2016 Project Abstract
For the Period Ending June 30, 2019

PROJECT TITLE: Determine Impacts on Wildlife from Emerald Ash Borer Infection of Black Ash Forests PROJECT
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FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: M.L. 2016, Chp. 186, Sec. 2, Subd. 03q

APPROPRIATION AMOUNT: $ 334,000
AMOUNT SPENT: $333,998
AMOUNT REMAINING: $2

Sound bite of Project Outcomes and Results
Black ash wetlands are high in biodiversity and support unique wildlife communities. EAB will fundamentally alter ecosystem structure, causing wildlife communities to shift from forest dependent species to open-canopy and wetland associated species. Management strategies that focus on diversifying tree composition (e.g., via planting) will maintain long-term forest cover and help maintain wildlife diversity.

Overall Project Outcome and Results
Black ash wetlands cover over one million acres of northern Minnesota forests and provide critical habitat for wildlife. The future of Minnesota's black ash swamps is critically threatened by EAB, which has been eliminating native populations of ash throughout the Great Lakes Region. Although EAB impacts to wildlife are certain, the magnitude and relative degree of impact to individual species and species diversity is unclear. To quantify the impacts of EAB on wildlife we measured seasonal bird, mammal, and herptile diversity in black ash stands across Minnesota. We established 29 long-term monitoring plots and developed protocols for measuring the current status of wildlife communities and also used eight experimental research sites that simulated EAB mortality and adaptive management strategies for EAB (clearcutting and group selection harvests) to assess the impacts of EAB on wildlife communities. Our results show that black ash stands are structurally and compositionally more diverse than paired upland and emergent habitats, providing a variety of microhabitats that support a large and unique assemblage of birds and amphibians. The loss of black ash due to EAB will result in turnover of bird, amphibian, and mammal communities from forest dependent species to open-canopy and wetland associated species. Increased ponding and hydroperiods may be beneficial for some amphibian species, but the loss of the forest canopy will result in an overall decrease in bird diversity, reduce forest connectivity, and exacerbate impacts of habitat loss for many mammal species. Our results show that the long-term, large-scale impacts of EAB on forest-associated wildlife will be significant. Management strategies that focus on establishing alternative trees species to maintain long-term forest cover and structural complexity will help maintain and conserve wildlife diversity.

Project Results Use and Dissemination

The results of this project have been presented at a variety of workshops and conferences:

- Joint Meeting of Ichthyologists and Herpetologists "Potential effects of emerald ash borer invasion on wetland community composition" in Austin TX, July 12-16, 2017.
- Science and Management of Ash Forests after Emerald Ash Borer: A workshop on the future of post-EAB ash forests "Potential effects of emerald ash borer invasion on wetland community composition" in Duluth, MN on July 25-27, 2017.
- Forestry and Wildlife Research Review, Cloquet Forestry Center, January 11, 2018.
- The Minnesota Chapter of The Wildlife Society Meeting, St. Cloud Minnesota, February 12-14, 2018.
- Charting the Future for Northern Forest Birds: Takin it to the Tweets workshop in Ashland, WI, April 16-17, 2018.
- Alexis Grinde presented a webinar "**Determining Impacts on Wildlife From Emerald Ash Borer Infestations of Black Ash Forests"** via EAB University on March 15, 2018. The webinar recording is available at http://www.emeraldashborer.info/eabu.php
- Forestry and Wildlife Research Review, Cloquet Forestry Center, January 10, 2019
- The Minnesota Chapter of The Wildlife Society Meeting, Duluth Minnesota, February 19-21, 2019.
- Rob Slesak and Alexis Grinde presented "EAB and black as wetlands: Holistic assessment of ecosystem impacts and potential for mitigation" at the Forest Resources monthly seminar on February 25, 2019. Recording is available on the Sustainable Forests Education Cooperative: https://youtu.be/9R5QKKNNMYU
- Alexis Grinde presented a poster "Emerald Ash Borer and Wildlife: A Look into the Future" at the 2019 Heart of the Continent Symposium in Duluth, MN on April 8, 2019.
- Melissa Youngquist gave a seminar "Potential effects of emerald ash borer invasion on wetland communities" at Arkansas State University on April 24, 2019.
- Melissa Youngquist presented "Protecting Our Threatened Wetlands: How Invasive Species Can Affect Wetland Communities." At the Shedd Aquarium on May 15, 2019.
- Rob Slesak discussed the implications of the work at MN Senate and House hearings during the 2019 legislative session.
- Rob Slesak gave an invited presentation "Impacts of Emerald ash borer on black ash in the lake states" at the Eastern Regional Meeting of the National Council on Air and Stream Improvement, Atlanta GA, June 4, 2019.
- Rob Slesak gave an invited presentation "Simulated effects of EAB on hydrology of black ash wetlands" at the Water and Watersheds annual conference of the MN Pollution Control Agency, Brainerd MN, February 6, 2019.

Results of this project were included in the following publications:

- Kolka, R.K., D'Amato, A.W., Wagenbrenner, J.W., Slesak, R.A., Pypker, T.G., Youngquist, M.B., Grinde, A.R. and Palik, B.J., 2018. Review of Ecosystem Level Impacts of Emerald Ash Borer on Black Ash Wetlands: What Does the Future Hold?. Forests, 9(4), p.179. https://www.fs.fed.us/nrs/pubs/jrnl/2018/nrs_2018_kolka_001.pdf
- The results of this project were incorporated into the updated version of the document "Managing Ash Woodlands: Recommendations for Minnesota Woodland Owners" this document is available on the UMN Digital Conservancy on-line and in a variety of print options. The persistent link to this item is: http://hdl.handle.net/11299/205052

- We are in the process of completing two peer-reviewed manuscripts for this project and plan to have them submitted by the end of the year; the manuscripts will be available on NRRI's website after they are published.

Environment and Natural Resources Trust Fund (ENRTF)
M.L. 2016 Work Plan

Date of Report: August 15, 2019

Final Report

Date of Work Plan Approval: June 7, 2016

Project Completion Date: June 30, 2019

PROJECT TITLE: Determine Impacts on Wildlife From Emerald Ash Borer Infection of Black Ash Forests

Project Manager: Gerald Niemi

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Location: Statewide

Total ENRTF Project Budget:		
	ENRTF Appropriation:	**$334,000**
	Amount Spent:	**$333,998**
	Balance:	**$2**

Legal Citation: M.L. 2016, Chp. 186, Sec. 2, Subd. 03q

Appropriation Language:

$334,000 the second year is from the trust fund to the Board of Regents of the University of Minnesota for the Natural Resources Research Institute in Duluth to assess impacts of emerald ash borer and adaptive management on wildlife diversity in black ash forests and to develop recommendations to mitigate wildlife impacts. This appropriation is available until June 30, 2019, by which time the project must be completed and final products delivered.

I. PROJECT TITLE: Determine Impacts on Wildlife from Emerald Ash Borer Infection of Black Ash Forests

II. PROJECT STATEMENT:

This project will examine the impacts of emerald ash borer (EAB) and adaptive management on bird, mammal, and herptile diversity in Minnesota's black ash forests. Black ash swamps cover over one million acres of northern Minnesota and provide critical habitat for wildlife. The future of Minnesota's black ash swamps is critically threatened by EAB, which has been destroying native populations of ash throughout the Great Lakes Region. In October 2015, EAB was confirmed in Duluth, the doorstep of black ash in northern Minnesota. Loss of this forest type following EAB infestation will have significant impacts on wildlife. This project will yield critical information for anticipating impacts of EAB on wildlife diversity in northern Minnesota.

Although impacts to wildlife are certain, the magnitude and relative degree of impact to individual species and species diversity is unclear. Given the continued and rapid westward spread of EAB, there is an urgent need to understand how wildlife that are dependent on black ash forests will be impacted following its arrival. This project will build upon past and current projects funded by LCCMR [239: Emerald Ash Borer Ecological and Hydrological Impacts and 082-D: Emerald Ash Borer Ecological/Hydrological Impacts- Phase II] that focus on assessing potential impacts of EAB in black ash forests as related to hydrology, tree regeneration, and native plants communities. Large-scale networks of research sites in black ash swamps have been established to assess EAB impacts and evaluate potential mitigation strategies. The initial phase (239) of this work has already identified significant impacts of EAB and pre-emptive harvesting on native plants and forest hydrology, including loss of native plant diversity and increased flooding. These major alterations will likely lead to a loss of wildlife species diversity in black ash habitats. Importantly, there is a large knowledge gap related to which wildlife species inhabit black ash wetland forests and how they will respond to ecosystem changes following EAB. These limitations seriously constrain our ability to predict EAB impacts to wildlife and develop strategies for mitigation.

Funding for this project will be used to measure seasonal bird, mammal, and herptile diversity in black ash stands. This project will use eight experimental research sites that simulate EAB mortality and adaptive management strategies for EAB (clearcutting and group selection harvests) to assess the impacts of EAB on wildlife communities. Utilizing existing experiments aimed at developing strategies for increasing the resilience of black ash forests to EAB will provide information not only about EAB impacts but also impacts of mitigation strategies to wildlife. We will also survey 30 additional black ash wetlands across northern Minnesota, which will provide critical information for developing landscape-level plans and vulnerability assessments for wildlife associated with these forest types. Data from both of these approaches will provide baseline information about the types of wildlife that use black ash habitats throughout the year and support future wildlife monitoring efforts as EAB spreads in Minnesota.

The goals of this proposed project are to:

1) Provide baseline information to assess existing conditions and establish a long-term monitoring program for wildlife communities in black ash forests to support future monitoring efforts as EAB spreads;
2) Evaluate the effects of mitigation and adaptation strategies on wildlife communities under simulated invasion scenarios to quantify long-term impacts on species diversity; and
3) Identify vulnerable wildlife species and develop recommendations and strategies to maintain biodiversity.

The overall goal of our proposed project is to provide foundational data that will inform and improve long-term black ash management objectives, maintain ecological health of black ash forest systems, and conserve Minnesota's bird, small mammal, and herptile diversity. Findings of this study will be used by state and federal agencies to address the threat of EAB throughout the state.

III. OVERALL PROJECT STATUS UPDATES:

Project Status as of January 1, 2017:

Work completed as of December 1, 2016 has focused the following activities: 1.) Preliminary site evaluation and selection of 30 additional EAB sites, 2.) Purchase of monitoring supplies and equipment that will be used for wildlife surveys including small mammal traps, trail cameras, and digital audio recorders, 3.) Development of survey protocols for wildlife surveys, and 4.) Completion of the first round of wildlife surveys (Fall 2016) in the EAB experimental sites.

Project Status as of July 1, 2017:
The project is on track with the timeline outlined in the work plan. We collected 1.) Digital audio recorder and camera trap data in experimental sites in winter 2016-2017, 2.) Conducted amphibian surveys in spring and summer 2017, and 3.) Completed breeding bird surveys in summer 2017.

Project Status as of January 1, 2018:
As of December 1, 2017 the project is on track with the timeline outlined in the work plan. We have completed the first full year of wildlife surveys and completed the second year of small mammal surveys in fall 2017.

Amendment Request (05/04/2018):
We request permission to move $7,500 in travel funds to the equipment budget category. We have been able to reduce the cost of travel for this project through coordinating field activities with other research projects funded by LCCMR. We would like to use the $7,500 to purchase seven additional digital audio recorders (DARs), the additional DARs will be used to collect data on amphibian and bird activities in black ash stands throughout the year. There will not be a change in scope of activities associated with the amendment request.
Amendment Approved by LCCMR 5/16/2018.

Project Status as of July 1, 2018:
The project is on track with the timeline outlined in the work plan. We have 1.) Collected Digital audio recorder and camera trap data in experimental sites in winter 2016-2017 and 2017-2018, 2.) Conducted small mammal surveys in the experimental EAB sites in fall 2016 and 2017, 3.) Conducted amphibian surveys in spring and summer 2017 and 2018, and 3.) Completed breeding bird surveys in summer 2017 and 2018.

Project Status as of January 1, 2019:
The project is currently on track with the timeline outlined in the work plan. We completed all of the field work for the project, completed the characterization of stand and landscape variables, and are currently in the process of conducting our final analyses for the project.

Overall Project Outcomes and Results:
Black ash wetlands cover over one million acres of northern Minnesota forests and provide critical habitat for wildlife. The future of Minnesota's black ash swamps is critically threatened by EAB, which has been eliminating native populations of ash throughout the Great Lakes Region. Although EAB impacts to wildlife are certain, the magnitude and relative degree of impact to individual species and species diversity is unclear. To quantify the impacts of EAB on wildlife we measured seasonal bird, mammal, and herptile diversity in black ash stands across Minnesota. We established 29 long-term monitoring plots and developed protocols for measuring the current status of wildlife communities and also used eight experimental research sites that simulated EAB mortality and adaptive management strategies for EAB (clearcutting and group selection harvests) to assess the impacts of EAB on wildlife communities. Our results show that black ash stands are structurally and compositionally more diverse than paired upland and emergent habitats, providing a variety of microhabitats that support a large and

unique assemblage of birds and amphibians. The loss of black ash due to EAB will result in turnover of bird, amphibian, and mammal communities from forest dependent species to open-canopy and wetland associated species. Increased ponding and hydroperiods may be beneficial for some amphibian species, but the loss of the forest canopy will result in an overall decrease in bird diversity, reduce forest connectivity, and exacerbate impacts of habitat loss for many mammal species. Our results show that the long-term, large-scale impacts of EAB on forest-associated wildlife will be significant. Management strategies that focus on establishing alternative trees species to maintain long-term forest cover and structural complexity will help maintain and conserve wildlife diversity.

IV. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1: Quantify the long-term impact of EAB and adaptive management on bird, mammal, and herptile diversity.

Description:

We will establish long-term wildlife monitoring plots in the eight existing experimental sites established in the initial EAB project (239) to assess the long-term impacts of EAB on wildlife diversity. The experimental sites are large-scale manipulations of black ash forests that allow for assessment of the ecological impacts of EAB. These sites also incorporate experimental adaptive management actions, clearcutting and group harvests, to assess potential strategies for sustaining the ecological functions of black ash systems after EAB infestation. Each experimental site has four levels of ash mortality that were implemented in four acre plots (n=8 for each mortality treatment). The ash mortality levels at these experimental sites were as follows: 1) retain all ash (control), 2) simulated EAB mortality girdling all ash >10 cm in diameter, 3) group selection harvests (remove groups of ash in 0.1 acres covering 20% of unit), and 4) harvest of all ash (clearcutting). Harvests and girdling occurred in the winter of 2011. We will establish permanent wildlife monitoring plots in the experimental sites to quantify differences in the species composition of birds, mammals, and herptiles in control sites compared to simulated EAB mortality and adaptive management sites. Experimental sites will be monitored seasonally for two years to provide a comprehensive assessment of EAB and adaptive management impacts on wildlife diversity.

Phase 2 (LCCMR Project 082-D) of the EAB project will identify 30 additional black ash swamp sites to conduct hydrologic monitoring and vegetation sampling across northern Minnesota. These sites will be used to fully represent the range of conditions and vulnerabilities of black ash swamps in the state and will span the primary Native Plant Communities (NPCs) in which black ash constitutes a significant component (NPC types Northern Wet Ash Swamp (WFn55) and Northern Very Wet Ash Swamp (WFn64)). We will survey these sites to assess bird, mammal, and herptile diversity. These additional sites will provide data about wildlife communities across Minnesota and complement data from experimental sites. Together these data will provide important baseline information about wildlife diversity in black ash stands across northern Minnesota.

We will use a variety of wildlife survey techniques and technology depending on site specific characteristics and time of year to obtain comprehensive information about wildlife communities in black ash forests. Avian survey techniques will include point counts, modified territory mapping, and digital audio recorders (DARs). Sherman traps, track stations, and camera traps will be used to survey mammals. Survey methods for herptiles include frog call surveys in the spring, digital audio recorders, time constrained searches, and surveys of coarse woody debris. Together these methods will provide a comprehensive estimate of biodiversity in black ash forests.

Wildlife survey methodology overview:

1. Experimental sites: (n= 32; 8 replicates)
    a. Spring: Frog surveys, camera traps (mammals), DARs (survey for frogs, owls, resident bird species), track plates (mammals).
    b. Summer: Modified territory mapping (birds), DARs (birds, frogs), camera traps (mammals), track plates (mammals).
    c. Fall: small mammals traps, DARs (birds), camera traps (mammals), track plates (small mammals)
    d. Winter: DARs (resident bird species), camera traps (mammals)
2. 30 additional sites across Minnesota
    a. Spring: Frog surveys , DARs (survey for frogs, owls, resident bird species)
    b. Summer: Point counts (birds), DARs (birds, frogs), camera traps (mammals)
    c. September: Camera traps (mammals), track plates (small mammals), and DARs (birds)
    d. Winter: DARs (resident bird species), camera traps (mammals)

Summary Budget Information for Activity 1:

ENRTF Budget: $ 227,278
Amount Spent: $ 227,276
Balance: $ 2

Outcome	Completion Date
1. Establish 30 long-term monitoring plots and develop protocol for measuring wildlife diversity in black ash forests.	December 2016
2. Quantify bird, small mammal, and herptile diversity in 30 black ash research sites.	December 2018
3. Final report and activity results submitted.	June 2019

Activity Status as of January 1, 2017:

We have worked with collaborators Rob Slesak, Anthony D'Amato, and Brian Palik to identify selection criteria for the 30 additional EAB sites. As of December 1, 2016, 20 of the 30 additional black ash sites have been selected based on hydrologic characteristics, vegetation, stand size, landscape matrix, and location. The remaining 10 sites require site visits to assess accessibility and habitat characteristics, these site visits will be completed in spring 2017.

Wildlife monitoring plots were created in the eight experimental plots (32 total sites) that were originally established in the initial EAB project (239). In September 2016, equipment and supplies were ordered and wildlife survey methods for the experimental sites were developed in September 2016. Our first round of wildlife surveys were conducted in the experimental EAB sites October 2016. This round of surveys used small mammal traps, visual surveys, camera traps, and digital audio recorders (DARs) to collect wildlife data.

A variety of species were captured on the camera traps (Figure 1.1), however the data collected from camera traps and DARs are currently being processed and analyzed. We have completed the preliminary analysis of small mammal trapping data and have included the summary below.

Figure 1.1. Photographs captured by camera traps in experimental emerald ash borer plots, October 2016. A.) gray jay, B.) American marten, C.) white-tailed deer, D.) short-tailed weasel.

Small mammal trapping

The University of Minnesota's Institutional Animal Care and Use Committee (IACUC) approved the protocol "Small mammal utilization of Minnesota's forests" (Protocol ID: 1608-34042A) on October 17, 2016.

Small mammal trapping was conducted in the experimental EAB sites, these sites are owned and managed by the USFS in the northern part of the Chippewa National Forest, MN. There are three general locations surveyed, which are found on the north side of Lake Winnibigoshish, MN – a region that can be characterized by large, extensive tracts of ash forests, are referred to as Third River Road (N 47 32.090, W 094 13.596), Squaw Lake (N 47 38.187, W 094 11.443), and Kupcho Road. (N 47 42.5, W 094 19.8; Figure 1.2). Each location is separated by a minimum distance of 10 km. Within each location, there are experimental blocks; each block consists of three treatment sites and a control site. The treatment sites consist of three different forest management techniques: clear-cut, girdle and group selection, while the control sites remained unmanaged. Management techniques were implemented approximately 4-5 years prior to 2016. The clear-cut sites had all standing woody vegetation removed, while girdled sites had trees that were debarked to simulate mortality by the emerald ash borer and group selection sites had small patches of trees removed within each site. All sites are circular, with radii of ~72 meters. The 32 sites sampled (8 blocks x 4 sites/block) represent a broad range of environmental conditions from dry to wet and forested to non-forested.

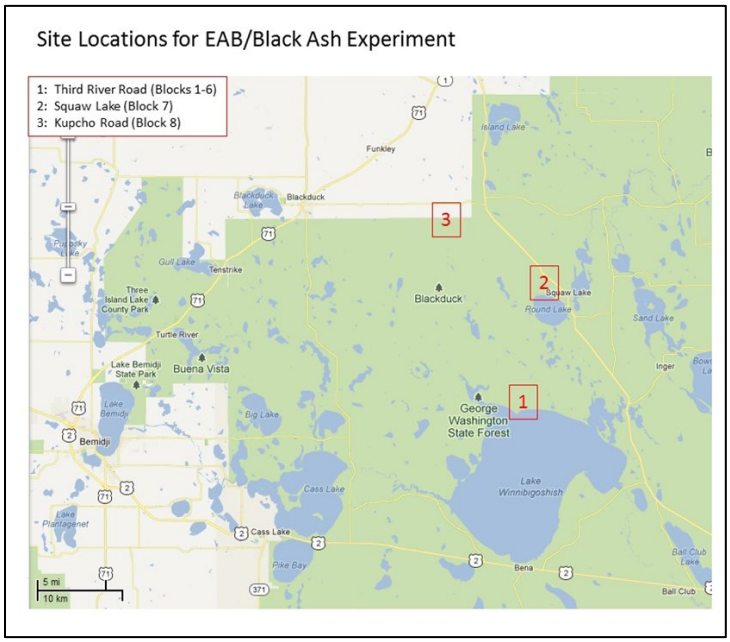

Figure 1.2. Three locations surveyed as part of the Emerald Ash Borer/Black Ash experiment in the Chippewa National Forest, MN: Third River Road, Squaw Lake and Kupcho Road.

Small mammals were trapped from 18 October to 29 October 2016. We used Sherman folding traps (3 x 3.5 x 9 " model LFATDG) baited with peanut butter dipped in oats, we also included a chunk of potato as a water source and cotton balls for bedding. Traps were set in the late afternoon of the first day, run for two consecutive nights and pulled the morning after. Traps were checked twice daily, re-baited, and cotton and potatoes were replaced as needed.

Trap transects consisting of 2 lines of 5 traps (10 traps) placed at 15 m intervals were placed in each site. To maximize capture probabilities, traps were placed opportunistically near the best available microhabitat (e.g. along logs, near stumps). If no suitable trap location existed (e.g. standing water), traps were moved to the next closest trap location. Small mammals were identified, weighed, marked with ear tags; small mammals were identified to species with the exception of *Peromyscus* species.

Figure 1.3. Photograph of flying squirrel that was captured in small mammal traps and released during Fall 2016 small mammal surveys. Photo by Josh Bednar.

A total of 183 captures occurred over the survey period including 150 individuals and 33 recaptures. A total of eight species were captured; *Peromyscus* species comprised 56% of the total captures, followed by red-backed vole (32%) and meadow vole (5%). There were five species that had four or fewer individuals: flying squirrel (3; Figure 1.3), short-tailed shrew (2), short-tailed Weasel (1), southern bog lemming (1) and water shrew (1). While it is too early in the project to formally analyze the data, Figure 1.4 summarizes 2016 small mammal abundance by treatment type (Figure 1.4a) and by block and treatment type (Figure 1.4b).

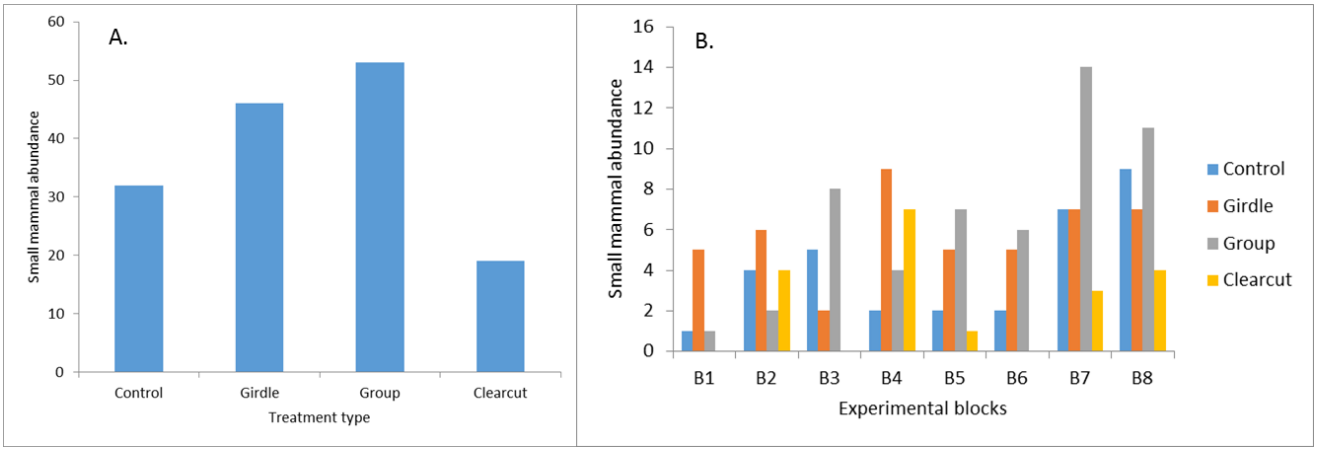

Figure 1.4. Summary of small mammal abundance by A.) treatment type and by B.) block and treatment type from Fall 2016 small mammal trapping surveys.

Activity Status as of July 1, 2017:

Winter surveys- DARs and camera traps were deployed in the control and clear cut experimental sites from December 2016 to March 2017 to capture wildlife activity in the stands.

Spring-Summer- Amphibian call and larval surveys are being conducted in experimental and 27 additional EAB sites, they began in March 2017 and will continue through July 2017. DARs were deployed in experimental and 29 additional stands in spring 2017 to detect amphibian calls and American Woodcock and Ruffed Grouse activity. Breeding bird surveys were conducted in the EAB experimental sites and 29 additional sites across Minnesota in June 2017. Data will be entered, quality checked, and summarized fall 2017.

Activity Status as of January 1, 2018:

We have completed the first full round of wildlife sampling and summarized the data for each focal taxa below:

Mammals 2017:

Fourteen **c**amera traps were deployed December 15- March 24 in the EAB control (N =7) and clearcut (N=7) experimental sites. Trap stations were baited with lure which included chicken wings attached to a tree that were placed approximately 0.5 m and 1.2 m off the ground, salmon oil was also placed 2m off the ground for a longer lasting scent. Cameras were set to trigger in sets of three with a five second delay between bursts, initial tests indicated the maximum distance of detection was approximately 16 m. Photos were stored and identified using Emammal, project photos can be accessed via: https://emammal.si.edu/emerald-ash-borer-infection-impacts-wildlife.

A total of 12 mammal species were captured on camera traps including American Marten, American Red Squirrel, Bobcat, Coyote, Eastern Gray Squirrel, Ermine, Fisher, Gray Wolf, Northern Raccoon, Red Fox, Snowshoe Hare, and White-tailed Deer. There were also several bird species captured on the camera traps including Gray Jay, Blue Jay, Common Raven, and Black-capped Chickadee. The preliminary results indicated that the control plots had a total of 125 captures, and twelve species used the plots, whereas the clearcut plot had a total of 39 captures of five species (Figure 1.5). All mammal species were captured in the control plots more often than clearcuts, with the exception of Ermine (Figure 1.6). The difference in habitat use was particularly pronounced for forest dependent species such as American Marten and Fisher (Figure 1.6).

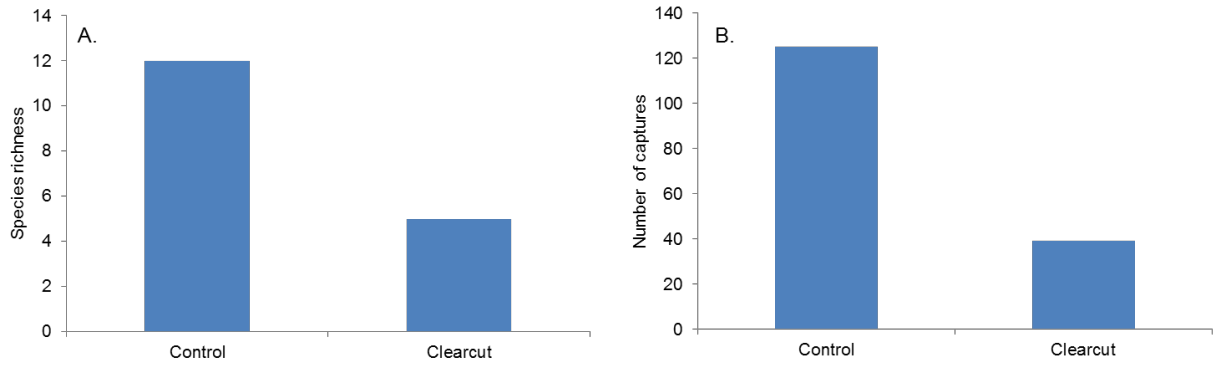

Figure 1.5. Summary of mammal camera trap detections by A.) species richness and by B.) number of detections from December 2016- March 2017 in control (black ash forests) and clearcut stands.

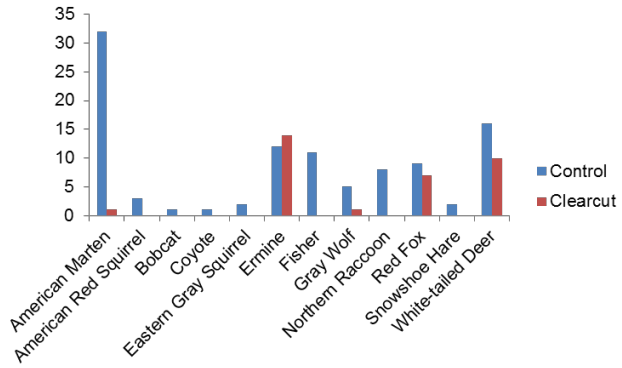

Figure 1.6. Summary of mammal camera trap detections by mammal species in control and clearcut stands for December 2016- March 2017.

Birds 2017

Digital Audio Recorders: Sixteen DARs were deployed December 15- March 24 in the EAB control (N =8) and clearcut (N=8) experimental sites. Data was analyzed using Kaleidoscope Software. A total of 16 bird species and 3 mammal species, American Red Squirrel, Gray Wolves, and Coyotes were detected on the DARs during this time period. DARs were also deployed May-June 2017 to record amphibian calls and birds throughout the breeding season. We are currently developing methods and protocol for analyzing the DARs data.

Breeding Bird Point Counts: In June 2017, we surveyed the 32 experimental EAB sites along with 29 additional EAB stands distributed throughout northern Minnesota. Each stand survey consisted of one point count in the middle of the black ash stand and a paired point count conducted in an adjacent upland forest stand a minimum of 250 m apart. This survey design allowed us to assess differences between bird communities in black ash

stands and those in upland forests. Point counts were conducted by trained observers from approximately 0.5 h before to 4 h after sunrise on days with little wind (< 15 km hr−1) and little or no precipitation. All birds heard or seen from the site were recorded, and distance was estimated as 0–25 m, 25–50 m, 50–100 m,>100 m.

A total of 526 birds and were detected in black ash stands in June 2017. In the experimental stands, the number of observations, species richness, and species diversity was highest in the girdle and group selection treatments. Control and clearcut treatments had similar number of observations, richness, and diversity (Figure 1.7). Preliminary data from the 29 additional sites showed that the number of observations, species richness, and diversity was higher in black ash forest stands compared to upland forests (Figure 1.7).

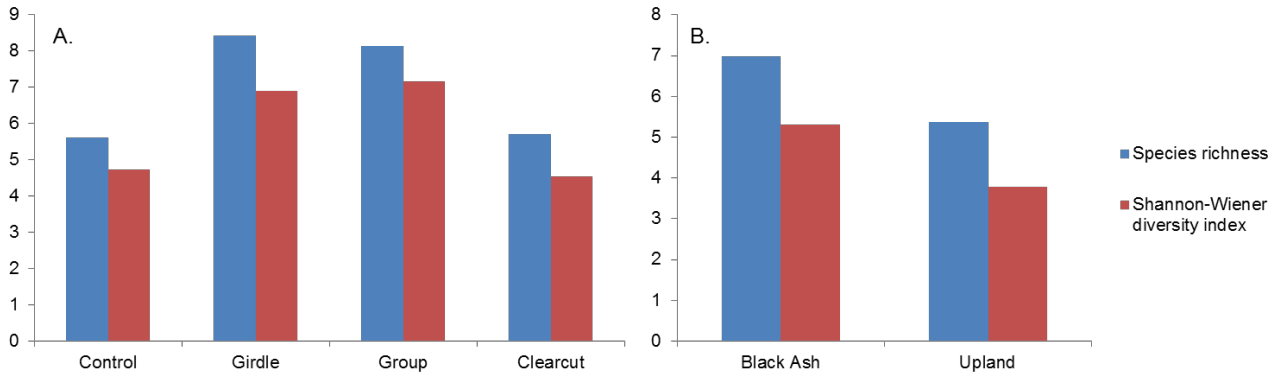

Figure 1.7. Summary of bird data species richness and Shannon-Wiener diversity index in A.) experimental black ash sites and B.) additional black ash sites and paired upland forest stands distributed throughout northern Minnesota. Surveys were conducted June 2017.

Amphibians 2017:

Call Survey Methods: We surveyed for calling amphibians at 14 sites on the Chippewa National Forest (8 controls and 6 clear cuts). We also surveyed 27 Phase-2 black ash sites across northern Minnesota and 20 paired emergent wetlands. If black ash sites were within ~ 2 km of each other, we selected a single emergent wetland. We recorded the identity and relative intensity (0-3) of all species calling within the stand/emergent wetland and outside the stand (within the larger landscape area). We also searched black ash sites for wood frog egg masses; we conducted two searches during the first call survey period.

Call Survey Results: In the experimental sites we heard wood frogs in 3/8 sites, spring peepers in 2/8 sites, and chorus frogs in 1/8 sites; we found wood frog egg masses in 3/8 sites. Within clear cut stand, wood frogs were heard in 3/6 sites and spring peepers in 1/6 sites; we found wood frog egg masses in 2/6 sites. Egg mass counts ranged 2–37. Within the larger area, we also heard northern leopard frogs, American toads, and Cope's gray tree frog. In the 27 additional sites we heard five species of anuran calling from within ash stands and six species of anurans calling from emergent wetlands and the surrounding landscape. Leopard frogs were the only species not heard calling from ash stands. Wood frog egg masses were observed in 9 sites; counts ranged 16–124.

Larval Survey Methods: We surveyed for larval amphibians using quantitative sampling and qualitative dip-netting. We sampled 6 experimental sites on the Chippewa National Forest (3 control and 3 clear cut). We sampled 16 of the Phase-2 ash stands; these sites had a ponded area at least 20 m^2 and maximum depth greater than 10 cm. For quantitative sampling, we used a 29 cm (12 inch) diameter stove pipe. We placed the stove pipe sampler every 5 meters along the longest diameter of the wetland. We constrained our sampling effort to 10 samples per wetland (50 m). We removed and counted each amphibian larvae; we searched each stove pipe

until five consecutive dip net searches were empty. We sampled each wetland twice during June 2017; some sites were only sampled once because of early dry-down.

Larval Survey Results: In the EAB experimental sites we surveyed 6 sites in early June; one control and one clear cut were too dry for quantitative sampling. We use dip-netting to confirm species presence. By the second survey period these sites had dried completely and a second control site had almost dried. We encountered four species of larval amphibians in the overall study area; wood frog, spring peeper, chorus frog, and blue spotted salamanders. All additional EAB sites were ponded during the first survey period. During the second period three sites had dried. Species composition was comparable to the Chippewa sites. Wood frogs and blue-spotted salamanders were the most abundant amphibians, followed by spring peepers and chorus frogs. While toads and tree frogs were heard at least once during call surveys, they did not appear to use these habitats for breeding.

Small Mammal Trapping 2017:

In fall 2017, we completed our second round of small mammal trapping, the same methods were used as those used in 2016. A total of 202 individuals of 6 species were caught over 640 trap nights and 320 trap days. Red-backed Voles made up 66% (133 individuals) of the total captures, followed by *Peromyscus* sp. (26%, 52 individuals). The four remaining species had six or fewer individuals: Meadow Vole (6), Short-tailed weasel (6), Short-tailed shrew (4) and Water Shrew (1).

Total number of individuals was highest in girdled sites, which accounted for 37% of all individuals, followed by group selection sites (30%), control sites (20%), and clearcut sites (13%). Girdled sites had the highest species richness (2.33 species per site), followed by group selection sites, (2.17 species per site), and clearcut and control sites with each averaging 1.89 species per site. Overall, results between 2016 and 2017 were fairly consistent with most of the metrics we calculated. Total number of individuals from 2017 was slightly higher than 2016, which may be attributed weather, or time of year.

Activity Status as of July 1, 2018:

Winter 2017-2018 surveys: DARs and camera traps were deployed in the control and clear cut experimental sites from December 2017 to March 2018 to capture wildlife activity in the stands.

Digital Audio Recorders: Sixteen DARs were deployed December 2017- March 2018 in the EAB control (N =8) and clearcut (N=8) experimental sites. Data was analyzed using Kaleidoscope Software. A total of 19 bird species were detected on the DARs during this time period. DARs were also deployed May-June 2018 to record amphibian calls and birds throughout the breeding season. Preliminary analyses indicate no significant differences in the winter use of control stands compared to clearcut stands for most bird species (Figure 1.8). We are developing methods for analyzing the DARs data.

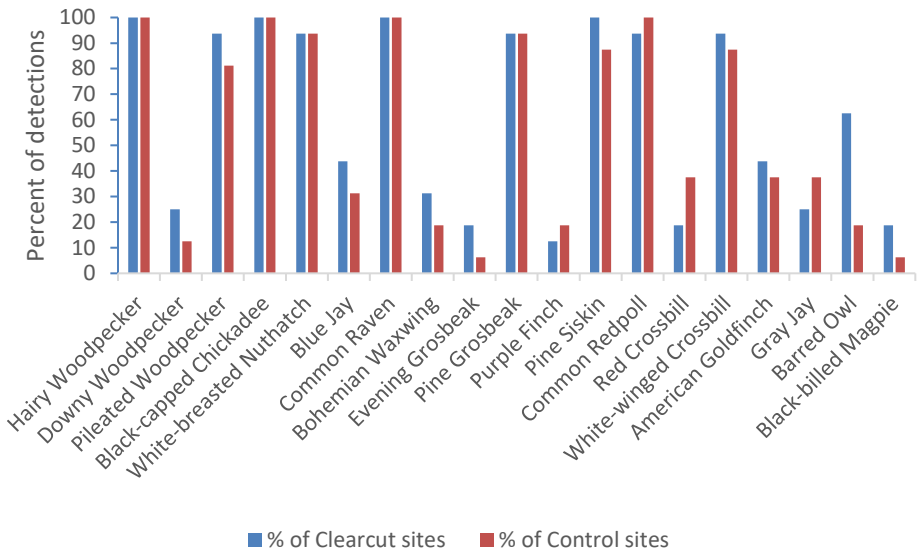

Figure 1.8. Summary of bird species detected on digital audio recorders in EAB experimental stands in Chippewa NF in winter 2016-2017 and 2017-2018 seasons.

Camera Traps: Sixteen camera traps were re-deployed during winter 2017-2018, the same methods for baiting were used as in the 2016-2017 season. Overall, the most common species detected were White-tailed deer, American marten, and ermine, a summary of top 10 species detections are provided in Figure 1.9 and sample photographs from the camera traps are provided in Figure 1.10 all project photos can be accessed via: https://emammal.si.edu/emerald-ash-borer-infection-impacts-wildlife.

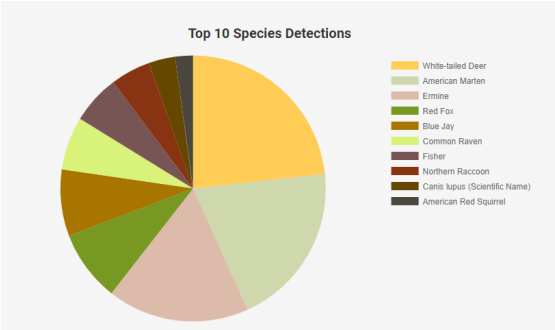

Figure 1.9. Summary of top 10 camera trap captures in EAB experimental stands in Chippewa NF in winter 2016-2017 and 2017-2018 seasons.

Figure 1.10. Photographs captured by camera traps in experimental emerald ash borer plots, winter 2017-2018 A.) coyote, B.) moose, C.) raccoon, D.) Common Raven.

Spring-Summer 2018:

Digital Audio Recorders: DARs were deployed in experimental and 29 additional stands in spring 2018 to detect amphibian calls and American Woodcock and Ruffed Grouse activity. DARs are currently deployed in experimental stands to record amphibian calls and birds throughout the 2018 breeding season.

Amphibian surveys: We are currently conducting our second field season of amphibian call and larval surveys in experimental and 29 additional EAB stands.

Breeding bird surveys: We completed the second year of breeding bird surveys in experimental and 29 additional EAB stands in June 2018. Data will be entered, quality checked, and summarized fall 2018.

Activity Status as of January 1, 2019:

We have completed all wildlife surveys for this project. We have identified 80 bird species and counted over 2,900 individual birds during the 2017 and 2018 breeding season. The most abundant bird species identified in our study sites were Ovenbird, Red-eyed Vireo, Veery, Least Flycatcher, White-throated Sparrow, and Common Yellowthroat.

A total of 278 individuals of six small mammal species were caught over 800 trap nights and 400 trap days. Red-backed Voles made up 82% (229 individuals) of the total captures, followed by *Peromyscus* sp. (12%, 34 individuals), and meadow vole (4%, 12 individuals). Three other species were caught in 2018 including a masked shrew, a meadow jumping mouse, and a short-tailed weasel.

We are currently analyzing the data to characterize the wildlife communities found in Minnesota's black ash forests. Our first approach includes a comprehensive assessment of species composition across taxa to determine 1.) The environmental variables that best explain wildlife communities found in black ash forests, and 2.) Differences in species composition between experimental treatments. Together these results will allow us to predict potential impacts of EAB on wildlife (Activity 2). Our second analyses is focusing on quantifying the differences in bird and amphibian communities that occur in black ash forests compared with paired upland cover types. These results will allow us to determine if lowland forests provide unique microhabitats for species and to identify species that are potentially vulnerable to loss of black ash forests. Both analytical approaches will use a variety of environmental (explanatory) variables that have been calculated at multiple spatial scales.

Final Report Summary:
We established 29 long-term monitoring sites across northern Minnesota, these sites capture the range of conditions found in black ash wetlands (Figure 1.11). We also established wildlife monitoring plots in the existing experimental EAB sites established by Slesak et al. (2014) in Chippewa National Forest (Figure 1.11).

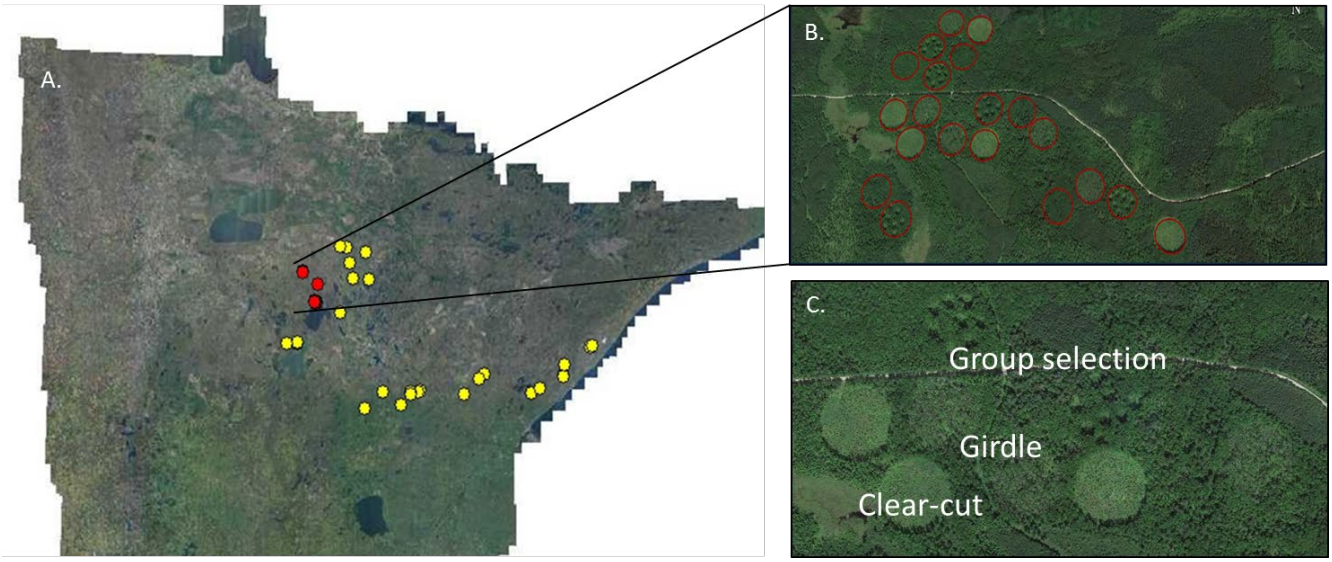

Figure 1.11. A.) Locations of monitoring sites across northern Minnesota. Yellow dots represent the 29 long-term monitoring sites and the red dots are the locations of the experimental EAB plots. B.) Experimental study plots, C.) Close-up of experimental treatment plots.

We used a variety of methods to evaluate wildlife communities in black ash stands. To assess bird communities we conducted point count surveys in the 29 monitoring plots paired with surveys of upland forests plots to compare community composition. We deployed digital audio recorders in the spring in the monitoring plots to detect early-breeding species such as American Woodcock and Ruffed Grouse. The digital audio recorders were also used to assess bird use in the winter at the experimental stands. Overall, we detected 89 bird species during our winter, spring, and summer surveys 2017 and 2018. To assess mammal communities we used baited camera traps in the experimental stands in the fall and winter months, additionally we used live trap arrays in the experimental stands to quantify small mammal communities in the fall of 2016, 2017, and 2018. We detected 15 mammal species using the camera traps and caught 12 species of small mammals in the live trap arrays. We used a combination of call and larval surveys to assess amphibian use of black ash wetlands at the 29 monitoring plots and the experimental sites. We also conducted call surveys at paired emergent wetland sites near the monitoring plots to compare community composition. We detected nine species of amphibians via the call surveys and egg masses and larva were also quantified for five of the species.

Literature cited in this section:

- Slesak, R.A., C. Lenhart, K. Brooks, A.W. D'Amato, and B. Palik. 2014. Water table response to simulated emerald ash borer mortality and harvesting in black ash wetlands, Minnesota USA. Canadian Journal Forest Research 44:961-968.

ACTIVITY 2: Develop and implement recommendations for mitigating wildlife impacts of EAB in black ash forests.

Description:
Impacts of EAB on wildlife are likely to occur; however, the magnitude and relative degree of impact to individual species and species diversity is unclear. There is a large knowledge gap related to which wildlife

species inhabit black ash wetland forests and how they will respond to ecosystem changes following EAB. For this reason, it is difficult to make specific hypotheses until data are collected in black ash forests. However, the major alterations to black ash habitats, such as an increase in ponding and tree mortality, in EAB simulated sites will likely lead to changes in wildlife species composition. For example, in bird communities we expect decreases in ground nesting species abundance and diversity but a potential increase in wetland associated and waterfowl species in EAB simulated sites compared to control sites. Similarly, we expect decreases small mammal diversity but increases in herptile diversity in EAB simulated sites compares to control sites. Analyses of data from Activity 1 will address general hypotheses related to predicted habitat changes in black ash stands. Because alterations to black ash forests will likely impact taxa and specific species in different ways, we will test species specific impacts along with species composition and diversity, to fully assess impacts of EAB on wildlife.

We will use data collected from Activity 1, along with vegetation data collected in the initial phase and Phase 2 of the EAB project to test how wildlife have responded to EAB and adaptive management alternatives. These tests will allow us to build models to predict and further to test how wildlife species and communities will respond to ecosystem changes following EAB. Pairing the habitat information with the wildlife survey data from the experimental plots in addition to the landscape level survey sites will determine the magnitude of biodiversity change that could be expected for black ash wetlands following EAB infestation. These models will allow us to identify vulnerable wildlife species in the context of Minnesota's forest wildlife and overall impacts on wildlife communities.

In Phase 2 of the EAB project (LCCMR Project 082-D), the distribution, extent, and configuration of black ash forests across northern Minnesota will be mapped based on multispectral and multi-temporal satellite digital data and regional forest inventories. We will use the forest composition maps depicting the extent and characteristics of black ash forest across northern Minnesota created in Phase 2 to determine areas with the highest degree of vulnerability to EAB. Estimates of changes in species composition and diversity obtained from wildlife models will be paired with maps of black ash to determine where EAB may have the greatest impact on wildlife throughout the state. The overall results of this modeling effort will allow us to identify vulnerable wildlife species, develop recommendations and strategies for long-term conservation of species diversity in Minnesota, and identify prioritization of areas for mitigation.

Summary Budget Information for Activity 2:

ENRTF Budget: $ 106,722
Amount Spent: $ 106,722
Balance: $ 0

Outcome	Completion Date
1. Incorporate bird, small mammal, and herptile data into forest landscape models.	December 2018
2. Quantify long-term effects of EAB and adaptive management on species diversity and identify vulnerable wildlife species.	April 2019
3. Develop mitigation strategies and publish project summaries aimed at wildlife biologists within the state	June 2019

Activity Status as of January 1, 2017:
Limited work has been completed associated with this activity other than researching the development of forest landscape models that will be used for the project.

Activity Status as of July 1, 2017:
Limited work has been completed associated with this activity at this point of the project.

Activity Status as of January 1, 2018:

We have conducted preliminary analyses to quantify long-term effects of EAB on species diversity and have developed potential modeling approaches based on the first year of wildlife data we have collected.

Activity Status as of July 1, 2018:
We have continued to conduct analyses on the first year of data and presented preliminary results to several audiences.

Activity Status as of January 1, 2019:
Black ash maps from the Phase 2 EAB project (LCCMR Project 082-D) are currently being validated with Forest Inventory Analysis data. Once these maps are complete, we will use the results of the wildlife community models developed in Activity 1 to predict the impacts of EAB. Our objective is to assess the differences in potential impacts on wildlife between management options, specifically we will compare impacts of "adaptive management" using parameter estimates from group selection treatments and EAB invasion "do nothing management" using parameter estimates from clear cut treatments.

Final Report Summary:
We used the wildlife data collected in Activity 1 to evaluate two research questions: 1.) **Are wildlife communities in black ash forests unique?** and 2.) **How will EAB influence wildlife communities?** We are in the process of writing two manuscripts that will be submitted to peer-review journals, the results of the analyses are summarized below.

Are wildlife communities in black ash forests unique?: We used the bird and amphibian data collected at the 29 black ash monitoring sites and paired habitat points to evaluate differences in community composition. Bird communities were summarized using two metrics: species richness (total number of species in a stand) and species diversity (calculated using the Shannon–Wiener index of diversity). A generalized linear mixed-effects model was used to assess the differences between black ash wetlands and upland forest stands. We also used joint species distribution models, which uses multivariate abundance data and accounts for correlations among species, to analyze community composition and compare bird communities in black ash and upland sites and amphibian communities in black ash and emergent wetland sites. Several dataset were used to quantify habitat characteristics of the study sites including vegetation surveys, LiDAR, and National Land Cover Data. We quantified 57 environmental variables across four spatial scales: stand-level, 100 m buffer, 500 m buffer, and 1000 m buffer to determine which variables best accounted for species correlations and overall community composition.

The results of the generalized linear mixed-effect model indicated that there was a significant difference in bird species richness and species diversity between black ash and paired upland forest habitats; black ash stands supported a greater number of species (Figure 2.1). Results of the joint species distribution models indicated that bird community composition between black ash and upland stands were significantly different. Percent forested wetland in the 100 m buffer, stand height, and percent ash cover in the stand also significantly impacted bird community composition. Similarly, results of the joint species distribution models indicated that amphibian community composition between black ash and emergent wetlands were significantly different and the amount of forest cover in the landscape was important for amphibian community composition.

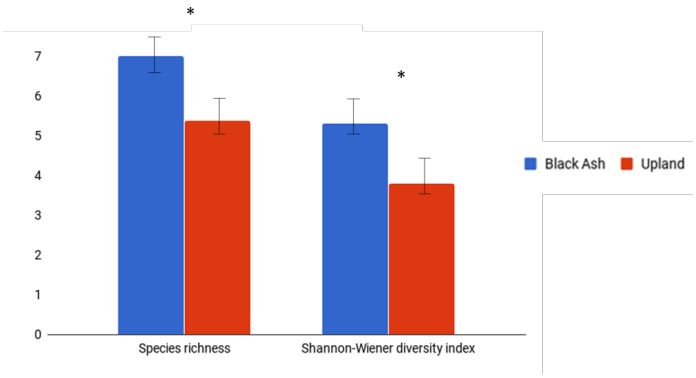

Figure 2.1. Summary of breeding bird A.) species richness and B.) species divresity in black ash wetlands compared to paired upland forest stands from 2017-2018 summer breeding bird surveys. * indicates significance based on results of generalized linear mixed-effects models.

Conclusion: Black ash stands provide a variety of microhabitats that support a unique assemblage of bird and amphibian species compared with similar habitats (upland or emergent wetlands) available on the landscape.

How will EAB influence wildlife communities?: We used the small mammal, amphibian, and bird community data collected at the experimental EAB sites to evaluate the potential impacts of EAB on wildlife. For these analyses we used joint species distribution models to analyze differences in community composition in bird, small mammal, and amphibian communities between treatments.

Results of the amphibian models show that communities are significantly different between control and clear-cut treatments; there was insufficient data to assess differences between the girdled and group selection treatments due to large differences in precipitation and ponding between the two years of the surveys. The larval models found that there are higher densities of larva in clear-cut stands; this is likely because many amphibians and invertebrates preferentially select open canopy wetlands. Open-canopy wetlands have higher water temperatures that are correlated with increased food availability and faster larval growth. Therefore, increases in ponding due to the loss of black ash may increase species richness and species abundance of pond-breeding amphibians.

Results of the bird community models indicated that each experimental treatment had distinct species assemblages. The control treatments had forested species such as Least Flycatcher and Red-eyed Vireo, whereas the clear-cut treatments had species associated with open areas and wetlands such as Golden-winged Warbler and Swamp Sparrow. The girdled community had species overlap with the clear-cut community and the group selection community overlapped with the control community. Results of vegetation surveys completed in the study areas indicate that black ash wetlands have a more diverse understory and complex canopy structure compared with nearby upland habitats. These features provide unique micro-habitats that are beneficial for breeding birds. For example, structural features common in black ash stands such as large trees and high proportions of coarse woody debris provide increased foraging opportunities, potential nest sites, and suitable singing perches for forest birds. Several bird species commonly associated with mature forests such as Winter Wren were common in black ash wetlands; however, species that require canopy openings such as Chestnut-sided Warbler were also common. These factors contribute to the unique bird communities found in the black ash stands and ultimately increased abundance, species richness, and species diversity in black ash forested wetlands.

Results of the small mammal models show that community composition was significantly different between clear-cut and control treatments; group selection was also significantly different than clear-cut treatments, but not different than the controls. Girdled treatments were not significantly different from the clear-cut treatment or the controls. The species in the “clear-cut community” are species associated with open and wet areas such as meadow vole and water shrew, whereas the species in the “control and group selection communities” are

associated with forested habitat such as flying squirrel and red-backed voles. The "girdled small mammal community" represent a combination of the clear-cut and control communities. Camera trap data comparing mammals detected in control and clear-cut treatments show significantly fewer species and detections occurred in the clear-cut areas. The differences in habitat use were particularly pronounced for forest-dependent species such as American marten and fisher. These results suggest mammals are actively avoiding open areas; therefore, the conversion of forested wetlands to open wetlands may impact forest connectivity and could exacerbate impacts of habitat loss for forest dependent species.

Conclusion: The loss of black ash will result in turnover of wildlife communities from forest-dependent species to open-canopy and wetland associated species. Results from the forest landscape models show that prioritizing adaptive management to black ash complexes that are large in size, have a high proportion of black ash in the overall canopy, and have high proportion of forest matrix (not open or developed) will be beneficial for wildlife. Although net changes in wildlife biodiversity may be minimal or potentially increase for some taxa (amphibians), the long-term, large-scale impacts of EAB on forest-associated wildlife will likely be significant. Group selection is a viable adaptive management solution that maintains bird and small mammal communities that are similar to existing communities found currently in black ash forests. Therefore, adaptive management strategies that focus on planting replacement tree species that maintain long-term forest cover and structural complexity within these wetland systems will help maintain wildlife diversity.

V. DISSEMINATION:

Description:

The overall goal of our proposed project is to improve long-term black ash management objectives, maintain ecological health of black ash forest systems, and conserve Minnesota's bird, mammal, and herptile diversity. The information will be transferred to resource managers in the state (MNDNR) and federal agencies (USFS) to address the threat of EAB throughout the state. Manuscripts detailing project results will be written and submitted for publication in peer-reviewed journals. A fact sheet summarizing principal findings of this project will be distributed to LCCMR members and legislators at the state and federal level. Results will be presented at state and national forest and wildlife management conferences. All reports and publications from this project will be made available via the Natural Resource Research Institute web site.

Status as of January 1, 2017:
Materials are not ready to disseminate.

Status as of July 1, 2017:
Materials are not ready to widely disseminate. However, preliminary results of the amphibian data were presented at the Joint Meeting of Ichthyologists and herpetologists, Austin TX July 12-16 2017 "Potential effects of emerald ash borer invasion on wetland community composition", and at the Science and Management of Ash Forests after Emerald Ash Borer: A workshop on the future of post-EAB ash forests July 25-27 2017, "Potential effects of emerald ash borer invasion on wetland community composition".

Status as of January 1, 2018:
Materials are not ready to widely disseminate. However, preliminary results will be presented at 2018 Forestry and Wildlife Research Review at the Cloquet Forestry Center January 11, 2018 and The Minnesota Chapter of The Wildlife Society Meeting February 12-14 2018.

Status as of July 1, 2018:
We have presented preliminary results at the following conferences and workshops:

- Forestry and Wildlife Research Review, Cloquet Forestry Center, January 11, 2018.

- The Minnesota Chapter of The Wildlife Society Meeting, St. Cloud Minnesota, February 12-14, 2018.
- Charting the Future for Northern Forest Birds: Takin it to the Tweets workshop in Ashland, WI, April 16-17, 2018.
- Alexis Grinde presented a webinar "**Determining Impacts on Wildlife From Emerald Ash Borer Infestations of Black Ash Forests"** via EAB University on March 15, 2018. The webinar recording is available at http://www.emeraldashborer.info/eabu.php
- Additionally, preliminary results of this study were included in a recent publication:
    - Kolka, R.K., D'Amato, A.W., Wagenbrenner, J.W., Slesak, R.A., Pypker, T.G., Youngquist, M.B., Grinde, A.R. and Palik, B.J., 2018. Review of Ecosystem Level Impacts of Emerald Ash Borer on Black Ash Wetlands: What Does the Future Hold?. Forests, 9(4), p.179.

Status as of January 1, 2019:

- We will be presenting the results of this project at the Forestry and Wildlife Research Review, Cloquet Forestry Center, January 10, 2019 and The Minnesota Chapter of The Wildlife Society Meeting, Duluth Minnesota, February 19-21, 2019.

Final Report Summary:

- We have already disseminated our findings to practitioners at a number of workshops and training sessions with positive feedback from attendees.
- Rob Slesak and Alexis Grinde presented "EAB and black ash as wetlands: Holistic assessment of ecosystem impacts and potential for mitigation" at the Forest Resources monthly seminar on February 25, 2019. Recording is available on the Sustainable Forests Education Cooperative: https://youtu.be/9R5QKKNNMYU
- Alexis Grinde presented a poster "Emerald Ash Borer and Wildlife: A Look into the Future" at the 2019 Heart of the Continent Symposium in Duluth, MN on April 8, 2019.
- Melissa Youngquist gave a seminar "Potential effects of emerald ash borer invasion on wetland communities" at Arkansas State University on April 24, 2019.
- Melissa Youngquist presented "Protecting Our Threatened Wetlands: How Invasive Species Can Affect Wetland Communities." At the Shedd Aquarium on May 15, 2019.
- The results of this project were incorporated into the updated version of the document "Managing Ash Woodlands: Recommendations for Minnesota Woodland Owners" this document is available on the UMN Digital Conservancy on-line and in a variety of print options. The persistent link to this item is: http://hdl.handle.net/11299/205052
- Rob Slesak discussed the implications of the work at MN Senate and House hearings during the 2019 legislative session.
- Rob Slesak gave an invited presentation "Impacts of Emerald ash borer on black ash in the lake states" at the Eastern Regional Meeting of the National Council on Air and Stream Improvement, Atlanta GA, June 4, 2019.
- Rob Slesak gave an invited presentation "Simulated effects of EAB on hydrology of black ash wetlands" at the Water and Watersheds annual conference of the MN Pollution Control Agency, Brainerd MN, February 6, 2019.
- We are in the process of completing two peer-reviewed manuscripts for this project and plan to have them submitted by the end of the year.

VI. PROJECT BUDGET SUMMARY:

A. ENRTF Budget Overview:

Budget Category	$ Amount	Overview Explanation
Personnel:	$ 293,588	1 project manager at 0.5% FTE each year for 3 years ($3,300); 1 co-investigator at 36.3% FTE each year for 3 years ($71,670); 2 post-doctoral researchers at 30% FTE each year for 3 years ($115,540); 1 graduate research assistant at 40.78% FTE for year 2 ($36,680); 2 field technicians at 30% FTE each year for 3 years ($53,000); 1 undergraduate research assistant at 35% FTE for year 2 ($9,700); administrative support at 2% FTE each year for 3 years ($3,700).
Equipment/Tools/Supplies:	$ 27,500	Sherman traps ($2,500); pitfall supplies, including flashing and buckets ($1,000); Trail cameras ($4,500); digital audio recorders ($17,500); and digital audio analysis software ($2,000).
Travel Expenses in MN:	$ 12,500	Mileage ($9,375); lodging ($3,125)
Other:	$ 410	GIS lab services
TOTAL ENRTF BUDGET:	**$ 333,998**	

Explanation of Use of Classified Staff: N/A

Explanation of Capital Expenditures Greater Than $5,000: N/A

Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation: 5.4 FTEs

Number of Full-time Equivalents (FTE) Estimated to Be Funded through Contracts with this ENRTF Appropriation: N/A

B. Other Funds:

Source of Funds	$ Amount Proposed	$ Amount Spent	Use of Other Funds
Non-state			
Anthony D'Amato, University of Vermont (in-kind support)	$ 30,000	$ 30,000	Salary and fringe of $10,000 each year for 3 years for effort spent on project activities.
State			
Gerald Niemi, project manager (cash support)	As needed	-	If awarded, NRRI will contribute time and effort as needed for successful completion of the project without requesting further funds from LCCMR.
Foregone F&A funding of 52% MTDC (TDC less grad student tuition and fringe ($334,218 less $30,923)	$ 157,600	$ 157,600	Indirect costs on personnel, travel, supplies, and other (GIS lab fees) related to work on the sponsored project

Robert Slesak, MN Forest Resources Council (in-kind support)	$ 35,000	$ 35,000	Salary and fringe of 0.1 FTE each year for 3 years for effort spent on project activities.
Brian Palik and technician, USDA Forest Service (in-kind support)	$ 30,000	$ 30,000	Salary and fringe in amount of $5,000 per person per year for 3 years for effort spent on project activities.
TOTAL OTHER FUNDS:	**$ 252,600**	**$252,600**	

VII. PROJECT STRATEGY:

A. Project Partners: The project team includes Dr. Gerald Niemi and Dr. Alexis Grinde from the Natural Resources Research Institute, Dr. Rob Slesak from the MN Forest Resources Council, Dr. Brian Palik from the USFS Northern Research Station, and Dr. Anthony D'Amato from the University of Vermont.

B. Project Impact and Long-term Strategy: This proposal is a part of a larger effort to develop strategies to minimize the impacts of emerald ash borer on black ash forests in Minnesota. Results of this project will provide baseline information to evaluate the long-term impacts of emerald ash borer on wildlife populations throughout Minnesota and identify best practices to maintain wildlife diversity in Minnesota's forests.

C. Funding History: N/A

VIII. FEE TITLE ACQUISITION/CONSERVATION EASEMENT/RESTORATION REQUIREMENTS:

A. Parcel List: N/A

B. Acquisition/Restoration Information: N/A

IX. VISUAL COMPONENT or MAP(S): See attached

X. RESEARCH ADDENDUM: N/A

XI. REPORTING REQUIREMENTS:

Periodic work plan status update reports will be submitted no later than January 1, 2017; July 1, 2017; January 1, 2018; July 1, 2018; and January 1, 2019. A final report and associated products will be submitted between June 30 and August 15, 2019.

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Environment and Natural Resources Trust Fund
M.L. 2016 Project Budget

Project Title: Determine Impacts on Wildlife From Emerald Ash Borer Infection of Black Ash Forests
Legal Citation: M.L. 2016, Chp. 186, Sec. 2, Subd. 03q
Project Manager: Gerald Niemi
Organization: Natural Resources Research Institute, University of Minnesota Duluth
M.L. 2016 ENRTF Appropriation: $334,000
Project Length and Completion Date: 3 years, June 30, 2019
Date of Report: August 15, 2019

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Activity 1 Budget (revised 5/16/18)	Amount Spent	Activity 1 Balance	Activity 2 Budget	Amount Spent	Activity 2 Balance	TOTAL BUDGET	TOTAL BALANCE
BUDGET ITEM	**Quantify the long-term impact of EAB and adaptive management on bird, small mammal, and herptile diversity.**			**Develop and implement recommendations for mitigating wildlife impacts of EAB in black ash forests.**				
Personnel (Wages and Benefits)	$189,278	$189,276	$2	$104,312	$104,312	$0	$293,590	$2
Gerald Niemi, Project Manager: $3,300 (66.3% salary, 33.7% benefits); 0.5% FTE each year for 3 years								
Alexis Grinde, Co-Investigator: $71,670 (82.4% salary, 17.6% benefits); 36.3% FTE each year for 3 years								
2 Post-doctoral Reseachers: $115,540 (77.6% salary, 22.4% benefits); 30% FTE each year for 3 years								
Graduate Research Assistant: $36,680 (58% salary, 42% benefits including fringe and tuition reimbursement); ~40.78% FTE for year 2								
2 Field Technicians: $53,000 (92.1% salary, 7.9% benefits); 30% FTE each year for 3 years								
Undergraduate Research Assistant: $9,700 (100% salary, 0% benefits); 35% FTE for year 2								
Administrative Support: $3,700 (72.6% salary, 27.4% benefits); 2% FTE each year for 3 years								
Equipment/Tools/Supplies	$27,500	$27,500	$0				$27,500	$0

100 Sherman traps ($25 each) for small mammal monitoring of wildlife habitat use at field sites. ($2,500)								
Pitfall supplies for small mammal and herptile monitoring; flashing and buckets at each site. ($1,000)								
30 trail cameras ($150 each) for longer-term monitoring of wildlife habitat use at field sites.								
17 ~~10~~ digital audio recorders ($1,000 each) for longer-term monitoring of bird and frog habitat use at field sites. ($17,500)								
Analysis software (Song Scape), required to analyze digital audio data. ($2,000)								
Travel expenses in Minnesota								
Due to the high number of study sites and logistics associated with visiting and measuring black ash wetland sites $12,500 is budgeted for domestic travel within Minnesota. This money will be used to pay for mileage (75%) and lodging (25%) for researchers, field technicians, and graduate and undergraduate students. Mileage costs are associated with rental of a field vehicle through the University of Minnesota motorpool for four field sessions per year for 2 years. Travel reimbursement will follow University of Minnesota protocols.	$10,500	$10,500	$0	$2,000	$2,000	$0	$12,500	$0
Other								
Natural Resources Research Institute GIS Lab services for personnel and computer services, 100 hours at $4.10/hr				$410	$410	$0	$410	$0
COLUMN TOTAL	**$227,278**	**$227,276**	**$2**	**$106,722**	**$106,722**	**$0**	**$334,000**	**$2**