AGENDA
CITY OF MAPLEWOOD
PARKS AND RECREATION COMMISSION
6:00 PM April 20, 2022
City Hall, Council Chambers

Meeting is also available on Comcast Ch.16 and streaming via vod.maplewoodmn.gov

A. CALL TO ORDER

B. ROLL CALL

C. APPROVAL OF AGENDA

D. APPROVAL OF MINUTES

1. February 16, 2022

E. NEW BUSINESS

1. Maplewood Historical Society Presentation
2. Update to Emerald Ash Borer Management Plan

F. UNFINISHED BUSINESS

G. VISITOR PRESENTATIONS

H. COMMISSION PRESENTATIONS

I. STAFF PRESENTATIONS

1. Parks and Natural Resources Updates – (No Report)

J. ADJOURNMENT

RULES OF CIVILITY FOR THE CITY COUNCIL, BOARDS, COMMISSIONS AND OUR COMMUNITY

Following are rules of civility the City of Maplewood expects of everyone appearing at Commission Meetings - elected officials, staff and citizens. It is hoped that by following these simple rules, everyone's opinions can be heard and understood in a reasonable manner. We appreciate the fact that when appearing at Commission meetings, it is understood that everyone will follow these principles:

Speak only for yourself, not for other Commission members or citizens - unless specifically tasked by your colleagues to speak for the group or for citizens in the form of a petition.

Show respect during comments and/or discussions, listen actively and do not interrupt or talk amongst each other.

Be respectful of the process, keeping order and decorum. Do not be critical of Commission members, staff or others in public.

Be respectful of each other's time keeping remarks brief, to the point and non-repetitive.

MINUTES
MAPLEWOOD PARKS AND RECREATION COMMISSION
6:00p.m., February 16, 2022

A. CALL TO ORDER

A meeting of the Parks and Recreation Commission was called to order by Chairperson Porter at 6:00 p.m.

B. ROLL CALL

Commissioners	
Craig Brannon, Commissioner	Absent
Vickie Lee-Her, Commissioner	Present
Monica Barton, Commissioner	Present
Terri Mallet, Chair	Absent
Mark Harris, Commissioner	Present
Karen Poppa, Commissioner	Present
Kimii Porter, Commissioner	Present
Staff	
Audra Robbins, Parks and Recreation Manager	Present
Nikki Villavicencio, City Council Liaison	Present

C. APPROVAL OF THE AGENDA

Commissioner Poppa made a motion to approve the agenda.

Seconded by Commissioner Harris. Ayes – All

The motion passed.

D. APPROVAL OF MINUTES

1. **January 19, 2022**

   Commissioner Poppa made a motion to approve the January 19, 2022 Parks and Recreation Commission minutes.

   Seconded by Commissioner Harris Ayes – All

E. NEW BUSINESS

1. **Election of Officers (Chair and Vice Chair)**
   Audra Robbins, Parks and Recreation Manager, noted that both absent commissioners (Mallet and Brannon) indicated a willingness to continue in their current chair/co-chair role if needed.

CHAIRPERSON ELECTION:
Commissioner Harris made a motion to nominate himself for Chair of the Parks and Recreation Commission.

Seconded by Commissioner Poppa.

Commissioner Porter made a motion to nominate Terri Mallet for Chair of the Parks and Recreation Commission.

Seconded by Commissioner Poppa.

Commission members voted and Terri Mallet was elected Chair of the parks and Recreation Commission.

VICE CHAIR ELECTION:
Commissioner Harris made a motion to nominate himself for Co-Chair of the Parks and Recreation Commission.

Seconded by Commissioner Barton.

Commissioner Porter made a motion to nominate Craig Brannon for Co-Chair of the Parks and Recreation Commission.

Seconded by Commissioner Barton.

Commission members voted and Craig Brannon was elected Co-Chair of the parks and Recreation Commission.

2. **Trash Can Container Eagle Scout Project at the Nature Center**
   Ensim gave a presentation to the commission about his idea for an Eagle Scout project at the Nature Center.

F. UNFINISHED BUSINESS

1. **2022 Parks and Recreation Commission Goal Setting**

   Commissioner Harris made a motion to adopt the 2022 Parks and Recreation Goals.

   Seconded by Commissioner Her. Ayes – All

G. VISITOR PRESENTATIONS

H. COMMISSION PRESENTATIONS

I. STAFF PRESENTATIONS

1. **Minnesota Department of Agricultural/Urban Agricultural Grant for the Greening of Maplewood Edgerton Community Garden Improvements.**

Audra Robbins, Parks and Recreation Manager, updated the commission on the staff applying for an urban agriculture grant for improvements to the Edgerton Community Garden and the possibilities of the positive impacts of the grant.

2. **Skating Rinks/Warming House Updates**
   Audra Robbins, Parks and Recreation Manager, gave an update to the commission on the quality of the ice and extended season of the warming houses.

3. **RevSports Update**
   Audra Robbins, Parks and Recreation Manager, gave an update to the commission on the start of RevSports session 2.

4. **Gnome Hunt Challenge**
   Audra Robbins, Parks and Recreation Manager, informed the commission of gnome hunt challenge put on by the Friends of Maplewood Nature.

5. **Snowshoe Update**
   Audra Robbins, Parks and Recreation Manager, updated the commission on snowshoe happenings.

6. **Pleasantview Park Raingarden Update**
   Audra Robbins, Parks and Recreation Manager, updated the commission on the Pleasantveiw Park raingarden project and staff will be looking for alternative locations.

7. Audra Robbins, Parks and Recreation Manager, answered commission Harris' question regarding the tree trust program.

8. **Pleasantview Park Raingarden Update**
   Audra Robbins, Parks and Recreation Manager, updated the commission on the Pleasantveiw Park raingarden project and staff will be looking for alternative locations.

J. ADJOURNMENT

Commissioner Harris <u>made a motion to adjourn the meeting.</u>

Seconded by Commissioner Her   Ayes – All

The motion passed.

The meeting was adjourned at 6:56 p.m.

ENVIRONMENTAL & NATURAL RESOURCES COMMISSION STAFF REPORT
Meeting Date April 18, 2022

REPORT TO:	Parks and Recreation Commission
REPORT FROM:	Carole Gernes, Natural Resources Coordinator
PRESENTER:	Carole Gernes, Natural Resources Coordinator
AGENDA ITEM:	Recommendation to Update Emerald Ash Borer Management Plan

Action Requested: ✓ Motion ☐ Discussion ☐ Public Hearing
Form of Action: ☐ Resolution ☐ Ordinance ☐ Contract/Agreement ☐ Proclamation

Policy Issue:

The City's 2011 Emerald Ash Borer (EAB) Management Plan banned the use of chemical treatments to prevent infestation of high value specimen trees on City property. More information is now available to support the use of selected chemicals on a limited number of specimen ash trees on City property

Recommended Action:

Motion to recommend an update to the 2011 Emerald Ash Borer Management Plan, Allowing the Limited use of Specific Pesticides

Fiscal Impact:

Is There a Fiscal Impact? ✓ No ☐ Yes, the true or estimated cost is enter amount or $0.00.
Financing source(s): ☐ Adopted Budget ☐ Budget Modification ☐ New Revenue Source
☐ Use of Reserves ☐ Other: Click here to enter other source or n/a.

Strategic Plan Relevance:

☐ Community Inclusiveness ☐ Financial & Asset Mgmt ✓ Environmental Stewardship
☐ Integrated Communication ☐ Operational Effectiveness ☐ Targeted Redevelopment

Adding the use of chemicals to preserve specimen ash trees on a limited basis will preserve a tree on site until a newly planted tree can grow to take its place or to preserve the tree until EAB numbers and threat have been reduced.

Background:

In 2011, the Emerald Ash Borer Management Plan stated that "High value ash trees can be preserved from EAB with consistent treatments over time", however the use of chemical treatments as a tool for managing EAB on Maplewood property was banned. Details outlining toxicity of

Imidacloprid, a neonicotinoid, and Emamectin benzoate, a non-neonic pesticide were outlined in the document, but a second non-neonic, Azadirachtin (TreeAzin) was not discussed.

The City currently employs all other management tools recommended in the plan for our EAB infestation. Staff have a completed tree inventory, are actively monitoring and inspecting trees, removing infested or declining trees, have partnered with the Minnesota department of Agriculture for EAB Biocontrol releases, and have Secure funding for EAB management.

The Parks and Recreation Commission identified a large green ash near the Wakefield building as a specimen tree worthy of saving. Adding careful chemical treatment to our EAB management toolbox would allow treatment of the Wakefield ash.

Staff recommends adding non-neonic chemical treatment to the management toolbox for limited specimen trees in parks, to be used away from water and under an abundance of caution.

Attachments:

1. Emerald Ash Borer Management Plan
2. Appendix A Memo ENRC Chemical Usage for EAB
3. Risk to Bees from TreeAzin® Systemic Insecticide Injections for Emerald Ash Borer

Emerald Ash Borer Management Plan

City of Maplewood, Minnesota

May 3, 2011

I. Purpose

The purpose of this management plan is to address and plan for the eventual invasion of Emerald Ash Borer (EAB) into Maplewood urban forests. The goal of this plan is to slow the spread of the infestation through education, inspection, and strategic management. By defining and beginning management now we hope to lessen disruption to our urban forest, stretch the management costs associated with EAB over a longer period of time, and create an atmosphere of EAB awareness to detect an infestation as early as possible.

II. Applicability

This plan is applicable to all public land in Maplewood and all private properties where EAB may negatively impact public areas or generally threaten the overall health of Maplewood's urban forest.

III. Administration

Maplewood's City Forester and Natural Resources Coordinator will be responsible for implementing this program, with support from Parks and Recreation Department and Public Works Department.

IV. EAB Background

Emerald Ash Borer (EAB) is a non-native beetle that causes widespread decline and death of ash trees. The larval stage of EAB feeds on the tissue between the bark and the sapwood, disrupting the transport of nutrients and water in the trees. If infestation is high enough in an individual tree, the damage will be severe enough to kill the tree. EAB has destroyed millions of ash trees in other states. (See Appendices A, B, and C for more information.)

V. EAB Status in Minnesota

In 2009, EAB was found in southern Minnesota and in St. Paul. The infestation in St. Paul was in the St. Anthony area and on the University of Minnesota St. Paul Campus. Subsequently EAB was found in Minneapolis, in the Tower Hill and Prospect Park areas. The metro infestations are about 1 mile apart. The Minnesota Department of Agriculture (MDA), Minnesota Department of Natural Resources and University of Minnesota have helped coordinate the response to the infestation and education. In St. Paul this included ash tree removal in the infested areas as well as preemptive removal of ash in selected neighborhoods. In 2010, the MDA released biological control agents (three species of wasps) at the site of the southern MN infestation. The MDA plans to do a release in the metro area in 2011.

VI. EAB Management Strategies

When EAB was first found in Minnesota, it was believed that we would eventually lose all ash trees in Minnesota. But EAB may spread differently in Minnesota than it has in other states, since it appears that we have found it relatively early in the infestation. SLAM (Slow Ash Mortality) is an approach to EAB that focuses on slowing ash tree mortality through integrated management strategies. It may involve a combination of monitoring for EAB, preemptive removal of ash trees, insecticide treatment, and biological control. Slowing the spread of EAB and slowing ash tree mortality enables us to spread management costs over a longer time period. In addition, with biological control now a possibility, the outlook for ash in Minnesota could be different than initially predicted.

VI – 1 EAB Management: Tree Inventory

A tree inventory is the foundation of an EAB plan and provides the baseline data for a city's urban forestry program. The data can also be used to track management of individual trees, similar to the way a city tracks infrastructure maintenance (ex: storm sewer structures).

In 2010, Maplewood hired S&S Tree Specialists to conduct a complete inventory for park (not preserve) trees including location, species, diameter, and health. Only manicured areas of parks were inventoried. Maplewood parks have 2507 trees, 484 of which are ash (19.3%). In 2010, staff inventoried a sampling of boulevard trees. The protocol being used requires we inventory a minimum of 2000 boulevard trees in order to estimate how many trees we have on boulevards. This sampling will be completed in 2011.

The boulevard sampling and the complete park tree inventory provide data that enables us to understand the potential financial, aesthetic, and ecological impacts of EAB in Maplewood. But a complete boulevard tree inventory, with information on the health of each tree, is required for the city to strategically target individual trees for treatment or removal, and to make planting decisions that ensure tree diversity.

It is strongly recommended that the city hire a contractor to do a complete inventory of boulevard trees. In addition, it is recommended that staff conduct informal inventories on a few natural areas in the city to obtain some basic information about the ash population in forested areas.

VI – 2 EAB Management: Inspection, Detection, and Monitoring

The goal of detection is to find infestations as early as possible. Once an infestation center is found, we need to determine the duration and outer boundaries of the infestation. Many people should be involved in detection.

1. **City Forester.** Maplewood contracts a part-time forester to inspect properties for oak wilt and Dutch Elm Disease. The forester's contract should be expanded to include EAB detection and inspection. In addition, the City Forester should be the person responsible for delineating the infestation boundaries.
2. **City Staff**. City staff need to be key players in detecting EAB. It is recommended that staff at the nature center and parks and public works crew members undergo EAB training so they can help monitor the ash trees in the areas where they work. In addition, it is recommended that EAB training be provided for all employees interested in learning about the insect and its threat.
3. **Residents and the Maplewood Tree Hotline.** Residents will often be first to detect EAB on private lands. If they have a tree with suspected EAB, they are encouraged to review EAB information online and/or call the Maplewood Tree Hotline. The city forester responds to all calls and does a site check if he can't rule out EAB during the phone conversation.
4. **Arrest-The-Pest-Hotline.** The state maintains an Arrest-the-pest-hotline. Citizens can call the hotline to report a suspected incidence of EAB.
5. **Minnesota Forest Pest First Detector Network.** The first detector network is the state's early warning system for invasive tree pests. First detectors can help verify the presence of EAB.
6. **Minnesota Tree Care Advisors**. The tree care advisor program is a network of trained, community-based volunteers who promote urban and community forestry to all residents of Minnesota. This program is run by the University of Minnesota's Department of Forestry.

7. **Citizen-monitoring program**. Some Maplewood residents have expressed interest in learning more about Emerald Ash Borer and its potential impact to the city and the landscapes around their homes. The city should encourage interested residents to participate in the Forest Pest First Detector program or the Minnesota Tree Care Advisor program so they can help the city watch for EAB. The city should consider paying the tuition for residents in these programs if they commit to volunteering hours for inspecting sites in the city for EAB.
8. **Purple Traps**. In 2010, the Minnesota Department of Agriculture set purple traps throughout the state, including in Maplewood. The purpose of the traps is to help the MDA better determine the extent of the EAB infestation. The city should continue working with the MDA to have these traps set in Maplewood.

VI – 3 EAB Management -- Tree Removal

When ash trees die or decline they become hazards near boulevards, buildings, and play areas. Most dead trees and hazard trees will need to be removed. But strategic removal of trees before they die, whether they are infested or not, should also be a part of the city's EAB management strategy. Strategic removal helps spread out removal and replanting costs and may help slow the spread of EAB. The city should use four removal strategies:

1. ***Remove trees that die.*** Some trees may not be detected early in the infestation process so they will be removed when they die. On boulevards and in landscaped area of parks, all dead ash trees should be removed. In natural areas, it will not be feasible to remove all dead ash trees and deadfall should be addressed on a site-by-site basis. On private sites, owners should remove dead trees that are hazardous to people or structures.
2. ***Remove trees that are infested.*** A good detection program must be in place to use this removal strategy. Typically infestation centers are not detected for 3-5 years after insects arrive due to subtleties of initial signs in the tree. When an infested tree is identified, surrounding trees will need to be surveyed to determine the extent of infestation and the number of trees that will need to be removed. The city should consult with the MDA when infestations are initially identified.
3. ***Remove trees preemptively based on health.*** Selective removal of public ash trees based on health condition should be a part of the city's EAB strategy. In order to use this strategy the city will have to complete a boulevard tree inventory, including health information for each tree. The city has this data for park trees. The ash trees that would be considered for removal include:
    a. Unhealthy trees—inventoried trees that have a condition rating of four or less (out of ten).
    b. Trees that are unsafe due to poor health or structure and are located where they are likely to damage people and/or property (hazard trees).
    c. Trees that are in conflict with utilities.
    d. Trees that are poorly located and/or require excessive maintenance.

    If several trees will be removed preemptively from a park or a neighborhood, the full site impacts should be considered prior to removal.
4. ***Remove trees preemptively in an area***. Preemptive removal by area may be appropriate in situations such as:
    a. When a large population of ash trees is near an existing infestation and there are a significant number of trees in poor condition.
    b. In conjunction with a public works project if the health of ash trees on a street would be negatively impacted by the project and make them more susceptible to EAB.
    c. In conjunction with adjacent cities or regional strategies to manage EAB.

A priority removal list should be developed and revised regularly. In targeting trees for removal, the following should also be considered:

1. Proximity of ash tree removals to current infestation centers and their anticipated spread.
2. The number of trees in poor condition that are located near each other.
3. Spreading out removal costs over several years.

VI – 4 EAB Management: Pesticide Treatment

Insecticides are available for managing EAB. When timed appropriately, these treatments can create a toxic environment for the Emerald Ash Borer, killing dispersing adults as well as eggs and larvae. High value ash trees can be preserved from EAB with consistent treatments over time. There are two primary methods of pesticide application for EAB: soil drenching and trunk injection. In soil drenching, the insecticide is applied to the soil under the tree canopy and the tree roots take it in. In trunk injection, a hole is drilled into the tree trunk and the chemical is injected into the tissues under the bark. With either method, the chemical is dispersed throughout the tree. Emerald ash borers (and other insects) feeding on the tree ingest the chemical and are killed.

The city has determined that it will ~~not~~ permit the use of pesticides to control Emerald Ash Borer on city land, including the right-of-way, ~~due to negative environmental and health impacts.~~ on a limited basis for selected specimen trees. Approved non-neonictiod chemicals may be used via the injection method only. Appendix C includes references on EAB insecticides. Appendix D contains a memo and documentation from Maplewood's Environmental and Natural Resources Commission regarding the impacts of EAB insecticides.

The city shall encourage property owners to carefully evaluate environmental impacts before using pesticides to treat EAB on private property. Owners that decide to use EAB pesticides are urged to use trunk injection rather than soil drenching, which will help reduce pesticide drift and reduce impacts to groundwater and surface water.

VI-5

EAB Management: Biological Control

The Minnesota Department of Agriculture considers biological control the best option of cost-effective, long-term management of EAB. In 2010, the MDA released wasps that kill EAB eggs or larvae in Houston County, in southeast Minnesota. This release will be monitored to determine its efficacy. The MDA plans to do a release in spring 2011 near the infestation in Minneapolis and St. Paul. Appendix E contains information on biological control for EAB. If biological control for EAB proves effective, the city should coordinate with the MDA for release of these biocontrol agents in Maplewood.

VI – 6 EAB Management: Wood Disposal and Utilization

EAB can spread through transportation of ash wood—in logs, tree waste, chips or fire wood. Restricting the movement of ash wood can help slow the spread of EAB. Ramsey County and selected counties in Minnesota are under an ash quarantine which prohibits movement of ash out of the county. The quarantine restricts movement of firewood of all deciduous species. Businesses that need to move the restricted items across county lines may apply for Compliance Agreement that indicates how they will treat the regulated articles to mitigate the spread of EAB.

If large numbers of ash die, it is essential to look for ways to dispose of or utilize ash wood. Information continues to be published on potential markets for urban wood utilization. Possible uses for ash wood include fuel (biomass energy chips), mulch, pulpwood, and sawlogs. The city should identify local options for disposal and wood utilization. In addition, the city should seek partnerships with nearby cities for disposal and utilization.

VI – 7 EAB Management: Replanting

The loss of ash in our urban forest will have a visual and ecological impact. It is recommended that at least one tree be planted for every tree removed or lost to EAB. Increased diversity should be a key element in our replanting program. There are different models for boulevard tree diversity. For example, Dave Hanson from the University of Minnesota promotes the 10-20-30 rule: plant no more than 10% of any species, 20% of any genus, and 30% of any family. Prior to moving forward with replanting, the city should develop a Tree Master Plan that sets goals for our urban forest, ensures diversity of tree species within neighborhoods, identifies appropriate tree species, and addresses planting and care guidelines.

Maplewood's Tree Rebate program provides a cost-share match for residents to plant trees on private land. It is recommended that the city continue funding this program and, if needed, adjust the program so it supports residents in replanting after ash removal.

VII Education and Outreach

Education and outreach are essential components of the EAB Management Plan. The city shall develop an EAB education and outreach program that:

1. Educates residents so they understand the threats of EAB, know what to look for, know what to do when they find EAB or a declining ash tree, understand replanting and care of trees, and can make informed decisions for ash trees on their property.
2. Educates parks and public works staff so they can recognize signs and symptoms of EAB infestation.
3. Uses diverse forums for education including: public programs, website, articles in city publications, handouts, public service announcements, etc.
4. Provides advance notification to a neighborhood or homeowner of ash tree management that will occur in their area.
5. Provides educational and other support to residents that wish to form neighborhood groups to detect and manage EAB in their neighborhood.
6. Develops partnership with groups such as Tree Care Advisors.

VIII Ordinance and Policy

City code should be reviewed and revised to account for EAB. Two sections of code in particular may need revision:

1. Section 38, Article I. This section prohibits planting in the public right-of-way. If we have major losses of boulevard trees our ordinance should allow for and encourage replacement. Staff and Community Design Review Board should review this policy and make recommendations to council.
2. Section 38, Article II. This section covers the city's tree disease inspection program. It allows the city to control and eliminate Dutch elm disease fungus and elm bark beetles and "other epidemic diseases of shade trees." It states that the city may enter properties to inspect for epidemic tree diseases. Property owners are required to abate trees that are declared a nuisance. This ordinance shall be revised to include emerald ash borer as a tree pest. In addition, guidelines shall be developed to identify appropriate abatement actions. For example, in the early stages of EAB infestation in Maplewood, the city may need to require that homeowners remove infested ash to

help slow the spread. But, once EAB is widespread in the city, it may become impractical to require removal of all infested trees.

In addition, the city should develop a Street Tree Master Plan and policy that addresses:
1. Goals for street trees;
2. Guidelines and design templates for species diversity;
3. List of appropriate species;
4. Guidelines for planting and care.

IX Licencing/permitting

As part of EAB management, the city should review requirements for tree contractors licensed in the city and determine whether revisions are necessary.

X Funding

Funding will be needed to implement the EAB management plan. Primary costs include:
1. Boulevard tree inventory (estimate: $25,000-$32,000);
2. City forester – increased hours for detection and inspection. Maplewood's city forester is contracted for 150-170 hours per year, primarily to inspect public and private properties for oak wilt and Dutch Elm disease. We will need a significant increase in forester hours once EAB is found in Maplewood.
3. Tree removal (staff or contractors);
4. Pesticide treatment of selected trees, if approved as part of the EAB plan (staff or contractors);
5. Education and public outreach (staff and city forester);
6. Replanting (staff, contractors, volunteers).

Estimated cost for removal and replanting ash trees at Maplewood parks is $193,600 to $290,400. This is based on 484 ash trees, with removal costs of $200-$250 per tree and replanting costs of $200 to $350 per tree. While smaller trees establish well and catch up in size to larger trees in a few years, it is thought that planting larger trees on boulevards and in public places helps reduce vandalism and accidental injury of trees. When the sampling inventory of boulevard trees is completed in 2011, we will be able estimate removal and replanting costs for boulevard trees.

Maplewood will need to secure funding for EAB management.
1. **Grants.** Currently there is no long-term grant funding dedicated to assisting communities in Minnesota to manage EAB. An initial round of grants was available for EAB planning and management. Maplewood will need to stay informed on grant opportunities. To be competitive, it will be helpful to strengthen the city's urban forestry program. Having an EAB plan, a tree inventory, and a street tree policy will all be looked at in a positive light.
2. **General levy or fees.** The city will likely need to use some general operating funds for EAB management and may need to consider additional fees. St. Paul proposed a 2% surcharge on right-of-way rates dedicated to EAB management.
3. **City's tree fund.** The city's tree fund could be used to complete the boulevard tree inventory and for some tree planting. But this funding will not go far, and its purpose is not to control tree disease and pests.
4. **Tree donations.** The funding package should also consider a tree donation program. Currently Friends of the Parks and Trails (St. Paul and Ramsey County) has tree donation and Tribute Tree programs that serve cities in Ramsey County, including Maplewood. Publicizing these programs, or

creating our own donation program, will help provide plant material and funds for planting trees at parks.

XI Summary of Actions Needed

1. Conduct inventory of boulevard trees.
2. Develop details for strategic removal and re-evaluate the plan frequently.
3. Develop strategies for disposal or utilization of ash.
4. Develop and provide educational and outreach materials for residents.
5. Educate staff in parks and public works to recognize EAB.
6. Implement program for volunteers to help detect EAB in Maplewood.
7. Review and revise tree disease ordinance to include EAB as a forest pest that should be controlled on private land.
8. Develop a Tree Master Plan that includes goals for street and park trees, guidelines for species diversity, lists of appropriate species, guidelines for planting and care.
9. Secure funding for EAB management.

Appendices:

A. Pest Alert – Emerald Ash Borer
B. Do I Have EAB?
C. EAB References
D. Pesticide Impacts
E. Biological Control for EAB
F. What are other metro communities doing to manage EAB?

Appendix A

Pest Alert

United States
Department of Agriculture
Forest Service
Northeastern Area
State and Private Forestry
NA-PR-02-04
Revised September 2008

Emerald Ash Borer

A beetle from Asia, *Agrilus planipennis* Fairmaire (Coleoptera: Buprestidae), was identified in July 2002 as the cause of widespread ash (*Fraxinus* spp.) tree decline and mortality in southeastern Michigan and Windsor, Ontario, Canada. Larval feeding in the tissue between the bark and sapwood disrupts transport of nutrients and water in a tree, eventually causing branches and the entire tree to die. Tens of millions of ash trees in forest, rural, and urban areas have already been killed or are heavily infested by this pest.

A. planipennis has been found throughout Michigan, across much of Ohio, and in parts of Indiana, Illinois, Maryland, Missouri, Pennsylvania, Virginia, West Virginia and Wisconsin. Infestations have also been found in more areas of Ontario and in the province of Quebec. The insect is likely to be found in additional areas as detection surveys continue. Evidence suggests that *A. planipennis* is generally established in an area for several years before it is detected.

The broad distribution of this pest in the United States and Canada is primarily due to people inadvertently transporting infested ash nursery stock, unprocessed logs, firewood, and other ash commodities. Federal and state quarantines in infested states now regulate transport of these products.

Identification

Adult beetles are generally larger and brighter green (Fig. 1) than the native North American *Agrilus* species. Adults are slender, elongate, and 7.5 to 13.5 mm long. Males are smaller than females and have fine hairs, which the females lack, on the ventral side of the thorax. Adults are usually bronze, golden, or reddish green overall, with darker, metallic emerald green wing covers. The dorsal side of the abdomen is metallic purplish red and can be seen when the wings are spread (Fig. 2). The prothorax, the segment behind the head and to which the first pair of legs is attached, is slightly wider than the head and the same width as the base of the wing covers.

Larvae reach a length of 26 to 32 mm, are white to cream-colored, and dorso-ventrally flattened (Fig. 3). The brown head is mostly retracted into the prothorax, and only the mouthparts are visible. The abdomen has 10 segments, and the last segment has a pair of brown, pincer-like appendages.

Figure 1. Adult emerald ash borer.

Figure 2. Purplish red abdomen on adult beetle.

Figure 3. Second, third, and fourth stage larvae.

Figure 4. Gallery of an emerald ash borer larva.

Biology

A. planipennis generally has a 1-year life cycle. In the upper Midwest, adult beetles begin emerging in May or early June. Beetle activity peaks between mid June and early July, and continues into August. Beetles probably live for about 3 weeks, although some have survived for more than 6 weeks in the laboratory. Beetles generally are most active during the day, particularly when it is warm and sunny. Most beetles appear to remain in protected locations in bark crevices or on foliage during rain or high winds.

Throughout their lives beetles feed on ash foliage, usually leaving small, irregularly shaped patches along the leaf margins. At least a few days of feeding are needed before beetles mate, and an additional 1 to 2 weeks of feeding may be needed before females begin laying eggs. Females can mate multiple times. Each female probably lays 30-60 eggs during an average lifespan, but a long-lived female may lay more than 200 eggs. Eggs are deposited individually in bark crevices or under bark flaps on the trunk or branches, and soon darken to a reddish brown. Eggs hatch in 7 to 10 days.

After hatching, first instar larvae chew through the bark and into the phloem and cambial region. Larvae feed on phloem for several weeks, creating serpentine (S-shaped) galleries packed with fine sawdust-like frass. As a larva grows, its gallery becomes progressively wider (Fig. 4). Beetle galleries often etch the outer sapwood. The length of the gallery generally ranges from 10 to 50 cm. Feeding is usually completed in autumn.

Prepupal larvae overwinter in shallow chambers, roughly 1 cm deep, excavated in the outer sapwood or in the bark on thick-barked trees. Pupation begins in

Figure 5. D-shaped hole where an adult beetle emerged.

Figure 6. Jagged holes left by woodpeckers feeding on larvae.

Figure 7. Ash tree killed by emerald ash borer. Note the serpentine galleries.

Figure 8. Epicormic branching on a heavily infested ash tree.

late April or May. Newly eclosed adults often remain in the pupal chamber or bark for 1 to 2 weeks before emerging head-first through a D-shaped exit hole that is 3 to 4 mm in diameter (Fig. 5).

Studies in Michigan indicate 2 years may be required for *A. planipennis* to develop in newly infested ash trees that are relatively healthy. In these trees, many *A. planipennis* overwinter as early instars, feed a second summer, overwinter as prepupae, and emerge the following summer. In trees stressed by physical injury, high *A. planipennis* densities, or other problems, all or nearly all larvae develop in a single year. Whether a 2-year life cycle will occur in warmer southern states is not yet known.

Distribution and Hosts

A. planipennis is native to Asia and is found in China and Korea. It is also reported in Japan, Mongolia, the Russian Far East, and Taiwan. In China, high populations of *A. planipennis* occur primarily in *Fraxinus chinensis* and *F. rhynchophylla*, usually when those trees are stressed by drought or injury. Other Asian hosts (*F. mandshurica* var. *japonica*, *Ulmus davidiana* var. *japonica, Juglans mandshurica* var. *sieboldiana,* and *Pterocarya rhoifolia)* may be colonized by this or a related species.

In North America *A. planipennis* has attacked only ash trees. Host preference of *A. planipennis* or resistance among North American ash species may vary. Green ash (*F. pennsylvanica*) and black ash (*F. nigra*), for example, appear to be highly preferred, while white ash (*F. americana*) and blue ash (*F. quadrangulata*) are less preferred. At this time all species and varieties of native ash in North America appear to be at risk from this pest.

Signs and Symptoms

It is difficult to detect *A. planipennis* in newly infested trees because they exhibit few, if any, external symptoms. Jagged holes excavated by woodpeckers feeding on late instar or prepupal larvae may be the first sign that a tree is infested (Fig. 6). D-shaped exit holes left by emerging adult beetles may be seen on branches or the trunk, especially on trees with smooth bark (Fig 5). Bark may split vertically over larval feeding galleries. When the bark is removed from infested trees, the distinct, frass-filled larval galleries that etch the outer sapwood and phloem are readily visible (Fig. 4 and Fig. 7). An elliptical area of discolored sapwood, usually a result of secondary infection by fungal pathogens, sometimes surrounds galleries.

As *A. planipennis* densities build, foliage wilts, branches die, and the tree canopy becomes increasingly thin. Many trees appear to lose about 30 to 50 percent of the canopy after only a few years of infestation. Trees may die after 3 to 4 years of heavy infestation (Fig. 7). Epicormic shoots may arise on the trunk or branches of the tree (Fig. 8), often at the margin of live and dead tissue. Dense root sprouting sometimes occurs after trees die.

A. planipennis larvae have developed in branches and trunks ranging from 2.5 cm (1 inch) to 140 cm (55 inches) in diameter. Although stressed trees are initially more attractive to *A. planipennis* than healthy trees are, in many areas all or nearly all ash trees greater than 3 cm in diameter have been attacked.

Resources

For more information on the emerald ash borer and related topics...

- Visit the following Web sites:

  Multi-agency Emerald Ash Borer Web Site: www.emeraldashborer.info

  USDA Forest Service: www.na.fs.fed.us/fhp/eab/

  USDA Animal and Plant Health Inspection Service: www.aphis.usda.gov/plant_health/

- Contact your state Department of Agriculture, State Forester, or Cooperative Extension Office.

Published by:
USDA Forest Service
Northeastern Area
State and Private Forestry

Newtown Square, PA 19073

www.na.fs.fed.us

Federal Recycling Program
Printed on recycled paper.

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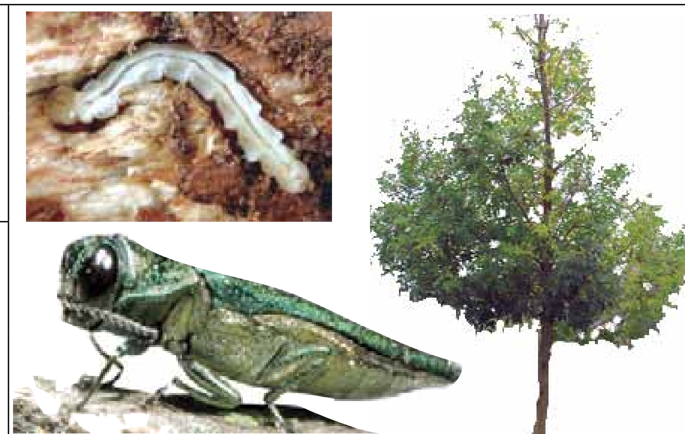
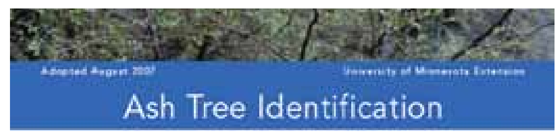
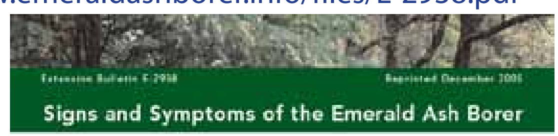
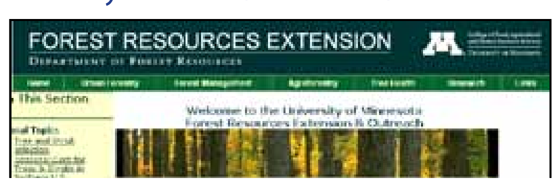
Edward Czerwinski, Ontario Ministry of Natural Resources, www.forestryimages.org

MINNESOTA DEPARTMENT OF AGRICULTURE
625 Robert St. N., St. Paul, MN 55155-2538
www.mda.state.mn.us

Do I Have Emerald Ash Borer (EAB)?

University of Minnesota EXTENSION

Minnesota Department of Natural Resources

STEP 1	**I think my ash tree may be infested with Emerald Ash Borer.** → *Go to step #3*	
STEP 2	**I suspect I have seen an Emerald Ash Borer.** → *Go to step #5*	
STEP 3	**Is my tree an ash?** → *If yes, go to step #4* → *If no, go to step #7*	Review this guide www.mda.state.mn.us/news/publications/ext/ashtreeid.pdf 
STEP 4	**Does my ash tree have symptoms of Emerald Ash borer?** → *If yes, go to step #5* → *If no, go to step #7*	Review this guide www.emeraldashborer.info/files/E-2938.pdf 
STEP 5	**Are the symptoms or insects EAB look-alikes?** → *If yes, go to #7* → *If no, go to #6*	Review these guides www.mda.state.mn.us/news/publications/ext/eablookalikes.pdf OR www.mda.state.mn.us/sitecore/content/Global/MDADocs/pestsplants/eab/eabreference.aspx
STEP 6	**It could be EAB.** → *Contact the U of M Forest Resources Extension to find an EAB First Detector near you: treeinfo@umn.edu or 612-624-3020*	www.forestry.umn.edu/extension/index.html 
STEP 7	**It isn't EAB; so, what is it?** → *Visit the University of Minnesota Extension "What's Wrong With My Plant" website to diagnose the problem.*	www.extension.umn.edu/gardeninfo/diagnostics/deciduous/ash/index.html 

Appendix C: EAB References

General EAB information

www.emeraldashborer.info
www.extension.umn.edu/distribution/horticulture/M1242.html
www.dnr.state.mn.us/invasives/terrestrialanimals/eab/slideshow.html

Minnesota Department of Agriculture:

General: www.mda.state.mn.us/plants/pestmanagement/eab.aspx
Management strategies: www.mda.state.mn.us/plants/pestmanagement/eab/eabstrategies.aspx
Quarantine information: www.mda.state.mn.us/en/plants/pestmanagement/eab/quarantinefaq.aspx
Biocontrol: www.mda.state.mn.us/plants/pestmanagement/eab/biocontrolinsemn.aspx

Insecticides for EAB:

16-page guide: www.emeraldashborer.info/files/multistate_EAB_Insecticide_Fact_Sheet.pdf
Environmental impacts of Imidacloprid: www.sierraclub.ca/national/programs/health-environment/pesticides/imidacloprid-fact-sheet.shtml
Impacts: www.emeraldashborer.info/files/Potential_Side_Effects_of_EAB_Insecticides_FAQ.pdf
Homeowner guide: www.mda.state.mn.us/en/plants/pestmanagement/~/media/Files/plants/eab/eabtreatmentguide2.ashx

Note—Commissioner Ginny Yingling has assembled several technical articles on EAB insecticides and staff can make these available.

Appendix D: 4/18/11 Memo from Environmental and Natural Resources Commission

To: Maplewood City Council

From: Maplewood Environmental and Natural Resources Commission

Date: April 18, 2011

Re: Concerns regarding use of chemical treatment to address potential Emerald Ash Borer infestations.

At its March 2011 meeting, the Maplewood Environmental and Natural Resources Commission passed a resolution strongly urging the City Council not to allow the use of chemical treatments on ash trees owned by the city as part of its Emerald Ash Borer (EAB) strategy. This decision was based on several lines of reasoning:

1. Such treatments, once begun, must continue for the life of the tree, at potentially considerable expense to the city.
2. Damage to the trees as a result of injecting the chemicals (the environmentally "preferred" approach) is likely to reduce the life of the trees anyway.
3. Financial resources used for treatment would be better spent in mitigation strategies, such as thinning of ash trees on city property and boulevards to reduce the overall coverage of this species (thereby making the larger forest "less attractive" for EAB) and pre-emptive replacement with other tree species.
4. Chemical treatments may postpone, but ultimately likely will not prevent the loss of many ash trees; but chemical treatments come with potentially high environmental costs.

It is these environmental costs that we have outlined in greater detail for you below (and describe in even greater detail with supporting documentation in the attached document). The two most likely chemicals to be used against EAB are imidacloprid (IM) and emamectin benzoate (EB). Both of these chemicals are highly toxic to various beneficial insects and have known and potential environmental consequences that, in our opinion, make them undesirable for use in our city:

<u>Imidacloprid (IM)</u>

1. IM is extremely toxic to honeybees and high concentrations of IM are found by researchers in sap, pollen, and nectar of treated plants. Short-term exposure to as little as 5 nanograms (one-billionth of a gram) results in 50% mortality among honeybees.
2. While pollination by bees is not important for ash trees, in the upper Midwest the pollen from ash trees constitute nearly 40% of bees' pollen source in April, when other sources are not yet available.
3. Studies linking IM to collapse of honeybee populations in Europe has led Italy, France and Germany to ban it and the EU to schedule it's phasing out.
4. IM is also very toxic to beneficial predator insects such as ladybird beetles and lacewings, to aquatic insects such as mayflies and caddisflies, and to earthworms.

5. Studies suggest IM's use in trees may actually promote infestations by unwanted insects, such as spider mites. These studies indicate such infestations are due not only to the elimination of beneficial insects that prey on the mites, but also as a result of the chemicals causing greater egg production by the mites themselves.
6. Leaves from systemically treated ash and maple trees were found to inhibit feeding of decomposer organisms, such as earthworms and aquatic invertebrates.
7. IM is highly soluble so it is found in runoff from agricultural fields, in streams, and groundwater throughout North America.
8. At concentrations found in the environment, aquatic insect communities show reduced populations and biodiversity.
9. Once applied to a tree, either by soil drench or injection, IM is quickly detectable in leaves, sap, and pollen, where non-target species may be exposed to significant concentrations.
10. The breakdown products, or metabolites of IM, are often more toxic than IM itself.

Emamectin benzoate (EB)

1. EB is extremely toxic to butterflies and moths and does not distinguish between "good" and "bad" species. Studies have shown it is 20- to 64,000-times more toxic to butterfly and moth catepillars than other pesticides used on the same crops as EB.
2. EB is used in agriculture as a topical (spray) treatment on a variety of crops because it has been found to be relatively less toxic to non-target insects than other pesticides (other than moths and butterflies). However, when sprayed onto plants, EB degrades rapidly in sunlight limiting exposure of non-target species. No studies were found evaluating EBs toxicity as a systemic pesticide, so it is not known what kind of exposures or affects would be experienced by non-target species when EB is used in this manner.
3. EB is also used to kill parasitic sea lice in fish farms. Studies indicate it may act as an endocrine disruptor, causing early induction of molting in lobsters and other crustaceans. Would the same be true in crawfish? There is no information.
4. EB appears to be moderately toxic to freshwater fish such as bluegill, trout and fathead minnow.
5. EB is very toxic to marine copepods, but there is no information regarding how it would affect freshwater invertebrates.
6. EB tends to bind to soil or sediment particles, making it less likely to leach to groundwater, but also making it very persistent in soil. Also, runoff carrying soil particles could carry EB to surface waters.
7. The biggest concern is the lack of information about EB as a systemic pesticide and its potential impacts in terrestrial and freshwater ecosystems.

Pesticides such as IM and EB have gained favor because of their apparent low toxicity to mammals, including humans. We believe this is short-sighted. Our health and quality of life depends upon the integrity of the ecosystems in which we live. From our perspective the loss of certain insect species may seem inconsequential; from the perspective of the larger system it can be devastating. Upsetting the delicate balance between predator and prey, plants and pollinators, detritus and decomposers is often considered by us to be a regrettable, but remote effect on the "lowest orders" of the animal world. In fact, it is akin to chipping away at the foundation of our home.

Given the potential impacts of these chemicals on our environment (and in the case of EB the gaping holes in our knowledge regarding its potential impacts), we urge the city council to not allow the use of them on trees in our city. While chemical treatments may provide a short-term fix to the EAB problem, we believe the city would be better served by taking a holistic view of our environment that considers the indirect consequences of these toxic chemicals and adopt a long-term, preventative approach through strategic management of our forests.

Environmental Fate and Ecological Toxicity of Chemicals Proposed for Emerald Ash Borer Treatments

Prepared for the Maplewood Environmental and Natural Resources Commission

by commission member, Ginny Yingling. April 17, 2011.

Imidacloprid

Imidacloprid (IM) is a nicotine mimic that produces toxicity by binding to and over-stimulating certain neuron receptors, disrupting the nervous system. It binds much more readily to these receptors in invertebrates than vertebrates, giving it a higher margin of safety for humans. In insects, the disruption of the nervous system results in modified feeding behavior, paralysis and subsequent death (Mullins, 1993). IM is used against a wide variety of insect pests, including Asian longhorn beetles (maple trees), potato beetle, cockroaches, fleas on domestic pets (Advantage®), termites, turf insects, etc. While it only moderately toxic to mammals and fish, it is extremely toxic to non-target beneficial organisms, such as honeybees and earthworms (Zang, et al., 2000; Luo, 1999), and important predator insects, including ladybird beetles and lacewings (Kaakeh, et al., 1996; Mizell and Sconyers, 1992). Some studies have also shown that treatment with IM may result in infestations by other, unwanted insects, such as spider mites (James and Price, 2002; Raupp, et al., 2004; Sclar, et al, 1998). These infestations are promoted not only by the reduction or elimination of beneficial predator insects, but also by increased spider mite egg production resulting from their exposure to IM (James and Price, 2002).

IM is highly water soluble and does not bind readily to soil particles (Fossen, 2006), so it may readily leach into groundwater. It is quite persistent in the environment, degrading quite slowly in water (half-life[1] = 31-46 days; Kidd and James, 1991; Tomlin, 1997) and soil (half-life = 69 – 997 days; Sarkar, et. al., 1999; Gupta, et al., 2002; Roberts and Hutson, 1999). However, when exposed to sunlight IM has a short (3 hour) half-life in surface water (Moza, et al, 1998; Wamhoff, et al., 1999), so it is less likely to be found in surface waters than groundwater. Yet, despite its rapid degradation in sunlight, investigators report detecting concentrations of 0.2, 0.4, and 1.0 parts per billion (ppb) in streams in New York, New Brunswick and Florida, respectively. Concentrations as high as 11.9 ppb have been detected in runoff from agricultural fields in Canada (CCME, 2007). IM has been detected in the groundwater in New York at concentrations up to 6.69 ppb (US EPA, 2003). Several IM breakdown products have been shown to be of equal or greater toxicity than the parent compound (Nauen et al, 1998).

Despite its environmental persistence and presence in waters, very little is known about IM's long-term chronic and short-term "pulse" effects on non-target aquatic organisms. However, in studies by Kreutzweiser,

[1] A half-life is the time it takes for half of the mass of a contaminant to degrade.

et al. (2007 and 2008), leaves from ash and maple trees treated with IM at typical field rates contained 0.8 – 1.3 and 3-11 parts per million (ppm) IM, respectively. The leaves were then added to aquatic and forest microcosms to evaluate the effect on leaf-shredding insects. While there appeared to be no effect on the invertebrates' survival rates, the 1.3 ppm and higher concentrations caused significant feeding inhibition among aquatic insects and earthworms, as well as measurable weight loss in the earthworms. IM applied directly to the water of the aquatic microcosms, to simulate leaching from soils, was at least 10-times more toxic to aquatic insects than the IM in the leaves, with high mortality at 0.13 ppm and significant feeding inhibition at 0.012 ppm. Pestana, et al. (2009) found that both the abundance and biodiversity of aquatic bottom-feeding invertebrates was reduced by exposure to IM at concentrations of 2 and 20 ppb. They also note that IM is toxic to other aquatic insects, such as caddisflies and mayflies. Mayflies are particularly sensitive with 50% of the mayflies dying within 24- and 96-hrs of being exposed to 2.1 and 0.65 ppb IM, respectively. Premature maturation and emergence of mayflies, and impaired reproductive fitness, occurred when they were exposed to pulses of IM at concentrations of as little as 0.1 ppb (Alexander, et al., 2007 and 2008).

IM rapidly moves through plant tissues after applications and can be present in detectable concentrations in the leaves, vascular fluids (sap) and pollen. Studies have shown plants grown from seeds treated with IM can have significant concentrations (up to 15 ppm in leaves of young seedlings, up to 13 ppb in pollen) of IM in their sap, pollen, flowers, and leaves (Laurent and Rathahao, 2003; Rouchaud, et al, 1994; Bonmatin, et al., 2005; Westwood, et al, 1998). As a result, many non-target insects, such as honey bees, parasitic wasps, and predaceous ground beetles sensitive to IM may be exposed as they forage for sap, pollen and nectar or feed on other insects that have been exposed.

Bees are particularly sensitive to IM. Pollen constitutes the only protein source for a beehive, and its contamination can induce both contact- and oral-intoxication. Fifty percent of bees will die if they ingest just 5 nanograms[2] (ng) of IM over a short period of time (acute exposure), or just 0.01 – 1 ng over a longer period of time (chronic exposure). These values are often referred to as the LD-50, or the amount of a toxin that is a "lethal dose" (LD) to 50% of the exposed organism (Suchail, et al, 1999). When bees forage for nectar, they often become coated with pollen. The LD-50 for simply coming into contact with IM contaminated pollen is 24 ng of IM (Suchail, et al, 1999). Even if the use of IM is of short duration (spring applications), the exposure for bees in chronic, as both bees and their larvae feed on the stocked contaminated pollen and nectar, especially in the winter and early spring (Bonmatin, et al., 2005). Low doses of IM and IM-metabolites also negatively affect honeybee foraging and learning behavior (Decourtye et al, 2003 and 2004).

Perhaps the most compelling evidence for the toxicity of systemic IM on honeybees is an online video at http://www.youtube.com/watch?v=e8Nsn4KvjwM . In this video, researchers compare the effects on

[2] A nanogram is one billionth of a gram

honeybees of feeding them sap expressed from the blade tip of corn seedlings grown from IM-treated and untreated seeds. The bees fed the sap from the treated seedlings died within 2 to 5 minutes.

As use of IM as a seed-dressing formulation for various crops has increased, researchers have noted a coincidental sudden and drastic decline in honeybee populations and honey production in Europe (Colin, et al., 2004). While a conclusive link has not been made, it is suspected that IM has played a major role in these declines (Bonmatin, et al, 2005) and has led several individual nations (Italy, France, Germany) and the EU to ban or phase-out the use of IM.

It is often noted that ash trees largely pollinate by airborne dispersion of their pollen, and therefore do not rely heavily on bees for their pollination, suggesting that bee exposure to ash pollen (and any IM it may contain) may be minimal. However, ash trees are one of the earliest flowering trees in the upper Midwest and bees rely heavily on them as a source of food when they first begin foraging in the spring. In fact, in a PhD thesis from Wisconsin, Severson (1978) reports that ash pollen may constitute as much as 39% of the bee's pollen source in mid-April.

Emamectin Benzoate

Emamectin benzoate (EB) belongs to a class of pesticides called avermectins, which disrupt the transmission of nerve impulses, resulting in paralysis and death of the target organisms. Recent studies also suggest that EB has the ability to induce premature molting in insects, suggesting it is also an endocrine disruptor (Bright, et al., 2005). Avermectins are broad spectrum toxicants for nematodes and insects. EB was developed as a lepidoptericide, so it is extremely toxic to moths and butterflies. A Canadian study found EB is also toxic to green algae at relatively low concentrations (3.9 ppb; OPP, 2000). It also appears to be moderately toxic to freshwater fish, such as bluegill, trout, and fathead minnow, with LC-50[3] values of 180, 174, and 194 ppb in water, respectively (OPP, 2000). Irreversible, toxic effects on marine copepods were observed at water concentrations as low as 0.12 ppb and significant reduction in egg production was observed at 0.158 ppb (Willis and Ling, 2003). EB appears to be relatively non-toxic for birds and mammals (Bright, et al, 2005).

In the environment, EB tends to bind to soil or sediment particles (SPAH, 2002), making it less likely than IM to leach into the groundwater, but more likely to be washed into surface water with runoff carrying sediment. Studies have shown it to have a half-life in soil of 174 – 427 days (the lower the oxygen levels in the soil, the longer EB persists). EB is very stable in water, although if exposed to sunlight it has a half-life of 1.4 – 22 days (Bright, et al, 2005).

EB has been used as a topical (spray) treatment in a wide variety of agricultural crops such as cotton, tobacco, cabbage, potatoes, etc. where it is used primarily to kill "chewing and sucking pests", such as aphids, leafhoppers, tobacco budworms, southern armyworm, potato beetle, and whiteflies. Its agricultural uses have

[3] LC-50, the 50% lethal concentration, is similar to LD-50, but refers to the concentration (rather than dose) of a toxin in water, soil, or food, at which 50% of exposed organisms will die.

increased in recent years because it is relatively less harmful to beneficial insect species than other avermectins when applied as a spray (Sechser, et al., 2003; Lasota and Dybas, 1991). However, no studies were found evaluating the effects of EB when used as a systemic pesticide.

In recent years, EB has been used to kill parasitic sea lice which infect salmon in fish farms. Studies have indicated that the high doses found in fish feed and feces beneath the fish pens may have adverse effects on the molting cycle and reproductive success of lobsters (Waddy, et al., 2010). This may have implications for the development and subsequent reproduction of other crustaceans (such as freshwater crawfish), beneficial insects, and other invertebrates, but no studies have been done to evaluate this. EB has also been detected in blue mussels up to 100 m from the fish pens, but it does not appear to persist in them once the source has been removed (Telfer, et al., 2006). No studies were found to have been conducted on freshwater bivalves to determine whether they would be similarly affected if exposed to EB.

The main concern surrounding EB is the lack of information regarding how it will behave when used as a systemic pesticide in trees (or other plants) and the general absence of information regarding its effects on freshwater organisms.

References cited:

Alexander, AC., Culp, MN, Liber, K. and Cessna, AJ (2007) Effects of insecticide exposure on feeding inhibition in mayflies and oligochaetes. Env. Toxicol. & Chem., 26:1726-1732.

Alexander, AC., Heard, KS, and Culp JM (2008) Emergent body size of mayfly survivors. Freshwater Biol., 53:171-180.

Bonmatin, JM, et al. (2005) Quantification of imidacloprid uptake in maize crops. Jour. Agric. Food Chem., 53:5336-5341.

Bright, DA and Dionne, S. (2005) Use of Emamectin Benzoate in the Canadian Finfish Aquaculture Industry: A Review of Environmental Fate and Effects. Prepared for Environment Canada. March 2005.

Burridge, L.E., et al. (2004) Acute toxicity of emamectin benzoate (SLICE) in fish feed to American lobster, Homarus americanus. Aquacult. Res., 35:713-722.

CCME (2007) Canadian Water Quality Guidelines: Imidacloprid. Scientific Supporting Document. Canadian Council of Ministers of the Environment, Winnipeg.

Conlin, M.E., et al. (2004) Qunatitative analysis of the foraging activity of honeybees: relevance to the sub-lethal effects induced by systemic insectides. Archive Environ. Contam. Toxicol., 47:387-395.

Decourtye, A., Lacassie, E. and Pham-Delegue, MH (2003) Learning performances of honeybees (*Apis mellifera L.*) are differentially affected by imidacloprid according to the season. Pest Management Sci., 59:269-278.

Decourtye, A., Devillers, J., Cluzeau, S., Charreton, M. and Pham-Delegue, MH (2004) Effects of imidacloprid and deltamethrin on associative learning in honeybees under semi-field and laboratory conditions. Exotoxicol. Environ. Safety, 57:410-419.

Fossen, M (2006) Environmental Fate of Imidacloprid. Department of Pesticide Regulation, Sacramento, CA. April 2006.

Gupta, S., et al (2002) Leaching behavior of imidacloprid formulations on soil. Bull. Environ. Contam. Toxicol., 68:502-508.

James, DG and Price, TS (2002) Imidacloprid Boosts TSSM Egg Production. Agrichem. & Env. News, Issue 189. Washington State Univ. Extension Service.

Kaakeh, N., Kaakeh, W, and Bennet, G (1996) Topical toxicity of imidacloprid, fipronil, and seven conventional insecticides to the adult convergent lady beetle (Coleoptera: Coccinellidae). Jour. Of Entomol. Sci, 31(3): 315-322.

Kidd H. and James DR (1991) The Agrochemicals Handbook, Third Ed. The Royal Society of Chemistry. Unwin Brothers Ltd., Old Woking, Surrey, UK.

Kreutzweiser, D., Good, K., Chartrand, D., Scarr, T., and Thompson, D. (2007) Non-target effects on aquatic decomposer organisms of imidacloprid as a systemic insecticide to control emerald ash borer in riparian trees. Ecotoxicol. Env. Safety, 68:315-325.

Kreutzweiser, DP, Good, KP, Chartrand, DT, Scarr, TA, and Thomspon, DG (2008a) Are leaves that fall from imidicloprid-treated maple trees to control Asian longhorned beetles toxic to non-target decomposer organisms? Jour. Env. Quality, 37:639-646.

Kreutzweiser, DP, Thomspon, DG, and Scarr, TA (2008b) Imidicloprid in leaves from systemically treated trees may inhibit litter breakdown by non-target invertebrates. Ecotoxicol. & Env. Safety, 72:1053-1057.

Kreutzweiser, et al. (2008c) Toxicity of the Systemic Insecticide, Imidacloprid, to Forest Stream Insects and Microbial Communities. Bulletin of Environmental Contaminant Toxicology, 80:211-214.

Lasota, JA and Dybas, RA (1991) Avermectins, a novel class of compounds: Implications for use in arthropod pest control. Ann. Rev. of Entomol., 36:91-117.

Laurent, FM and Rathahao, E. (2003) Distribution of C^{14} imidacloprid in sunflowers (*Helianthus annuus L.*) following seed treatment. Jour. Agric. Food Chem., 51:8005-8010.

Luo, Y. (1999) Toxicological study two novel pesticides on earthworm*, Eisenia foetida*. Chemosphere, 39:2347-2356.

Mizell, RF and Sconyers, MC (1992) Toxicity of imidacloprid to selected arthropod predators in the laboratory. Florida Entomol., 83:1806-1812.

Moza, PN, Hustert, K., Fesicht, E. and Kettrup A. (1998) Photolysis of imidacloprid in aqueous solution. Chemosphere. 36(3):497-502.

Mullins, JW (1993) Imidacloprid: A new nitroguanidine insecticide. Am. Chem. Soc. Symposium Series 5240097-6156.

Nauen, RK, Tietjen, K., Wagner, K. and Elbert, A. (1998) Efficacy of plant metabolites of imidacloprid against *Myzus persicae* and *Aphis gossypii* (Homoptera: Aphididae). Pestic. Sci., 52:53-57.

OPP, 2000 Pesticide Ecotoxicity Database (Formerly: Environmental Effects Database (EEDB). Data retrieved from USEPA Ecotox database. Office of Pesticides Program.

Pestana, J., et al. (2009) Structural and functional responses of benthic invertebrates to imidacloprid in outdoor stream mesocosms. Env. Pollution (2009).

Raupp, MJ, Webb, RE, Szczepaniec, A., Booth, D., and Ahern, R. (2004) Incidence, Abuncance and Severity of Mites on Hemlocks Following Applications of Imidacloprid. Jour. of Arboriculture, 30(2):108-113.

Roberts, TR and Hutson, DH (eds) (1999) Chlorpyrifos. In: Metabolic Pathways of Agrochemicals, Part 2. The Royal Soc. of Chem., Cambridge, UK, pp 234-242.

Sarkar, MA, et al (1999) Effect of pH and type of formulation on the persistence of imidacloprid in water. Bull. Environ. Contam. Toxicol., 63:604-609.

Rouchaud, J., Gustin F., and Wauters, A. (1994) Soil biodegradation and leaf transfer of insecticide imidacloprid applied in seed dressing in sugar beet crops. Bull. Environ. Contam. Toxicol., 53(3): 344-350.

Sclar, D.C., Gerace, D., and Cranshaw, W. S. (1998) Observations of Population increases and injury by spider mites (Acari: Tetranychidae) on Ornamental Plants Treated with Imidacloprid. Jour. Econ. Entomol., 91(1):250-255.

Sechser, B., Ayoub, S., and Monuir, N. (2003) Selectivity of emamectin benzoate to predators of sucking pests on cotton. Jour. of Plant Disease and Protection, 110(2):184-194.

Severson, DW (1978) Pollen Gathering by Honey Bees in LaCrosse County, Wisconsin. Thesis submitted to the faculty of the University of Wisconsin. September 1978.

SPAH, 2002 Potential environmental impacts of emamectin benzoate, formulated as Slice™, for salmonids. Technical Report. 36 pp. Schering-Plough Animal Health.

Suchail, A, Guez, D., and Belzunces, LP (1999) Discrepancy between acute and chronic toxicity induced by imidacloprid and its metabolites in *Apis mellifera*. Environ. Toxicol. Chem., 20(11): 2482-2486.

Telfer, T.C., et al. (2006) Environmental effects of the anti-sea lice (Copepoda: Caligidae) therapeutant emamectin benzoate under commercial use conditions in the marine environment. Aquaculture, 260: 163-180.

Tomlin, C (1997) The pesticide manual: Incorporating the agrochemicals handbook, 10th ed. British Crop Protection Council, Farnham, Surrey, UK.

U.S. EPA (2003) Imidacloprid; Pesticide Toerances. Fed. Regist. 68:35303-35315 [Online]. Available at http://www.epa.gov/fedrgstr/EPA-PEST/2003/June/Day-13/p14880.htm (as cited in Fossen, 2006; verified 1-11-06). US EPA, Washington, DC.

Waddy. SL, Merritt, VA, Hamilton-Gibson, MN, and Aiken, DE (2010) Effect of emamectin benzoate on the molt cycle of ovigerous American lobsters *Homarus americanus* is influenced by the dosing regimen. Aquatic Biol., 11:47-52.

Wamhoff, H. and Schneider, V. (1999) Photodegradation of imidacloprid. Jour. Agric. Food Chem., 47(4):1730-1734.

Westwood, F., Bean, K., Dewar, A., Bromilow, R., and Chamberlain, K. (1998) Movement and persistence of [^{14}C] imidacloprid in sugar-beet plants following application to pelleted sugar-beet seed. Pesti. Sci., 52(2):97-103.

Willis, KJ and Ling, N. (2003) The toxicity of emamectin benzoate, an aquaculture pesticide, to planktonic marine copepods. Aquaculture, 221:289-297.

Zang, Y., et al. (2000) Genotoxicity of two novel pesticides for the earthworm*, Eisenia foetida*. Environ. Pollut., 108:271-278.

Appendix E: Biological Control

The following text is from the Minnesota Department of Agriculture website, 3/4/11:

Biological control (biocontrol) is the best option for cost-effective, long-term EAB population reduction. A variety of insecticides are available to treat individual, high-value ash trees. Cost and logistical considerations make these treatments impractical on a large scale. Biocontrol, already used successfully to fight some weed and insect pests in Minnesota, is considered the only feasible large-scale tool for combating EAB. Biocontrol reunites a target pest with the insects or diseases that control the pest in its native range. In this case, tiny, stingless wasps that control EAB in Asia are released to reduce EAB damage. Prior to their use, biocontrol organisms are thoroughly tested to ensure they will not harm humans, native plant and animal species, or the environment.

USDA rears three species of wasps as biocontrol agents for EAB. Two species kill EAB larvae. *Tetrastichus planipennisi* adults find and insert their eggs into EAB larvae. *Spathius agrili* behaves similarly except that the wasp eggs and developing wasps are attached to the outside of the EAB larvae. The developing wasps feed on and eventually kill the EAB larvae. Egg parasitoid, *Oobius agrili*, adults insert their eggs into EAB eggs on ash bark. The developing wasps feed on and destroy the eggs.

Appendix F: What Are Other Metro Communities Doing to Combat EAB?

Below are notes compiled in March 2011 regarding what nearby communities are doing to manage EAB.

Saint Paul

- Removed all infested ash trees from initial infestation
- Created trap trees to monitor EAB population (destructive sampling of ash)
- Structured removal of full blocks of declining ash
- 2011: some pesticide treatment in infested areas
- 2011: residents will be allowed to hire licensed contractors to treat boulevard trees via trunk injection

Minneapolis

- Removed all infested trees
- Trunk injection of select park trees
- 2011: release of biological near infestation

Ramsey County

- Removing 300 trees
- Trunk injection of 1600 trees in county parks/golf courses

Woodbury

- EAB plan presented to council March 2011
- Ordinance will be updated to include EAB
- Not recommending chemical treatment at this time
- Council will determine whether or not to do preemptive removals

Cottage Grove

- Plans for trunk injection of 3000 blvd ash trees
- Plan calls for removal of 50-150 ash per year depending on several factors, including costs
- Plan calls for removal and replacement of approximately 1000 of their 4000 boulevard ash trees over 12 years
- Possible structured removal of poorer quality public ash trees depending on funding

Roseville

- City council approved EAB plan in fall of 2010
- $100,000 budgeted for EAB, plus received $50,000 grant
- Each year will remove some ash that are in poor condition
- Will treat some ash trees considered significant
- Residents may treat boulevard ash trees if they apply for a permit and use a licensed city contractor
- Updating disease ordinance to include ash

North Saint Paul

- Allowing residents to register boulevard ash trees they would like to have treated with the city
- Planning on some structured removal

4/18/11 Memo from Environmental and Natural Resources Commission

To: Maplewood City Council

From: Maplewood Environmental and Natural Resources Commission

Date: April 18, 2011

Re: Concerns regarding use of chemical treatment to address potential Emerald Ash Borer infestations.

At its March 2011 meeting, the Maplewood Environmental and Natural Resources Commission passed a resolution strongly urging the City Council not to allow the use of chemical treatments on ash trees owned by the city as part of its Emerald Ash Borer (EAB) strategy. This decision was based on several lines of reasoning:

1. Such treatments, once begun, must continue for the life of the tree, at potentially considerable expense to the city.
2. Damage to the trees as a result of injecting the chemicals (the environmentally "preferred" approach) is likely to reduce the life of the trees anyway.
3. Financial resources used for treatment would be better spent in mitigation strategies, such as thinning of ash trees on city property and boulevards to reduce the overall coverage of this species (thereby making the larger forest "less attractive" for EAB) and pre-emptive replacement with other tree species.
4. Chemical treatments may postpone, but ultimately likely will not prevent the loss of many ash trees; but chemical treatments come with potentially high environmental costs.

It is these environmental costs that we have outlined in greater detail for you below (and describe in even greater detail with supporting documentation in the attached document). The two most likely chemicals to be used against EAB are imidacloprid (IM) and emamectin benzoate (EB). Both of these chemicals are highly toxic to various beneficial insects and have known and potential environmental consequences that, in our opinion, make them undesirable for use in our city:

Imidacloprid (IM)

1. IM is extremely toxic to honeybees and high concentrations of IM are found by researchers in sap, pollen, and nectar of treated plants. Short-term exposure to as little as 5 nanograms (one-billionth of a gram) results in 50% mortality among honeybees.
2. While pollination by bees is not important for ash trees, in the upper Midwest the pollen from ash trees constitute nearly 40% of bees' pollen source in April, when other sources are not yet available.
3. Studies linking IM to collapse of honeybee populations in Europe has led Italy, France and Germany to ban it and the EU to schedule it's phasing out.

4. IM is also very toxic to beneficial predator insects such as ladybird beetles and lacewings, to aquatic insects such as mayflies and caddisflies, and to earthworms.
5. Studies suggest IM's use in trees may actually promote infestations by unwanted insects, such as spider mites. These studies indicate such infestations are due not only to the elimination of beneficial insects that prey on the mites, but also as a result of the chemicals causing greater egg production by the mites themselves.
6. Leaves from systemically treated ash and maple trees were found to inhibit feeding of decomposer organisms, such as earthworms and aquatic invertebrates.
7. IM is highly soluble so it is found in runoff from agricultural fields, in streams, and groundwater throughout North America.
8. At concentrations found in the environment, aquatic insect communities show reduced populations and biodiversity.
9. Once applied to a tree, either by soil drench or injection, IM is quickly detectable in leaves, sap, and pollen, where non-target species may be exposed to significant concentrations.
10. The breakdown products, or metabolites of IM, are often more toxic than IM itself.

<u>Emamectin benzoate (EB)</u>

1. EB is extremely toxic to butterflies and moths and does not distinguish between "good" and "bad" species. Studies have shown it is 20- to 64,000-times more toxic to butterfly and moth catepillars than other pesticides used on the same crops as EB.
2. EB is used in agriculture as a topical (spray) treatment on a variety of crops because it has been found to be relatively less toxic to non-target insects than other pesticides (other than moths and butterflies). However, when sprayed onto plants, EB degrades rapidly in sunlight limiting exposure of non-target species. No studies were found evaluating EBs toxicity as a systemic pesticide, so it is not known what kind of exposures or affects would be experienced by non-target species when EB is used in this manner.
3. EB is also used to kill parasitic sea lice in fish farms. Studies indicate it may act as an endocrine disruptor, causing early induction of molting in lobsters and other crustaceans. Would the same be true in crawfish? There is no information.
4. EB appears to be moderately toxic to freshwater fish such as bluegill, trout and fathead minnow.
5. EB is very toxic to marine copepods, but there is no information regarding how it would affect freshwater invertebrates.
6. EB tends to bind to soil or sediment particles, making it less likely to leach to groundwater, but also making it very persistent in soil. Also, runoff carrying soil particles could carry EB to surface waters.
7. The biggest concern is the lack of information about EB as a systemic pesticide and its potential impacts in terrestrial and freshwater ecosystems.

Pesticides such as IM and EB have gained favor because of their apparent low toxicity to mammals, including humans. We believe this is short-sighted. Our health and quality of life depends upon the integrity of the ecosystems in which we live. From our perspective the loss of certain insect species may seem inconsequential; from the perspective of the larger system it can be devastating. Upsetting the delicate balance between predator and prey, plants and pollinators, detritus and decomposers is often considered by us to be a regrettable, but remote effect on the “lowest orders” of the animal world. In fact, it is akin to chipping away at the foundation of our home.

Given the potential impacts of these chemicals on our environment (and in the case of EB the gaping holes in our knowledge regarding its potential impacts), we urge the city council to not allow the use of them on trees in our city. While chemical treatments may provide a short-term fix to the EAB problem, we believe the city would be better served by taking a holistic view of our environment that considers the indirect consequences of these toxic chemicals and adopt a long-term, preventative approach through strategic management of our forests.

Environmental Fate and Ecological Toxicity of Chemicals Proposed for Emerald Ash Borer Treatments

Prepared for the Maplewood Environmental and Natural Resources Commission

by commission member, Ginny Yingling. April 17, 2011.

Imidacloprid

Imidacloprid (IM) is a nicotine mimic that produces toxicity by binding to and over-stimulating certain neuron receptors, disrupting the nervous system. It binds much more readily to these receptors in invertebrates than vertebrates, giving it a higher margin of safety for humans. In insects, the disruption of the nervous system results in modified feeding behavior, paralysis and subsequent death (Mullins, 1993). IM is used against a wide variety of insect pests, including Asian longhorn beetles (maple trees), potato beetle, cockroaches, fleas on domestic pets (Advantage®), termites, turf insects, etc. While it only moderately toxic to mammals and fish, it is extremely toxic to non-target beneficial organisms, such as honeybees and earthworms (Zang, et al., 2000; Luo, 1999), and important predator insects, including ladybird beetles and lacewings (Kaakeh, et al., 1996; Mizell and Sconyers, 1992). Some studies have also shown that treatment with IM may result in infestations by other, unwanted insects, such as spider mites (James and Price, 2002; Raupp, et al., 2004; Sclar, et al, 1998). These infestations are promoted not only by the reduction or elimination of beneficial predator insects, but also by increased spider mite egg production resulting from their exposure to IM (James and Price, 2002).

IM is highly water soluble and does not bind readily to soil particles (Fossen, 2006), so it may readily leach into groundwater. It is quite persistent in the environment, degrading quite slowly in water (half-life[1] = 31-46 days; Kidd and James, 1991; Tomlin, 1997) and soil (half-life = 69 – 997 days; Sarkar, et. al., 1999; Gupta, et al., 2002; Roberts and Hutson, 1999). However, when exposed to sunlight IM has a short (3 hour) half-life in surface water (Moza, et al, 1998; Wamhoff, et al., 1999), so it is less likely to be found in surface waters than groundwater. Yet, despite its rapid degradation in sunlight, investigators report detecting concentrations of
0.2, 0.4, and 1.0 parts per billion (ppb) in streams in New York, New Brunswick and Florida, respectively. Concentrations as high as 11.9 ppb have been detected in runoff from agricultural fields in Canada (CCME,
2007). IM has been detected in the groundwater in New York at concentrations up to 6.69 ppb (US EPA, 2003).
Several IM breakdown products have been shown to be of equal or greater toxicity than the parent compound (Nauen et al, 1998).

[1] A half-life is the time it takes for half of the mass of a contaminant to degrade.

Despite its environmental persistence and presence in waters, very little is known about IM's long-term chronic and short-term "pulse" effects on non-target aquatic organisms. However, in studies by Kreutzweiser, et al. (2007 and 2008), leaves from ash and maple trees treated with IM at typical field rates contained 0.8 – 1.3 and 3-11 parts per million (ppm) IM, respectively. The leaves were then added to aquatic and forest microcosms to evaluate the effect on leaf-shredding insects. While there appeared to be no effect on the invertebrates' survival rates, the 1.3 ppm and higher concentrations caused significant feeding inhibition among aquatic insects and earthworms, as well as measurable weight loss in the earthworms. IM applied directly to the water of the aquatic microcosms, to simulate leaching from soils, was at least 10-times more toxic to aquatic insects than the IM in the leaves, with high mortality at 0.13 ppm and significant feeding inhibition at 0.012 ppm. Pestana, et al. (2009) found that both the abundance and biodiversity of aquatic bottom-feeding invertebrates was reduced by exposure to IM at concentrations of 2 and 20 ppb. They also note that IM is toxic to other aquatic insects, such as caddisflies and mayflies. Mayflies are particularly sensitive with 50% of the mayflies dying within 24- and 96-hrs of being exposed to 2.1 and 0.65 ppb IM, respectively. Premature maturation and emergence of mayflies, and impaired reproductive fitness, occurred when they were exposed to pulses of IM at concentrations of as little as 0.1 ppb (Alexander, et al., 2007 and 2008).

IM rapidly moves through plant tissues after applications and can be present in detectable concentrations in the leaves, vascular fluids (sap) and pollen. Studies have shown plants grown from seeds treated with IM can have significant concentrations (up to 15 ppm in leaves of young seedlings, up to 13 ppb in pollen) of IM in their sap, pollen, flowers, and leaves (Laurent and Rathahao, 2003; Rouchaud, et al, 1994; Bonmatin, et al., 2005; Westwood, et al, 1998). As a result, many non-target insects, such as honey bees, parasitic wasps, and predaceous ground beetles sensitive to IM may be exposed as they forage for sap, pollen and nectar or feed on other insects that have been exposed.

Bees are particularly sensitive to IM. Pollen constitutes the only protein source for a beehive, and its contamination can induce both contact- and oral-intoxication. Fifty percent of bees will die if they ingest just 5 nanograms[2] (ng) of IM over a short period of time (acute exposure), or just 0.01 – 1 ng over a longer period of time (chronic exposure). These values are often referred to as the LD-50, or the amount of a toxin that is a "lethal dose" (LD) to 50% of the exposed organism (Suchail, et al, 1999). When bees forage for nectar, they often become coated with pollen. The LD-50 for simply coming into contact with IM contaminated pollen is 24 ng of IM (Suchail, et al, 1999). Even if the use of IM is of short duration (spring applications), the exposure for bees in chronic, as both bees and their larvae feed on the stocked contaminated pollen and nectar, especially in the winter and early spring (Bonmatin, et al., 2005). Low doses of IM and IM-metabolites also negatively affect honeybee foraging and learning behavior (Decourtye et al, 2003 and 2004).

Perhaps the most compelling evidence for the toxicity of systemic IM on honeybees is an online video at http://www.youtube.com/watch?v=e8Nsn4KvjwM . In this video, researchers compare the effects on

[2] A nanogram is one billionth of a gram

honeybees of feeding them sap expressed from the blade tip of corn seedlings grown from IM-treated and untreated seeds. The bees fed the sap from the treated seedlings died within 2 to 5 minutes.

As use of IM as a seed-dressing formulation for various crops has increased, researchers have noted a coincidental sudden and drastic decline in honeybee populations and honey production in Europe (Colin, et al., 2004). While a conclusive link has not been made, it is suspected that IM has played a major role in these declines (Bonmatin, et al, 2005) and has led several individual nations (Italy, France, Germany) and the EU to ban or phase-out the use of IM.

It is often noted that ash trees largely pollinate by airborne dispersion of their pollen, and therefore do not rely heavily on bees for their pollination, suggesting that bee exposure to ash pollen (and any IM it may contain) may be minimal. However, ash trees are one of the earliest flowering trees in the upper Midwest and bees rely heavily on them as a source of food when they first begin foraging in the spring. In fact, in a PhD thesis from Wisconsin, Severson (1978) reports that ash pollen may constitute as much as 39% of the bee's pollen source in mid-April.

Emamectin Benzoate

Emamectin benzoate (EB) belongs to a class of pesticides called avermectins, which disrupt the transmission of nerve impulses, resulting in paralysis and death of the target organisms. Recent studies also suggest that EB has the ability to induce premature molting in insects, suggesting it is also an endocrine disruptor (Bright, et al., 2005). Avermectins are broad spectrum toxicants for nematodes and insects. EB was developed as a lepidoptericide, so it is extremely toxic to moths and butterflies. A Canadian study found EB is also toxic to green algae at relatively low concentrations (3.9 ppb; OPP, 2000). It also appears to be moderately toxic to freshwater fish, such as bluegill, trout, and fathead minnow, with LC-50[3] values of 180, 174, and 194 ppb in water, respectively (OPP, 2000). Irreversible, toxic effects on marine copepods were observed at water concentrations as low as 0.12 ppb and significant reduction in egg production was observed at 0.158 ppb (Willis and Ling, 2003). EB appears to be relatively non-toxic for birds and mammals (Bright, et al, 2005).

In the environment, EB tends to bind to soil or sediment particles (SPAH, 2002), making it less likely than IM to leach into the groundwater, but more likely to be washed into surface water with runoff carrying sediment. Studies have shown it to have a half-life in soil of 174 – 427 days (the lower the oxygen levels in the soil, the longer EB persists). EB is very stable in water, although if exposed to sunlight it has a half-life of 1.4 – 22 days (Bright, et al, 2005).

EB has been used as a topical (spray) treatment in a wide variety of agricultural crops such as cotton, tobacco, cabbage, potatoes, etc. where it is used primarily to kill "chewing and sucking pests", such as aphids, leafhoppers, tobacco budworms, southern armyworm, potato beetle, and whiteflies. Its agricultural uses have increased in recent years because it is <u>relatively</u> less harmful to beneficial insect

[3] LC-50, the 50% lethal concentration, is similar to LD-50, but refers to the concentration (rather than dose) of a toxin in water, soil, or food, at which 50% of exposed organisms will die.

species than other avermectins when applied as a spray (Sechser, et al., 2003; Lasota and Dybas, 1991). However, no studies were found evaluating the effects of EB when used as a systemic pesticide.

In recent years, EB has been used to kill parasitic sea lice which infect salmon in fish farms. Studies have indicated that the high doses found in fish feed and feces beneath the fish pens may have adverse effects on the molting cycle and reproductive success of lobsters (Waddy, et al., 2010). This may have implications for the development and subsequent reproduction of other crustaceans (such as freshwater crawfish), beneficial insects, and other invertebrates, but no studies have been done to evaluate this. EB has also been detected in blue mussels up to 100 m from the fish pens, but it does not appear to persist in them once the source has been removed (Telfer, et al., 2006). No studies were found to have been conducted on freshwater bivalves to determine whether they would be similarly affected if exposed to EB.

The main concern surrounding EB is the lack of information regarding how it will behave when used as a systemic pesticide in trees (or other plants) and the general absence of information regarding its effects on freshwater organisms.

References cited:

Alexander, AC., Culp, MN, Liber, K. and Cessna, AJ (2007) Effects of insecticide exposure on feeding inhibition in mayflies and oligochaetes. Env. Toxicol. & Chem., 26:1726-1732.

Alexander, AC., Heard, KS, and Culp JM (2008) Emergent body size of mayfly survivors. Freshwater Biol., 53:171-180.

Bonmatin, JM, et al. (2005) Quantification of imidacloprid uptake in maize crops. Jour. Agric. Food Chem., 53:5336-5341.

Bright, DA and Dionne, S. (2005) Use of Emamectin Benzoate in the Canadian Finfish Aquaculture Industry: A
Review of Environmental Fate and Effects. Prepared for Environment Canada. March 2005.

Burridge, L.E., et al. (2004) Acute toxicity of emamectin benzoate (SLICE) in fish feed to American lobster, Homarus americanus. Aquacult. Res., 35:713-722.

CCME (2007) Canadian Water Quality Guidelines: Imidacloprid. Scientific Supporting Document. Canadian Council of Ministers of the Environment, Winnipeg.

Conlin, M.E., et al. (2004) Qunatitative analysis of the foraging activity of honeybees: relevance to the sublethal effects induced by systemic insectides. Archive Environ. Contam. Toxicol., 47:387-395.

Decourtye, A., Lacassie, E. and Pham-Delegue, MH (2003) Learning performances of honeybees (*Apis mellifera*

L.) are differentially affected by imidacloprid according to the season. Pest Management Sci., 59:269-278. Decourtye, A., Devillers, J., Cluzeau, S., Charreton, M. and Pham-Delegue, MH (2004) Effects of imidacloprid and deltamethrin on associative learning in honeybees under semi-field and laboratory conditions. Exotoxicol. Environ. Safety, 57:410-419.

Fossen, M (2006) Environmental Fate of Imidacloprid. Department of Pesticide Regulation, Sacramento, CA. April 2006.

Gupta, S., et al (2002) Leaching behavior of imidacloprid formulations on soil. Bull. Environ. Contam. Toxicol., 68:502-508.

James, DG and Price, TS (2002) Imidacloprid Boosts TSSM Egg Production. Agrichem. & Env. News, Issue 189. Washington State Univ. Extension Service.

Kaakeh, N., Kaakeh, W, and Bennet, G (1996) Topical toxicity of imidacloprid, fipronil, and seven conventional insecticides to the adult convergent lady beetle (Coleoptera: Coccinellidae). Jour. Of Entomol. Sci, 31(3): 315322.

Kidd H. and James DR (1991) The Agrochemicals Handbook, Third Ed. The Royal Society of Chemistry. Unwin Brothers Ltd., Old Woking, Surrey, UK.

Kreutzweiser, D., Good, K., Chartrand, D., Scarr, T., and Thompson, D. (2007) Non-target effects on aquatic decomposer organisms of imidacloprid as a systemic insecticide to control emerald ash borer in riparian trees. Ecotoxicol. Env. Safety, 68:315-325.

Kreutzweiser, DP, Good, KP, Chartrand, DT, Scarr, TA, and Thomspon, DG (2008a) Are leaves that fall from imidicloprid-treated maple trees to control Asian longhorned beetles toxic to non-target decomposer organisms? Jour. Env. Quality, 37:639-646.

Kreutzweiser, DP, Thomspon, DG, and Scarr, TA (2008b) Imidicloprid in leaves from systemically treated trees may inhibit litter breakdown by non-target invertebrates. Ecotoxicol. & Env. Safety, 72:1053-1057.

Kreutzweiser, et al. (2008c) Toxicity of the Systemic Insecticide, Imidacloprid, to Forest Stream Insects and
Microbial Communities. Bulletin of Environmental Contaminant Toxicology, 80:211-214.

Lasota, JA and Dybas, RA (1991) Avermectins, a novel class of compounds: Implications for use in arthropod pest control. Ann. Rev. of Entomol., 36:91-117.

Laurent, FM and Rathahao, E. (2003) Distribution of C^{14} imidacloprid in sunflowers (*Helianthus annuus L.*) following seed treatment. Jour. Agric. Food Chem., 51:8005-8010.

Luo, Y. (1999) Toxicological study two novel pesticides on earthworm, *Eisenia foetida*. Chemosphere, 39:23472356.

Mizell, RF and Sconyers, MC (1992) Toxicity of imidacloprid to selected arthropod predators in the laboratory. Florida Entomol., 83:1806-1812.

Moza, PN, Hustert, K., Fesicht, E. and Kettrup A. (1998) Photolysis of imidacloprid in aqueous solution. Chemosphere. 36(3):497-502.

Mullins, JW (1993) Imidacloprid: A new nitroguanidine insecticide. Am. Chem. Soc. Symposium Series 5240097-6156.

Nauen, RK, Tietjen, K., Wagner, K. and Elbert, A. (1998) Efficacy of plant metabolites of imidacloprid against
Myzus persicae and *Aphis gossypii* (Homoptera: Aphididae). Pestic. Sci., 52:53-57.

OPP, 2000 Pesticide Ecotoxicity Database (Formerly: Environmental Effects Database (EEDB). Data retrieved from USEPA Ecotox database. Office of Pesticides Program.

Pestana, J., et al. (2009) Structural and functional responses of benthic invertebrates to imidacloprid in outdoor stream mesocosms. Env. Pollution (2009).

Raupp, MJ, Webb, RE, Szczepaniec, A., Booth, D., and Ahern, R. (2004) Incidence, Abuncance and Severity of
Mites on Hemlocks Following Applications of Imidacloprid. Jour. of Arboriculture, 30(2):108-113.

Roberts, TR and Hutson, DH (eds) (1999) Chlorpyrifos. In: Metabolic Pathways of Agrochemicals, Part 2. The Royal Soc. of Chem., Cambridge, UK, pp 234-242.

Sarkar, MA, et al (1999) Effect of pH and type of formulation on the persistence of imidacloprid in water. Bull. Environ. Contam. Toxicol., 63:604-609.

Rouchaud, J., Gustin F., and Wauters, A. (1994) Soil biodegradation and leaf transfer of insecticide imidacloprid applied in seed dressing in sugar beet crops. Bull. Environ. Contam. Toxicol., 53(3): 344-350.

Sclar, D.C., Gerace, D., and Cranshaw, W. S. (1998) Observations of Population increases and injury by spider mites (Acari: Tetranychidae) on Ornamental Plants Treated with Imidacloprid. Jour. Econ. Entomol., 91(1):250-
255.

Sechser, B., Ayoub, S., and Monuir, N. (2003) Selectivity of emamectin benzoate to predators of sucking pests on cotton. Jour. of Plant Disease and Protection, 110(2):184-194.

Severson, DW (1978) Pollen Gathering by Honey Bees in LaCrosse County, Wisconsin. Thesis submitted to the faculty of the University of Wisconsin. September 1978.

SPAH, 2002 Potential environmental impacts of emamectin benzoate, formulated as Slice™, for salmonids. Technical Report. 36 pp. Schering-Plough Animal Health.

Suchail, A, Guez, D., and Belzunces, LP (1999) Discrepancy between acute and chronic toxicity induced by imidacloprid and its metabolites in *Apis mellifera*. Environ. Toxicol. Chem., 20(11): 2482-2486.

Telfer, T.C., et al. (2006) Environmental effects of the anti-sea lice (Copepoda: Caligidae) therapeutant emamectin benzoate under commercial use conditions in the marine environment. Aquaculture, 260: 163180.

Tomlin, C (1997) The pesticide manual: Incorporating the agrochemicals handbook, 10th ed. British Crop Protection Council, Farnham, Surrey, UK.

U.S. EPA (2003) Imidacloprid; Pesticide Toerances. Fed. Regist. 68:35303-35315 [Online]. Available at http://www.epa.gov/fedrgstr/EPA-PEST/2003/June/Day-13/p14880.htm (as cited in Fossen, 2006; verified 111-06). US EPA, Washington, DC.

Waddy. SL, Merritt, VA, Hamilton-Gibson, MN, and Aiken, DE (2010) Effect of emamectin benzoate on the molt cycle of ovigerous American lobsters *Homarus americanus* is influenced by the dosing regimen. Aquatic Biol., 11:47-52.

Wamhoff, H. and Schneider, V. (1999) Photodegradation of imidacloprid. Jour. Agric. Food Chem., 47(4):1730-1734.

Westwood, F., Bean, K., Dewar, A., Bromilow, R., and Chamberlain, K. (1998) Movement and persistence of [^{14}C] imidacloprid in sugar-beet plants following application to pelleted sugar-beet seed. Pesti. Sci., 52(2):97103.

Willis, KJ and Ling, N. (2003) The toxicity of emamectin benzoate, an aquaculture pesticide, to planktonic marine copepods. Aquaculture, 221:289-297.

Zang, Y., et al. (2000) Genotoxicity of two novel pesticides for the earthworm, *Eisenia foetida*. Environ. Pollut., 108:271-278.

BioForest

Risk to Bees from TreeAzin® Systemic Insecticide Injections for Emerald Ash Borer

The risk to bees from any emerald ash borer insecticide can be determined by how toxic the insecticide is to bees and the degree of exposure bees have to the insecticide: **Risk = Toxicity X Exposure**

Toxicity

The active ingredient in TreeAzin Systemic Insecticide is azadirachtin, an extract from the neem seed. As a measurement of toxicity, the LD_{50} of azadirachtin for honey bees is 6.1 µg/bee (Naumann and Isman 1996). By EPA's scale for rating toxicity (EPA et al. 2014), azadirachtin is moderately toxic to bees. In contrast, other active ingredients used for emerald ash borer (EAB) treatments, namely imidacloprid, dinotefuran, and emamectin benzoate, are all highly toxic to bees.

Emerald Ash Borer treatment options	Toxicity	Contact LD_{50} (ug/bee)
Azadirachtin	Moderate	6.1[a]
Dinotefuran	High	0.024 – 0.061[b]
Imidacloprid	High	0.0179 – 0.24[b]
Emamectin benzoate	High	0.0035[c]

Sources: a. Naumann and Isman 1996; b. Hopwood et al. 2012; c. EPA et al. 1992

Exposure (i.e. likelihood of bees coming into contact with EAB insecticides)

- **Environmental persistence:** The longer an insecticide persists in the environment, the greater the likelihood that bees could come into contact with that insecticide
    - Foliar half-life of azadirachtin: 5.1 to 12.3 days (Kleeberg 1992; Grimalt et al. 2011).
    - Following summer injections, azadirachtin degrades to near undetectable limits in autumn shed leaves (Grimalt et al. 2011).
    - Azadirachtin in autumn-shed leaves poses no measurable risk of harm to terrestrial or aquatic decomposer invertebrates (Kreutzweiser et al. 2011).
    - Imidacloprid can persist in woody plants for more than a year (Bonmatin et al. 2014).
    - Autumn-shed leaves from imidacloprid treated trees can contain residues that pose risk of harm to terrestrial or aquatic invertebrates (Kreutzweiser et al. 2007, 2008, 2009).
    - Azadirachtin is a promising alternative to neonicotinoid insecticides because of its non-persistent environmental profile (Furlan and Kreutzweiser 2014).
- **Ash pollen:** Bees forage for ash pollen (Johnson 2015).
    - Stem injections occur long after trees have flowered, so possibility of exposure in year of treatment should be minimal (Hahn et al. 2011).
- **Repellency**
    - Honey bee workers are able to detect neem seed extract (NSE) concentrations as low as 0.1 ppm of NSE in sugar syrup. This detection is manifested in a tendency to avoid NSE-treated syrup in preference to untreated syrup. Because of the small amounts of NSE acquired by foragers on flowers, and the rapid degradation of NSE in the environment, it is unlikely that enough azadirachtin could be concentrated in the nest stores to affect larval development (Naumann et al. 1994).
- **Ingestion vs. contact**
    - Azadirachtin products must be ingested to be effective (Extoxnet 1995a), whereas imidacloprid, emamectin benzoate, and dinotefuran are effective on contact or ingestion (Extoxnet 1995b, EPA 2009, and Fishel 2013, respectively).

References:

1. Bonmatin J-M, Giorio C, Girolami V, Goulson D, Kreutzweiser D, Krupke C, Liess M, Long E, Marzaro M, Mitchell E, Noome D, Simon-Delso N, Tapparo A. 2014. Environmental fate and exposure; neonicotinoids and fipronil. Environmental Science and Pollution Research 22: 35-67.
2. Extension Toxicology Network (Extoxnet). 1995a. Azadirachtin. http://pmep.cce.cornell.edu/profiles/extoxnet/24d-captan/azadirachtin-ext.html
3. Extension Toxicology Network (Extoxnet). 1995b. Imidacloprid. http://pmep.cce.cornell.edu/profiles/extoxnet/haloxyfop-methylparathion/imidacloprid-ext.html
4. Fishel, M. 2013. Pesticide Toxicity Profile: Neonicotinoid Pesticides PI-80. Pesticide Information Office, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences. University of Florida. 2pp.
5. Furlan, L., & Kreutzweiser, D. 2014. Alternatives to neonicotinoid insecticides for pest control: case studies in agriculture and forestry. Environmental Science and Pollution Research, 22(1), 135-147.
6. Grimalt, S., Thompson, D., Chartrand, D., McFarlane, J., Helson, B., Lyons, B., & Scarr, T. 2011. Foliar residue dynamics of azadirachtins following direct stem injection into white and green ash trees for control of emerald ash borer. Pest management science, 67(10), 1277-1284.
7. Hahn, J., Herms, D.A., & McCullough, D.G. 2011. Frequently asked questions regarding potential side effects of systemic insecticides used to control emerald ash borer. University of Minnesota, Michigan State University, and The Ohio State University Extension Emerald Ash Borer Fact Sheet.
8. Hopwood, J., Vaughan, M., Shepherd, M., Biddinger, D., Mader, E., Black, S. H., & Mazzacano, C. 2012. Are Neonicotinoids Killing Bees? A review of research into the effects of neonicotinoid insecticides on bees, with recommendations for action. Xerces Society for Invertebrate Conservation, USA.
9. Johnson, R. 2015. Effects of EAB Treatment on Pollinators. Ohio Agriculture Research and Development Center. http://www.emeraldashborer.info/eab_university_ondemand.cfm#sthash.E540ndGT.dpuf
10. Kleeberg, Hubertus. 1992. 'The NeemAzal conception: test of systemic activity.' Practice Oriented Results on Use and Production of Neem-Ingredient: 5-16.
11. Kreutzweiser, D., Good, K., Chartrand, D., Scarr, T., & Thompson, D. 2007. Non-target effects on aquatic decomposer organisms of imidacloprid as a systemic insecticide to control emerald ash borer in riparian trees. Ecotoxicology and environmental safety, 68(3), 315-325.
12. Kreutzweiser, D. P., Good, K. P., Chartrand, D. T., Scarr, T. A., & Thompson, D. G. 2008. Are leaves that fall from imidacloprid-treated maple trees to control Asian longhorned beetles toxic to non-target decomposer organisms? Journal of environmental quality, 37(2), 639-646.
13. Kreutzweiser, D. P., Thompson, D. G., & Scarr, T. A. 2009. Imidacloprid in leaves from systemically treated trees may inhibit litter breakdown by non-target invertebrates. Ecotoxicology and Environmental Safety, 72(4), 1053-1057.
14. Kreutzweiser, D., Thompson, D., Grimalt, S., Chartrand, D., Good, K., & Scarr, T. 2011. Environmental safety to decomposer invertebrates of azadirachtin (neem) as a systemic insecticide in trees to control emerald ash borer. Ecotoxicology and environmental safety, 74(6), 1734-1741.
15. Naumann, K., Currie, R. W., & Isman, M. B. 1994. Evaluation of the repellent effects of a neem insecticide on foraging honey bees and other pollinators. The Canadian Entomologist, 126(02), 225-230.
16. Naumann, K., & Isman, M. B. 1996. Toxicity of a neem (Azadirachta indica A. Juss) insecticide to larval honey bees. American Bee Journal.
17. US Environmental Protection Agency. 1992. Reference Number: 344 Pesticide Ecotoxicity Database (Formerly: Environmental Effects Database (EEDB)). Environmental Fate and Effects Division, U.S.EPA, Washington, D.C. EPA Office of Pesticides.
18. US Environmental Protection Agency. 2009. Section 3 Request for a New Use of the Insecticide Emamectin Benzoate (PC Code 122806). Environmental Fate and Effects Division. U.S.EPA, Washington, D.C. EPA Office of Pesticide Programs. 21pp.
19. US Environmental Protection Agency. 2014. Guidance for Assessing Pesticide Risks to Bees. Office of Pesticide Programs United States Environmental Protection Agency, Health Canada Pest Management Regulatory Agency, California Department of Pesticide Regulation. June 19, 2014. 59pp.

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