**Pesticide Use Impact Assessment: Emerald Ash Borer Treatments on VT ANR Lands**

SUMMARY

Without an insecticide option, the likelihood of retaining ash as part of the landscape on high priority sites is limited, and there is no opportunity to preserve individual ash trees that contribute to the state lands visitor experience or have unique cultural value. While planned ash tree removal ahead of EAB is recommended to prevent risk to human safety, targeted systemic trunk injections of emamectin benzoate (4% active ingredient) or azadirachtin (5-6% active ingredient) to ash trees can delay ash mortality where risk is imminent.

The proposed pesticides are both effective at protecting ash trees that are still in good condition. Emamectin benzoate (4 % active ingredient) is generally recommended for its broader efficacy and ability to protect trees for two or more years. However, azadirachtin (5-6% active ingredient) is a botanical pesticide that should be available for use where needed.

Both pesticides are applied through systemic trunk injection and will have minimal impacts to the environment or human health if properly managed. Because the concentration in pollen has not been studied, applications will be timed to maximize the time between treatment and flowering. Precautions will be taken to prevent accidental exposure of humans and non-target organisms.

1. PROPOSED ACTION: Targeted systemic trunk injections of emamectin benzoate (4% active ingredient) or azadirachtin (5-6%active ingredient) to ash trees to secure public safety, to retain ash on the landscape, or protect individual trees with unique aesthetic or cultural value.
2. NEED FOR ACTION:
	* 1. Pest Profile: Emerald Ash Borer (EAB), *Agrilus planipennis*
		2. Physical Setting *The proposed action may occur in the following locations:*
			+ High use areas where imminent ash mortality will pose a risk to humans and/or property.
			+ Locations with aesthetically or culturally significant ash trees.
			+ Uncommon natural communities where ash is ecologically significant.
			+ Sites suitable for ash regeneration.
			+ Sites suitable for research.
		3. Biological Considerations *The proposed action will address the following potential ecosystem impacts:*
			+ EAB attacks all native ash species. Widespread ash mortality will occur. A small percentage of ash have survived EAB attacks.
			+ Impacts of ash mortality include altered hydrologic function of wetland forests and stand disturbance that promotes invasive plants.
			+ The survival of ash species depends on retaining genetic diversity within ash populations.
		4. Social/Economic Considerations *The proposed action will address the following potential social and ecological impacts:*
			+ Rapid mortality allows only a short period of time to respond once an area is infested.
			+ Dead ash trees are hazardous, and removal is expensive due to decreased structural integrity of EAB-infested trees.
			+ Some state parks have thousands of ash trees within high use areas, including larger trees that are aesthetically significant.
			+ Black ash on ANR lands is harvested under license by Abenaki citizens for use in making baskets
			+ Since it was only detected in North America in 2002, much about EAB management is unknown and research is needed.
3. ALTERNATIVES
	* 1. Alternatives Not Assessed:
			+ Foliar sprays: Foliar sprays of large trees create a higher likelihood of off-target drift, and greater impact on non-target organisms.
			+ Soil and basal bark applications: These application methods are used for certain neonicotinoid pesticides. Applications must be repeated annually. Efficacy test results have been mixed. The use of neonicotinoids was previously evaluated, and a decision was made not to utilize this group of pesticides for EAB management on state lands.
			+ Non-chemical alternatives: Currently, there are no non-chemical methods that prevent ash mortality where EAB is present.
		2. Alternatives Assessed:
			+ 1. Proposed Action: Targeted systemic trunk injections of emamectin benzoate (4% active ingredient) or azadirachtin (5-6% active ingredient) to ash trees

Pesticide Profile: Emamectin benzoate or azadirachtin products which are labeled for systemic trunk injection and emerald ash borer and which are registered in the State of Vermont.

* + - * Emamectin benzoate (4% active ingredient)

A nerve signal disrupter that kills insects that feed on treated tissue and by contact. It kills EAB adults feeding on foliage as well as larvae feeding under the bark.

One treatment is effective for at least two years because it persists in vascular tissues. It is more consistently effective on larger ash trees than other insecticides.

Because the active ingredient is based on actinomycete chemistry, it is sometimes listed as a biorational pesticide.

* + - * Azadirachtin (5-6% active ingredient)

An antifeedant and growth regulator that kills insects that feed on treated tissue. It is not toxic to EAB adults but may reduce fecundity.

Annual treatments are needed. The residual activity is shortened because it hydrolyzes within the tree.

It is a botanical pesticide extracted from neem seeds and can be used on products labeled “organic”.

VT DEC Preventive Action Level

Emamectin benzoate: in ground water = none found

Azadirachtin: in ground water = none found

Safety Data Sheet (SDS): As an example, the following are included

Emamectin benzoate: TREE-äge G4 (4% active ingredient)Insecticide. Arbormectin (4% active ingredient) systemic insecticide

Azadirachtin: TreeAzin (5 % active ingredient)Systemic Insecticide, Azasol (6% active ingredient) systemic insecticide.

Pesticide Label: As an example, the following labels are included

Emamectin benzoate: TREE-äge G4 (4% active ingredient)Insecticide. Arbormectin (4% active ingredient) systemic insecticide

Azadirachtin: TreeAzin (5 % active ingredient)Systemic Insecticide, Azasol (6% active ingredient) systemic insecticide

Potential for Off-site Movement: Systemic trunk injection minimizes the potential for movement off site, however the product does have potential exposure routes in leaves, fruits and seeds and can enter the water through soil erosion, and or falling leaves (Anderson et al. 2009). Some application systems may provide an opportunity for accidental spillage, and some techniques may allow leakage from the injection site. Premeasured doses, closed systems and/or plugs reduce these risks.

Emamectin benzoate: Mobility studies indicate the product would be expected to be relatively immobile in the environment due to a high degree of sorption to soil particles. Therefore, most of the product that enters the terrestrial environment is expected to remain at the site of application until it degrades or is transported via soil erosion. The product is expected to enter the water primarily through soil erosion. Moderate water solubility (93 mg/L @ pH 7.0).

Azadirachtin: Only slightly soluble in water. Information is mixed about potential to move off site.

Potential for Reducing Reliance on Chemicals: Because emerald ash borer is new to Vermont, any chemical use represents an increase. Furthermore, the reliance on pesticide treatments is expected to continue increasing as the insect spreads within Vermont. However, the following will help reduce reliance on chemicals:

Targeted systemic trunk injections of emamectin benzoate (4% active ingredient) or azadirachtin (5-6% active ingredient) to ash trees will only occur at high-priority sites and where EAB is an immediate threat.

The purpose of some treatments will be to slow ash mortality in order to allow time for removals and tree replacement. Treatments will be discontinued when tree removals are completed.

The State of Vermont plans to introduce biocontrols and cooperate with efforts to promote ash resistance to EAB.

Although not yet validated by research, modeling suggests that, following the initial wave of EAB-caused mortality, surviving trees may tolerate the lower EAB populations that will be present.

* + - * 1. No Action:

No ash trees will be treated on state lands. Nearly all trees proposed for treatment are expected to die.

Some actions will occur, including tree removals before or after mortality, tree replacements through planting, control of invasive plants, and silviculture to promote regeneration of alternative species.

1. EVALUATION OF ALTERNATIVES:
	* 1. Human Health
			+ 1. Proposed Action: Other than accidental spillage, there is no realistic pathway of exposure for the general public. Pesticide handlers could be exposed through accidental spillage or improper personal protective equipment.

Emamectin benzoate: Causes severe eye irritation. Injury may be permanent. Inhalation can cause irritation to the respiratory tract and can result in chemical pneumonitis if aspirated. Ingestion results in central nervous system effects such as tremors and decreased activity. Causes mild skin irritation, Vapors may cause drowsiness and dizziness. Somewhat neurotoxic to mammals. Low absorption through skin or the digestive tract. Rat LD50 = 1030 mg/kg.

Azadirachtin: Low oral toxicity. Rat LD50 >2000 mg/kg. May cause severe eye irritation and mild skin irritation. Ingestion and inhalation may cause symptoms.

* + - * 1. No Action: The public and tree crews will be exposed to risk trees where removals do not keep pace with ash mortality.
				2. Assessment:

The proposed action increases the likelihood of securing human safety in high use areas.

Potential human health impacts are limited, and should be minimized through precautions against accidental spillage, correct protective clothing, and excluding non-applicators from the area during active treatments.

* + 1. Environmental
			- 1. Proposed Action:

Pesticide uptake is through sapflow, so foliage loss and injured vascular tissue reduce efficacy. Trees with moderate dieback often improve, but success is unpredictable when over half the canopy is dead.

Although ash is wind pollinated, its pollen is used by bees, and has been found to comprise up to 25% of honeybee pollen load in late April.

Both pesticides break down in sunlight. Neither is expected to bioaccumulate.

Both pesticides will kill other insects that feed on treated ash trees, which include a variety of chewing and sucking insects.

Vertebrate insect predators or vertebrates that feed in or on ash trees will not be affected as they would not be exposed to toxic concentrations. Neither pesticide is considered toxic to plants.

Emamectin benzoate:

Highly toxic to honey bee (3.5 ng), highly toxic to rainbow trout (LC50 = 174 µg/L), very highly toxic to water flea (LC50 = 1.0 µg/L) and very highly toxic to mysid (LC50 = 0.04 µg/L).

The EPA risk assessment for emamectin benzoate use as tree injection insecticide (2017) identified potential risks to terrestrial invertebrates that forage on treated trees and potential risks to birds, mammals and aquatic invertebrates. Aquatic biota risk were evaluated by utilizing label rates and large volume of water (5 million gallons) to determine environmental concentrations; results indicated concentrations could be 0.03 – 2.1 ppb depending on application rate. These values exceed toxicity data results for several aquatic invertebrates.

Pesticide concentrations in pollen may be lower than in other plant parts because it binds to vascular tissues. Sublethal effects to bees and levels in pollen of treated ash trees have not been determined. Highly toxic to bees exposed to direct treatment or residues on blooming trees.

Although persistent in ash foliage if protected from sunlight, it binds closely to leaf molecules and is likely to have minimal bioavailability when leaves are shed.

Although administered through tree injections, risks to other terrestrial organisms, surface water, and aquatic organisms cannot be precluded. Potential exposure pathways include soil erosion, and or falling leaves and accidental spills.

With less frequent applications needed, opportunities for accidental spillage are reduced.

Azadirachtin:

Much less toxic to honeybees, although sublethal impacts have been documented. Levels occurring in pollen of treated ash trees have not been determined.

By the time of leaf senescence, present only at low levels in foliage if at all. Not detectable in foliage the year after treatments.

* + - * 1. No Action:

The opportunity to establish ash regeneration on suitable sites may be lost for lack of seed trees.

Hydrologic functions may be altered in forested wetlands due to ash mortality, thereby impacting other species.

* + - * 1. Assessment

While widespread ash mortality will occur under both alternatives, the proposed action increases the likelihood of retaining ash on the landscape, especially if treated trees have at least 70% of their canopy intact.

The major non-target impact is to other insects that feed on ash or that are associated with ash in the case of emamectin benzoate. The impact on those that feed exclusively on ash will be minor compared to the impact of ash mortality. Insects with broader preferences will persist on other hosts.

The impact on honeybees is incompletely understood, but there are possible impacts through contaminated ash pollen, treatments should be conducted when ash flowering is complete to maximize the time between treatment and ash bloom the following year.

Other potential environmental impacts are limited and should be minimized through systems which limit the opportunity for accidental spillage and/or products that reduce the number of treatments required.

* + 1. Social/Economic
			- 1. Proposed Action:

Treatment is labor-intensive and must be repeated to ensure tree survival. Current pesticide cost is an estimated $25 to treat a 10” tree. Treatments conducted by outside contractors would be more costly. Treatments conducted by ANR staff would require training and specialized equipment.

* + - * 1. No Action:

To prevent risk to human safety, ash trees would need to be removed ahead of EAB, or at substantial cost and urgency after mortality occurs.

* + - * 1. Assessment

Although the proposed action may be costly, without an insecticide option there is no opportunity to preserve ash trees that contribute to the state lands visitor experience, to retain black ash as a seed source for basketmaking, or to provide sites for needed research.

In developed areas, ash tree removal ahead of EAB is an option to prevent risk to human safety. Where this cannot be accomplished, treating ash trees in high use areas helps spread out the cost of removals.

1. PROJECT PLANNING AND RISK REDUCTION:
	* 1. Need for treatment: Ash trees within sites listed under Section II. b. may be treated with targeted systemic trunk injections of emamectin benzoate (4% active ingredient) or azadirachtin (5-6% active ingredient) if they are within the mapped EAB Infested Area.
		2. Human health risk:
			+ Applicators will hold a current SOV government pesticide applicator certification under Category 2, Forest Pest Control.
			+ The applicator will ensure that people other than applicators are excluded from the area during treatments.
			+ The public notice law (10 VSA 2662) will apply for treatments conducted by FPR. Worker Protection Standards will not apply because the pesticide uses under this PUIA will not be for commodity production.
		3. Environmental consequences:
			+ To minimize impacts on honeybees: Treatments will be conducted when ash flowers are no longer present, preferably in late spring.
			+ To minimize accidental transport to surface waters, treatment shall not be applied within 24 hours of rain occurring or forecasted to occur.
			+ To avoid accidental spillage: Closed systems that minimize on-site handling and that prevent leakage from the injection site are preferred. On-site handling of product should be conducted in location distant from surface waters and other sensitive receptors. In evaluating pesticide alternatives, consider products that reduce the number of retreatments.
			+ Potential risks to surface waters will be addressed through the general application of buffer zones between treatments and standing water. A general buffer zone of 50 feet will be maintained between standing water and targeted systemic trunk injections of *emamectin benzoate* (4% active ingredient) to ash trees. Targeted systemic trunk injections of *azadirachtin* (5-6% active ingredient) to ash trees can be utilized within the 50-foot buffer.
		4. Project review and reporting:
			+ Prior to treatment the applicator will complete **the Emerald Ash Borer Pesticide Treatment on State Land Project Review Sheet**, including information from the product label and inspection of the site.
			+ Prior to treatment each tree will be inspected, and data collected according to the **EAB tree evaluation for pesticide treatment**
			+ Following each day of use, the applicator’s Pesticide Use Record will be updated. When completed, the treatment will be recorded in the designated lands management database.
			+ Follow-up inspections will be conducted on a yearly basis until the tree is no longer treated. Utilize the **EAB tree evaluation for pesticide treatment**
2. REFERENCES AND OTHERS CONSULTED
	* 1. General Information about EAB Treatments
			+ 1. Hahn, J. et al. 2011. [Frequently Asked Questions Regarding Potential Side Effects of Systemic Insecticides Used to Control Emerald Ash Borer](http://www.emeraldashborer.info/documents/Potential_Side_Effects_of_EAB_Insecticides_FAQ.pdf). emeraldashborer.info
				2. Herms, D. et al. 2019 [Insecticide Options for Protecting Ash Trees from Emerald Ash Borer](http://www.emeraldashborer.info/documents/Multistate_EAB_Insecticide_Fact_Sheet.pdf).
				3. Johnson, R. 2015 [Effects of EAB Treatments on Pollinators](https://www.youtube.com/watch?v=K4zPXzeDEh8). EAB University
				4. North Central IPM Center Bulletin
				5. Sadof, C et al. 2017. [Tools for Staging and Managing Emerald Ash Borer in the Urban Forest](https://int.entm.purdue.edu/ext/treecomputer/files/Sadof_et_al_2017_Staging_EAB_Infestation.pdf). Arbor. and Urban For.
				6. Siegert, Nate; Entomologist, US Forest Service, Forest Health Protection.
				7. VT FPR. 2018. [Options for Protecting Ash Trees from Emerald Ash Borer with Insecticide Treatments](https://vtcommunityforestry.org/sites/default/files/pictures/eabtreatment.pdf)
		2. Emamectin benzoate
			+ 1. Anderson, B. et al. 2009. [Ecological risk assessment for emamectin benzoate use as a tree injection insecticide to control arthropod pests](https://www3.epa.gov/pesticides/chem_search/cleared_reviews/csr_PC-122806_13-Jan-09_a.pdf). 2009. United States Environmental Protection Agency. PC Code: 122806. DB Barcode: 351736.
				2. Burkhard, R. 2014. [Environmental fate of emamectin benzoate after tree micro injection of horse chestnut trees](https://setac.onlinelibrary.wiley.com/doi/full/10.1002/etc.2795). Env. Toxic. and Chem.
				3. Durkin, P. 2010. [Emamectin benzoate Human Health and Ecological Risk Assessment](https://www.fs.fed.us/foresthealth/pesticide/pdfs/052-23-03b_Emamectin-benzoate.pdf). Submitted to USDA Forest Service Southern Region.
				4. Flower, C. et al. 2015. [To treat or not to treat: Diminishing effectiveness of emamectin benzoate tree injections in ash trees heavily infested by emerald ash borer](https://www.fs.fed.us/nrs/pubs/jrnl/2015/nrs_2015_flower_001.pdf). Urban For. & Urban Greening.
				5. Hafner, S. et al. 2017. [Preliminary Ecological Risk Assessment for the Registration Review of Emamectin Benzoate](https://www.regulations.gov/document/EPA-HQ-OPP-2011-0483-0025). United States Environmental Protection Agency Memorandum, PC Code: 122806, DB Barcode: 438443.
				6. McCullough, D. et al. 2011. [Evaluation of *Agrilus planipennis* Control Provided by Emamectin Benzoate and Two Neonicotinoid Insecticides, One and Two Seasons After Treatment](https://www.nrs.fs.fed.us/pubs/jrnl/2011/nrs_2011_mccullough_001.pdf). J. Econ. Entomol.
		3. Azadirachtin
			+ 1. Barbosa, W. 2015. [Lethal and sublethal effects of azadirachtin on the bumblebee Bombus terrestris (Hymenoptera: Apidae)](https://www.ncbi.nlm.nih.gov/pubmed/25300506). Ecotoxicology.
				2. Extension Toxicology Network. 1995. [Azidrachtin Pesticide Information Profile](http://pmep.cce.cornell.edu/profiles/extoxnet/24d-captan/azadirachtin-ext.html)
				3. Grimalt, S. 2011. [Foliar residue dynamics of azadirachtins following direct stem injection into white and green ash trees for control of emerald ash borer](http://cetreecare.com/wp-content/uploads/2013/10/s_grimalt_et_al_2011-1.pdf). Pest Manag Sci.
				4. Kreutzweiser, D. 2011. [Environmental safety to decomposer invertebrates of azadirachtin (neem) as a systemic insecticide in trees to control emerald ash borer](https://www.ncbi.nlm.nih.gov/pubmed/21531021). Ecotoxicol. Environ. Saf.
				5. McKenzie et al. 2010. [Azadirachtin: An Effective Systemic Insecticide for Control of *Agrilus planipennis* (Coleoptera: Buprestidae)](http://bioforest.ca/documents/assets/uploads/files/en/n_mckenzie_et_al_2010.pdf) J. Econ. Entomol.
3. LIST OF PREPARERS
	* Barbara Schultz, FPR Forest Health Program Manager
	* Kathy Decker, FPR Forest Protection Program Manager
4. APPENDIX
	* 1. Public Involvement: Not included. There was no public involvement for this PUIA
		2. Reviewer Comments and Response: Page X
		3. Project Review Sheet: Page X
		4. Safety Data Sheet (SDS): Pages X. [As an example, the SDS for TREE-äge G4 and TreeAzin are included. Other emamectin benzoate or azadirachtin products are allowed.]
		5. EAB tree evaluation for pesticide treatment
		6. Pesticide Label: Pages X. [As an example, the SDS for TREE-äge G4 and TreeAzin are included. Other emamectin benzoate or azadirachtin products are allowed.]

Approved: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 ANR Secretary

**Reviewer Comments and Response**

**Drafts were sent to the following for review and comment**:

**Comments and Responses:**

**Comment**:

**Response**: