

# Ep1\_EAB

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## SUMMARY KEYWORDS

ash, trees, eab, riparian, ash trees, forests, species, stands, canopy, invasion, mortality, michigan, understory, emerald ash borer, vermont, invaded, impacts, important, area, big

## SPEAKERS

Liz Woodhull, Alison Adams, Patrick Engelken

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Alison Adams 00:04

Welcome to Restoration Roundup, a monthly podcast that explores recent research on, new and emerging best practices for, and stories about riparian forest restoration. I'm Alison Adams. I'm the watershed forestry coordinator with University of Vermont Extension and Lake Champlain Sea Grant and I run the Watershed Forestry Partnership.



Liz Woodhull 00:22

And I'm Liz Woodhull, a junior at UVM Rubenstein School of the Environment and Natural Resources, studying environmental studies and parks, recreation and tourism.



Alison Adams 00:32

For this first episode, we thought it would be helpful to clarify what riparian forests are and why they're important.



Liz Woodhull 00:37

Riparian forests are wooded areas next to streams, rivers and wetlands. Healthy riparian ecosystems can intercept nutrients, sediments and pesticides from nearby areas before they enter our waterways,



Alison Adams 00:49

which is particularly important here since Lake Champlain doesn't meet EPA Clean Water Act standards.



Liz Woodhull 00:54

That's right, and they can stabilize stream banks, decrease the frequency and severity of flood events, keep streams cool for aquatic organisms, store carbon, provide critical habitat for wildlife, and even serve as the venue for all sorts

of cultural and recreational activities and experiences.

A

Alison Adams 01:11

This monthly podcast will touch on a variety of issues related to riparian forest restoration and management. So let's jump right in.

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Alison Adams 01:30

Today for this first inaugural episode of Restoration Roundup, we'll be speaking with Patrick Engelken. Patrick is an entomologist with the US Forest Service in St. Paul, Minnesota. As a graduate student at Michigan State University, he studied the effects of emerald ash borer on riparian forests, and continues to work with emerald ash borer and wetland and riparian forest ecosystems in his current position. He is particularly involved with black ash health and tribal outreach for black ash support in the Minnesota area. As our listeners may know, emerald ash borer was first found in Vermont in 2018, and since has been identified in every county in the state posing a major threat to the health and functioning of our forests. So hi, Patrick, and welcome to the podcast.

P

Patrick Engelken 02:09

Thanks for having me.

A

Alison Adams 02:10

Absolutely. So we're just going to jump right in. Emerald ash borers, for those of our listeners who might not know though I'm anticipate that most do know, are jewel beetles that are native to Eastern Asia and they were identified in Michigan where you did your graduate work in 2002. Can you explain for our listeners what emerald ash borers do?

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Patrick Engelken 02:28

So emerald ash borers - they're beetles, they're in the family Buprestidae, which is a pretty diverse and widespread species. They have a species all across the world, there's some in the United States as well. And essentially, what these beetles do in their native habitats is they feed in the phloem layer of the trees and typically in their native ecosystem, they feed in stressed and dying trees. So the phloem layer is the outermost layer, the tree that the tree uses is kind of its nutrient highway, where it moves nutrients from the leaves down to the roots and vice versa. And when these beetles are feeding within the phloem, essentially, they're starving from the inside out. So once that phloem layer is eaten through and deteriorated, the tree isn't able to move the nutrients around within its trunk and branches. And it'll ultimately starve to death. And that's why you see the kind of branch die back and the mortality of the above ground stem. As EAB feeds and starts to kill the tree.

A

Alison Adams 03:23

You said that they mainly focus on already-stressed trees, are there other things that are stressing ash trees that would make them susceptible to the scale of outbreaks of emerald ash borer that we've seen?

P

Patrick Engelken 03:34

So in its native ecosystem, it'll feed on stressed and declining trees. So there are lots of Buprestids in the United States: bronze birch borer and two-line chestnut borer, which are kind of active secondary pests that attack these stressed, dying, declining trees. And that's how EAB works in its native Asia as well. But in the United States where EAB doesn't have that kind of long evolved history with Fraxinus species in North America, it actually attacks and kills healthy ash trees. Most if not all species of North American ash can be killed when they're healthy, big strong trees they can be inhabited and killed by EAB.

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Liz Woodhull 04:12

So how did you first get interested in emerald ash borers and what brought you over to this kind of work?

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Patrick Engelken 04:19

So when I was an undergrad, I'm originally from Eastern Kansas, I got my undergrad degree at Washburn University in Topeka. And while I was there my advisor he kind of got me working with him on a project looking at impacts of a defoliator moth on paw paw trees, and they're important because the leaves of these trees are the only food for the tiger swallowtail. He noticed these paw paw trees being defoliated by something. And he kind of developed this project around kind of this outbreak cycle of this defoliating moth on these papaya trees. I was working with him on that project. And he got me tied into Michigan State because he did his postdoc at Michigan State working for Deb and he was a big guy in the early days of EAB, modeling the spread of emerald ash borer trying to slow and kind of mitigate the impacts EAB was having in the early days. So he kind of got me connected to forest health to begin with. And from there, he kind of got me to a good location where I could work. And it gets some some good, interesting research working with emerald ash borer.

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Alison Adams 05:18

And when you say Deb, you're talking about your co-author on one of the recent papers that you wrote about this, right?

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Patrick Engelken 05:25

Yep. She was my advisor at Michigan State.

A

Alison Adams 05:28

Can you summarize in a few sentences what your research at Michigan State, and maybe even your research now too, on emerald ash borer and riparian areas-- what that work aimed to do, and what questions you were trying to answer?

P

Patrick Engelken 05:41

Yeah, sure. So emerald ash borer, it's been in Michigan for a long time, particularly in the southeast Michigan near the Detroit Metro. There's been a lot of research, a lot of work to show that in ash stands, you see very high levels of

mortality, upwards of 99- 100% in green ash stands and black ash stands. And we know a lot about how it impacts the overstory. The things that we don't know, though, are what are the long term effects going to be on the ecosystems after EAB invades once the overstory dies back? How is the regeneration going to respond? We know ash, it's a mast species, it puts out a ton of seeds every few years. We know there's going to be a lot of regen in these sites. We don't know how it's going to persist in the long term. So some of the questions we had going into this were: What do stands that have been invaded for a long time near Detroit Metro--what does the regen look like in the stands? And how does it differ from forests that had been invaded more recently? So pretty much the main chapter, my master's work in Michigan State was kind of working from Southeast Michigan to Southwest Michigan along headwater streams. Looking at how these, these stands have been impacted by EAB and looking at the understory in particular, and seeing what was coming back in. And were we seeing good substantial healthy ash trees and stands that had been invaded for 15 to 20 years? We also wanted to know were these canopy openings, you know, ash trees are very abundant and very important trees in riparian forests-- were these ash trees, or were these were these canopy gaps, providing pathways for invasive species to get established? We know there's like there's a big theory in ecology called invasional meltdown theory, where it's kind of hypothesizing once an invasive moves in, does it create a pathway for other new invasives to get in and kind of create this cascading spiraling invasive meltdown? So the kind of the big, overarching questions of my research were, what kind of things happen after the EAB invasion? How does the regen respond, and what kind of other co-occurring impacts may be seen in the long term as well?

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Liz Woodhull 07:55

So can you talk more about what you ended up finding?

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Patrick Engelken 07:58

So what we found was as you can expect, EAB invades, most of these are riparian forests are dominated by green ash in southern Michigan, and a mix of green and black in northern Michigan. They have pretty much total canopy collapse, you have 90-100% mortality. Ash species typically made up between 40 to 70% of the trees in our stands. So we saw pretty large canopy caps had formed, and what we had seen was that after this canopy gap had formed, the understory changed in a way that promoted dense vegetation. There was really high abundances of these wetland adapted sedges and forbs. This is probably in part due to the openness of the canopy, the high light levels and also yeah, that loss of the water table control below ground when you have all of these trees die, you're losing a lot of the transpiration power of that forest and you're having much lower control over the water tables. And what it ended up doing is it made these really dense, or really thick sedge mats in the understory, and it kind of excluded everything. We didn't really see any tree ceiling regen underneath it. What we saw was a lot of ash regen, but all this ash regen was above that herbaceous level. There's a term in EAB work called the "orphan cohort," which is kind of that generation left behind after the overstory died out and saw this orphan cohort of 1-3 inch green ash trees mostly in southern Michigan but really didn't see anything underneath it. So you see a good healthy understory, but if they don't make it, there's really going to be kind of that transition from that overstory into open canopy sedge meadow along these --, which, as you can imagine, can have some pretty, pretty dire circumstances on that aquatic ecosystem or that riparian ecosystem, especially so within the stream corridor where they kind of rely on that nutrient input from the leaf litter and the shading from the canopy kind of to maintain their habitat.

A

Alison Adams 09:54

Yeah, so I was going to ask sort of what are the main impacts that you expect to see on riparian ecosystems in the long term as a result of this invasion in Michigan?

P

Patrick Engelken 10:03

Once the canopy disappears, you're going to a loss of control over that, that that system, it's going to kind of collapse if you don't have anything coming back up underneath it. You're gonna have sedimentation into the streamway, you're gonna have higher water temperatures, loss of nutrient inputs. The aquatic ecosystem is going to be substantially different. And you're going to see some some changes are probably going to be not so good for the organisms to kind of occupy these stream systems. I personally didn't sample these these systems but I know, Eric Benbow, who was a co-author on that paper, he did sample some in another paper, and his postdoc, Courtney Larson, did as well. So these--they're certainly different now. And there's certainly going to be some long term impacts especially so if the the ash saplings and recruits that are still there are not allowed to kind of reach maturity and kind of fill in that gap in the canopy.

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Liz Woodhull 10:59

So is there another tree that can fill this niche?

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Patrick Engelken 11:04

Well, there are species that could, especially in southern Michigan, you have species like red maple, it's really, really good at occupying these riparian corridors. American elm historically has been a common species and these habitats. It has its own issues with Dutch Elm Disease, as I'm sure you know, but the issue is, there's not really an opportunity for these species to get established post invasion. Like I said, you have that kind of a takeover of the dense herbaceous and sedge mats at the ground level, and it kind of excludes any new regeneration from forming, so what was there before EAB was present was primarily ash, and that's what's there now. And unless there's some sort of intervention or management in the future, it's going to be really hard to get any co-occurring species established in these forests.

A

Alison Adams 11:51

So it sounds like you basically end up seeing sort of a wholesale transition of the ecosystem to a different kind of ecosystem.

P

Patrick Engelken 11:58

Mhm. Yeah you see that transition from a closed forest to kind of a sedge meadow or open sedge meadow like you might see in a big open bog.

A

Alison Adams 12:06

And in Vermont, you may know and there may be similar problems in Michigan, we have a pretty serious water quality issue in Lake Champlain, it doesn't meet Clean Water Act standards, and there's a pretty serious statewide effort to address that problem. And there's a lot of different approaches, and one of them is reforesting riparian areas. So we hear a lot about how important intact forests are for maintaining water quality in the lake. And I'm wondering, does this ecosystem state transition affect the water quality at all? Do you know?

P

Patrick Engelken 12:33

I mean, it surely will. The best way to maintain water quality is having a healthy forest. And as to having these big, strong trees kind of filtering the water as it moves through the corridor. And once you have these trees die, you have these kind of shallow rooted grasses and forbs that really don't fill that role. They don't really pull nearly as much water out, they don't pull nearly as many of those hard metals and those minerals that you want to get out of the water out as well as a healthy canopy would.

A

Alison Adams 13:03

You mentioned that there was a fair amount of regeneration of I think it was green ash is what I read in one of the papers, and then sort of this orphan cohort effect. I'm wondering, do you think that those saplings are likely to reach maturity and sort of restore this canopy back to what it was previously? Or what challenges are they facing? What does that look like for the future of that area?

P

Patrick Engelken 13:26

So personally, I find it hard to believe that ash will ever be wiped out of these forests completely, and they're still low levels of EAB in Michigan stands even though you've seen that the 90% overstory mortality has occurred. You still if you hang a sticky trap in a tree, you're going to catch something so there's EAB in the area feeding on something. And what you're going to see all these trees are similar age class, they're all between one and four inches in diameter. Once these trees start to reach a stage where EAB can start to feed on them, you're surely going to start to see some dieback and probably some mortality as well. Green ash trees are really resilient. They're really hardy trees. That's the reason you see them planted in cities so often, they can handle pollution, soil compaction, drought, they can handle a lot of things. Green ash can handle some EAB pressure when they're healthy trees, and they're attacked by a low density of larva, green ash in particular, and white ash as well, they make this stuff called wound periderm which essentially is a corky substance they form around a gallery and it kind of boxes the larva in. In the long term, we have like 99% reduced carrying capacity of EAB in these stands so you're never going to get that-- the huge kind of invasion wave of EAB that you had prior to EAB invasion. What you're going to have probably is a low to intermediate level of EAB that kind of follows the maturation of these ash trees in these stands, and what I would predict is you're gonna see some mortality down the road as these trees mature. You may see these trees kind of act like elm trees where you see them get kind of to that sub canopy, maybe 25-30 year age range in some cases before they succumb, but you're always going to see green ash, it's never going to disappear. But on the other hand, you're probably never going to see ash trees that are going to be the dominant or predominant species in these forests again. You're going to need to have some sort of intervention, some sort of management strategy in these stands.

L

Liz Woodhull 15:21

So you mentioned in your paper that blue ash, which is not here in Vermont, is more likely to survive in post-invasion forests. So what does that sort of mean for us here?

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Patrick Engelken 15:32

So if you don't have blue ash for mine, I mean, blue ash is kind of a minor species in Michigan, it kind of occupies that central Upper Midwest region. It's never really a dominant species. But blue ash is really unique in that it seems to be really resistant to EAB. I know there's been some studies in Southeast Michigan near the core of the EAB

invasion that show that these trees they were there before EAB, and all of the trees around them died and they're still there. They don't show much decline or or dieback at all. So I mean, blue ash certainly could be an important species, maybe for planting in cities in the future, because it has that kind of innate resistance to EAB. But if you don't have blue ash in Vermont, it's not going to be a big thing in the forest setting, I wouldn't think.

A

Alison Adams 16:20

Yeah, instead we have white ash. Do you happen to know what the susceptibility of that is to emerald ash borer as compared to green ash which we also have a fair amount of and black ash which is relatively, I mean, it's around, but relatively rare compared to what it sounds like maybe in Michigan?

P

Patrick Engelken 16:36

So white ash is kind of a complex species when it comes to EAB. White ash certainly can be fed on and killed by EAB. Um, there has been a lot of studies, or not a lot of studies, but some studies have shown that white ash, it doesn't die nearly as quickly as black and green ash does. There's a woman who did her PhD in Deb's lab, Molly Robinette, that was kind of the bulk of her research was looking at ash survival in the core of the the invasion, and she was saying stands in southeast Michigan, they've been invaded for 18-20 years where white ash was still surviving, you saw in some cases less than 10% mortality. But in other cases, they said you'd see upwards of 60, 70, 80% mortality. So there are a lot of questions about white ash, why it doesn't seem to succumb nearly as well EAB, maybe it's a little less preferable? Maybe when there's black and green ash around it... Um, it kind of gets honed in by EAB, but when there's not maybe kind of avoids it. I'm not sure what the answer is. But there is some work that shown that white ash, is probably if you have white ash in your stand, is going to have a little higher chance of surviving than green and black ash, which if there's EAB those species are almost certainly going to be taken out at some point.

L

Liz Woodhull 17:59

So can you talk on how this issue could possibly intersect with climate change at all?

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Patrick Engelken 18:05

So sure, um, yeah, so at its core with climate change, what you're going to be looking at are, an insect like EAB that is able to feed longer in the summer, is going to have less cold mortality in the winter. What really impacts cold mortality in northern states are these really cold nights when you get up into northern Minnesota up into UP in Michigan, I'm sure when you get up into in Vermont, Maine, where you can have these really, really cold sub-zero nights. Like I said, the EAB, it feeds right under the bark layer of the tree. So when you have these bone called nights, you can see some some cold mortality occur. But with climate change in the future, if you'll start to lose some of these some of these very super cold nights, and if you start to see earlier warming in the spring, later cooling in the fall, the warmer it is, the more they're going to be able to feed. I don't know if you're going to see multiple generations a year. I know I don't think EAB will do that. But what you certainly could see is less cold mortality faster, more healthy adults that come out of these trees that can develop faster, feed on more phloem throughout the summer, possibly have higher fecundity, females that can lay more eggs, that can fly farther, there's surely going to be some impacts with climate change, just based on warmer summer days, and it being an insect it kind of reacts to that.

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Alison Adams 19:34

So it sounds like potentially the invasion just spreads faster, with warmer weather.

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Patrick Engelken 19:40

Yeah, the the insect can feed faster maybe it will develop earlier in the summer, those kind of things. So you see some faster population build up in some areas, once EAB gets there if you're starting to see some effects of climate change.

A

Alison Adams 19:54

Yeah, one of the things that we read about when we were doing some research for this podcast is we saw that ash mortality can increase the fire susceptibility of forests. I think this research was particularly coming out of the west where there's sort of more you know, those ecosystems are more prone to fire in the first place. But I'm wondering, have you seen any of that in Michigan? Do you have a sense of whether that could happen here in climates like ours as well?

P

Patrick Engelken 20:20

Well, I haven't seen any in Michigan but in any forested stand when you start to see the buildup of dead wood, it increases kind of that fuel load and the understory ash trees are prone to snapping, kind of at about two meters in height once they die you see that snap off and you see the big-- I've seen some big piles of ash logs in the understory in Michigan and all it would take is a lightning strike or a camper who doesn't-- is not careful putting his fire out or something, then you have a huge fuel load. So yeah, it certainly would increase the chances of creation or sustaining a forest fire in these stands.

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Alison Adams 20:58

Patrick, how long does it typically take to see these very high you know, 90% or higher mortality rates in a stand once the stand has been invaded or once emerald ash borer has been located in that stand?

P

Patrick Engelken 21:12

So once EAB gets into a stand, the first couple of years, you won't see much of anything. So they kind of feed in the upper canopy of trees, when they're first starting to get established in the stand, you won't notice much, might see some very upper canopy dieback. But once you get about maybe two to three, four generations in, then the population will just explode. So typically, anywhere from about three to six years after EAB invasion, you're going to start to see substantial mortality and dieback in the stand. You can see 90-100% mortality occurring probably as soon as, I'd say, about five years after invasion.

A

Alison Adams 21:50

Wow, that is dramatic-- and scary. Emerald ash borer was, as I've mentioned, the beginning found in Vermont just about three years ago. So we're still in that window where we haven't seen stand level impacts in most cases, but everybody's anticipating it and kind of trying to figure out what we can do.



L

Liz Woodhull 22:07

So um, what advice would you have for riparian forest restoration practitioners working in an area where emerald ash borer has just recently started to invade?

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Patrick Engelken 22:18

So my biggest piece of advice is that you should be actively under planting these forests. You know, ash species, green or black if it's a riparian or wetland forest, is going to be-- probably going to be one of the most abundant species, and from what we've seen is if you wait till after invasion, you're gonna see that loss of understory. You're gonna see you kind of that takeover of sedges and herbaceous plants that can be really hard to manage. So I would say you need to be going in you need to be finding what suitable species in your stands would work in the future, you need to see what wetland-adapted species can you underplant and get them established ahead of the invasion so that once the overstory dies back, which is almost inevitable, you're not going to stop EAB, you can certainly go in and treat, you can use systemic insecticides to treat high value trees... I know using insecticides in a wetland habitat is kind of a touchy issue, but a lot of these insecticides like a imidacloprid and emamectin benzoate they show really-- they degrade really quickly once they leave the tree, so there's not really that crossover into the aquatic ecosystem. So that's another thing you could do, you could certainly go in you could treat high value trees in the stands, kind of maintain some control over the water table. Keep some good seed trees in the stands. But the biggest piece of advice I would say is you need to be under planting, you need to get into the stands, you need to see what other species, whether it's red maple, whether it's balsam poplar, balsam fir, and try to get them established in the understory before your ash trees begin to die.

A

Alison Adams 23:50

And if I could jump in here, Patrick, for those who maybe aren't as familiar with restoration practices, what Patrick is referring to is planting young trees in the understory, so underneath the main canopy, so that when the canopy does die off those trees can fill those those gaps in the canopy. At least that's my understanding. Is that correct? Patrick?

P

Patrick Engelken 24:09

Yep that's correct. Okay, great.

A

Alison Adams 24:12

A lot of our listeners are people who are working on reforestation currently, in most cases, agricultural land that has riparian areas, so trying to get those riparian areas out of agricultural use and into forest. What would your advice be for them? Should they be planting ash or just avoiding it knowing that it's likely to face this threat from emerald ash borer and plant something else?

P

Patrick Engelken 24:38

I would always advise against planting ash in your stands. If you're, whether you're within the area where EAB is invaded or ahead of it. these species unless you--unless there's a lot of proaress in the resistance front in the near

future, you're just going to set these trees up for failure in the short term. EAB can feed on trees as little as one inch in diameter. So you really don't have to have a big tree for EAB to feed and kill them. There's enough other species in these kind of mixed forests that would do well-- red maple would be a really good one to get into these kind of open early successional stands, especially riparian stands. But yeah, I would not recommend planting green or black ash and a wetland habitat. Blue ash and white ash, they're not going to do that great in these these riparian corridors anyway.

A

Alison Adams 25:26

Right. You mentioned-- you said unless there's progress in finding sort of resistant genetic variations in the trees or trees that are more resistant, or at least stopping the spread in some other way. Do you have any insight about what's going on with that? Is there a lot of work happening in that area or not? How's it going if so?

P

Patrick Engelken 25:46

I know there's some work I'm not familiar with the projects at all but I know there's there's some work looking at green ash resistance, where they have plantations established whether they're trying to find some resistance and breed in some resistance in these trees. I know there's been some efforts of kind of crossing Asian ash species with green ash, to try to create a resistant hybrid. But then you kind of get the issue of your planting a non-native species in a forest or at least a species with some non-native qualities in a forest. So I wouldn't think it's going to be a quick fix anything coming out in the near future.

A

Alison Adams 26:22

Yeah, sounds like it, but maybe something to keep an eye on, if folks are interested in maintaining ash in the forest. I, as an aside, enjoy mushroom foraging. And in Vermont, a lot of the morel mushrooms are found around ash trees. So I've been watching this personally kind of closely, a little concerned about what that means for mushroom prospects in the spring, in coming years.

L

Liz Woodhull 26:41

And so not just for, you know, practitioners and people working right in riparian forests--what about concerned citizens or policymakers? What can they do to also help address this spread of EAB?

P

Patrick Engelken 26:57

So I think awareness is a big thing. It's almost startling to me, when I talk with somebody who's at the leading edge of EAB, how little information is being spread about the research that's been done. It's important to know EAB looks like, what the signs of the EAB are. If you're a homeowner and you're worried about your big, healthy 150 year old green ash in your backyard, keep an eye out. You need to know when EAB gets in your area. You're certainly able to protect these trees. There's a lot of insecticide research that's shown you can keep trees healthy using, like I said, imidacloprid emamectin benzoate injections can keep these trees alive, even in the midst of invasion. So I think awareness is just the biggest thing. You need to keep an eye out, look up in the canopy or trees, it's important to the know what's there and what the status of any invasive is, you know, any invasive in these stands, there's always new ones coming up.

A

Alison Adams 27:55

Yeah, unfortunately, that does seem to be true that there are always new ones coming up. A couple of the things that I've heard, just sort of, you know, sort of being around this conversation kind of loosely is, I've heard things like you don't want to carry wood from one location to a faraway location. I assume that's still a recommended practice for firewood and things like that try and burn locally? And then the other thing that I've also heard, that I think may not be practiced anymore, and maybe you can shed some light on this for us, is the idea of quarantining trees, like trying to clear nearby trees that are, you know, also ash trees to sort of limit the spread. Is that still a recommended practice? Or do you know what's happening with that?

P

Patrick Engelken 28:38

So are you referring to kind of clear cutting those trees around an infested site? Is that what you're talking about?

A

Alison Adams 28:45

I think that is the practice I'm thinking of, yes.

P

Patrick Engelken 28:47

So that's something they do for Asian Longhorn beetle. And it's shown to be effective that way, for Asian longhorn beetle. But for EAB, in the early days, they tried that-- they tried going in and if EAB is in stand, clear cut every ash tree for 10-20 kilometers around around the infested site, see if you can kind of stop the spread, kind of eradicate the population. It never works. EAB always spreads faster than you think it is. It's always ahead of the invasion wave, it's really hard to detect them at low densities. EAB, they don't have at least not a known long range sex pheromone. So it's really hard to trap for them. When you have these long range sex pheromones, you can hang a lure and a trap, and you can pretty much attract males from every direction in if there's some in the area. EAB you really, they have some contact and short range pheromones for when they're on a tree, males can find the females, but you don't have those long range pheromones. So it's really hard to detect EAB at low densities. So we're always behind the current EAB invasion windows. So yeah, it's difficult to map EAB and it's really difficult to eradicate it once it's in an area.

A

Alison Adams 29:57

What's next for you, Patrick? I mean, what are-- Where's your research headed? What are the next questions you're looking to address? What are you working on right now?

P

Patrick Engelken 30:06

So currently, a project I'm working on with Deb is looking at kind of the impacts of EAB on black ash stands, riparian and wetlands stands across the native range of black ash, which, as I mentioned, it ranges from pretty much Minnesota, all the way up into Maine down as far south as about Ohio. So kind of trying to address some questions on what can we do with black ash? How, what are the chances of it persisting? What kind of regeneration are you seeing? Are there ways to protect it, both ahead of and behind the invasion? Black ash is a really really important

ecological species and in these wetlands all the way through New England and kind of the upper Midwest area, so in addition to being that's also really important cultural species for tribes in the upper Midwest and up into New England, they've utilized that black ash for hundreds, thousands of years probably as a basket tree and it's also really important for them spiritually as well. So there's a lot of concern about black ash. It's also the most susceptible species of ash to EAB, so with it's really important cultural and ecological importance. There's a lot of concern about the health of these ecosystems in the future. So last year, I spent a lot of time in Michigan, upper Michigan in the UP surveying these black ash stands that had been post invasion where the overstory had been killed. This year, what I'm working on right now is going in looking at stands ahead of or currently invaded in Wisconsin and Minnesota. And I know there's another forest health entomologist in Durham, New Hampshire, Nate Seeger, who's doing the same thing up in in your neck of the woods up in Vermont, Maine, and in upstate New York doing the same thing. That's kind of what I'm working on now, kind of seeing how black ash has been impacted by EAB in these stands in Michigan and kind of comparing how are the stands that have not been invaded or are currently being invaded differ from those stands?

L

Liz Woodhull 32:14

Can you say a little more about your work on tribal outreach around ash mortality?

P

Patrick Engelken 32:20

Yeah, so like I said, we have a lot of tribes that are concerned about black ash, so I communicate with these tribes throughout the summer, if they need any outreach materials, if they would like me to come out and look at their their ash trees and talk with them about their black ash resource and stuff like that. That's what I provide for them, I'm kind of an open ear, if they have any concerns, connect them with the Forest Service. We have a lot of funding opportunities for tribes. So there's a lot of opportunities for them to receive financial aid to protect their ash stands, or to do things like parasitoid control if they if you want to try to do that. We have a lot of opportunities. So yeah.

A

Alison Adams 33:03

That sounds like really interesting and important work, Patrick, I'm really happy to hear that that's something that the Forest Service is working on. Well, that brings us to the end of our episode today. Thank you so much for being with us today, Patrick.

P

Patrick Engelken 33:16

No problem. Happy to be here.

A

Alison Adams 33:31

Today's episode featured the song of the very a bird found in Vermont's riparian forests. It was recorded by Sue Riffe on June 11 2017 at Brownfield Bog Wildlife Management Area in Maine. We downloaded the song from [xeno-canto.org](http://xeno-canto.org). For more information about the topics covered in this episode, including links on how to identify and stop the spread of emerald ash borer, visit the podcast tab of Lake Champlain Sea Grant's Watershed Forestry Partnership website. This project has been funded wholly or in part by the United States Environmental Protection Agency under an assistance agreement to NEIWPCC in partnership with the Lake Champlain Basin Program.

