Form 1100-001
(R 9/07)

NATURAL RESOURCES BOARD AGENDA ITEM

Item No. 3.B.1

SUBJECT: Update on the status of emerald ash borer in Wisconsin and efforts to minimize its spread and impacts

FOR: OCTOBER 2009 **BOARD MEETING**

TO BE PRESENTED BY: Andrea Diss-Torrance & David Sivyer, Milwaukee City Forestry

SUMMARY:

Emerald ash borer (EAB) was first found last summer on the border of Ozaukee and Washington counties. In April, a second population was discovered along the Mississippi River in Vernon Co. Both of these populations were several years old before they became detectable. In August, three more infestations were detected in Green Bay, Kenosha and Franklin. While the department had been preparing for the first find of this invasive pest, it's confirmation in the state triggered many actions to minimize the spread and impact this pest will have on human and natural communities across the state. This update will cover the status of known populations of EAB in Wisconsin, the several methods that will be used to try to detect it around the state, options that are being used to try and minimize its spread and population growth, and assistance and guidance offered by the department to landowners and communities to help minimize the economic impacts of EAB. David Sivyer of Milwaukee City Forestry will present work being done in Milwaukee to limit impacts of EAB by maintaining healthy ash for as long as possible and by spreading the expense of replacing city ash trees over many years.

RECOMMENDATION: This is an informational item requested by the board

LIST OF ATTACHED MATERIALS:

No	☑	Fiscal Estimate Required	Yes	☐	Attached
No	☑	Environmental Assessment or Impact Statement Required	Yes	☐	Attached
No	☐	Background Memo	Yes	☑	Attached

APPROVED:

Robert J Macha — Bureau Director, — Date 10/7/09

Paul DeLong — Administrator, — Date 10/7/09

Matt Frank — Secretary, Matt Frank — Date 10/13/09

cc: Laurie J. Ross - AD/8

CORRESPONDENCE/MEMORANDUM

State of Wisconsin

DATE: 10/2/09

TO: Natural Resources Board Members

FROM: Matthew J. Frank MF

SUBJECT: Update on the status of emerald ash borer in Wisconsin and efforts to minimize its spread and impacts

Last year at this time, we came to you with an update on the initial find of emerald ash borer (EAB) in Newburg, Ozaukee County. This update will cover developments since that time including the current status of EAB and work that has been done, is occurring, or is planned for the near future. At the board meeting, this update may be followed by a presentation on what the City of Milwaukee is doing to manage the impacts of EAB on its urban forest. A summary of their efforts as well as those of six other municipalities can be read in the Wisconsin Urban & Community Forests newsletter Vol. 17 No. 1 http://dnr.wi.gov/forestry/uf/resources/vol17no1.pdf .

Current status of EAB in Wisconsin

We have verified EAB in five locations, in Newburg, Kenosha and Franklin in the southeast, Green Bay in the northeast, and Victory in the southwest. The first population discovered at Newburg in Ozaukee County appears to have been there since 2004 and infested trees have been found over two miles from the apparent center of the infestation. The population in Victory on the west side of the state has been confirmed back to 2006 but may have been there longer. A beetle was recently caught in a trap five miles from the apparent center of this infestation. The ages of infestations in Green Bay, Kenosha and Franklin have not yet been determined.

We should bear in mind that our ability to detect low populations of EAB is poor and it is likely there are other populations of this pest in the state. We typically don't realize it is present or catch it in traps until the population has been in place long enough and is high enough to cause a noticeable number of trees to die. Distance from known populations is not assurance of protection. Quarantines are only put in place once EAB has been detected in an area, and as can be seen in our populations, they have been present in Wisconsin well before Illinois was known to be infested and at least two years after EAB was first found in North America. We expect we will continue to find new populations that were introduced prior to the placement of quarantines or that are the result of unregulated movement of firewood.

Expectations for the future

Because our current abilities to detect and manage EAB are so limited, the future for ash in Wisconsin is grim or uncertain at best. There is a real possibility that ash species could be driven to extinction as a naturally reproducing group of species on the landscape although this will take many years even if no progress is made in control methods. This worst case scenario would have serious impacts on natural communities, especially those in black ash swamps or other wetlands that already have lost American elm as a dominant tree and that are pressured by invasives like reed canary grass. Well before ash is largely lost from our forests, there will be economic impacts on communities and forest landowners. Economic impacts on communities and their residents include the cost of removing and replacing dead ash, reduction in property values with loss of trees and increased demand for water and energy once the

canopy is removed. Losses to forest landowners include value of trees killed before they could be harvested. Value of the ash logs harvested may also decline if the market is glutted with EAB killed trees.

What can be done

It is important to realize that while we currently have limited options for controlling EAB, there is a lot we can do to slow the impacts this pest will have on our communities and forests and this can minimize the cost of those impacts. Doing nothing will assure that the impact of this pest will be maximized.

1. Preventing or slowing spread. Natural spread of EAB is fairly slow. Even in states that are infested like Michigan, there are still many communities and rural areas where the pest is not established yet. Unfortunately, EAB is easily moved in firewood so introduction is a constant threat. In Wisconsin quarantined counties, many areas could remain free of EAB and its impacts for many years if it is not carelessly introduced. It is also not safe to assume that EAB is not in areas that are not currently quarantined; it just may not have been found there yet. The best practice to prevent accidental spread of EAB is to obtain firewood close to where it will be used or to use certified wood that has been treated to kill imbedded larvae.

In addition to long distance spread, local expansion of infestations is a concern. Research is being done on methods to redirect adult EAB from dispersing out of infested areas. Girdled trees within an infested stand could act as "islands of attraction" for adult EAB, encouraging them to lay their eggs in already infested trees instead of dispersing outwards. Infested trees would then be treated with insecticide or destroyed to kill the larvae. Islands of girdled trees were established at the Newburg infestation this spring.

2. Buying time for development of control options. EAB only achieved the status of a serious pest when it became established in North America. Development of control methods for this insect has only been going on since 2002 for this reason. It is encouraging that much progress has been made in the areas of systemic insecticides and biological controls in seven years. However, we still do not have an insecticide treatment for larvae that can be applied over large areas nor has there been encouraging results on resistance in native ash or crosses with Asian ash. It is reasonable to expect that more management options will be developed with time, just as this has happened with other pests such as gypsy moth. By preventing the artificial spread of EAB and slowing the growth of established populations by reducing host availability we "buy time" for the development of better control options.

3. Spreading losses over time. Given current control options, we can assume we will lose all ash trees in an infested community or forest except for individual trees that will be preserved by regular insecticide treatment into the future. We do, however, have some control as to how fast the losses will occur and thus how costly they will be.

a. Communities - Wisconsin cities, towns and villages have an average of 20% ash in their street and park trees though the proportion in some communities can be much higher. There is probably a similar proportion in private yard trees. This high proportion of ash leaves our communities vulnerable to devastating costs if these trees die over a period of 2-4 years as has been the case in Michigan and Ohio communities where EAB infestations proceeded naturally. When so many trees die so quickly, a community's budget is drained trying to keep up with necessary removals and dealing with the waste wood. There is no money or staff time left for replanting, tree maintenance or anything else for that matter. In addition to the cost of removal, neighborhoods are stripped of many trees, decreasing property values and increasing water and energy demands resulting from the loss of shade. There is a way to

minimize many of these costs, however. Communities can decide to remove and replace ash proactively and on their own timetable. When removals can be spread over ten or more years, each years cost becomes more manageable. Because the yearly cost of removals is more reasonable, replacement trees can be planted and selected trees can be proteeted with insecticides. Because replacement trees are planted and have time to grow as older ash are slowly removed, severe reduction of neighborhood tree cover is prevented; property values are maintained and water and energy demands are kept low. This work must be started before damage from EAB becomes noticeable, though. If it is delayed until EAB is obvious, it will be impossible to achieve all or most of the potential savings.

b. Woodlands - Forests in Wisconsin vary in their proportion of ash but it is a significant component of many forest types, especially in lowlands. Woodlot owners could face significant losses in value as EAB can cause a glut of ash wood on the market just as the landowner may be facing a salvage harvest of EAB killed ash. Here too, landowners can minimize economic losses by early action. Increasing the proportion of ash taken at each thinning and pre-salvage harvests can prevent losing the value of marketable ash.

Actions the State is taking

The state agencies, DNR, DATCP and UW Extension have taken leadership roles in identifying the scope of the infestations and helping communities, landowners and businesses deal with the implications of EAB in the state.

1. Survey – Surveys are done to identify locations where EAB has become established in order to focus regulation and control efforts. The federal government currently provides support for the trapping program and has provided support for visual and detection tree surveys in the past. DNR, DATCP and Extension staffs also recognize that many initial finds are made by the general public; public education and the EAB reporting line contribute to the survey effort.

a. Traps - EAB traps are about two feet tall, shaped like a prism and purple. They appeal visually to EAB which are attracted to vertical shapes and the color purple and are also baited with tree oils, the scent of which is similar to that of distressed ash trees. Insects landing on the traps are caught in a sticky material that coats the trap. These traps are deployed near currently known populations to define the area infested, on a grid in several east-central counties and along the border with the Upper Peninsula of Michigan, and at sites determined to be of high risk for introductions across the state. A map of the 2009 EAB trapping program can be viewed here,
http://emeraldashborer.wi.gov/articleassets/2009_Trapping_Plan_5_09.pdf
Traps detected EAB at Newburg within days of its find in dying trees last summer. Recently a beetle was found on a trap 5 miles southeast of the population in Victory and the finds in Green Bay, Franklin and Kenosha were in traps.

b. Detection trees/destructive survey - Open grown ash are girdled to stress them and make them more attractive to EAB looking for a site to lay eggs. A sticky band may be placed on the girdled trees to potentially catch adults. Surveyors return in the fall or following year to peel the tree's bark and determine if any larvae are present. Alternatively, a pre-stressed ash may be selected for cutting and peeling, skipping the girdling step. Detection trees are generally thought to be a more sensitive method of detecting EAB than are the traps. This technique has been used by DATCP in intensive surveys in quarantined counties and by DNR in a survey of state lands determined to be of higher risk of introduction (http://dnr.wi.gov/forestry/fh/ash/eab-surveys.htm). No new infestations have been found using detection trees and this technique is being phased out due to its high workload and cost.

c. Visual Survey - Surveyors look for symptoms and signs of EAB. A visual survey may be followed by cutting and peeling suspect trees to verify suspicions of EAB infestation. The visual survey is considered the least sensitive method but it is fast, isn't necessarily destructive and can be done at any

time of the year. It has been used by DATCP and DNR staff to initially delimit finds at Newburg and Victory and by DNR staff to survey county and private campgrounds determined to be at high risk of introduction (http://dnr.wi.gov/forestry/fh/ash/eab-surveys.htm).

d. Biosurveillance - This technique is in development, but could be used more widely in the future. This survey technique uses a native, solitary wasp to collect EAB for surveyors. The wasp, *Cerceris fumipennis*, specializes on beetles of the same family and size as EAB, paralyzing adult beetles and bringing them back to their burrows to feed their young. Surveyors monitor the prey being brought back to the nesting grounds of this wasp, if EAB is brought in; we know that a population of this pest must exist within one and a quarter miles of the nesting ground. This technique is potentially more sensitive than others and in the future, mobile nests could be used to triangulate EAB population locations. Its drawbacks are that the monitoring can only be done for 6 weeks in the summer and currently we are dependent on naturally occurring populations of the wasp. For more information, go to http://www.cerceris.info/.

f. EAB reporting line - Because many new EAB populations are found responding to reports from the public, public education and a routes to report potential EAB play an important role in early detection of this pest. Radio spots, interviews, articles, presentations and booths at meetings from Wisconsin Woodland Owners to hunting and fishing expos, websites and pocket cards all play a role in alerting the public and letting them know we want to hear if they have a suspicious insect or declining ash. The DATCP hosts a toll free reporting line, 1-800-462-2803 and takes email reports at the website http://emeraldashborer.wi.gov. DATCP staffs assess reports and send DATCP or DNR staff to visit sites that warrant verification. DNR foresters may also serve as points of initial contact by the public. In the cases of both the Newburg and Victory populations, individuals first contacted local DNR foresters about dying ash that were then determined to be infested with EAB.

2. Preventing or slowing spread

a. Quarantines - Federal and state quarantines have been placed on 11 counties in Wisconsin, for the most current map of the quarantine in Wisconsin, go to http://emeraldashborer.wigov and select maps. Quarantines are effective at regulating businesses that move potentially infested wood or nursery stock. They do allow for movement of wood and wood products if treated or movement timed to prevent possible spread of EAB. Businesses interested in movement of regulated wood enter into a compliance agreement to do such treatments or modify their schedules of movement with state and federal regulators; DATCP and the US Animal and Plant Health Inspection Service (APHIS).

b. Redirection of adult EAB such as "islands of attraction" - This technique is experimental but is being tried in Newburg by DNR forest health staff. Clusters of ash were girdled this spring to attract adult EAB back into the center of the infestation to lay eggs rather than moving outwards, spreading the infestation. In the fall and winter, these trees will be cut, utilized and the waste destroyed, killing the resulting larvae.

c. Regulation of firewood onto state lands - We are in the third year of prohibiting from state lands firewood originating from more than 50 miles from the property or campground and it is the fourth year DNR has prohibited firewood from out of state onto state lands. This regulation of wood provides some protection for state lands but it also provides an unparalleled opportunity to educate the public on the risks of moving firewood. Parks staff are among the most trusted sources of information for the public and the camping registration process offers several opportunities to give the "don't move firewood" message. A survey of campers in 2006 and 2008 showed a significant increase in their awareness of the risk of transmission of invasive pests in firewood and of the threat of emerald ash borer. It also showed that campers were changing behavior given this information. Campers reported that they reduced the amount of firewood they moved and the distance they moved it since 2006. It is pleasing that

the public appears to be generalizing their behavior regarding firewood movement, not only are they not bringing wood to state campgrounds, they are moving it less even when camping elsewhere.

d. Certification of firewood dealers - The state lands prohibition of firewood from beyond 50 miles does have an exemption for firewood from dealers certified by the DATCP as having treated their wood to prevent survival and transmission of pests and diseases. DNR and DATCP staff worked together to help support the development of this state category of treated wood; DNR supplied a market and DATCP handled the certification. As concerns and increasing regulation of firewood may lead to a larger market for treated wood in this and other states, early state encouragement for this product may give an advantage to our local businesses.

3. Slowing the rate of population increase

a. Phloem reduction - This technique to reduce the buildup and spread of EAB by reducing the amount of ash phloem available for consumption in an area is still in development. It is consistent with reeommendations being made by DNR staff to reduce the ash component of both rural and urban forests. Many highly infested ash were cut and destroyed in Fireman's Park in Newburg, as part of a training workshop this spring. More will be taken and destroyed as part of a utilization demonstration this fall. While these removals are done for educational purposes they may contribute in part to slowing the rate of population increase in this area. An inventory of selected forest lands within three miles of Newburg was conducted in 2009. DNR forestry staff will be working with these landowners to facilitate timber sales that not only remove ash to reduce host material but also ensure sustainable management practices.

b. Biological controls - Wisconsin has received federal approval to introduce the three species of parasitoids available from federal agencies for introduction against EAB. DATCP staffs are currently working on the state permit. The interagency Science Panel has provided guidance on issues to be considered in such an introduction and the Operations Group is developing an operational plan for introductions with input from this guidance.

c. Pesticides - DATCP staff worked to get special approval for the use of emenectin benzoate, Treeage, for use in Wisconsin. This pesticide is injected into trees and provides the highest level of consistent protection found so far against EAB. Protection has been confirmed for two years and this summer tests are being done to determine if the effect lasts for three years. Staff from UW Extension working with entomologists in the lake states affected by EAB has developed a guide to insecticides for use against EAB. This can be viewed at http://emeraldashborer.wi.gov/articleassets/InsecticideOptionsForProtectingTreesFromEAB.pdf .

4. Education and communication with the public - The public plays an important role in the spread, identification and eventually management of EAB. Movement of infested firewood by the general public is thought to be a leading source of new infestations especially from quarantined areas where commercial sources such as nurseries and wood industries are well regulated. The public has also served as the initial reporter of many new infestations of EAB including the two currently recognized in Wisconsin. Public support will be necessary for communities to successfully minimize the impacts EAB could have on them. For these reasons, public communication and education are important goals for the overall EAB program. Awareness of the threat of EAB and methods to avoid spreading the pest is communicated through both general and targeted methods. General awareness messages include radio spots, billboards, posters at boat landings and on public bulletin boards, and interviews with the media. Targeted awareness efforts include notification of firewood regulation during the reservation process at state campgrounds, presentations and booths at special interest conventions, postcards to landowners from out of state or from particular areas, and notices included with licenses for fishing, ATV's, snowmobiles or boats. Once the public is aware of EAB, they need a source of reliable information on the issue. The website http://emeraldashborer.wi.gov is the primary source for EAB information for Wisconsin residents. The

section on resources provides a variety of publications, audio and video educational shorts and newsletters with the latest developments on EAB and its management in Wisconsin. It also includes specific information for homeowners, communities, professionals and woodlot owners, signs and symptoms, the option to report a potential infestation and where to go for more specific information.

5. Reducing economic impacts of EAB

a. Workshops - Two workshops are planned for the Newburg area this fall utilizing a USDA Forest Service grant: one for municipalities within 10 miles of Newburg and one for landowners. The workshops are a joint effort between DNR, UW-Extension, DATCP and Town and Country Resource Conservation and Development. The sessions will cover options to reduce the impact of EAB through sustainable forestry practices. It will also demonstrate options for utilization of wood from quarantined areas and ways for communities and small landowners to band together to arrange contracts for tree removal and utilization. These workshops are expected to be used as prototypes for similar workshops around the state for municipal forest managers and private arborists hosted by the Urban Forestry Program staff.

b. Providing guidance to communities in developing ash conversion/EAB response plans - This is a high priority goal for the DNR Urban Forestry Program. Support materials including the EAB Toolkit, municipal planning guidelines and presentation are already prepared. See the attached 2009 DNR Urban Forestry Working Group EAB Activities for more details on planned outreach for this year.

c. Providing grants to support inventories and development of response plans by communities - The urban forestry grant program is currently the only source of cost sharing for community EAB preparedness and response. So far, 77 Wisconsin communities have received urban forestry grants to begin preparing for EAB, but many more remain to be served. Go to http://dnr.wi.gov/forestry/UF/grants/ for more information on this program.

d. Silvicultural guidance for woodlot owners - This guide has been developed and is available at http://emeraldashborer.wi.gov/articleassets/EABWIManagementGuidelinesBS.pdf . An update is currently in development dealing specifically with woodlots within several miles of known EAB infestations. Local DNR foresters are working with owners of larger forested lands to accelerate ash removal near known infestations of EAB.

e. Facilitating group contracts for tree removal and utilization - A list of wood residue brokers assembled by DNR wood utilization specialists is available at http://emeraldashborer.wi.gov/articleassets/wood_residue_brokers.pdf . The DNR forester for the Newburg area is working with owners of small woodlots there to set up a group contract for harvesting ash. DNR Urban Foresters are developing guidance for communities that wish to facilitate a community contract for residents who need tree removal and chipping services.

f. Ash production stopped at state nurseries - Given the current poor expectation for long term survival of ash in woodlots, state nurseries have stopped producing ash for distribution.

6. Research - EAB is a new significant forest pest and research is needed on techniques for detection and management. DNR, DATCP and UW Extension staffs are working on a range of studies that will provide information helpful to managing EAB in Wisconsin.

- DNR is supporting research on multitemporal Land Sat imagery analysis to detect ash in forest stands. Work being conducted by Dr. Phil Townsend, UW-Madison.
- DNR is supporting research on hyperspectral imagery analysis to detect stressed ash, oak, beech and hemlock in forest stands. Work is being conducted by Dr. Rich Hallett, University of New Hampshire and USDA Forest Service.
- DNR and DATCP staffs are participating in biosurveillance of EAB using *Cerceris fumipennis*.
- DNR and DATCP staffs are participating in survey of native relatives of EAB.

- DNR staff conducted baseline and follow-up surveys of camper awareness of EAB and the risk of moving firewood in its introduction, firewood use behavior, and what changes in firewood availability at campgrounds are most important to them.
- The use of "islands of attraction" in limiting spread of expansion of EAB populations.

2009 DNR Urban Forestry Working Group EAB Activities

Focus: assisting Wisconsin communities in preparing a response for EAB
Target Audience: municipal urban forest managers and elected officials

Action:

1) Assist communities in understanding why planning is important and what a plan includes.
   Tools: -EAB Toolkit for Wisconsin Communities
   -Municipal Readiness Planning PowerPoint presentation
   (maintained/updated/housed on UF program page of the WDNR website)
   -Guidelines for Municipal EAB Plans
   -UF Grant Program (matching grants for up to $25,000)

2) Serve as a technical resource for municipalities regarding ash management.
   Tools: -Ash Pest Gallery, Larvae & Emergence Hole Comparison Card
   -Urban Ash Management Guidelines (due for release in 8/09)

Delivery Venues:

- **Regional Municipal Networking Groups** (meet 2 to 4 x per year)
  (Five Regional UF Coordinators each service towns, villages and cities within a region averaging 14 counties)
- **Formal Presentations** to stakeholder groups
  (emphasis on presentations, exhibits and articles to association publications)
  - APWA Spring Conference –May 7, 2009
  - League of Municipalities –August 20, 2009
- **Newsletters** regular features on EAB related topics
  - *Wisconsin Urban & Community Forests* print newsletter to (5400 print, 250 electronic) 4 times/year http://dnr.wi.gov/forestry/uf/resources/vol17no1.pdf
  - *Wisconsin Urban Forestry Insider* (1082 electronic) bi-weekly http://dnr.wi.gov/forestry/UF/resources/InsiderArchive.html
- **UF Workshops (fall)**
  - Using the wood utilization workshop that Jane Cummings-Carlson is coordinating as a prototype, four additional workshops will be conducted through-out the state for municipal forest managers and professionals
- **Webcasts & podcasts**
  - Potential partnering with EAB University (MI, OH, IN FS funded project)
  - Chris Williamson project-providing content for one podcast addressing community planning
- **Annual DNR/WAA Conference** (FEB)
  - Presentations/Exhibits/Networking
- **Urban Forestry Council** (advises the DNR State Forester, meets quarterly)
  - Stakeholder group comprised of representatives of numerous stakeholder groups providing comment on state efforts
- **Wisconsin EAB website**
  - Provide content for Management Options, Tips and Tools for Communities http://emeraldashborer.wi.gov/

05/21/2009

City of Milwaukee Forestry

MILWAUKEE FORESTRY - MAPPING THE FUTURE FOR EMERALD ASH BORER READINESS AND RESPONSE PLANNING

Background

Communities threatened by Emerald Ash Borer are aggressively pursuing best practices for early rapid detection and management including improved reconnaissance tools (geospatially accurate forest risk maps) and new suppression strategies. Emergent research and frontline intelligence is desperately needed by coordinating federal, state and local officials working to revise management strategies for EAB. Expensive eradication attempts repeatedly thwarted by the elusive Emerald Ash Borer have forced many neighboring communities to concede defeat and pursue preemptive removal of public ash trees. Other communities further removed from the advancing front share a time advantage needed to evaluate and integrate new tools aimed at slowing the spread of EAB. Fundamentally important to both management strategies is the need for an accurate risk assessment.

Milwaukee's multi-faceted strategy for Emerald Ash Borer readiness and response planning is highly dependent on an accurate host inventory. Milwaukee completed the final phase of a 5-year computerized street tree inventory project in 2009. The inventory identifies the number, size distribution, condition, and location of ash street trees at risk; information fundamental to accurate budget forecasting and cost-benefit analysis of various EAB management strategies.

Municipal Arborists armed with a current street and park tree inventory can easily quantify the number of ash trees at risk and evaluate various management strategies. However, communities like Milwaukee which have statutory responsibility for abating dead and hazardous trees on private property, need other tools to more fully assess community risk associated with aggressive invasive forest pests such as Emerald Ash Borer. The development and 2006 release of i-Tree's UFORE application (now iTree Eco http://www.i-treetools.org) affords municipal arborists with the tools needed to quantify the number of ash trees and associated ecological services in their community. Milwaukee's UFORE project completed in 2008 estimated the citywide ash population at 573,000 trees, representing 17.4% of urban tree canopy and providing $221 million and $600,000+ in structural and annual functional value, respectively.

While knowing the number of ash trees in the City of Milwaukee at risk is helpful as a planning tool for assessing community risk related to canopy loss impacts, projecting associated wood waste volume, and budget forecasting code enforcement staffing needs, UFORE and other conventional survey techniques are of limited assistance in managing an actual EAB outbreak. To effectively manage risk to public safety associated with 573,000 ash trees in a highly urbanized community, the specific location, in addition to the number of trees at risk, was needed. To solve the ominous task of locating 573,000 trees in the sights of a rapidly advancing enemy, the Milwaukee Forestry Division looked to an emergent remote sensed technology called Hyperspectral Imagery (HSI).

Airborne HSI is an advanced digital imaging process that utilizes high-powered sensors to record hundreds of contiguous narrow bands of electromagnetic energy reflected from objects or materials on the Earth's surface. Each substance, such as the leaves of green and white ash, yields a unique reflectance or "spectral signature" based on the molecular and electromagnetic properties of the substance that can be targeted and extracted from the hyperspectral data.

HSI has been utilized successfully for military reconnaissance, counter narcotics surveillance, and in natural resources management applications including mineral exploration, water and soil analysis, fire risk assessment, and to a limited extent vegetation mapping. HSI has also been successfully utilized to classify the health and condition of vegetation, and thus shows high potential for early detection and improved delimitation of incipient forest pest infestations by mapping imperceptible stress in host species.

Project Description

Milwaukee's project, funded in part through a WDNR Urban Forestry Grant, applied advanced geospatial technology, including high resolution remote sensed Hyperspectral Imagery and LIDAR data, in conjunction with GIS analytical applications, to develop new tools needed for improved species mapping, risk assessment, forest health monitoring, rapid early detection, and management of EAB.

The specific objectives of the project were to:

1. Utilize HSI to geospatially map the location and condition of ash species in the City of Milwaukee with 80% or greater accuracy.
2. Develop replicable protocols for ash species identification in urbanized areas utilizing remotely-sensed HSI.
3. Integrate HSI derived ash species maps with existing GIS analytical tools to provide specific property ownership and contact information for ash trees throughout the city.
4. Evaluate the use of HSI in conjunction with UFORE analysis data for predicting the volume of wood waste generated by an EAB outbreak
5. Utilize remote sensed HSI to establish new best practices for EAB and invasive species risk assessment.

Project Methodology and Results

The project was completed in four steps; field HSI data collection and analysis, airborne HSI and LIDAR data collection, HSI data analysis and processing, and target data integration with GIS analytical tools.

Both ground and airborne HSI and LIDAR data was collected simultaneously in August 2008. NCDC Imaging, SRA International, ASD, Inc. and RFP Mapping LLC partnered with Milwaukee forestry staff to collect "canopy level" spectral signatures from ash species as well as several other common trees and vegetation in the Milwaukee area. The spectral signatures were collected with a hand held spectrometer from a lift truck positioned at the top of the canopy to eliminate potential differences in spectral radiance or reflectance readings between the hand-held spectrometers and airborne sensors due to physiological differences in leaf chemistry (i.e. chlorophyll content), anatomy or health within the crown.

Following ground (canopy) spectral collection, the team conducted initial analysis to determine the spectral separability of ash species from other trees and common vegetation in the Milwaukee area. This assessment was necessary to confirm that the airborne sensors would be able to detect required spatial and spectral information needed to accurately classify ash from other tree species.

While enough spectral differences were noted to proceed with the project, team member Daniel Puchalsi of SRA International, who in his thirteen years working with 20 different sensors and hundreds of targets, found ash to be the hardest target to separate from its background with limited false alarms (incorrect species classification). 'The difference between an ash tree and some of the other common trees in the Milwaukee area are unbelievably subtle, when you add things like plant health and stage of growth, it is an amazingly complex problem".

Airborne HSI and LIDAR data collection over Milwaukee's 95 square miles and initial data processing was conducted by Terra Remote Sensing and the University of Victoria. NCDC Imaging conducted the LIDAR analysis and SRA International conducted follow up analysis of the hyperspectral data utilizing spectral signature exploitation, proprietary algorithm and analysis methodology. LIDAR fusion with the hyperspectral data improved the positional accuracy of the hyperspectral imagery and resulted in a high precision tree polygon layer and a tree point dataset with tree height, crown width and stem diameter attributes.

Following initial delivery of the GIS ash classification layer in March 2009, the SRA analysis team worked with NCDC Imaging and Milwaukee Forestry Division to conduct an initial accuracy assessment (ground verification). Initial results provided approximately 80% overall accuracy for ash classification with certain honey locust, maple (mostly silver but also some Norway and sugar) and red oak constituting the majority of false alarms. Subsequent adjustments to the spectral angle mapping process yielded a dramatic reduction in false alarms with 85% overall accuracy for all ash trees and as high as 93% accuracy for larger ash trees. Following reprocessing of the data, false alarms with similar reflectance levels were limited to red oak and catalpa, neither of which occur in abundance in the Milwaukee area and are easily distinguishable on the ground from ash species.

Conclusions

High-resolution remote sensed Hyperspectral Imagery provides the foundation for new invasive species best practices. The ability to overlay an orthorectified ash classification map with 85% or greater accuracy onto an existing GIS parcel map represents a powerful new application for invasive species detection and response planning. This technology will permit coordinating federal, state and local personnel to efficiently target property owners with high ash concentrations for EAB inspections, monitoring, control, and dissemination of outreach materials.

Armed with a HSI derived GIS ash classification layer, the Milwaukee Forestry Division plans to conduct an extensive outreach campaign during the summer of 2009 to over 35,000 households identified as having ash trees. Residents will be alerted to the presence of ash on their property and provided with information related to Emerald Ash Borer risk and management options. It is hoped that the increased awareness and opportunity for advanced planning will lead residents to take appropriate action to either treat or remove their ash tree(s) in advance of EAB, and ultimately reduce code enforcement action required by Milwaukee forestry staff.

The ash classification affords Milwaukee with a unique opportunity to be more proactive in managing the highly elusive Emerald Ash Borer by increasing the probability for early rapid

detection and the potential to more accurately predict EAB movement within a community based on known host distribution.