

Questions and Answers about the Emerald Ash Borer in Colorado

What is the emerald ash borer? The emerald ash borer is a type of beetle that develops under the bark of ash trees. Its scientific name is *Agrilus planipennis*. It is a type of beetle in the family Buprestidae, which are known as metallic wood borers in their adult form and flatheaded borers in the immature stage.

Where did the emerald ash borer come from? The natural range of the emerald ash borer is eastern Russia, northern China, Japan, and Korea. Before June of 2002, it had never been found in North America.

How did it get here? We don't know for sure, but it most likely came in ash wood used for stabilizing cargo in ships or for packing or crating heavy consumer products (Solid Wood Packaging Materials).

What types of trees does the emerald ash borer attack? In North America, it has only been found in ash trees (*Fraxinus* species). Trees in woodlots as well as landscaped areas are affected. Larval galleries have been found in trees or branches measuring as little as 1/2-inch in diameter. All species of North American ash appear to be susceptible.

Ash commonly grown in Colorado include green ash (*Fraxinus pennsylvanicus*) and white ash (*F. americana*). Both are highly susceptible to emerald ash borer.

Is mountain-ash susceptible to emerald ash borer? No. Despite the name, mountain-ash (*Sorbus* species) are very different types of plants and are not attacked by emerald ash borer.

What do emerald ash borers look like? The adult beetle is dark metallic green in color, 1/2 inch-long and 1/8 inch wide. The larvae, which are found under the bark, are a type of flatheaded borer which is pale-colored, has an elongate body, and a slightly flattened area behind the head.

There are numerous sites where one can find excellent images of emerald ash borer. Several are accessed through the national emerald ash borer information web site:

<http://www.emeraldashborer.info> (To find the publications on EAB identification go to the link "About EAB" and then view the site "How to Identify EAB".) A great many images of this insect, which can be downloaded and used for educational purposes, are available through IPMImages.org (aka BugWood.org): <http://www.ipmimages.org/search/action.cfm?q=emerald%20ash%20borer> Photos of EAB taken in Colorado can be viewed at the EAB Photo Gallery site established by the Colorado Department of Agriculture: http://www.colorado.gov/cs/Satellite/ag_Plants/CBON/1251646275463

Are there other insects that are similar in appearance to emerald ash borer? There are several beetles native to Colorado that one may mistake for emerald ash borer. Also, there are some other types of insects that tunnel in ash trees. One source to help identify these "EAB lookalikes" can be found at: <http://bspm.agsci.colostate.edu/files/2013/03/Emerald-Ash-Borer.pdf>

I have treated my ash trees in the past for borers. Wasn't this for the emerald ash borer? There are several insects that are native to North America, long present in Colorado, and that tunnel into trunks and limbs of ash. Most commonly encountered is the **lilac/ash borer** (*Podosesia syringae*) a type of wood boring caterpillar that usually tunnels into the lower trunk of the tree. Various **ash bark beetles** (*Hylesinus* species) are fairly common in branches, particularly those that are damaged or overshadowed. Some other insects that may be found occasionally tunneling limbs of ash include the **flatheaded appletree borer** (*Chrysobothris femorata*) and **redheaded ash borer** (*Neoclytus acuminatus*).

These are all insects that are normal residents of ash trees. Most cause very little damage and may only be found in trees or limbs that are suffering from serious stress or injury. Of these native, wood boring insects of ash, the lilac/ash borer is potentially the most injurious. However, the damage potential of the emerald ash borer far exceeds any of these other insects.

Why should I try to control emerald ash borer? Emerald ash borer (EAB) is an extremely destructive insect of ash trees (*Fraxinus* species), including the kinds of ash (green ash, white ash) that are widely planted in Colorado. It is far more damaging to trees than any other insect that previously has been found in the state and, as populations of the insect increase in the infested areas, it very likely will kill any unprotected ash trees within a few years.

Emerald ash borer is a species native to parts of eastern Asia that was accidentally introduced into North America, probably sometime in the 1990s. It is not a very damaging insect in its native land, where the ash species that grow there have evolved resistance to it and natural controls limit its injury.

Unfortunately the species of ash that are native to North America have very little resistance to this new pest and emerald ash borer is devastating to the kinds of ash trees grown in the state. In the Midwest and eastern areas of North America where this insect has been present for several years, EAB has already killed many millions of ash trees. It is expected that emerald ash borer will ultimately kill almost every unprotected ash tree presently growing in North America.

Mountain pine beetle kills enormous numbers of trees in Colorado. How does this compare with emerald ash borer damage? Other than both can kill large numbers of their host trees, these involve different situations.

Mountain pine beetle is a native insect of the pine forests of western North America. Periodically it occurs in outbreaks that cause massive die-offs of their host plants (mostly lodgepole and ponderosa pine). Over the past decade much of the state has experienced a very damaging outbreak and 25-30 years before that there was also a serious outbreak. These are natural events, sometimes abetted a bit by human activities, but they always end at some point with surviving trees that will allow regeneration of the forest over time.

The emerald ash borer is not a native insect to North America. It is a new organism to the continent and its host trees (ash) are extremely susceptible to its damaging effects. Where it becomes established it not only can be expected to kill essentially all of its hosts but it will do it forever as long as susceptible species of ash are present.

The invasion of the emerald ash borer is an ecological disaster that is unprecedented. Never before has there been a newly introduced insect that will so permanently destroy and irreversibly alter an important component of the North American forests. Its potential effects on forest ecology are only rivalled by such previous ecological disasters as the introduction of the chestnut blight fungus (which functionally exterminated the American chestnut in the early 1900s) and the smaller European elm bark beetle and fungus that produces Dutch elm disease (which has largely eliminated American elm since its introduction in the 1930s).

How fast does emerald ash borer kill ash trees? Emerald ash borer damages trees by tunneling areas under the bark, producing girdling wounds that interfere with movement of water and nutrients. The damage is progressive, with more effects of infestation becoming visible as increasing numbers of insects develop within and damage the plant.

When emerald ash borer first arrives and becomes established in a neighborhood it is usually present in low numbers and is very difficult to detect. However, they survive and reproduce well so that populations build steadily and within a few years it may be possible to observe some external evidence of infestation. A thinning of the leaf canopy is the most consistent symptom associated with EAB injury.

Often, about the time symptoms first become noticeable the populations of EAB explode in numbers and damage accelerates greatly. During this period of peak outbreak even trees that previously appeared healthy may die within just a couple of years.

Where is emerald ash borer found in North America? Emerald ash borer was originally detected in southern Michigan in 2002, but is thought to have been present in the area a decade before this detection. It has since spread rapidly and, by the end of 2013, has been found to be established in 22 states and two provinces. Colorado is the most recent state where this insect has been detected, being found in Boulder in September 2013. It is also the first state in the western US where EAB has been detected. Maps of the present distribution of the insect within North America can be accessed through the national emerald ash borer web site at:

<http://www.emeraldashborer.info/map.cfm#sthash.hWvMiNj5.dpbs>

At present (winter 2014) Boulder is the only place within Colorado where EAB has been detected. However, the insect will spread in the upcoming years and it is reasonable to expect that essentially all of northeastern Colorado will be infested within a decade.

Also, with greater attention being given to this insect following the Boulder detection, it is now much more likely that any other infestations in the state, if any, may be identified. Any needed updates on the distribution of emerald ash borer in Colorado will be made available through several outlets, including the Colorado Department of Agriculture site at www.eabcolorado.com

Now that emerald ash borer has been found in a part of the state, can we eradicate it? Unfortunately, there is no chance that emerald ash borer can be eradicated once it has become established.

In the first few years after it had been detected in Michigan, several efforts were made to attempt eradication of emerald ash borer. Efforts were also made in other states (e.g., Maryland) when first detections were made and infestations were limited. These eradication efforts typically involved removal of all ash trees over a wide area (1/2-1 mile diameter) of known infestations and widescale use of insecticides on ash trees in areas within the vicinity. Very large sums of money were expended in these efforts. None were successful.

A fundamental problem hampering eradication is the inability to detect emerald ash borer when it is in low populations. Wherever EAB is known to occur, at least a small number of beetles can be expected to have dispersed beyond the area where they establish and continue the infestation.

How does emerald ash borer spread? The adult beetle can fly and that is how it spreads naturally. Normally they will fly only short distances, staying in the near vicinity of the tree from which they developed. However, some will fly longer distances and, with the aid of favorable winds, it is possible that a few may fly several miles if the right conditions come together. This natural spread will cause the present outbreak of EAB to expand beyond Boulder in the next few years to progressively encompass the areas of the state within the South Platte Drainage. This includes the greater Denver Metro area, Fort Collins, Greeley and all the communities further down river.

However, emerald ash borer can also be spread if it is carried by humans. Transport of firewood or other ash materials harboring live emerald ash borers is the way that this insect is carried over long distances. This is undoubtedly the means by which it carried across the eastern plains and was introduced into Boulder, an event which seems to have occurred at least four years prior to its detection.

Geographic barriers present in Colorado, notably mountains and large expanses of ash-free forest, can be expected to prevent natural spread of EAB to much of Colorado outside the South Platte drainage. However, the entire state will always be at risk of the insect being introduced on infested firewood or other material containing live EAB that originated from some area where this insect is present. National quarantines of infested counties (including Boulder County in Colorado) are in place to try and prevent this type of human-assisted spread of EAB.

Will altitude restrict where emerald ash borer can become established? Altitude should have no direct effect on whether emerald ash borer can survive. As long as there host trees (ash) emerald ash borer should be able to survive.

Indirectly, there may be some effects of higher elevations that may act to affect EAB. Often temperatures are cooler at higher elevations. Cooler temperature will slow development of the insect and slow development of the ash trees.

Will cold temperatures kill emerald ash borer in Colorado? On rare occasions it may be cold enough to kill some insects, but never will all be killed. Furthermore the types of winter temperatures required to kill any emerald ash borers is very low. During winter the larvae within trees may be killed if they can be exposed to temperatures of -13⁰F or below. However, it would take a cold period sustained for days to

produce temperatures that would reach this point within the tree where the insect is developing. One study on this subject can be seen at:

http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5191794.pdf

Extreme winter temperatures that occur in some areas of the state (e.g., San Luis Valley) may suppress the effects of EAB, if it ever reaches these areas. But extreme winter temperatures are unlikely to significantly affect EAB in most all of Colorado.

However, it is possible that EAB may be affected by cold temperatures occurring at other times of the year. Warm spells in late winter and spring, followed by abrupt freezing events, are not uncommon in the state. When this occurs the first flush of ash leaves can be frozen, which would eliminate the food needed by the newly emerged adults. It is also likely that the pupae and adults present in spring may be more susceptible to freezing. For example, there are some indications that the extreme cold temperatures that occurred in early May 2013 (ca 8⁰-15⁰F) may have killed many of the adults that were preparing to emerge from trees at that time.

What is the life history of the emerald ash borer? Emerald ash borer has a life cycle that normally takes one year to complete. During winter the life stage present is a full grown larva (a type of flatheaded borer) that lives within a chamber cut into the outer sapwood of the wood. In spring it will transform to the pupal stage, during which it transitions to the ultimate adult form.

The adult, a type of metallic wood borer, emerges from the tree by cutting through the bark, producing a D-shaped exit hole. Adults of the emerald ash borer likely will normally begin to emerge in early –to–mid May, with peak emergence in June. However, there is some range in the time of beetle emergence, which may extend into midsummer.

They then move to the crown of the tree where they feed on ash leaves, making small cuts along the edges of the leaves. After about a week of feeding, the now mature adults will begin to mate and a few days after mating females will begin to lay eggs. Eggs are laid on the surface of the bark, usually deposited singly into cracks and crevices. Females typically live for about a month and during this time will lay several dozen eggs.

Eggs hatch in about a week and the tiny, newly hatch larvae burrow through the bark. They enter and begin to feed on the tissues under the bark, the phloem, cambium and outer sapwood where they spend all of their larval life. During the course of feeding the larvae produce meandering galleries that progressively widen as the larvae grow. Ultimately the gallery produced by a single larva may range over an area ranging from 4 to 20" (10-50 cm) in length. Larvae feed until cooler fall temperatures arrive, when they prepare for overwintering by tunneling a bit deeper into the sapwood to produce the overwintering chamber.

Can plants recover from injury by emerald ash borer? Trees can recover from EAB injury – to a point. If one attempts to control EAB with insecticides it is most likely to be effective if the ash tree is still relatively healthy. If trees have already sustained EAB injuries that have caused the leaf canopy to thin more than 30-50%, it is probably too late to save the tree.

This is because most of the insecticides used for EAB control act systemically — the insecticide must be transported within the tree. When EAB larvae feed, their galleries injure the phloem and xylem, the vascular tissues that move water and nutrients. This also interferes with the ability of the tree to transport and distribute insecticides that move systemically in the vascular system. As a tree becomes more and more infested, the injury becomes more extensive. When damage has progressed too far, insecticides can no longer move within the tree in a manner to provide effective EAB control.

Often if the canopy of a tree is already declining when insecticide treatments are initiated, the condition of the tree may continue to deteriorate during the first year of treatment. When effective controls are applied, in many cases, the tree canopy will begin to improve in the second year of treatment. This lag in the reversal of canopy decline probably reflects the time needed for the tree to repair its vascular system after the EAB infestation has been reduced.

Can we control emerald ash borer? The answer to this question depends on how one defines "control".

There are treatments that can be applied to individual ash trees that can be used to limit the damage caused by emerald ash borer and usually can save trees threatened by emerald ash borer. These primarily involve the use of various insecticides that can move systemically within ash trees. Depending on the treatment these are applied either to soil (for root uptake), as a spray on the lower trunk, or injected into the base of the tree.

Ability to "control" emerald ash borer on an area-wide basis is much more problematic. There are some strategies that have been proposed to "slow the spread" of emerald ash borer. These usually involve a coordinated treatment plan over a wide area that involves extensive use of insecticides and timely removal of EAB-infested trees. It is possible that such strategies can be used to slow the rate at which EAB causes damage at a site, which can provide more time for implementing methods for mitigating EAB effects, such as planting alternative replacement trees. However, within Colorado EAB will eventually disperse from the present location (2014) where established (Boulder) throughout the northeastern part of the state within the South Platte drainage.

Of course, EAB can become established anywhere, immediately, if a human carries the insect to a new location via movement of EAB-infested wood or other means. The use of quarantines, which presently exist in every US county where EAB is known or expected to occur, is designed to inhibit this human assisted spread. However, we will always be at risk that uninformed or criminally negligent individuals ignore these quarantines and assist the spread and damage of this insect.

What treatments can be used to control emerald ash borer? There are several treatments that have been identified that can be used to manage emerald ash borer in an individual tree. All involve the use of insecticides which have to be applied on an annual or biannual basis to maintain control.

In general there are four control approaches considered for use in management of emerald ash borer:

1. ***Soil applications of systemic insecticides.*** Two insecticides can be applied to the root system of ash trees and will subsequently be taken up by the roots – imidacloprid and dinotefuran.

2. **Non-invasive systemic trunk sprays.** The insecticide dinotefuran can be applied as a coarse spray onto the trunk of ash trees and will be absorbed through the bark.
3. **Trunk injections with systemic insecticides.** Some insecticides can be injected into the lower trunk of trees and then will move systemically in the tree. These include emamectin benzoate, azadirachtin, and imidacloprid.
4. **Persistent surface-applied contact insecticides.** A standard method of controlling many borers and bark beetles is to apply a persistent insecticide onto the trunk and branches to kill adults as they lay eggs and to kill newly hatched larvae before they enter the plant. Various pyrethroid insecticides are usually used for this purpose (e.g., bifenthrin, cyfluthrin, permethrin).

What stages of the emerald ash borer are controlled by these treatments? The systemic insecticide treatments (soil drench/injection, trunk bark spray, trunk injection) used for EAB generally target two of the life stages. Adults can be killed as they feed on ash leaves on trees treated with insecticides effective against EAB. These treatments are best timed to be present in trees during the peak period of adult activity, which likely will occur sometime between mid-May and late June.

Early stage larvae that tunnel under the bark can be killed with insecticides that move systemically in the tree to the tissues where they are feeding (phloem, outer sapwood). These treatments are optimally timed to be present when young larvae are present and before there has been extensive injury; prior injuries that disrupt movement of water and nutrients will similarly disrupt distribution of systemic insecticides. The peak period when early stage larvae are present will likely occur sometime between late May and early July.

The persistent surface-applied contact sprays are primarily applied to bark and can kill adults that walk on the bark and the larvae when they hatch from eggs and tunnel into trees. They cannot kill larvae within the tree. Sprays applied to the foliage can also kill adults that feed in the canopy leaves. However, to effectively catch all the susceptible stages with this control method at least two applications are needed per year, and it is rarely used for EAB control.

What are the effects of these insecticides on other insects, birds, mammals....? The best summary of the subject presently available is the sheet *Frequently Asked Questions Regarding Potential Side Effects of Systemic Insecticides Used To Control Emerald Ash Borer* (http://www.emeraldashborer.info/files/Potential_Side_Effects_of_EAB_Insecticides_FAQ.pdf) This was prepared by University Extension and research scientists from the Midwest and is a good summary of the subject.

Are there biological controls useful for control of emerald ash borer? In the areas of Asia where emerald ash borer is native there are several important natural controls at work. Most important are defenses produced by the trees, which protect them from attacks of invading organisms common to the region, such as emerald ash borer. In addition, there are numerous natural enemies, notably various species of parasitic wasps. Together, the inherent resistance of Asian species of ash combined with the natural enemies very effectively limit emerald ash borer so that it rarely causes serious damage.

Host plant resistance is largely absent from the native North American species of ash that we grow, and always will be, greatly undermining the potential of natural controls. However, there is work being done by federal agencies to identify parasites of the emerald ash borer present in Asia. Some of these have been found suitable for introduction and release into North America. Already a few of these introduced natural enemies have been released in EAB outbreak areas of the Midwest and in some cases they seem to have proved capable of establishing and reproducing.

This work with natural enemies is ongoing. It is hoped that natural enemies may be useful in helping to suppress EAB populations in the post-outbreak phase. If effective, these may then allow some reduction in the need for treatments in the future and, possibly, allow some of the remaining native ash to survive without treatment. Only preliminary information is presently available but, in a few years, we can expect there to be a much better understanding of how much potential they may have in suppressing emerald ash borer in North America.

At some point in the future it may be decided that some of the more promising natural enemies may be suitable for introduction into Colorado. This is a decision that will be done by state and federal agencies, who will consider not only the possible benefits of such introductions but also possible risks.

Should I try to control emerald ash borer? The decision on what to do about managing this insect will have to be done individually by every owner for every ash tree in an area where this insect becomes established. This calculation will have to consider all the costs of treatment and balance these against the costs associated with not attempting to control EAB injury. Often the most critical factor in these decisions will be how much the tree is valued.

Unfortunately there will be costs associated with this insect regardless of what choice is made. Trees that are infested with emerald ash borer that are untreated or ineffectively treated will die prematurely, requiring their removal and, often, the purchase of replacement trees.

Some models exist to attempt to determine the economic value of trees, such as the National Tree Benefit Calculator: <http://www.treebenefits.com/calculator/> These can come up with figures on values related to benefits the trees provide in terms of air quality, shade, property value, etc. What they cannot capture is personal value of the tree to the owner.

When should I begin to treat for emerald ash borer? There can be some benefit to the health of the tree if treatments are applied to trees that are already infested or can be expected to be infested with emerald ash borer during the present growing season. However, since EAB is extremely difficult to detect in trees in early stages of infestation this decision will often have to be an educated guess, based on the information available on where the insect is known to be present within Colorado.

As of January 2014 EAB had only been found within a relatively confined area of the City of Boulder and overall EAB populations still appear to be low at these areas. Trees within the area of known EAB infestation, and up to a 5 mile radius of this infestation, may benefit from EAB treatment beginning in 2014. However, over time emerald ash borer will expand its distribution and an increasingly large area will be determined to be infested with EAB. As new infestations are detected, information on the

distribution of the insect in Colorado will be updated. One source summarizing the distribution of this insect in the state that is useful to reference is the web site maintained by the Colorado Department of Agriculture: www.eabcolorado.com.

Since most EAB treatments provide control for one year or, at most, two years following application there is no benefit in treating a tree prior to when EAB is present.

When can I discontinue treatments for emerald ash borer? Once established at a location emerald ash borer can be expected to survive in the area as long as any ash trees remain. Therefore some management of emerald ash borer will be required for as long as one wishes to maintain the tree.

Controls will have to be particularly intensive during the period when the insect populations increase to high levels and many ash trees in the neighborhood decline rapidly and die. After this wave of ash tree mortality is past, and populations of remaining trees consist largely of those that were effectively treated, numbers of emerald ash borers can be expected to decline dramatically. In this post-outbreak period it may be possible to reduce treatment intensity, although some management will always be required. Several years from now, when the first areas of Colorado affected by EAB go into the post-outbreak phase, there should be considerably more information available as to how to manage this phase of the emerald ash borer infestation.

What do I do if I suspect that I have emerald ash borer in a part of the state where it is not known? It is very important to identify any new areas where this insect may be established so that management plans can be adjusted. Therefore if you suspect that you have an EAB-infested tree that is outside the areas where it is previously known please do follow-up so that it can be investigated to determine positively whether - or whether not - it is emerald ash borer. Updated information regarding EAB in Colorado and the present information on its distribution within the state is found at:

<http://www.eabcolorado.com>

Often it is easiest to first contact local agencies to make the initial follow-up inspection. City forestry personnel, Colorado State Forest Service offices and county CSU Extension offices are examples of places where one might find help in determining whether it is likely to be emerald ash borer.

(Remember there are some other insects that resemble emerald ash borer or also damage ash:

<http://bspm.agsci.colostate.edu/files/2013/03/Emerald-Ash-Borer.pdf>)

If there is strong likelihood that a new infestation is detected then it is important to communicate this to the Colorado Department of Agriculture. The CDA can be contacted by phone (888-248-5535) or through the Emerald Ash Borer web site: <http://www.eabcolorado.com>

Federal agencies, specifically the regional branch of the USDA/APHIS/PPQ, also are involved in making final determination of whether new infestations are positively confirmed. Their phone contact is (303) 371-3355.

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