

Tracking the emergence of emerald ash borer adults

Author

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Abstract

Emerald ash borer (*Agrilus planipennis* Fairmaire) is a serious exotic pest of ash trees. Determining when emerald ash borer adults first emerge, reach their emergence peak, and reach the end of emergence has important implications for its management. Adult emergence takes place over an extended period of time, which may make timing of pesticide applications for its control difficult. In this study, weekly observations of new emergence holes were recorded to track emergence from the trunk by direction (NW, NE, SW and SE), track key stages of emergence, look at concurrent plant phenological events, and their corresponding degree day accumulations. In 2003, adult EAB emergence was tracked at one location, and degree day and bloom stage of potential indicator plants was tracked at four locations. In 2004, adult EAB emergence was tracked at two locations, and degree day and bloom stage of potential indicator plants was tracked at four locations.

Methodology

In 2003, adult emergence was monitored at a single location in Ann Arbor, Michigan by counting and marking all emergence holes found within a two-foot section of trunk, at 4-6 ft. and 10-12 ft on each of twenty green ash (*Fraxinus pennsylvanica*) of approximately the same age. Trees were examined weekly, from May 8, 2003- August 28, 2003. Surface areas of trunk sections (high/low) were measured and divided by four to get surface areas for each direction- NE, NW,SE,SW. Since trunk sections varied in size (approx. 3.8"-12" diameter/lower section, 2.2"-7.6" diameter /upper section), the number of emergence holes for each area was divided by the area in square centimeters to arrive at the number of emergence holes/cm² of trunk. Each tree was a whole plot; while high/low on the trunk and direction (NE, NW, SE, and SW) were recorded as within tree measurements. Eleven trees were mulched with stone and planted in parking lots; nine were planted in grassed lawn areas.

In 2004, adult emergence was monitored beginning May 11, 2004 using the same methods at two locations: a neighborhood in Troy, Michigan planted almost entirely with green ash, and a neighborhood in Novi (within a mile of the Tollgate Center) planted with white ash (*Fraxinus americana*). All trees were planted in grassed strips between the sidewalk and street. Monitoring continued until September 21, two weeks after new emergence was recorded.

Bloom stages of common landscape plants and degree-days were recorded once-twice weekly from the first week of May until the end of August at four locations in 2003: MSU's Tollgate Education Center in Novi, MI, Applewood Garden in Flint, MI, St. Joseph's Hospital in Ann Arbor, MI and on the MSU campus at a University- maintained weather station. Except for the University weather station, dataloggers were used to record hourly temperature readings. The modified sine wave method (Baskerville-Emmons) was used to calculate degree-days, using a base temperature of 50° F. Trunk diameters for the measured sections ranged from 4.8-7.4" for the lower, and 2.3" to 4.2" upper, at the Novi site, and 9.1-16" for the lower section and 4.2-9.7" for the upper section at the Troy location.

In 2004, bloom stage/degree day monitoring was done at the Tollgate Center and Novi neighborhood, in the Troy neighborhood, at Applewood Garden, on the MSU campus using data from the University weather station, and in the Delapa Perennial Garden on MSU's campus using a datalogger located in the garden. Monitoring was done once/twice weekly beginning in early May, and continued until September 21, when there were two successive weeks with no new EAB emergence holes found.

Results and discussion

In 2003, there were significant differences in emergence by direction on the trunk. Of the 388 total emergence holes counted, 82 were in the NW quadrant, 153 in the SW quadrant, 52 in the NE quadrant, and 101 in the SE quadrant. There was greater emergence of EAB adults high on the trunk than low on the trunk for trees planted in grass. Insect development is strongly correlated to temperature. Most of the trees planted in grass had shaded lower trunks, and more sunlight on the trunks at the 10' height, which may have contributed to warmer bark temperatures on the high sections compared to the lower sections. Our observations support this; greater emergence of adults occurred on the sunniest exposures of the trees, and earlier on trees mulched with stone and planted in parking lots. As a measure of EAB density, the number of emergence holes/cm² of bark was calculated for each tree. The range was from 0-0.1226 holes/cm² with an average of 0.0333 holes/cm².

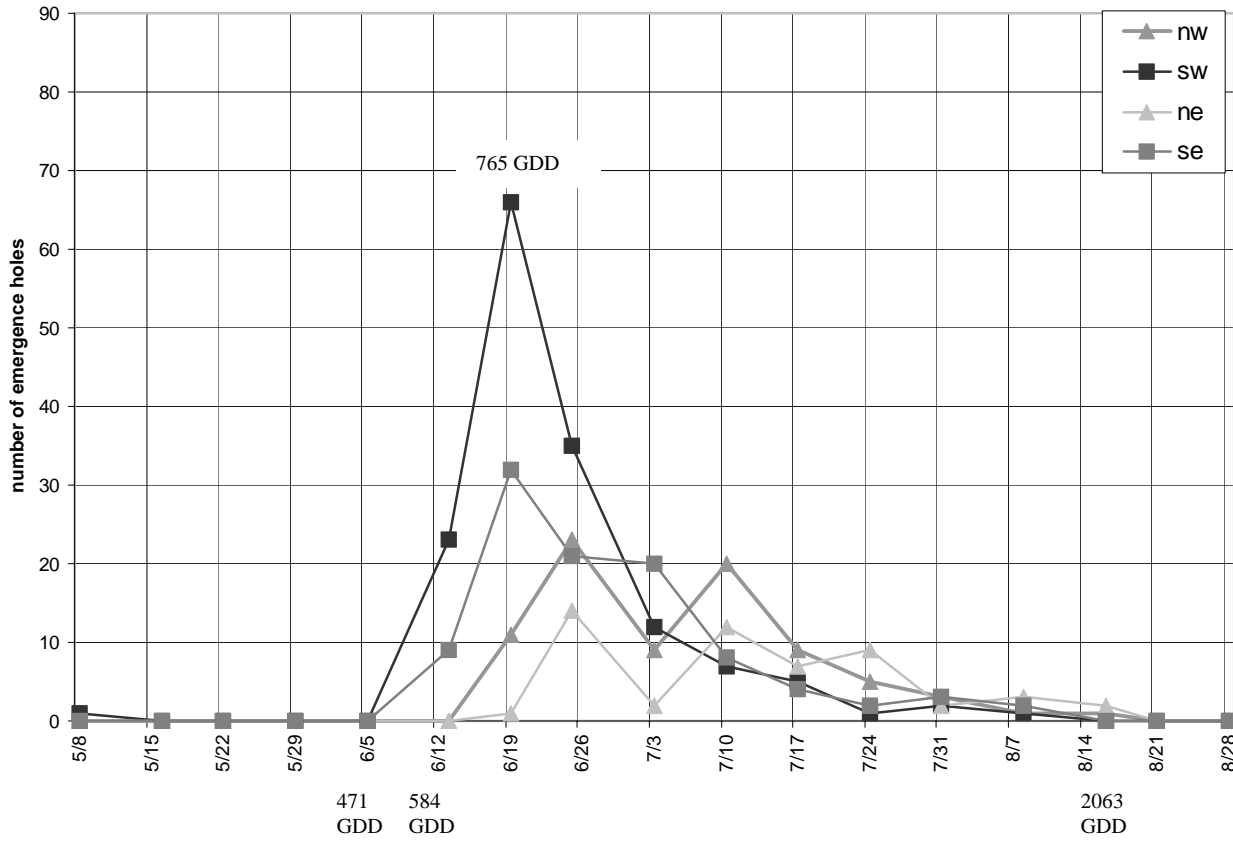
Data collected for 2004 present a somewhat different picture than 2003. Earlier emergence still occurred on the SW and SE quadrants of the trees compared with the NW and NE quadrants. Data have not been statistically analyzed, but it appears that the effect of direction will be less significant than in 2003. Of the 606 emergence holes counted at the Novi location, 127 were in the NW quadrant, 142 in the NE, 142 in the SW and 193 in the SE. These trees are somewhat smaller than the trees at the Ann Arbor site, and do not have any lower branches shading the trunks. As a measure of EAB density, the number of emergence holes/cm² of bark was calculated for each tree. The range was from 0-0.1789 holes/cm² with an average of 0.0548 holes/cm². Very low emergence was recorded for the ash trees at the Troy site. Only 41 emergence holes were recorded from 20 trees. Of these, 11 were in the NW quadrant, 16 in the SW, 6 in the NE and 8 in the SE quadrant. As a measure of EAB density, the number of emergence holes/cm² of bark was calculated for each tree. The range was from 0-0.0044 holes/cm² with an average of 0.0009 holes/cm². The trees at the Troy site are larger and have more shade on the trunks and limbs than those at the Novi site.



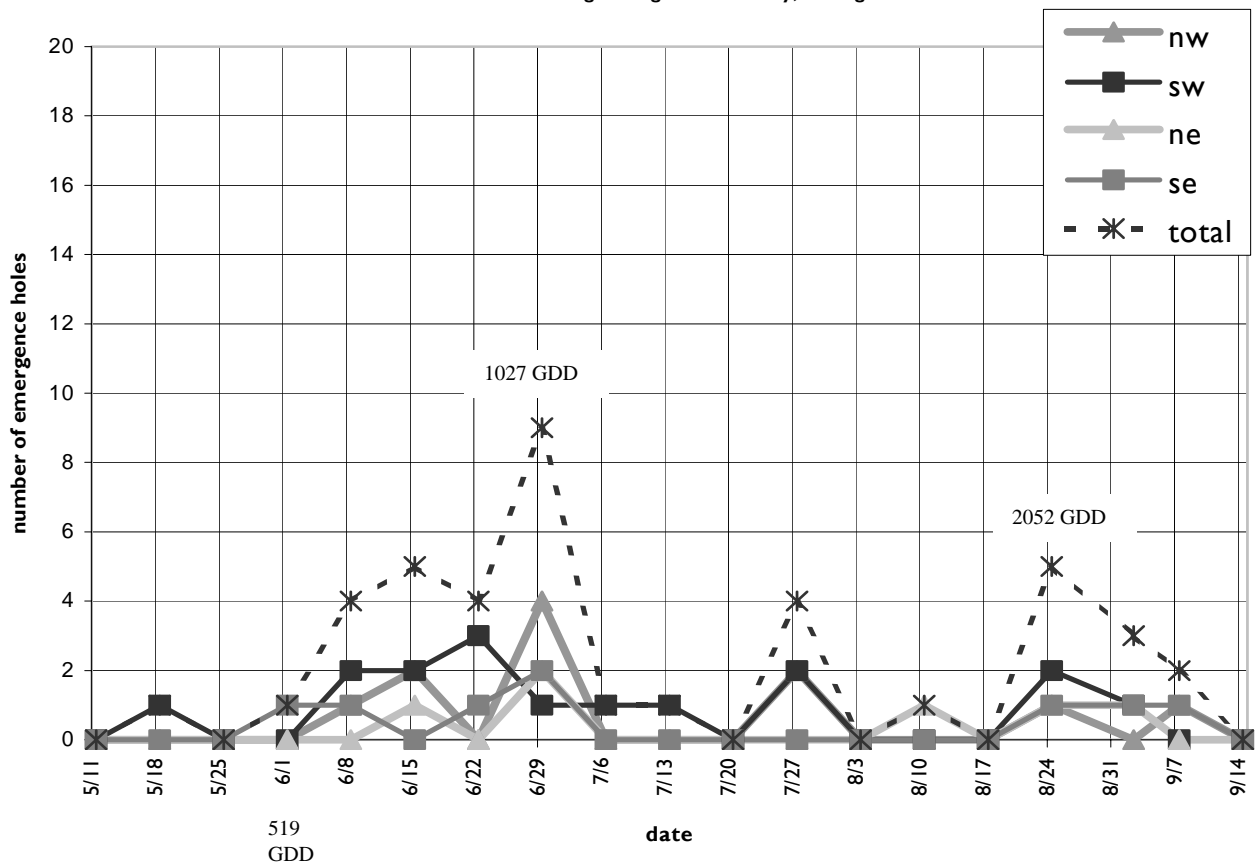
Left: Tree at the Novi site- light colored bands delineate the 4-6 ft section where emergence holes were counted.

Right: this tree is heavily infested; the canopy is sparse and bark is peeling from the trunk.

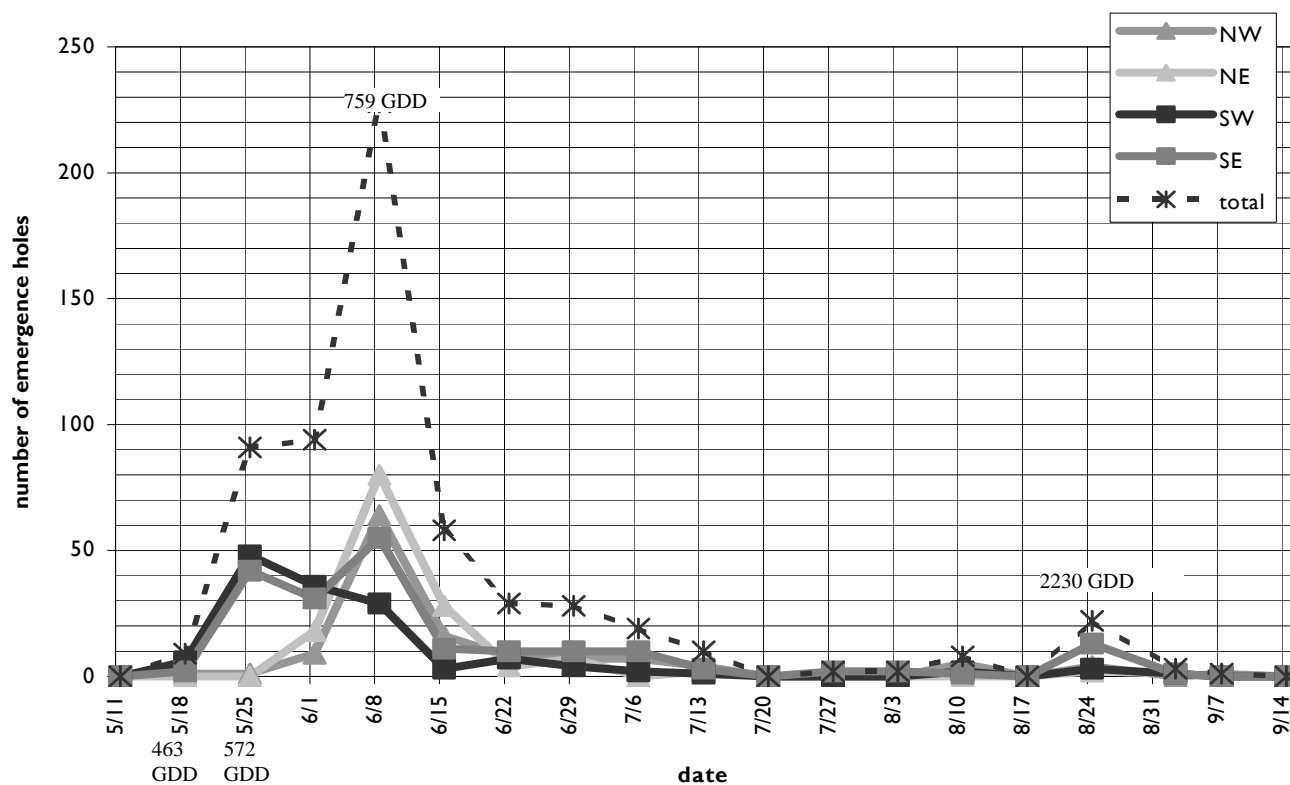
adult EAB emergence- green ash- Ann Arbor, MI 2003



adult EAB emergence- green ash-Troy, Michigan 2004



adult EAB emergence- White ash-Novi, Michigan 2004



Bloom and growing degree day accumulations (GDD50) of selected indicator plants correlated to key EAB adult stages

Indicator plant	Location	Ann Arbor	Apple-wood	Novi	Novi	Flint	Troy
	Date	Jun 5-13	Jun 6-13	May 11-18	May 18-25	May 24-25	May 25-Jun 1
	Year	2003	2003	2004	2004	2004	2004
	GDD range	471-584	448-610	348-463	463-572	454-472	444-518
	Emerald ash borer	1 st emergence		1 st emergence		1 st emergence	1 st emergence
Black locust	<i>Robinia pseudoacacia</i>	C-D			B-C	C	C-D
Vanhoutte spirea	<i>Spirea x vanhouttei</i>	D	C-D	B-C		C-D	
Dame's rocket	<i>Hesperis matronalis</i>	C		A-B	C	C	C
Common lilac	<i>Syringa vulgaris</i>	E		C	D		
Doublefile viburnum	<i>V. plicatum tomentosum</i>		C			C-D	D-E

Indicator plant	Location	Ann Arbor	Applewood	Novi	Flint	Troy	Novi (Tollgate)
	Date	Jun 13-19	Jun 11-23	Jun 1-8	Jun 1	Jun 22-29	Jun 22-29
	Year	2003	2003	2004	2004	2004	2004
	GDD range	584-703	611-750	655-759	524	894-1027	998
	Emerald ash borer	Peak		Peak	Peak	Peak	
Black locust	<i>R. pseudoacacia</i>	D-E		D-E			
Dame's rocket	<i>Hesperis matronalis</i>	D	D			E	
Slender deutzia	<i>Deutzia gracilis</i>		D		C-E		
White fringetree	<i>Chionanthus virginicus</i>		D		C-E		
Beautybush	<i>Kolkwitzia amabilis</i>		D	C	C-D		
Jap. tree lilac	<i>Syringa reticulata</i>		A-C	A-B	A-B	D	D-E
Common daylily	<i>Hemerocallis fulva</i>					B-C	B-C

A= first bloom; ≤5% flowers open B=> 5-95% flowers open C= full bloom ≥95% flowers open D=flowers dropping; late bloom
E= bloom ended

Indicator plant	Location	Ann Arbor	Applewood	Novi	Flint	Troy	Applewood
	Date	Aug 8-16	Aug 15-25	Aug 17-24	1840	Aug 17-24	Aug 16-23
	Year	2003	2003	2004	2004	2004	2004
	GDD range	1901-2083	1892-2028	2089-2230	1840	1948-2052	1891-1998
	Emerald ash borer	end emergence		2 nd peak	End emergence	2 nd peak	
Purple coneflower	<i>Echinacea purpurea</i>	C-D		C	C	D	C-D
Joepyee weed	<i>Eupatorium purpureum</i>	A-C		B-C	C		C-D
goldenrod	<i>Solidago sp.</i>	A		B-C		B-C	
Jap. scholar tree	<i>Sophora japonica</i>		A-C			D	B-C

A= first bloom; $\leq 5\%$ flowers open B= $> 5-95\%$ flowers open C= full bloom $\geq 95\%$ flowers open D=flowers dropping; late bloom E= bloom ended

Conclusions and future directions

Emerald ash borer adult development correlates to temperature, but the threshold temperature is as yet unknown; 50°F was used as a starting point. Spring of 2003 was cool; adult EAB emergence was observed for a ten-week period, not beginning until sometime between June 5 and 13 (471-584 GDD50). By contrast, in 2004 spring weather warmed quickly and summer was cooler than normal. Emerald ash borer emergence was observed from the Novi site began sometime between May 11 and 18 (GDD50 348-463) and continued for nearly a 17-week period. There has been speculation about whether emerald ash borers are able to complete their life cycle within a one year time period or whether some larvae might take two years, or even three years, in more northern climates. The second small emergence peak this year suggests that this year, larvae that might “normally” take an additional season to develop into adults may have been able to mature and emerge within a single year instead. This is one possible hypothesis; there may be other explanations. Monitoring of emerald ash borer adult emergence, plant bloom stages and GDD accumulations are planned for 2005. It will be interesting to see what emergence pattern develops next year. There is additional work to be done to compile and analyze degree day and plant phenological information. The data in the tables above is a partial listing of what was in bloom during key stages of adult activity.

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