Monitoring and Managing Ash in SLELO:
a platform for citizen science and land manager engagement, and a
source of hope in the fight against EAB

Final report, December 2019

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Overview

This document constitutes the final report by the Ecological Research Institute, on its 2019 project *"Monitoring and Managing Ash in SLELO: A Platform for Citizen Science and Land Manager Engagement and a Source of Hope in the Fight Against Emerald Ash Borer"*. In it, we describe the project's activities and outcomes and make recommendations for future work to build on what has already been accomplished.

Project achievements include, among others, establishing 5 ash mortality monitoring plots (only 4 were required by the project's contract) in the SLELO region, with these plots forming part of the MaMA Monitoring Plots Network, which extends through much of New York and beyond; presenting training sessions at 4 locations spread throughout much of the PRISM region; managing, validating, and analyzing data from the SLELO region's MaMA Monitoring Plots Network plots; using the data from the plots and surveys, in combination with EAB detection history data supplied by New York Department of Environmental Conservation Forest Health and research data from the US Forest Service to determine – to the extent now possible – where and when to search for lingering ash and potential lingering ash in the SLELO region; creating a georeferenced SLELO MaMA Action Map that the high priority tasks to be undertaken in different areas of the region based upon their EAB invasion history and status; and making this map available through both a web page (www.monitoringash.org/mama-in-slelo/) and a brochure (attached) we developed specifically devoted to the implementation of MaMA in the SLELO region. Numerous partner institutions, citizen scientists and private landowners participated in this project in 2019. Its achievements to date provide a solid foundation for additional progress and even broader participation in 2020, further facilitating ash conservation and EAB mitigation throughout the PRISM.

Background: *Monitoring and Managing Ash (MaMA)*
The Ecological Research Institute's program *Monitoring and Managing Ash (MaMA)* provides an innovative framework that promotes undertaking particular tasks at each stage of emerald ash borer (EAB) invasion in order to achieve EAB mitigation and, even more importantly, to advance long-term conservation of native ash. Such conservation can be advanced by locating "lingering ash", i.e., rare naturally occurring trees (of each native species) that remain healthy at least two years after virtually all the rest of the nearby trees have been killed by EAB; the USFS has shown such trees to have heritable EAB resistance, and through a relatively rapid propagation and selective breeding approach, scion from them can yield locally adapted, native lines to be used in ash restoration. The hope provided by lingering ash provides the basis for MaMA's positive message, that everyone can still take important steps to help conserve ash, no matter what stage EAB infestation has reached in their area (and even before infestation has occurred).

ERI's MaMA program has been developed in close consultation with two of the USFS scientists leading the efforts for ash conservation, Dr. Kathleen Knight and Dr. Jennifer Koch, who together have pioneered methods to identify lingering ash and propagate EAB-resistant lines. In particular, it has taken their methods for lingering ash detection and modified them to make them accessible for citizen scientists while still retaining their rigor. This close cooperation and coordination is maintained on an ongoing basis. Moreover, ERI, analyzes the relevant data contributed to its citizen science projects to determine, in collaboration with the USFS, which areas are ready to be searched (based on reaching particular mortality thresholds) for lingering ash.

MaMA's framework provides the foundation for locating and protecting lingering ash trees while integrating this into an overall program that takes account of various land management goals and constraints (see Fig. 1).
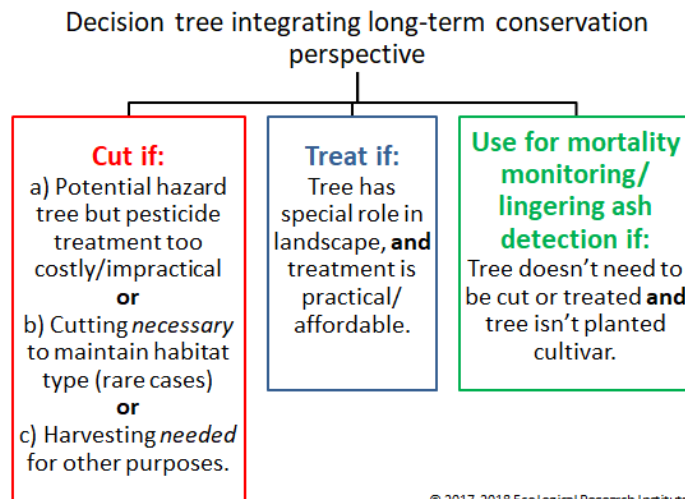
Decision tree integrating long-term conservation perspective

Cut if:	Treat if:	Use for mortality monitoring/ lingering ash detection if:
a) Potential hazard tree but pesticide treatment too costly/impractical **or** b) Cutting *necessary* to maintain habitat type (rare cases) **or** c) Harvesting *needed* for other purposes.	Tree has special role in landscape, **and** treatment is practical/ affordable.	Tree doesn't need to be cut or treated **and** tree isn't planted cultivar.

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Fig. 1. MaMA's management approach takes into account local needs as well as actions needed to ensure long-term conservation and restoration

Implementing the MaMA framework requires engagement by well-informed citizen-scientists, land managers, forestry professionals and natural resource agencies and organizations; this is made possible by its outreach activities and materials as well as its four distinct citizen-scientist/land manager-driven data reporting projects (hosted on the Anecdata.org citizen science platform). Information on these

projects; other materials (e.g., decision tree) we have designed to guide ash management; background materials on relevant topics (e.g., ash identification, EAB-resistance breeding); and links to tools (e.g., cost calculators) are available at our MaMA program website www.MonitoringAsh.org. Here, we briefly describe the three citizen-science projects we have constructed on the Anecdata.org platform:

MaMA Ash/EAB Surveys (https://www.anecdata.org/projects/view/316). In this project, the observer documents the presence/absence of evidence of EAB infestation and EAB-induced mortality at a site having ash trees. Its purpose is to fill information gaps regarding the distribution of EAB.

MaMA Monitoring Plots Network (www.anecdata.org/projects/view/319). To assess EAB-induced ash mortality levels, which is necessary for appropriately timing the local search for lingering ash, ERI has developed this network of plots, each of which must cover at least 0.5 acres, and have at least 40 native ash that have not been chemically treated against EAB, are at least 10 cm dbh and are unlikely to be cut down while living (even if dying). This network extends through much of NY and as far east as Vermont and west as Illinois and continues to expand rapidly. While establishing a plot (which can only be done during the June-September field season), data are collected on tree location, crown health and whether or not each tree has evidence of EAB infestation. Living trees (which get tagged) are included along with trees that have been killed by EAB. Data has to be collected and reported once yearly until either the 50% mortality level is reached (for relatively recently invaded sites) or the 95% threshold has been reached (for long invaded sites). Reaching the 50% threshold triggers the onset of a four-year waiting period until the search for lingering ash in the nearby area; the 95% threshold triggers such a search two years after it has been attained. These thresholds and waiting periods were developed by the USFS (95% + 2 years) and ERI using USFS data (50% + 4 years) based on ash mortality trajectories.

MaMA Lingering Ash Search (www.anecdata.org/projects/view/320). Participants can submit reports for this project only after an area has been determined to be eligible based upon its having reached one of the mortality thresholds and completed its associated waiting period. Trees that are still healthy before these criteria have been satisfied may not truly be lingering ash (and therefore would not have significant heritable EAB resistance). Locations of healthy, untreated ash in such areas are reported along with other information needed to document their status.

Monitoring and Managing Ash in SLELO: overview
The present project aimed to promote implementation of MaMA throughout the SLELO region and consisted of the following essential elements: designing, scheduling and presentation of training workshops; establishment of mortality monitoring plots; preparation of action maps; creation and publication of a web page on the project; creation and distribution of a brochure on it; managing the data submitted by participants and communicating with participants; coordinating the overall project; and serving as liaison with Drs. Knight and Koch of the USFS Northern Research Station.

The St. Lawrence Eastern Lake Ontario PRISM region is an especially important area to implement the MaMA program, because the vast majority of the region is either uninvaded or in only the early stages of invasion, making it crucial for those who manage ash – be they natural resource professionals or private landowners – to timely receive and embrace MaMA's crucial message, that needlessly cutting healthy ash diminishes the hope of finding lingering ash, while accelerating the spread of EAB. Moreover, although some sites have had documented EAB infestations for a few years, much of the region has still not shown definitive evidence of invasion, enabling the region to demonstrate the roles that the various stage-specific tasks of the MaMA framework play in promoting EAB mitigation and

enabling long-term ash conservation. Indeed, along with the large-scale implementation of MaMA in Vermont and in other areas of New York, we have featured the implementation of MaMA in the SLELO region as a model system at presentations both within and beyond the region's boundaries.

Training workshops

We presented a total of four training workshops (Figs. 2-5 and 6-9 show the indoor and outdoor components, respectively) at the following locations across the region (host organizations indicated in parentheses): Lowville, Lewis County (DEC); Sandy Island Beach State Park in Pulaski, Oswego County (The Nature Conservancy); Oriskany (CCE - Oneida County); and Copenhagen, Jefferson County (Tug Hill Tomorrow Land Trust).

Fig. 2. Workshop hosted by DEC in Lowville.

Fig. 3. Workshop hosted by Tug Hill Tomorrow Land Trust.

Fig. 4. Workshop hosted by The Nature Conservancy.

Fig. 5. Workshop hosted by CCE Oneida County.

These were attended by a total of 59 people, including representatives of NGOs, government agencies, and cooperative extension units; forestry professionals; private landowners, and other members of the public. Contact information was recorded for all attendees, enabling us to maintain ongoing communication with them regarding MaMA program developments. The workshops introduced participants to all three of MaMA's citizen science initiatives – MaMA Monitoring Plots Network, MaMA Ash/EAB Surveys, MaMA Lingering Ash Search – described the steps to be taken at each stage of EAB invasion (including pre-invasion), and most importantly explained how the search for lingering ash fits into an overall framework for ash management and EAB mitigation. These workshops also made

participants aware of particularly helpful management tools and trained them regarding ash identification, tree canopy health assessment, and recognition of signs of EAB infestation.

Establishment of MaMA Monitoring Plots Network plots

At or near four of the training workshop sites, MaMA Monitoring Plot Network plots were established and initial data collected with participation by workshop attendees. In addition to the four plots established as part of the training sessions, another MaMA Monitoring Plots Network plot was established in the SLELO region by a workshop attendee on his own. The approximate locations and the mortality data of each of the five plots are shown on the accompanying SLELO MaMA Action Map

Fig. 6. Field training at Maple Ridge Center (DEC Lowville).

Fig. 7. Field training at Joseph A. Blake Wildlife Sanctuary (Tug Hill Tomorrow Land Trust).

Fig. 8. Field training at Sandy Island Beach State Park (TNC).

Fig. 9. Field training at CCE Oneida County.

(Appendix 1).

MaMA Ash/EAB Surveys project on Anecdata.org

In addition to the MaMA Monitoring Plots Network plots established in the SLELO region, EAB presence/absence data was reported via our MaMA Ash/EAB Surveys project from 20 locations either in or directly adjacent to (and thus relevant for) the SLELO region.

SLELO MaMA Action Map

An initial SLELO MaMA Action Map was developed in June 2019 based upon EAB detection history data provided by one of our partners, NY DEC Forest Health. Using first-detection dates for locations to infer invasion stage, we applied the relevant actions listed in the MaMA Task Chart (for chart see www.MonitoringAsh.org) to prioritize different stage-appropriate actions for different parts of the PRISM's region, as shown in the Action Map. This map was incorporated into training workshops, posted on the MaMA in SLELO web page (see below) and included in the MaMA in the SLELO brochure.
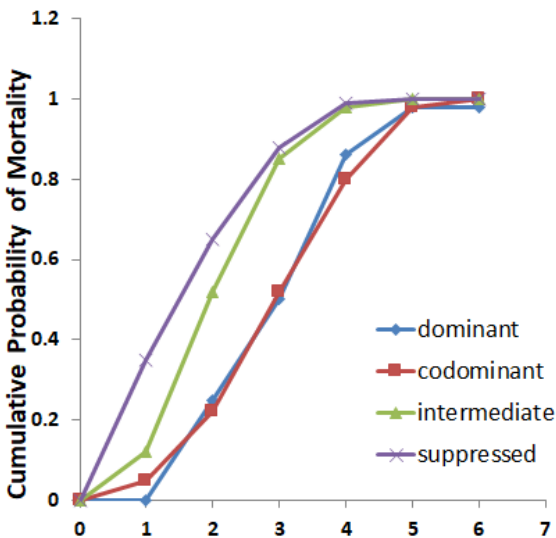

Fig. 10. Response curves (Wildova unpubl.) based on Knight et al. 2012 data shows mortality trajectories of ash trees die after being infested by EAB. Crucially, regardless of trees' canopy dominance status, they reach 95% mortality within 5 years of infestation.

The Action Map was updated based on: 1) additional detection history data provided by iMapInvasives and SLELO; as well as 2) data reported from the MaMA Monitoring Plots Network sites in the SLELO region from the 2019 field season. We were able to relate the detection history data to the monitoring plots data and use these, in combination with information on the time course of EAB-induced mortality data (see the graph in Fig. 10 on cumulative probability of mortality based on data from Knight et al. 2012) to revise the prioritization of tasks for different areas of the SLELO region. Additionally, based on new findings by our USFS partners on mortality dynamics of stands containing lingering ash, we developed corresponding management guidelines related to lingering ash and potential lingering ash.

In the areas of the SLELO region where EAB was first detected in 2015-2017, establishment of mortality monitoring plots as part of the MaMA Monitoring Plots Network on Anecdata.org. is a high priority, in order to be able to project when they will be ready for the search for lingering ash. Additionally, in these areas, we suggest that at any sites with ≥50% EAB-induced mortality, it would be helpful for land managers to protect remaining *healthy* trees from felling, as some of these may subsequently qualify as potential lingering ash, and a subset of these turn out to be actual lingering ash. Without such proactive, targeted protection from cutting, there will likely be major losses of lingering ash.

For those portions of the SLELO region in which no infestation has yet been detected (or for which 2019 first detection data are not yet available), we recommend focusing on several actions that will crucially set the stage for future ash/EAB management and ash conservation. One is to use the MaMA Ash/EAB Surveys project on Anecdata.org to report whether particular evidence of EAB is present *or absent* from ash stands (including planted trees) – the basic data this entails can be gathered and reported for a given location in just a few minutes. It will be increasingly needed as the state agencies decrease their EAB-infestation delimitation activities and is an important to accurately documenting the spread of EAB. Moreover, it enables land managers to be informed about the infestation status of their sites, allowing them to plan their management activities accordingly. Establishing mortality monitoring plots as part of the MaMA Monitoring Plots Network on Anecdata.org will also provide much-needed information, and will be particularly needed in areas where MaMA Ash/EAB Surveys reveal evidence of EAB presence. As outlined in the MaMA Decision Tree (Fig. 1), land managers should develop and begin

implementing comprehensive strategies in which at least some trees are set aside to allow the possibility of some of these ultimately revealing themselves as lingering ash (and some trees are also set aside as a MaMA Monitoring Plot for mortality monitoring), and if appropriate others are designated to be (hazard trees and trees needing to be harvested), and others for systemic insecticide treatment if desired and feasible. Additionally, invasive plant mitigation measures (underplanting ash canopy or targeted beneath it) should be taken if merited (high ash representation meaning large canopy gaps will open; incipient invasions beneath them in largely uninvaded landscape; high conservation priority flora/fauna threatened by invasive plant proliferation at the site) and achievable.

SLELO MaMA web page
On ERI's MaMA program website, www.MonitoringAsh.org, we created a special web page dedicated to the implementation of MaMA in the SLELO region (www.monitoringash.org/mama-in-slelo/). On this web page, we provided notices of upcoming training workshops in the SLELO region, and also posted the initial and updated versions of the georeferenced SLELO MaMA Action Map. This map can be downloaded from the website onto a computer or smartphone and with the use of programs such as Avenza Maps, the user can see their current location on the map. Instructions for downloading and using the map are also found on the web page.

SLELO MaMA brochure
We created a brochure describing the overall MaMA framework and how it is being implemented in the SLELO region. It features the SLELO MaMA action map and, along with its hopeful message, it lets the public know how they can become involved in MaMA's citizen science projects and take steps to conserve ash. Hard copies of this brochure were distributed at workshops and conferences, to partners on demand, and the PDF was also made available to project participants. A second edition of the brochure, in which the initial Action Map has been replaced with the updated version has been created – it will be distributed shortly via email to workshop participants, with printed copies also available for distribution.

Data management and validation
Data from the two MaMA citizen-science projects for which data has been collected (MaMA Ash/EAB Surveys and MaMA Monitoring Plots Network) were largely submitted directly by participants to Anecdata.org (via the phone app or uploading via the Anecdata.org website). However, in cases where participants were unable to do this or for some mapping information for monitoring plots, they would send the data to our project email address (Outreach@MonitoringAsh.org) and we would upload it to Anecdata.org.

We would validate data by examining entries for likely errors (e.g., inappropriate values because they were entered in wrong fields) and examining required submissions of photographic documentation (of tree ID and health status, EAB evidence). We would then communicate, via email, with participants to address any errant entries or incorrect or equivocal documentation, in some cases, for example, asking for additional photographs to be submitted. In all cases, data issues were satisfactorily resolved using this process. It would be premature to submit reports for the MaMA Lingering Ash Search citizen science project, because no areas in this PRISM are yet designated as ready for this action, and therefore it is entirely appropriate that no data have yet been submitted for this project.

Coordination and communication
In addition to validating submitted data, we fairly often communicated with MaMA's SLELO-region participants (via email and to a lesser extent phone) seeking advice on EAB management or ash

conservation, or with particular questions about tree or EAB identification or other aspects of our citizen science projects. This enabled our interaction with participants to often consist of an ongoing conversation, in which their concerns would be addressed and they would feel empowered to offer helpful feedback and suggestions regarding MaMA's implementation in SLELO – we believe that this relationship greatly strengthened this project.

Collaborating with US Forest Service researchers and other agencies involved in forest health
As mentioned in the overview of MaMA, above, ERI developed this program based on close consultation with the leading USFS EAB researchers, Dr. Kathleen Knight and Dr. Jennifer Koch. In so doing, we took approaches that they had developed for professional scientists and adapted them for use by citizen scientists and land managers; moreover, we brought to bear our own original insights on, for example, the timing of lingering ash search as determined by mortality trajectories (and in particular, recognition of the 50% mortality threshold coupled with a 4-year waiting period as an alternative trigger for lingering ash searches). Our collaboration with these researchers has been ongoing, with them briefing us on their new developments relevant to our MaMA program and keeping them informed not only of our progress in implementing MaMA, but any knowledge on either the efficacy of program components or on actual EAB invasion ecology. They have promoted MaMA widely, including, for example, SLELO's MaMA workshops. Our relationship with these researchers is especially important because of the roles that we play in rigorously determining which areas are ready to be searched for lingering ash, providing rigorous trainings incorporating the latest relevant developments, and validating data.

The NY DEC Forest Health, under Jerry Carlson, has provided extensive detection history data to us that are crucial for constructing the SLELO MaMA Action Map, and we are in frequent communication with him regarding the MaMA program.

Project Partners
Our 2019 partners in implementing MaMA in the SLELO region include the following list, who along with the many participating citizen scientists and private landowners have brought diverse capabilities to this project:

St. Lawrence-Eastern Lake Ontario Partnership for Regional Invasive Species Management
The Nature Conservancy
Tug Hill Tomorrow Land Trust
Cornell Cooperative Extension Oneida County
NYS Department of Environmental Conservation
NY Natural Heritage Program - iMapInvasives
New York Invasive Species Research Institute
US Forest Service Northern Research Station

Future directions
We recommend the following actions be undertaken in 2020 to enable MaMA to further advance ash conservation and EAB mitigation in the SLELO region:

1. Establishing more MaMA Monitoring Plots Network plots. One goal for 2020 would be to have plots well-distributed both at and near all the areas noted on the Action Map as having had EAB detected on them. The locations of existing plots should be taken into account in determining where to aim to place plots in the upcoming field season, such that the new plots will be most informative. Another consideration in determining where to target for monitoring plots would be doing the plot

establishment at sites where setting them up can function as opportunities for outreach and engagement.

2. Continued data collection for the MaMA Monitoring Plots Network plots project. All already-established monitoring plots will need to have their tree health, EAB infestation status, and mortality assessed once during the June-September field season.

3. Expanded participation in the MaMA Ash/EAB Surveys project. Participation in the MaMA Ash/EAB Surveys project should be promoted for those areas where EAB has not yet been detected; the importance of this citizen-science project has increased as detection effort by agencies has been scaled back.

4. Maintaining communication with MaMA's 2019 SLELO partners and workshop participants. This communication should be aimed at both promoting further participation in MaMA's citizen science projects and – perhaps even more importantly – integrating a long-term ash conservation perspective into ash and EAB management such that sufficient healthy, mature ash are left standing to enable eventual lingering ash detection for all three ash species (white, green, black) in the region. Beyond showing partners and workshop participants that their time, interest, and efforts are valued, the communication should inform (and remind) them of the relevant tools and resources not only for participation in MaMA's projects, but in achieving ash conservation through informed decision-making. Ideally, partners and workshop participants will get seasonally messages informing them of the best actions to take during the given time of year. For example, although the winter and spring are not appropriate times to establish or collect data from mortality monitoring plots, they are good times to look for definitive signs of EAB infestation (since woodpeckers do a lot of bark flaking during winter, exposing EAB larval galleries) and to plan for management actions to be taken during the summer.

Additionally, it's important that messages take account of the big picture, both in terms of the fight against EAB and the competing demands upon land managers. Thus, to encourage participation, updates on the overall progress of the MaMA program as well as other efforts against EAB should be shared, and the ways to integrate lingering ash detection into overall timber management should be emphasized.

5. Presenting targeted workshops. It would be helpful to have a small number of additional workshops, with their emphases tailored to particular places or audiences. For example, these could include municipalities or tribal authorities, especially in areas where EAB has already been detected or is known to nearby.

6. Development of management guidelines. Although the MaMA program includes a general decision tree (Fig. 1), we have had some discussions with interested foresters regarding development of specific management guidelines that will be consistent with MaMA's principles, showing users how the search for lingering ash can be integrated with other demands. One core element of such guidelines would be the idea that although it is perfectly reasonable to cut some healthy ash to satisfy economic, safety, or other imperatives, the greater the number of healthy ash that are left standing, the greater the chance of ultimately finding lingering ash in the area. Similarly, setting aside rather small numbers (40 trees) of ash to be used for mortality monitoring in an area can yield big benefits, both in terms of helping to find lingering ash in the vicinity and in terms of tracking the progression of EAB in the area – which is very useful for better-informed management. Finally, these guidelines need to emphasize that all of the

latest scientific evidence shows that cutting healthy ash has the effect of accelerating, rather than slowing, the spread of EAB.

7. Developing educational materials to yield demonstration plots. Three of the MaMA mortality monitoring plots established in the SLELO region in 2019 can easily be converted into educational demonstration plots to inform visitors about EAB and appropriate responses to it. These are the plots at Maple Ridge Center (Lowville), Oneida CCE (Oriskany), Joseph A. Blake Sanctuary (Rutland), all of which are adjacent to publicly accessible trails. On-site educational signage should be developed and installed, explaining about EAB and MaMA's management framework, how the plots yield important information, and how the public can get involved. Additionally, on the SLELO MaMA website, updates on each plot's status can be posted, as has been done for demonstration plots in the CRISP region – these are very helpful to people in the area, as there is no other source of mortality data.

8. Updating all outreach materials. This is necessary on a continuous basis, to reflect new information and developments.

9. Data management, validation, and analysis. These tasks, along with project coordination are also being done on a continuous basis by ERI.

10. Ongoing collaboration with partner agencies and NGOs.

Appendix 1.

SLELO MaMA Action Map

- SLELO boundary
- County lines
- Town an city lines

MaMA
Monitoring and Managing Ash

This map does not reflect EAB distribution in Canada

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Areas with no infestation yet detected
Actions: Inspect ash for EAB evidence and report data via MaMA Ash/EAB Surveys project. Consider establishing a mortality monitoring plot as part of the MaMA Monitoring Plots Network, especially if you detect EAB. Do ash management planning, including setting aside trees for lingering ash detection. Do invasive plant mitigation if appropriate.

EAB first detected 2015-2017 / ● EAB first detected 2018-2019
Actions: At sites with ≥50% mortality, protect healthy ash trees from felling; report their locations using the MaMA Lingering Ash Search project. Establish mortality monitoring plots as part of the MaMA Monitoring Plots Network.

EAB first detected 2013-2014
Actions: Protect healthy, untreated, mature native ash ("potential lingering ash") in this area from felling; report their locations using the MaMA Lingering Ash Search project. Remove dead/dying ash near potential lingering ash. Establish mortality monitoring plots for the MaMA Monitoring Plots Network.

☆ MaMA ash mortality monitoring plot (showing percentage of adult ash trees killed by EAB as of 2019)

EAB infestation data provided by NY DEC and NYNH / iMapInvasives.

0 4 8 16 24 32 Miles

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12