VERMONT BLACK ASH PROJECT

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Figure 1. Black ash tree in Tinmouth Channel South WMA.

PROJECT OVERVIEW

The Emerald Ash Borer (EAB) is native to China, eastern Russia, and the Korean peninsula (Cappaert et al., 2005). First detected in North America in 2002, EAB has caused high mortality in every member of the *Fraxinus* genus it has contacted, including the three prominent ash species in Vermont: white ash (*Fraxinus americana*), green ash (*Fraxinus pennsylvanica*), and black ash (*Fraxinus nigra*) (Smith, 2006). From the initial introduction of EAB in the Great Lakes region, the beetle has spread to other regions of North America (Department of Forests, 2021). While white and green ash have shown limited resistance to the EAB, all observed infested black ash have died within 3-5 years (Rebek et al., 2008).

In 2018, EAB was detected in Orange County, Vermont (Department of Forest, Parks, & Rec, 2021). Evidence of the infestation can now be found throughout the state, causing a significant threat considering that approximately 5% of Vermont's trees are in the *Fraxinus* genus. On average, it takes 3-5 years after infestation for an ash to succumb to mortality (Department of Forests, 2021). An adult beetle can fly 1-2 miles per year but mobility of EAB is significantly increased by the movement of infected ash firewood to areas without EAB. Due to the later arrival and detection of EAB, Vermont is behind the Midwest in terms of the progression of the EAB infestation, as well as EAB response and research.

VTUCF has been working with communities and municipalities to facilitate EAB planning. This initial planning largely focused on white and green ash because of their prominence in built and managed landscapes including roadways. The locations of these trees pose a significant safety and management concern. Black ash trees have been largely overlooked for two reasons: (1) Black ash trees generally present less risk to property and human safety. These relatively small trees prefer wet, swampy environments, and are not planted in managed landscapes. (2) Black ash are not typically targeted by commercial forestry activities because of their lower timber value and infrequent occurrence in the upland forested settings supporting the bulk of forest harvesting activities in the state.

However, the impacts of EAB reach far beyond losing trees from our forests, wetlands, and roadways. For Indigenous peoples of North America, including the Abenaki, black ash are a cultural keystone species, important for connecting past to present (Benedict & David, 2000). Black ash basketry is a long-documented practice, where stand location, processing methods, and basket designs are passed down through generations. Black ash also plays a role in stories and rituals, such as in an Abenaki creation story, where it is told that the Abenaki people emerged from the ash:

> These people of ash were growing and green, in harmony with their Mother, the Earth. Their skins were soft, and breathed in all of life. They shared their breath with all living things. Their limbs were supple and strong, and they danced like leaves in the wind (Davis, 2010).

During a Webinar hosted by the Association of Vermont Conservation Commissions in the fall of 2020, Chief Don Stevens of the Nulhegan Band of the Coosuk of the Abenaki Nation reiterated the significance of black ash in Abenaki cultural practice. Chief Stevens mentioned the

need for an inventory that mapped the distribution of black ash in Vermont. Joanne Garton of Vermont Urban and Community Forestry (VTUCF) responded to this idea and, with the approval of Chief Stevens and Kerry Wood of the Nulhegan Band, submitted a master's project proposal to the Field Naturalist program.

The Vermont Black Ash Project grew out of this initial proposal. This report contains notes on relationships with Indigenous peoples, a review of the black ash literature (see file, "Black_Ash_Literature_Review"), a summary detailing protocols for the long-term monitoring plots, a synthesis of the baseline data collected during plot establishment, recommendations from NR206 regarding black ash on municipal land, iNaturalist results, and the ongoing work to build and maintain a black ash network. I presented a one-hour webinar summarizing the project in March of 2022 that can be found on the Vermont Urban and Community Forestry's YouTube Channel.

INDIGENOUS RELATIONSHIPS & OUTREACH

A note on Indigenous peoples and relationships: identities, affiliations, preferred terminology, and relationships are in constant flux. The relationships and identities that exist at the time of the writing of this report are subject to change. As this project progresses, following ongoing and novel conversations is integral, both out of respect for Indigenous peoples and for the success of this project. At present, monitoring relationships between the four Vermont state-recognized Abenaki bands and the Odanak people is of particular relevance. There are citizens of the Odanak First Nation that disagree with elements of the state recognition of the four Abenaki bands in Vermont. There are also people in Vermont who identify as Indigenous, but choose not to affiliate with the four Vermont bands. The VCNAA Meeting Minutes and Unsettling Vermont websites are important resources to consult as these relationships develop.

The Vermont Commission on Native American Affairs is a state-wide organization that serves to strengthen Native American heritage in the state. The Commission meets every month except July, August, and December, and has a chair, a vice chair, a secretary, and six additional commissioners. Many, but not all, of the commissioners are members of Vermont Abenaki bands. VCNAA is a central communication channel for reaching out to Vermont's Indigenous community, sharing information, and receiving feedback. A link to the VCNAA website can be found here.

In September, I presented on the black ash project to the VCNAA. The goals of this presentation were to share information about the project, and to make sure that the project's trajectory continues to have input from Vermont's Indigenous voices. Here's a link to the StoryMap that I created for the presentation.

As of 2012, there are four state-recognized bands in Vermont. Links to existing websites and associated contact information can be found below. Note that there is not a link for the The Koasek Traditional band of the Koas Abenaki Nation because a current website could not be located.

ELNU ABENAKI TRIBE

- Chief Roger Longtoe Sheehan
  gitceedadann@yahoo.com
- Jim Taylor: Elder and Tribal Council Member
  swiftfox1@yahoo.com
- Vera Longtoe Sheehan: Tribal Genealogist and Director of the Vermont Abenaki Artists Association
  vera.sheehan@abenakiart.org
- Melody Walker Brook: Elnu Abenaki Tribe Representative to the Vermont Commission on Native American Affairs and VCNAA Chairperson
  melody.brook8@gmail.com

THE NULHEGAN TRIBE OF THE COOSUK ABENAKI NATION

- Chief Don Stevens: Nulhegan Abenaki Tribe
  chiefdonstevens@comcast.net
- Kerry Wood: Nulhegan Abenaki Basketmaker
  krwoodvermont@comcast.net

THE KOASEK TRADITIONAL BAND OF THE KOAS ABENAKI NATION

- Chief Shirly Hook: Chief of the Koasek
  shirly480@gmail.com

THE ABENAKI NATION OF MISSISIQUOI

- Chief Joanne Crawford
  info@abenakination.com

BLACK ASH LONG-TERM MONITORING PLOTS

Throughout the summer season, field work occurred three days a week, with two to four plots being sampled per day. Total plots sampled depended on site location, ease of access, and proximity to other sites.

The Vermont Agency of Natural Resources (ANR) has mapped natural communities on both public and private lands. To facilitate access to these communities, the Vermont Black Ash Project prioritized utilization of the natural communities mapped on Vermont state lands to determine locations for long-term monitoring plots. After communicating with state lands employees such as Jim Duncan and Hannah Phillips, it was determined that a special use permit was not required for plot establishment in 2022. Ongoing communication with the greater Vermont FPR Team is essential for the future of the plots.

Figure 2. Measuring the DBH of a black ash in Sweet Pond State Park.

The natural communities that were sampled include the natural communities in Vermont where black ash is listed as an "abundant species" (Thompson et al., 2019). Sugar maple floodplain forests were also inventoried. This reflects the findings that in Maine, black ash are most likely to be of basket quality when found in floodplain environments (Costanza et al., 2017; Diamond & Emery, 2011). This finding was augmented by personal communication with Aaron Wood, who mentioned the significance of floodplain forests in producing basket quality black ash trees. The natural communities where black ash is "Abundant" include: red maple-black ash seepage swamps, hemlock-balsam fir-black ash seepage swamps, northern hardwood seepage forests, wet clayplain forests, red maple-northern white cedar swamps, and boreal floodplain forests (Table 1). Note that as of May, 2022, there were no boreal floodplain forests/northern conifer floodplain forests mapped in the ANR Natural Communities database. Additional communities where black ash is known to occur "occasionally" include: calcareous red maple-tamarack swamps, maple-green ash swamps, and northern white cedar swamps. While these communities fell outside the scope of this project, they likely warrant future study and inventory.

Table 1. Mapped natural communities on Vermont's state lands that fall within the scope of this inventory.

Natural Community	Sites in ANR Database	Total Acres	Mean Community Size (acre)	Median Community Size (acre)
Red maple-black ash seepage swamp	26	88.5	3.4	1.4
Hemlock-balsam fir-black ash seepage swamp	94	215.1	2.3	1.27
Northern Hardwood Seepage Forest	2	51.4	25.7	25.7
Wet Clayplain Forest	8	30.3	3.8	1.19
Red maple-northern white cedar swamp	26	747.3	28.7	8.5
Sugar maple floodplain forest	8	19.5	2.4	2.3

NARROWING IN ON SITES

From the 164 sites listed in the table above (see Table 2), Tony D'Amato and I used several factors to narrow the proposed sites down to 15 sites, containing a possible 55 plots. This reduction allowed us to be more focused in our efforts, communicate specifics with the stewardship foresters when planning for plot establishment, allowed for the possibility that there would be some sites with no black ash, and still provided plenty of field work for a one-person summer project. The factors used for narrowing in on site locations included:

- <1km from the nearest road or trail
- Most readily accessible of sites in the general vicinity
- >1 acre in size
- Most likely to have black ash based on presence of muck and peat soils, contour lines and toes slopes, and ortho imagery that reveal the ratio of conifers to deciduous trees in a given area, evidence of water in the spring

Table 2. Natural communities, ANR database mapped sites on state lands, proposed sites for the project, plots established during the 2022 field season, number of acres within a given site, the location, and the county.

Natural Community	ANR Sites	Proposed Sites	Proposed Plots	Established Plots	Site size (ac)	Location	County
Hemlock-Balsam Fir-Black Ash Seepage Swamp	94	3	9	2	5.07	Aitken State Forest	Rutland
				0	2.91	Atherton Meadows WMA	Windham
				2	7.40	Victory State Forest	Essex
Northern Hardwood Seepage Forest	2	2	9	0	1.44	None listed? Near CC Putnam State Forest	Lamoille
				0	49.91	Elmore State Park	Lamoille
Red Maple-Black Ash Seepage Swamp	26	2	8	3	14.83	Tinmouth Channel WMA	Rutland
				1	14.25	Alburg Dunes State Park	Grand Isle
Red Maple-Northern White Cedar Swamp	26	2	10	2	17.61	Tinmouth Channel WMA	Rutland
				2	91.03	Alburg Dunes State Park	Grand Isle
Sugar Maple-Ostrich Fern Riverine Floodplain Forest	8	3	9	2	1.51	Okemo State Forest	Rutland
				1	1.71	Sweet Pond State Park	Windham
				2	2.07	Niquette Bay State Park	Chittenden
Wet Clayplain Forest	8	3	10	1	17.23	Dead Creek WMA	Addison
				0	1.46	Whipstock Hill WMA	Bennington
				0	7.19	Alburg Dunes State Park	Grand Isle
Total	164	15	55	18			

CREATING MAPS FOR THE FIELD

Prior to field work, several maps need to be made using ArcGIS. These maps allow for navigation to and from the site, determining where one is relative to the site boundaries, and where black ash is most likely to be found within the site.

To create the maps, several layers need to be downloaded from the Vermont Open Geodata Portal:

- ANR Lands - Natural Communities: Use for narrowing in on where black ash is most likely to be on state lands in Vermont that have had natural community mapping.
- VT Data – E911 Trails: For determining whether or not there are trails that allow for easy access to/from sites. See the Aiken State Forest maps for an example.
- VT Data - E911 Road Centerlines: For determining a site's proximity to the nearest road. Note that this dataset contains Class 4 roads, so double check what you're working with, or write a query to exclude Class 4 roads from the dataset… Or, ride your gravel bike to the field site.
- VT Data - VT Hydrography Dataset - cartographic extract lines: Because black ash tend to prefer wetter sites, having an idea of "floodplain" environments within sites is critical. Having this data also informs the hydrology of the site.
- VT Data - NRCS Soil Survey Units: Black ash tends to prefer muck and peat soils, so this layer can be used to further narrow in on the most likely locations to find black ash.

Additionally, connecting to the VCGI server via ArcGIS allows for quick access to:

- Orthoimagery: By using orthoimagery from leaf-off conditions, one can determine the ratio of coniferous to deciduous trees. Black ash tend to grow faster and be higher quality in areas with lower concentrations of conifers (Costanza et al., 2017).
- Topographical contour lines: Allows for narrowing in on "toe-slope" locations where an upwelling of nutrients provides good habitat for black ash trees.

To view or use field maps from the 2022 field season, see the folder titled "Black_Ash_Georeferenced_Site_Maps". The folder contains maps for each site. Dead Creek WMA has a great example of the three scales of maps that will prove most useful in the field: Zoom Out, Zoom Mid, and Zoom In. The maps for Victory State Forest provide an example of how different basemaps can be used depending on the intention of the maps – for example: light grey canvas versus imagery (Figure 3). Zoomed-out maps should include roads near the site, and is most helpful for finding the closest parking location to the

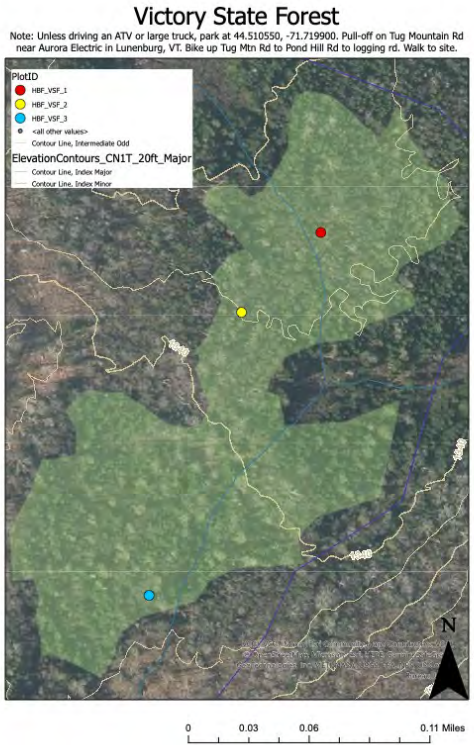

Figure 3. Zoomed-in map of the Victory State Forest Site. Colored points indicate locations that were expected to have the highest concentrations of black ash based on remote sensing.

site if the hoped-for parking spot doesn't pan out. The zoomed-mid map is most useful for navigating from the parking location to the field site. The zoomed-in map should be used when exploring the site, identifying areas with black ash, and establishing plots.

The folder titled, "GIS.Black_Ash_Long_Term_Plots", will also be useful for mapping, and contains GPS coordinates for each of the existing plots, as well as the sites that were visited but did not have plots established, and recommendations for future plots.

FIELD PREP

Prior to beginning field work, materials for plot monumentation need to be acquired. Plot centers are marked by inserting a piece of #4 Grade 60 rebar sheared to 9" into the ground, which is then enveloped by a 16-18" length of 1" PVC pipe.

Also be sure to print data collection sheets. The sheets used in the 2022 season can be found in the "Data_Collection_Sheet_2022.docx" file In the future, it might be wise to transition to Survey123 for data collection, but in the short-term, paper-based data collection is efficient enough and meets the needs of the project.

TRAVEL TO SITES

Because many of the sites do not have cell phone service, it is a good idea to:

1) Identify the closest parking spot to the proposed site while preparing field maps, mark it on the maps, and record the GPS coordinates.
2) Load directions to the located GPS coordinates.
3) Carry a Vermont Road Atlas.
4) Let someone (colleague, family member, etc) know where you're going, and when you expect to be back in service.

Before leaving for the field, check over your field checklist. The 2022 field checklist can serve as a guide, but should be adjusted to meet individual needs – i.e. epi pen, Benadryl, etc. See the "Black_Ash_Field_Checklist.docx" file to view the checklist from 2022.

Figure 4. Establishing a plot in Victory State Forest.

PLOT ESTABLISHMENT

Upon arriving at a site, it is best to walk through the entirety of the site and determine if there are any black ash present, and if so: (1) where are the highest densities of black ash? (2) Are there enough black ash to establish 1, 2, or 3 plots? Locations of observed black ash can be added to the

Avenza map. Note that during the first year of data establishment, one 5” + DBH black ash warranted plot establishment. This was only the case in natural communities that were sparsely populated by black ash, such as sugar maple ostrich fern floodplain forests.

Begin by surveying the entire site, whose boundaries are dictated by the polygons provided through the ANR layer in the ArcGIS geodatabase. Using Avenza maps, note areas with high concentration of black ash by creating GPS referenced points on the “Zoom-In” map. Once the site has been surveyed, plots should be established in the areas with the highest concentrations of black ash, with up to three plots per site. The center of the 11.3-meter radius circular plot (0.04 ha) should be chosen to maximize the number of trees that will be included within the circumference. In order to mark the plot center, take a 9” length of rebar and a 16-18” length of PVC. After inserted the piece of rebar into the ground (should be at least ¾ underground), place the PVC so that the pipe encircles the rebar. The PVC should be hammered into the ground (actually using a hammer works well here) until only ~6” remain aboveground (Figure 4).

From plot center, use a 30-meter tape to measure 11.3 meters in each cardinal direction (slight variations in directions are okay). Tie bright flagging tape (pink or orange) to trees, bushes, or plants that mark the plot perimeter. On the eighth and final radius measurement, leave the measuring tape unfurled – this will serve as a physical indication of where you start and finish plot measurements.

Plot Measurements

The coordinates of the center of each plot need to be recorded, along with the date, weather, and elevation. Within each stand, black ash should be measured for DBH, height, canopy condition. All other tree species present need to be identified and measured for DBH. The soil pH should be measured, and a basketry survey, informed by the characteristics identified by Constanza et al, 2017, and Diamond & Emery, 2011 (Costanza et al., 2017; Diamond & Emery, 2011), needs to be performed (table 4). Tyler Everett, a citizen of the Aroostook Band of Micmac and current Ph.D. student at the University of Maine, has also done extensive work to monitor, preserve, and raise awareness about the cultural and ecological importance of black ash in Maine (Everett, 2019). His efforts and ongoing work have been consulted and has helped to shape the measurements and procedures in the Vermont black ash monitoring plots. Specifics about each of the plot measurements are listed below.

Figure 5. Setting up an 11.3-meter radius plot in Alburgh Dunes State Park.

1. Plot ID: This should be the same key that was used for remote mapping and preparatory work. For example, the first plot established in a hemlock balsam fir black ash seepage

swamp in Victory State Forest would be “HBF_VSF_1”.

2. Observer: Whoever is collecting date.

3. Date: Date when data was collected.

4. State Land Location: Wherever the site is located, such as, “Victory State Forest”.

5. County: County where the site is located, such as, “Essex”.

6. Lat/Long: The location of the plot should be added to the Avenza map. Note that your location on Avenza might jump around a bit at first, but should settle as you remain at the plot center. Once the dot has appeared to stabilize, zoom in as much as you can, and mark your current location. Name it with the Plot ID, and jot down the plot coordinates that Avenza provides.

Figure 6. Testing soil pH in Aitken State Forest.

7. Soil pH: Four samples from the plot should be taken and tested using a Lovibond Kit soil pH Tester 694 (Figure 6). Ideally, these should be from areas that are unaffected by recent decomposing leaf litter that represent the pH of the system, rather than small microenvironments within the plot. The range of the four samples should be noted on the field data sheet.

8. Hydrology: Based on observations of local environment and prior remote sensing, and educated assessment should address whether the plot is predominantly groundwater or surface water fed, and if the plot is sloped or if it is in a depression (Figure 7).

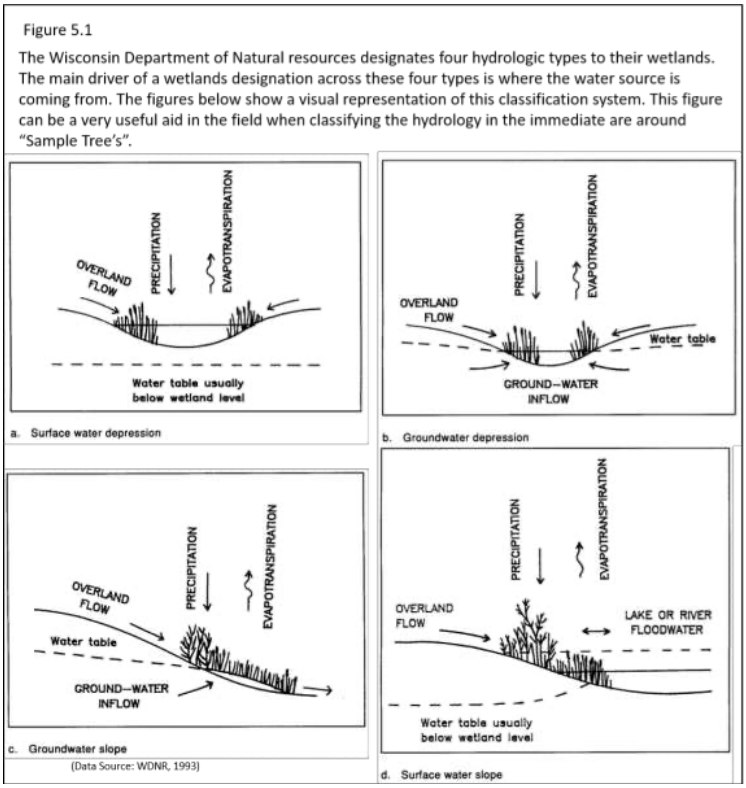

Figure 7. Hydrological Classifications. Hydrological classification for wetlands used by the Wisconsin Department of Natural Resources. Also used by Tyler Everett for his brown ash research in Maine.

9. Natural Community: The natural community indicated by the ANR database, such as "HBFBASS" (or Hemlock Balsam Fir Black Ash Seepage Swamp).

10. Microtopography: A survey to determine how high the hummocks are within the plot, and how far apart they are spread. This should be both a visual assessment, and take into account observations that were made when establishing the plot (ie distance between hummocks). Several hummocks should also be measured for maximum accuracy. The value recorded on the data collection sheet will be two characters ranging from SM – MO – ST – EX (Table 3).

Table 3. Mound Survey. Importance of this survey was conveyed by Tyler Everett via personal communication, as well as well as in his Ash Resource Inventory Field Manual (2019). The classification in this table originally comes from the Province of British Columbia's Resource Inventory Committee.

Code	Description
SM	Smooth Few or no mounds; if present, less than 1 foot high, and no more than 20 feet apart
MO	Moderately mounded Mounds 1 ft. to 3 ft. high and 10-20 ft. apart
ST	Strongly mounded Mounds 1 ft. to 3 ft. high and less than 10 ft. apart
EX	Mounds more than 3 ft. high

11. % Canopy from Plot Center: A densiometer is used to measure canopy cover from plot center. A reading should be taken in each of the cardinal directions, adjusted based on the instructions written on the densiometer. The four readings should then be averaged and recorded on the data sheet.

12. Invasives present: Throughout the data collection project, the observer will look for signs of invasive plant species. Common invasives in forested wetlands include Japanese barberry (*Berberis thunbergia*), common buckthorn (*Rhamnus cathartica*), multiflora rose (*Rosa multiflora*), Morrow's honeysuckle (*Lonicera morrowii*), and bittersweet nightshade (*Solanum dulcamara*). Species and description of abundance/presence should also be noted.

13. Seedlings and Saplings: For the 18 plots established in the summer of 2022, the approach for noting regeneration (seedlings and saplings) did not follow a rigorous protocol. As other plot measurements were made, any observed seedling or sapling species were noted. Before leaving the plot down, an additional 5-to-10-minute survey would ensure that there were no unobserved regeneration species. There was no data collected on relative abundance, and no differentiation between sizes. For the future, the following regeneration protocol is recommended:

    To sample regeneration, denote two sets of smaller representative plots: a seedling and a sapling plot. The two representative plots will be taken 5m from the plot center on the 0˚

and 5m from the plot center on the 180˚ azimuth (see figure 8). Once the center of this representative plot is located, all saplings (DBH 2.5-7.5cm) within a 2m radius will be identified to species and the abundance will be counted. Subsequently, all seedlings (DBH less than 2.5cm) within in a 1m radius will be identified to species and counted. Note that seedling ID often requires brushing away the leaf and duff layer (if applicable) to account for even the smallest and youngest regeneration.

14. Herbaceous Cover: Similar to regeneration or understory data, there was no rigorous protocol for monitoring herbaceous cover, and the same approach was taken as for seedlings and samplings.

    For future herbaceous monitoring, a more standardized approach is recommended. Using a 1m quadrat, five representative herbaceous subplots will be evaluated (see Figure 8). Each sublot will be $1m^2$. The first subplot will be at the plot center, while the other four will be 6m from plot center on at 45˚, 135˚, 225˚, and 315˚. Within each subplot, all species should be identified. Note that the timing of plot monitoring will affect the species that are identifiable.

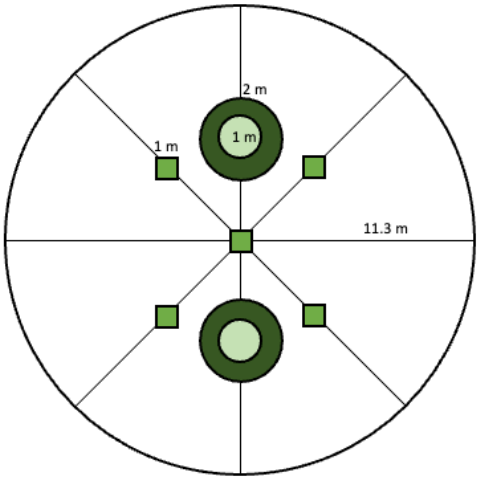

Figure 8. Diagram of approximate locations of sampling subplot locations within the 400m^2 monitoring plot.

    If further accuracy is desired, approximate percent cover of each species will be noted.

    To determine if this approach is sufficiently representative of the plot, the observer should make note of other species observed within the plot that were not present in the five subplots. If it is determined that more than many species are being missed using herbaceous sampling approach, additional subplots should be included.

15. Other Trees Present & Reference Trees: Moving clockwise from the reference tape, all stems greater than 1” DBH should be measured, and the species and diameter need to be recorded. For each plot, at least two notable trees (large, funky, unique species) need to noted as “Reference Trees,” meaning that their direction and distance from plot center (i.e. 5.48 meters at 248˚) need to be recorded alongside the DBH. If a future researcher is having trouble finding the PVC or rebar, these physical references will help them to identify the plot center.

16. Black Ash Measurements: Diameter, bole survey, and canopy survey. Moving clockwise from the reference tape, stop at each black ash tree to measure the DBH (in) of each black ash, perform a bole survey (Table 4), and a canopy survey (see Table 5). Note the results of each of these measurements/surveys in the data collection sheet. Any additional notes should also be jotted down. Differentiating between black ash and green ash, as well as between white and green ash can be a tricky task. One study that looked at survivability

between different ash species began by using DNA-based technologies to properly identify commercially obtained species, and found that 70% of all of the commercially obtained Fraxinus seed sources had been incorrectly identified at the species level (Koch et al., 2012). While these misidentifications may have several causes, and may be the result of untrained eyes, ash ID can still be tricky. See the "Ash_ID.docx" file for a guide on best practices for ash ID, and know that there will still be times of uncertainty.

Table 4. Bole Survey. The bole survey assesses how straight and free of defects the trunk is. This measurement was intended to inform the potential basket quality of a tree. Basket quality trees are straight, and free of defects. Depending on who you talk to, basket trees are also 5 +" in diameter, with exact preferred diameter ranges varying by basketmaker. By having some data about where the highest quality black ash are in Vermont, having data about where basket quality trees grow might be able to prioritize treatment of higher quality trees, as recommended by the Maine Black Ash Task Force.

Code	Trunk Description
B1	Trunk is straight, free of knots, and lacking any curvature
B2	Trunk has straight sections of 8 ft. +
B3	Trunk has at least one straight sections of 6 - 8 ft.
B4	Trunk has frequent curves, twists, and knots. No straight sections greater than 6 feet
B5	Trunk is about as twisty as can be, significant epicormic activity

Table 5. Tree Canopy Survey. A tree canopy survey ranging from 1-5 has been shown to correlate with stress experienced by a tree, and specifically with EAB stress. A canopy value of 1 indicates that the canopy is full and healthy, while a canopy value of 5 describes a canopy with no leaves except for epicormic sprouts may be present on the tree. As EAB progresses, we expect to see decreasing canopy health across Fraxinus species, but especially in black ash which tend to get hit first and hardest. Informed by Forest Health Monitoring Field Guide Methods (pg 106), and the iNaturalist Canopy Fields).

Code	Canopy Description
C1	Canopy is full and healthy
C2	Canopy has started to lose leaves (thinning), but no dieback (dead top canopy twigs without leaves) is present
C3	Canopy has <50% dieback
C4	Canopy has >50% dieback
C5	Canopy has no leaves; epicormic sprouts may be present on the tree

17. Black ash heights: Measure the heights of black ash greater than 5" DBH. Attach the 30m tape to the tree. Holding the other end of the 30m tape, walk away from the tree until you are able to see both the bottom and top of the tree. Note how far away from the tree you

are, then take a reading for both the base of the tree and the top of the crown by using a clinometer.

18. Before leaving the plot, be sure to collect all instruments and flagging tape.

DATA TRANSCRIPTION

Within a week of establishing a plot and collecting baseline data, the data should be transcribed into a Google Sheet or Excel file. During the 2022 field season, data was compiled in a spreadsheet that mirrored the setup of the data collection sheet. Future transcription does not need to follow this approach – the goal is simply to transcribe all of the data in a format that is easy to read, reference, and manipulate.

At the end of the field season, the data needs to be cleaned and compiled. See the "Black_Ash_Long_Term_Monitoring_Plots_2022_data_clean.xlsx" file for the 2022 data set. Note that this cleaning process was rather extensive, and future data transcription processes could be adjusted to make for easy cleaning.

After cleaning, desired analyses and figures can be produced. See the "Black_Ash_Long_Term_Monitoring_Plots_2022_figures.xlsx" for the figures that were created using the 2022 data set.

2022 SITE DESCRIPTIONS & DATA

As of April 2023, there are 10 sites with a total of 18 black ash long-term monitoring plots (see table 2). Each site from 1 to 3 plots, depending on the distribution and frequency of black ash within the site boundaries. Three of the sites were visited, but did not have black ash: Atherton Meadows WMA, Elmore State Park, and Whipstock Hill WMA. CC Putnam State Forest, was not actually managed by the state of Vermont, and was therefore never visited. The wet clayplain forest at Alburgh Dunes State Park was also not visited due to the incredibly high concentration of poison sumac that surrounded the site.

- GPS coordinates for the centers of the 18 plot locations can be found in the "Black_Ash_Plot_Locations_ 2022.docx" file.
- A summary of the baseline dataset can be found in this StoryMap.
- See the "Black_Ash_Plot_Data_2022_raw .xlsx" to view the raw data that was collected during the 2022 field season.
- See the "Black_Ash_Long_Term_ Monitoring_Plots_2022_data_ clean.xlsx" for the cleaned data from the 2022 data set.
- See the "Black_Ash_Long_Term_ Monitoring_Plots_2022_figures .xlsx" for the figures that were created from the 2022 data set.

Figure 9. Measuring the DBH of a 14" diameter black ash in Aitken State Forest.

- See the "Black_Ash_Site_ Descriptions_2022" file for descriptions of the 10 sites where plots were established during the 2022 field season.

INITIAL TRENDS

Because these are long-term monitoring plots, we have not yet run any statistical analyses. However, a few initial trends and observations are included below. See the "Black_Ash_Long_Term_Monitoring_Plots _2022_figures.xlsx" for the figures and data that were created using the 2022 data set.

Basal Area

As black ash disappears, measuring basal area through time allows us to see how other trees respond, and how the overall basal area of the system responds. Does it decline in the short-term? What about the long-term? Is there an initial surge in growth by other species like red maple and yellow birch?

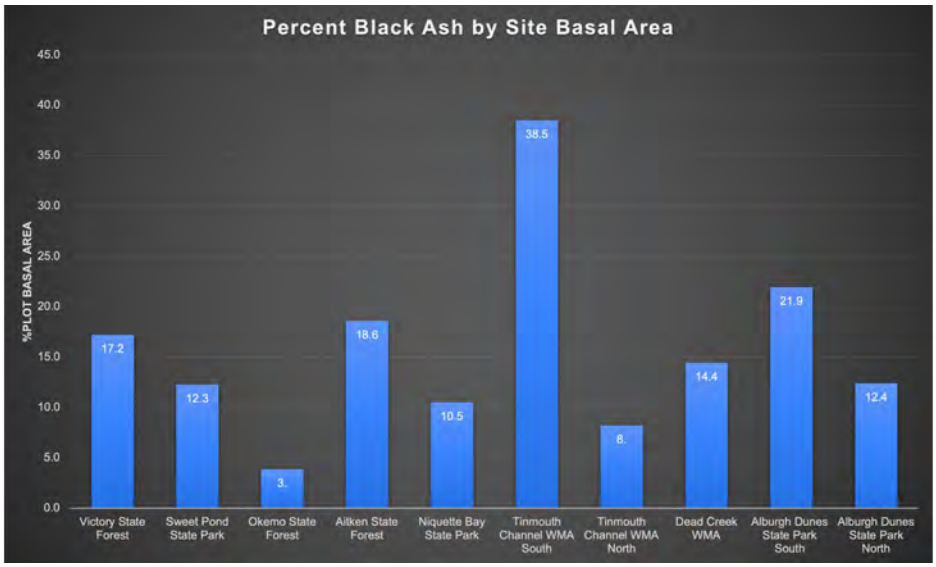

Figure 11. Percent black ash by basal area across the 10 sites that house long-term monitoring plots.

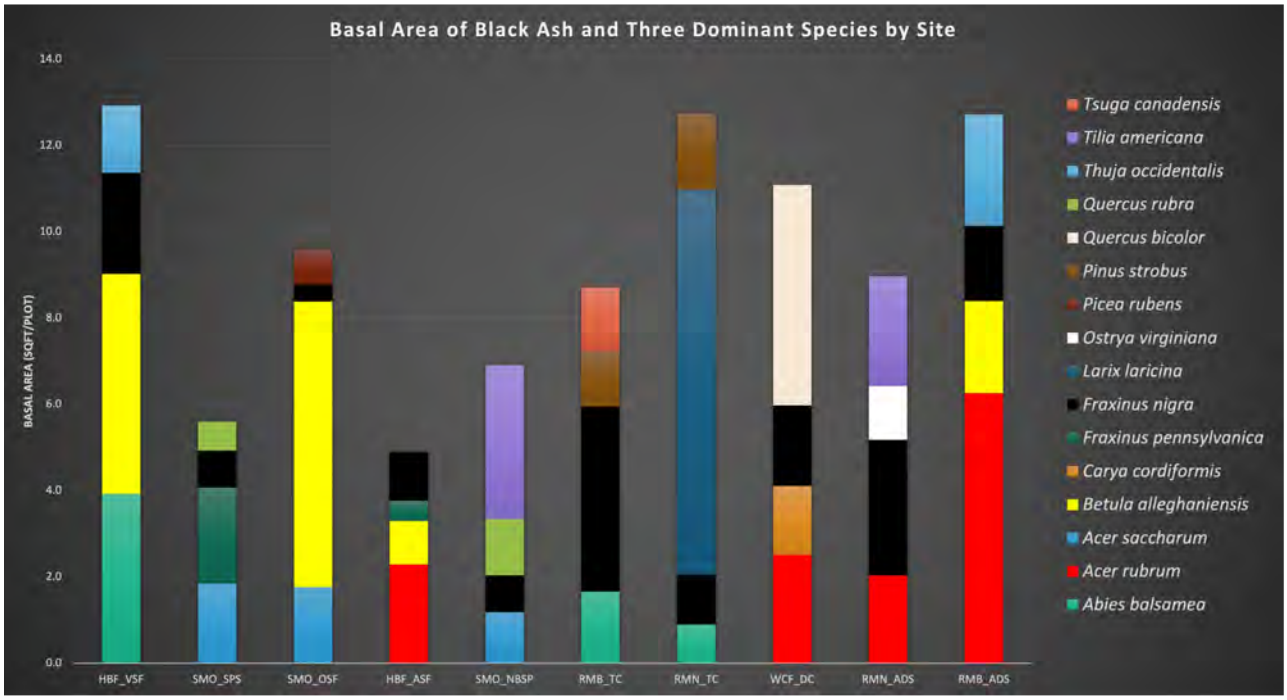

Figure 10. Basal area (ft2/0.04ha) of black ash and the three most abundant non-black ash species per site.

Basal area measurements revealed that in general, Vermont's forested wetlands contain a relatively small percent of black ash (Figure 10). Note that these plots were specifically chosen for the high concentration of black ash relative to the surrounding landscape. Still, those efforts yielded values between 3-38% black ash by basal area. Tinmouth Channel South, a clear outlier in the group, was in a 14.8-acre red maple black ash seepage swamp, and the only site where we established three plots. This site will be an interesting one to monitor as EAB continues to spread across Vermont.

Looking across the data for all 10 sites, black ash is the only species to occur in all 10 sites. Other than black ash, yellow birch and red maple are the most commonly occurring species, and are both present in 8 of the sites. Furthermore, when considering the three most prominent non-black ash species per site, we again see that yellow birch and red maple are the most common, with both being prominent in 4 of the 10 sites (Figure 11).

Bole Condition

Bole condition is a measure of how straight and free of defects the trunk is. This measurement was intended to inform the potential basket quality of a tree. Basket quality trees are straight, and free of defects. Depending on who you talk to, basket trees are also 5+" in diameter, with exact preferred diameter ranges varying by basketmaker. So, by having some data about where the highest quality black ash are in Vermont, we might be able to prioritize treatment of higher quality trees, as recommended by the Maine Black Ash Task Force. This is a preliminary survey that I carried out, and therefore was not performed by a trained basketmaker.

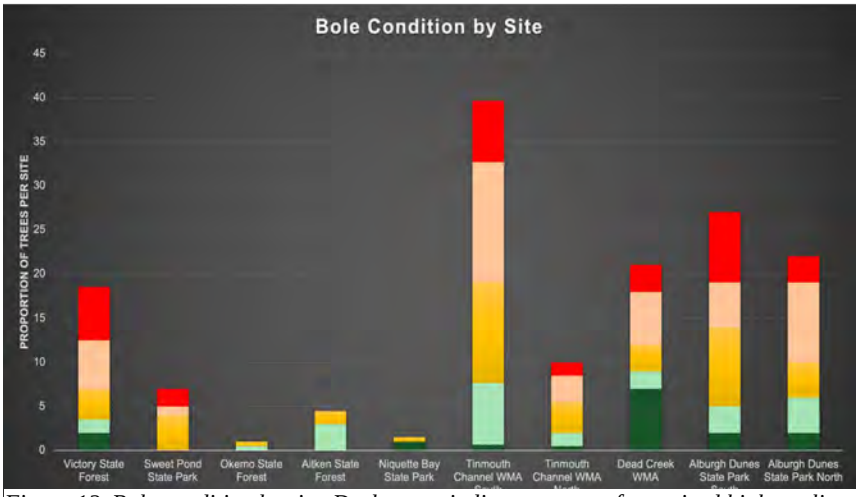

Figure 12. Bole condition by site. Dark green indicates a tree of perceived high quality for basketry, while deep red indicates a very poor-quality tree.

The conditions "Bole 1" through "Bole 5" are a numeric scale that was developed for the project this summer where a 1 represents a straight trunk free of knots, and lacking any curvature, to a 5, which describes a super twisty, knotted, and possibly epicormic trunk.

Richard David and other basketmakers have shared that only 5-20% of black ash trees are of basket quality (Benedict & Frelich, 2008). In these plots, we see a similar trend with only 22 of the 294 black ash trees measured having a bole condition of "1", or approximately 7.5% Figure 12). Dead Creek WMA had the highest density of perceived basket quality black ash, the only site located in a wet clayplain forest. Black ash distribution within wet clayplain forests tends to be relatively patchy, with small clusters of black ash occurring along drainages.

Tree Canopy Assessments

A tree canopy survey ranging from 1-5 has been shown to correlate with stress experienced by a tree, and specifically with EAB stress (Flower et al., 2010). A canopy value of 1 indicates that the canopy is full and healthy, while a canopy value of 5 describes a canopy with no leaves except for epicormic sprouts may be present on the tree. As EAB progresses, we expect to see decreasing canopy health across Fraxinus species, but especially in black ash which tend to get hit first and hardest.

Figure 13. Black ash in Tinmouth Channel WMA South. DBH: 6.28", Canopy 2, Bole 2.

Currently, 186 of the 294 black ash trees or 63% of the black ash are either a canopy level 1 or 2 (Figure 14). It's important to note that this scale is somewhat subjective, and that black ash tend to have less canopy cover than other species. Regardless, over time, we expect to see these values decrease.

The observed black ash decline was highest Alburgh Dunes State Park, and could be due to the EAB infestation that was recently detected in the park. During field visits, high levels of woodpecker activity were observed, which can indicate presence of EAB, as woodpeckers are one of their most pronounced natural predator.

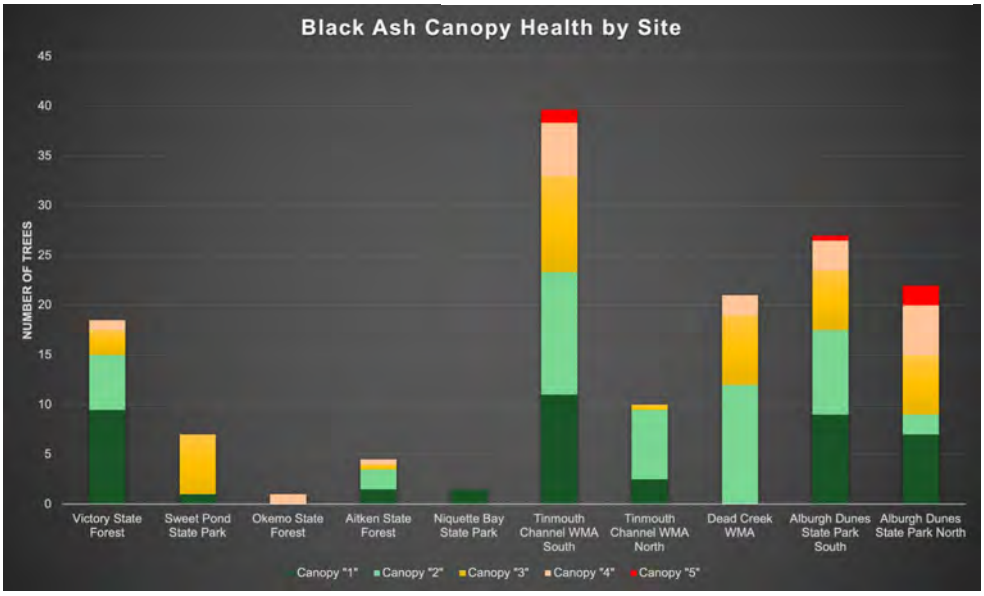

Figure 14. Graph displaying canopy condition at each of the ten sites. Dark green indicates a canopy level of "1", while dark red indicates a canopy with no leaves remaining.

Herbaceous Cover

A total of 135 species were observed in the 17 plots. This includes species such as Swamp candles (*Lysimachia terrestris)*, Canada lily (*Lilium canadense*), Sensitive fern (*Onoclea sensibilis)*, False nettle *(Boehmeria cylindrica*), and swamp milkweed (*Asclepias incarnata*). The full species list can be found in the "Black_Ash_Long_Term_Monitoring_Plots_2022_data_clean.xls" file, under the "Understory Species Present" tab.

Regeneration: Seedlings and Saplings

A total of 27 species were observed within the plots. This includes balsam fir (*Abies blasamea*), striped maple (*Acer pennsylvanicum*), red maple (*Acer rubrum*), sugar maple (*Acer saccharum*), speckled alder (*Alnus incana*), serviceberry (*Amelanchier arborea*), yellow birch (*Betula alleghaniensis*), paper birch (*Betula papyrifera*), musclewood (*Carpinus caroliniana*), bitternut hickory (*Carya cordiformis*), American beech (*Fagus grandifolia*), black ash (*Fraxinus nigra*), green ash (*Fraxinus pennsylvanica*), juniper species (*Juniperus sp.*)., eastern larch (*Larix laricina*), hop hornbeam (*Ostrya virginiana*), red spruce (*Picea rubens*), white pine (*Pinus strobus*), quaking aspen (*Populus tremuloides*), swamp white oak (*Quercus bicolor*), red oak (*Quercus rubra*), common buckthorn (*Rhamnus cathartica*), willow species (*Salix sp.*), northern white cedar (*Thuja* occidentalis) basswood (*Tilia americana*), eastern hemlock (*Tsuga canadensis*), and American elm (*Ulmus americana*).

Figure 15. American elm (Ulmus americana).

Of these species, four are expected to do well as underplantings or as species in a future without black ash: red maple, American elm, basswood, and northern white cedar (Bolton et al., 2018).

Recommendations for Future Plots

Additional Plots

In March of 2023, Joanne Garton and Tony D'Amato discussed the possibility of increasing the number of black ash long-term monitoring plots during the 2023 summer field season. Adding plots, would lead to a more representative sample, as well as provide more opportunities for plot experiments such as insecticide treatments or underplantings. Three possible scenarios for ongoing plot establishment are listed below:

<u>Scenario 1: No more plots</u>

The total number of black ash long-term monitoring plots remains at 10 sites/locations, with 18 total plots.

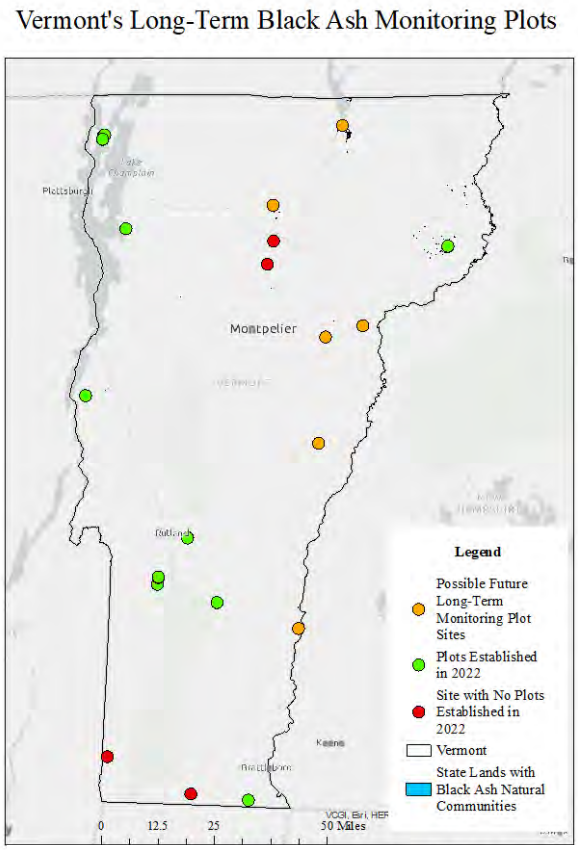

Figure 16. Map displaying established black ash long-term monitoring plots, proposed sites where no black ash were observed, and proposed future sites.

Scenario 2: Establish 4-12 (*ideally 7+)* additional plots

Visit additional sites on state lands, establishing 1-3 plots per site, depending on concentration of black ash. After securing permissions from the state, expect: Approximately 1 day of computer mapping, 1 day setting up survey123 for easier data collection, and 4-10 days of field work.

Locations (Figure 16): Specific site locations will depend on further mapping and remote sensing, and the locations of the plots will be determined in the field. GPS information for the following site recommendations is included in a geodatabase in the "GIS.Black_Ash_Long_Term_Plots" folder, and can be accessed via ArcGIS Pro.

- Podunk WMA
- Skitchewaug WMA
- Green River Reservoir
- South Bay WMA
- Roy Mountain WMA: specific location requires communication with Charlie Hohn
- LR Jones State Forest: based on personal communication with foresters who recalled a black ash stand in the northernmost corner of the parcel. This site will be particularly interesting to monitor given the proximity to EAB ground zero in Vermont, and the nearby biocontrol release.

Scenario 3: In addition to the 7-12 plots on state lands, establish ~10 monitoring plots in town forests.
Goal: regional continuity and representation. Total plots: ~40. Total time, including state land plots: 2 days of computer mapping and prep work. 8-16 days of field work.

Locations:
Mud Pond Conservation Area (2+)
Pond Brook Wetland Conservation Area
Ferrisburgh Municipal Forest (2+)
Montpelier City Forest
Town of Wells (municipal land near West Lake Road)
Lincoln Town Forest

Future Monitoring and Experimentation
Because they are long-term monitoring plots, the plots will be visited every 3-5-10 years, depending on how EAB progresses throughout the state, funding for researchers, and whether or not treatments are applied to some of the plots.

Depending on future goals for the black ash long-term monitoring plots, additional variables may be added in the future, some protocols may become more rigid, such as surveying for regeneration, male-to-female ratios, and seed-bearing info. Note that male-to-female ratios can be challenging to determine unless the tree is actively bearing flowers or seeds.

Additionally, it is possible that the black ash long-term monitoring plots will be used to experiment with treatments. One example of a possible treatment is comparing the efficacy of

insecticide injections into the trunks of black ash trees. Another might be testing the survival of underplanting different species in sites.

Finally, at a minimum, the plots should be monitored to determine what happens as black ash disappear from Vermont's forested wetlands. And, on an optimistic note, there's always hope that the black ash long-term monitoring plots harbor EAB resistant black ash, and monitoring would allow for detection of these lingering ash. Other organizations have similar projects that are hoping to detect lingering ash, such as the Ecological Institute's Monitoring and Managing Ash (MaMA) project. More about the MaMA efforts can be found on their website. The Ash Protection and Collaboration Across Wabanaki (APCAW) organization, which is discussed in greater detail under "Collaboration with Regional Efforts", has also been establishing ash monitoring plots in Maine.

NR206 and Black Ash on Municipal Lands

In the summer of 2022, with the help of Kate Forrer, I reached out (Figure 17) to a list of folks involved with Vermont's town forests as well as the Association of Vermont Conservation Commissions (AVCC). A handful of folks responded, and I compiled their responses into a table for future use (Table 6).

> Email to Town Forest Network (July 1, 2022)
>
> This summer, Charlotte Cadow is working with Vermont Urban and Community Forestry to inventory Vermont's black ash trees. Black ash play a significant ecological role, and play an important role in Abenaki basket making. These trees are also highly susceptible to emerald ash borer, having shown no resilience to EAB infestations. By studying the patterns of black ash across Vermont's landscape and monitoring the population, we can simultaneously connect basketmakers with this resource and work to mitigate the effects of EAB in the future.
>
> If you'd like to include your town forest in the inventory, you can contribute to the iNaturalist project here, or reach out to charlotte.cadow@uvm.edu.

Figure 17: Email sent Vermont town forest folks on July 1, 2022.

Table 6: Reports of black ash in Vermont towns. Confirmed via personal communication. Last updated on April 1, 2023.

Town	Location(s)	Contact	Notes
Marshfield	Marshfield Town Forest	Contact: nancyjeverhart@gmail.com// Notified by: Anne Reed, Chair of the Marshfield Conservation Commission annereed48@gmail.com	There is a parking lot on Hollister hill. Take the trail down the Thompson Rd and you will find several wetlands that have it, some trees are right next to the trail. There is another nice swamp and vernal pool on the moon field trail with black ash.

Williston	Mud Pond	Laura Meyer, previously chair fo the Williston Conservation Commission laura.e.meyer@gmail.com	Mud Pond Management plan includes language that allows black ash and other plants to be used by the Abenaki tribes// "The black ash stand I was in was off the small unmapped loop trail from the viewing station that is at the end of the short trail from the Mud Pond parking area. If you have trouble finding it I can show it to you. "
Burlington	Arms Forest	Tip from Laura Meyer laura.e.meyer@gmail.com	
Huntington	Audubon Center	Anne Dannenberg acd@gmavt.net	They are in the wooded area in between the lower parking lot and the meadow as it is somewhat of a wet area. The folks up at the office would be able to tell you more if you have trouble locating them with this description.
Barre	Barre Town Forest	Caitlin Cusack Caitlin@vlt.org	"I hope your summer is going well. I did see some black ash in the Barre Town Forest. Would that be something you'd like to include in your project? If so, I can connect you with the Town Manager."
Salisbury	Salisbury Town Forest	Jim Andrews jandrews@vtherpatlas.org	"We have some Black Ash on the Salisbury town forest in the floodplain of Halnon Brook. If you take our Pitch Pine Trail and the extension that travels down to the brook, there are Black Ash along the trail in the lower section. There may not be much."
Hinesburg	Hinesburg Town Forest	Ethan Tapper ethan.tapper@vermont.gov Chittenden County Forester	
Ferrisburgh	Ferrisburgh Town Forest	Don Dewees ddewees@gmavt.net Ferrisburgh Conservation Commission	Numerous black ash in a wet clayplain forest.

During the 2022 fall semester, seven students in UVM's NR206 class (Lauren Cresanti, Max Hertz, Ethan Lareau, Sofia Vallecillo, Alex Vokey, Heather Walker, and Ella Weigel) partnered with the Vermont Black Ash Project. They worked on inventorying black ash in selected municipal forests: Mud Pond Conservation Area in Williston (Figure 18), the Audubon Center in Huntington, and Ferrisburgh Town Forest. These locations were selected based on the responses received during the summer, some remote sensing work, and proximity to Burlington.

After wrapping up field work, the students synthesized their data using iNaturalist and ArcGIS. In conjunction with the summer data derived from the long-term monitoring plots, the students determined that black ash often co-occurred with muck and peat soils, mapped natural communicates containing "abundant" black ash, and locations where black ash had already been observed on iNaturalist. The group then turned these observations into a query, and extrapolated their findings to other municipally managed lands in Vermont.

Figure 18: NR206 students inventorying black ash in Mud Pond, Williston, VT.

The NR206 team also provided management recommendations to towns to include language that provides access for cultural harvest, and considers options for navigating EAB (i.e. treatment). Some towns, such as Williston's Mud Pond Conservation Area Management Plan, already include some of this language, and is serving as a guide for what might work in other towns, as well as areas of growth.

To synthesize and communicate their findings, the NR206 team created an ArcGIS Story Map, a resource packet for municipal lands managers (see file "BlackAshManagement_ResourcePacket _206.pdf"), and a project report titled, "Black Ash Documentation and Cultural Management in Vermont Public Forests" (see file "NR206_Final Report.pdf"). They also presented their project, and the recorded version can be found on VT UCF's YouTube Page.

COMMUNITY SCIENCE & iNATURALIST PROJECTS

iNaturalist is a user-friendly platform, which already had numerous black ash records prior to the start of this project. There are several types of projects that can be used to collect or compile observations that meet specific qualifications: location, species, grade of the observation, etc. For the purposes of the Vermont Black Ash Project, there are two separate iNaturalist projects.

The first is a collection project, the "Vermont Black Ash Collection Project," that automatically collects any and all reports of black ash in Vermont. There are currently 909 observations of black ash in Vermont. For the purpose of data communication, we created a map of these observations using ArcGIS. The map automatically updates ever 24 hours, and can be embedded on websites to reflect the current observed distribution of black ash in Vermont.

The second iNaturalist project is a traditional project, the "Vermont Black Ash Inventory," and requires that users join the project before adding their black ash observations directly to the project. The benefits of this project include optional fields that are specific to this project including landowner and landowner contact info, trunk condition, tree health, and evidence of

EAB signs (Table 7). Additionally, because users are required to join the project, it's likely that they're familiar with the work, have experience identifying black ash trees, and are inclined to grow the black ash network. This project currently has 343 observations.

Table 7. Data fields included in the traditional "Vermont Black Ash Inventory."

iNaturalist Field	Required?	Justification
Geolocated Photo	Yes	Required by iNaturalist platform. Also essential to have location and date/time of any type of inventory information.
Confidence of Black Ash ID	Optional	To allow existing "Research Grade" observations to be added to the project, this will not be required. However, given the challenges of black ash identification, future research might entail verifying a sample of the data entered into iNaturalist.
Trunk diameter (DBH)	Optional	Most folks don't carry a DBH tape with them in the woods. But! If they do, this is important info.
Possible EAB sign	Optional	This field might be off-putting to some folks, and decrease user access.
Trunk characteristics	Optional	Easy to observe these qualitative characteristics, and important information for basket makers. Dead branches, epicormic shoots, curved bole
Land type	Optional	Private, public, unknown.
Landowner contact info	Optional	If willing to communicate with Abenaki for purposes of basket-tree harvest
Site Hydrology	Optional	To provide more info about how losing black ash in Vermont might affect water levels (see literature review).

Indigenous Data Sovereignty

Given that iNaturalist is a public-facing platform, it's important to consider the implications of Indigenous Data Sovereignty (IDS) (Rainie et al., 2019). While open data is convenient for researchers, scientists, and managers, it can have negative impacts on Indigenous communities who have connections to the land or resources concerned by the data.

> All too often researchers, agency staff, and others digitise Indigenous knowledge and information and enter it into open data arenas without the express permission of Indigenous peoples. While these acts may be well- intentioned, the result is the co-opting of Indigenous knowledge and the removal of Indigenous peoples from data governance processes. Therefore, IDS also comprises the entitlement to determine how Indigenous data is governed and stewarded, referred to as Indigenous data governance (IDG) (Rainie et al., 2019, pg. 301).

The complexities of IDS may present future complications for using iNaturalist as a platform for collecting black ash observations. Currently, black ash observations have been collected by a

variety of observers across Vermont's private, public, and municipal lands. If some of Vermont is eventually returned to Indigenous peoples, or people within the Indigenous community are voice concern over the project, the black ash iNaturalist projects may need to be deleted, have the "bole" category and data deleted, or have the observations obscured. Currently, any observation containing a bole survey or bole notes is visible to anyone who clicks on the observation. However, I presented the iNaturalist component of the project to the VCNAA, and have not heard of any concerns up to this time.

The Ash Protection and Collaboration Across Wabanaki (APCAW) lab team in Maine is currently contemplating how to collect community observations of black ash, and is wrestling with the complexities of IDS. As of late March 2023, their inclination is to provide an intake form that people can submit when they encounter a black ash stand. The APCAW team would then audit and evaluate the submission on the backend, before ultimately publishing a story map with black ash observations, but would obscure the exact locations of the observations.

Figure 19. Black ash basket made by Kerry Wood, citizen of the Nulhegan Band of the Coosuk Abenaki Nation.

VERMONT BLACK ASH NETWORK

BASKETMAKER NETWORK

In Vermont, black ash basketry remains an important practice for people of both Indigenous and settler descent. Throughout the last year and a half, we've been reaching out to basketmakers and black ash artisans in Vermont. See the "Black_Ash_Network.xls" document for a list of who we've reached out to, and who has confirmed that they would like to be included in future emails regarding black ash in Vermont.

While the network remains fairly small, we hope to continue connecting with basketmakers and black ash artisans throughout Vermont and in neighboring states. When connections are made with additional basketmakers and basket tree harvesters, their names and contact information should be added to "Black_Ash_Network.xls". Additionally, any time there is a new connection, that person should be asked about any additional basketmakers of black ash artisans to contact. To see the initial email that was sent out to folks in Vermont, see the "Black_Ash_Network_Email" file.

So far, we have emailed the network to share information about upcoming events such as the APCAW presentations. Joanne Garton is also preparing to send an email about a landowner who has black ash on his property in Calais and is open having folks come and harvest the trees for basketry. In the future, the network should continue to be used for these purposes.

Finally, a future goal of the black ash network might be to connect the basketmakers and artisans with one another. Prior to sharing contact info, it would be best to asking permission from everyone in the network.

LANDOWNER SURVEY

In the fall of 2022, the Vermont Urban and Community Forestry Program piloted a black ash intake form. The goal of the survey was to create a platform that hosted information about landowners who have black ash on their property and are open to having some of those trees harvested. By hosting this platform, VTUCF can share information about those black ash with the Black Ash Network.

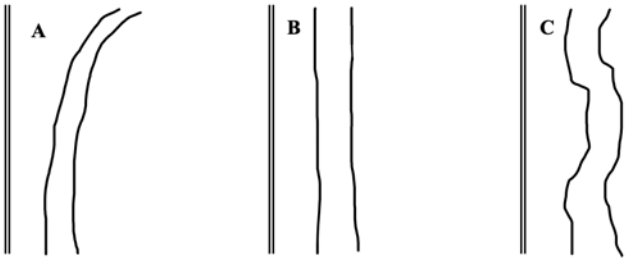

Figure 20. Diagram of black ash straightness for landowner survey.

We debuted the intake form during a Vermont Land Trust Webinar in November, and have since received several submissions in Irasburg, Calais, and Plainfield, with landowners reporting relatively straight black ash trees with diameters between 7 – 12 inches. Any responses to this survey are transferred into a spreadsheet, which is connected to VT UCF.

After receiving a report of black ash, further communication with the landowner should entail: clarifying the quantity and quality of the trees (How straight are they? Are there signs or symptoms of EAB? Size?), and explaining next steps (i.e. "We'll reach out to basketmakers, but there's no guarantee that someone will have the time or resources to come and harvest"). When possible, visiting the landowner's property to view the black ash is reocommended.

Once the presence and quality of the black ash have been confirmed, information about the location, size, and perceived quality of the black ash trees should be shared with the black ash network. If there are basketmakers or artisans who express interest, they should be connected with the landowner.

RECOMMENDATIONS FOR THE FUTURE OF THE VERMONT BLACK ASH PROJECT

Throughout this report, recommendations for future work are listed within the relevant section. What follows are additional recommendations that fall outside the current scope of the project, or that are still in the preliminary phase.

COLLABORATION WITH REGIONAL EFFORTS

The cultural and ecological significance of black ash extend across the range of this species in North America. Mitigating the impacts, as well as navigating the consequences of EAB, are also regional in scope. Collaborating across borders, from tribe to state to country, is a critical step in creating a future where black ash is a functional part of cultures and landscapes.

Throughout the last 15 months, we've been in regular contact with the recently named APCAW team (Ash Protection and Collaboration Across Wabanaki) at the University of Maine. We've also read and listened to accounts from Odanak and the St. Regis Mohawk of Akwesasne.

Continuing to invest time and integrate project goals throughout these relationships is highly recommended.

Note that this list of individuals and organizations is not an exhaustive list and will continue to grow with ongoing outreach and research.

Maine:

- John Daigle: Citizen of the Penobscot Nation. Works with the USFS. Professor of Forest Recreation Management at the University of Maine in Orono. Works with tribal communities on climate change and EAB.
- Tyler Everett: Citizen of the Micmac Nation. Works for Passamaquoddy Forest Service. Focusing on adaptive ash management on tribal lands. Also works with the United States Eastern Tribes on climate resilience and forestry projects. University of Maine PhD student.
- Ella McDonald. University of Maine Masters' student working on increasing the outreach capacity of our lab group through the development of a webinar series and a lab group website for sharing information about the work APCAW supports and is involved in, particularly for their Tribal Nation partners to stay up to date and current on these efforts.
- Emily Francis: University of Maine PhD Candidate looking at landowner involvement in the management of ash forests under their ownership as well as ash seed collection and storage protocols.
- Darren Ranco: Citizen of the Penobscot Nation. University of Maine anthropologist and academic, working on the intersection of climate and environmental science with Indigenous knowledge systems.

New Hampshire:

- Nate Siegert: USFS Forest Entomologist.
- Kyle Lombard: Forest Entomologist/Pathologist with the N.H. Division of Forests and Lands and Program Coordinator of the Statewide Forest Health program.
- Paul and Denise Pouliot: The Cowasuck Band of the Pennacook-Abenaki. Email: cowasuck@tds.net

New York:

- Les Benedict: Member of the Saint Regis Mohawk Tribe, has worked extensively on black ash protection in New York.
- Akwesasne Task Force on the Environment (ATFE) has an organized, methodical, and informed response plan to EAB.

Great Lakes Region - Anishnaabek (Odawa, Ojibway, Potawatomi): Note that at the timing of this report, the individuals listed below have not been contacted. However, their work is documented and available online, and EAB is rapidly affecting their region.

- Keith Karnes: Forester with the Leech Lake Band of Ojibwe. Email: forestry@lldrm.org
- Kelly Church: A Pottawatomi/Ottawa/Ojibwe Black Ash Basketry Artist, Activist, Educator, and Culture Keeper
- April Stone: Citizen of the Bad River Band of Lake Superior Ojibwe, Black Ash Basketmaker

- Liandra Skenandore: Citizen of the Oneida Nation of Wisconsin; also, Prairie Band Potawatomi, Seminole Nation of Oklahoma, and Mvskoke Creek Nation. Basketmaker.

Figure 21. Seed-bearing black ash tree in Milton, VT.

SEED COLLECTION

Collection and preservation of black ash seeds serves several purposes: 1) If the seeds are short-term storage, such as a fridge at the right temperature and humidity, they can remain viable for up to 8 years. These seeds can then be propagated and used for various research projects. 2) Long-term storage of black ash seeds requires the seeds to be shipped to specialized facilities such as the National Plant Germplasm Ash Conservation Project at the USDA ARS Iowa facility, or the Agricultural Genetic Resources Preservation Research Center at the USDA ARS Colorado Black Box.

Les Benedict and Richard David of the St. Regis Mohawk Tribe, also published a guide to black ash seed collection and propagation (Benedict & David, 2003). While their recommendations are summarized in the "Seed Collection" section of the "Black_Ash_ Literature_Review" file, reading the original document is highly recommended. The Akwesasne Mohawk Territory also has a detailed Emerald Ash Borer Response plan, which includes a section on ash preservation through seed collection(Akwesasne Task Force on the Environment (ATFE), 2014). Their process for ash seed collection includes identifying and recording the GPS location of flowering basket grade trees, as well as collection and handling procedures in accordance with Kathleen S. Knight's 2010 publication on black ash seed collection (Knight, 2010). These seeds are sent to long-term storage facilities to preserve the genetic diversity of regional black ash, in hopes of propagating and planting the trees in their native environment after EAB has been controlled (Akwesasne Task Force on the Environment (ATFE), 2014).

The APCAW Team at the University of Maine maintains an informative website, which contains oodles of information about these two long-term storage facilities. Additionally, APCAW recently revised their Ash Seed Collection Manual (Francis, 2023). This extensive report details why it's important to collect ash seed, how to prioritize areas for ash seed collection, when and how to collect black ash seed, what to do with collected seed, and future use of seed.

During the 2022 ash seed mast year, several ash seed collection efforts were organized. One example include a collaboration between Holden Forests & Gardens and the Great Lakes Basin (GLB) Forest Health Collaborative to collect seeds from as many lingering ash trees as possible (Garden, 2022). They plan to use the collected seeds for research and breeding efforts. A summary of their approach, including outreach to volunteers and news outlets, can be found here.

During the 2022 field season, I collected approximately ½ of black ash seeds in Milton, VT, which Jason Mazurowski recently planted in Woodbury, Vermont. If the planting was successful, Jason expects that the seedlings will emerge next year. Beyond this one effort, I do not know of anyone who has collected or is currently collecting black ash seeds in Vermont. Given the patchiness of the Vermont landscape, it's likely that the state's forested wetlands hold a genetically diverse assemblage of black ash. To maximize the genetic diversity of black ash seeds in long-term storage, it is recommended that Vermont undertake ash seed collection efforts. This could be state-organized, but should occur in conjunction and in conversation with regional ash seed collection efforts. Additionally, if lingering ash are detected in Vermont' long-term monitoring plots, seeds from these trees should certainly be collected and shared with various research and facilities who are working on breeding resistant ash.

SUPPORT FOR BLACK ASH POUNDING TECHNOLOGIES

While many basketmakers pound by hand, some use mechanical pounders to process black ash logs into splints (Figure 22). This process is more efficient and less physically taxing. Over the last year and a half in Vermont, there have been rumblings about developing mechanical pounders that would allow folks to process more black ash before EAB spreads throughout the state. Given the connections to this project, it is important to stay aware of these developments.

Figure 22. Black ash pounding event in the Nulhegan Basin during May, 2022.

Current efforts towards building a black ash pounder in Vermont include the following:

- Chris Callahan (UVM Extension) has been working on a prototype with help from Kerry and Richard Wood.
- Chief Don Stevens has mentioned that, pending acceptance of a grant, he will be working with UVM to develop an ash pounding machine to process ash splints.

SUPPORT FOR COMMUNITY ASH POUNDING EVENTS

Over the last year and half, there have been several ash pounding events around the state of Vermont. Examples include:

- Ash Pounding Event at the Ethan Allen Homestead in April, 2022 (Figure 22)
- Ash Pounding Event at the Nulhegan Basin in May, 2022
- Ash Pounding Demonstration at the County Foresters Retreat in September, 2022

Future events will require black ash logs, and may be a good opportunity to connect landowners with basket tree harvesters. The events also require planning, input, and outreach that the project can help to inform. Additionally, attending these events is a wonderful opportunity to hear stories, develop connections, and partake in the communal rhythmic pounding experience.

SUPPORT FOR BLACK ASH SPLINT STORAGE

Ongoing processing of black ash for the purpose of saving splint material requires the capacity for black ash storage, which is another focus for black ash basketmakers. This includes storing both logs in ponds, as well as processing and saving splint materials. Currently, we have not come across any examples of splint storage in Vermont. However, there is interest and enthusiasm for establishing some sort of storage facility. Folks who have been involved in these conversations include Nancy Patch, Kerry and Aaron Wood, and Laura Edling. Again, while explicitly investing in this project is currently beyond the scope of the Black Ash Project, it is important to keep tabs of ongoing developments and conversations on the topic of black ash splint storage.

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REFERENCES

Akwesasne Task Force on the Environment (ATFE), S. R. M. T., USDA-APHIS PPQ. (2014). *Akwesasne Mohawk Territory Emerald Ash Borer Community Response Plan*. https://forestadaptation.org/sites/default/files/demonstration-files/Akwesasne%20Mohawk%20Territory%20EAB%20Response%20Plan%20Final%20121415%20Part1.pdf

Benedict, L., & David, R. (2000). *Handbook for black ash: preservation, reforestation/regeneration*. Mohawk Council of Akwesasne, Department of Environment.

Benedict, L., & David, R. (2003). Propagation Protocol for Black Ash (Fraxinus nigra Marsh.). *Native Plants Journal*, *4*(2), 100-103. https://doi.org/10.3368/npj.4.2.100

Benedict, M. A., & Frelich, L. E. (2008). Site factors affecting black ash ring growth in northern Minnesota. *Forest Ecology and Management*, *255*(8-9), 3489-3493.

Bolton, N., Shannon, J., Davis, J., Grinsven, M. V., Noh, N. J., Schooler, S., Kolka, R., Pypker, T., & Wagenbrenner, J. (2018). Methods to improve survival and growth of planted alternative species seedlings in black ash ecosystems threatened by emerald ash borer. *Forests*, *9*(3), 146.

Cappaert, D., McCullough, D. G., Poland, T. M., & Siegert, N. W. (2005). Emerald ash borer in North America: a research and regulatory challenge. *American Entomologist. 51 (3): 152-165.*, *51*(3).

Costanza, K. K., Livingston, W. H., Kashian, D. M., Slesak, R. A., Tardif, J. C., Dech, J. P., Diamond, A. K., Daigle, J. J., Ranco, D. J., & Neptune, J. S. (2017). The precarious state of a cultural keystone species: tribal and biological assessments of the role and future of black ash. *Journal of Forestry*, *115*(5), 435-446.

Davis, W. B., Joseph. (2010). *Dawn Land* (First Edition ed.). First Second. (First Second
)

Department of Forests, P., & Recreation. (2021). *Emerald Ash Borer: Information for Forest Landowners*

Diamond, A. K., & Emery, M. R. (2011). Black ash (Fraxinus nigra Marsh.): Local ecological knowledge of site characteristics and morphology associated with basket–grade specimens in New England (USA). *Economic botany*, *65*(4), 422-426.

Everett, T. D. U. o. M. (2019). *EAB RESPONSE: An Ash Resource Inventory Field Manual*. https://www.maine.gov/dacf/php/caps/EAB/documents/Ash_Resource_Inventory_Field_Manual_Everett.pdf

Flower, C. E., Knight, K. S., & Gonzalez-Meler, M. A. (2010). Using stable isotopes as a tool to investigate impacts of EAB on tree physiology and EAB spread. Proceedings of the Emerald Ash Borer Research and Technology Development Meeting. Forest Service Health Technology Enterprise Team, Pittsburgh, PA,

Francis, E. (2023). *Brown Ash Seed Collection Manual:*

Preserving Brown Ash (Fraxinus nigra, wikp/wiskoq) through the Ash Protection Collaboration Across Wabanakik, APCAW. https://umaine.edu/apcaw/wp-content/uploads/sites/668/2023/03/Ash-Seed-Collection-Manual_Version2-2_Feb2023-1-compressed.pdf

Garden, H. F. (2022, Fri., Oct. 21, 2022). *Ash Trees Are Exploding with Seeds; Researchers Are Capitalizing on It* https://holdenfg.org/news/ash-trees-are-exploding-with-seeds-researchers-are-capitalizing-on-it/

Knight, K. S. (2010). *Methods for collecting ash (Fraxinus spp.) seeds*. United States Department of Agriculture, Forest Service, Northern Research ….

Rainie, S. C., Kukutai, T., Walter, M., Figueroa-Rodríguez, O. L., Walker, J., & Axelsson, P. (2019). Indigenous data sovereignty.

Rebek, E. J., Herms, D. A., & Smitley, D. R. (2008). Interspecific variation in resistance to emerald ash borer (Coleoptera: Buprestidae) among North American and Asian ash (Fraxinus spp.). *Environmental Entomology*, *37*(1), 242-246.

Smith, A. (2006). *Effects of community structure on forest susceptibility and response to the emerald ash borer invasion of the Huron River watershed in southeast Michigan* The Ohio State University].

Thompson, E. H., Sorenson, E. R., & Zaino, R. J. (2019). *Wetland, Woodland, Wildland: A Guide to the Natural Communities of Vermont, 2nd Edition*. Vermont Fish & Wildlife Department. https://books.google.com/books?id=yHmlxAEACAAJ