REGIONAL FOREST HEALTH MONITORING PROGRAM

2025 Report

Forest Ecosystem Monitoring Cooperative

Last updated: April 2026

Regional Forest Health Monitoring Program: 2025 Report

Published
Version 1.0
Forest Ecosystem Monitoring Cooperative
South Burlington, VT, USA
femc@uvm.edu
(802) 656-2975

Benjamin Porter, Soren Donisvitch, Nancy Voorhis, Alexana Wolf, Matthew Rios, Elissa Schuett, Alison Adams, and Jennifer Pontius

DOI: https://doi.org/10.18125/9921gk

Cover image: Matthew Rios

Preferred Citation
Porter B, Donisvitch S, Rios M, Sirch M, Voorhis N, Wolf A, Schuett E, Adams A, and Pontius J. 2026. Regional Forest Health Monitoring Program: 2025 Report. Forest Ecosystem Monitoring Cooperative. South Burlington, Vermont.
https://doi.org/10.18125/9921gk

Acknowledgements

The Forest Ecosystem Monitoring Cooperative (FEMC) is grateful for the guidance and support provided by the numerous partners that helped make regional monitoring possible, as well as all the state employees that assisted FEMC FHM crews at campsites and with accessing gated roads.

We would also like to thank our field technicians for all their hard work braving the elements to collect data during the summer months: Lindsey Muench, Olivia Bernier, Lillian Cyr, Alannah Fleming, Aidan Justino, Christian Baker, Amelia Ritt, Amelia Weeden, Ben Anderson, Rita Narbonne, Luly Kaye, Simon Loomis, Garrett Garbry, Bjorn Myglund, and Andrew Hahn. We are appreciative of the long-term funding and support from the U.S. Department of Agriculture Forest Service, Vermont Agency of Natural Resources, and the University of Vermont.

Additionally, FEMC recognizes that its service region consists of unceded lands of approximately 50 Indigenous nations. FEMC also recognizes the historical and ongoing violence inflicted by Western colonial powers on these lands and peoples, including attempts to erase their traditions, culture, and knowledge. FEMC is committed to including consideration of both this history and ongoing colonization and land dispossession in its work; incorporating and amplifying Indigenous voices in projects and organizational governance; including different ways of knowing in its science; and explicitly recognizing the history of Indigenous peoples in its many fora, from meetings to publications. FEMC acknowledges that this is merely a first step in an ongoing process of justice.

Table of Contents

Table of Contents 4

Executive Summary 6

Background 7

Forest Threats 7

2025 Methods Summary 8

Field Metrics 8

Field Crew and Calibration 8

Data Analysis 8

Results & Discussion 10

2025 Focused Results 10

Overstory Composition 10

Tree Health 12

Agents of Change: Tree Damage, Browse, and Invasive Plants 15

Tree Regeneration 17

Saplings 17

Seedlings 18

Jumping Worms 20

Regional Temporal Analyses (Trends) 21

Section 1. Tree Analyses (Regional) 21

Dieback Trends (Regional) 25

Transparency Trends (Regional) 25

Vigor Trends (Regional) 26

Annual Growth and Mortality Trends – Trees (Regional) 28

Total Composition - Trees (Regional) 31

Northeast Regional Ash Health Dashboard - Trees (Regional) 32

Northeast Regional Beech Health Dashboard - Trees (Regional) 34

Northeast Regional Oak Health Dashboard - Trees (Regional) 36

Section 2. Sapling Analyses (Regional) 38

Annual Growth and Mortality Trends – Saplings (Regional) 39

Total Composition – Saplings (Regional) 41

Section 3. Seedling Analyses (Regional) 42

Annual Growth and Mortality Trends – Seedlings (Regional) 43
Annual Seedling Density Trends (Regional) 44
Conclusions 47
References 49
Appendix i

Executive Summary

In 2025, FEMC visited 172 plots from CT (15), MA (25), ME (11 out of 35), NH (25), NY (40), RI (7), and VT (49). Due to funding limitations and hiring logistics, our partners in Maine were unable to complete their survey of the monitoring plots in Maine; FEMC was able to visit the 11 Maine plots nearest to FEMC headquarters at the end of the monitoring season.

Results from the 2025 monitoring season indicate that red maple (*Acer rubrum*), sugar maple (*Acer saccharum*), and eastern hemlock (*Tsuga canadensis*) were the most abundant species across the 172-plot network. Based on the 5,926 trees (5+ inch DBH) measured, average live overstory tree density in 2025 was 173 stems per acre (SPA) and 131 ft^2/ac basal area. Regeneration assessments show sapling densities of 4,534 live SPA with balsam fir (*Abies balsamea*) and American beech (*Fagus grandifolia*) representing the most abundant species. Red maple was the most abundant seedling tallied in 2025, followed by sugar maple, and eastern white pine (*Pinus strobus*). While there are a wide range of stressors and vulnerabilities impacting Northeastern forests, data from the 2025 season suggest that the region's forests are generally diverse, vigorous, and healthy. While network-wide averages indicate generally good condition, they mask emerging species-specific and structural concerns.

However, there are notable exceptions that we should continue to monitor. From the 2025 crown health assessments, we determined that American beech, black oak (*Quercus velutina*), and American mountain-ash (*Sorbus americana*) are species of concern. Average vigor ratings for these species were 2.2, 1.9, and 2.1, respectively (where 1 is healthy and 4 is severe decline). The percent of fine twig dieback for these species was 23%, 14%, and 15% of the tree crown. With the recent spongy moth outbreaks across the Northeast, we recorded 2% of oaks with >30% defoliation. This highlights the importance of continuing annual assessments to better understand trends, patterns and drivers of change for the state's forested ecosystems.

2025 represents the fourth year of regional data in our plot network; as a result, we have included both regional- and state-wide time series analyses in this year's summary report. State-specific figures can be found in the 2025 State Supplemental Figure Package (available at: https://doi.org/10.18125/8j574j). Regionally, we observed continued trends of decline for many aspects of crown health between 2022 and 2025. Both transparency and dieback continue to increase across species, while vigor is declining. The mean basal area of standing dead trees has increased in our plots from 2022 to 2025, a trend that appears to be largely influenced by white ash, red maple, and northern red oak. Regeneration trends indicate balsam fir and American beech saplings are the most abundant species in the understory. After a significant seed crop year for red maple and white pine seedlings in 2024 with large increases in seedling densities compared with prior years, seedlings appeared to return to baseline in 2025. It is important to note that with only four data points (2022, 2023, 2024, and 2025), our confidence in these trends is moderate but growing, as these trends are consistent with those observed last year. As we gather additional data in subsequent years, trend observations will become more robust. Due to the missing 24 Maine plots in 2025, some results and trends may be affected by the lower sample size.

Background

Forest health monitoring is a critical tool to understand how forests change and respond to stressors such as climate change, invasive species, pests and pathogens, and land use. As these stressors become more prevalent in the Northeast, robust annual forest health monitoring can provide important insights on how these disturbances are affecting forests in the region.

FEMC has been visiting a network of long-term forest monitoring plots in Vermont since 1991. By the 2022 field season, the Forest Ecosystem Monitoring Cooperative (FEMC) had worked with state partners in Connecticut, New Hampshire, New York, Maine, Massachusetts, and Rhode Island to expand the Forest Health Monitoring (FHM) network to include permanent plots in each of the seven northeastern states. In most cases, these FHM plots were co-located with each state's existing Continuous Forest Inventory (CFI) or Forest Inventory and Analysis (FIA) plot network and were designed to complement the state's network with annual measurements (vs. the more typical 5- to 10-year rotation for re-measurements) on a subset of existing FIA or CFI plots. Replicating these protocols from CFI and FIA plots allows easy comparison with data from other long-term monitoring programs, thus expanding the impact of FEMC data.

For more details on plot establishment, protocols, methods, and program history, please refer to our 2025 FHM Methods document (available at: https://doi.org/10.18125/75t265).

Forest Threats

Although overall the forests represented by our plot network are healthy and robust, Northeastern forests currently face multiple threats, including invasive species, vector-borne diseases, abiotic damages, and other forest health concerns. Common insects of concern include the eastern spruce budworm (*Choristoneura fumiferana*), emerald ash borer (EAB; *Agrilus planipennis*), hemlock woolly adelgid (HWA; *Adelges tsugae*), elongate hemlock scale (*Fiorinia externa*), and spongy moth (*Lymantria dispar dispar*), while emerging threats like southern pine beetle (SPB; *Dendroctonus frontalis*) and elm zigzag sawfly (*Aproceros leucopoda)* are being closely monitored. Beech bark disease and the rapidly expanding beech leaf disease are causing extensive impacts to American beech (Stephanson and Coe, 2017; Kantor, Demirel, and Kantor, 2025), and white pine needle damage remains prevalent across the region, likely exacerbated in some areas by anomalous precipitation and temperature fluctuations (Wyka et al., 2016). Invasive plants and persistent deer browse are added stressors affecting forest regeneration and composition. These biological stressors, combined with increasing swings between heavy rainfall, flooding, drought, and early frosts, as well as wildfire in southern New England, are all playing a major role in forest health across the region.

2025 Methods Summary

Below is a summary relating specifically to the 2025 field season. For further details on plot selection, layout, training, QAQC procedures, field metrics, and equipment specifications, refer to the 2025 FHM Methods document (available at: https://doi.org/10.18125/75t265).

Field Metrics

In 2025 FEMC inventoried 172 out of the 196 total plots in the regional network, missing 24 plots in Maine due to budgetary and logistic hurdles in Maine. In addition to tree biometry and health in the overstory plot; regeneration assessments that include seedling tallies by species and size class; and sapling biometry and health (e.g., species, diameter, status) assessments in the four subplots; jumping worm presence/absence surveys were included in the sampling at all FHM plots in 2025. Other metrics, including animal browse, invasive plants, and forest composition (prism plots), were collected at the overstory plot level. Detailed methods for each metric are provided in the 2025 FHM Methods document.

Field Crew and Calibration

During the 2025 FHM field season, three crews consisting of 3-4 technicians conducted monitoring in Massachusetts, New Hampshire, Connecticut, Rhode Island, Maine, and Vermont. Through a partnership with FEMC, crews from the New York DEC completed plots in New York. These crews were trained by both FEMC staff as well as Vermont Forests, Parks, and Recreation (FPR) personnel on forest health metrics before the FHM field season. FPR forest health specialists also led calibration of crew members conducting crown health assessments to ensure standardization of ratings from year-to-year. Additionally, all technicians were informed of FEMC's field standards of practice. All technicians were trained in the proper use of forestry equipment, including DBH tapes, hypsometers, compasses, GPS units, remote tablets for data entry, prisms, and other tools.

Data Analysis

Data from the 2025 field season were analyzed across 172 regional FEMC FHM plots. Overstory composition was computed in several different metrics for each species, including total stems (N), average stems per acre (SPA), basal area (ft^2/acre; BA), percent composition, and importance value (IV). Total stems and average trees per acre provide raw metrics of forest composition, while basal area and percent composition provide more information on the prevalence of each species relative to the total stocking. All standing trees, including living and standing dead trees (vigor ratings 1-5), were included in most analyses for overstory trees. However, in some analyses, it was appropriate to include only live trees (vigor ratings 1-4). The importance value is a representation of how dominant a species is in a given forest, and is calculated as follows for a given species:

$$\left(\left(\frac{SPAspecies1}{SPAallspecies}\right) + \left(\frac{TotalBAspecies1}{TotalBAallspecies}\right)\right) \div 2 \times 100\%$$

*SPA = Stems Per Acre; BA = Basal Area

Results & Discussion

2025 Focused Results

In 2025, FEMC FHM crews measured 5,431 live trees, 9,699 live saplings, and tallied 37,781 seedlings across the 172 FEMC FHM plots. Below, we provide summaries of data collected from the 2025 field season..

Overstory Composition

We found that species composition across the 172 plots was broadly similar in dominant species and relative composition patterns, according to FIA data (USFS 2024, Figure 2). We attribute some notable discrepancies to the lack of Maine data in 2025 (e.g., the near-complete lack of Northern white cedar in this year's inventory).

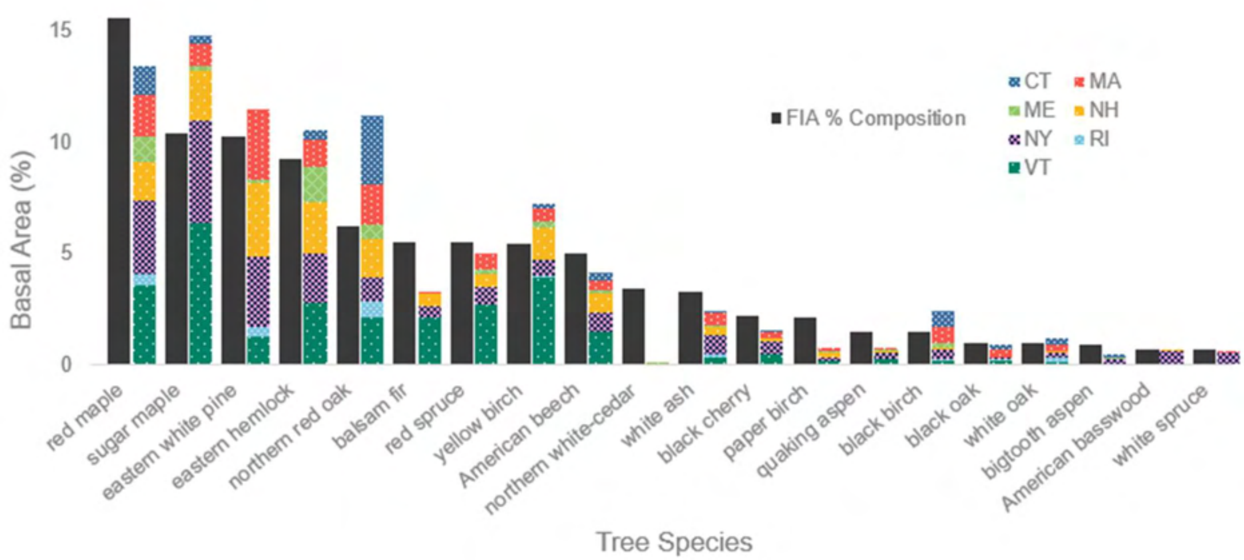

Figure 1. A comparative analysis between FEMC FHM and the USFS FIA species compositions, showing percent live species composition by basal area for CT, MA, ME, NH, NY, RI, and VT from both the FHM 2025 season and the FIA 2024 season (USFS 2024) (only trees with ≥5 inch DBH were included).

Across the 172 FEMC FHM plots sampled in 2025, there were a total of 5,431 live and 433 standing dead trees (see Appendix, Table A1). For live trees, this represents an average of 173 live stems per acre (SPA) and basal area (BA) of 131 ft^2/ac. Standing dead trees averaged 14 SPA and a BA of 13 ft^2/ac. The total BA (live and standing dead) was 144 ft^2/ac, which may be too high to encourage regeneration, especially for shade-intolerant species. Only 8% of standing trees sampled were dead snags. Note that dead trees are no longer sampled after being recorded as dead for 5 years, thus the number of sampled dead trees does not represent all dead trees in the plots. Across the survey area, hardwoods comprised 67% of the total overstory composition by live stem count. Red maple had the greatest live SPA (30), followed by sugar maple (26 SPA) and eastern hemlock (17 SPA). Red maple also had the highest live IV (15.5%) and BA of 18 ft^2/ac across all plots. Sugar maple had the second highest live IV (15%) with a BA of 20 ft^2/ac, followed by eastern hemlock (10.4%, BA 14 ft^2/ac) and eastern white pine (9.1%, BA 15 ft^2/ac).

The distribution of size classes across the FEMC FHM plot network in 2025 reflects the complex land use and disturbance history of forests in the northeastern United States. Much of this region was cleared for agriculture during the eighteenth and nineteenth centuries, with widespread agricultural abandonment beginning in the mid-twentieth century (Hall et al. 2002). While these forests have had several decades to regenerate, the dominance of trees in the 5–15 inch diameter size class likely reflects not just successional age, but ongoing recruitment of new stems and the legacy of more recent periodic logging that has periodically reset stand development across the landscape. Some larger trees persist that measure greater than 30 inches DBH, particularly of eastern white pine, northern red oak (*Quercus rubra*), red maple, and yellow birch (*Betula alleghaniensis*). As these stands continue to age, we can expect to see these numbers of large stems increase, particularly for late successional species such as eastern hemlock and sugar maple (Figure 2).

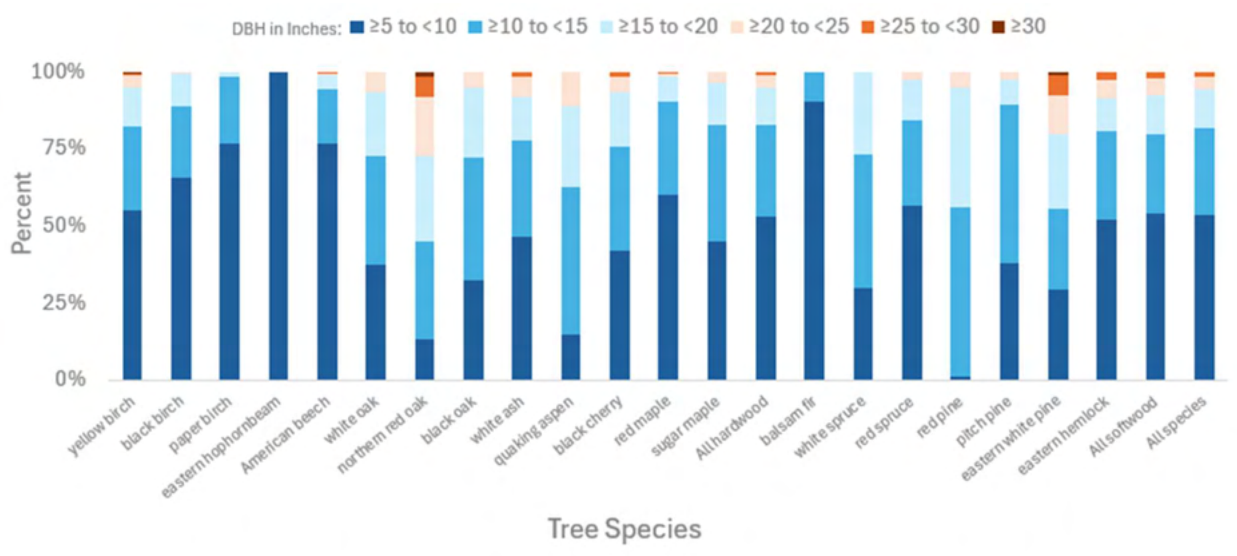

Figure 2. Size classes of live trees by diameter at breast height (DBH; inches) across FEMC FHM plot network in 2025. Species with the highest importance value were included in this chart. Dead trees and saplings (trees < 5” DBH) were excluded from this analysis.

Tree Health

Across the 172 FEMC FHM plots assessed in 2025, live tree vigor (mean ± SD) was 1.5 ± 0.7, or between *healthy* and *light* decline. Of live trees measured, we found that 4,949 trees (91.1%) had vigor ratings corresponding to *healthy* and *light decline* (vigor 1 and 2, respectively) and 482 trees (8.9%) were in *moderate* to *severe decline* (vigor 3 and 4, respectively). For tree species with more than 10 individuals measured, crown health assessments show American beech with lower vigor rating (average vigor of 2.2, where 1 is healthy and 4 is severe decline), and average crown dieback of 23%, and defoliation of 0.6 (where 1 is less than 30 percent crown defoliated and 2 is 30-60% defoliation). The overstory trees with the highest average rates of moderate or severe decline were American beech (17%), white ash (*Fraxinus americana*; 10.6%), green ash (*Fraxinus pennsylvani*; 9.1%), striped maple (*Acer pensylvanicum*; 9.1%), and white oak (*Quercus alba*; 5.1%). Across all species, <3% of total live stems surveyed were determined to be in severe decline. Overall, this points to a healthy, vigorous population of trees in the sampled plots. However, the large portion of trees in the light decline category should continue to be monitored for further decline in future years. Among all surveyed species, American beech, black cherry, and white oak had the greatest proportion of their basal area in poor vigor classes (Vigor 3 and 4), at 29%, 17%, and 15% respectively, indicating these hardwood species are experiencing the most significant decline proportionally to size class (Figure 3). Additionally, white ash, paper birch, and quaking aspen had the highest percentages of Vigor 5 (dead and standing) by basal area, indicating that these species are experiencing the greatest levels of mortality across the surveyed area by volume. Vigor trends are further shown in Figure 4, which shows that American beech, American mountain-ash, northern white-cedar*, white ash, quaking aspen, and black cherry had the highest proportion of their individual tree counts rated as having poor vigor (Vigor 3 or 4), with 35%, 33%, 33%*, 23%, 19%, and 18% of trees within each species classified as being in decline across the seven-state network.

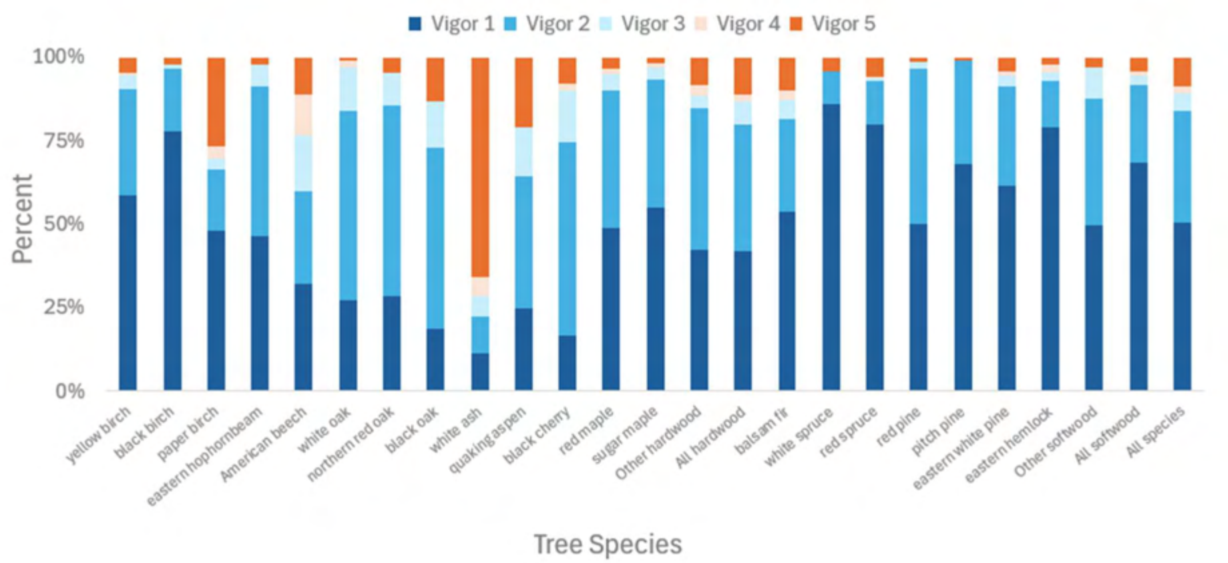

Figure 3. Average basal area per hectare (%) of each vigor rating (1 is healthiest, 2-4 is increasing decline, 5 is dead and standing) for each overstory tree species. Tree species with the highest importance (abundance) values were included.

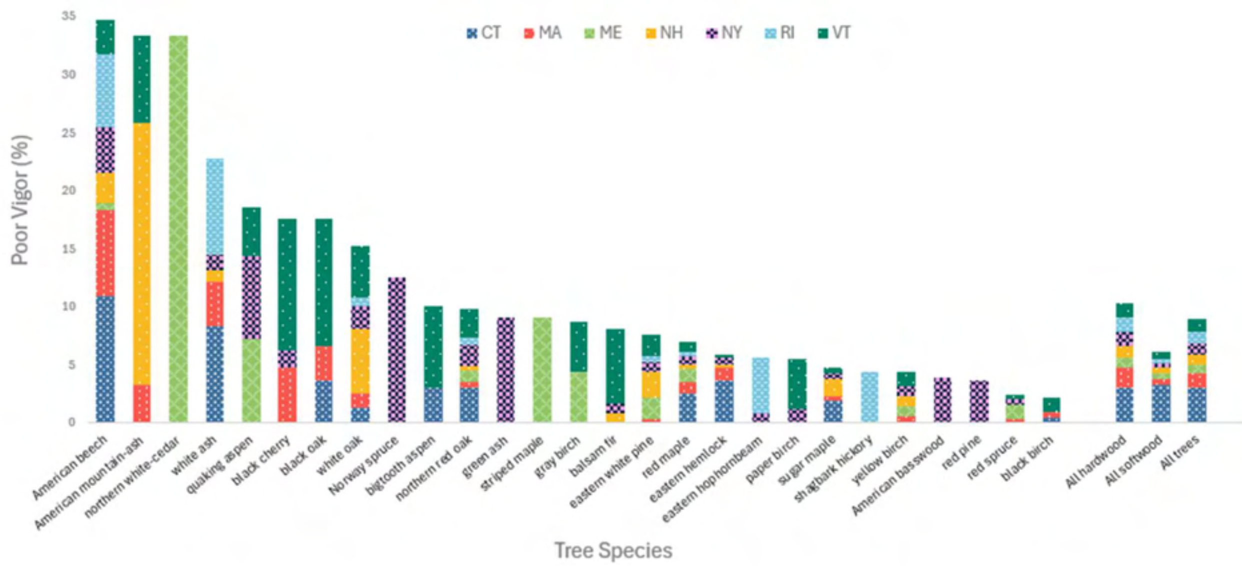

Figure 4. Percentage of trees with a 'poor vigor rating' sampled in 2025 across the seven states in the plot network, including only species with at least 10 individuals measured. Percent poor vigor is the proportion of live trees by species that were classified to be 'in decline' (vigor ratings of 3 or 4). Each bar represents the percentage of trees of that species that had vigor ratings of 3 or 4. *Northern white cedar values are impacted by a low sample size in Maine in 2025.

Across all live trees, average fine twig dieback was 11.3%. American beech had the highest mean dieback at 22.8%, while white ash and northern white cedar (*Thuja occidentalis*) had 20% and 16.2% mean dieback, respectively (see Appendix, Table A2). However, dieback results for northern white cedar in 2025 may have been affected by the reduced sample size owing to logistical issues visiting Maine plots, where a substantial proportion of our northern white cedar sample is located. These values do not suggest widespread crown health issues, but certain species or genera (e.g., oaks) should continue to be monitored for widespread changes in dieback over time.

Across all live trees, average foliar transparency ranged from 21% to 33% (Table A2). Transparency is rated the same way across all species; however, each species has a different range of commonly observed transparency ratings due to the natural structure of each species crown. Trees that reached a higher transparency value of ≥30% include American beech, white ash, black cherry (*Prunus serotina*), and quaking aspen (*Populus tremuloides*) (Figure 8; Table A2). Foliar discoloration impacted American beech the most with a mean discoloration estimate of 0.9 (Table A2), only slightly higher than all other species measured, which averaged a discoloration score of 0.1 (zero to trace discoloration on average). A score of 1 for discoloration indicates 1-30% of the crown was discolored.

Defoliation rates were highest among American beech, but still with mean defoliation rates below 1 (no or trace defoliation; Table A2). Nearly every hardwood species saw some low level of defoliation, with very minimal to no defoliation recorded on softwood species. In several plots spongy moth caterpillars and egg masses were observed on the trunks of the trees.

Agents of Change: Tree Damage, Browse, and Invasive Plants

Refer to Table 1 for an overview of tree damages recorded per species, and Table A4 in the Appendix for a list of special damages we record in our plots. In 2025, damage related to beech bark disease (BBD) was the most common damage agent recorded across plots. In total, 43% of the plots (74) were impacted by BBD and approximately 82% of live American beech trees showed symptoms of the disease (Figure 22). Another prevalent damage was crack and seam, which occurs when a tree splits due to weather. This damage was present on 51% of plots (87) and impacted 3% of live trees. Evidence of browse was recorded on 94% of plots (162), which is likely a primary driver of regeneration trends in the region. For invasive species, we found 3% of plots (6) with buckthorn present, 3% of plots (5) containing honeysuckle, and 2% of plots (3) containing barberry.

Table 1. Damages recorded on live trees across the 172 FEMC FHM plots in 2025. Damages are shown as the percentage affected per species. Note that damages that were not obvious or visible from the ground were not recorded. For example, eastern hemlock trees that were surveyed may have appeared discolored and/or showed symptoms of hemlock woolly adelgid (HWA), but often we cannot confirm the presence of HWA. Specific damage percentages for each species are available upon request but are not shown in the table to preserve legibility.

Species	Total # live trees	Damage recorded (%)
American beech	389	93
sugar maple	804	39
green ash	22	31
red maple	955	30
blackgum	8	25
white ash	123	24
eastern hemlock	545	18
striped maple	11	18
Am. mountain-ash	18	16
northern red oak	288	16
quaking aspen	27	14
black cherry	74	12
American basswood	26	11
chestnut oak	9	11
balsam fir	412	10
black birch	190	9
yellow birch	392	8
shagbark hickory	23	8
eastern hophornbeam	36	8
northern white-cedar	12	8
black oak	40	7
red spruce	299	7
paper birch	74	6
Norway spruce	16	6
gray birch	23	4
eastern white pine	355	3
white oak	59	3
pitch pine	37	2
red pine	82	2
All live trees	**5,431**	**24**

Tree Regeneration

Saplings

Fifteen (15) out of 172 plots did not contain any saplings within the plot's four microplots. There were 9,699 living saplings across the remaining 157 plots, with 411 stems per acre (SPA) (see Appendix, Table A3). The tree layer displayed the lowest species diversity of the three strata (trees, saplings, seedlings). Across all plots, there were 31 different species recorded in the sapling plots, compared to 46 tree species and 44 seedling species. The number of sapling species recorded per plot ranged from 0 to 8. We found that balsam fir (33% of the total sapling composition), American beech (15%), and red spruce (11%) were the most abundant species in the sapling layer (Table A3). American beech stems were likely suckers based on their small size and due to the prevalence of BBD on mature trees (see Agents of Change section).

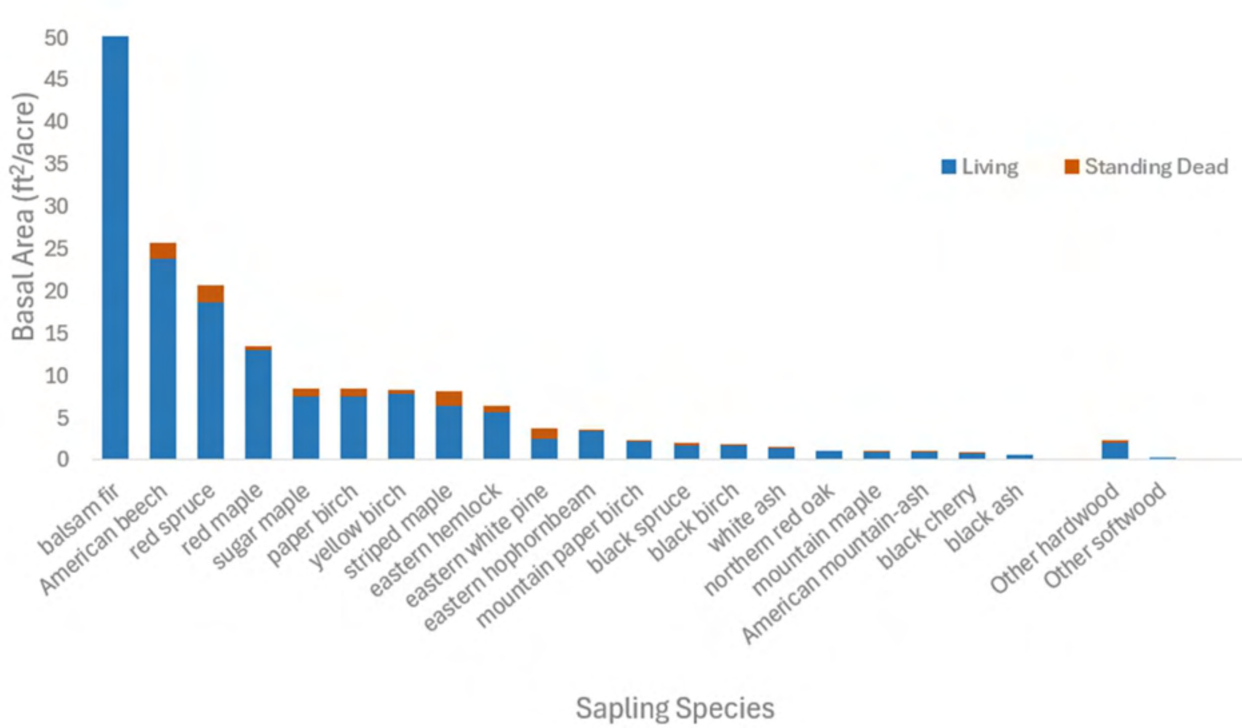

Figure 5. Basal area (ft^2) per hectare for most common sapling species, including live saplings (status 1) and standing dead saplings (status 2).

Seedlings

In total, 37,781 seedlings were tallied across the regeneration microplots in 2025 (Table 2). Of all seedlings counted, 91% (34,537) were classified as class 1 (hardwood seedlings <12 inches tall and softwood seedlings <6 inches tall) while 9% (3,244) were classified as class 2 (more established; hardwood <12 inches and softwood <6 inches tall). Seedling counts per plot ranged from 0 to 1,547 seedlings per plot. There was an average density of 19,084 stems per acre (SPA) across the 172 plots assessed in 2025. Seedling diversity was high within microplots with seedlings identified for a total of 37 species, and 7 genera where species identification was not clear. Species diversity per plot ranged from zero to 13 unique species, and there did not appear to be a relationship between the number of species in the overstory trees and the number of species in the understory (paired t-test using R; $t(171) = 0.19878$, $p = 0.84267$). Red maple was the most abundant seedling tallied in 2025 (48%, 9,187 SPA), followed by sugar maple (11%, 2,165 SPA), and eastern white pine (10% composition, 1,907 SPA). Seedling densities are subject to yearly shifts due to changing weather conditions (e.g., available precipitation), herbivory, and seed availability (e.g., masting events). Many seedlings do not survive beyond their first year. Therefore, while we present seedling counts for 2025, stronger conclusions about shifts in forest composition and density can be made by tracking seedling survival over multiple years (Figures 31-34).

Table 2. Seedling composition across FEMC FHM plots in 2025 showing total seedling (<1 inch DBH) count as well as class 1 (hardwood <12 inches tall, softwood <6 inches tall) and the more established class 2 (hardwood ≥12 inches tall, softwood ≥6 inches tall). Average density of stems per acre (SPA) and percent composition (%) of the seedling layer is also included. To accommodate for space, species below 25 SPA are not listed.

Species	Seedling count	Class 1	Class 2	SPA	%
red maple	17,913	17,796	117	9,187	48
sugar maple	4,640	4,547	93	2,165	11
eastern white pine	3,710	3,411	299	1,907	10
striped maple	2,384	1,990	394	1,203	6
balsam fir	2,135	1676	459	1049	5
northern red oak	1341	1299	42	723	4
American beech	1432	622	810	696	4
red spruce	567	340	227	293	2
eastern hophornbeam	572	366	206	287	2
white ash	513	406	107	276	1
yellow birch	586	530	56	274	1
Am. mountain-ash	354	340	14	160	0.8
serviceberry	239	181	58	130	0.7
black cherry	196	142	54	104	<0.1
black birch	169	95	74	93	<0.1
eastern hemlock	188	98	90	91	<0.1
white oak	145	102	43	79	<0.1
Birches*	125	124	1	70	<0.1
red alder	83	83	0	47	<0.1
bitternut hickory	58	38	20	32	<0.1
black oak	63	62	1	30	<0.1
quaking aspen	57	53	4	28	<0.1
paper birch	48	39	9	23	<0.1
mountain maple	42	29	13	19	<0.1
shagbark hickory	28	25	3	16	<0.1
Other hardwood	160	114	46	83	<0.1
Other softwood	33	29	4	19	<0.1
All species	**37,781**	**34,537**	**3,244**	**19,084**	**100**

*seedlings were identified to genus when species was unknown

Jumping Worms

Evidence of jumping worms was identified in only 8 FHM plots (Figure 6), though it is likely that jumping worms were not located in some plots where they are present due to misalignment with sampling locations or crew error. Eight detections do not represent sufficient information to estimate jumping worm distribution across the FEMC service area; however, FEMC intends to continue surveying for jumping worms as part of the FHM protocol for several more years with the hope of being able to better estimate distribution across the region.

Jumping worms were found across a variety of forest types and locations, though we note that 5 out of the 8 detection locations were in forests with a significant maple component. This may be due to the prevalence of maple across the Northeast landscape, or it may be due to the nutrient density of the leaf litter in maple-dominated stands. UVM Professor Josef Gorres has noted that maple forests seem to be particularly susceptible to jumping worms.

More information on jumping worm detection methods and results are available in our jumping worms monitoring brief.

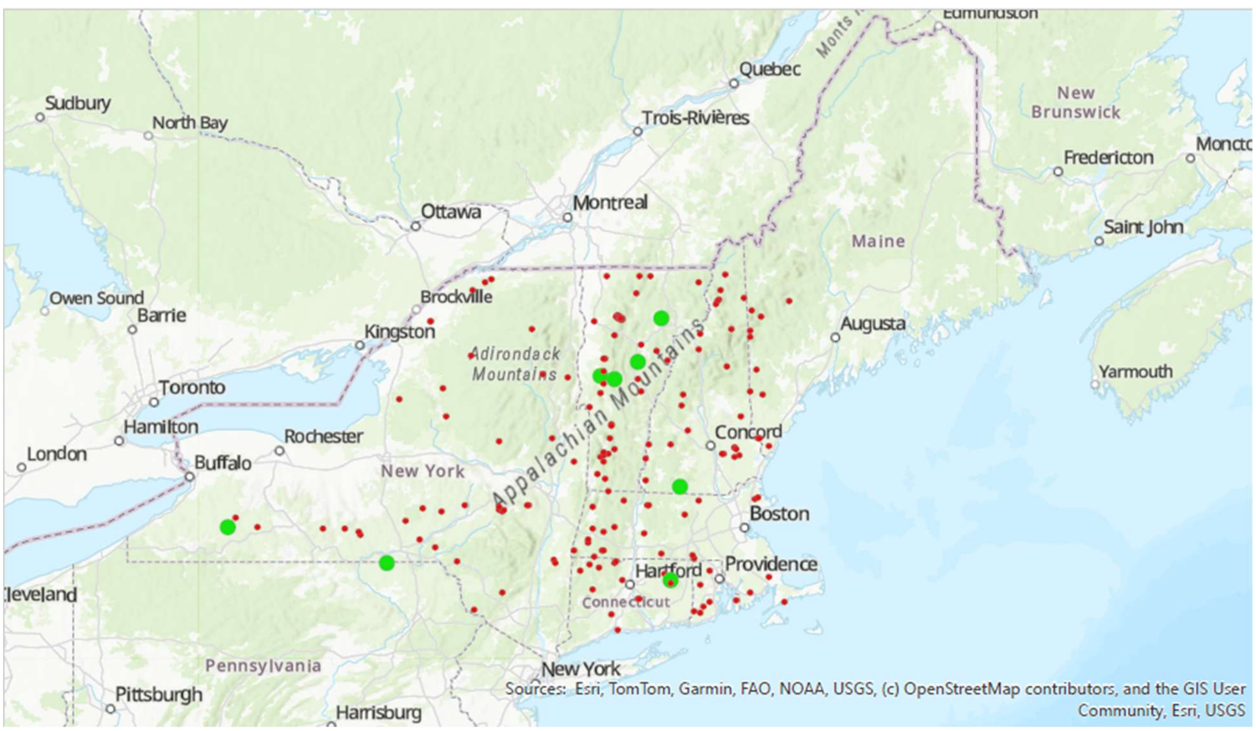

Figure 6. FHM plots visited in 2025 where jumping worms were present (green) and absent (red).

Regional Temporal Analyses (Trends)

Section 1. Tree Analyses (Regional)

The 2025 field season was the fourth year of region-wide sampling for the Northeast FHM network. As such, the data provide a clearer assessment of recent temporal trends in forest health and condition. While four years still represent a short window for detecting long-term ecological change, the addition of 2025 data substantially improve confidence in trend direction compared to the preliminary patterns described in the 2024 report. As we gather additional years of data, our confidence grows that observed changes reflect true responses to stressors. While we are currently still limited in distinguishing long-term regional trends from short-term interannual variability due to our small temporal sample size, each additional year of data provides increased confidence in the repeated directional signals we have observed.

State-level figures are provided in the supplementary materials accompanying this report (see 2025 State Supplemental Figure Package, available at: https://doi.org/10.18125/8j574j). However, due to sample size limitations, sapling growth and mortality remain best interpreted at the regional scale.

It is important to note that due to logistical reasons, we were only able to visit 11 of the 35 Maine plots in 2025. Therefore, there may be some differences in the Maine data reflected in this year's report that are not necessarily reflective of statewide trends. We will return to visit all Maine plots in the 2026 season.

Crown Condition: Dieback & Transparency

For many of our species with high importance values, average crown transparency and fine-twig dieback increased from 2022 through 2025. Our 2025 data show that these trends have persisted, rather than reversing or leveling off. White ash and American beech lead among those exhibiting the highest fine-twig dieback in 2025, with both species at and exceeding 20% dieback respectively (Figure 7; Table A2).

Elevated dieback may indicate continued stress from swings between drought and excessively moist years (see Appendix, Figure A2), persistent disease (oak wilt, beech leaf disease, emerald ash borer, white pine needle damage, etc.), and/or other ongoing factors. For example, eastern white pine's consistently increasing dieback observed in our plots across study years (Figure 7) may be a result of stress from concomitant precipitation fluctuations and white pine needle damage (Wyka et al., 2016; USFS Forest Health Highlights, 2024b,d,e,f). Beech leaf disease is likely responsible for worsening branch dieback, transparency, and discoloration among American beech (Figure 7; Table A2), as infected trees are likely to exhibit these symptoms (Kantor, Demirel, and Kantor, 2025).

Notably, emerald ash borer (EAB) has continued to spread throughout much of New England and New York (USFS Forest Health Highlights, 2024 a,c,d,e), a trend reflected by increasing EAB damage and declining ash health in our plots (Figure 7; Figures 19-20). The majority of Massachusetts and Vermont counties have detected EAB, with EAB now present in all but one county in the latter state (personal communication, 2025). Our white ash transparency and dieback results align with the endemic progression of EAB infestation that begins with thinning in the outer crown before escalating to branch dieback (Flower et al., 2013). Given the frequency of EAB in our plots, rising dieback could indicate progressive infestation among white ash trees that were reported as having

EAB damage in previous years. EAB may further stress crown health during years with lower precipitation, which 2025 falls into (Figure A2), as EAB attacks water-transporting tissues within ash trees (Flower et al., 2013). Higher rates of EAB damage in 2023 in Figure 19 are likely due to field crew error and over-estimation of EAB rather than a spike in occurrence during that specific year.

Climate and other stressors may be similarly affecting overstory transparency (Figure 8; Table A2). Black cherry, northern white cedar, and white ash are consistently showing elevated transparency for their proportion of total basal area. Black cherry transparency increased in 2024 (Porter et al., 2025) followed by a return to baseline in 2025, which strengthens the hypothesis that black cherry was responding to moisture stress and fungal issues associated with the unusually wet summer of 2023 (Figure A2). These wet conditions persisted through 2024 but had diminished by 2025, which is reflected in current black cherry transparency metrics. However, black cherry vigor declined in 2024 and did not rebound in 2025, suggesting that some effects of previous years' stressors may have persisted. Northern white cedar displays some of the greatest transparency among softwoods (Table A2), continuing a trend of elevated transparency seen in previous years (Porter et al., 2024, 2025). While still elevated, northern white cedar transparency in 2025 may appear reduced this year as an artifact of sample size, as a large portion of the FEMC network's white cedar representation is present in Maine. As a result, we cannot definitively state whether northern white cedar is recovering from stressors that may have affected it in previous years. Finally, increasing transparency among white ash is likely due to early stage EAB infestations (Flowers et al., 2013).

It should also be noted that transparency is rated without adjusting for different species' growth patterns, so species with a naturally more open canopy may rate higher on the transparency scale. As a result, observing year-over-year transparency trends within a species can be more informative than comparing absolute transparency values between species.

Tree Vigor

Aggregated vigor metrics show a clear and increasingly consistent shift toward poorer overall tree vigor across the region. The distribution of basal area among vigor classes (Figures 9-10) indicates that a smaller proportion of live basal area is now categorized as "healthy," with corresponding increases in light and moderate decline classes, continuing the trends seen in 2024. Although severe decline remains relatively uncommon, the gradual accumulation of trees in early decline classes is potentially concerning, as such changes could be warning signs of future mortality.

The vigor of species with the lowest (healthiest) average tree vigor scores in 2025 (Figure 11) has been relatively stable over the past four years. In contrast, several hardwood species with poorer average tree vigor (Figure 12) have shown a steady decline. White oak and northern red oak show notably worsening vigor ratings, which correlates with significant defoliator outbreak events over the past few years in several states regionally (Figure 24), alongside oak wilt in New York (USFS Forest Health Highlights, 2024a,b,c). Consistent white ash vigor decline is likely related to the effects of EAB and drought stress on canopy health (see previous section). Black cherry decline may be due to the lingering effects of high precipitation from previous years (Figure A2) causing water stress and facilitating black fungus pathogen infection. Another species to note is quaking aspen, which has shown high year-to-year variation in previous years. However, quaking aspen vigor declined in 2025 for a second year in a row, possibly indicating that this species may be entering a more consistent state of decline (see Table A2 in this report, and Porter et al., 2025, Table 2).

American beech displayed the poorest overall vigor in 2025 (Figure 12; Table A2). This follows the species' persistent vigor decline witnessed in previous years, likely owing to the high prevalence of beech bark disease and increasing presence of beech leaf disease observed in our plots (Figure 22) in conjunction with other regional stressors. American beech is generally intolerant of extreme precipitation and drought fluctuations; beech trees that are already stressed are more vulnerable to attacks by the pest and pathogen complexes responsible for beech bark and beech leaf diseases (Kasson and Livingston, 2012; Stephanson and Coe, 2017). Furthermore, milder winters promote overwintering by the beech scale (*Cryptococcus fagisuga*) insect responsible for beech bark disease, thereby enabling seasonal progression of the disease (Kasson and Livington, 2012). Beech leaf disease, which continues to expand throughout the Northeast (Kantor, Demirel, and Kantor, 2025), is also a key contributor to declining beech vigor. Our results align with aerial survey observations indicating the expansion of beech leaf disease throughout the region (USFS Forest Health Highlights, 2024a,b,c,d,e). As of 2024, all but 19 counties in the FEMC region have encountered cases of BLD, including every county in Connecticut, Massachusetts, and Rhode Island (see Appendix, Figure A1, USFS, 2024).

Mortality Patterns

The inclusion of 2025 data corroborate previous findings that tree mortality is on the rise but remains unevenly distributed among species and metrics. Total number of dying individuals is low and does not necessarily indicate a significant mortality event, though the elevated decline within each species sample is something to continue to monitor as more data are collected each year. The three species experiencing the most within-species mortality are American ash, paper birch, and black cherry (Figures 13 and 15). This metric reflects the percentage of individual trees of a particular species transitioning from living to dead across the region, rather than their share of forest mortality as a whole. The share of total forest mortality by tree count (Figure 14) continues to be dominated by American beech, balsam fir, and red maple, likely a combination of their higher abundance in the forest, as well as some impacts from stressors such as BBD, BLD, and Balsam Wooly Adelgid. American beech has consistently high mortality across all measured intervals, which may be a result of the combined effects of beech bark disease and beech leaf disease (Figures 21-22), both now widespread throughout the region (Figure A1). White ash mortality remains substantial in 2025, aligning with the continued impacts of emerald ash borer and indicating that many stands are now entering later phases of infestation where larger individuals are being lost. Balsam fir mortality, while variable year to year, remains elevated, particularly when assessed by tree count as a share of the total forest mortality. This pattern suggests potential vulnerability likely related to balsam wooly adelgid, climatic stress, and the species' southern range limits. It may also simply indicate that this species has higher share of forest mortality (by count) due to its higher abundance. While paper birch is not known to have a major specific pest or pathogen driving mortality, it is known to be sensitive to site conditions (Muilenburg & Herms, 2012) and its higher within-species mortality may be a climate-driven decline. However, vigor scores indicate that the overall vigor of paper birch is trending in an overall heathy direction (Figure 11).

The data also indicate gradually increasing mortality among oaks (Figure 23). The health of oak stands in the Northeast is likely sensitive to climate change, namely cycles of drought followed by excessive precipitation, which may increase vulnerability to pests, pathogens, and other stressors (Stump et al., 2024). The period from 2022-2025 has been one of immense fluctuations in precipitation and drought in the Northeast, with 2023-2024 marked by near-historic precipitation levels, and 2022 and 2025 representing relatively dry years (Table A2). Oaks in our plots have endured increased defoliation throughout this period (Figure 24) congruent with other recent defoliator outbreaks seen in the Northeast (USFS Forest Health Highlights, 2024a,b,c). Sustained periods of oscillating climate stress in conjunction with observed defoliator and pathogen presence in our plots may shed light on our oak mortality findings.

When measured by basal area as a share of total forest mortality, rather than count, mortality data tells a slightly different story (Figure 16). Species like white ash and northern red oak, which tend to be larger in diameter, contribute disproportionately to structural change in forests when mortality occurs (basal area). By contrast, balsam fir contributes heavily to mortality counts but less so to total basal area loss, reflecting its typically smaller stature.

Growth Trends and Species Composition

Species growth and composition data through 2025 indicate that, among hardwoods, red maple, sugar maple, and northern red oak continue to show the highest average basal area growth region-wide (Figures 17-18). This could potentially indicate species that are faring better than the rest and taking advantage of longer growing seasons, release from competition, or site-specific advantages. However, it should be noted that growth for sugar and red maple appears to be slowing compared to the growth in 2023. Species composition data indicate that overall live basal area has remained relatively stable with a slight increase in 2025.

Northern red oak growth exhibits notably greater variability than in 2024. This may be attributable in part to sample size differences, resulting from most Maine plots not being surveyed in 2025. Thus, outliers at the plot or state level may have influenced some observed northern red oak growth trends in 2025.

Summary (Trees)

Four years of region-wide forest monitoring data show early signs of an increase in forest stress in the Northeast, most clearly expressed through crown condition and vigor metrics. Changes in transparency, dieback, and vigor often come before more noticeable increases in mortality. As such, the trends observed in the data from 2022-2025 may indicate larger structural changes for future forests, particularly as pest and pathogen pressure continues to increase. It will be important to continue to monitor these trends in the coming years.

Dieback Trends (Regional)

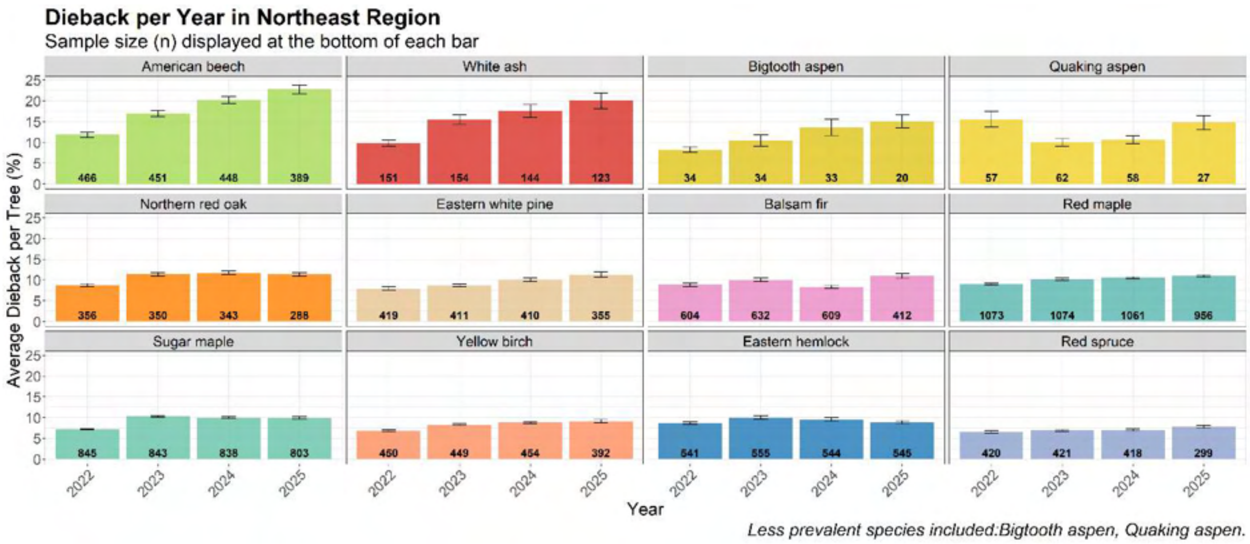

Figure 7. Regional average fine twig dieback trends by species and year for the top ten species by basal area, plus two that are less representative by basal area but showed high dieback. Species are ordered based on dieback rates in 2025.

Transparency Trends (Regional)

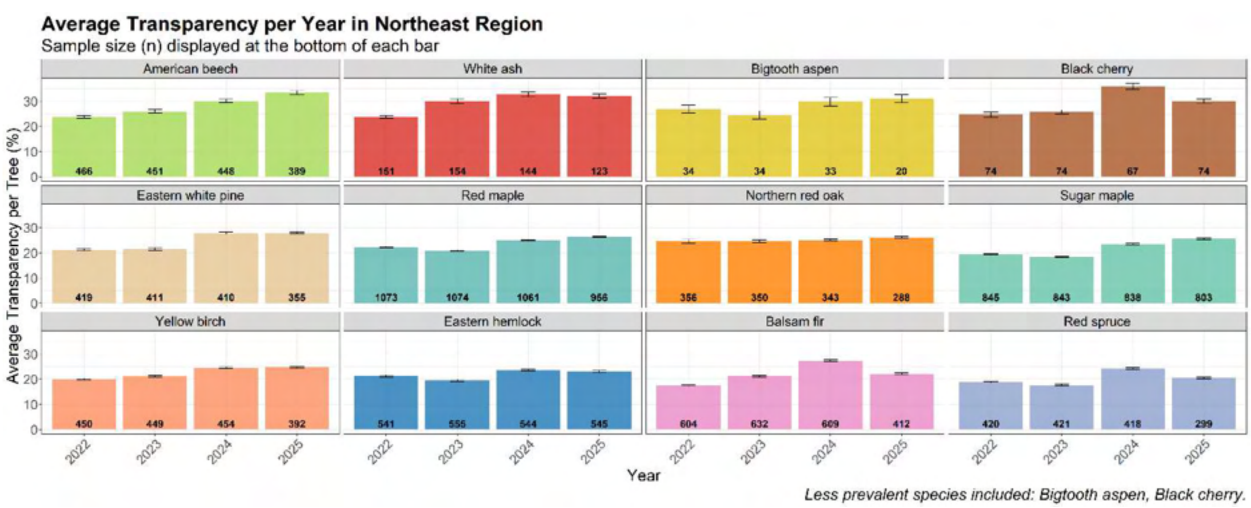

Figure 8. Regional average leaf transparency trends by species and year for the top ten species by basal area plus two that are less prevalent by basal area but are showing high transparency. Species are ordered by greatest transparency in 2025.

Vigor Trends (Regional)

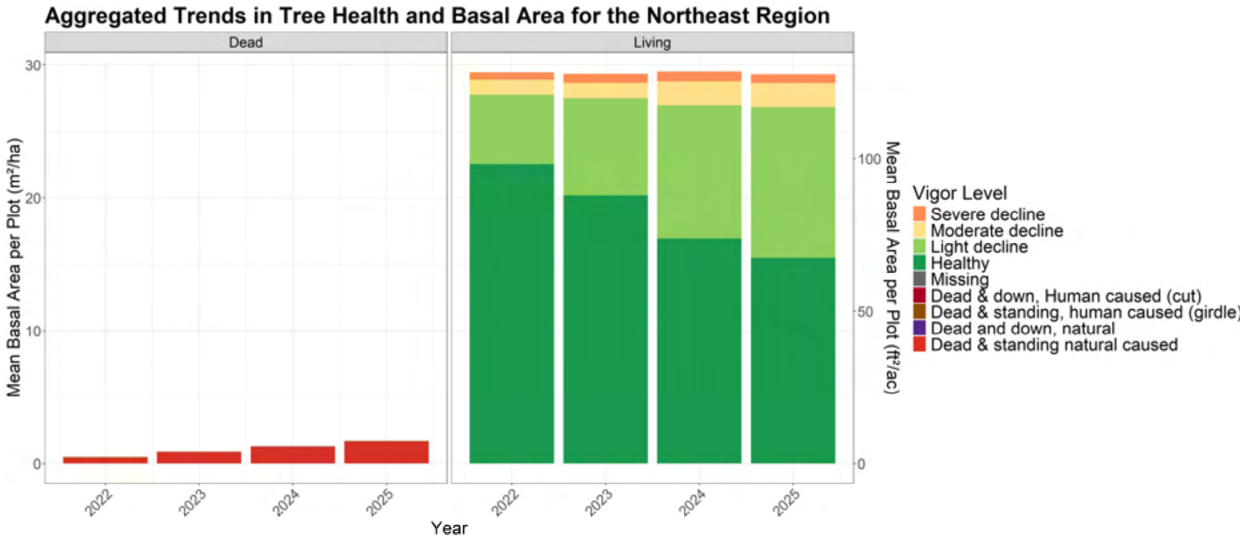

Figure 9. State-specific mean basal area per plot in hectares (m^2/ha, left axis) and acres (ft^2/ac, right axis) for living and dead trees in the Northeast region across different tree vigor classes. Data are grouped by tree status, with living classes shown on the right and dead classes on the left.

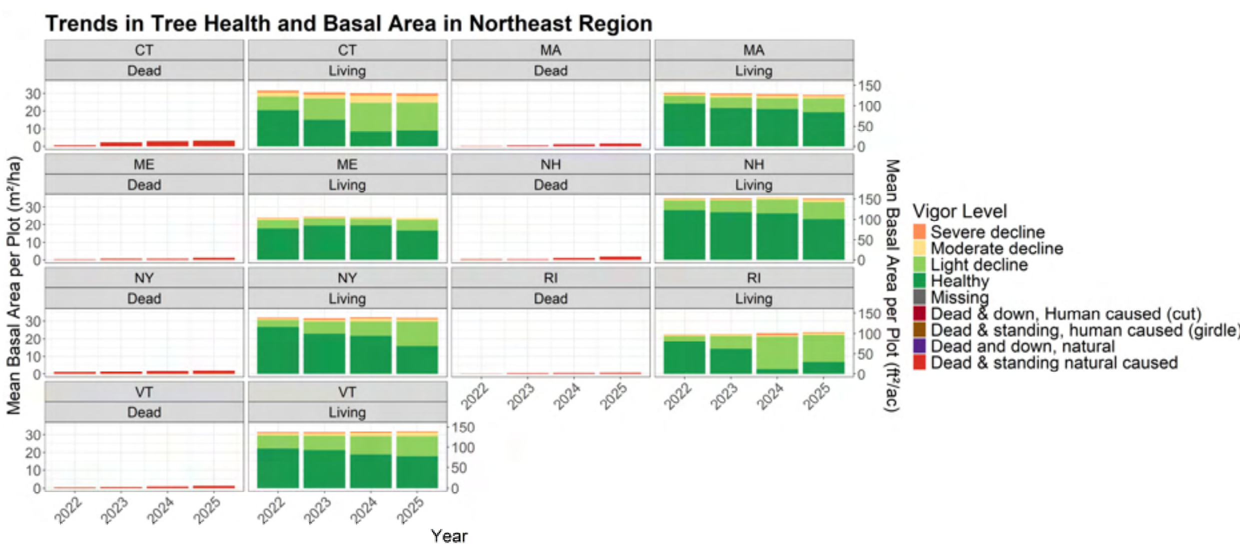

Figure 10. Region-wide mean basal area per plot in hectares (m^2/ha, left axis) and acres (ft^2/ac, right axis) for living and dead trees across different tree vigor classes. Data are grouped by tree status, with living classes shown on the right and dead classes on the left.

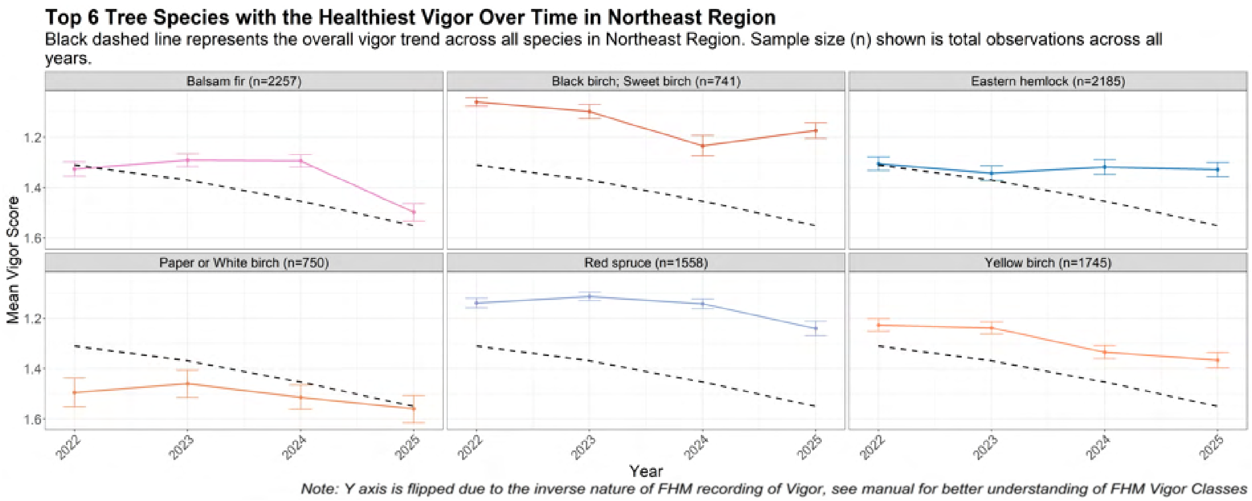

Figure 11. Top six tree species with the healthiest vigor (lowest stress levels) over time across the Northeast region among species comprising at least 0.5% of basal area regionally. Vigor scores range from 4 (severe decline) to 1 (healthy), with intermediate values for trees in decline. The dashed black line indicates the overall region-wide vigor trend across all species. Error bars represent the standard error of the vigor score for each species and year. Note that the y-axis is inverted to aid interpretation, because higher vigor scores indicate worsening tree condition while lower scores represent healthier trees.

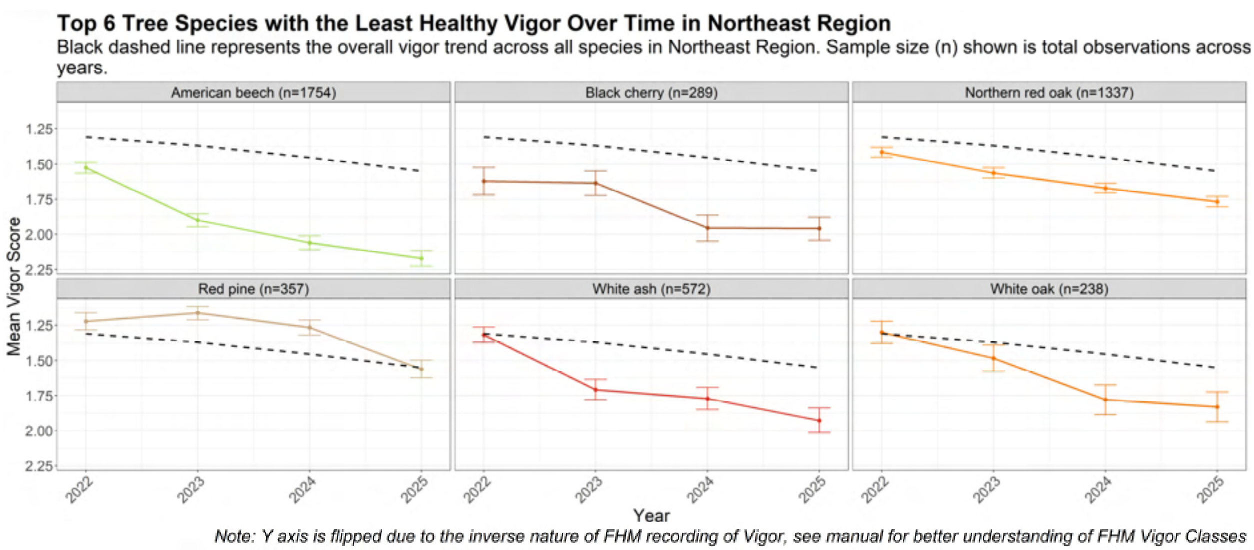

Figure 12. Top six tree species with the greatest decline in vigor (highest stress levels) over time across the Northeast region, among species comprising at least 0.5% of total basal area region wide. Vigor scores range from 4 (severe decline) to 1 (healthy), with intermediate values for trees in decline. The dashed black line provides an overall trend for comparison across all species, and the error bars show the standard error of the vigor score per species and year. Note that the y-axis is inverted to aid interpretation, because

higher vigor scores indicate worsening tree condition, while lower scores represent healthier trees.

Annual Growth and Mortality Trends – Trees (Regional)

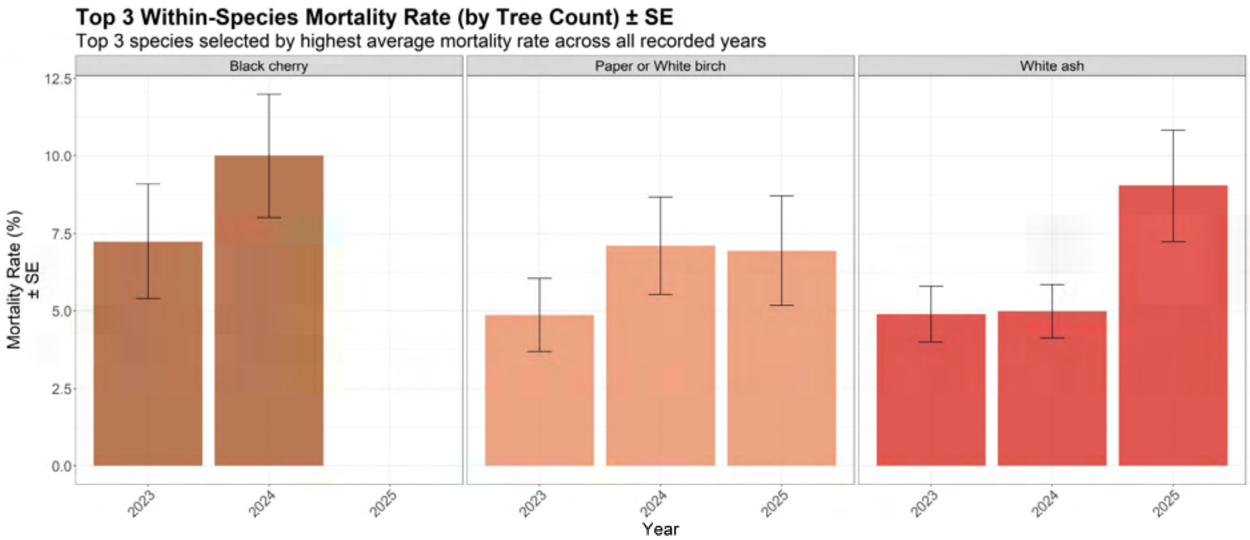

Figure 13. Within-species mortality trends across the Northeast region for the top three tree species with the highest number of newly dead trees among species comprising greater than 1% of total basal area. This plot shows the annual number of newly dead trees per species, based on individual tree tracking identifiers, within the species' total regional sample size. A tree is counted as 'newly dead' if it was recorded as alive in the previous year and classified as dead in the current year. As a result there are only three time periods; because 2022 was the first regional data collection year, 2023 was the soonest we could determine whether a tree alive the previous year had died.

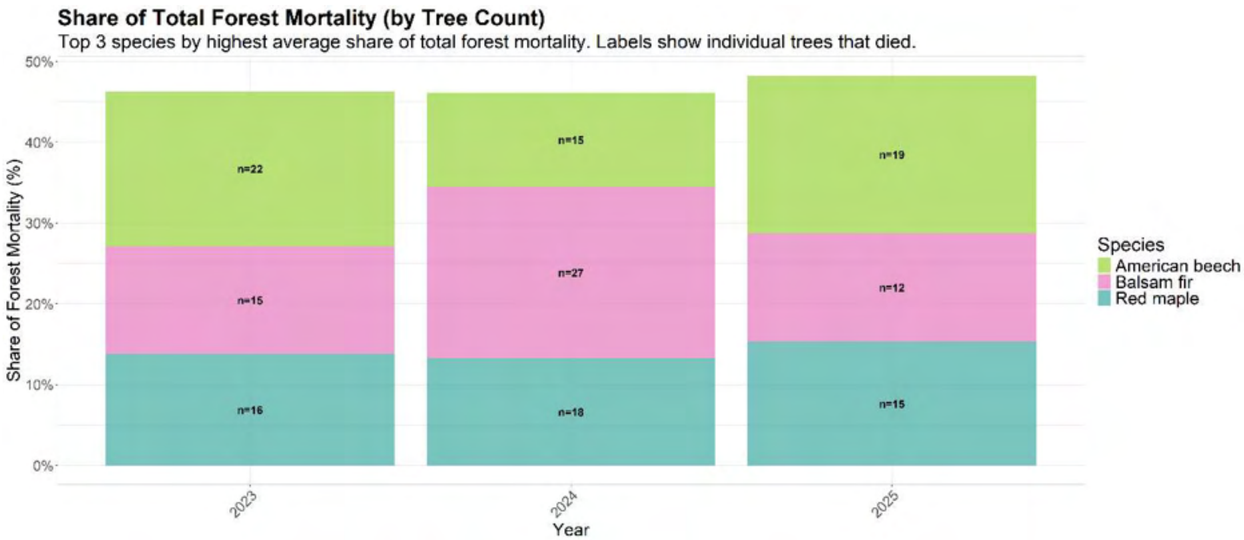

Figure 14. Share of total forest mortality trends by total count across the Northeast region for the top three species with the highest number of newly dead trees, relative to all newly reported tree deaths across all species comprising greater than 1% of regional total basal area.

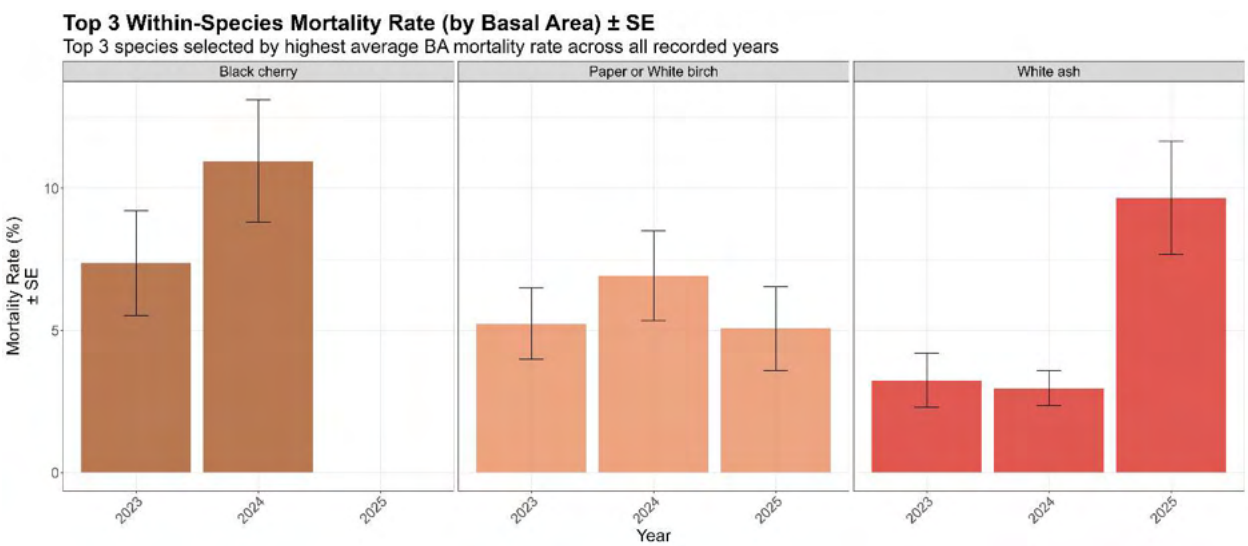

Figure 15. Within-species mortality trends by basal area across the Northeast region for the top three species with the greatest total basal area loss among species comprising more than 1% of total basal area, calculated as the sum of the last recorded basal area of all trees within a given species that transitioned from living to dead each year. Instead of simply accounting for the number of dead trees, basal area loss accounts for tree size, an important metric to understand potential effects on forest structure.

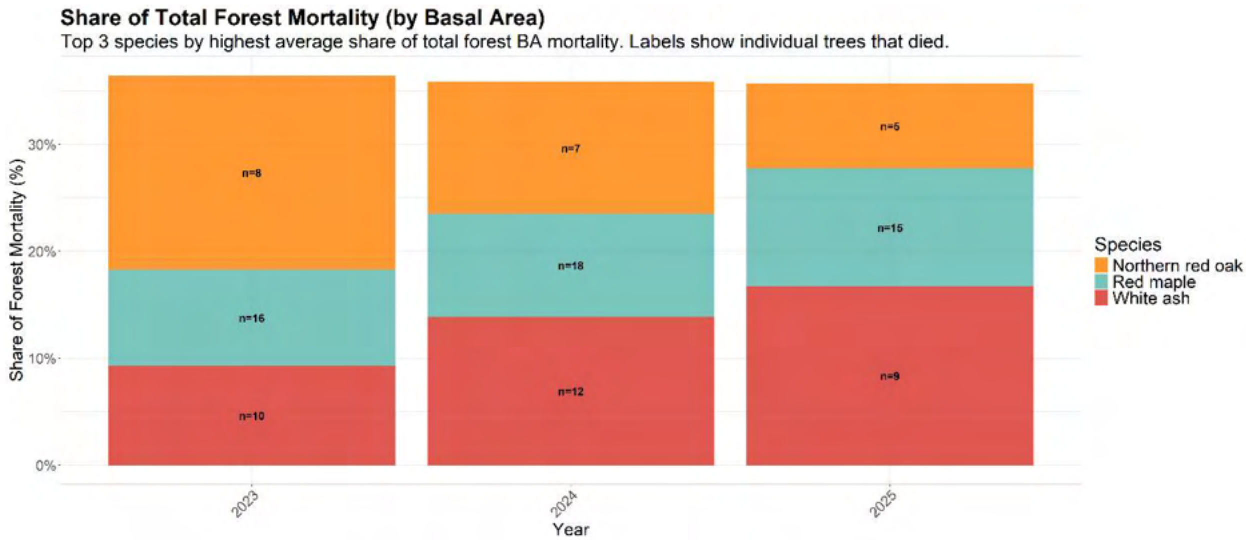

Figure 16. Share of total lost basal area across the Northeast region for the top three species with the greatest basal area loss due to mortality among species comprising greater than 1% of total basal area regionally.

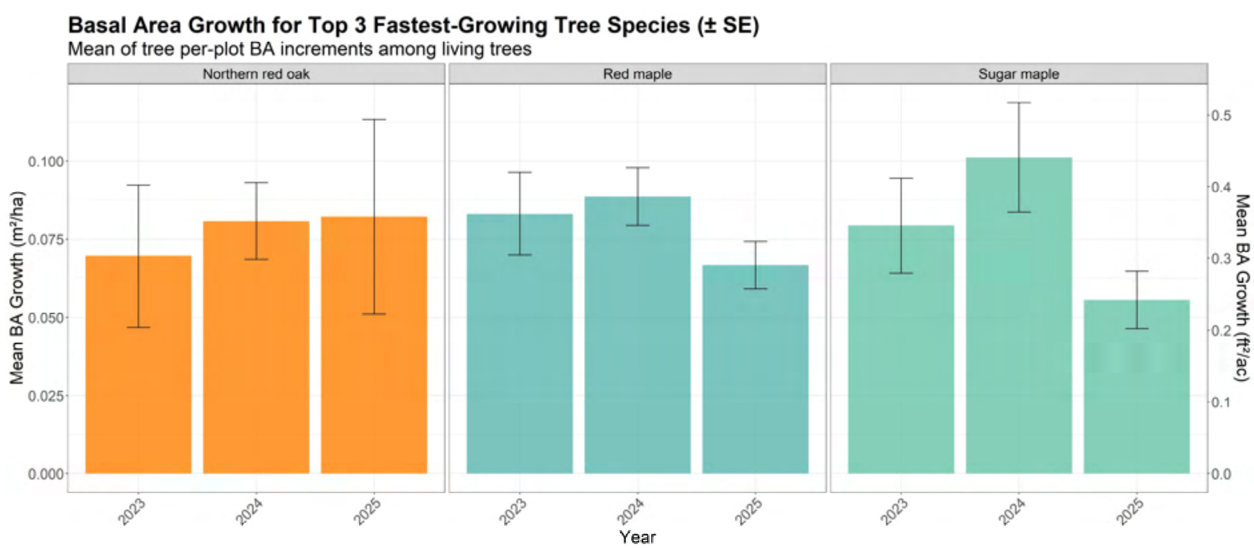

Figure 17. The top three species with the greatest average basal area growth across the Northeast region. Bars represent the mean basal area increment in hectares (m^2/ha, left axis) and acres (ft^2/ac, right axis) each year. Error bars represent the standard error of individual growth in basal area within each species.

Total Composition - Trees (Regional)

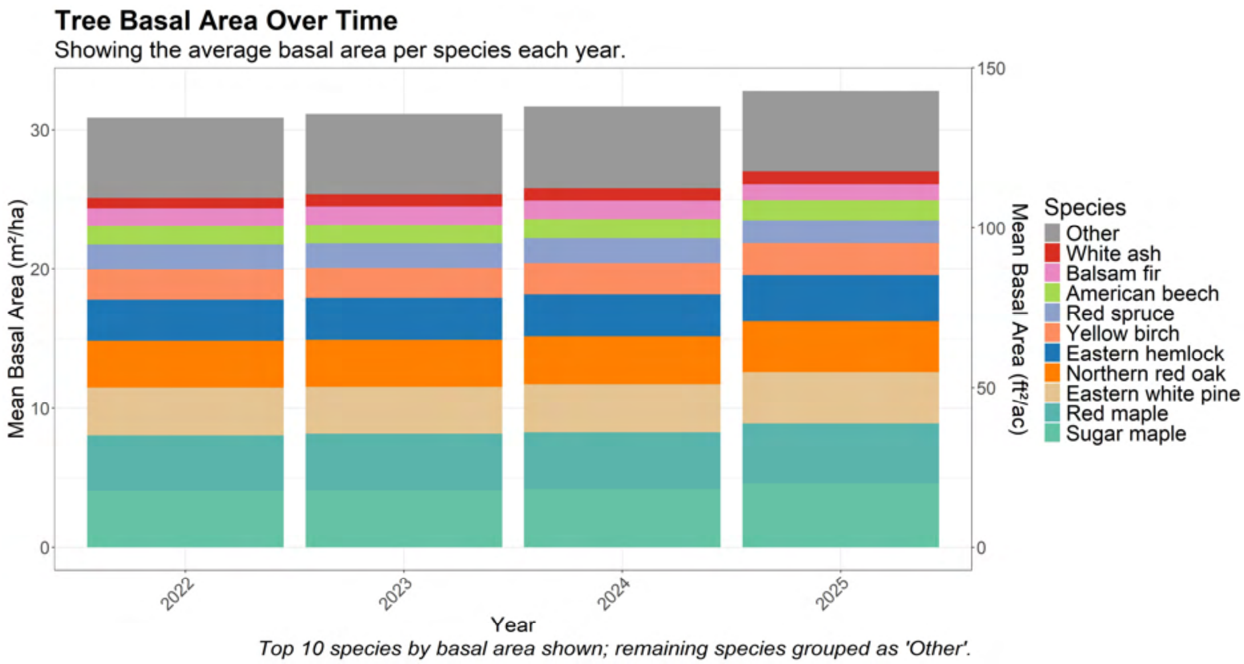

Figure 18. Overall species composition by average live basal area per year across all tree species surveyed in the Northeast region each year. The top ten most represented species by basal area are shown individually, while all species not in the top ten are combined and represented as "Other." The overall bar height indicates total mature tree basal area per hectare and acre regionally for each year. Note that Vermont FHM plots are biased towards sugar maple stands, increasing overall representation of sugar maple in the regional dataset.

Northeast Regional Ash Health Dashboard - Trees (Regional)

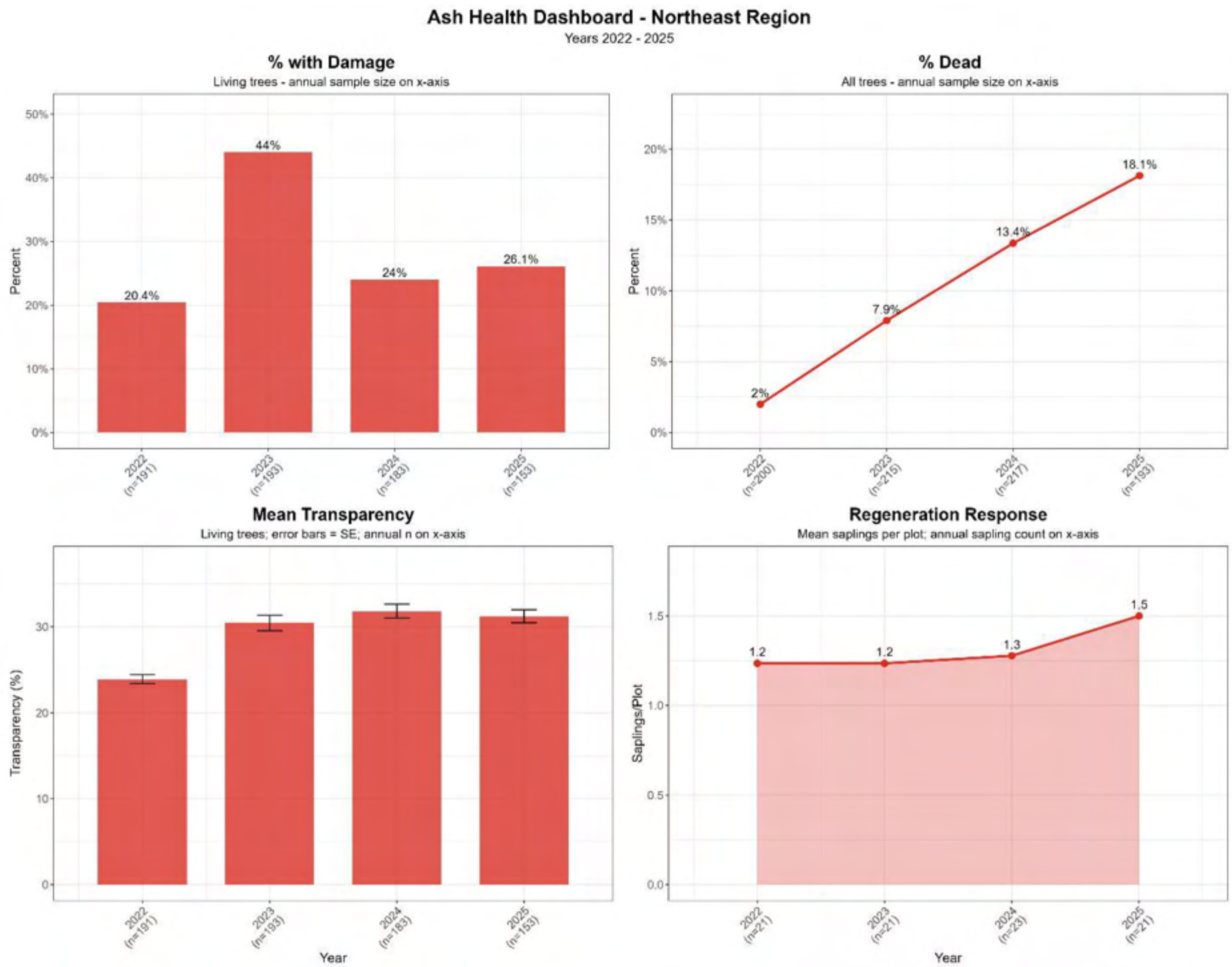

Figure 19. Key ash health metrics in FHM plots from 2022-2025. All *Fraxinus* spp. (white, green, and black ash) in our plots are included. Tree counts (*n*) represent the total of (1) only living trees (in the percent with damage panel) or (2) both living and dead trees (the percent dead panel), both year-to-year. Damages, percent dead, and mean transparency apply to overstory trees while regeneration pertains to saplings.

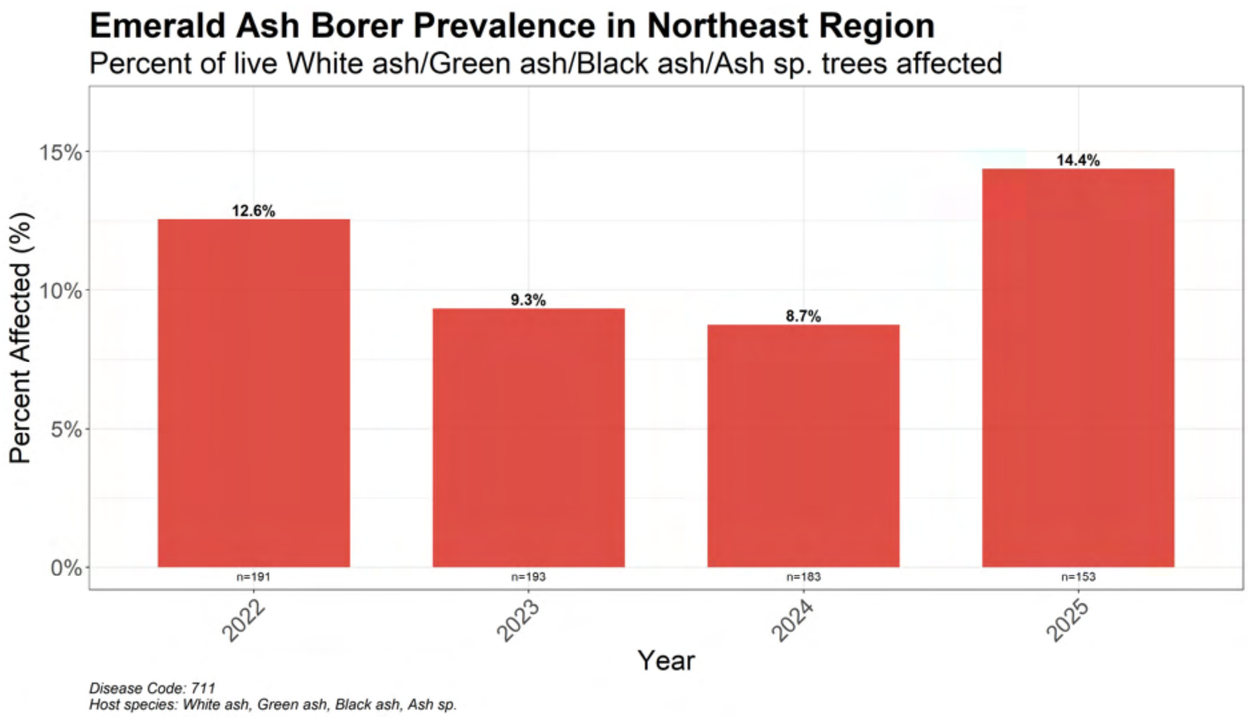

Figure 20. Percentage of ash trees in FEMC FHM plots with recorded emerald ash borer damage from 2022-2025. n = number of live ash trees sampled each year. Note the smaller sample size in 2025 due to most Maine plots not being sampled that year.

Northeast Regional Beech Health Dashboard - Trees (Regional)

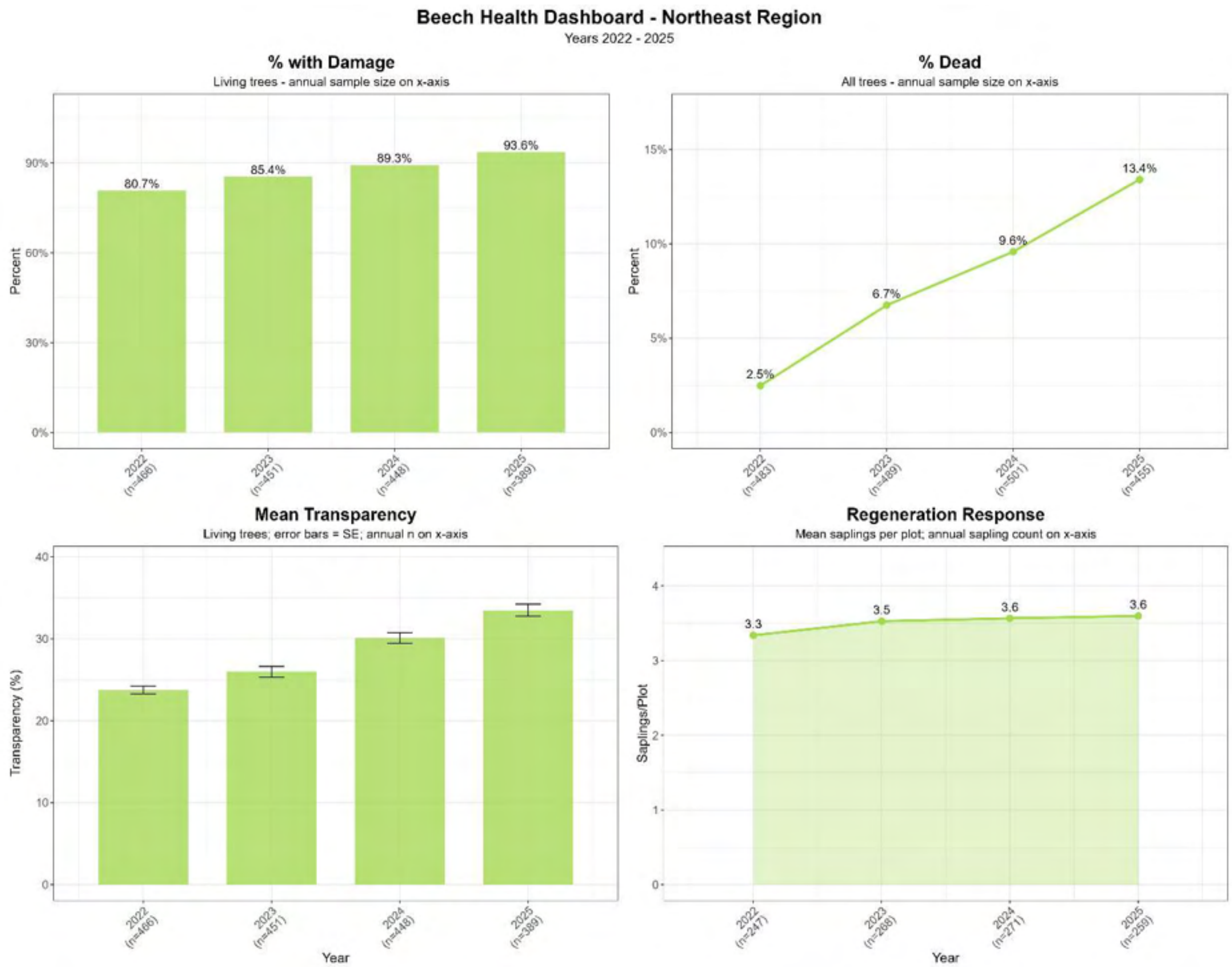

Figure 21. Key American beech health metrics in FHM plots from 2022-2025. Depending on the figure, tree counts (*n*) represent the total of (1) only living trees (in the percent with damage panel) or (2) both living and dead trees (the percent dead panel), both year-to-year. Damages, percent dead, and mean transparency apply to overstory trees while regeneration pertains to saplings.

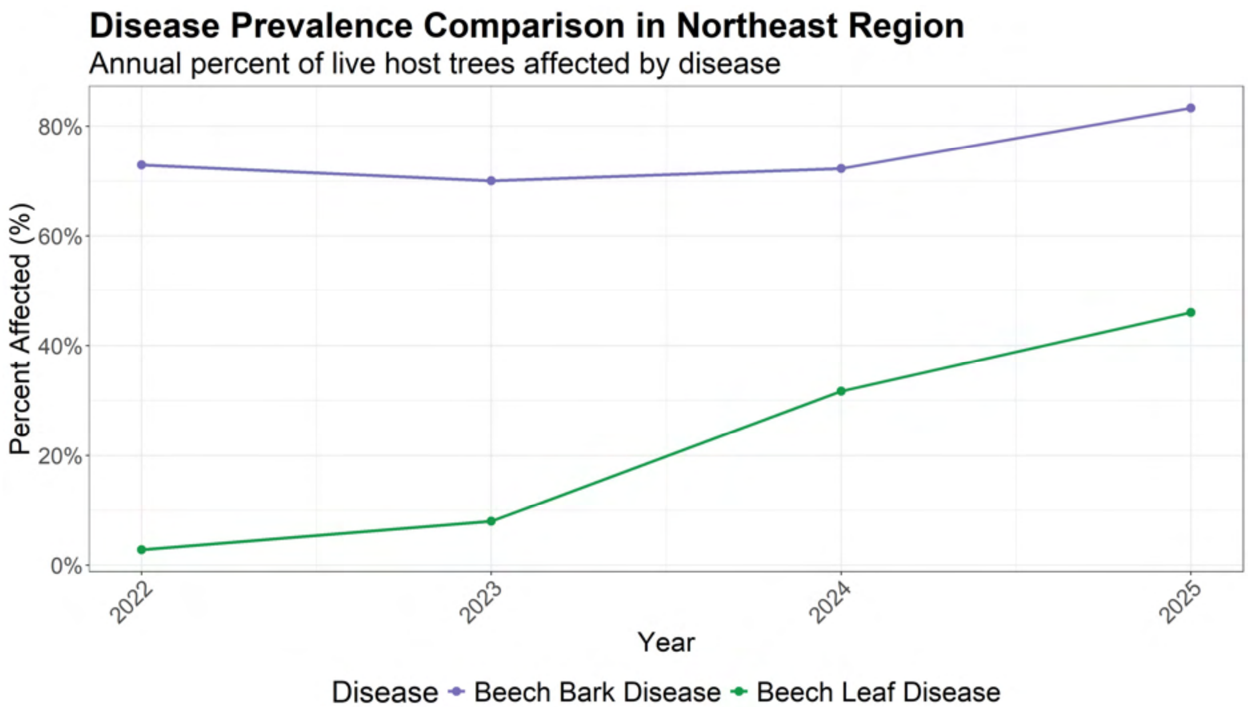

Figure 22. Percentage of live American beech trees in FHM plots that show symptoms of beech bark disease and/or beach leaf disease.

Northeast Regional Oak Health Dashboard - Trees (Regional)

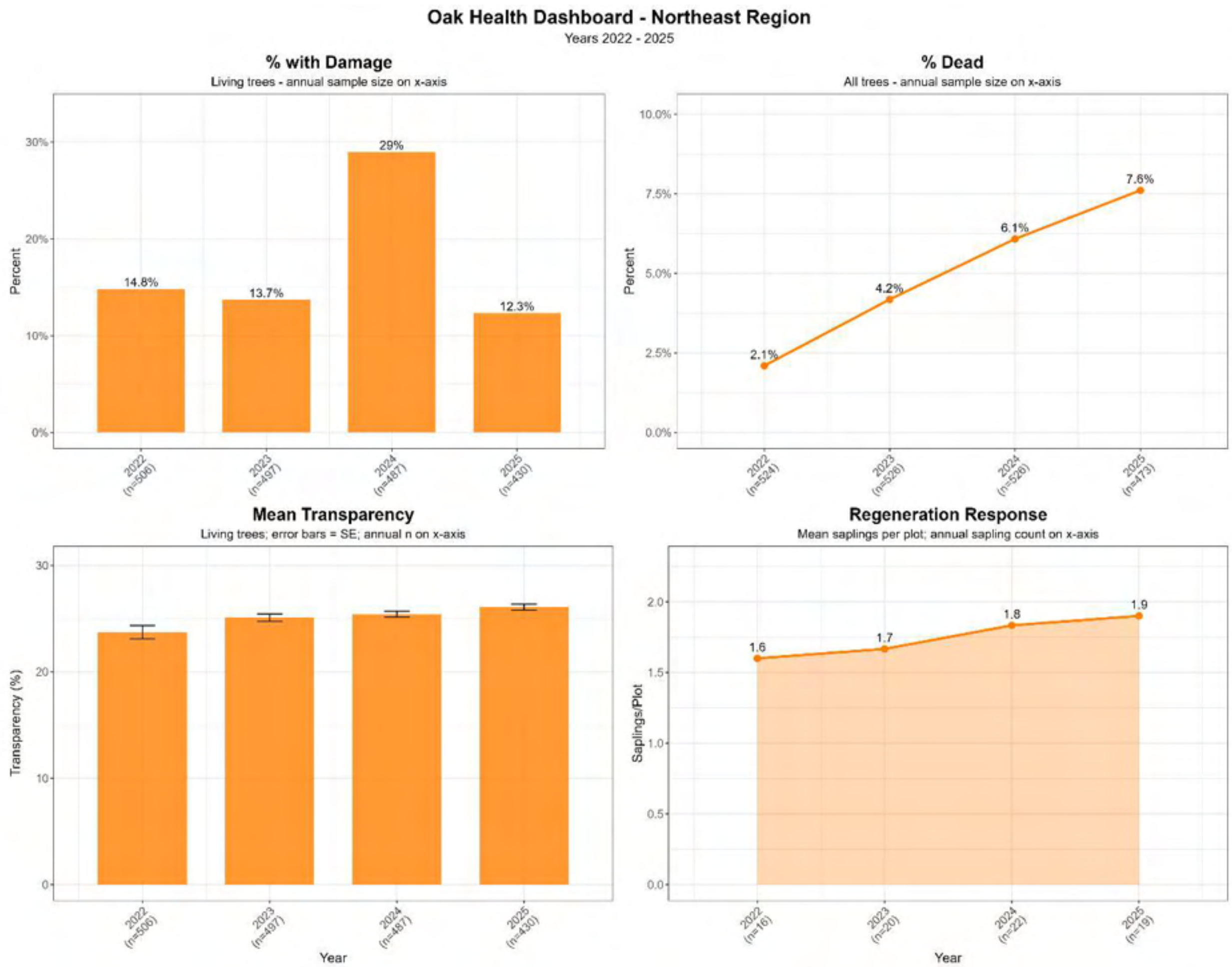

Figure 23. Key oak health metrics in FHM plots from 2022-2025. All *Quercus* spp. (northern red, white, and black oaks, along with a small number of other species) in our plots are included. Tree counts (*n*) represent the total of (1) only living trees (in the percent with damage panel) or (2) both living and dead trees (the percent dead panel), both year-to-year. Damages, percent dead, and mean transparency apply to overstory trees while regeneration pertains to saplings.

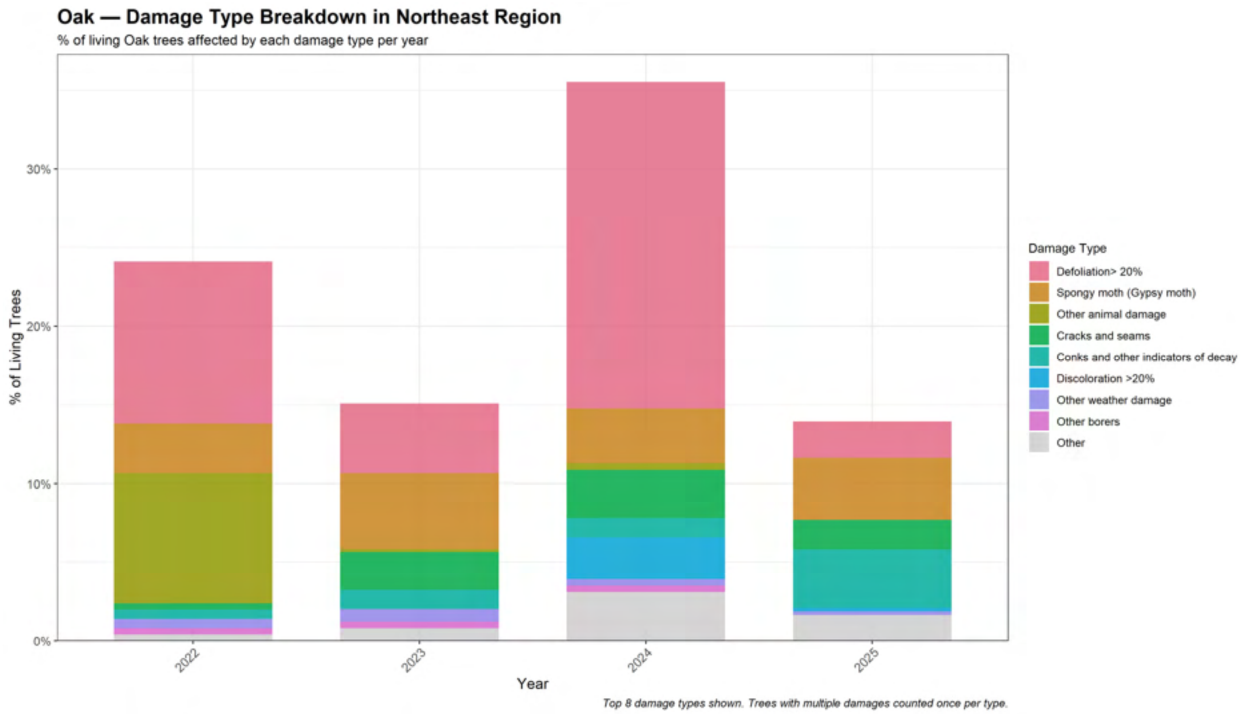

Figure 24. Percentage breakdown of damages recorded on all oak (*Quercus* spp.) species recorded in FEMC FHM plots.

Section 2. Sapling Analyses (Regional)

Sapling Mortality Patterns
Sapling mortality across the region remains quite low, but species-level trends can indicate which species are most stressed in early development. American beech and balsam fir experienced consistent sapling mortality across monitoring years (Figures 25-26), while eastern hemlock and eastern white pine also contributed notable shares of mortality.

White pine accounted for a relatively large percentage of sapling mortality in 2024, but returned to baseline in 2025 (Figure 25), possibly indicating a stress event on white pine in 2024 likely related to white pine needle damage or climatic conditions. These numbers are based on a small number of individuals across the entire study area, so small mortality events can show up dramatically in the data. Conclusions based on small sample sizes should be treated cautiously, but the pattern is still ecologically meaningful. The concentration of white pine sapling mortality in 2024 aligns with known impacts of white pine needle damage, which, in conjunction with climate and competitive stressors, can affect trees at early developmental stages (Wyka et al., 2016).

Similarly, eastern hemlock's appearance on this list aligns with crown transparency and crown vigor data suggesting stress in the overstory, which is likely due to hemlock woolly adelgid infestations and climactic conditions. HWA has continued to persist substantially in the southern part of the FEMC region, particularly in the Finger Lakes and Catskills of New York and the southern New England states. With the trend of milder winters due to climate change, overwintering HWA mortality rates may not reach the estimated threshold of ninety percent needed to decrease HWA populations (USFS, 2022). New Hampshire and New York both reported increasing HWA presence from 2023-2024 (personal communication). Overstory and understory trends among the same species indicate stress across the life stages, a trend we will continue to track in future years. However, while the share of sapling mortality is concerning for hemlock, the overall mortality rate is relatively low in this layer and is accompanied by a higher growth rate and abundance (BA), indicating that sapling mortality may be a side effect of being a highly represented species in the sapling layer.

Sapling Growth
Sapling growth trends (Figure 27) show that balsam fir, American beech, and eastern hemlock are all dominant components of the sapling layer and have relatively stable growth despite stress pressures. This could be due to these species' growth strategies and may not be an indication of sapling health; this finding does not necessarily suggest that these trends will continue into future life stages.

Trends among other species are less consistent. For example, some species, such as black birch, eastern white pine, and hop-hornbeam (*Ostrya virginiana*), exhibit temporal variability, potentially due to sensitivity to site-specific conditions. This may also indicate release following the death of neighboring trees and subsequent increases in light reaching lower layers of the forest. High growth rates at the sapling level alone do not indicate a species will continue to thrive into the tree canopy, especially when accompanied by high mortality rates or highly variable annual growth rates.

Sapling Composition
Sapling composition by basal area (Figure 28) indicates that balsam fir, red maple, American beech, eastern hemlock, and eastern white pine dominate the understory across the region.

American beech remains highly represented in the sapling layer despite elevated mortality (Figure 25), reflecting its ability to regenerate vegetatively through root suckering. Beech bark disease can result in increased beech root suckers. While this will likely ensure the persistence of beech in the understory, it will not result in recruitment to the canopy due to beech bark disease and beech leaf disease, which typically kill trees when they are young.

Balsam fir and red maple appear in both the sapling and seedling data, suggesting they could be competitive in future forests if they can continue to evade deer browse, insect infestations, and increased climate variability. Hemlock being present in both sapling growth charts, while also higher in sapling mortality may be a result of hemlock comprising a higher percentage of the understory than other trees.

Note: Figures that do not present data for a given year or display inconsistent numbers of species between analyses are a result of insufficient sample sizes for individual trees, total species, or plots (depending on the analysis). For example, a species may be absent from a particular year in a mortality time series analysis if no mortality was observed for that species within a given monitoring year.

Annual Growth and Mortality Trends – Saplings (Regional)

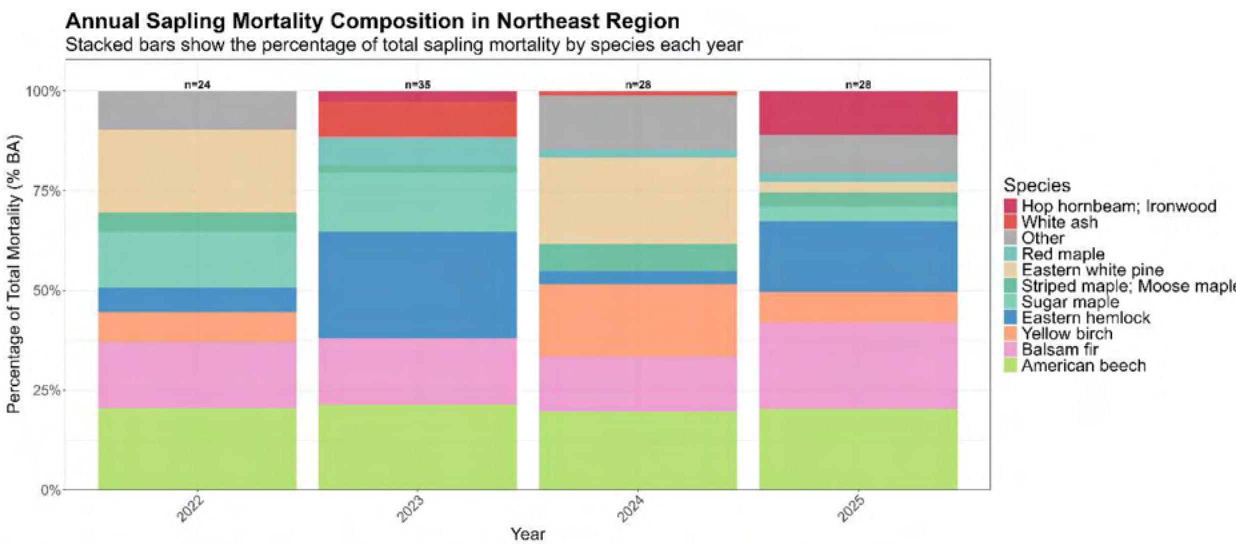

Figure 25. Annual sapling mortality composition in the Northeast region by basal area, shown as the percentage of total regional sapling mortality each species represented from 2023-2025. Sapling mortality is counted only once at the time a sapling is observed to be dead. Note the low sample size (38 dead saplings in 2023; 28 in 2024) when interpreting species level results.

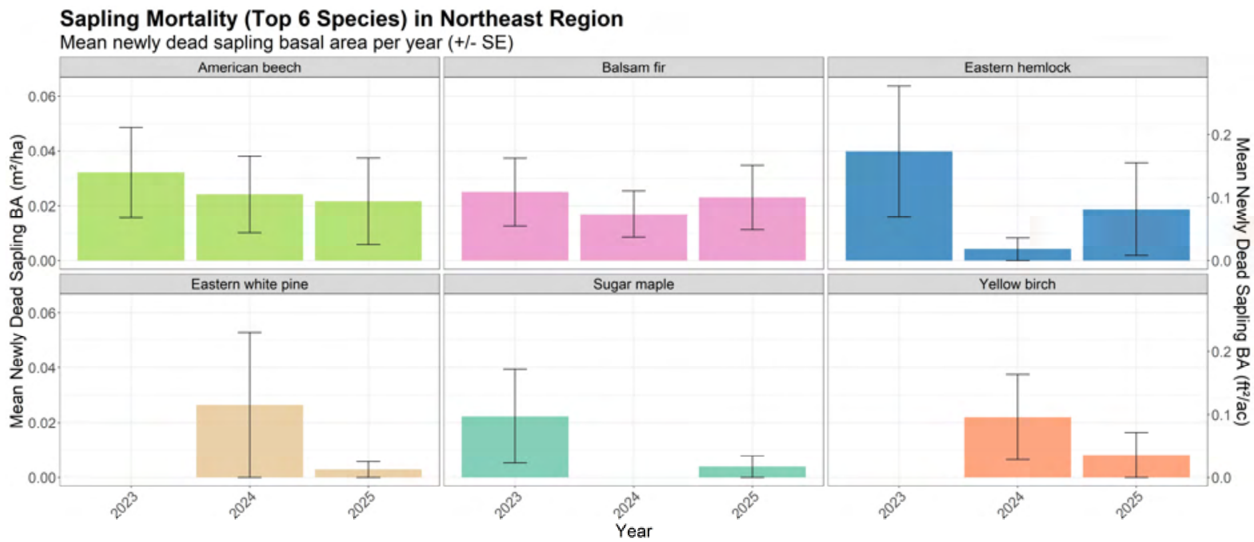

Figure 26. The top six species experiencing the greatest sapling mortality across the Northeast region, shown as basal area per hectare (m^2/ha, left axis) and acre (f^2/ac, right axis) lost per year. Only species with more than ten individuals in the sample were assessed for inclusion in this chart.

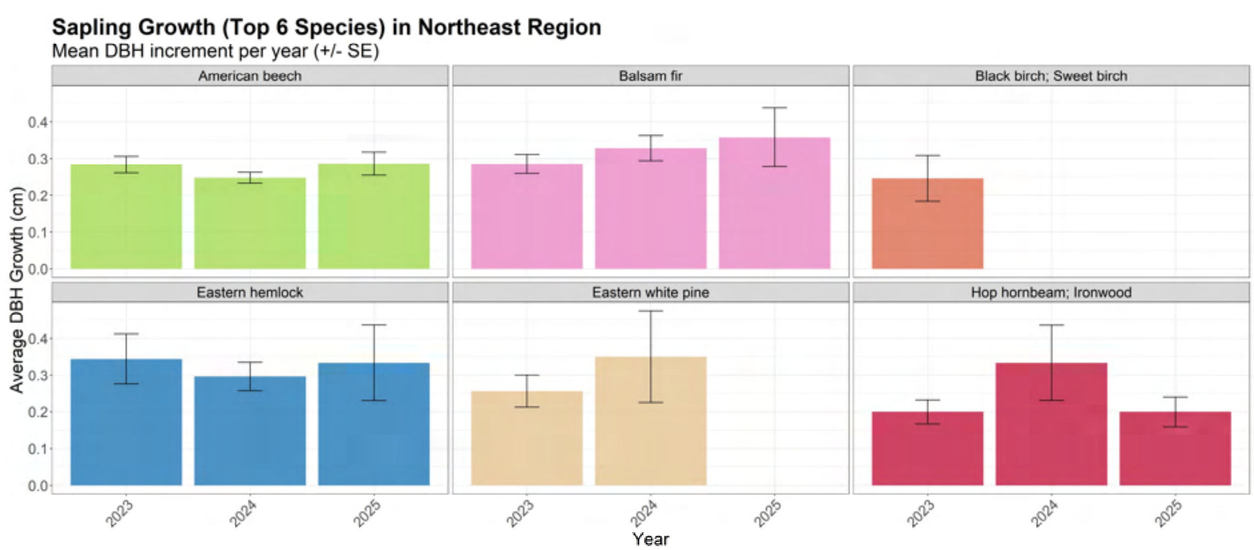

Figure 27. The top six species whose saplings demonstrated the greatest average growth in diameter across the Northeast region. Only species with more than ten individuals in the sample were assessed for inclusion in this chart.

Total Composition – Saplings (Regional)

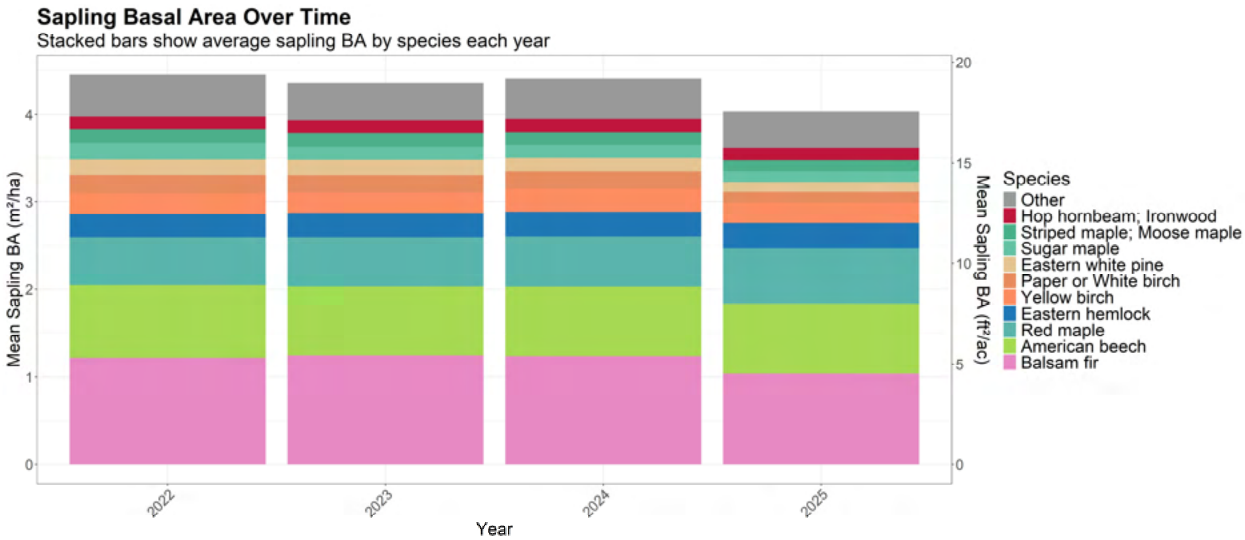

Figure 28. Overall sapling basal area composition in hectares (m^2/ha, left axis) and acres (ft^2/ac, right axis) throughout the Northeast region for all species each year. The ten species with highest basal area are shown individually, while all other species are grouped as "Other." The overall bar height indicates total sapling basal area per hectare and acre regionally for each year.

Section 3. Seedling Analyses (Regional)

Seedling Mortality

High mortality (Figure 29) in Class 1 seedlings is expected as seedlings are vulnerable to abiotic and biotic factors in the first year of establishment. Because seedling mortality is calculated from yearly stem reductions and not observed directly, we recommend interpreting these results as relative filtering intensity rather than absolute mortality rates.

Many species that exhibit high seedling mortality also exhibit high recruitment rates, indicating that mortality during the seedling life stage is part of those species' respective regeneration strategies. Species that produce a relative overabundance of seeds may comprise a substantive share of seedling composition but then experience subsequent high mortality as many of these seedlings die off. For example, red and sugar maple are abundantly represented each year in our Class 1 seedling data (Figures 31-32), which aligns with their known reproductive habits. Similarly, eastern white pine experienced a masting-like event in 2023 (Porter et al., 2024), which could explain the species' high seedling mortality in 2024 and 2025 (Figure 29). This burst of seedling output by white pine in 2023 also aligns with known white pine needle damage outbreaks and may be a reproductive response to ongoing stress in the canopy.

Recruitment Variability

The recruitment rates for red maple, sugar maple, and eastern white pine are significantly higher in 2024 (Figure 32). High recruitment rates in 2024 are likely the result of a good seed year and germination conditions, reflecting a masting-like event (though these species are not true masting species like oak or beech).

The absence of another recruitment year similar to 2024 highlights the need for long-term data to understand how these seedling bursts align with other conditions and inputs. Red maple appears to be adapted to highly variable recruitment rates relying on a combination of frequent reproduction and high mortality to maintain relatively constant regeneration rates despite intense attrition during the first year of establishment.

Class 2 Seedlings:

A better indicator of future forest composition than Class 1 recruitment rates alone are the transition rates into Class 2 seedlings (Figures 33-34). Across all years, balsam fir and American beech consistently have the highest rates of transition into Class 2 seedlings. These results are consistent with the abundance of balsam fir and American beech in the sapling layer.
The persistent presence of American beech in the Class 2 seedling stage supports previous results that although disease impacts may reduce recruitment of American beech into the overstory, it is likely to remain a dominant species in the understory. This may limit regeneration of other species, promote structural uniformity, and encourage a feedback loop of continued understory establishment of American beech.

Despite greater yearly variation, balsam fir recruitment into the Class 2 seedling layer is consistently high, suggesting that under current conditions this species is able to regenerate. However, its known sensitivity to warming temperatures and southern range highlight the importance of continued monitoring in other life stages.

Table 6. Definitions of seedling classes used in regeneration assessment.

Seedling Type	Class 1	Class 2
Conifer	< 6 in (15 cm) tall	≥ 6 in (15 cm) tall
Hardwood	<12 in (30 cm) tall	≥ 12 in (30 cm) tall

Annual Growth and Mortality Trends – Seedlings (Regional)

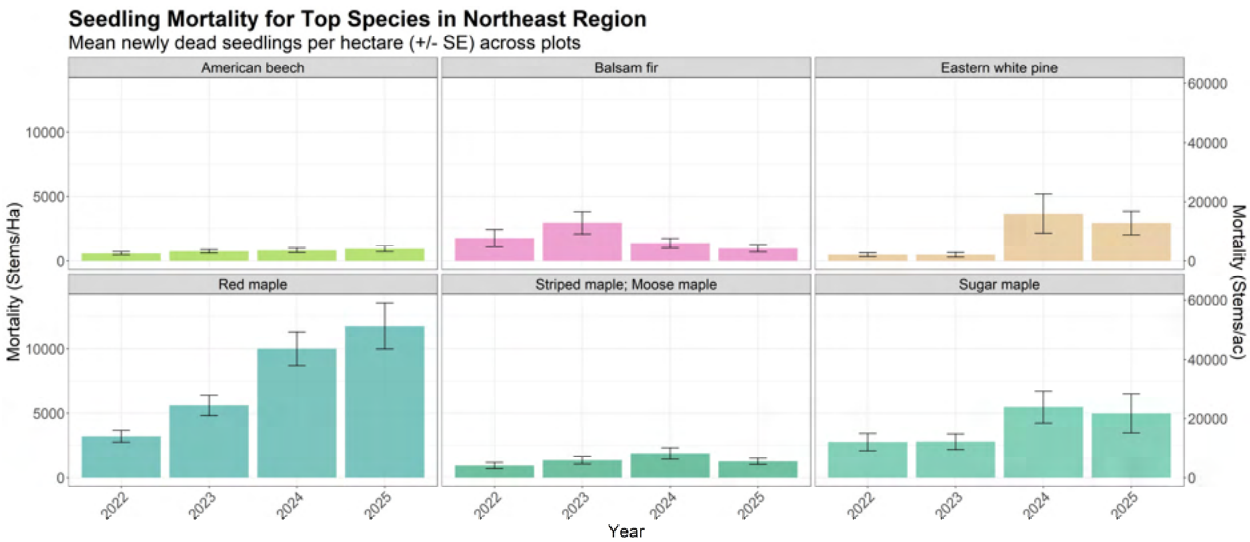

Figure 29. The top six species with the greatest mortality at the seedling stage by stem count region-wide (stems per hectare, left axis, and stems per acre, right axis). While we do not directly record seedling mortality, we estimate decline based on reductions in seedling counts in our seedling microplots from one year to the next.

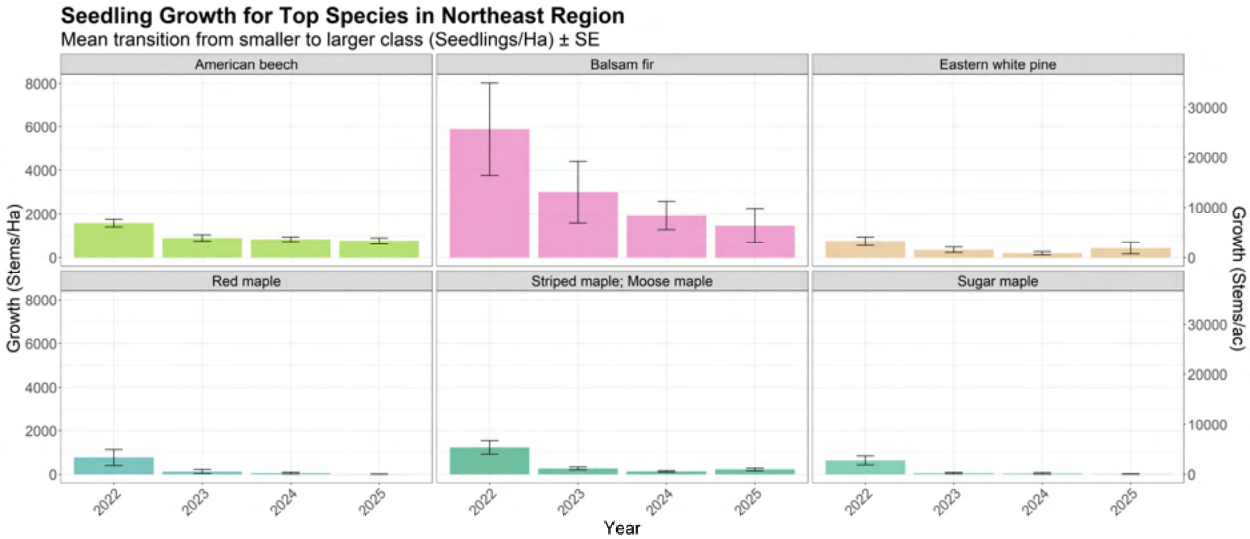

Figure 30. The top six species showing the greatest growth at the seedling stage by stem count region-wide (stems per hectare, left axis, and stems per acre, right axis). This chart shows the mean number of seedlings transitioning from smaller to larger classes each year.

Annual Seedling Density Trends (Regional)

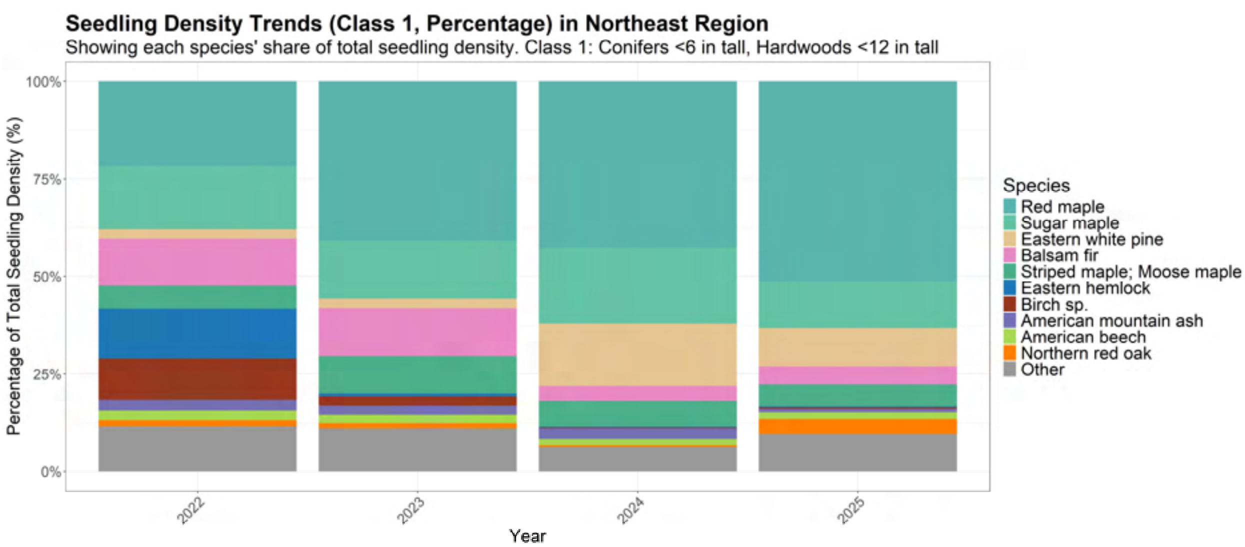

Figure 31. Percent composition of Class 1 seedlings each year throughout the Northeast region. The top ten most representative species by stem count are shown individually, while all species not in the top ten are represented collectively as "Other."

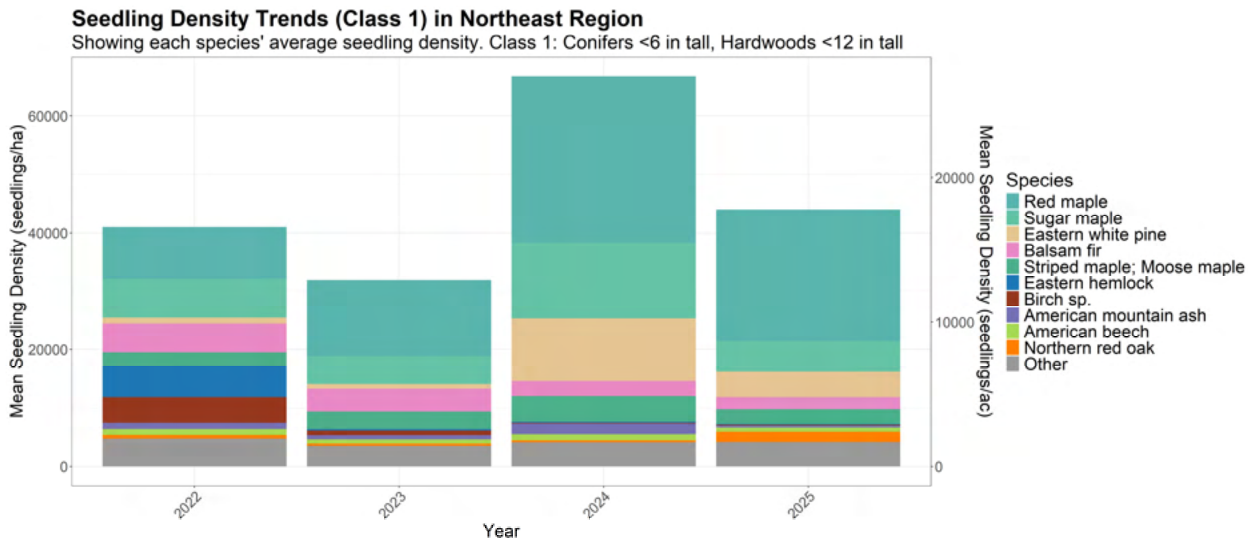

Figure 32. Class 1 seedling counts in stems per hectare (SPH, left axis) and acre (SPA, right axis) for all species surveyed each year throughout the Northeast region. The overall bar height indicates total number of Class 1 seedlings per hectare and acre regionally for each year. The top ten most representative species by stem count are shown individually, while all species not in the top ten are shown collectively as "Other."

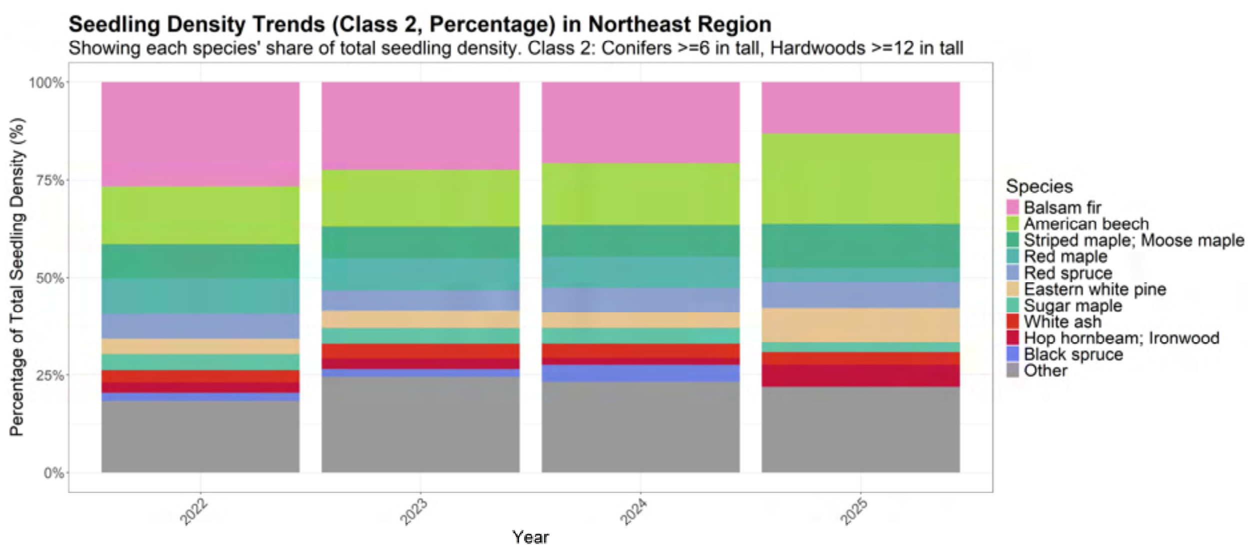

Figure 33. Percent annual composition of Class 2 seedlings each year throughout the Northeast region for all species surveyed each year. The top ten most represented species by stem count are shown individually, while all species not in the top ten are grouped collectively as "Other."

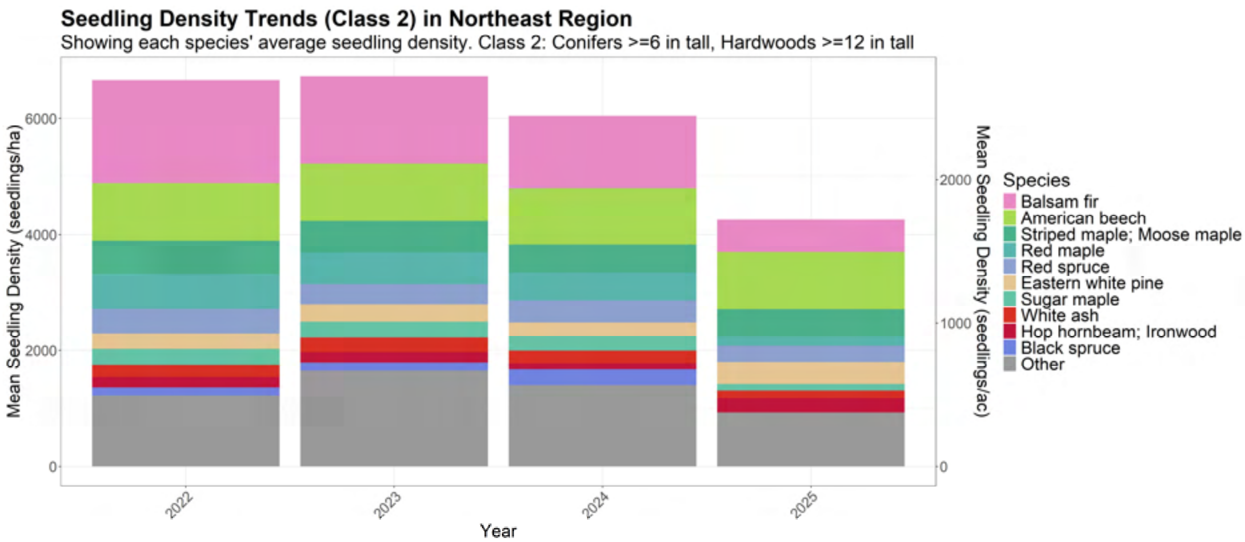

Figure 34. Class 2 seedling counts in stems per hectare (SPH, left axis) and acre (SPA, right axis) for all species surveyed each year throughout the Northeast region. The overall bar height indicates total number of Class 2 seedlings per hectare and acre regionally for each year. The top ten most representative species by stem count are shown individually, while all species not in the top ten are shown collectively as "Other."

Regeneration Summary

Taken together, sapling and seedling data suggest that regeneration across the Northeast remains active and diverse, with no indication of widespread failure.

Species capable of high seed production (e.g., red maple), vegetative reproduction (e.g., American beech), or able to survive exposure to early-life stressors (e.g., balsam fir) continue to dominate later stages of regeneration. As a result, it's possible that species with lower recruitment and lower tolerance to stressors (deer browse, drought, etc.) may gradually decline in future canopy representation.

The alignment in mortality patterns among saplings, persistence patterns among seedlings, and stress signals among overstory trees highlights the need for continued monitoring of forest health across life stages. Continued data collection will be essential to determine whether these regeneration patterns, now evident, will ultimately stabilize forest composition or will instead reinforce shifts in forest structure and composition brought about by ongoing climatic and biological stressors.

Conclusions

With four consecutive years of region-wide data now available, we are starting to observe emerging trends in forest condition that stand apart from annual fluctuations. Although four years still represent a very short window for detecting changes in ecological systems, the inclusion of 2025 data strengthens confidence in several trends that were previously considered preliminary. With continued monitoring, the growing time series analysis will provide greater opportunity to detect both gradual shifts in forest composition and structure as well as more dramatic changes associated with longer-term climatic, biological, and disturbance-related processes. State-specific figures are included in the 2025 State Supplemental Figure Package (available at: https://doi.org/10.18125/8j574j); however, it should be noted that sample sizes for some individual states are too small to support additional interpretation of forest change.

Regional indicators of forest health suggest that, while northeastern forests remain structurally and functionally healthy, they continue to show consistent signs of increasing stress. Metrics of crown condition, including crown transparency and fine-twig dieback, continue to increase, while overall tree vigor is gradually declining; all of these metrics are signs of decline. Importantly, the persistence of these trends into 2025 suggests that these results are not a one-year anomaly but instead may reflect ongoing stress from a variety of interacting factors, including climate, pests, and pathogens. Nonetheless, most overstory trees remain alive and, on average, have relatively healthy crowns, indicating that, at this time, these observations represent an early warning rather than a broad decline.

Observed trends in regeneration help place the overstory trends into perspective. Diversity is relatively high across all forest layers (overstory, saplings, seedlings) although somewhat lower in the sapling layer, where a small group of species dominates basal area. Regeneration is present across most monitored plots, but persistence through life stages is increasingly selective. The seedling layer is characterized by masting-like events such as the pronounced increases observed in 2024 for red maple and eastern white pine, followed by substantial early mortality. The 2025 data reinforce that such pulses do not necessarily translate into long-term establishment, highlighting the importance of transitions from seedlings to saplings, and ultimately to canopy trees, when evaluating future forest composition.

The sapling layer provides particularly valuable insight into future trajectories. Species such as balsam fir, red maple, and American beech remain highly represented, reflecting a combination of high recruitment, vegetative reproduction, and tolerance of early-stage stress. Eastern hemlock also makes up a substantial percentage of the sapling layer which may indicate some future resilience to current mortality events in the tree layer. For some of these species, however, persistent regeneration may not necessarily lead to successful canopy replacement, particularly in the face of persistent pests and diseases. The alignment of stress signals across seedlings, saplings, and overstory trees for certain species suggests that forest health pressures are acting across life stages, reinforcing the need for continued monitoring and management.

Overall, the 2025 results indicate that northeastern forests are undergoing gradual, measurable shifts in condition and composition. Continued increases in crown transparency and dieback, coupled with declining vigor and selective regeneration success, warrant close attention in coming years to see if this trend signals a longer-term decline. Ongoing annual monitoring will be essential for determining whether these patterns stabilize, intensify, or translate into increased mortality and structural change, and for supporting forest managers as they work to sustain the long-term vitality, productivity, and resilience of these ecosystems.

Data

Forest Ecosystem Monitoring Cooperative (2025) Regional Forest Health Monitoring (FHM). FEMC. Available online at: https://www.uvm.edu/femc/data/archive/project/regional-forest-health-monitoring

References

Flower, C. E., Knight, K. S., Rebbeck, J., & Gonzalez-Meler, M. A. (2013). The relationship between the emerald ash borer (*Agrilus planipennis*) and ash (*Fraxinus spp*.) tree decline: Using visual canopy condition assessments and leaf isotope measurements to assess pest damage. *Forest Ecology and Management*, *303*, 143-147. https://doi.org/10.1016/j.foreco.2013.04.017

Hall, B., Motzkin, G., Foster, D., Syfert, M. and J. Burk. (2002). Three hundred years of forest and land- use change in Massachusetts, USA. *Journal of Biogeography* 29: 1319–1335.

Kantor, C., Demirel, M. C., & Kantor, M. (2025). Unveiling the threat of beech leaf disease: lessons from North America. *Frontiers in Forests and Global Change*, *8*, 1606260. https://doi.org/10.3389/ffgc.2025.1606260

Kasson, M. T., & Livingston, W. H. (2012). Relationships among beech bark disease, climate, radial growth response and mortality of American beech in northern Maine, USA. *Forest Pathology*, *42*(3), 199-212. https://doi.org/10.1111/j.1439-0329.2011.00742.x

Muilenburg, V. L., & Herms, D. A. (2012). A review of bronze birch borer (Coleoptera: Buprestidae) life history, ecology, and management. *Environmental Entomology*, *41*(6), 1372–1385. https://doi.org/10.1603/en12238

Porter B, Vitale J, Sirch M, Donisvitch S, Voorhis N, Wolf A, Lee J, Schuett E, Adams A, and Pontius J. 2024. Regional Forest Health Monitoring Program: 2023 Report. Forest Ecosystem Monitoring Cooperative. South Burlington, Vermont. https://doi.org/10.18125/51ic7j

Porter B, Donisvitch S, Rios M, Sirch M, Voorhis N, Wolf A, Schuett E, Adams A, and Pontius J. 2025. Regional Forest Health Monitoring Program: 2024 Report. Forest Ecosystem Monitoring Cooperative. South Burlington, Vermont. https://doi.org/10.18125/vi6441

Stephanson, C. A., & Ribarik Coe, N. (2017). Impacts of beech bark disease and climate change on American beech. *Forests*, *8*(5), 155. https://doi.org/10.3390/f8050155

Stump, A. J., Bershing, K., Bal, T. L., & Külheim, C. (2024). Current and Future Insect Threats to Oaks of the Midwest, Great Lakes, and Northeastern United States and Canada. *Forests*, *15*(8), 1361. https://doi.org/10.3390/f15081361

USDA Forest Service (USFS). 2022. *Eastern Region Forest Health Conditions Report 2022.* Eastern Region State, Private, and Tribal Forestry.

USDA Forest Service (USFS). 2024. Eastern Region State, Private and Tribal Forestry. BLD Distribution Map.

USFS Forest Health Highlights (2024a). *2024 Forest Health Highlights: The Connecticut Agricultural Experimental Station.* https://www.fs.usda.gov/foresthealth/docs/fhh/CT_FHH_2024.pdf

USFS Forest Health Highlights (2024b). *Forest Health Highlights Vermont 2024.* https://www.fs.usda.gov/foresthealth/docs/fhh/VT_FHH_2024.pdf

USFS Forest Health Highlights (2024c). *Forest Health Highlights New York 2024.* https://www.fs.usda.gov/foresthealth/docs/fhh/NY_FHH_2024.pdf

USFS Forest Health Highlights (2024d). *2024 New Hampshire Forest Health Update.* https://www.fs.usda.gov/foresthealth/docs/fhh/NH_FHH_2024.pdf

USFS Forest Health Highlights (2024e). *Massachusetts Forest Health Highlights 2024.* https://www.fs.usda.gov/foresthealth/docs/fhh/MA_FHH_2024.pdf

USFS Forest Health Highlights (2024f). *Maine Forest Service Forest Health and Monitoring – Forest Health Highlights Annual Report 2024.* https://www.fs.usda.gov/foresthealth/docs/fhh/ME_FHH_2024.pdf

Wilmot, S., Duncan, J.A., Pontius, J., Gudex-Cross, D., Sandbach, C., and J. Truong. 2019. *Vermont Forest Health Monitoring Protocol.* Forest Ecosystem Monitoring Cooperative. Available at: https://www.doi.org/10.18125/d2c081.

Wyka, S. A., Smith, C., Munck, I. A., Rock, B. N., Ziniti, B. L., & Broders, K. (2016). Emergence of white pine needle damage in the northeastern United States is associated with changes in pathogen pressure in response to climate change. *Global Change Biology*, *23*(1), 394-405.

Appendix

Table A1. Overstory composition of trees from FEMC FHM plot network in 2025 showing total live stems (*N* live), total standing dead trees (*N* snags), live tree stems per acre (SPA), live tree basal area per acre (BA, ft^2/ac), percent composition by live tree count (%), and live tree importance value (IV)

Species	N Live	N Snags	SPA	BA	SPA %	IV
red maple	955	54	30	18	17	15
sugar maple	804	35	26	20	15	15
eastern hemlock	545	20	17	14	10	10
eastern white pine	355	33	11	15	6	9
northern red oak	288	25	9	15	5	8
yellow birch	392	14	13	10	7	7
American beech	389	58	12	6	7	6
balsam fir	412	57	14	4	8	6
red spruce	299	22	10	7	6	5
black birch	190	5	6	3	3	3
white ash	123	30	4	3	2	2
red pine	82	3	2	3	1	2
black cherry	74	11	2	2	1	1
white oak	59	2	2	2	1	1
paper birch	74	21	2	<1	1	1
black oak	40	4	1	1	<1	<1
pitch pine	37	2	1	<1	<1	<1
quaking aspen	27	13	<1	<1	<1	<1
American basswood	26	1	<1	<1	<1	<1
white spruce	30	2	<1	<1	<1	<1
shagbark hickory	23	<1	<1	<1	<1	<1
bigtooth aspen	20	5	<1	<1	<1	<1
e.hophornbeam	36	3	1	<1	<1	<1
green ash	22	3	<1	<1	<1	<1
gray birch	23	3	<1	<1	<1	<1
Other hardwood	74	4	2	1	<1	1
Other softwood	32	2	<1	<1	<1	<1
Total	5431	433	173	131	100	100

Table A2. Crown health metrics from live trees in 2025 across the FEMC FHM plot network where at least 10 individuals of each species were measured. Percent poor vigor is the proportion of trees per species that were classified to be 'in decline' (vigor ratings of 3 or 4). Dieback and transparency were recorded in categories of 5% intervals. Discoloration and defoliation are estimates associated with the class assignment (Table 3). For example, a species with a mean discoloration rating of 0.5 will be between class 0 (none to trace discoloration) and class 1 (<30% discoloration). Percent class is based on the mean discoloration and defoliation. Species are ranked by % poor vigor.

	Poor Vigor	**Dieback (%)**		**Transparency (%)**		**Discoloration**			**Defoliation**		
Species	**%**	**mean**	**median**	**mean**	**median**	***mean***	***median***	***% class***	***mean***	***median***	***% class***
American beech	35	23	15	33	30	0.9	0	none to trace	0.6	0	none to trace
American mountain-ash	33	15	10	23	25	0.2	0	none to trace	0.4	0	none to trace
white ash	23	20	10	32	30	0	0	none to trace	0	0	none to trace
quaking aspen	19	15	10	30	30	0	0	none to trace	0.1	0	none to trace
black cherry	18	13	10	30	30	0.2	0	none to trace	0.2	0	none to trace
black oak	18	14	15	28	25	0.3	0	none to trace	0.5	0.5	none to trace
white oak	15	12	10	24	25	0.2	0	none to trace	0.2	0	none to trace
bigtooth aspen	10	15	15	31	30	0	0	none to trace	0	0	none to trace
northern red oak	10	11	10	26	25	0.3	0	none to trace	0.4	0	none to trace
green ash	9	12	10	28	27.5	0	0	none to trace	0.1	0	none to trace
striped maple	9	12	5	25	20	0.3	0	none to trace	0.3	0	none to trace
gray birch	9	9	5	30	30	0.1	0	none to trace	0.5	1	none to trace
red maple	7	11	10	26	25	0.4	0	none to trace	0.3	0	none to trace
eastern hophornbeam	6	11	10	26	25	0	0	none to trace	0.1	0	none to trace
paper birch	5	10	5	28	30	0.3	0	none to trace	0.4	0	none to trace
sugar maple	5	10	10	26	25	0.4	0	none to trace	0.2	0	none to trace
shagbark hickory	4	8	5	22	20	0.1	0	none to trace	0.4	0	none to trace
yellow birch	4	9	5	25	25	0.1	0	none to trace	0.3	0	none to trace
American basswood	4	11	10	25	25	0	0	none to trace	0.1	0	none to trace
black birch	2	7	5	26	25	0.1	0	none to trace	0.2	0	none to trace

All hardwood	10	12	10	27	25	0.3	0.3	none to trace	0.3	0	none to trace
northern white-cedar	33	16	10	27	25	0.2	0	none to trace	0	0	none to trace
Norway spruce	12	14	12	30	30	0	0	none to trace	0	0	none to trace
balsam fir	8	11	5	22	20	0	0	none to trace	0	0	none to trace
eastern white pine	8	11	5	28	25	0	0	none to trace	0	0	none to trace
eastern hemlock	6	9	5	23	20	0	0	none to trace	0	0	none to trace
red pine	4	10	10	30	30	0	0	none to trace	0	0	none to trace
red spruce	2	8	5	21	20	0	0	none to trace	0	0	none to trace
All softwood	3	10	5	24	20	0	0	none to trace	0	0	none to trace

Table A3. Sapling composition from FEMC FHM regeneration microplots in 2024 including total stems (N), percent composition (%) of sapling layer, and basal area per acre (BA, ft²/ac). Information for all species sapling data is shown in the last row.

Species	Live saplings	BA	%
balsam fir	**3,541**	**53**	**33**
American beech	**1,736**	**24**	**15**
red spruce	**1,204**	**18**	**11**
red maple	**528**	**13**	**8**
yellow birch	**391**	**8**	**5**
paper birch	**225**	**8**	**5**
sugar maple	**325**	**7**	**5**
striped maple	**472**	**6**	**4**
eastern hemlock	**252**	**6**	**3**
eastern hophornbeam	**197**	**3**	**2**
eastern white pine	**97**	**2**	**2**
mountain paper birch	**53**	**2**	**1**
black spruce	**99**	**2**	**1**
black birch	**94**	**2**	**1**
white ash	**75**	**1**	**<1**
northern red oak	**36**	**1**	**<1**
mountain maple	**76**	**<1**	**<1**
Am. mountain-ash	**57**	**<1**	**<1**
black cherry	**27**	**<1**	**<1**
black ash	**11**	**<1**	**<1**
Other hardwood	**179**	**3**	**2**
Other softwood	**24**	**<1**	**<1**

All species	9,699	163	100

Table A4: List of special damages to trees in FEMC Forest Health Monitoring program (Wilmot et al., 2019).

Bole Damage Code	Bole Damage Agent
Animal Damage	
441	Animal browse
444	Beaver damage
445	Porcupine damage
446	Sapsucker damage
447	Other animal damage
Borers and Insects	
707	Asian long-horned beetle
101	Balsam woolly adelgid
104	Beech bark scale only
111	Defoliation >20%
103	Hemlock woolly adelgid
710	Sirex wood wasp
108	Sugar maple borer
110	Other bark beetles
711	Emerald ash borer
109	Other borers
Cankers Conks and Diseases	
106	Beech bark disease symptoms
201	Butternut canker
206	European larch canker
203	Eutypella canker
204	Hypoxylon canker
202	Nectria canker
207	Other canker
208	Conks and other indicators of decay
209	Dwarf mistletoe
210	White pine blister rust
Human-related	
702	Logging damage > 20% of circumference
Weather-related	
708	Cracks and seams
501	Wind-thrown/uprooted
505	Other weather damage

Table A5: List on invasive plants and their codes for the Forest Health Monitoring program (Wilmot et al., 2019).

Code	Common name	Scientific name
1	Barberry: Japanese or common	*Berberis thunbergii, B. vulgaris*
2	Buckthorn: common or glossy	*Rhamnus cathartica, Frangula alnus*
3	Bittersweet: oriental	*Celastrus orbiculatus*
4	Honeysuckle: bell, Japanese, amur, Morrow or tartarian	*Lonicera* X *bella, L. japonica, L. maackii, L. morrowii, L. tatarica*
5	Multiflora rose	*Rosa multiflora*
6	Norway maple	*Acer platanoides*
7	Autumn or Russian olive	*Elaeagnus umbellate, E. angustifolia*
8	Japanese knotweed	*Fallopia japonica (Polygonum cuspidatum)*
9	Garlic mustard	*Alliaria petiolata (A. officinalis)*
10	Privet	*Ligustrum vulgare*
11	Tree of heaven	*Ailanthus altissima*
12	Wild chervil (cow parsnip)	*Anthriscus sylvestris*
13	Burning bush or winged euonymus	*Euonymus alatus*
14	Goutweed	*Aegopodium podagraria*
15	Amur maple	*Acer ginnala*
99	Other	

Table A6. Tree vigor codes and definitions from the FEMC FHM protocol (Wilmot et al. 2019).

Code	Definition
1	Healthy; tree appears to be in reasonably good health; no major branch mortality; crown is reasonably normal; less than 10 percent branch mortality or twig dieback.
2	Light decline; branch mortality, twig dieback present in 10 to 25 percent of the crown; broken branches or crown area missing based on presence of old snags is less than 26 percent.
3	Moderate decline; branch mortality, twig dieback in 26 to 50 percent of the crown; broken branches, or crown area missing based on presence of old snags is 50 percent or less.
4	Severe decline; branch mortality, twig dieback present in more than 50 percent of the crown, but foliage is still present to indicate the tree is alive; broken branches, or crown area missing based on presence of old snags is more than 50 percent.
5	Dead and standing, natural cause; tree is dead and still standing; phloem under bark has brown streaks; few epicormic shoots may be present on the bole; record the dead tree's height and DBH.
6	Dead and down, human cause; tree cut, or removed. Only record vigor/status
7	Dead and standing, human caused; tree is standing dead and there are signs of human cause (i.e. girdled or damaged by equipment). Record DBH and height
8	Dead and down, natural cause: tree is dead and on the ground or a snag less than 4.5' (DBH). Only record vigor/status.
9	Missing: Tree cannot be located, only record vigor/status.

Table A7. Foliar discoloration and defoliation classes and definitions from the FEMC FHM protocol (Wilmot et al., 2019).

Class	Definition
0	None to trace defoliation or discoloration
1	Less than 30 percent of crown defoliated or discolored.
2	31 to 60 percent defoliation or discoloration.
3	More than 60 percent defoliation or discoloration.

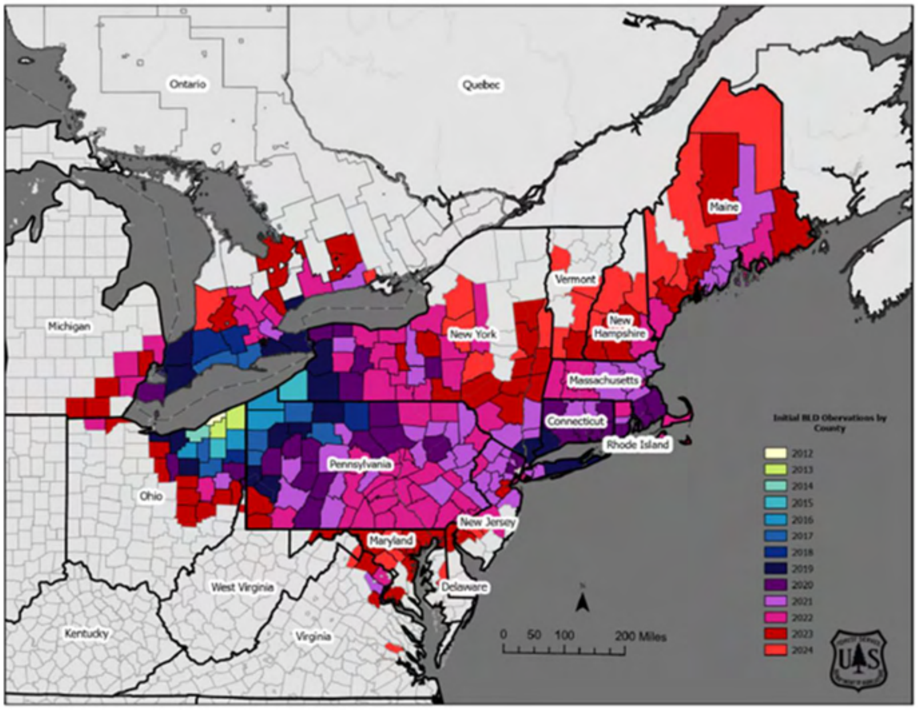

Figure A1. Beech leaf disease (BLD) distribution in the northeastern united states in 2024. Source: USDA Forest Service, Eastern Region State, Private and Tribal Forestry.

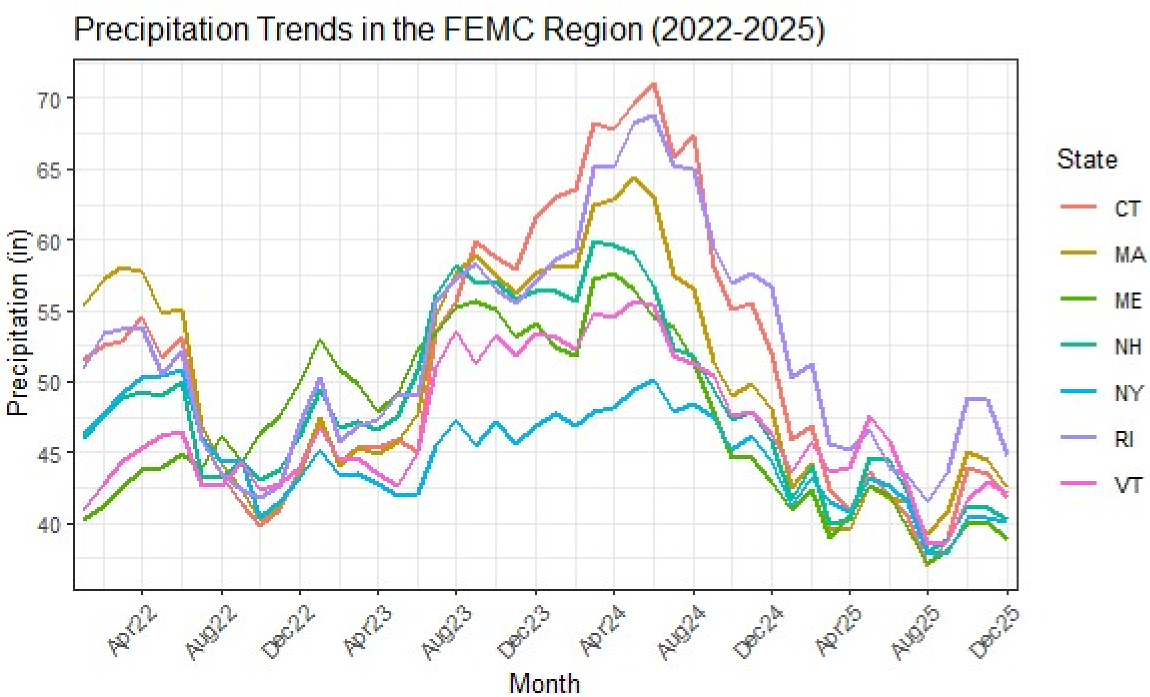

Figure A2: Precipitation trends in the seven focal FEMC FHM states from January 2022-December 2025. Each month corresponds to a cumulative precipitation amount for a given state over the preceding 12-month period. Aggregating precipitation cumulatively over this period illustrates seasonal trends between years, thereby showing total forest water input.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's

Providing the information needed to understand, manage, and protect the region's forested ecosystems in a changing global environment

TARGET Center at 202–720–2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410, or call 800–795–3272 (voice) or 202–720–6382 (TDD). USDA is an equal opportunity provider and employer.