weekly basis, to the Maine Health and Environmental Testing Laboratory in Augusta, Maine. Adult specimens collected for WNV testing were identified on frozen pieces of marble. It was essential that pooled mosquitoes were kept frozen between identification and delivery to the lab. When large collections were made, a representative sample was taken from half of the total collection. This half was then kept frozen, identified then delivered. The remainder of the sample did not have to be kept frozen and was identified at a later date.

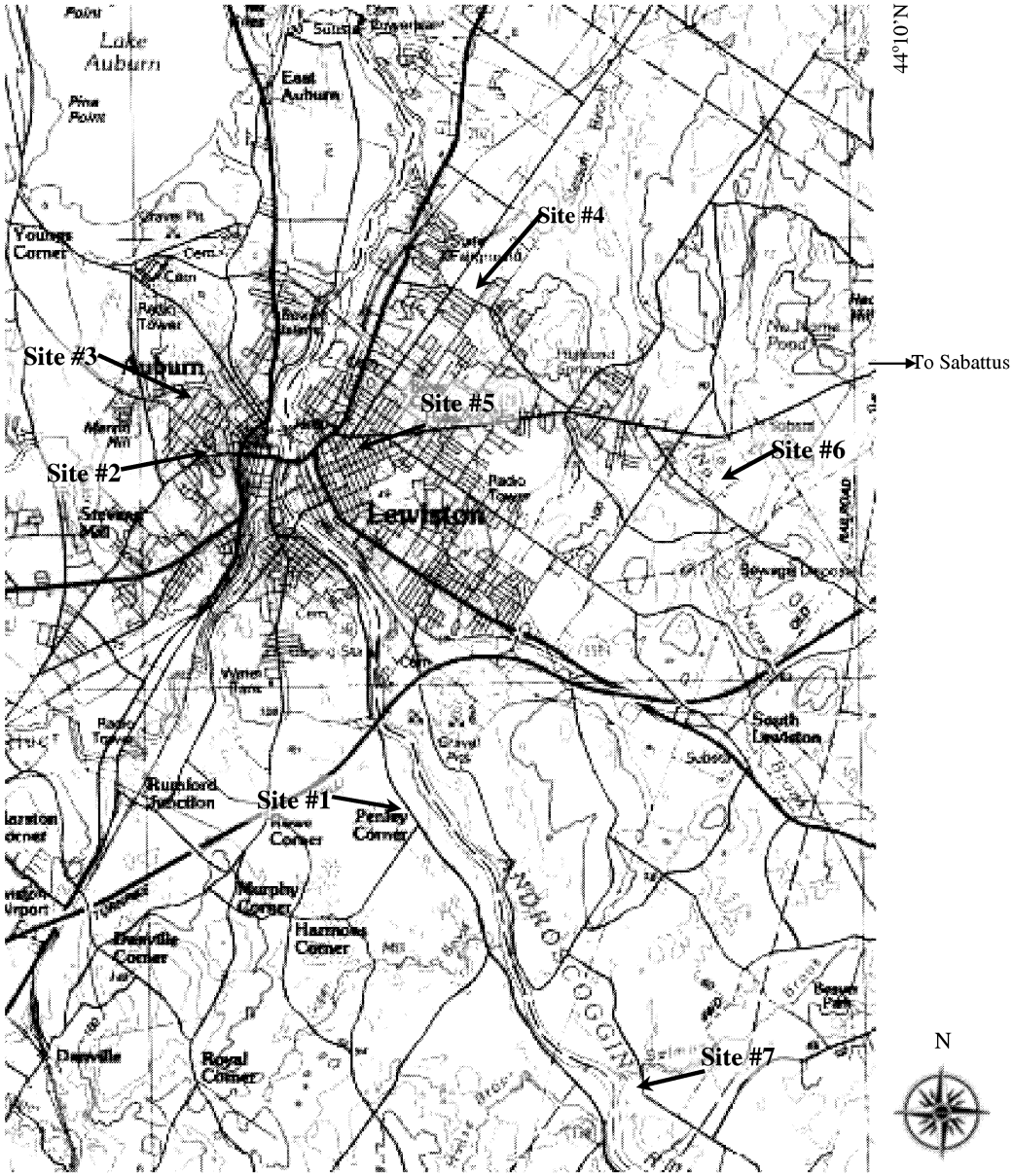
Based on our work in Portland during 2001, egg raft sampling begun on May 14, 2002. The CDC recommended hay infusion was added to black restaurant bus pans. A leaf infusion was also added to black five gallon buckets and placed next to the bus pans containing leaf infusion at three locations. Both were set at the same time as the other traps. The pans or buckets were placed under vegetation or in a shaded spot. The next day, *Culex* egg rafts were collected, counted, and placed individually into 24-well microplates, the wells were filled halfway with hay or leaf infusion and kept in a cool place away from sunlight. Immediately upon hatching *Cx. pipiens* and *Cx. restuans* first instar larvae were identified by the presence or absence of a transparent window located above the egg tooth on the dorsal portion of the head. If there was a window, larvae were called *Cx. restuans*, if no window was present they were called *Cx. pipiens*. Results from this study indicate unreliability of this method for use in determining *Culex pipiens* species populations. Egg raft sampling ceased in August 2002.

Identifications were done using a binocular dissecting microscope, and standard keys from Wood Dang and Ellis (1979), Darsie and Ward (1981), Burger (2001), and Carpenter and

LaCasse (1955). All collected specimens and pertinent information were recorded. Weekly, pooled specimens were counted, identified to species and recorded on a CDC formatted Excel spreadsheet that was then e-mailed to Beth Pritchard of the Maine Health and Environmental Testing Laboratory prior to delivery of the frozen pools. Previously unrecorded adult and larval specimens and specimens which were not collected during the 2001 study have been deposited in the Maine Department of Conservation, Forest Service, Insect and Disease Lab collection in Augusta, Maine for future reference.

Site Description

Lewiston/Auburn, Maine



The cities of Lewiston and Auburn are located in the Southwestern portion of the state of Maine, along the banks of the Androscoggin River. Combined, they constitute the second largest populated urban area in Maine. Nearly fifty percent of the state's population is located within a thirty-mile radius of Lewiston-Auburn. The combined population in 2000 was 58,893 (L/A Economic Growth Council). Seven of the eight trapping sites and sixteen of the preexisting larval sampling habitats were located within this area. The eighth trapping site was situated in Sabattus. Sabattus, Maine is approximately five miles northeast of the urban center of Lewiston, and its population according to the census was 4,486 in 2000. It was determined that traps and infusion containers be placed at a resident's home on Ballpark Road in Sabattus where a positive crow was discovered in September of 2001.

Auburn, Maine

Site #1- A resident's home on 545 Riverside Drive, Auburn, adjacent to winter crow roost. 1 CO_2 trap and 1 hay infusion container.

Site #2- Auburn Police Department, corner of Union and Court Street. 1 CO_2 trap and 1 hay infusion container.

Site #3- A resident's home on 88 Lake Street, Auburn, adjacent to an Elementary School. 1 CO_2 trap and 1 hay infusion container. Also collected larvae at this site from an old water and leaf filled blue tarp and a wading pool used for the family goose.

Additional weekly larval sampling sites: catch basins

Lewiston, Maine

Site #4- Elliot Avenue Little League Ball Fields, Lewiston. 1 CO_2 trap and 1 hay infusion container. Also collected larvae at this site from a discarded old tire.

Site #5- Lewiston Fire Department, corner of Ash and Bates Street, Lewiston. 1 CO_2 trap and 1 hay infusion container.

Site #6- A resident's home on 7 Knowlton Street, Lewiston. 2 CO_2 traps and 1 hay infusion container and 1 leaf infusion container. Also collected larvae at this site from a discarded old tire, a freshwater wetland/beaver pond and a temporary snowmelt pool.

Site #7- Bell Farms off River Road, Lewiston, spring crow feeding area. wooded area adjacent to the corn field. 2 CO_2 traps and 1 hay infusion container and 1 leaf infusion container. Also collected larvae at this site from a discarded old tire, agricultural drainage ditch, grassy flooded areas and temporary woodland snowmelt pools.

Additional weekly larval sampling sites: catch basins, Androscoggin River, Stetson Brook, Andrews Pond at Bates College, a pond off Webster Street, roadside ditches and marshy areas off Pond Road, old discarded tires off Lisbon Street and River Road, tree hole and two woodland ponds in Thorncrag Bird Sanctuary.

Sabattus, Maine

Site #8- A resident's home, Ballpark Road, Sabattus. Site of the 2001 positive crow. 2 CO_2 traps and 1 hay infusion container and 1 leaf infusion container.

Additional weekly larval sampling sites: Sabattus River

Results and Synopsis

All mosquito species discussed in this section were collected during the 2002 project season in Auburn, Lewiston and Sabattus, Maine. Results are also presented in condensed form in Appendix A. Adults of thirty-one species of mosquitoes and seventeen species of mosquito larvae were collected and identified during the 2002 project season. A total of thirty-two mosquito species were found in the Androscoggin County area. Species collected, but seasonality not determined due to low numbers of specimens, include 1 adult *Ochlerotatus atropalpus*, 2 adult *Ochlerotatus cantator* and 2 *Anopheles earlei* larvae. Anecdotal species information was compiled from data collected during this project and from a variety of other sources.

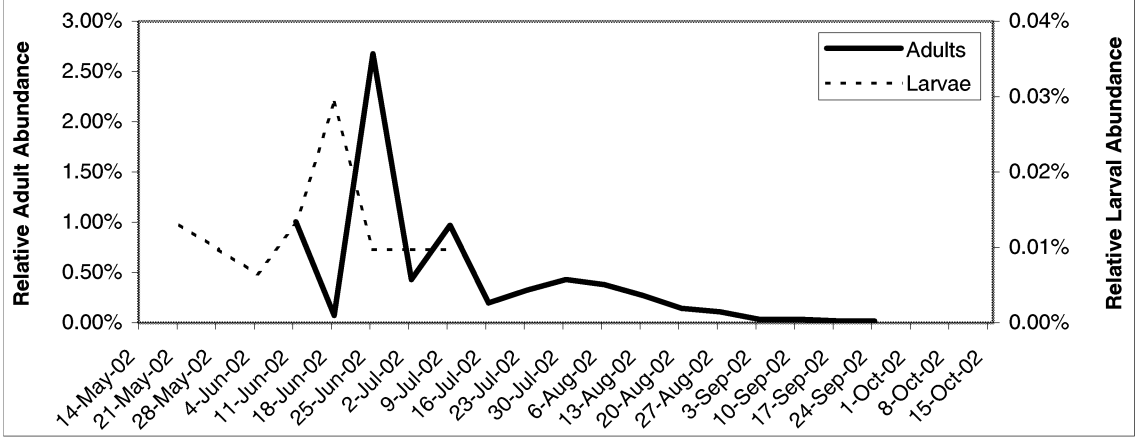
Mosquito Species Collected in Androscoggin County, 2002- A Synopsis

All of the species found in our 2002 survey in Androscoggin County except *Ochlerotatus aurifer, Oc.diantaeus, Oc. hendersoni, Anopheles walkeri, An. earlei,* and *Culiseta minnesotae* were found in our Portland survey of 2001. *Oc. sollicitans* and *Cs. melanura* were collected in Portland in 2001 but were not collected during the 2001 Androscoggin County survey. Rather than simply repeating most of the bionomic information that has been included in Foss and Dearborn 2001, we decided to use our 2002 information along with other information to provide the following species synopsis.

***Aedes cinereus* (Meigen)**

Overwintering stage: egg
Generations per year: 2-3
Primary larval habitat: woodland temporary snowmelt pools
Secondary larval habitat: semi permanent freshwater marshes
Peak larval activity during 2002: June 18
Total number of larvae collected in 2002: 31
Peak adult activity during 2002: June 25
Total number of adults collected in 2002: 398
Bites humans: yes
Enters homes: unknown
Day biter: yes
Night biter: yes
Attracted to artificial light: yes
Pest status: high in wooded areas, aggressive
Associated with WNV: yes (CDC 2001)

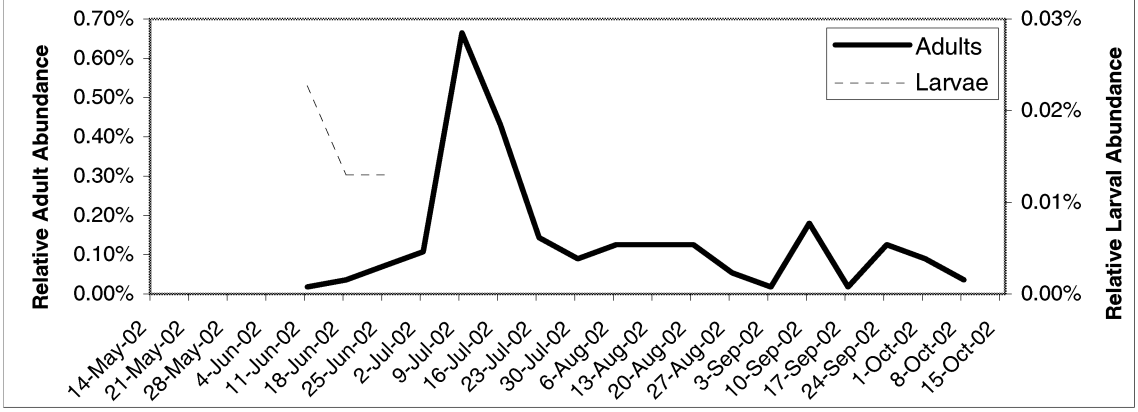
Figure 1. Observed Seasonality: *Aedes cinereus*



***Aedes vexans* (Meigen)**

Overwintering stage: egg
Generations per year: 2-3
Primary larval habitat: woodland temporary snowmelt pools
Secondary larval habitat: river floodplain areas
Peak larval activity during 2002: June 11
Total number of larvae collected in 2002: 15
Peak adult activity during 2002: July 9
Total number of adults collected in 2002: 104
Bites humans: yes
Enters homes: yes
Day biter: occasionally
Night biter: yes
Attracted to artificial light: equally attracted to CDC traps with or without a light
Pest status: high
Associated with WNV: yes (CDC 2001)

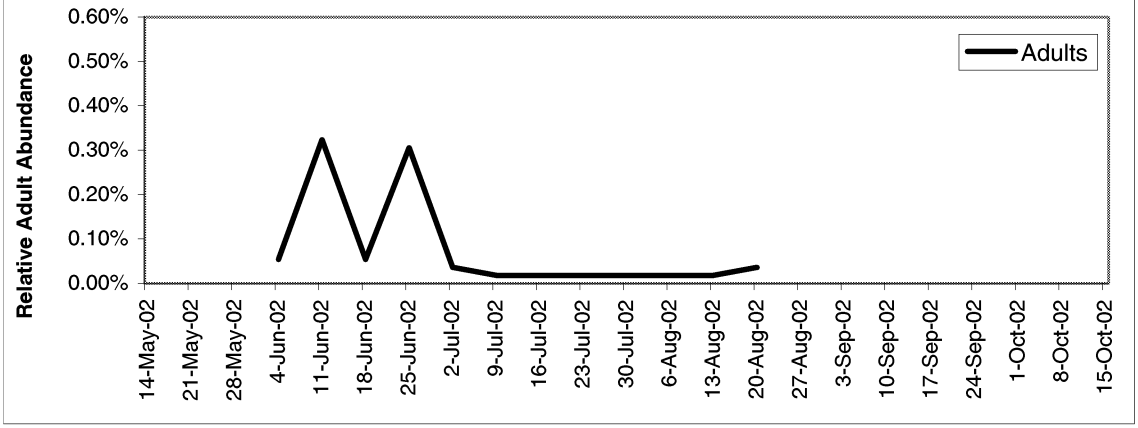
Figure 2. Observed Seasonality: *Aedes vexans*



Ochlerotatus abserratus (Felt and Young)

Overwintering stage: egg
Generations per year: usually 1
Primary larval habitat: woodland temporary snowmelt pools
Secondary larval habitat: -
Peak larval activity during 2002: no larvae collected
Peak adult activity during 2002: June 11
Total number of adults collected in 2002: 46
Bites humans: yes
Enters homes: unknown
Day biter: yes
Night biter: yes
Attracted to artificial light: yes
Pest status: moderate in wooded areas
Associated with WNV: unknown

Figure 3. Observed Seasonality: *Ochlerotatus abserratus*



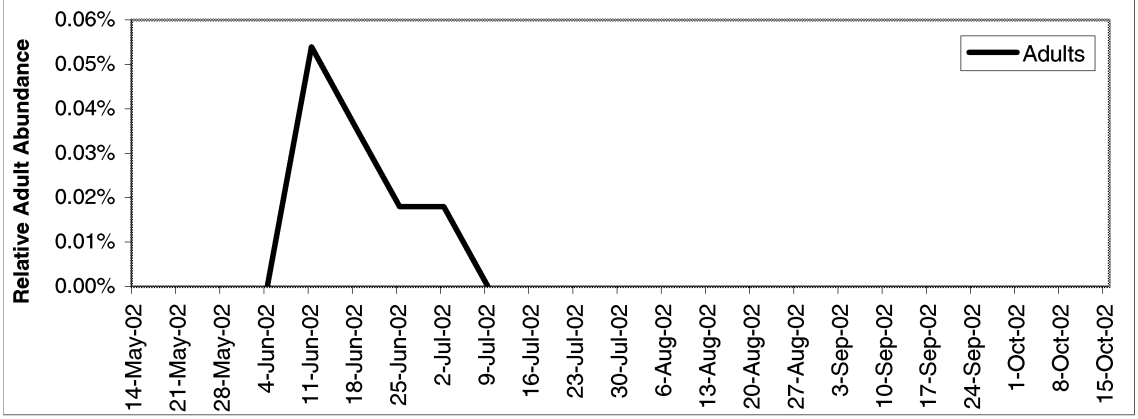
Ochlerotatus atropalpus (Coquillett)

Overwintering stage: egg
Generations per year: usually 1
Primary larval habitat: rock pools
Secondary larval habitat: natural and artificial containers
Peak larval activity during 2002: no larvae collected in Androscoggin County
Peak adult activity during 2002: unknown
Total number of adults collected in 2002: 1
Bites humans: yes
Enters homes: unknown
Day biter: yes
Night biter: yes
Attracted to artificial light: yes
Pest status:
Associated with WNV: unknown
Special note: Several 3rd and 4th instar larvae were collected on July 4th from rock pools in the Swift River at Coos Canyon, Maine.

Ochlerotatus aurifer (Coquillett)

Overwintering stage: egg
Generations per year: usually 1
Primary larval habitat: woodland temporary snowmelt pools, acid and peat bogs
Secondary larval habitat: shaded sphagnum and open cattail bogs
Peak larval activity during 2002: no larvae collected
Peak adult activity during 2002: June 11
Total number of adults collected in 2002: 7
Bites humans: yes
Enters homes: unknown
Day biter: yes
Night biter: yes
Attracted to artificial light: yes
Pest status: high near breeding sites, aggressive
Associated with WNV: unknown

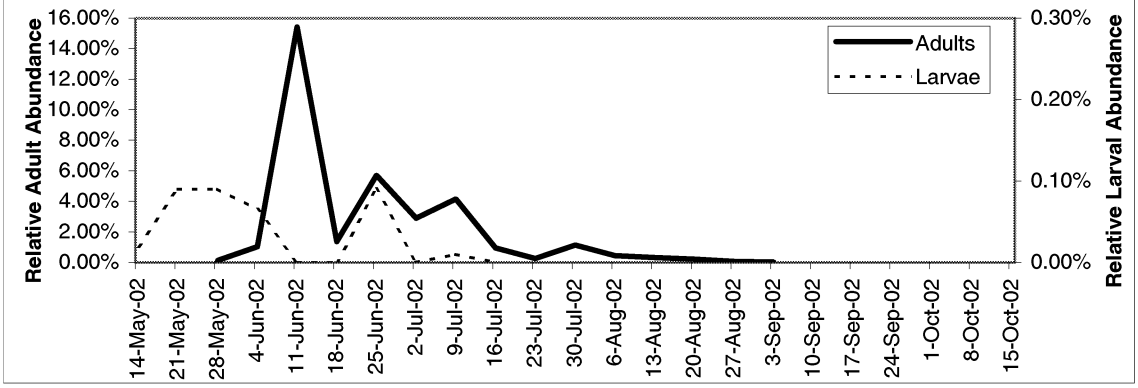
Figure 4. Observed Seasonality: *Ochlerotatus aurifer*



Ochlerotatus canadensis (Theobald)

Overwintering stage: egg
Generations per year: 1-2
Primary larval habitat: woodland temporary snowmelt pools
Secondary larval habitat: sphagnum bogs, open grassy roadside ditches
Peak larval activity during 2002: May through June
Total number of larvae collected in 2002: 64
Peak adult activity during 2002: June 11
Total number of adults collected in 2002: 1,896
Bites humans: yes
Enters homes: yes
Day biter: yes
Night biter: yes
Attracted to artificial light: equally attracted to CDC traps with or without a light
Pest status: high
Associated with WNV: yes (CDC 2001)

Figure 5. Observed Seasonality: *Ochlerotatus canadensis*



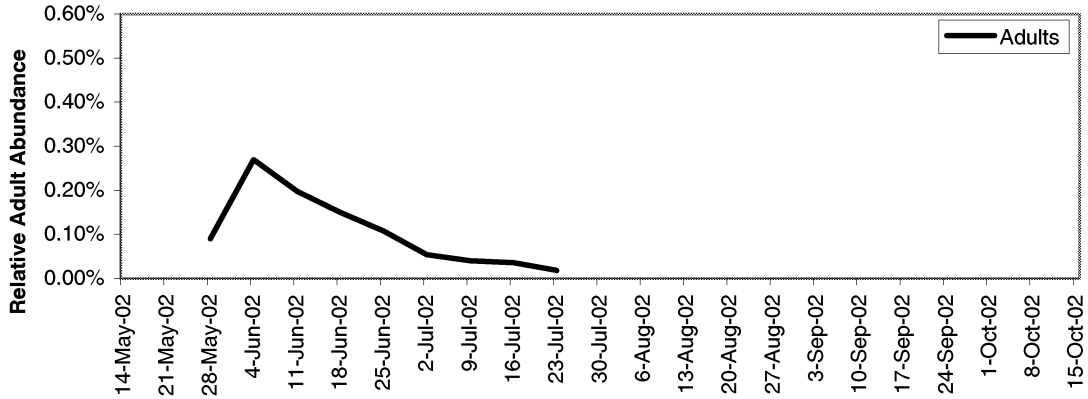
Ochlerotatus cantator (Coquillett)

Overwintering stage: egg
Generations per year: 1 or more
Primary larval habitat: salt marshes
Secondary larval habitat: fresh or brackish water
Peak larval activity during 2002: no larvae collected
Peak adult activity during 2002: unknown
Total number of adults collected in 2002: 2
Bites humans: yes
Enters homes: unknown
Day biter: yes
Night biter: yes
Attracted to artificial light: yes
Pest status: major
Associated with WNV: yes (CDC 2001)

Ochlerotatus communis (DeGeer)

Overwintering stage: egg
Generations per year: usually 1
Primary larval habitat: woodland temporary snowmelt pools
Secondary larval habitat: -
Peak larval activity during 2002: no larvae collected
Peak adult activity during 2002: June 4
Total number of adults collected in 2002: 43
Bites humans: yes
Enters homes: yes
Day biter: yes in wooded areas
Night biter: yes
Attracted to artificial light: will come to artificial light but observed to be more attracted to CDC traps without a light
Pest status: moderate
Associated with WNV: unknown

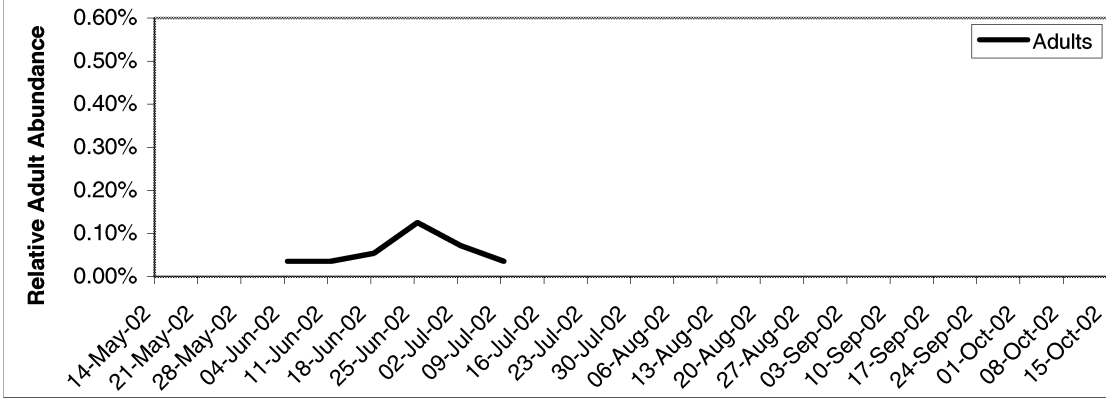
Figure 6. Observed Seasonality: *Ochlerotatus communis*



Ochlerotatus diantaeus (Howard, Dyar & Knab)

Overwintering stage: egg
Generations per year: 1
Primary larval habitat: woodland temporary snowmelt pools, boggy areas
Secondary larval habitat: open flooded fields
Peak larval activity during 2002: no larvae collected
Peak adult activity during 2002: June 25
Total number of adults collected in 2002: 18
Bites humans: yes
Enters homes: unknown
Day biter: yes
Night biter: yes
Attracted to artificial light: observed to be more attracted to CDC traps without a light
Pest status: low
Associated with WNV: unknown

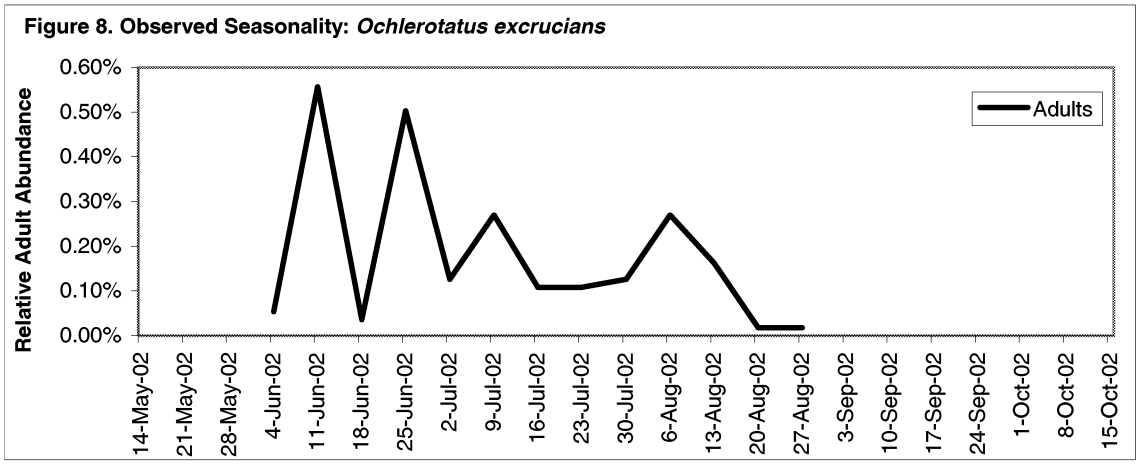
Figure 7. Observed Seasonality: *Ochlerotatus diantaeus*



Ochlerotatus excrucians (Walker)

Overwintering stage: egg
Generations per year: 1-2
Primary larval habitat: woodland temporary snowmelt pools

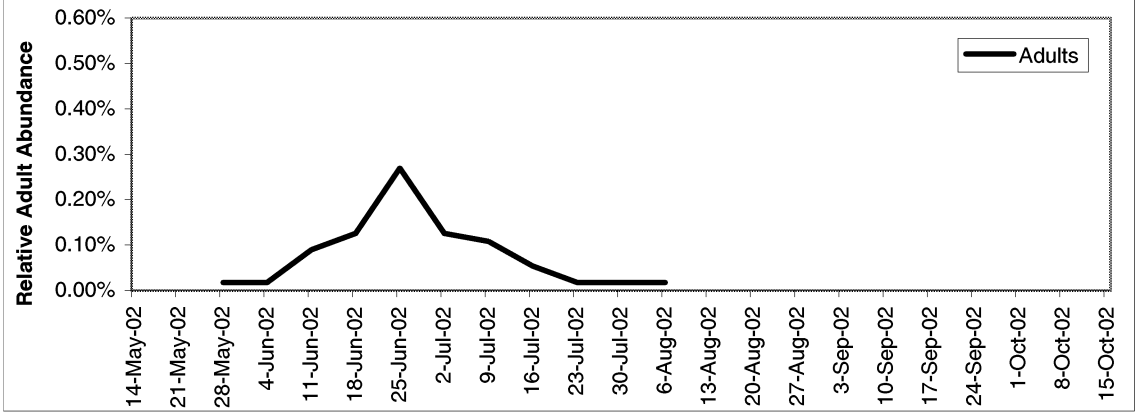
Secondary larval habitat: semi permanent pools, grassy ditches
Peak larval activity during 2002: no larvae collected
Peak adult activity during 2002: June 11
Total number of adults collected in 2002: 131
Bites humans: yes
Enters homes: yes
Day biter: yes in wooded areas
Night biter: yes
Attracted to artificial light: equally attracted to CDC traps with or without a light
Pest status: high, aggressive
Associated with WNV: unknown



Ochlerotatus fitchii (Felt and Young)

Overwintering stage: egg
Generations per year: usually 1
Primary larval habitat: woodland temporary snowmelt pools
Secondary larval habitat: sphagnum bogs, open grassy roadside ditches
Peak larval activity during 2002: no larvae collected
Peak adult activity during 2002: June 25
Total number of adults collected in 2002: 39
Bites humans: yes
Enters homes: yes
Day biter: yes
Night biter: yes, occasionally
Attracted to artificial light: equally attracted to CDC traps with or without a light
Pest status: moderate
Associated with WNV: unknown

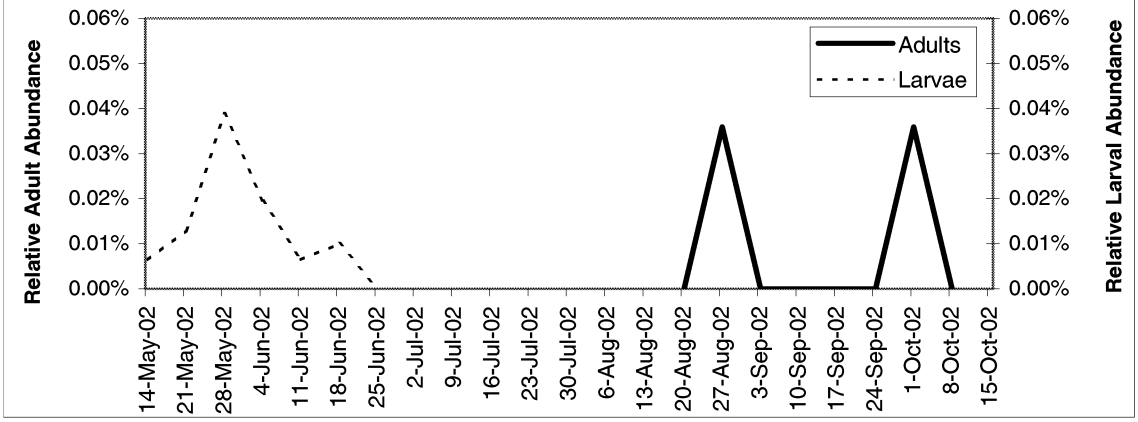
Figure 9. Observed Seasonality: *Ochlerotatus fitchii*



***Ochlerotatus hendersoni* (DeGeer)**

Overwintering stage: egg
Generations per year: 1-2
Primary larval habitat: tires and tree holes enriched with organic material
Secondary larval habitat: -
Peak larval activity during 2002: May 28
Total number of larvae collected in 2002: 27
Peak adult activity during 2002: August 27 and October 1
Total number of adults collected in 2002: 4
Bites humans: unknown
Enters homes: unknown
Day biter: unknown
Night biter: unknown
Attracted to artificial light: observed to be more attracted to CDC traps without a light
Pest status: unknown
Associated with WNV: unknown

Figure 10. Observed Seasonality: *Ochlerotatus hendersoni*

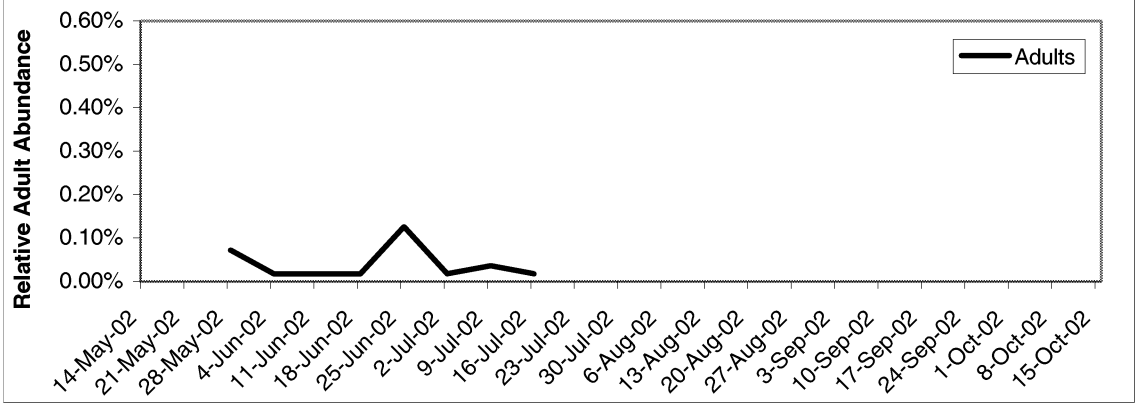


***Ochlerotatus intrudens* (Dyar)**

Overwintering stage: egg
Generations per year: usually 1

Primary larval habitat: woodland temporary snowmelt pools
Secondary larval habitat: bogs, open grassy roadside ditches, permanent and semi-permanent pools
Peak larval activity during 2002: no larvae collected
Peak adult activity during 2002: June 25
Total number of adults collected in 2002: 18
Bites humans: yes
Enters homes: yes
Day biter: yes
Night biter: yes
Attracted to artificial light: yes
Pest status: aggressive biters
Associated with WNV: unknown

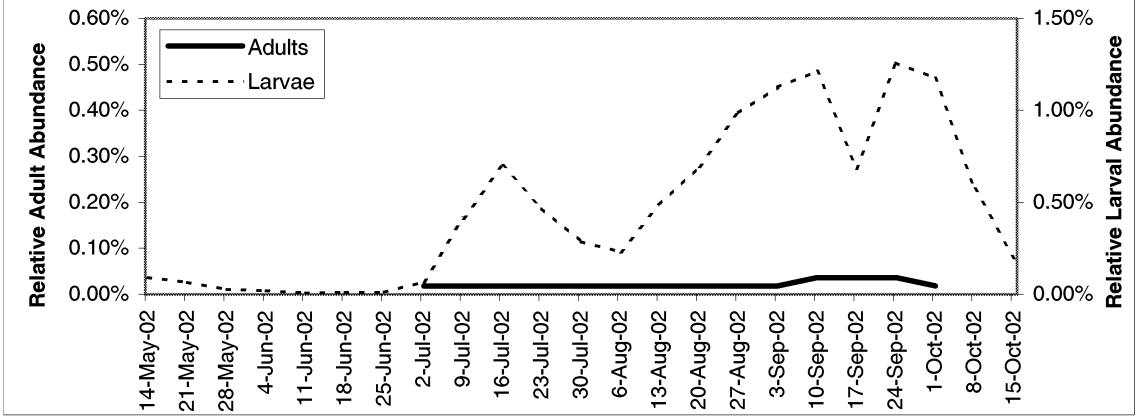
Figure 11. Observed Seasonality: *Ochlerotatus intrudens*



***Ochlerotatus japonicus* (Theobald)**

Overwintering stage: larvae
Generations per year: multiple
Primary larval habitat: tree holes, leaf filled artificial containers and tires
Secondary larval habitat: rock pools
Peak larval activity during 2002: September through early October
Total number of larvae collected in 2002: 3,318
Peak adult activity during 2002: September 17
Total number of adults collected in 2002: 5
Bites humans: yes
Enters homes: yes
Day biter: yes
Night biter: yes
Attracted to artificial light: equally attracted to CDC traps with or without a light
Pest status: will bite, but not extremely aggressive biters
Associated with WNV: yes (CDC 2001)
Special note: Adults can be collected more successfully with Gravid traps than with CO_2 traps. Larvae were collected as early as April 18, 2002 in a tire in Lewiston, Maine.

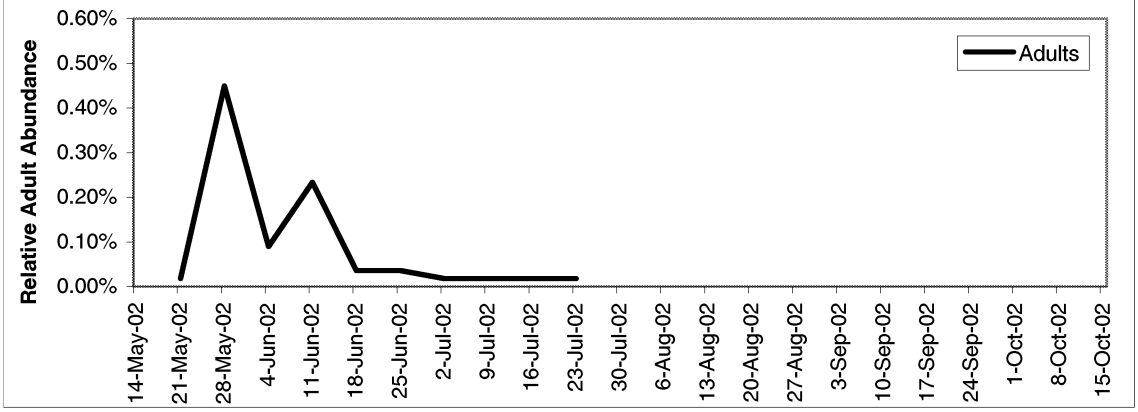
Figure 12. Observed Seasonality: *Ochlerotatus japonicus*



Ochlerotatus provocans (Walker)

Overwintering stage: egg
Generations per year: usually 1
Primary larval habitat: semi permanent marshes
Secondary larval habitat: woodland snowmelt pools and roadside ditches
Peak larval activity during 2002: no larvae collected
Peak adult activity during 2002: May 28
Total number of adults collected in 2002: 50
Bites humans: yes
Enters homes: unknown
Day biter: unknown
Night biter: yes
Attracted to artificial light: equally attracted to CDC traps with or without a light
Pest status: persistent biters
Associated with WNV: unknown

Figure 13. Observed Seasonality: *Ochlerotatus provocans*

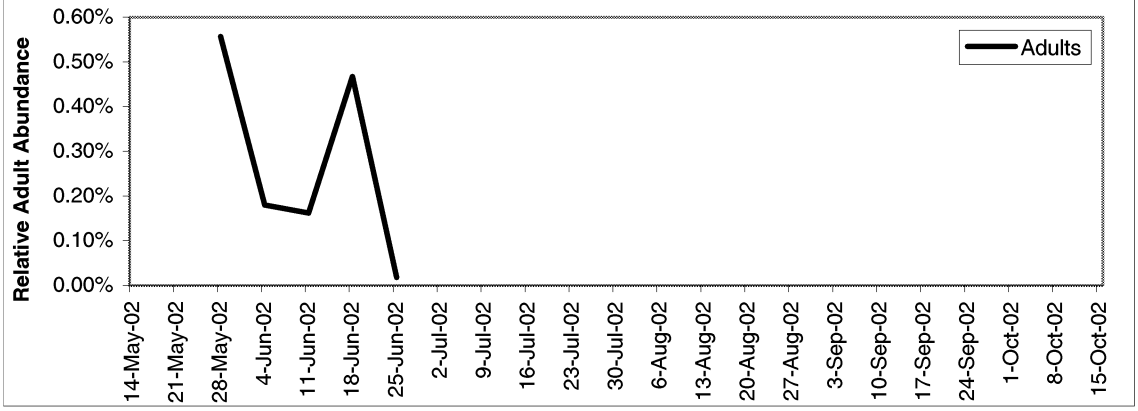


Ochlerotatus punctor (Kirby)

Overwintering stage: egg
Generations per year: usually 1
Primary larval habitat: woodland semi permanent snowmelt pools

Secondary larval habitat: sphagnum bogs, grassy marshes
Peak larval activity during 2002: no larvae collected
Peak adult activity during 2002: May through June
Total number of adults collected in 2002: 77
Bites humans: yes
Enters homes: yes
Day biter: yes
Night biter: yes
Attracted to artificial light: yes
Pest status: moderate in wooded areas
Associated with WNV: unknown

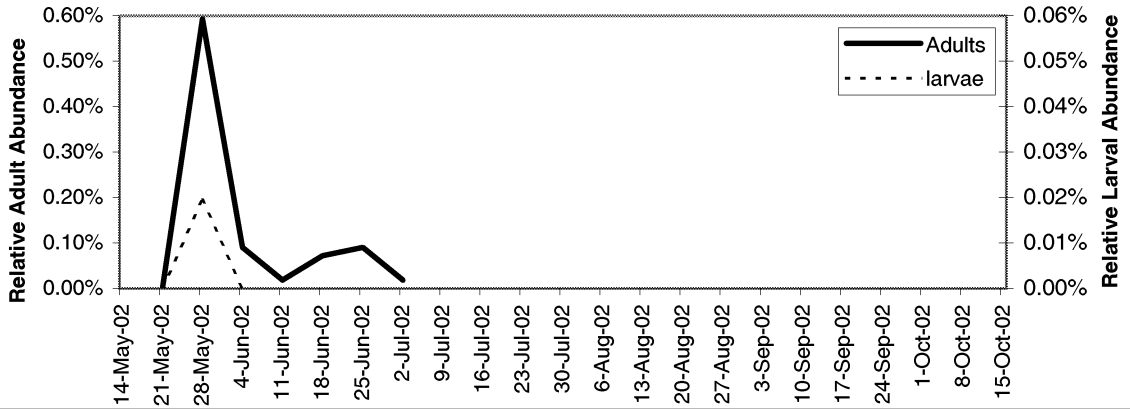
Figure 14. Observed Seasonality: *Ochlerotatus punctor*



***Ochlerotatus sticticus* (Meigen)**

Overwintering stage: egg
Generations per year: 1-2
Primary larval habitat: woodland temporary snowmelt pools
Secondary larval habitat: river floodplains
Peak larval activity during 2002: May 28
Total number of larvae collected in 2002: 6
Peak adult activity during 2002: May 28
Total number of adults collected in 2002: 49
Bites humans: yes
Enters homes: yes
Day biter: yes
Night biter: yes
Attracted to artificial light: yes
Pest status: persistent and aggressive biters
Associated with WNV: unknown

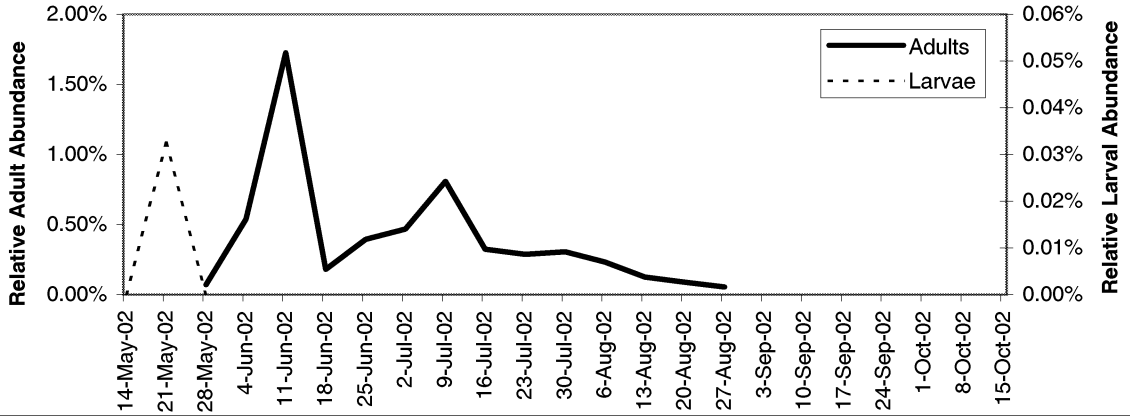
Figure 15. Observed Seasonality: *Ochlerotatus sticticus*



Ochlerotatus stimulans (Walker)

Overwintering stage: egg
Generations per year: 1
Primary larval habitat: woodland semi permanent and temporary snowmelt pools
Secondary larval habitat: river floodplains
Peak larval activity during 2002: May 21
Total number of larvae collected in 2002: 10
Peak adult activity during 2002: June 11
Total number of adults collected in 2002: 312
Bites humans: yes
Enters homes: unknown
Day biter: yes
Night biter: yes
Attracted to artificial light: equally attracted to CDC traps with or without a light
Pest status: high in wooded areas
Associated with WNV: unknown

Figure 16. Observed Seasonality: *Ochlerotatus stimulans*

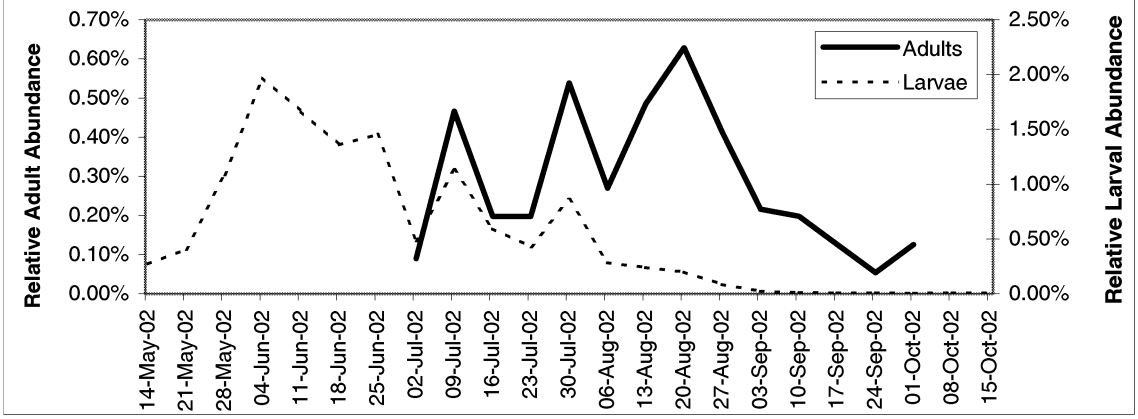


Ochlerotatus triseriatus (Say)

Overwintering stage: egg
Generations per year: usually 1

Primary larval habitat: tree holes and tires
Secondary larval habitat: artificial containers with organic debris
Peak larval activity during 2002: June 4
Total number of larvae collected in 2002: 3,875
Peak adult activity during 2002: July through August
Total number of adults collected in 2002: 223
Bites humans: yes
Enters homes: yes
Day biter: yes
Night biter: yes
Attracted to artificial light: equally attracted to CDC traps with or without a light
Pest status: high, aggressive in wooded areas
Associated with WNV: yes (CDC 2001)

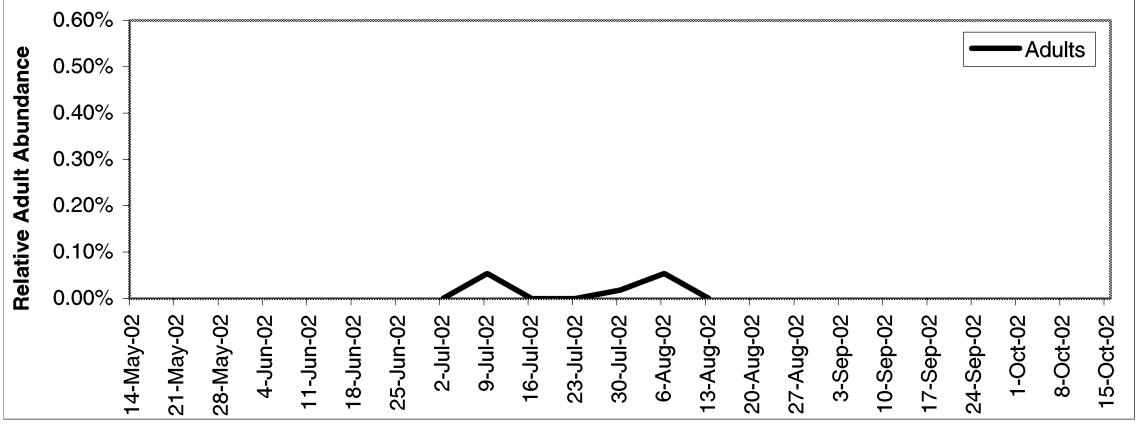
Figure 17. Observed Seasonality: *Ochlerotatus triseriatus*



***Ochlerotatus trivittatus* (Coquillett)**

Overwintering stage: egg
Generations per year: 1-2
Primary larval habitat: woodland temporary snowmelt pools
Secondary larval habitat: swamps and shallow grassy depressions
Peak larval activity during 2002: no larvae collected
Peak adult activity during 2002: July 9 and August 6
Total number of adults collected in 2002: 7
Bites humans: yes
Enters homes: yes
Day biter: yes
Night biter: yes
Attracted to artificial light: equally attracted to CDC traps with or without a light
Pest status: low-moderate
Associated with WNV: yes (CDC 2001)

Figure 18. Observed Seasonality: *Ochlerotatus trivittatus*



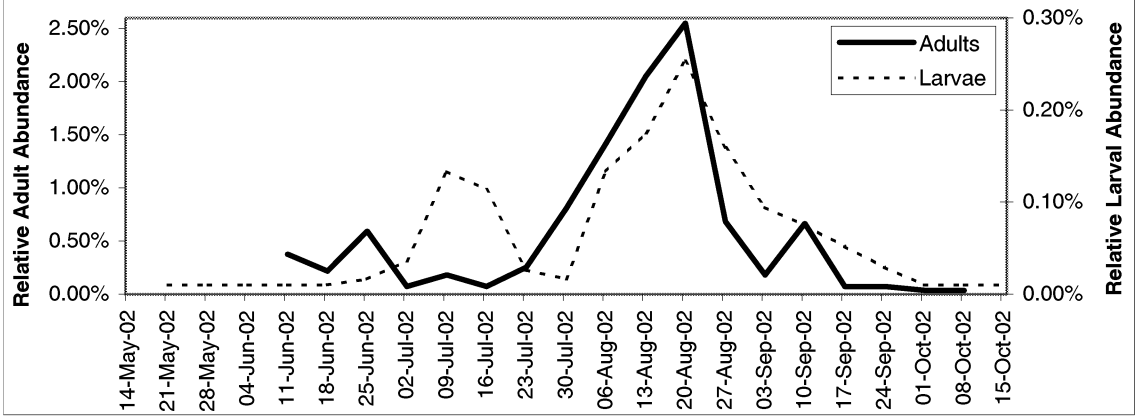
***Anopheles earlei* (Vargas)**

Overwintering stage: adult
Generations per year: 1-2
Primary larval habitat: river, stream, brook edges and floating debris in ponds
Secondary larval habitat: artificial containers (excluding tires), shaded puddles, roadside ditches
Peak larval activity during 2002: unknown
Total number of larvae collected in 2002: 2
Peak adult activity during 2002: no adults collected
Bites humans: yes
Enters homes: yes
Day biter: yes
Night biter: yes
Attracted to artificial light: yes
Pest status: aggressive biters
Associated with WNV: no

***Anopheles punctipennis* (Say)**

Overwintering stage: adult
Generations per year: 2-3
Primary larval habitat: river, stream, brook edges and floating debris in ponds
Secondary larval habitat: - artificial containers, excluding tires, shaded puddles, roadside ditches
Peak larval activity during 2002: August 20
Total number of larvae collected in 2002: 419
Peak adult activity during 2002: August 20
Total number of adults collected in 2002: 567
Bites humans: yes
Enters homes: yes
Day biter: yes in shaded areas
Night biter: yes
Attracted to artificial light: equally attracted to CDC traps with or without a light
Pest status: moderate
Associated with WNV: yes (CDC 2001)
Note: adults collected as early as April 13, 2002 in Lewiston and Rumford, Maine

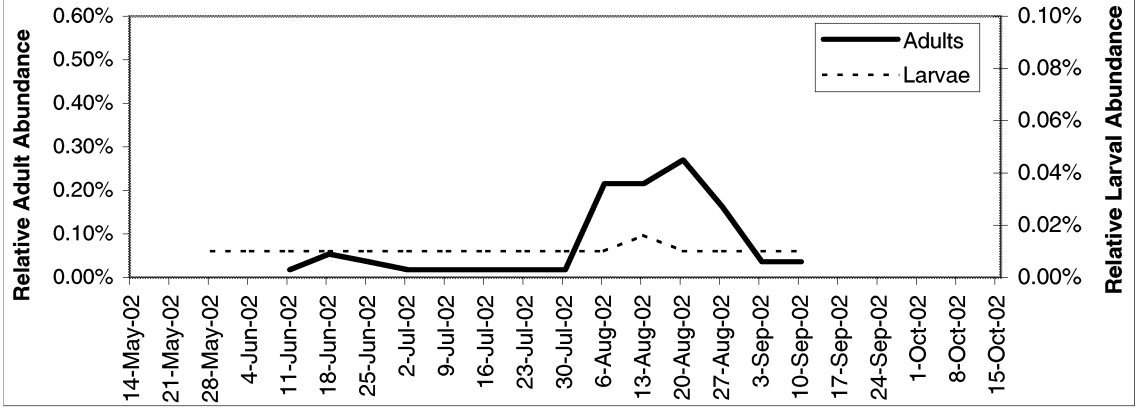
Figure 19. Observed Seasonality: *Anopheles punctipennis*



***Anopheles quadrimaculatus* (Say)**

Overwintering stage: adult
Generations per year: 2-3
Primary larval habitat: near emergent vegetation in ponds
Secondary larval habitat: freshwater marshy areas, salt marshes
Peak larval activity during 2002: August 13
Total number of larvae collected in 2002: 23
Peak adult activity during 2002: August 20
Total number of adults collected in 2002: 60
Bites humans: yes
Enters homes: yes
Day biter: yes in shaded areas
Night biter: yes
Attracted to artificial light: equally attracted to CDC traps with or without a light
Pest status: moderate
Associated with WNV: yes (CDC 2001)
Note: adults collected as early as April 13, 2002 in Lewiston and Rumford, Maine

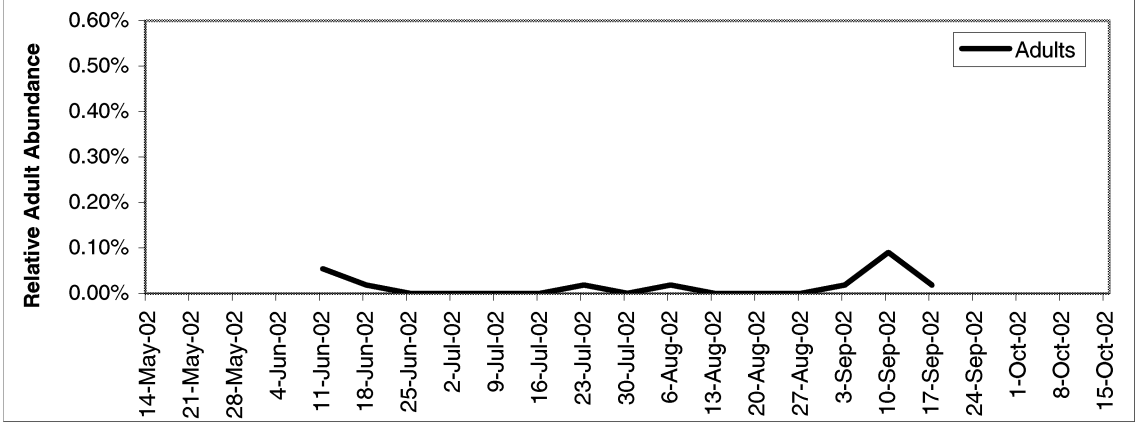
Figure 20. Observed Seasonality: *Anopheles quadrimaculatus*



Anopheles walkeri (Theobald)

Overwintering stage: egg
Generations per year: 2-3
Primary larval habitat: near emergent vegetation in ponds
Secondary larval habitat: - cattail marshes and open grassy pools
Peak larval activity during 2002: no larvae collected
Peak adult activity during 2002: September 10
Total number of adults collected in 2002: 12
Bites humans: yes
Enters homes: yes
Day biter: yes
Night biter: yes
Attracted to artificial light: yes
Pest status: unknown
Associated with WNV: unknown

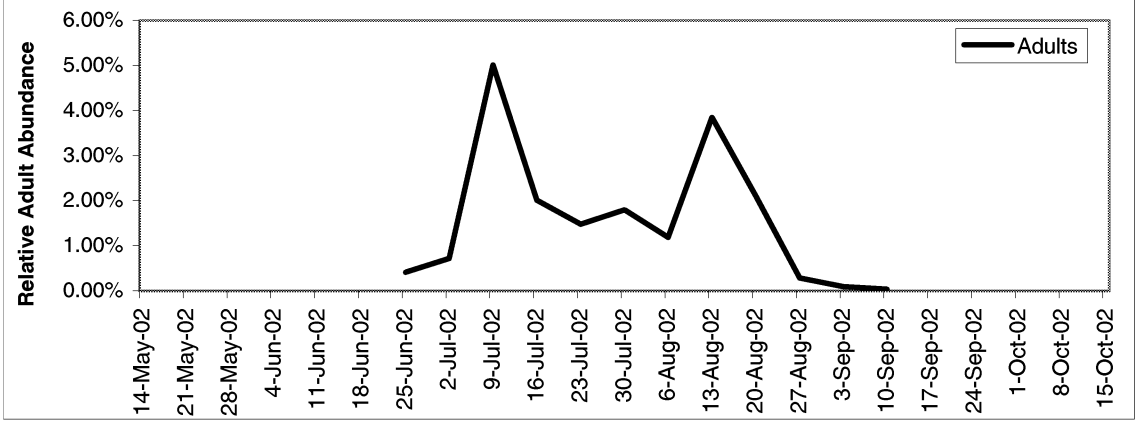
Figure 21. Observed Seasonality: *Anopheles walkeri*



Coquillettidia perturbans (Walker)

Overwintering stage: larval
Generations per year: 1-2
Primary larval habitat: Attached to the bottom of aquatic plants, marshes
Secondary larval habitat: -
Peak larval activity during 2002: no larvae collected
Peak adult activity during 2002: July 9 and August 13
Total number of adults collected in 2002: 1,056
Bites humans: yes
Enters homes: yes
Day biter: yes
Night biter: yes
Attracted to artificial light: equally attracted to CDC traps with or without a light
Pest status: major, aggressive biters
Associated with WNV: yes (CDC 2001)

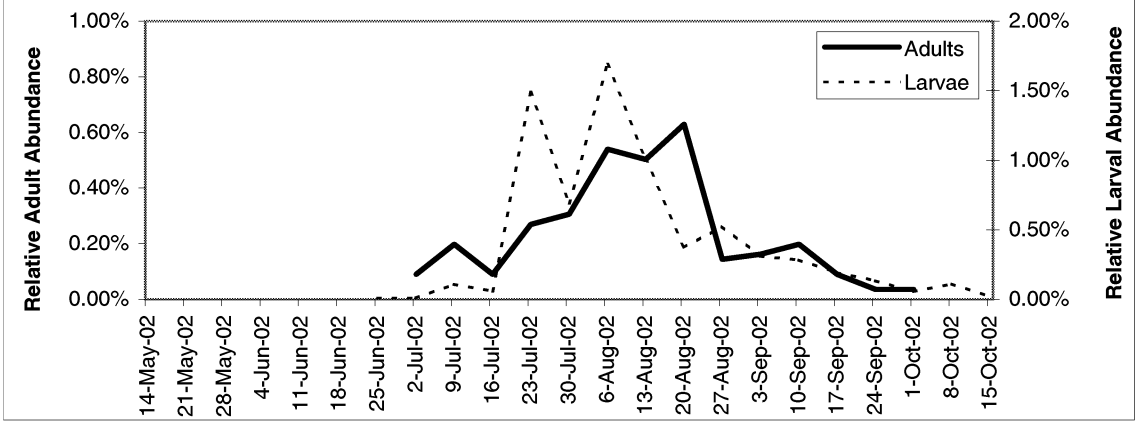
Figure 22. Observed Seasonality: *Coquillettidia perturbans*



Culex pipiens (Linn.)

Overwintering stage: adult
Generations per year: 1-2
Primary larval habitat: algae filled agricultural waste pools, sunny roadside vegetated ditches
Secondary larval habitat: artificial containers and tires filled with organic debris
Peak larval activity during 2002: August 6
Total number of larvae collected in 2002: 2,175
Peak adult activity during 2002: August 20
Total number of adults collected in 2002: 176
Bites humans: rarely, primarily an avian feeder
Enters homes: yes
Day biter: less commonly
Night biter: most commonly
Attracted to artificial light: equally attracted to CDC traps with or without a light
Pest status: primarily on birds
Associated with WNV: yes (CDC 2001), potential secondary vector

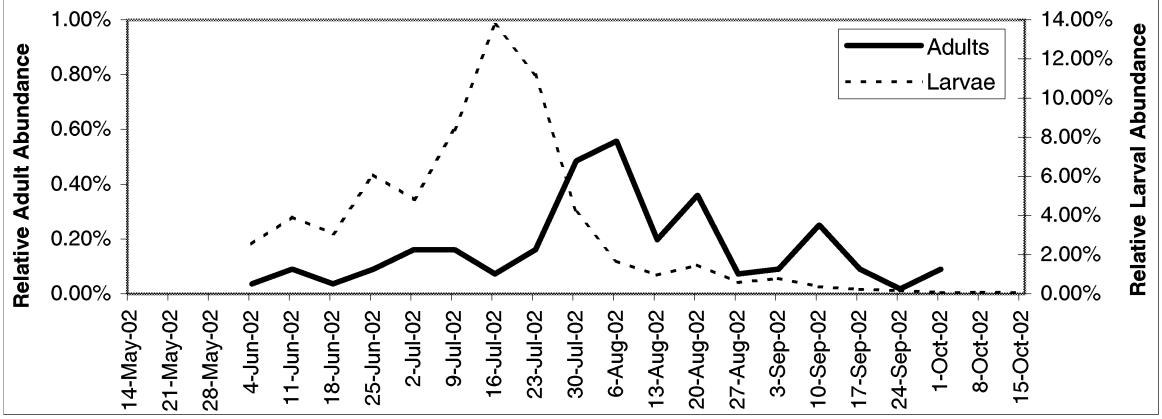
Figure 23. Observed Seasonality: *Culex pipiens*



Culex restuans (Theobald)

Overwintering stage: adult
Generations per year: 1-2
Primary larval habitat: tree holes, artificial containers, tires
Secondary larval habitat: ditches and temporary puddles with organic material present
Peak larval activity during 2002: July 16
Total number of larvae collected in 2002: 19,832
Peak adult activity during 2002: August 6
Total number of adults collected in 2002: 158
Bites humans: yes, but seems to prefer birds and other hosts
Enters homes: yes
Day biter: yes in shaded areas
Night biter: yes
Attracted to artificial light: yes
Pest status: low
Associated with WNV: yes (CDC 2001)

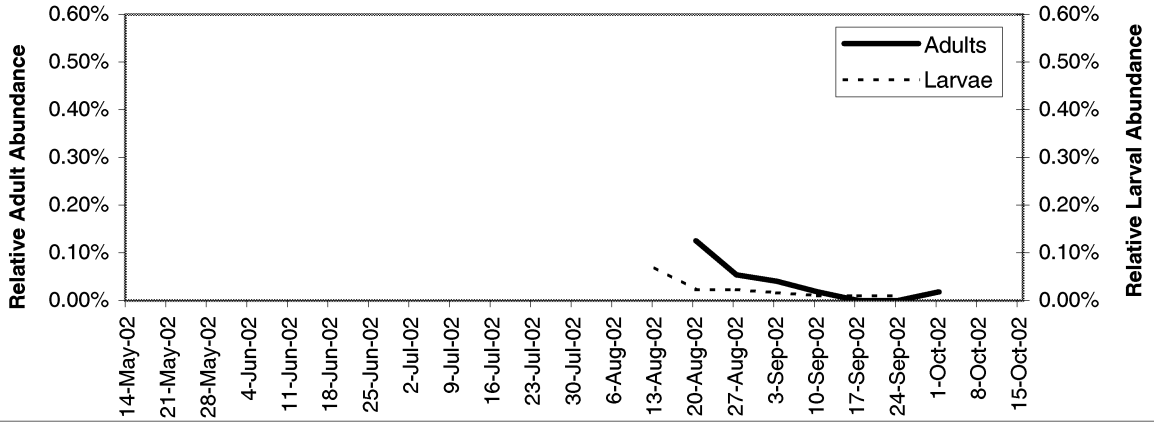
Figure 24. Observed Seasonality: *Culex restuans*



Culex salinarius (Coquillett)

Overwintering stage: adult
Generations per year: 1-2
Primary larval habitat: Artificial containers, brackish waters, flooded grassy areas
Secondary larval habitat: coastal and inland freshwater ground pools, discarded tires
Peak larval activity during 2002: August 13
Total number of larvae collected in 2002: 45
Peak adult activity during 2002: August 20
Total number of adults collected in 2002: 9
Bites humans: yes
Enters homes: yes
Day biter: no
Night biter: yes
Attracted to artificial light: yes
Pest status: aggressive biter
Associated with WNV: yes (CDC 2001)

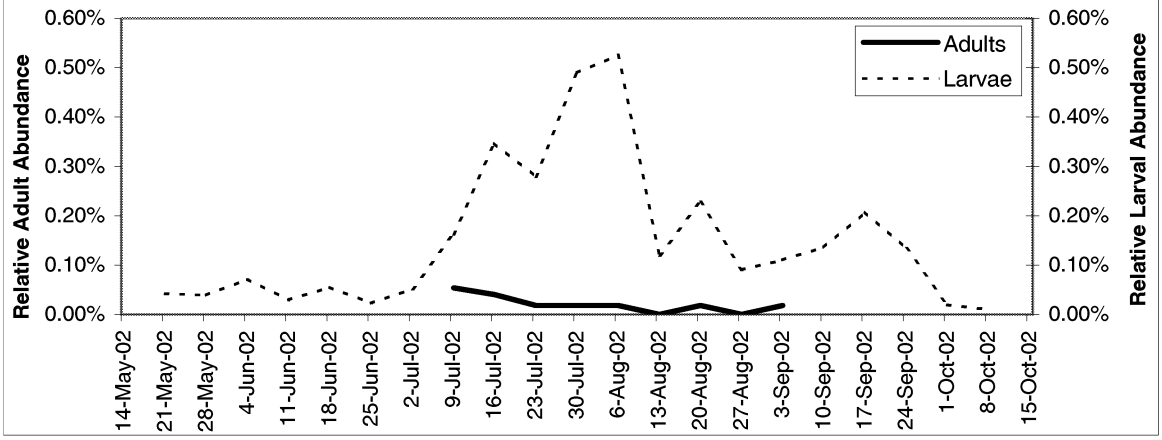
Figure 25. Observed Seasonality: *Culex salinarius*



***Culex territans* (Walker)**

Overwintering stage: adult
Generations per year: 1-3
Primary larval habitat: river, stream, brook edges and floating debris in ponds
Secondary larval habitat: - artificial containers, shaded puddles, roadside ditches
Peak larval activity during 2002: August 6
Total number of larvae collected in 2002: 977
Peak adult activity during 2002: July 9
Total number of adults collected in 2002: 6
Bites humans: rarely, feeds primarily on amphibians and reptiles
Enters homes: rarely
Day biter: yes
Night biter: yes
Attracted to artificial light: equally attracted to CDC traps with or without a light
Pest status: unknown
Associated with WNV: unknown

Figure 26. Observed Seasonality: *Culex territans*

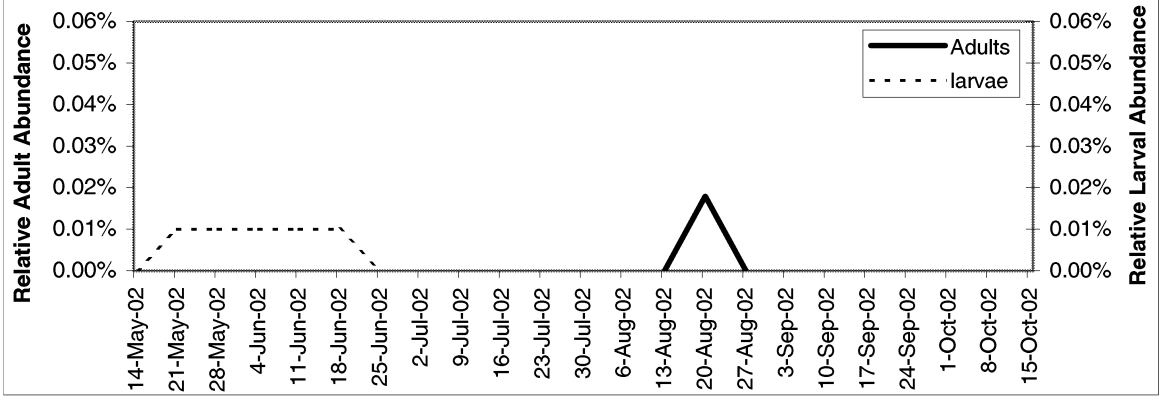


***Culiseta minnesotae* (Barr)**

Overwintering stage: adult

Generations per year: 1-2
Primary larval habitat: woodland temporary snowmelt pools
Secondary larval habitat: - permanent sedge and cattail marshes
Peak larval activity during 2002: May through June
Total number of larvae collected in 2002: 5
Peak adult activity during 2002: August 20
Total number of adults collected in 2002: 1
Bites humans: rarely
Enters homes: unknown
Day biter: unknown
Night biter: yes
Attracted to artificial light: equally attracted to CDC traps with or without a light
Pest status: unknown
Associated with WNV: unknown

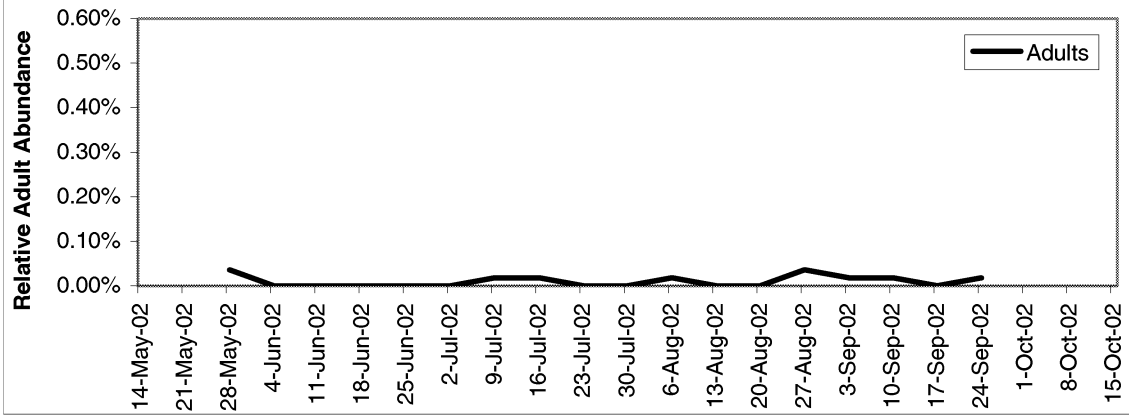
Figure 27. Observed Seasonality: *Culiseta minnesotae*



***Culesita morsitans* (Theobald)**

Overwintering stage: egg
Generations per year: usually 1
Primary larval habitat: shaded acidic swamps and bogs
Secondary larval habitat: holes under stumps in temporary woodland pools and marshes
Peak larval activity during 2002: no larvae collected
Peak adult activity during 2002: variable, throughout season
Total number of adults collected in 2002: 10
Bites humans: yes
Enters homes: unknown
Day biter: unknown
Night biter: yes
Attracted to artificial light: equally attracted to CDC traps with or without a light
Pest status: unknown
Associated with WNV: unknown

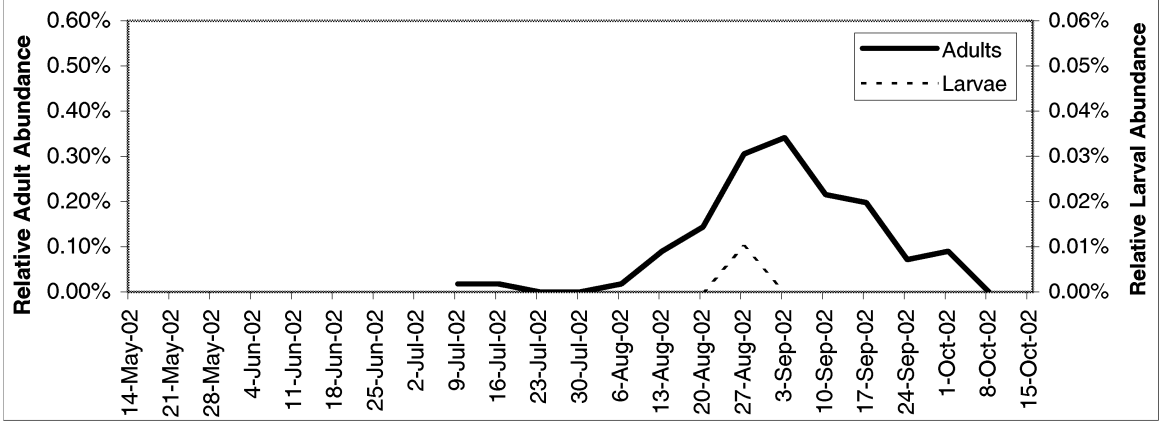
Figure 28. Observed Seasonality: *Culiseta morsitans*



Uranotaenia sapphirina (Osten-Sacken)

Overwintering stage: adult
Generations per year: 1-2
Primary larval habitat: floating vegetation in ponds
Secondary larval habitat: sphagnum bogs
Peak larval activity during 2002: August 27
Total number of larvae collected in 2002: 1
Peak adult activity during 2002: September 3
Total number of adults collected in 2002: 79
Bites humans: rarely
Enters homes: no
Day biter: unknown
Night biter: yes
Attracted to artificial light: yes
Pest status: unknown
Associated with WNV: yes (CDC 2001)

Figure 29. Observed Seasonality: *Uranotaenia sapphirina*



Relative Abundance of Mosquito Species Collected in Androscoggin County During the 2002 Project Season

There were 31 species with 5,574 individual adult mosquitoes and 17 species with 30,825 individual larvae collected and identified in Lewiston, Auburn and Sabattus upon completion of this survey. A total of 32 mosquito species were charted with relative abundance for adults (Figure 30) and larvae (Figure 31) calculated.

Figure 30. Relative Abundance of Adults collected in the Androscoggin County area: May 14 through October 15, 2002

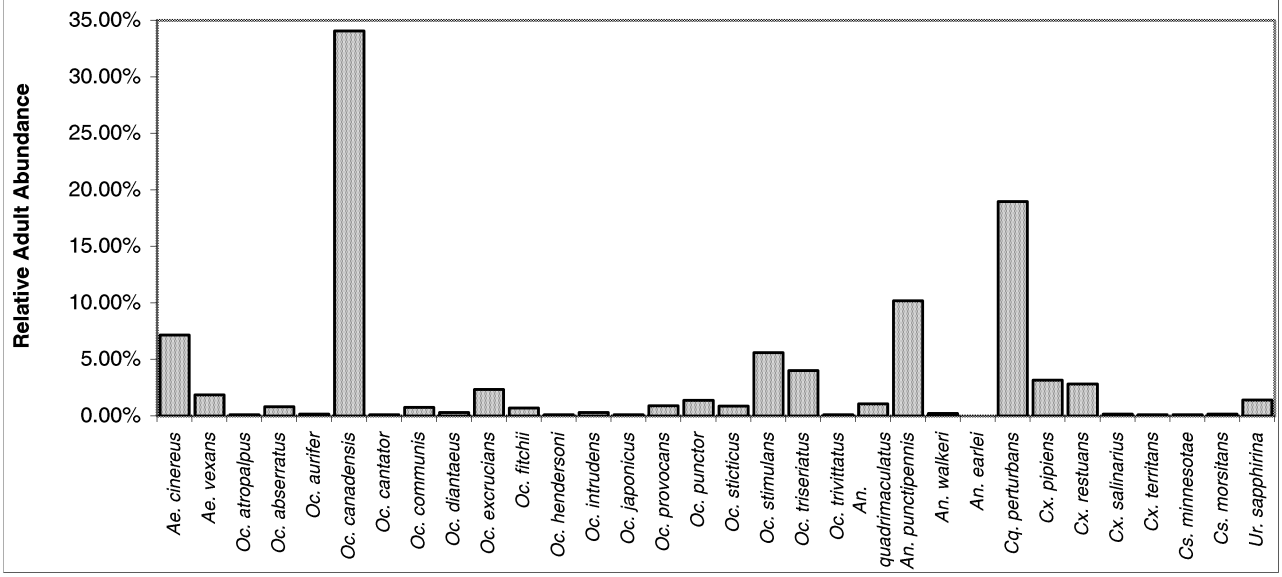
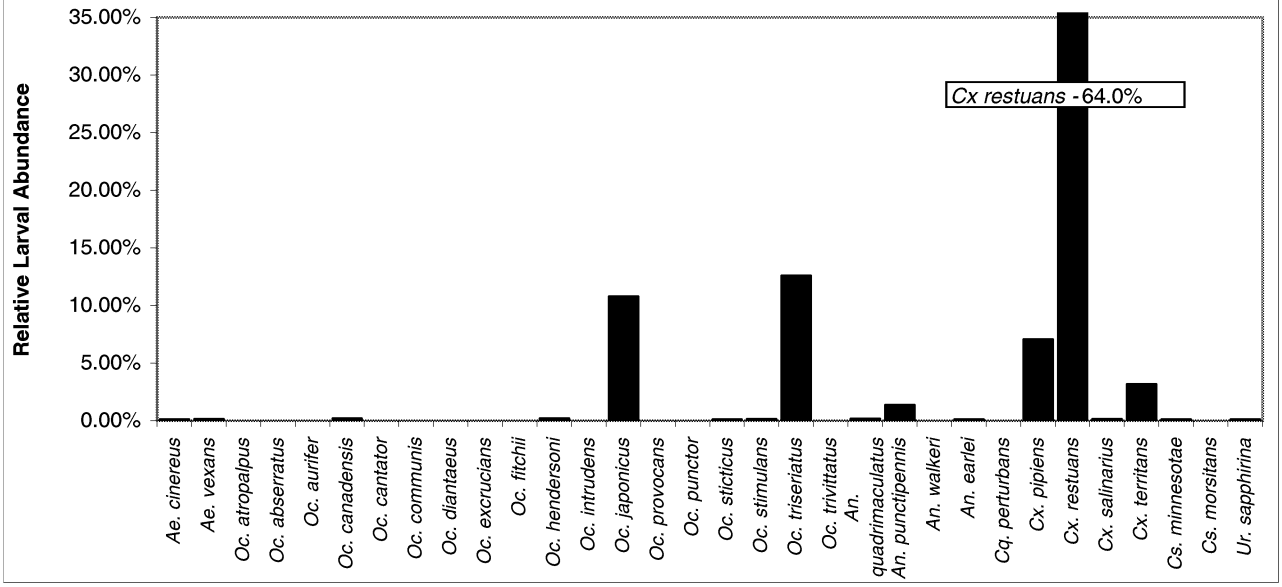


Figure 31. Relative Abundance of Larvae collected in the Androscoggin County area: May 14 through October 15, 2002

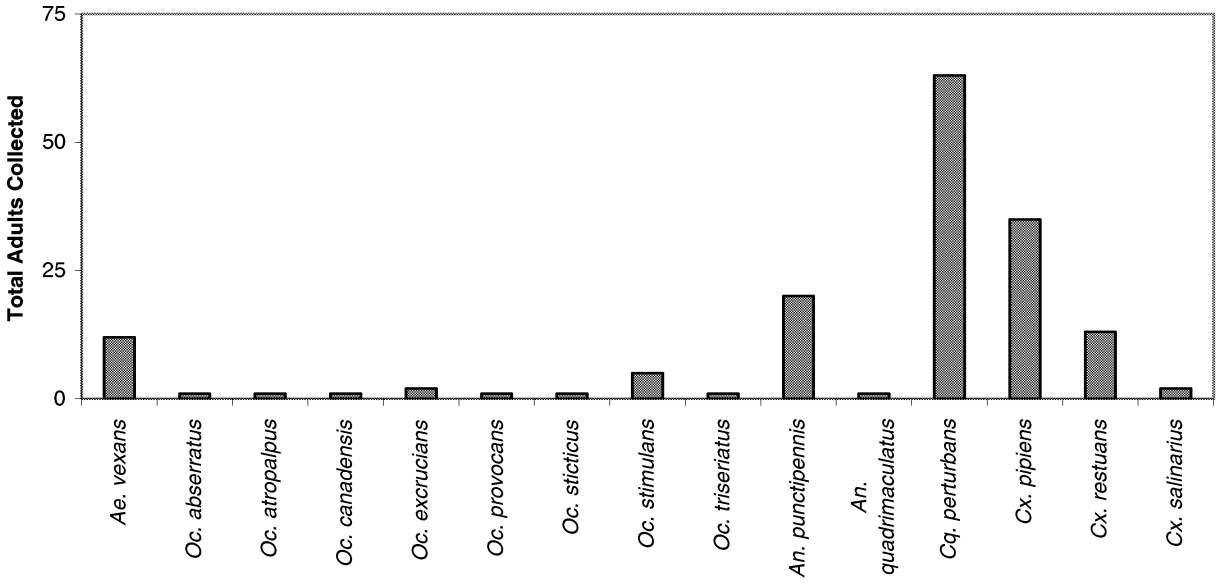


Total Mosquito Adults Collected Per Trapping Site During the 2002 Project Season

Auburn, Maine

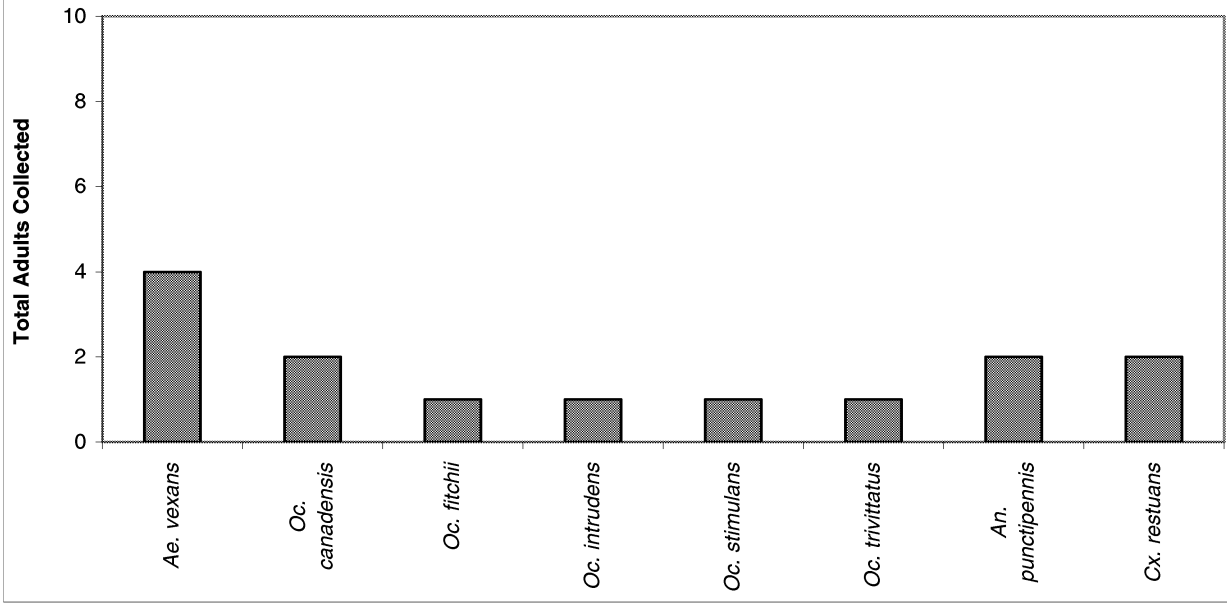
Site #1- 545 Riverside Drive, Auburn, adjacent to a winter crow roost. 1 CO_2 trap. A total of 159 adult mosquitoes were collected and identified at this site (Figure 32).

Figure 32. Total Adult Mosquito Species collected at Site # 1 during 2002



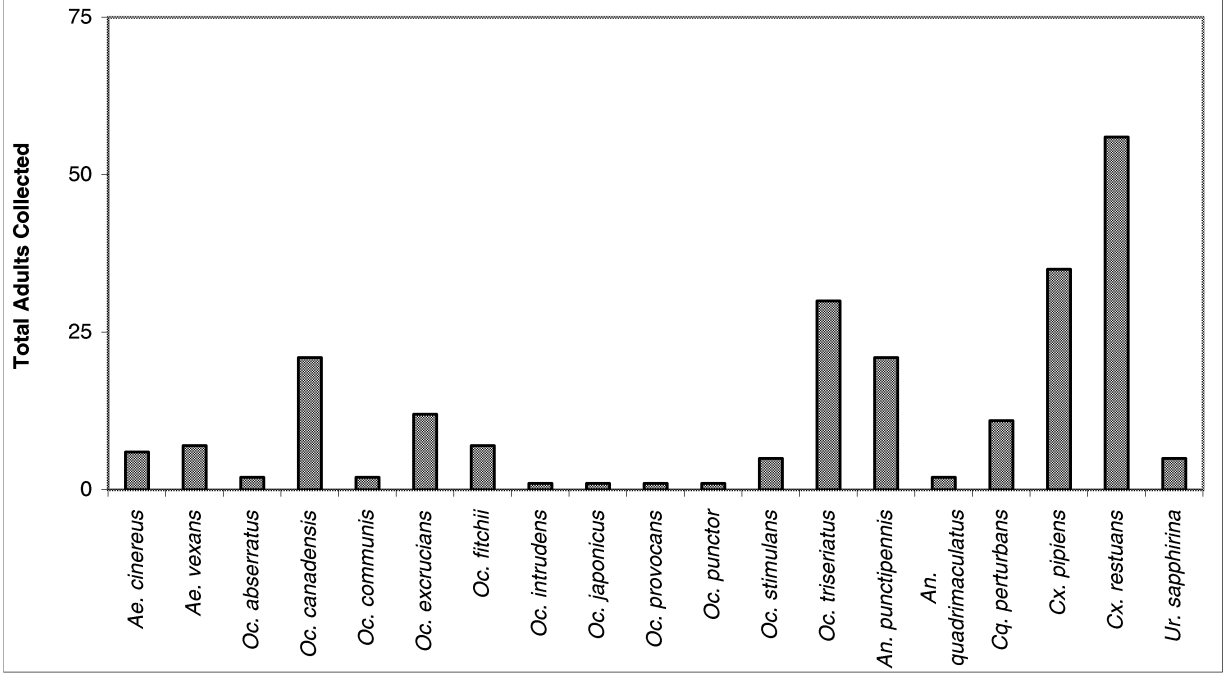
Site #2- Auburn Police Department, corner of Union and Court Street. 1 CO_2 trap. A total of 14 adult mosquitoes were collected and identified at this site (Figure 33).

Figure 33. Total Adult Mosquito Species collected at Site # 2 during 2002



Site #3- 88 Lake Street, Auburn, adjacent to an Elementary School. 1 CO_2 trap. A total of 226 adult mosquitoes were collected and identified at this site (Figure 34).

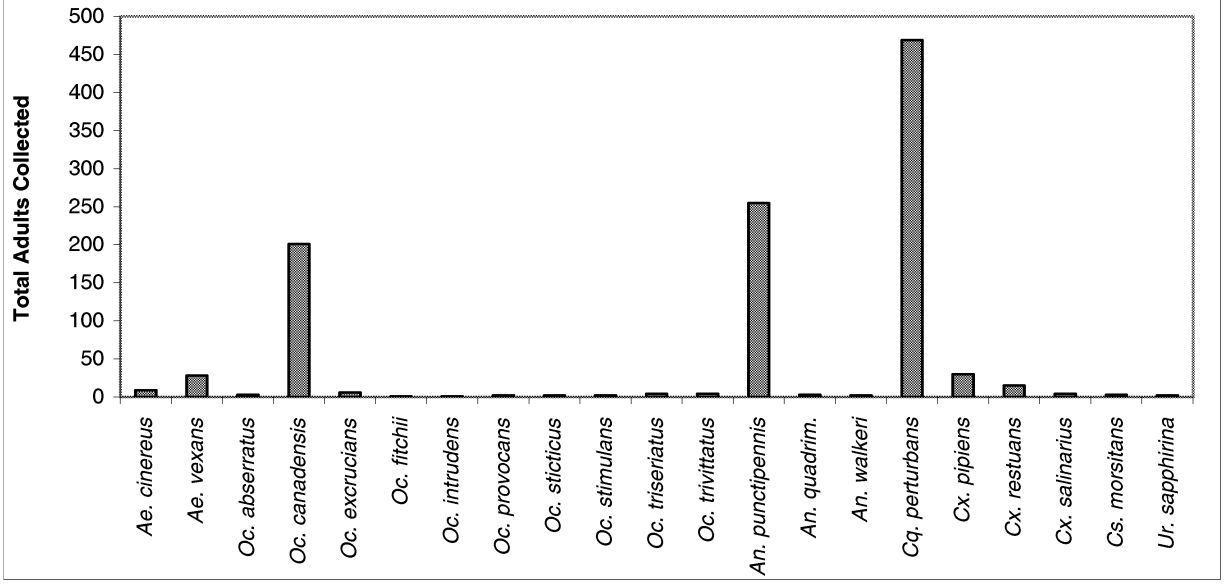
Figure 34. Total Adult Mosquito Species collected at Site # 3 during 2002



Lewiston, Maine

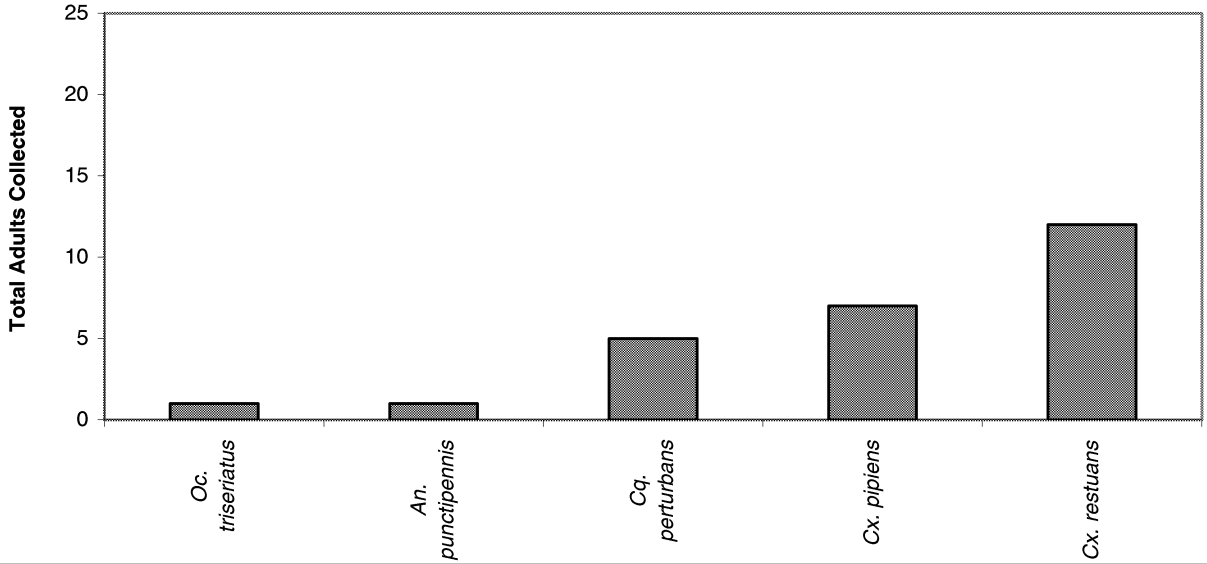
Site #4- Elliot Avenue Little League Ball Fields, Lewiston. 1 CO_2 trap. A total of 1,046 adult mosquitoes were collected and identified at this site (Figure 35).

Figure 35. Total Adult Mosquito Species collected at Site #4 during 2002



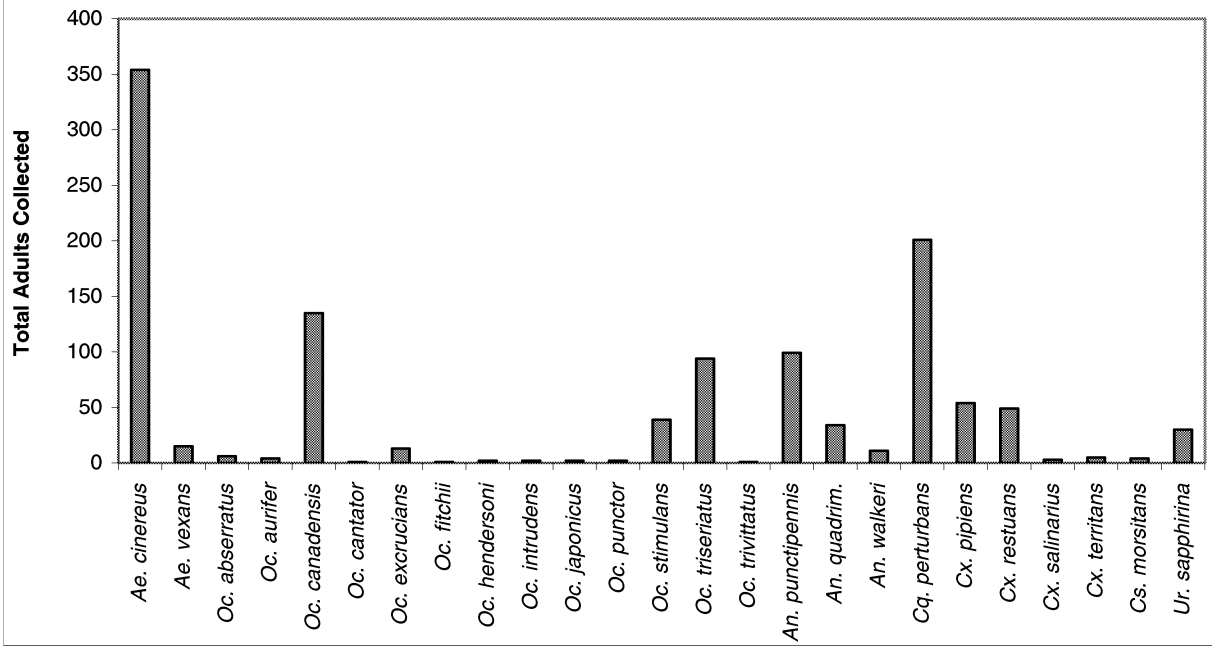
Site #5- Lewiston Fire Department, corner of Ash and Bates Street, Lewiston. 1 CO_2 trap. A total of 26 adult mosquitoes were collected and identified at this site (Figure 36).

Figure 36. Total Adult Mosquito Species collected at Site # 5 during 2002

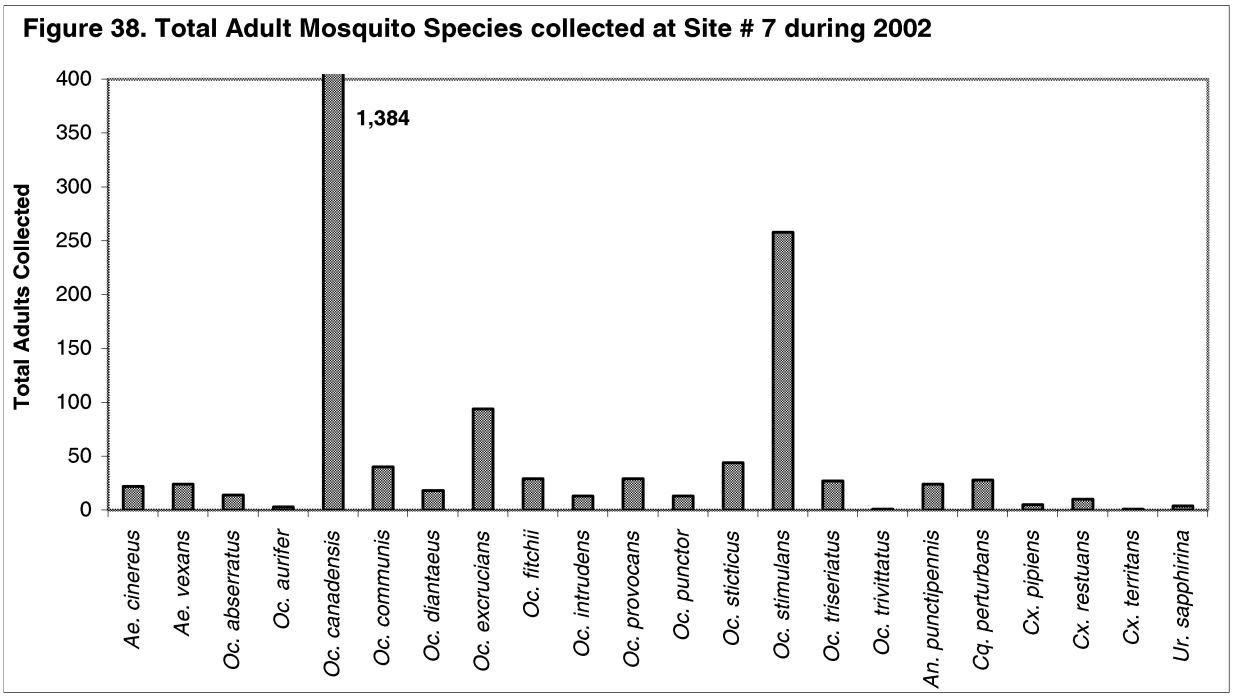


Site #6- 7 Knowlton Street in Lewiston. 2 CO_2 traps. A total of 1,161 adult mosquitoes were collected and identified at this site (Figure 37).

Figure 37. Total Adult Mosquito Species collected at Site # 6 during 2002

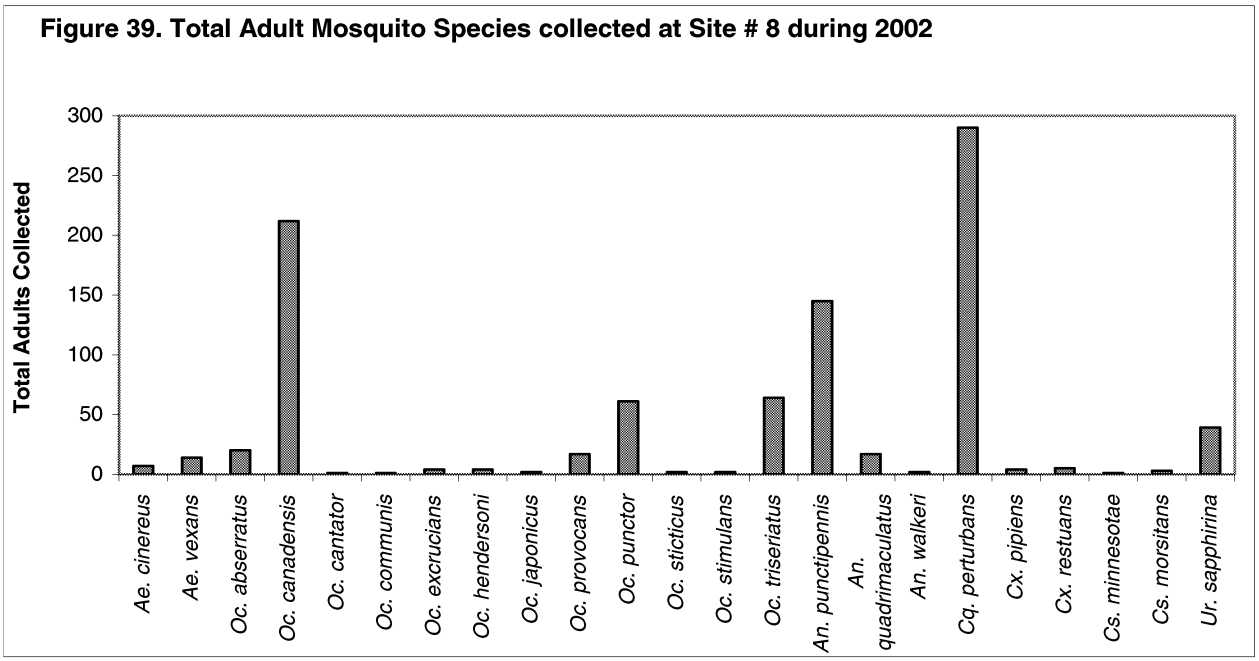


Site #7- Bell Farms off River Road in Lewiston, also a crow feeding area. 2 CO_2 traps. A total of 2,025 adult mosquitoes were collected and identified at this site (Figure 38).



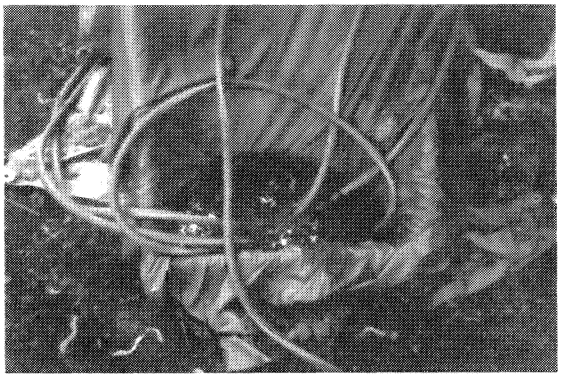
Sabattus, Maine

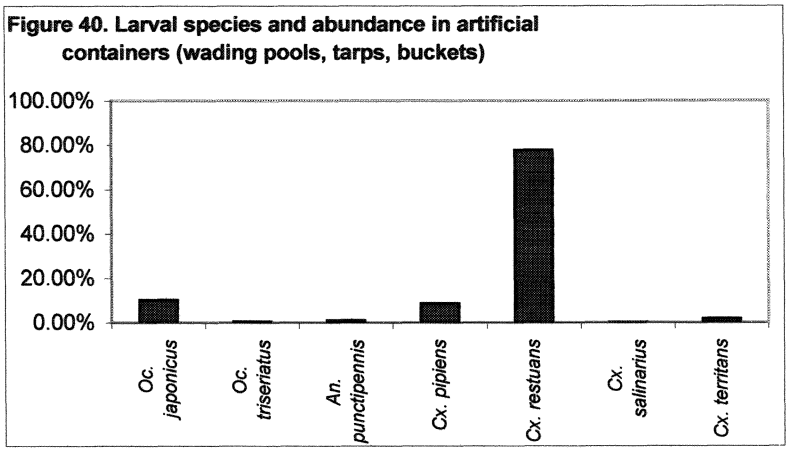
Site #8- Ballpark Road, Sabattus. Site of the 2001 positive crow. 2 CO_2 traps. A total of 917 adult mosquitoes were collected and identified at this site (Figure 39).



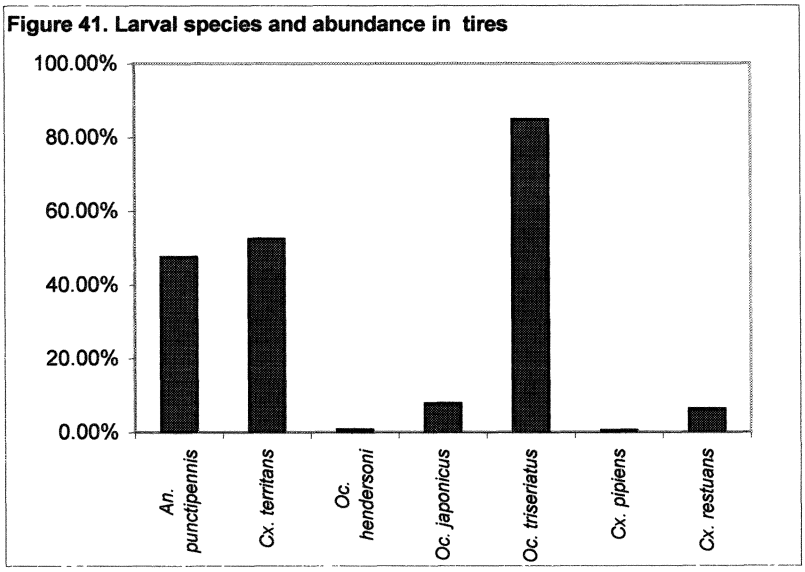
Larval Habitat Information Collected During the 2002 Project Season

Artificial Containers (tarps, wading pools, infusion containers)

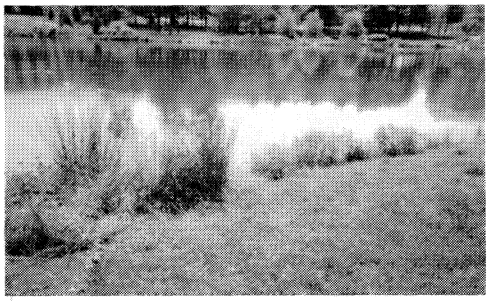


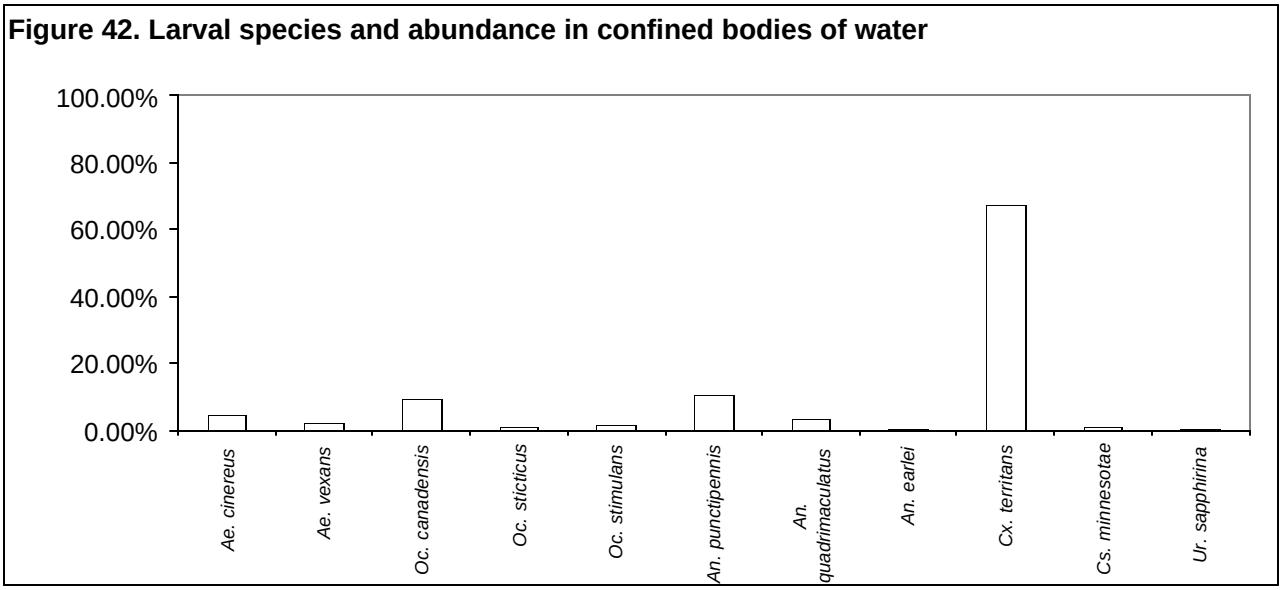


Artificial Containers (discarded tires)

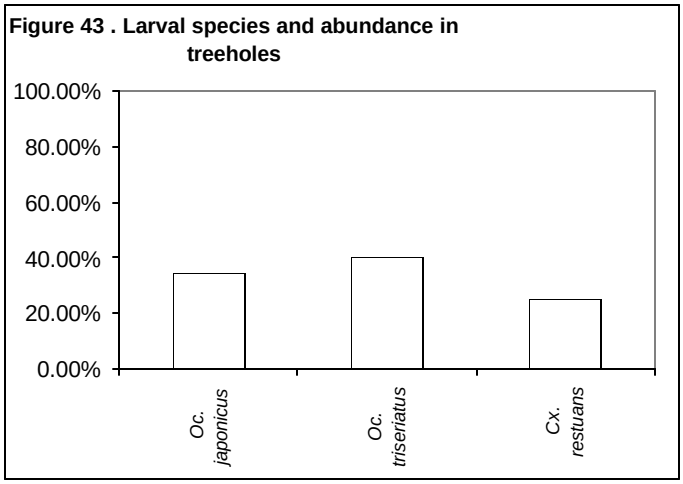


Confined Bodies of Water (ponds, freshwater marshes, temporary snowmelt pools)





Natural Containers (tree holes)



Moving Bodies of Water (river, stream, brook edges)

Egg Rafting Results

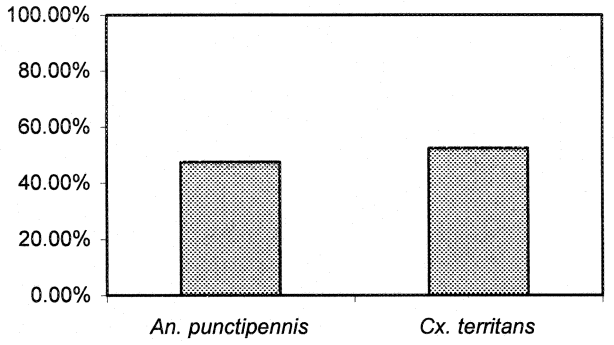
Egg rafting took place from May 14 through August, 2002. It was determined that current egg rafting techniques were not sufficient to determine *Culex pipiens* species populations. The *Culex* egg rafts were collected, counted, and placed individually into 24-well microplates, the wells were filled half-way with hay infusion and kept in a cool place away from sunlight. Upon hatching *Cx. pipiens* and *Cx. restuans* first instar larvae were identified by the transparent window located above the egg tooth on the dorsal portion of the head. If there was a window it was assumed to be *Cx. restuans*, if no window was present it was assumed to be *Cx. pipiens*. However, after collecting other *Culex* species in the infusion containers (*Cx. salinarius* and *Cx. territans*) and rearing several assumed *Cx. pipiens* larvae, **we have demonstrated that the first instar transparent window can not be used as a defining characteristic, as *Cx. territans* and *Cx. salinarius* as well as *Cx. pipiens* larvae do not have this transparent window at first instar.**

Additional 2002 Mosquito Responses and Activities

Mosquito Larvae Collected in Portland, Maine from Selected Catch Basins

With the assistance of David Petersen, Senior Wastewater Technician for the Portland Public Works Department, ten catch basins were randomly chosen [two each from around the five 2001 Portland sampling sites (Foss and Dearborn 2001)] and were sampled once per month, from July through October. The sampling yielded larvae of *Culex pipiens*, *Cx. restuans* and *Cx salinarius* (Table 1.). These basins did not contain larvae of *Ochlerotatus japonicus*. Although

Figure 44 . Larval species and abundance in moving bodies of water



adults were observed when sampling for larvae, none were collected for identification. It was noticed that larval populations increased in August 2002, despite the low water levels and dry conditions in the basins checked.

Any direct correlation between the presence or absence of: overhanging vegetation or Casco and hydrobreak traps and breeding mosquito populations could not be ascertained. We had hoped to be able to use such a relationship to facilitate predicting suitable breeding sites. The degree and type of debris floating on the surface of the water within the basins did; however, appear to have an influence (Figure 45). Also, the absence of rain created stagnant conditions suitable for breeding. When the water level rose from adequate rain, the larvae washed away with the debris in the basins without Casco or hydrobreak traps. Catch basins with traps were more likely to maintain a mosquito population regardless of the amount or frequency of rain.

Further annual studies to assess larval densities and seasonality within catch basins under differing weather patterns are needed to aid in developing mosquito management strategies.

Fig 45. An off road catch basin in Lewiston suitable for mosquito breeding.

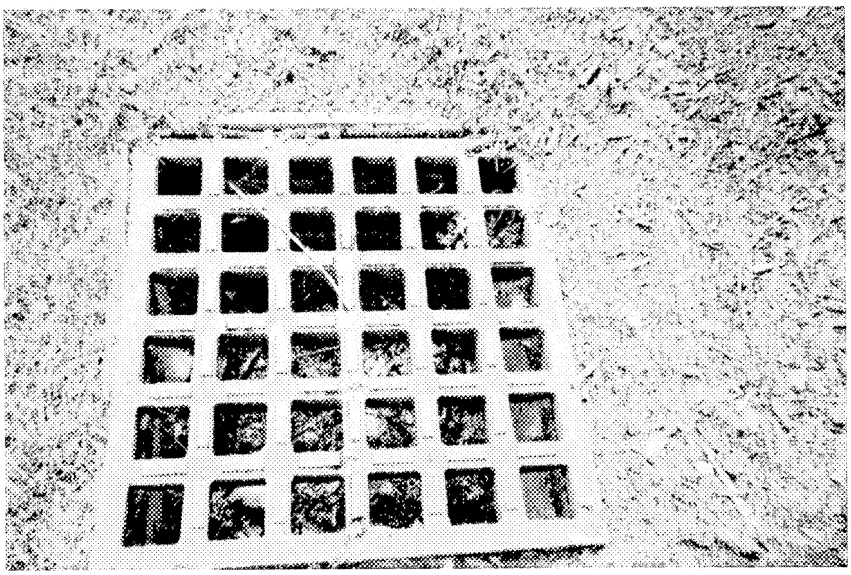


Table 1. Portland, Maine- Mosquito larvae collected from selected catch basins during 2002.

Street Intersection	2001 Portland Project Site Number	July 17, 2002		August 14, 2002			September 18, 2002		October 16, 2002	
		Cx. restuans	*Cx. pipiens*	*Cx. restuans*	*Cx. pipiens*	*Cx. salinarius*	*Cx. restuans*	*Cx. pipiens*	*Cx. restuans*	*Cx. pipiens*
Pearl/ Kennebec (T)	#2	0	0	0	0	0	0	0	0	0
Boyd/ East Oxford	#2	2	0	0	38	0	0	20	0	0
Spring/ Vaughan (T)(C)(M)	#3	18	2	20	76	0	5	48	0	0
Pine/ Vaughan	#3	0	0	14	16	3	8	8	0	0
Surrenden/ Bedford (T)(C)(M)	#4	8	0	4	6	0	1	5	0	0
Oakdale/ Dartmouth (T)(C)(M)	#4	3	1	12	21	0	5	17	0	0
Stevens/ Waverly	#6	0	0	6	25	0	2	12	0	0
Wall/ Arthur (T)(C)(M)	#6	22	5	19	4	3	11	2	0	0
Presumpscot/ Sherwood (C)	#1	12	6	0	1	1	1	2	2	5
Veranda/ Arcadia (T)(M)	#1	34	0	8	16	0	3	12	0	0
Total		99	14	83	203	7	36	126	2	5

*10 larval dips per visit were taken from each catch basin

(T) Casco or hydrobreak trap present in catch basin

(C) tree canopy present above catch basin

(D) moderate to heavy amounts of floating vegetative litter and debris in catch basin

University of Maine, Orono Mosquito Identification Assistance

When the first positive bird of the season was discovered in Orono, Maine on July 23rd, I assisted Jim Dill, from the University of Maine, in the identification of mosquito pools that he had collected at three sites within the positive bird location on August 3rd, 4th and 5th. These pools were divided, half were sent to Beth Pritchard at the Maine Environmental Health and Testing Laboratory in Augusta and half was identified to species. Species identified were as follows: *Aedes cinerus*, *Ae. vexans*, *Ochlerotatus abserratus*, *Oc. canadensis*, *Oc. excrucians*, *Oc. fitchii*, *Oc. stimulas*, *Oc. triseriatus*, *Anopheles punctipennis*, *An. quadrimaculatus*, *Coquilletidia perturbans* and *Culiseta morsitans*. Subsequently, the pool tested negative for WNV. As a concerted effort we were able to respond within days of the notification of the positive bird.

We immediately responded, with CO_2 and Gravid traps, to locations in Lewiston, Maine where additional 2002 positive birds were located. Mosquitoes trapped in this area were identified, pooled and sent for testing. These pools tested negative for WNV.

Mosquito Sampling Results for Bass Harbor and Cranberry Isle, Maine

We also received several calls from Bass Harbor and Cranberry Isle, Maine with respect to problematic numbers of salt marsh mosquitoes. The Cranberry Isle Mosquito Control Study group had been collecting mosquitoes in propane traps. We asked if they could send samples for identification. They sent samples on July 18th and again on August 29th (Appendix B). We identified intact species and sent him our summary of findings. Several residents of Bass Harbor, Maine called to have us visit them. They had collected several biting mosquitoes in a container and wanted identification. We visited them in late August and identified the collected specimens; we also collected several mosquitoes around the area and tried to locate larvae. We were not able to collect larvae. We later sent them a report with anecdotal species information (Appendix C). These responses provided us with valuable information regarding the seasonality of our salt marsh mosquito species.

Discussion and Conclusions

The first two years of mosquito surveillance have provided us with an opportunity to better understand Maine mosquito species and begin to assess their bionomics in relation to human populations and the West Nile Virus (WNV). Our work in 2001, in the Portland area (Foss & Dearborn 2001), focused on sampling methods, habitat preference and seasonality. Using our experience from Portland, in 2002 we moved our project to a large inland urban area, the Lewiston/Auburn area, and branched out to sample in specific sites while continuing our general species surveys. In addition, in 2002 we: conducted a preliminary assessment of mosquito populations in selected catch basins in Portland and in Lewiston; responded to WNV positive birds by trapping and testing adult mosquitoes; and assisted in very limited mosquito surveys in other areas of the State as time allowed.

Adult trapping with CDC CO_2 traps continued to be an adequate tool for determining mosquito species in a local area and their seasonality. However, their usefulness may be limited for collecting female specimens that may be already harboring an arbovirus. **Gravid traps may prove more effective for collecting vector species that may test positive since they select female mosquitoes that have already blood fed.** Females that have already fed would be more likely to harbor WNV than mosquitoes collected from the CO_2 traps, many of which have not fed at all. We also discovered that certain species might not be caught regularly in CO_2 traps. We observed this with *Oc. japonicus* females. In Portland during 2001, we collected a lone female from a gravid trap, the first record of this species in Maine. In Androscoggin County during 2002 we attempted to collect and determine seasonality of *Oc. japonicus* females by using the CDC CO_2 light traps. This species had been determined to be a primary vector of several arboviruses. We had already found the larvae of this species, early in the season in tires and a tree hole, where we were to set up our traps. Although larvae were abundant, adult females bypassed the CO_2 traps (with only a few exceptions).

We tried modifying the CO_2 traps to determine what may attract or deter this species from collection. We tried to remove all variables such as sound from the motor, light, the color of the dry ice container and the height of the trap from the ground. I had a few female *Oc. japonicus* feed from me during the day in wooded locations and at night under a porch light so it could not be the light from the trap. I tried to hang the traps closer to the ground, at approximately the same height as the gravid trap collection basket and that did not seem to help. I placed black cloth over the blue and red dry ice containers that hang from the traps to modify the color, also to no avail. I decided to place gravid traps in a few locations next to existing CO_2 traps. I started to collect

many *Oc. japonicus* females. Since these traps also run with a motor, it did not seem to be the sound that deterred them. **It was concluded that the cold air expressed from the dry ice seemed to prevent the females from coming to the CDC CO_2 traps. It is possible that this factor could also deter other potential vector species from collection in a CO_2 trap.**

Larval collection was shown to be an effective tool to identify mosquito species in a local area and can also play a large role in mosquito vector control and management. Collection is fairly easy and the equipment is inexpensive. It is an excellent method for identifying vector species in artificial containers. This effort should be expanded into 2003, especially in assessing larval densities and seasonality in the urban catch basins of Portland or Lewiston/Auburn.

In the two years that we have been monitoring mosquitoes we have learned a lot but have also realized that our window of knowledge for Maine populations is rather narrow. While we have come a ways in answering the questions we posed at the end of our 2001 project (See Foss & Dearborn 2001, p.29) we still have a ways to go. We need to: expand our surveys to more inland sites; continue to further define species habitats/habits; develop a risk rating system for vector species; and develop ways of comparing relative seasonality between different areas of the state. This, we believe, will assist us by providing scientific information necessary for developing effective management and control strategies.

Selected References

Bean, J.L. 1946. A Preliminary List of the Mosquitoes of Maine (Culicidae Diptera). The Canadian Entomologist, 78:25-28.

Burger, John F. 1981. New Records of Mosquitoes (Diptera: Culicidae) from New Hampshire. Entomological News. 92(1): 49-50.

Burger, John F. 2001. Mosquitoes of New Hampshire. unpublished list and key.

Carpenter, S.J. and W.J. LaCasse. 1955. Mosquitoes of North America (north of Mexico). University of California Press, Berkeley and Los Angeles. Vi, 360 pp., 127 pls.

CDC. 1966. Pictorial Keys to Arthropods. Reptiles, Birds and Mammals of Public Significance. U.S. Department of Health, Education and Welfare, Public Health Service, Centers for Disease Control. Atlanta, Georgia. 192 pp.

CDC. 2001. Epidemic/Epizootic West Nile Virus in the United States: Revised Guidelines for Surveillance, Prevention, and Control. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention. Charlotte, North Carolina. 111 pp. <http://www.cdc.gov/ncidod/dvbid/westnile/resources/wnv-guidelines-apr-2001.pdf>

Darsie, R.F. Jr. and R.A. Ward. 1981. Identification and Geographical Distribution of the Mosquitoes of North America, North of Mexico. Mosquito Systematics 1(Suppl): 1-313. The American Mosquito Control Association, Fresno, California.

Darsie, R.F. Jr. and R.A. Ward. 2000. Summary of New Distribution Records for Mosquito Species in the United States and Canada for the Period 1981-99. Journal of the American Mosquito Control Association, 16(1):1-4.

Dearborn, R.G., R. Bradbury and G. Russell. 1983. The Forest Insect Survey of Maine- Order Diptera. March, 1982. Unpublished report. 34 pp.

Fonseca, D.M., S. Campbell, W.J. Crans, M. Mogi, I. Miyaga, T. Toma, M. Bullians, T.G. Andreadis, R.L. Berry, B. Pagac, M.R. Sardelis, and R.C. Wilkerson. 2001. *Aedes* (Finlaya) *japonicus* (Diptera: Culicidae), a newly recognized mosquito in the United States: Analysis of genetic variation in the United States and putative source populations. Journal of Medical Entomology. 38(2): 135-146.

Foss, K.A. and R.G. Dearborn. 2001. Preliminary Faunistic Survey of Mosquito Species (Diptera: Culicidae) with a focus on Population Densities and Potential Breeding Sites in Greater Portland, Maine. Maine Department of Conservation. Technical Report No. 42. 35 pp. Revised May 2002. 38 pp.

Ginsberg, Ph.D., H.S. 2002. Research Ecologist. USGS Biological Resources Division in Rhode Island. Personal communication.

Goddard, J. 2001. Encephalitis Overview. Pest Control Technology. February 2001. p.80-83.

Haramis, Ph.D., L. D. 2002. Entomologist. Illinois State Department of Public Health. Personal communication.

Harrison, B.A., M.J. Turell, M.L. O'Guinn, M.R. Sardelis, and D.J. Dohn. 2000. Preparing for West Nile Virus and Multidirectional Surveillance and Control. Wing Beats. Winter 2000. p.14-15.

Jamnback, H. 1969. Bloodsucking Flies and Other Outdoor Nuisances, Arthropods of New York State. Albany NY. State Museum and Science Services Memoir 19. 90 pp.

Johnson, C.W. 1925. Fauna of New England 15, List of the Diptera or Two-winged insects. Boston Soc. Nat. Hist. 1. 326 pp.

Johnson, C.W. 1927. Biological Survey of the Mount Desert Region Part 1. The Insect Fauna. Philadelphia. The Wistar Instit. of Anatomy and Biology. 247 pp.

Kramer, R.D. 2001. Guide to Mosquito Control. Pest Control Technology. February 2001. p.64-77.

Lathrop, F.H. 1939. Mosquitoes Collected in Maine. Maine Agricultural Experiment Station Report. Bulletin No. 397: 828-829.

McDaniel, Ivan N. 1975. A List of Maine Mosquitoes Including Notes on their Importance as Pests of Man. Mosquito News. 35(2): 232-233.

Means, R. G. 1979. Mosquitoes of New York. Part I. The genus *Aedes* Meigen with identification keys to genera of Culicidae. N. Y. State Museum. Bull. 430a.

Means, R. G. 1987. Mosquitoes of New York. Part II. Genera of Culicidae other than *Aedes* occurring in New York. New York State Museum. Bull. 430b.

Patch, E.M. 1906. Insect Notes for 1906. Maine Agricultural Experiment Station Report. Bulletin No. 134: 225.

Procter, W. 1938. Biological survey of the Mount Desert Region. Part VI. The Insect Fauna. Philadelphia. The Wistar Instit. of Anatomy and Biology. 496 pp.

Procter, W. 1946. Biological survey of the Mount Desert Region. Part VII. The Insect Fauna. Philadelphia. The Wistar Instit. of Anatomy and Biology. 566 pp.

Schafer M. and J.O. Lundstrom. 2001. Comparison of Mosquito (Diptera: Culicidae) Fauna Characteristics of Forested Wetlands in Sweden. Annals of the Entomological Society of America. 94(4): 576-582.

Shaw, F.R. 1959. New Records and Distributions of the Biting Flies of Mt. Desert Island, Maine. Mosquito News. 19(3). 189-191.

Turell, M.J., M.L. O'Guinn, D.J. Dohn, and J.W. Jones. 2001. Vector Competence of North American Mosquitoes (Diptera: Culicidae) for West Nile Virus. Journal of Medical Entomology. 38(2): 130-134.

U.S. Census Bureau. 2001. Census 2000. <http://factfinder.census.gov>

Wallis, R.C. 1959. *Culiseta melanura* (Coquillett) and eastern equine Encephalitis in Connecticut. Mosquito News. 19(3). 157-158.

Wood, D.M., P.T. Dang and R.A. Ellis. 1979. The Insects and Arachnids of Canada. Part 6. (The Mosquitoes of Canada, Diptera: Culicidae). Agr. Canada Publ. 1686. 390 pp.

Appendix A. Androscoggin County Mosquito Species Summary and Observed Seasonality

Species Collected in Androscoggin County ✓ Associated with WNV (CDC 2001)	Adults Collected	Larvae Collected	Typical Larval Habitat	Observed Adult Seasonality					
				May	June	July	Aug	Sept.	Oct.
Aedes cinereus ✓	398	31	Snowmelt pools	■	■	■	■	■	■
Ae. vexans ✓	104	15	Snowmelt pools	■	■	■	■	■	■
Ochlerotatus abserratus	46	-	Snowmelt pools	■	■	■	■	■	
Oc. atropalpus	1	-	Rock pools			■	■		
Oc. aurifer	7	-	Snowmelt pools	■	■	■			
Oc. canadensis ✓	1,896	64	Snowmelt pools	■	■	■	■	■	■
Oc. cantator ✓	2	-	Salt marshes, fresh or brackish water	■	■	■	■		
Oc. communis	43	-	Snowmelt pools	■	■	■	■		
Oc. diantaeus	18	-	Snowmelt pools	■	■	■			
Oc. excrucians	131	-	Snowmelt pools	■	■	■	■	■	
Oc .fitchii	39	-	Snowmelt pools	■	■	■	■		
Oc. hendersoni	4	27	Tires, tree holes					■	■
Oc. intrudens	18	-	Snowmelt pools	■	■	■			
Oc. japonicus ✓	5	3,318	Tires, tree holes, artificial containers				■	■	■
Oc. provocans	50	-	Semi permanent marshes	■	■	■	■		
Oc. punctor	77	-	Snowmelt pools	■	■	■			
Oc .sticticus	49	6	Snowmelt pools	■	■	■			
Oc. stimulans ✓	312	10	Snowmelt pools	■	■	■	■	■	
Oc. triseriatus ✓	221	3,875	Tires, tree holes, artificial containers				■	■	■
Oc. trivittatus ✓	7	-	Snowmelt pools			■	■	■	
Anopheles punctipennis ✓	567	419	Confined and flowing bodies of water	■	■	■	■	■	■
An. quadrimaculatus ✓	57	23	Confined bodies of water	■	■	■	■	■	
An. walkeri	15	-	Confined bodies of water	■	■	■	■	■	
An. earlei	-	2	Confined bodies of water						
Coquillettidia perturbans ✓	1,067	-	Attached to bottom of aquatic plants, marshes	■	■	■	■	■	
Culex pipiens ✓	170	2,175	Artificial algae and organic filled containers, roadside ditches, catch basins	■	■	■	■	■	■
Cx. restuans ✓	162	19,832	Tires, tree holes, artificial containers, puddles, ditches, catch basins	■	■	■	■	■	■
Cx. salinarius ✓	9	45	Artificial containers, brackish water, catch basins					■	■
Cx. territans	6	977	Confined bodies of water, artificial containers	■	■	■	■	■	
Culiseta minnesotae	1	5	Snowmelt pools, marshes	■	■				
Cs. morsitans	10	-	Swamps, bogs, marshes	■	■	■	■	■	■
Uranotaenia sapphirina ✓	80	1	Ponds, bogs			■	■	■	■

Appendix B

STATE OF MAINE
DEPARTMENT OF CONSERVATION
MAINE FOREST SERVICE
INSECT AND DISEASE LABORATORY
50 HOSPITAL STREET
AUGUSTA, MAINE
04330-6514

ANGUS S KING, JR.
GOVERNOR

RONALD B. LOVAGLIO
COMMISSIONER

August 1, 2002

Cranberry Isles Mosquito Control Study

The mosquitoes which you sent to us on July 18th arrived in fairly good condition for such brittle creatures. This being a very busy season for us, it wasn't until this week that we had a chance to look through the sample. Kimberly Foss, our Entomology Technician who deals entirely with mosquito/W.N.V issues, found that the sample contained the following species in roughly these proportions:

Most (roughly 98% of individuals) mosquitoes were:

Ochlerotatus (aedes) cantator - the bulk of the sample
Ochlerotatus punctor/Ochlerotatus abserratus

Other species (< 2% of individuals) were:

Coquillettidia perturbans
Ochlerotatus sollicitans
Aedes cinereus
Aedes vexans

Mosquito species vary greatly with the season and with the nature of the landscape which governs available breeding sites (see Foss & Dearborn - copy enclosed). For this reason each sample is a snapshot in time and will vary in composition from all others. The one thing for certain from your sample, and my experience along the coast of eastern Maine, is that of our two salt marsh species, Ochlerotatus cantator and Ochlerotatus sollicitans, Ochlerotatus cantator is the more common in your area which can somewhat influence your approach to control as it will breed in water that is less saline than Ochlerotatus sollicitans.

I am enclosing a number of items on Maine mosquitoes and in particular the species in your sample. Mosquito population management is a complex issue and if done wisely should include a multifaceted, integrated approach. If not set up as a plan, one phase can negate another or cause more serious side effects. Maine has generally resisted the mosquito abatement system

MAINE FOREST SERVICE
THOMAS C. DOAK, DIRECTOR

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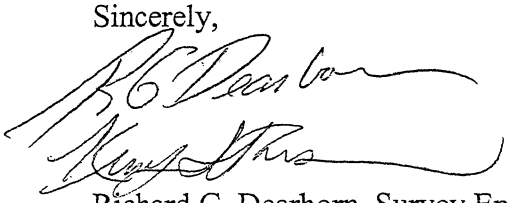
used further south probably because of the lack of mosquito larvae diseases as a stimulus here in the past. Ditching as you noted was the last real attempt at management along the Maine coast and the use of DDT which followed was dropped as it caused some serious problems with other organisms as you know. Wells has approached the problem biologically with some success and the same effort is now being made to use fish and ponding on the Scarboro marsh but the "jury is out" on this one. There is no "quick fix" nor can we completely eradicate mosquitoes in Maine without adverse environmental consequences. It will take time for any mosquito management program to sufficiently keep mosquito populations in check.

Our Division has as it's primary responsibility, the monitoring of forest insects so we are limited as to the time we can spend on mosquito work other than in response to funds committed to our W.N.V. Project. My suggestion to you when I spoke with you yesterday was to secure the services of someone who is involved commercially in such situations. However, I would be glad to answer any questions you may have. Hopefully you can glean some ideas from the enclosed items or our website - http://www.state.me.us/doc/mfs/insecthome.htm

Sincerely,



Richard G. Dearborn, Survey Entomologist
Kimberly A. Foss, Entomology Technician

/jlm
enclosures

STATE OF MAINE
DEPARTMENT OF CONSERVATION
MAINE FOREST SERVICE
INSECT AND DISEASE LABORATORY
50 HOSPITAL STREET
AUGUSTA, MAINE
04330-6514

ANGUS S KING, JR.
GOVERNOR

RONALD B. LOVAGLIO
COMMISSIONER

Cranberry Isles Mosquito Control Study

September 5, 2002

Thank you for sending the sample we requested. It made our sampling and surveying program this summer much more complete. Most of the mosquitoes you collected during the last week of August 2002 were *Ochlerotatus (Aedes) sollicitans* (45%) and *Ochlerotatus (Aedes) cantator* (39%). Also identified in the sample were *Anopheles punctipennis* (1%), *Ochlerotatus (Aedes) atropalpus* (10%) and *Ochlerotatus (Aedes) fitchii* (5%). This is the species mix that we would expect in your area at this time of year. Information on these species can be found in my Portland report for 2001 which was sent to you earlier. I am also providing you with the following brief description of *Oc. altropalpus* since this species was not mentioned in the Portland report.

Ochlerotatus (Aedes) atropalpus: Larvae inhabit rock pools or empty riverbeds below natural or artificial dams. Larvae can also develop in natural and artificial containers such as concrete septic tanks, trees and tree holes. There are several generations per year and this species overwinters in the egg stage. Hatching of eggs takes place in the early spring after flooding of rock pools and riverbeds and this species can remain active until October. The adult females will bite humans and can bite during the day as well as at night.

We are glad to have been able to help you and thank you for your assistance and interest in our Maine Mosquito Survey. If you have any further questions or comments please feel free to contact us.

Sincerely,

K A Foss

Kimberly A. Foss-Entomologist Technician
For: Richard G Dearborn- Survey Entomologist

MAINE FOREST SERVICE
THOMAS C. DOAK, DIRECTOR

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Appendix C

STATE OF MAINE
DEPARTMENT OF CONSERVATION
MAINE FOREST SERVICE
INSECT AND DISEASE LABORATORY
50 HOSPITAL STREET
AUGUSTA, MAINE
04330-6514

ANGUS S KING, JR.
GOVERNOR

RONALD B LOVAGLIO
COMMISSIONER

August 29, 2002

Thank you for collecting the mosquito sample we looked over. It made our work sampling and surveying this summer much easier. When Dick Dearborn and I visited Bass Harbor on Wednesday we surveyed the area for adults and larvae. The following is the list of species you collected along with a brief description of each:

(Aedes) Ochlerotatus sollicitans: 55 specimens were collected. *Oc. sollicitans* adults are capable of flying great distances. They may have several generations per year. They are aggressive biters and attack in full sun and strong winds. They rest in the grass during the day, but are not known to enter houses. They overwinter as eggs above the high tide mark in pools and pans. With sufficient flooding of warm water in the summer, the eggs will hatch and pupate within a week to an adult. Larvae are tolerant of pollution and variable levels of salinity and can even develop in freshwater.

(Aedes) Ochlerotatus cantator: 1 specimen was collected. *Oc. cantator* like *sollicitans* are a common coastal salt marsh and saline pool species. Although primarily an early season species, *Aedes cantator,* appears to start about the last week of May, peak the last week of June and continue through August. They have one or more generations per year.

(Aedes) Ochlerotatus triseriatus: 1 specimen was collected. *Oc. triseriatus* adults first start to appear around the third week of June, peak the fourth week of July and continue on through August. They have one generation per season. Females are active biters of a variety of hosts both day and night. While collecting on summer days, *triseriatus,* was one of the few species most likely to bite and can also find its way into homes. Larvae are found naturally in tree holes, but will use heavily shaded, dark natural and artificial containers containing rich organic material. They are usually found at the very bottom of the container.

Attempts were made to locate the larvae of the species we found, to no avail. However, upon visiting the salt marsh area, near the bridge, in Bass Harbor we found large numbers of *sollicitans* adults. The number of salt marsh adult species, emerging all at once, is probably due to fluctuations in environmental conditions such as increases in

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water temperature and salinity and decreases in accumulated water levels in the pans and pools in the local salt marshes.

Also enclosed is an informational pamphlet that you may find useful. It highlights personal protection and offers ideas on how to reduce populations of some mosquitoes in inland areas. We are glad to have been able to help you and thank you for your interest and assistance in our Maine Mosquito Survey. If you have any further questions or comments please feel free to contact us.

Sincerely,

Kimberly A. Foss
Entomologist Technician

Maine Forest Service
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