REGIONAL FOREST HEALTH MONITORING PROGRAM

2024 Report

FEMC
Forest Ecosystem Monitoring Cooperative

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FEMC is also actively pursuing efforts to integrate current and past land histories and cultures of Indigenous peoples into its work. FEMC recognizes that its 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.

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Executive Summary

Forest health monitoring is a critical tool for understanding 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.

The largest forest monitoring program in the United States, the US Forest Service's Forest Inventory and Analysis (FIA) program, revisits sites in 5–10-year intervals, which does not allow for the observation of small-scale temporal changes in response to specific events or outbreaks. For example, a significant defoliation event, or a forest's subsequent response to it, may be missed in forest monitoring programs employing these longer visitation intervals.

Annual forest health monitoring programs, like FEMC's regional program, can be a vital tool to identify subtle changes and long-term trends in forest composition and condition (Bechtold et al., 2007). Additionally, the health of mature, overstory trees in the forest can be tracked by measuring annual diameter and height, evaluating canopy condition, determining the overall vigor, and identifying specific damages and diseases. Changes in forest composition can also be assessed by tracking regeneration, growth, and mortality patterns year over year. Monitoring the prevalence of invasive pests, pathogens, and animal browse is also important, as this can provide further understanding of the impacts of common stressors on forest health and condition. Understanding how our forests are changing and how those changes affect forest health provides critical information for mitigation and adaptation strategies; this information can also help ensure the sustained provisioning of key ecosystem services in the face of a changing climate.

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.

In 2024, FEMC visited 194 plots in CT (15), MA (24), ME (35), NH (25), NY (39), RI (7), and VT (49). Results from the 2024 monitoring season indicate that red maple (*Acer rubrum*; 17% based on stems per acre (SPA)), sugar maple (*Acer saccharum*; 14%), and balsam fir (*Abies balsamea*; 10%) were the most abundant species across the 194-plot network. From the 6,789 trees (≥5 inch DBH) measured, average live overstory tree density in 2024 was 177 SPA and 129 ft^2/ac basal area. Regeneration assessments show sapling densities of 3,680 live SPA with balsam fir and American beech (*Fagus grandifolia*) representing the most abundant species. Red maple was the most abundant seedling tallied in 2024 (40% composition, 11,708 SPA), followed by sugar maple (18%, 5,355 SPA), and white pine (*Pinus strobus*; 15% composition, 4,420 SPA).

While there are a wide range of stressors and vulnerabilities impacting Northeastern forests, data from the 2024 season suggest that the region's forests are overall diverse, vigorous, and healthy. However, there are notable exceptions that merit continued monitoring. The 2024 crown health assessments indicated that white oak (*Quercus alba*), American beech, and black cherry (*Prunus serotina*) are species of concern. Average vigor ratings for these species were 1.8, 2.1, and 2, respectively (where 1 is healthy and 4 is severe decline; Table 2) and defoliation ratings were 1.5, 0.6, and 0.9 (where 0 is no to trace defoliation, 1 is less than 30 percent crown defoliated, and 2 is 30-60% defoliation; Table 3). The percentage of fine twig dieback for these species was 15, 20, and 15%, respectively, of the tree crown. Possibly due to recent spongy moth outbreaks across the Northeast, 26% of oaks showed >30% defoliation. Seedling regeneration was also sparse for eastern cottonwood (*Populus deltoides*; 0.4 SPA), white spruce (*Picea glauca*; 0.5 SPA), and eastern redcedar (*Juniperus virginiana*; 0.5 SPA) with only 1 seedling identified for each of these species in 2024; this may be due to a range of factors including low overstory representation of these species, light conditions, or successional stages of the forests. This highlights the importance of continuing annual assessments to better understand trends, patterns, and drivers of change for the state's forested ecosystems.

2024 represents the third year of regional data in our plot network; as a result, we can include region- and state-wide time series analyses in this year's summary report. We have created a supplemental figures package to be interpreted along with this report (see Supplementary Figures Package at the end of this document) depicting these time series analyses at the state level. We observed trends of slight decline for many aspects of crown health between 2022 and 2024 regionally. Both transparency and dieback appear to be increasing across species region-wide, while vigor is declining. The mean basal area of standing dead trees has increased in our plots from 2022 to 2024, a trend that appears to be largely influenced by white ash, American beech, and balsam fir. Regeneration trends indicate balsam fir and American beech saplings are the most abundant species in the understory, while white pine, American beech, and yellow birch contributed most to the total mortality within the sapling layer in 2024. Data from 2024 also indicates a significant seed crop year for red maple and white pine seedlings with large increases in seedling densities compared with prior years. It is important to note that with only three data points (2022, 2023, and 2024), our confidence in these trends is only moderate. As we gather additional data in subsequent years, trend observations will become more robust.

Background

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 Asian longhorned beetle (*Anoplophora glabripennis*), eastern spruce budworm (*Choristoneura fumiferana*), emerald ash borer (EAB; *Agrilus planipennis*), hemlock woolly adelgid (HWA; *Adelges tsugae*), elongate hemlock scale (*Fiorinia externa*), southern pine beetle (SPB; *Dendroctonus frontalis*), and spongy moth (*Lymantria dispar dispar*) (USFS, 2022). Combined with invasive insects, various diseases have been primary concerns for northeastern forest health, including beech leaf disease, oak wilt, and white pine needle damage (USFS, 2022). Together, these various threats and stressors contribute to the declines—in most cases limited to certain species or sub-regions—that are noted in this report.

In late 2024, FEMC worked with its collaborators in each of the organization's partner states to compile updates on invasive species and forest health threats. Below we provide a summary, based on both these communications and other sources, of the status of several pests and pathogens of concern across the region.

Of the insects listed, EAB, HWA, and spongy moth remain insects of high concern. In 2022, EAB was rated the "top tree killing agent recorded in the Eastern Region," with new annual detections in Vermont (USFS, 2021 and 2022). All other states in the FEMC partnership continue to endure EAB spread. New York identified EAB in one new county (Essex) in 2024, rendering Hamilton and Lewis counties the only areas in the state where EAB has not been detected. 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, 2024). However, various management practices are being implemented to reduce the spread of EAB in the Northeast. Such management practices include biocontrol management, which is underway through the release of parasitoid wasps (*Oobius agrili*, *Tetrastichus panipennisi*), who prey on EAB in the Eastern Region (USFS, 2022). As of 2024 most FEMC partner states, including Connecticut, Massachusetts, Maine, New Hampshire, Rhode Island, and Vermont, have implemented parasitoid wasp biocontrols. Vermont now deploys wasp biocontrols in five locations across the state (personal communication, 2024). New Hampshire is taking an Integrated Pest Management (IPM) approach, wherein researchers and resource managers are locating and collecting seeds from remaining healthy, mature white ash trees with the aim of cultivating ash trees with resistance or an increased tolerance to EAB (USFS, 2022). The Massachusetts Department of Conservation and Recreation (MA DCR) has been in collaboration with nonprofit partners, namely the Ecological Research Institute's Managing and Monitoring Ash (MaMA) initiative and the Sustaining Ash Partners network (SAP-ne), to identify lingering ash and develop a regional network of sites that highlight different approaches to ash conservation (personal communication, 2024).

HWA has continued to persist 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. Both states are implementing biocontrols for HWA: New York has seen success with *Laricobius* spp. beetles establishing in sites with HWA presence, while New Hampshire has released silver flies (*Leucotaraxis* spp.) to counter HWA (personal communication, 2024).

Spongy moth also remains a concern in the Northeast. Specific hotspots in western Massachusetts and western Connecticut indicate high levels of spongy moth egg mass counts (CT) and significant defoliation (MA; USFS, 2022). However, recent surveys suggest a possible decrease in populations of spongy moth; elevated levels of NPV (nucleopolyhedrosis virus), *Entomophaga maimaiga* (fungus), and insect predation are likely causes for reduced spongy moth populations. In New Hampshire and Vermont, larval mortality has increased due to both the fungi and the virus.

SPB may pose a developing threat to trees in the Northeast region, though detection of individual beetles and infestations varies between states. SPB outbreaks can be catastrophic, with one outbreak from 1999-2002 causing over $1 billion worth of damage (Clarke and Nowak, 2009). However, factors influencing SPB spread are multivariate, and not all beetle detections coincide with tree infestations. Extremely cold temperatures, forest fragmentation, thinning, and lumber mill closures present barriers to SPB spread (Clarke, Riggins, and Stephen, 2016). Several states in the region monitor SPB via trapping. Connecticut and Rhode Island have experienced rising numbers of SPB caught in traps despite few reported tree infestations (personal communication, 2024). Small scale infestations have been reported in several locations in Massachusetts beginning in 2023; although they are being managed through prescribed cuts the state continues to see elevating SPB detections in Martha's Vineyard and Nantucket (personal communication, 2024). Three out of New York's four long-term monitoring sites have detected SPB, with the first SPB being captured at the Schunnemunk, NY site in 2024 (personal communication, 2024). SPB are not yet known to occur in Vermont, and while New Hampshire has detected SPB in traps there have been no infestations reported in the state (personal communication, 2024). Despite dissimilar reports across FEMC states, managers should continue monitoring for SPB given its historic potential for outbreaks.

Elm zigzag sawfly (EZS; *Aproceros leucopoda*) represents another emerging pest threat to Northeastern forests. While native to Southeast Asia, the first reports of EZS in the Northeastern US came from New York in 2022 (Oten et al., 2023). EZS prevalence varies across the Northeast – FEMC partners report that while densities are currently low in Massachusetts and New York, it is present in the majority of Vermont counties (personal communication, 2024). New York State partners are studying biocontrols that show potential to regulate EZS, with the pale green assassin bug (*Zelus luridus*) linked to declining EZS in some locations (personal communication, 2024).

Finally, winter moth (*Operophtera brumata*) has recently resurged in Rhode Island and expanded its range into inland areas where it was not previously seen. Biocontrol efforts with parasitoids have not yet proven successful, and the state is currently evaluating approaches (personal communication, 2024).

Tree diseases are common and detrimental to northeastern forest health, and several operate in concert with invasive insects. A prime example of invasive insects and fungal pathogens working together to create a devastating disease for northeastern forests is beech bark disease (BBD), which is the combined result of the scale insect (*Cryptococcus fagisuga*) and the fungal invasion of *Neonectria*. In North America, a typical forest stand will range from an 80-90% infection rate for American beech trees infected with BBD, with approximately 50% of American beech either dead or dying from BBD (Stephanson and Coe, 2017). This trend is observed in overstory and midsized trees, but not to this extent in younger trees and saplings. Currently, researchers and natural resource managers are exploring American beech genes that may be resistant to BBD, as well as mapping habitat ranges and to forecast the expansion of BBD in future years (Stephanson and Coe, 2017). Considering that American beech is one of the most prolific seed dispersers through biennial masting and that it provides an important food resource for wildlife (LaMere, McNulty, & Hurst, 2011), the negative impact of BBD on American beech, combined with a range of other forest stressors due to climate change, can have a detrimental, cascading effect on northeastern forest ecosystems.

Another prevalent disease is Beech Leaf Disease (BLD), which has been spreading throughout the Northeast since 2012, likely due to *Litylenchus crenatae* spp. *maccannii*, a foliar nematode. 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 (Figure 1; USFS, 2024). BLD continues to spread in adjacent states, with its presence detected in 5 of Vermont's 14 counties, mostly in southern Vermont, and as far north as the White Mountains in New Hampshire (personal communication, 2024). In 2024 BLD was also detected in 5 new counties in New York, concentrated across the Central New York and Capital District regions (personal communication, 2024). Despite the rapid BLD expansion, there are ongoing efforts to manage BLD through a pesticide trial of PolyPhosphite 30, which will continue to be studied in experimental plots (USFS, 2022). Among FEMC partners, PolyPhosphite trials in New York have yielded mixed efficacy, while Bio-SAR, another proposed BLD treatment, has not yet proven successful at alleviating symptoms (personal communication, 2024). Monitoring efforts for BLD continue to develop, with New York and Massachusetts having established long-term monitoring plots to assess for BLD (personal communication, 2024). While several partner states have yet to witness the mass mortality events expected from BLD they continue to note symptoms of beech stress, and beech trees afflicted with BLD remain vulnerable to additional stressors, including defoliation by pest species.

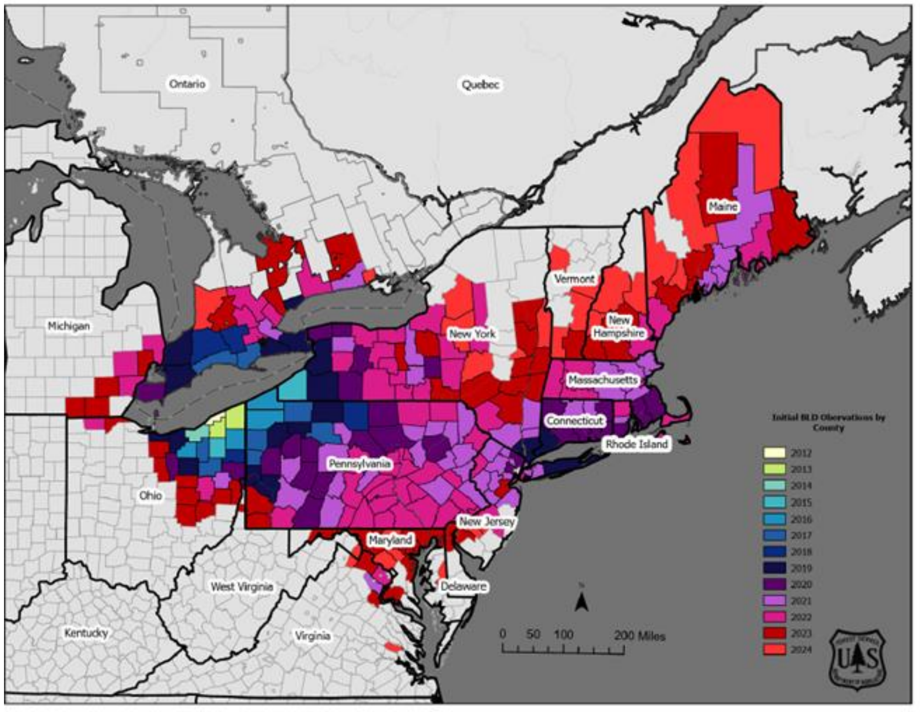

Figure 1. Beech leaf disease (BLD) distribution in the northeastern united states in 2024. Source: USDA Forest Service, Eastern Region State, Private and Tribal Forestry.

Another third common disease in northeastern forests is white pine needle damage (WPND), which is present in all FEMC regional states to an extent, and most common in Vermont, Connecticut, Rhode Island and Massachusetts. WPND is known to have multiple causal agents, including brown spot needle blight (*Lecanosticta acicula*, most common causal agent), Dooks needle blight (*Lophophacidium dooksii*), needle cast (caused by *Bifusella linearis*), and *Septorioides strobi* (USFS, 2022). Wetter springs are believed to be contributing factors to fungal growth and dispersal for WPND; however, despite drier springs over the past few years, the prevalence of WPND has remained relatively constant (USFS, 2022). In 2022, a year with a dry spring, Vermont experienced substantial yellowing and needle-drop in white pines while Massachusetts observed crown discoloration and thinning canopies (USFS, 2022). In 2024, record high precipitation in Connecticut, New Hampshire, and Rhode Island ushered widespread WPND. Nearly all white pines in Connecticut are noticeably affected by WPND, and New Hampshire has reported that although most white pines were able to recover due to the causative pathogens' native status, some canopies remain notably stressed (personal communication, 2024).

Finally, oak wilt (*Bretziella fagacearum*) is of some concern within the FEMC region but is only prevalent in a few counties in New York with no recent counties observing new cases (USFS, 2022). Oak wilt trends in New York persisted into the current year, with no new cases reported in 2024 (personal communication, 2024). New Hampshire tests for oak wilt in nitulid beetles and spore traps yielded no positive results (personal communication, 2024).

Invasive plant species are also a concern for northeastern forest health. Since invasive plants can act as aggressive colonizers, they can outcompete endemic plants which may lead to degraded habitat for wildlife, lower plant diversity, and an increase in soil erosion. Examples of common invasive plant species in the FEMC region include glossy buckthorn (*Frangula alnus*), common buckthorn (*Rhamnus cathartica*), Japanese barberry (*Berberis thunbergii*), multiflora rose (*Rosa multiflora*), and Japanese honeysuckle (*Lonicera japonica*; USFS, 2022). Management of invasive species continues to progress. For example, Vermont's Department of Forest, Parks, and Recreation (VT FPR) has recently collaborated with the VT Agency of Agriculture, VT Department of Fish and Wildlife, and UVM Extension to compile a list of eight species of early detection plants, which includes species whose populations are in the early stages of invasion and can thus be eliminated in the near future (personal communication, 2024). Priority invasive species initiatives in New York include eradication of kudzu (*Pueraria* spp.) and Japanese stiltgrass (*Microstegium vimineum*), which remain problematic in New York's lower Hudson Valley and Long Island regions, alongside targeted treatments for invasive plants in areas with high ash mortality (personal communication, 2024). Invasive plants remain a serious concern in Connecticut, with the state declaring Japanese angelica tree (*Aralia elata*), quackgrass (*Elymus repens*), Japanese wisteria (*Wisteria floribunda*), and Chinese wisteria (*Wisteria sinensis*) invasive effective 2024; Callery pear (*Pyrus calleryana*) is slated for invasive declaration effective 2027 (personal communication, 2024).

With the combination of both invasive insects and disease, abiotic damage can cause significant tree mortality in northeastern forest ecosystems. Most often, trees that are damaged from abiotic stressors—including frost damage, drought, saltwater intrusion (a more important issue in coastal areas than in FEMC plots), fire, wind, and flooding—are more susceptible to infection of invasive insects and diseases. For example, Maine experienced severe drought resulting in higher incidences of stress-related cankers on trees, early senescence, fall needle drop on pines, declines in oak health, and overall tree mortality (USFS, 2022). Other states, such as Rhode Island, experienced brief torrents that broke a 3-year drought but were interspersed with dry spells that kept the state's annual precipitation levels below average (USFS, 2022). Spring 2024 was one of the wettest in Rhode Island's history, causing widespread defoliation events attributable to fungal infections such as WPND complex, anthracnose, Phyllosticta, and Didymosporina (personal communication, 2024). Summer heavy rains and high humidity in Connecticut aggravated fungal infections associated with WPND and sugar maple browning, while fall droughts caused unprecedented numbers of wildfires throughout the state (personal communication, 2024); October 2024 saw 183 wildfires reported in Connecticut—an order of magnitude higher than the 17 reported on average for that month over the preceding five years (personal communication, 2024). In Vermont, increasing spring rain in conjunction with mud season caused the devastating 2024 floods that occurred primarily in the state's northeastern and central regions, while autumn droughts that same year sparked 81 wildfires (personal communication, 2024). Massachusetts experienced a late frost in May 2024 that contributed to mass tree defoliation, alongside similar rapid transitions between springs with heavy precipitation and high humidity to summer droughts that other FEMC partner states have reported (personal communication, 2024). Forests across the Northeast region continued to face the effects of dramatic oscillations between heavy rain and drought throughout 2024. Abnormal heavy precipitation is conducive to fungal infections while droughts may induce wildfires, trends which have been noticeable across several FEMC partner states. Several state-based FEMC partners have noted the detrimental effects that the recent precipitation-drought cycles have inflicted on sugar maple and white pines, with browning and WPND becoming increasingly prevalent across the region. With the rising concerns of the effect of climate change on forest ecosystems, abiotic damages are likely to remain consistent causal agents of tree mortality for northeastern forest ecosystems.

Deer browse (*Odocoileus* spp.) continues to influence sapling recruitment across the eastern US. Deer may alter understory and overstory composition by preferentially browsing certain species (Kittredge and Ashton, 1995; White, 2012). In addition, the effects of deer browse interacts with other variables that affect sapling establishment and growth, such as light availability and shrub density. For example, species whose sapling growth rates are highly light dependent may be disproportionately susceptible to the effects of deer browsing in closed canopies, while the same species may gain an advantage in open harvest gaps with high shrub density where deer are less likely to browse (Walters et al., 2020). Taking these interactions into account, sites with higher rates of deer browse are likely to see altered tree species community composition compared to those where deer are less prevalent. Sustained deer browse may also reduce understory complexity, leading to downstream effects such as altered nitrogen and carbon cycling and reduced understory habitat for wildlife (White, 2012). Data from other regions in the US show that preferential browsing negatively affects regeneration for northern red oak, eastern white pine, and eastern hemlock, which are prominent species across FEMC partner states (White, 2012).

Plot Network Establishment

In 1990, a national Forest Health Monitoring program was established by the U.S. Forest Service to monitor forest health and detect emerging threats (Bechtold et al., 2007). The program had three main objectives: 1) to identify deteriorating conditions in forest ecosystems; 2) to monitor forest ecosystem resources, specifically where conditions are deteriorating; and 3) to comprehend the intricate complexities behind forest health problems (Bechtold et al., 2007). Plots consisting of four fixed area subplots, each measuring 7.32 m (24 ft) in radius, were initially set up across six northeastern states. Eventually, the program was expanded to 45 states (Bechtold et al., 2007). Since 1999, Forest Health Monitoring (FHM) field plots have been integrated into the ground plot network maintained by the US Forest Service's Forest Inventory and Analysis (FIA) program. Continuous Forest Inventory (CFI) networks have also been established across the region by various state and public agencies. The FIA program assesses demography and forest utilization trends (Gillespie, 2000). CFI programs record similar metrics to assess timber stocks and yields. For both FIA and CFI programs, periodic inventories are designed to assess a subset of plots each year to capture changes over time across a large network of plots (Gillespie, 1998). FIA programs run on 5–7-year re-measurement cycles (USFS, 2013), while CFI rotations vary by agency but typically follow a 10-year return cycle (Nevins et al., 2019).

Annual plot assessments can better capture year-to-year fluctuations due to weather, disturbance, or pest and pathogen outbreaks. While periodic inventories, like the FIA and CFI programs described previously, allow for a larger number of total plots across the landscape, trends over shorter time periods may be obfuscated.

In order to provide more detailed annual measurements supporting a more nuanced and informative understanding of forest health, in 1991 the FEMC established 49 FHM long-term monitoring plots spanning Vermont's forest types and biophysical regions. For each plot, FHM technicians annually assess tree demography, canopy condition, seedling abundance, sapling survivorship, invasive species, browse presence, and damage agents. These metrics were selected to provide information on early symptoms of tree stress and changes in forest structure and composition. The information obtained from FEMC FHM program provides timely assessments of current forest conditions and emerging trends while complementing other forest assessment programs that have longer re-measurement cycles, such as the FIA and CFI programs.

After successfully establishing and conducting annual assessments on FHM plots in Vermont for almost three decades, FEMC expanded its FHM program into surrounding states to yield a more complete picture of forest health across New England and New York. In 2019, FEMC collaborated with MA DCR to establish FHM plots on Massachusetts state and private lands to add to its annual FHM network. Following a similar approach, in 2020 and 2021 FEMC expanded efforts to establish permanent plots in CT (15 plots), ME (35 plots), NH (25 plots), NY (40 plots), and RI (7 plots). To improve comparability and utility of each program, where possible the FHM plots were co-located at established, long-term plot locations, representing the major forest types and geographies on public and private lands in each state. Co-locating FHM plots with the FIA and CFI networks connects the FEMC FHM program to historic long-term data that may give insight into previous land use, forest health, and large-scale changes that have occurred over time. In turn, the state and federal programs have access to annual measurements on a subset of plots to better understand year-to-year changes and detect emerging forest health issues. This report provides details on FEMC FHM program and plot selection, and highlights findings from the 2024 FEMC FHM field season.

Methodology

For more details on methodology including plot selection, layout, training, QAQC procedures, and field metrics, please refer to the 2022 and 2023 FEMC FHM monitoring reports (accessed online at https://www.uvm.edu/femc/CI4/cooperative/projects/forest_health_monitoring) and the FHM field protocol (Wilmot et al., 2019).

Field metrics

In 2024 FEMC inventoried 194 out of the 196 total plots in the regional network. Two (2) plots were removed from the data pool in 2024 due to one NY plot being flooded by beaver activity and becoming unsampleable (this plot will be moved to another location in 2025), and another MA plot having erroneous treeID data that will be fixed during the 2025 field season. All metrics have been outlined in the FEMC FHM protocol (Wilmot et al., 2019) and previous FHM annual reports (Porter et al., 2024; Porter et al., 2023). These metrics include assessments of 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 (Wilmot et al., 2019). Other metrics, like animal browse, invasive plants, and forest composition (prism plots), were collected at the overstory plot level. Detailed methods for each metric are provided below.

Field crew and calibration

During the 2024 FHM field season, three crews consisting of 3-4 technicians conducted monitoring in Massachusetts, New Hampshire, New York, and Vermont. Through a partnership with FEMC, crews from the Connecticut Agricultural Experiment Station completed plots in Connecticut and Rhode Island, and the Maine Department of Agriculture, Conservation and Forestry conducted monitoring in Maine. 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 2024 field season were analyzed across all 194 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. Only standing 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

In 2024, FEMC FHM crews measured 6,337 live trees, 8,904 live saplings, and tallied 70,462 seedlings across the 194 measured FHM plots. Below, we provide summaries of data collected from the 2024 field season.

Overstory composition

We found that species composition across the 194 plots was similar to the region-wide composition, according to the most recent available FIA data (USFS 2022, Figure 2).

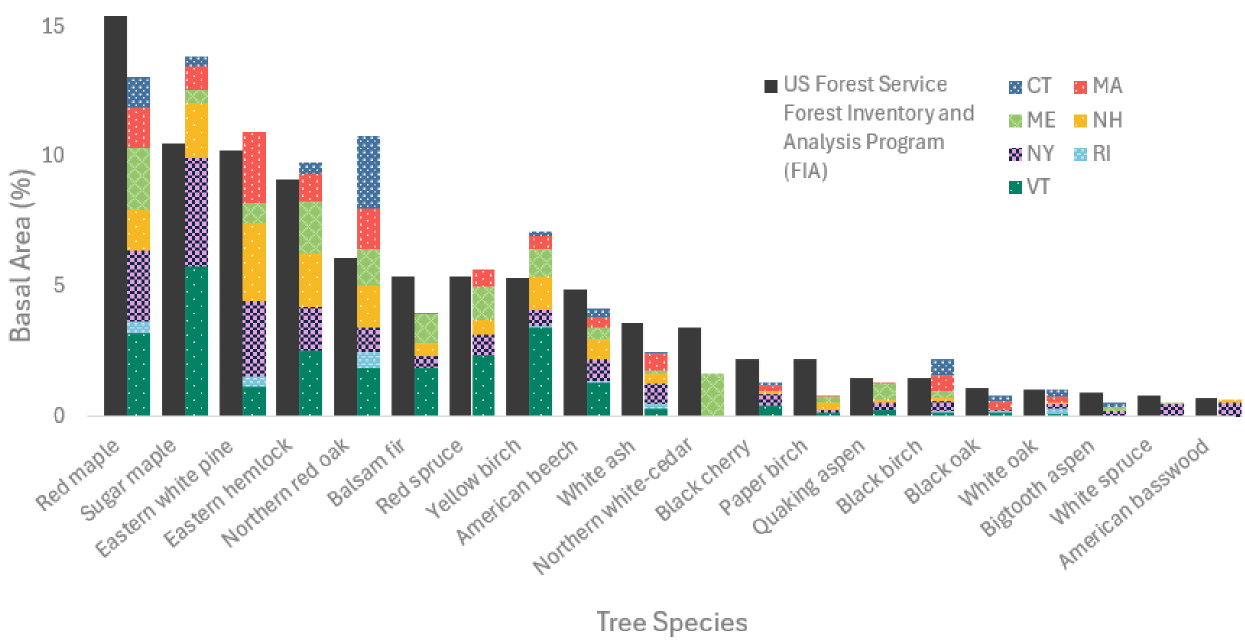

Figure 2. A comparative analysis between FEMC FHM and the USFS FIA species compositions, showing percent live species composition by basal area for CT, MA, ME, NH, NY, RI, and VT from both the FHM 2024 season and the FIA 2022 season (USFS 2022) (only trees with ≥5 inch DBH were included).

Across the 194 FEMC FHM plots, there were a total of 6,337 live and 390 standing dead trees. For live trees, this represents an average of 177 live stems per acre (SPA) and basal area (BA) of 129 ft^2/ac basal area. Standing dead trees averaged 11 SPA and a BA of 5 ft^2/ac. The total BA (live and standing dead) was 134 ft^2/ac which may be too high to encourage regeneration, especially for shade-intolerant species. Only 6% of standing trees sampled were snags.

Across the survey area, hardwoods comprised 64% of the total overstory composition by live stem count. Red maple had the greatest live SPA (29), followed by sugar maple (24 SPA) and balsam fir

(17 SPA; Table 1). Red maple also had the highest live Importance Value (IV) with an IV of 14.9% and BA of 17 ft^2/ac across all plots. Sugar maple had the second highest live IV (13.8%) with a BA of 18 ft^2/ac, followed by eastern hemlock (*Tsuga canadensis*; 9.3%, BA 13 ft^2/ac) and eastern white pine (8.8%, BA 14 ft^2/ac).

Table 1. Overstory composition of trees from FEMC FHM plot network in 2024 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	1059	43	29	17	17	15
sugar maple	839	30	24	18	14	14
eastern hemlock	544	18	15	13	9	9
eastern white pine	410	29	11	14	6	9
northern red oak	343	21	9	14	5	8
yellow birch	454	12	13	9	7	7
balsam fir	609	66	17	5	10	7
red spruce	418	21	12	7	7	6
American beech	448	46	13	6	7	6
black birch	184	3	5	3	3	3
white ash	144	23	4	3	2	2
n. white-cedar	126	6	3	2	2	2
red pine	90	3	2	3	1	2
black cherry	67	10	2	2	1	1
quaking aspen	60	15	2	2	<1	1
paper birch	85	14	2	1	1	1
white oak	59	2	2	1	<1	1
black oak	41	4	1	1	<1	<1
white spruce	36	1	<1	<1	<1	<1
pitch pine	37	2	<1	<1	<1	<1
American basswood	27	<1	<1	<1	<1	<1
bigtooth aspen	32	4	<1	<1	<1	<1
e. hophornbeam	39	2	1	<1	<1	<1
shagbark hickory	23	<1	<1	<1	<1	<1
green ash	25	3	<1	<1	<1	<1
Other hardwood	112	9	3	1	<1	1
Other softwood	26	2	<1	<1	<1	<1
Total	**6337**	**390**	**177**	**129**	**100**	**100**

The distribution of size classes across the FEMC FHM plot network in 2024 reflects the typical age of forests in the region, resulting from the widespread abandonment of agriculture in the mid-twentieth century (Hall et al. 2002). The majority of trees are in the 5-10 inch diameter size class, dominated by mid-successional species that would have become established around the time of agricultural abandonment, mid-1800s to mid-1900s. Some larger trees persist that measure greater than 30 inches DBH; these are most commonly eastern white pine, northern red oak (*Quercus rubra*), eastern hemlock, red maple, sugar maple, and yellow birch (*Betula alleghaniensis*). As these stands continue to age, we can expect to see the number of large stems to increase, particularly for late successional species such as eastern hemlock, American beech, and sugar maple (Figure 3).

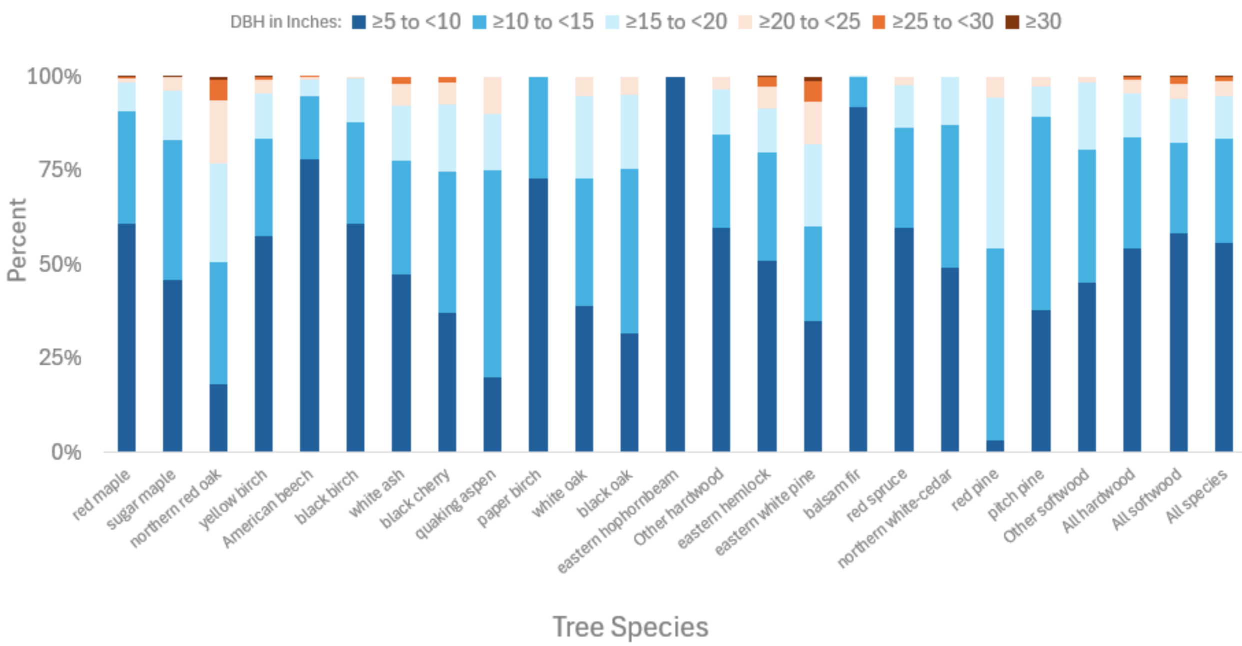

Figure 3. Size classes of live trees by diameter at breast height (DBH; inches) across FEMC FHM plot network in 2024. Species with the highest importance value were included in this chart. Dead trees and saplings (trees < 5" DBH) were excluded from this analysis.

Tree health

Across the 194 FEMC FHM plots assessed in 2024, live tree vigor (mean ± SD) was 1.4 ± 0.7, or between 'healthy' and 'light decline.' Of live trees measured, we found that 5,838 trees (92.1%) had vigor ratings corresponding to 'heathy' and 'light decline' (vigor 1 and 2, respectively) and 499 trees (7.9%) were in 'moderate' to 'severe decline' (vigor 3 and 4, respectively).

For tree species with more than 10 individuals measured, crown health assessments show white oak with lower vigor rating (average vigor of 1.8, where 1 is healthy and 4 is severe decline), and average crown dieback of 15%, and defoliation of 1.5 (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 (vigor 3 or 4) were American beech (13.4% of all overstory trees of the same species), green ash (*Fraxinus pennsylvani*; 8%), white ash (*Fraxinus americana*; 7.6%), Norway spruce (*Picea abies*; 5.9%), and white oak (5.1%). Across all species, ~2% of total live stems surveyed were determined to be in severe decline. Overall, this points to a healthy 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.

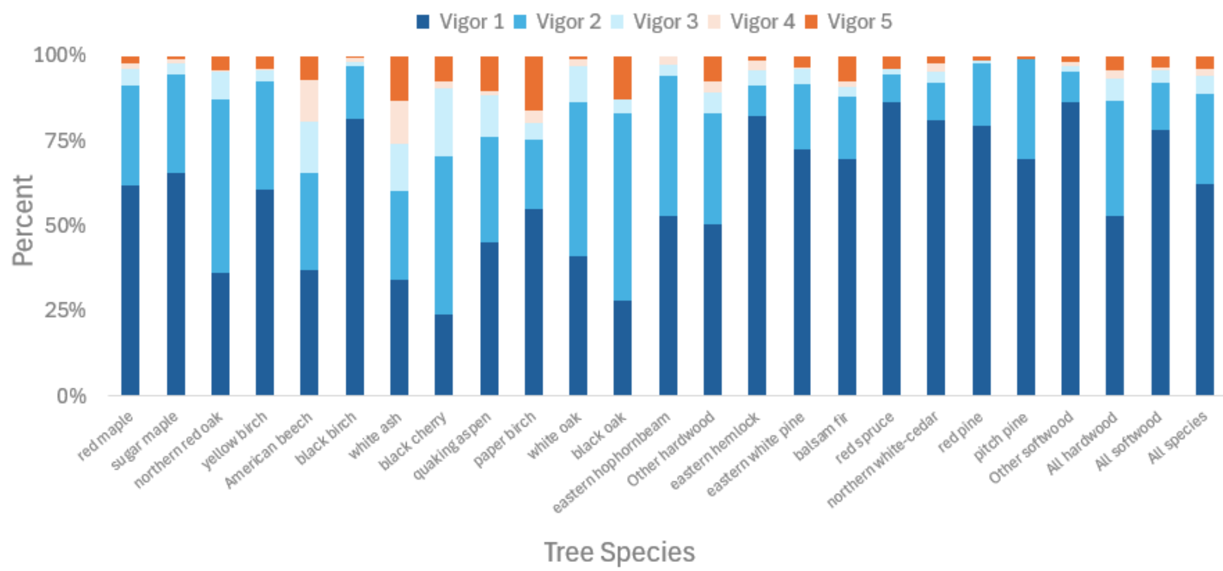

Figure 4. Average basal area per hectare (%) of each vigor (1 is healthiest, 2-4 is increasing decline, 5 is dead and standing) for each overstory tree species. Tree species with the highest importance (abundance) values were included.

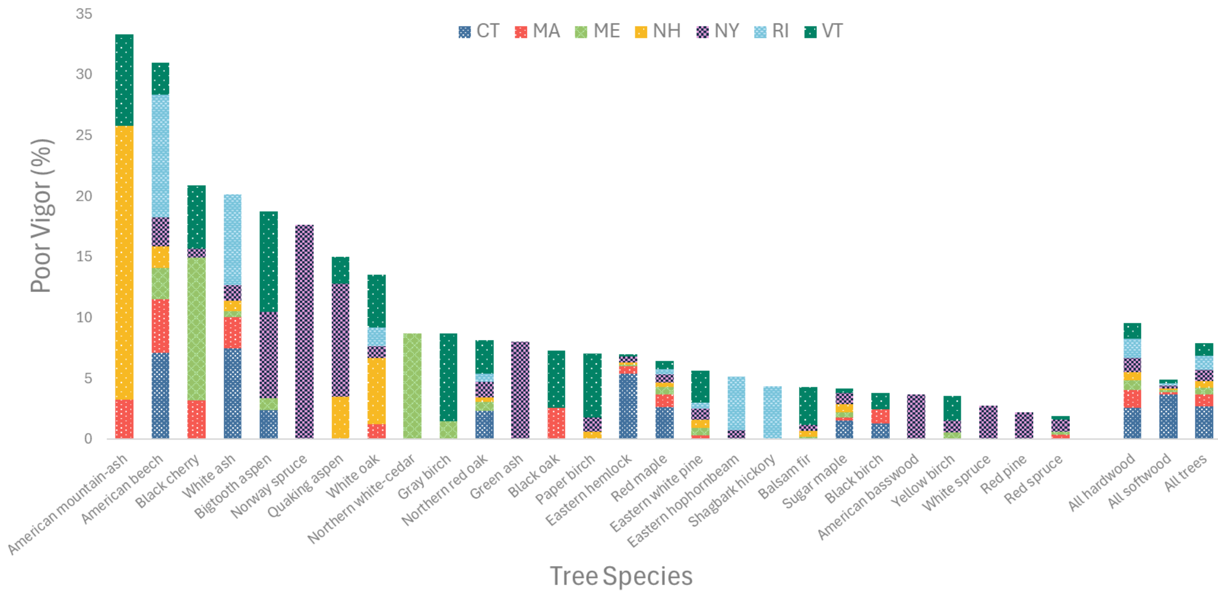

Figure 5. Percentage of trees with a 'poor vigor rating' sampled in 2024 across the seven states in the plot network, including only species with at least 10 individuals measured. Percent poor vigor is the proportion of live trees by species that were classified to be 'in decline' (vigor ratings of 3 or 4). Each bar represents the percentage of trees of that species that had vigor ratings of 3 or 4.

Across all live trees, average fine twig dieback was 10.7%. American beech had the highest mean dieback at 20.2%, while white ash and Norway spruce had 17.5% and 15.3% mean dieback, respectively (Table 2). Average dieback for all tree species ranged from 0-20%, with particular species such as American beech and white ash displaying higher dieback percentages, specifically in Rhode Island, Massachusetts, and Connecticut (Figure 6)—this is likely due to specific pathogens. These values do not suggest widespread crown health issues, but those species and genera with higher dieback percentages should continue to be monitored for widespread changes in dieback over time.

Across all live trees, average foliar transparency ranged from 18% to 38% (Table 2). Transparency is rated the same way across all species; however, each species has a different range of commonly observed transparency ratings due to the general structure of each species crown. American basswood (*Tilia americana*), American beech, and American mountain-ash (*Sorbus americana*) had mean transparency >25%.

Foliar discoloration impacted American beech the most with a mean discoloration estimate of 0.8 (Table 2), which indicates American beech exhibited no to trace discoloration on average, only slightly higher than all other species measured, which averaged a discoloration score of 0.1 (zero to trace discoloration on average). Since some monitoring occurred in early September, it is possible that some of the deciduous species' leaves were beginning to change color, particularly for black gum (*Nyssa sylvatica*), which is known to begin the senescence process early. It is possible that the eastern hemlock discoloration noted was related to hemlock woolly adelgid infestations, but our data cannot confirm this.

Defoliation rates were highest among white oak and American basswood with mean defoliation rates above 1 (defoliation class <30%; Table 2). Nearly every species saw some level of defoliation, with minimal defoliation recorded on softwood species. In several plots, we observed spongy moth caterpillars and egg masses on the trunks of trees.

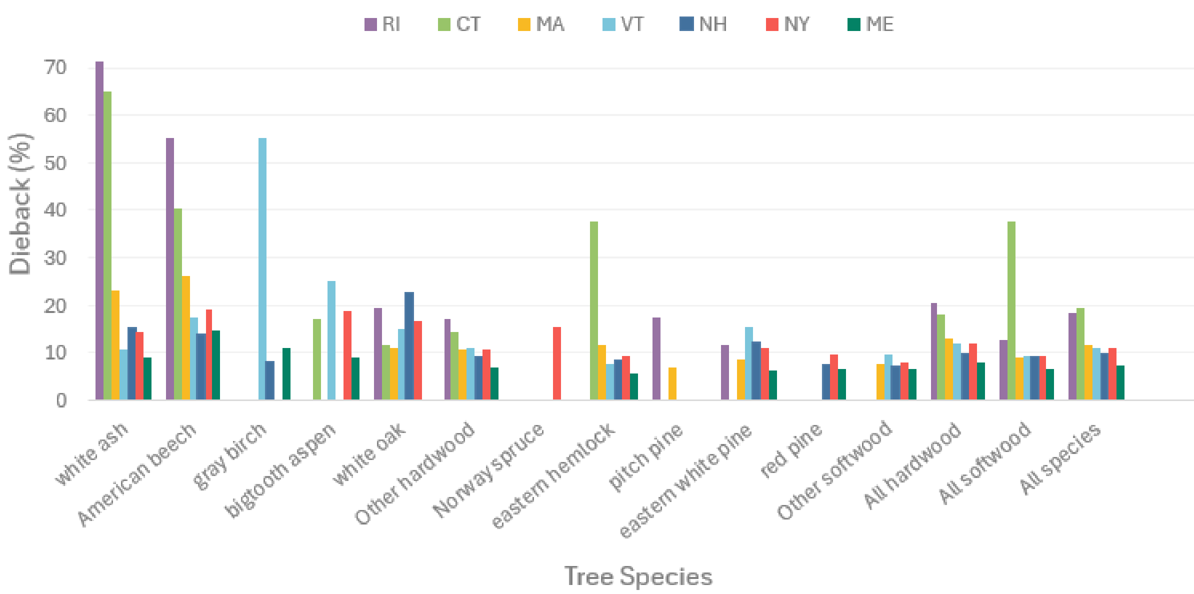

Figure 6. A comparison of average crown dieback (%) per species in each of the seven (7) regional states. Crown dieback is identified as the percent of fine twig dieback and is rated from 0-100% (0% indicating no fine twig dieback, 100% indicating complete fine twig dieback). Tree species with the highest importance (abundance) values were included.

Table 2. Crown health metrics from live trees in 2024 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***
Am. mountain-ash	33	15	15	30	30	0.1	0	0 to trace	0.6	0.5	0 to trace
American beech	31	20	15	30	25	0.8	0	0 to trace	0.6	0	0 to trace
black cherry	21	15	15	36	35	0.1	0	0 to trace	0.9	1	0 to trace
white ash	20	18	10	33	30	0.1	0	0 to trace	0.5	0	0 to trace
bigtooth aspen	19	14	12	30	30	0.4	0	0 to trace	0.9	1	0 to trace
quaking aspen	15	11	8	24	20	0.5	0.5	0 to trace	0.3	0	0 to trace
white oak	14	15	10	24	25	0.4	0	0 to trace	1.5	1	<30%
gray birch	9	11	5	24	20	0.4	0	0 to trace	0.4	0	0 to trace
northern red oak	8	12	10	25	25	0.2	0	0 to trace	0.9	1	0 to trace
green ash	8	14	10	31	30	0.1	0	0 to trace	0.3	0	0 to trace
black oak	7	13	10	27	25	0.2	0	0 to trace	0.8	1	0 to trace
paper birch	7	10	5	27	25	0.6	0	0 to trace	0.9	1	0 to trace
red maple	6	11	10	25	25	0.4	0	0 to trace	0.7	1	0 to trace
e. hophornbeam	5	11	10	26	25	0.2	0	0 to trace	0.9	1	0 to trace
shagbark hickory	4	11	10	21	20	0.4	0	0 to trace	1.2	1	<30%
sugar maple	4	10	10	23	25	0.3	0	0 to trace	0.7	1	0 to trace
black birch	4	8	5	23	22.5	0.1	0	0 to trace	0.5	0	0 to trace
Am. basswood	4	9	5	26	25	0.1	0	0 to trace	1.3	1	<30%
yellow birch	4	9	5	25	25	0.2	0	0 to trace	0.7	1	0 to trace
All hardwood	10	12	10	26	25	**0.3**	**0.3**	**0 to trace**	**0.7**	**1**	**0 to trace**
Norway spruce	18	15	10	38	35	0.1	0	0 to trace	0	0	0 to trace
n. white-cedar	9	9	5	34	35	0.7	1	0 to trace	0.4	0	0 to trace
eastern hemlock	7	10	5	24	20	0	0	0 to trace	0.1	0	0 to trace
e. white pine	6	10	5	28	30	0.2	0	0 to trace	0	0	0 to trace
balsam fir	4	8	5	27	25	0.3	0	0 to trace	0.1	0	0 to trace
white spruce	3	7	5	22	20	0.1	0	0 to trace	0	0	0 to trace
red pine	2	10	10	32	30	0	0	0 to trace	0	0	0 to trace
red spruce	2	7	5	24	25	0.1	0	0 to trace	0	0	0 to trace
All softwood	3	9	5	27	25	**0.2**	**0.2**	**0 to trace**	**0.1**	**0**	**0 to trace**
All live trees	8	11	5	26	25	**0.3**	**0**	**0 to trace**	**0.5**	**0**	**0 to trace**

Agents of change: Tree damage, browse, and invasive plants

In 2024, beech bark disease (BBD) was one of the most common damage agents recorded across plots. In total, 36% of the plots (70 plots) were impacted by BBD and approximately 71% of live American beech trees (greater than 12.7 cm DBH) showed symptoms of the disease. Another prevalent damage was crack and seam, which occurs when a tree splits due to environmental factors. This damage was present in 64% of plots (124) and impacted 6% of live trees. Emerald ash borer, hemlock woolly adelgid, and sapsucker damage was observed on <2% of trees. Of the other damages recorded, "defoliation >20%" was the most common damage agent. Evidence of browse was recorded on 91% of plots (176), which may negatively impact regeneration success. For invasive species, we found 1% of plots (2) with buckthorn present, 1% of plots (2) containing multiflora rose, and 1% of plots (1) containing barberry (*Berberiis* spp.).

Table 3. Damages recorded on live trees across the 194 FEMC FHM plots in 2024. Damages are shown as the percentage affected per species. Note that not all damages were recorded if they were not obvious or visible from the ground. 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	448	88
white oak	59	47
shagbark hickory	23	39
Am. mountain-ash	18	38
American basswood	27	33
northern white-cedar	126	33
quaking aspen	60	30
black cherry	67	29
sugar maple	839	28
red maple	1059	25
white ash	144	25
blackgum	8	25
northern red oak	343	24
green ash	25	24
black birch	184	22
chestnut oak	9	22
yellow birch	454	18
bigtooth aspen	32	18
Norway spruce	17	17
gray birch	23	17
eastern red cedar	6	16
balsam fir	609	15
eastern hemlock	544	15
eastern hophornbeam	39	15
black ash	7	14
paper birch	85	14
eastern white pine	410	11
black oak	41	9
red spruce	418	6
pitch pine	37	5
red pine	90	4
All live trees	**6337**	**25**

Tree Regeneration

Saplings

Fifteen (15) out of 194 plots did not contain any saplings in any of their four microplots. There were 8,904 living saplings across the remaining 179 plots, with 3,680 stems per acre (SPA). The sapling layer displayed the lowest species diversity of the three strata (trees, saplings, seedlings). Across all plots, 35 different species were recorded in the sapling plots, compared to 49 tree species and 47 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, 1337 SPA), American beech (14%, 632 SPA), and red spruce (12%, 457 SPA) were the most abundant species in the sapling layer (Table 4). American beech stems were likely suckers based on their small size (Figure 3) and the prevalence of BBD on mature trees (see Agents of Change section).

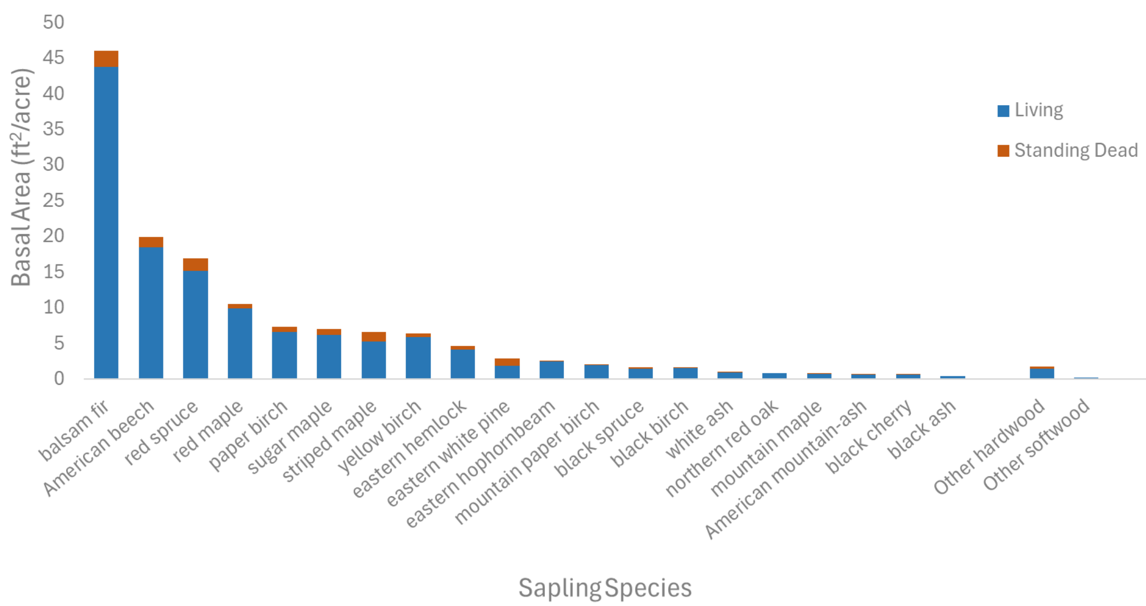

Figure 7. Basal area (ft^2) per hectare for most common sapling species, including live saplings (status 1) and standing dead saplings (status 2).

Table 4. Sapling composition from FEMC FHM regeneration microplots in 2024 including total stems (N), saplings per acre (SPA), percent composition (%) of sapling layer, and basal area per acre (BA, ft^2/ac). Information for all species sapling data is shown in the last row.

Species	Live saplings	SPA	BA	%
balsam fir	3,340	1337	44	33
American beech	1,533	632	18	14
red spruce	1,096	457	15	12
red maple	462	207	10	8
paper birch	222	88	7	5
sugar maple	305	125	6	5
yellow birch	349	143	6	5
striped maple	438	180	5	4
eastern hemlock	212	90	4	3
e. hophornbeam	170	76	3	2
mountain paper birch	53	20	2	1
eastern white pine	84	41	2	1
black birch	99	45	2	1
black spruce	99	49	2	1
white ash	58	26	<1	<1
northern red oak	34	17	<1	<1
mountain maple	71	27	<1	<1
Am. mountain-ash	54	21	<1	<1
black cherry	28	12	<1	<1
black ash	10	4	<1	<1
Other hardwood	166	73	2	2
Other softwood	21	9	<1	<1
All species	**8,904**	**3,680**	**131**	**100**
Species	**Live saplings**	**SPA**	**BA**	**%**

Seedlings

In total, 67,366 seedlings (<1-inch DBH) were tallied across the FEMC FHM regeneration microplots in 2024. Of all seedlings counted, 92% (62,171) were classified as class 1 (hardwood seedlings <12 inches tall and softwood seedlings <6 inches tall) while 8% (5,188) were classified as class 2 (hardwood ≥12 inches and softwood ≥6 inches tall). Seedling counts per plot ranged from 2 to 2,772 seedlings per plot. There was an average density of 29,285 stems per acre (SPA) across the entire 194-plot network in 2024.

Seedling diversity was high within microplots with seedlings identified for a total of 41 species (and 6 identified to the genus level where species was not clear). Species diversity per plot ranged from one 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(193) = -0.33001, p = 0.74175).

Red maple was the most abundant seedling tallied in 2024 (40%, 11,706 SPA), followed by sugar maple (18%, 5,355 SPA), and Eastern white pine (15%, 4,420 SPA). Seedling densities are subject to yearly fluctuations 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, stronger conclusions about shifts in forest composition and density can be made by tracking seedling survival over multiple years.

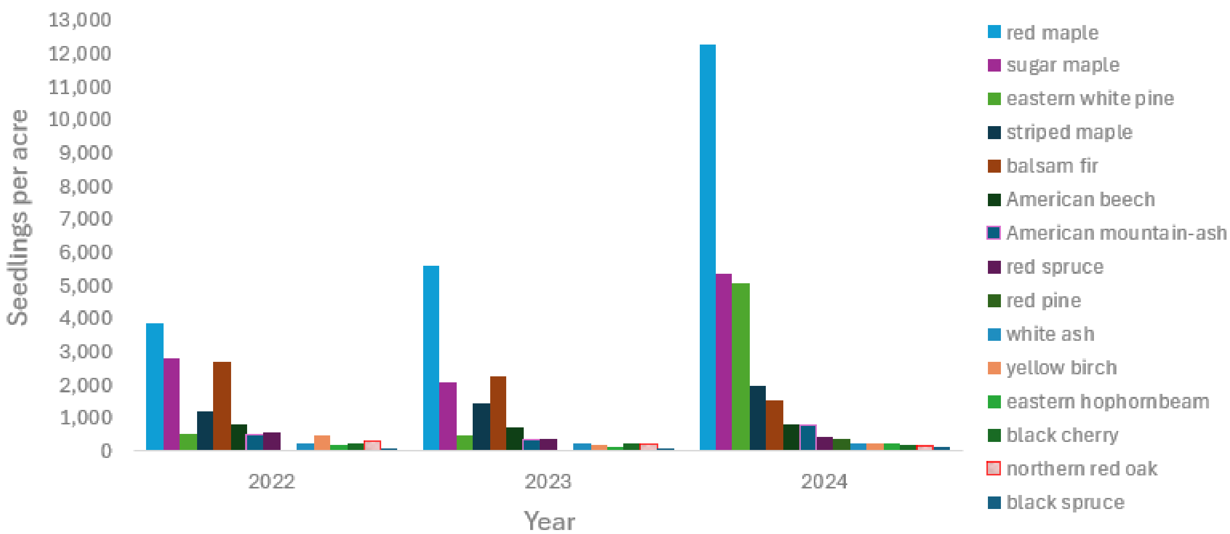

Figure 8. A temporal analysis of the mean seedling density (counts per acre) for each species between 2022 and 2024. Plots consistently visited (189 plots) since 2022 were used in the analysis. Masting years could be the cause of large seedling discrepancies between years.

Table 5. Seedling composition across FEMC FHM plots in 2024 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	28,304	27,894	410	12,259	40
sugar maple	12,684	12,458	226	5,355	18
e. white pine	11,675	11,452	223	5,064	17
striped maple	4,633	4,169	464	1,983	7
balsam fir	3,521	2422	1099	1544	5
American beech	1849	964	885	807	3
Am. mountain-ash	1983	1974	9	768	3
red spruce	917	579	338	412	1
red pine	720	675	45	357	1
white ash	542	348	194	251	0.9
yellow birch	497	367	130	226	0.8
e. hophornbeam	450	363	87	210	0.7
black cherry	355	271	84	174	0.6
northern red oak	344	281	63	156	<0.1
eastern hemlock	257	140	117	114	<0.1
black spruce	224	6	218	111	<0.1
n. white-cedar	179	70	109	88	<0.1
birches*	211	123	88	87	<0.1
mountain maple	186	143	43	86	<0.1
black birch	177	96	81	85	<0.1
white oak	120	78	42	56	<0.1
paper birch	97	84	13	42	<0.1
serviceberry	59	32	27	25	<0.1
Other hardwood	461	271	190	216	0.6
Other softwood	10	7	3	5	<0.1
All species	**70,364**	**65,203**	**5,154**	**30,435**	**100**

*seedlings were identified to genus when species was unknown

Regional Temporal Analyses

Section 1. Tree Analyses (Regional)

2024 represents the third year of sampling of our complete regional network, allowing us to begin to assess region-wide temporal trends. It is important to note that emerging trends described here are based on only three years of sampling and may not represent true trends across these forests over longer time periods; as we collect more data in future years, observed trends will become less uncertain. Please see our state supplementary figures package released along with this report (after the appendix) for state-specific time series trend figures for each of the seven states in the FEMC region; note that sapling growth and mortality charts are not provided at the state level due to low sample size at that scale.

Between 2022 and 2024 there was a subtle yet steady increase in crown transparency and fine-twig dieback across species region-wide, while vigor declined. This may reflect growing stress in our forests from a variety of threats (e.g., drought and oak wilt may be driving the increasing dieback in scarlet and white oak). Most of the reported decline in vigor is light, with small amounts of moderate and severe decline present in some states, particularly Rhode Island (though the small number of RI plots may skew results) and Maine (Figure 11). In the latter case, this may be due to recent severe droughts noted in other regional forest health reports (USFS, 2022). This shift in tree vigor, even while total mortality remains moderate, may point to the forest's response to stressors such as oscillations between abnormally wet and dry periods, or increases in pests and pathogens. These stressors typically show up as shifts in transparency and dieback before they cause mortality, so it is important to continue to monitor these trends as more data are collected.

During the same timeframe, we also observed increasing numbers of newly dead trees in several states. Crown transparency trends (Figure 10) highlight black cherry and Northern white cedar, though not the most dominant in terms of basal area, as species with notably high transparency values, possibly linked to drought stress or pest pressures. While black cherry is not known as a specific host for certain pests or pathogens, it is sensitive to drought and fungal infections, which have become increasingly common with recent swings in precipitation events and drought across the region. The species with the healthiest average vigor scores, most of which are conifers, have remained stable over the three-year period (Figure 13). Quaking aspen stands out as a species exhibiting an overall average healthy vigor score, yet there is notable variability over the three years (Figure 13).

American beech, balsam fir, and white ash experienced the greatest mortality across the region (Figures 15-18), while red maple, sugar maple, and Northern red oak experienced the most growth (Figure 19). Mortality trends (Figures 15-18) show that American beech has consistently high mortality rates, which is likely linked to widespread beech bark disease and beech leaf disease – now present in all seven FEMC states. Balsam fir also saw an increase in mortality in 2024, even over the relatively high levels of mortality in previous years; this may be influenced by insect outbreak cycles or variation in climatic conditions. Declines in balsam fir should be monitored in future years as populations at lower elevations and at its southern range are vulnerable to warming temperatures. White ash is also experiencing significant mortality, likely due to the continued spread of emerald ash borer across the region.

When looking at aggregated basal area trends in vigor across the region (Figure 12), the proportion of basal area associated with dead trees has slightly increased from 2022 to 2024. Among living trees, the share of trees classified as "healthy" has decreased, with more trees observed in light or moderate decline categories. Additionally, mortality measured by basal area (Figure 17) suggests that while individual tree losses may be high in some species, their overall impact on forest structure varies. Species with larger individuals, such as white ash, contribute disproportionately to forest structure when there is a wave of mortality. Conversely, mortality trends based on tree count (Figures 15-16) reflect the number of trees dying, which is represented more by species with smaller but more abundant individuals, like balsam fir.

For some analyses, including those pertaining to dieback, transparency, and mortality, only species with a total basal area comprising 0.5% or 1.0% of the basal area from all plots were included. This was to eliminate outlier species that do not represent substantive shares of total regional basal area.

Dieback trends (regional)

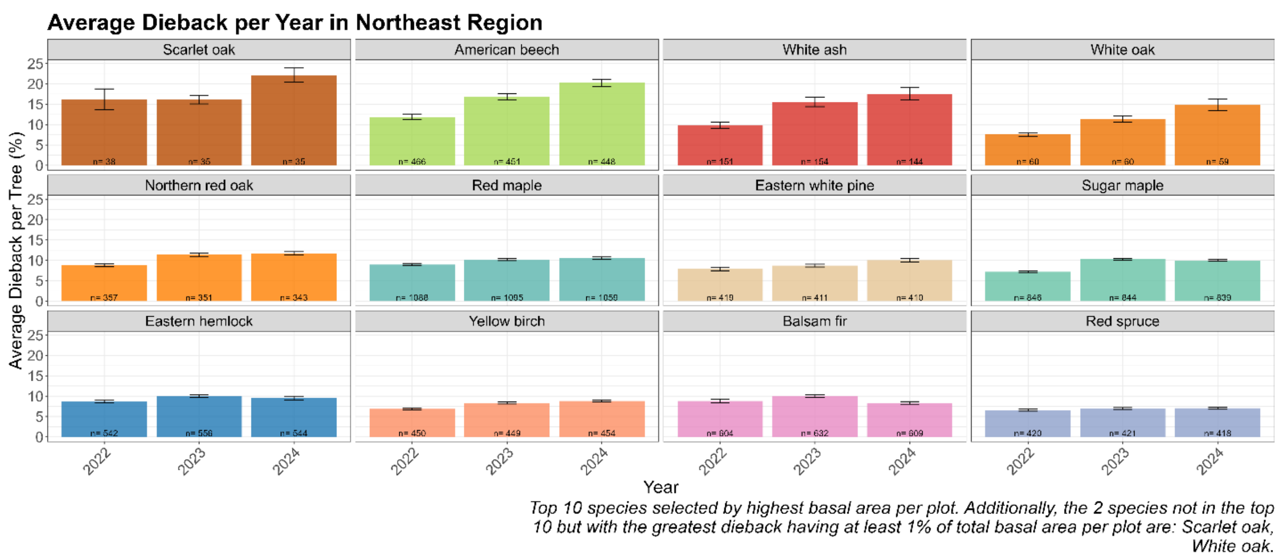

Figure 9. Regional average fine twig dieback trends by species and year for the top ten species by basal area, plus two that are less representative by basal area but nonetheless showed high dieback (scarlet oak and white oak). Species are ordered based on dieback rates in 2024.

Transparency trends (regional)

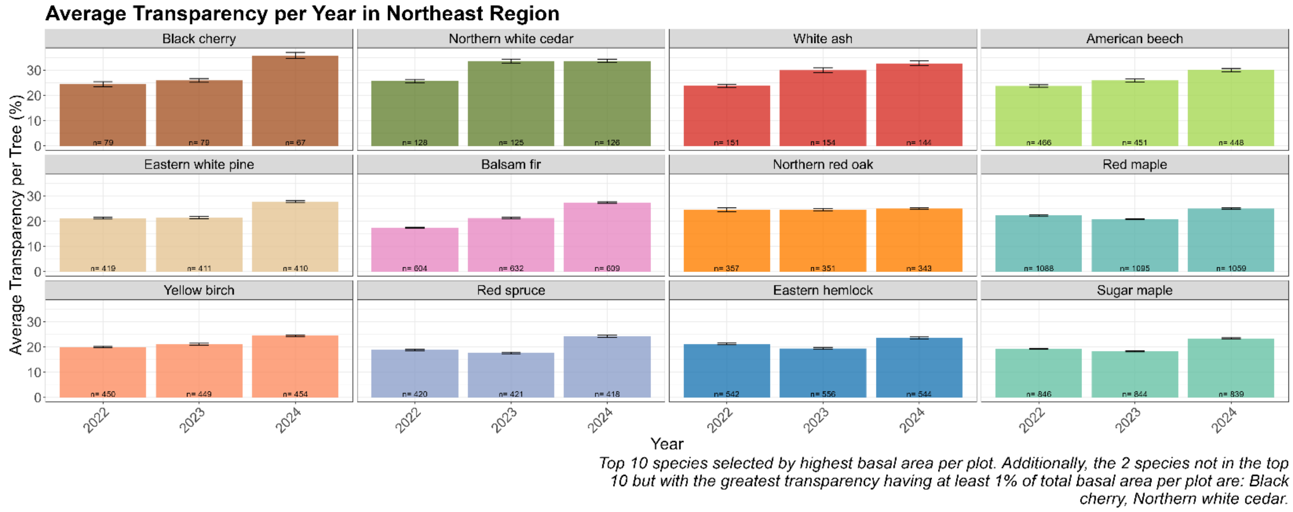

Figure 10. Regional average leaf transparency trends by species and year for the top ten species by basal area plus two that are less prevalent by basal area but are nonetheless showing high transparency (black cherry and northern white cedar). Species are ordered by greatest transparency in 2024.

Vigor trends (regional)

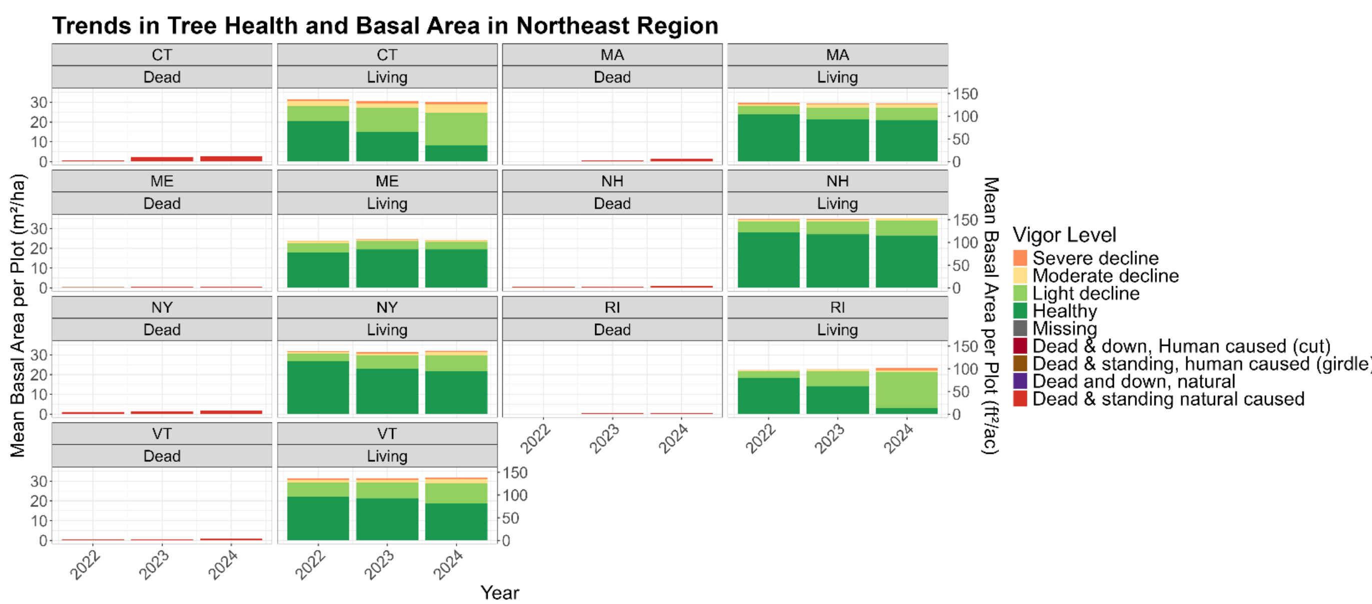

Figure 11. Mean basal area per plot in hectares (m^2/ha, left axis) and acres (ft^2/ac, right axis) for living and dead trees in the Northeast region across different tree vigor classes, delineated between each state. Data is grouped by tree status, with living classes shown on the right and dead classes on the left.

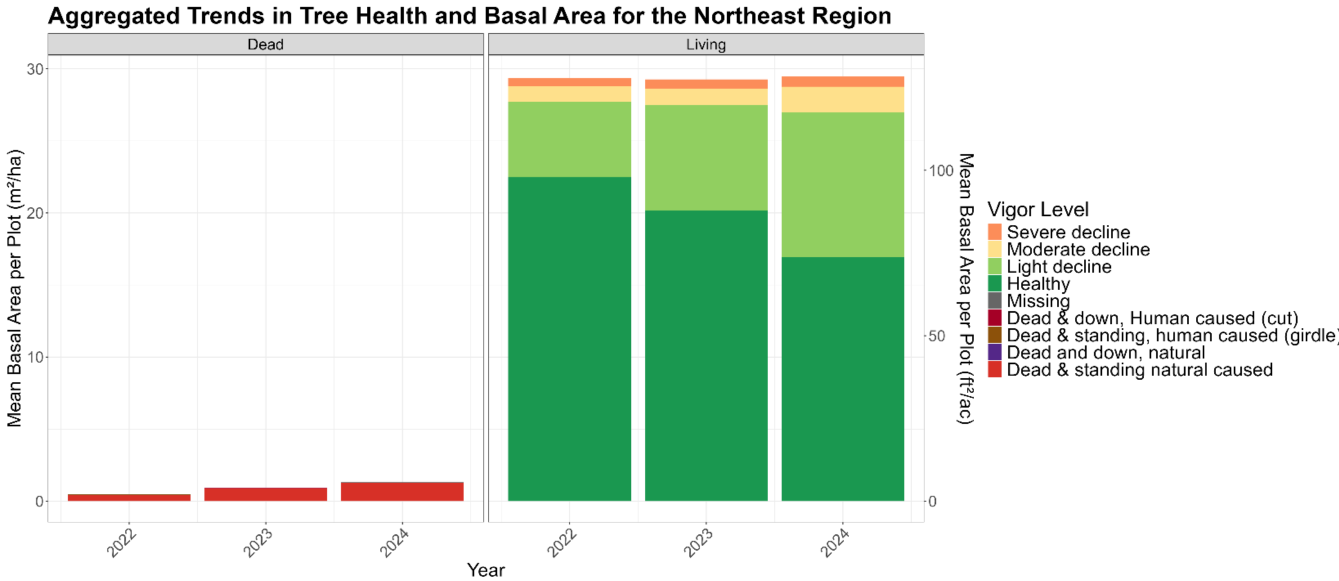

Figure 12. Region-wide mean basal area per plot in hectares (m^2/ha, left axis) and acres (ft^2/ac, right axis) for living and dead trees across different tree vigor classes. Data are grouped by tree status, with living classes shown on the right and dead classes on the left. An overall average trend towards less vigorous trees is evident.

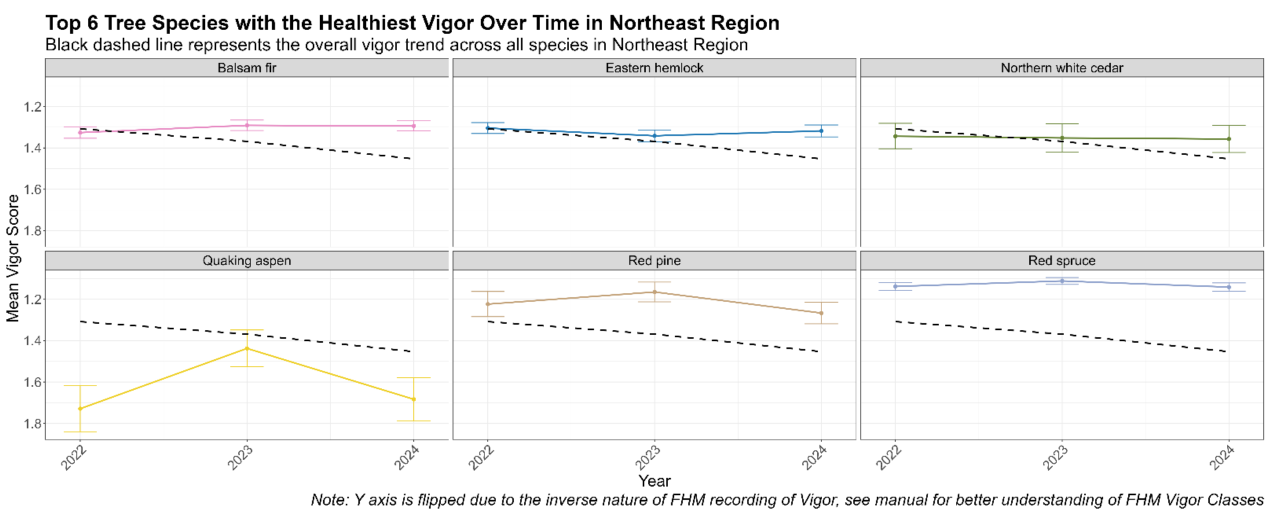

Figure 13. Top six tree species with the healthiest vigor (lowest stress levels) over time across the Northeast region, among species comprising at least 0.5% of basal area regionally. Vigor scores range from 4 (severe decline) to 1 (healthy), with intermediate values for trees in decline. The dashed black line indicates the overall region-wide vigor trend across all species, helping contextualize species-specific changes within broader forest conditions. 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.

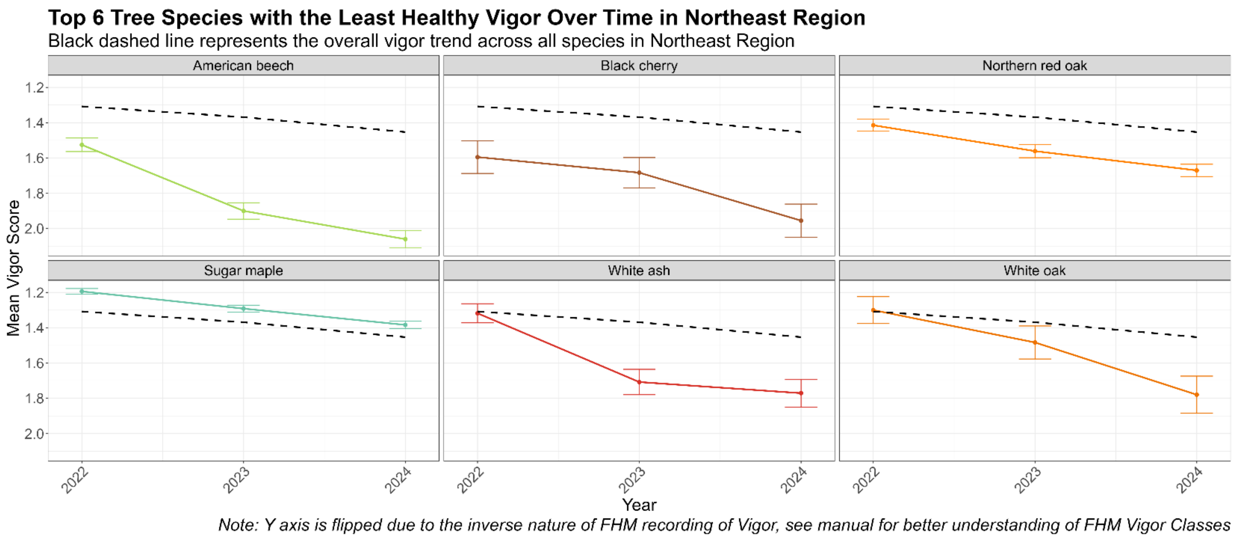

Figure 14. Top six tree species with the greatest decline in vigor (highest stress levels) over time across the Northeast region, among species comprising at least 0.5% of total basal area region wide. Vigor scores range from 4 (severe decline) to 1 (healthy), with intermediate values for trees in decline. 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)

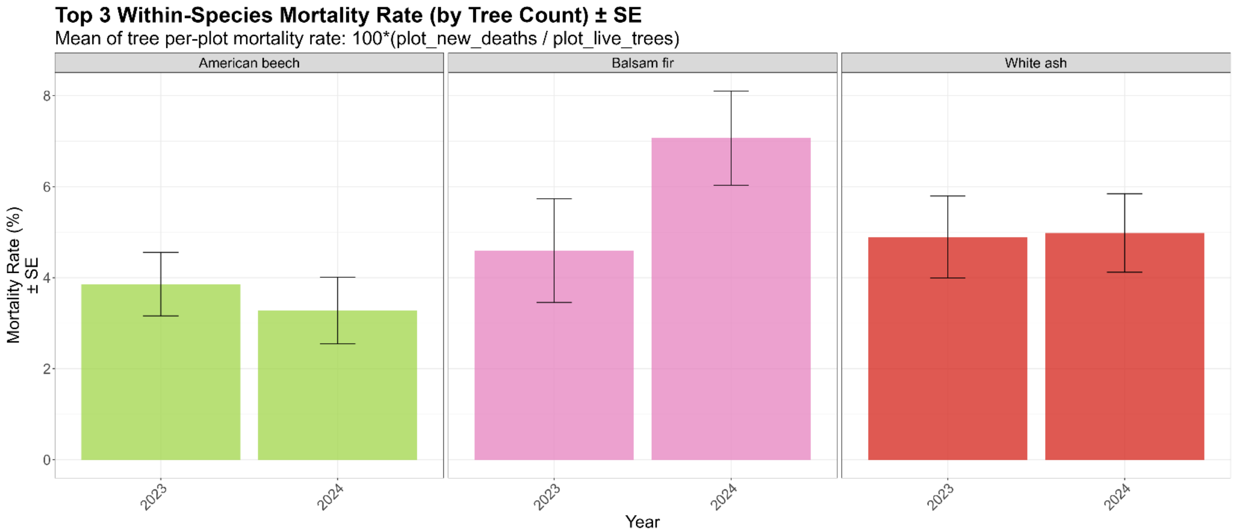

Figure 15. Within-species mortality trends across the Northeast region for the top three tree species with the highest number of newly dead trees among species comprising greater than 1% of total basal area. This plot shows the annual number of newly dead trees per species, based on individual tree tracking using unique tree identifiers. 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 two 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. This metric reflects the percentage of individual trees transitioning from living to dead within their total species' samples region wide.

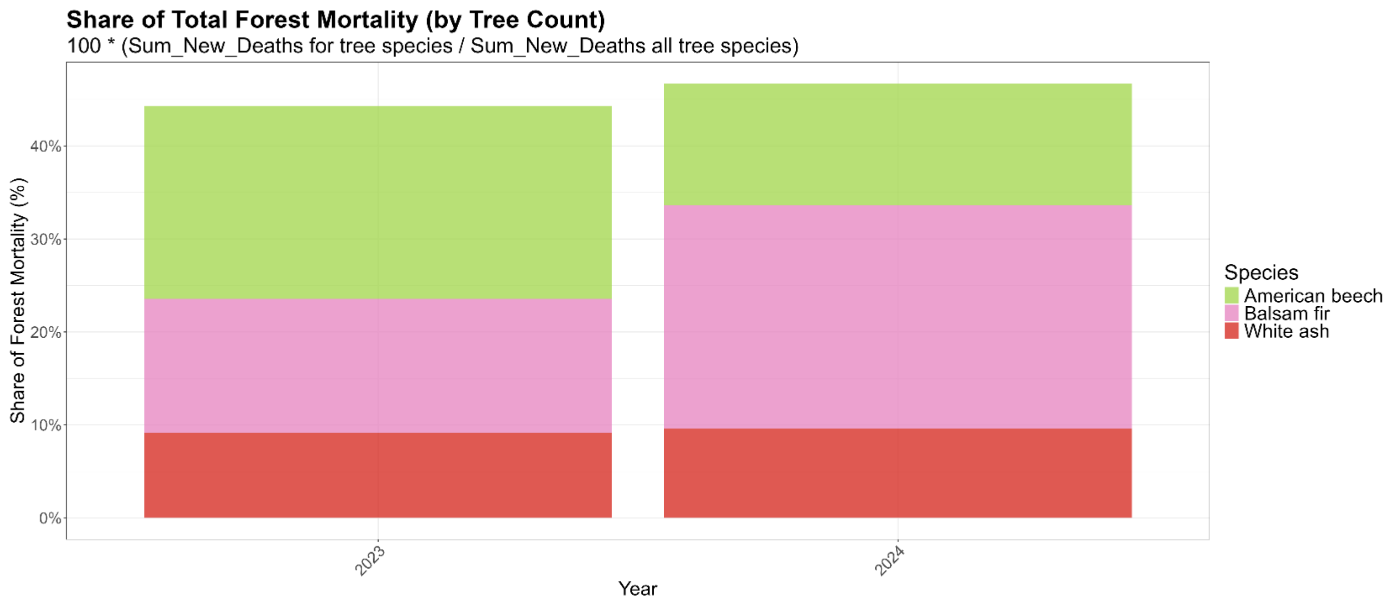

Figure 16. Share of total forest mortality trends by total count across the Northeast region for the top three species with the highest number of newly dead trees, relative to all newly reported tree deaths across all species comprising greater than 1% of regional total basal area.

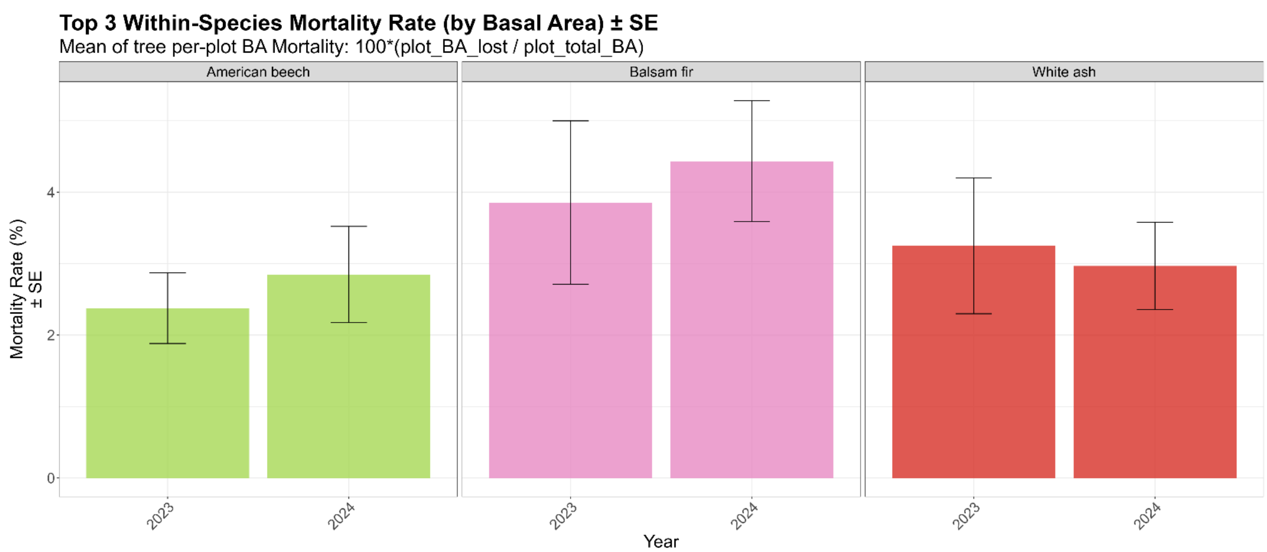

Figure 17. Within-species mortality trends by basal area across the Northeast region for the top three species with the greatest total basal area loss among species comprising more than 1% of total basal area, calculated as the sum of the last recorded basal area of all trees within a given species that transitioned from living to dead each year. Instead of simply accounting for the number of dead trees, basal area loss accounts for tree size, providing a different perspective on the impact to forest structure.

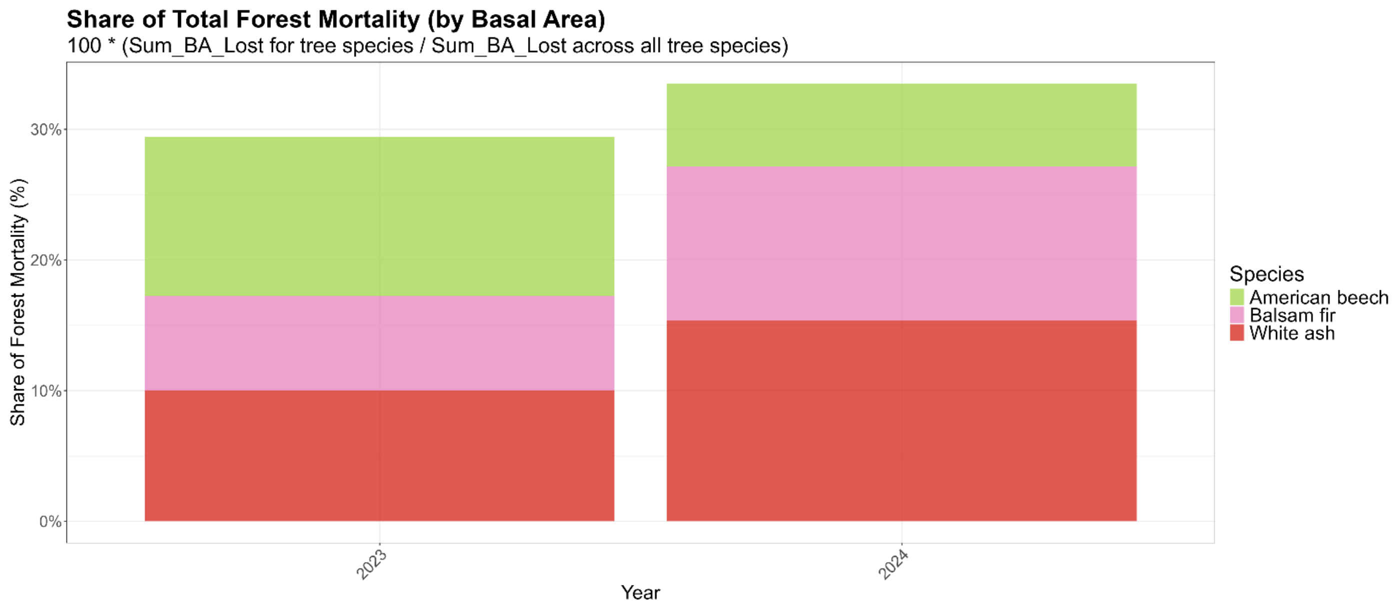

Figure 18. Share of total lost basal area across the Northeast region for the top three species with the greatest basal area loss due to mortality, among species comprising greater than 1% of total basal area regionally.

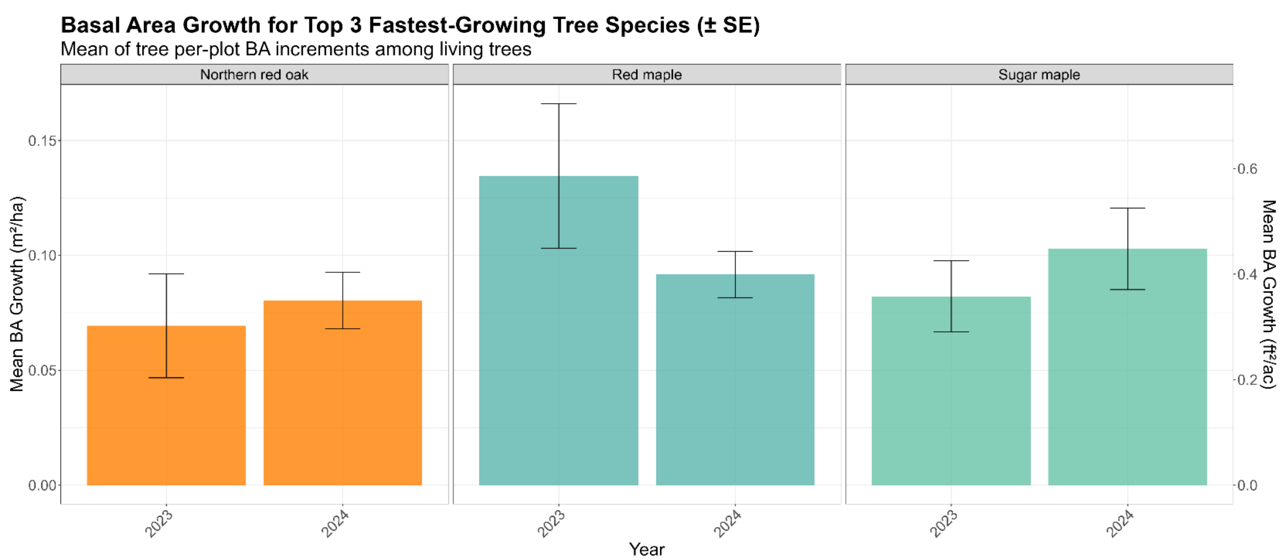

Figure 19. The top three species with the greatest average basal area growth across the Northeast region. Bars represent the mean basal area increment in hectares (m^2/ha, left axis) and acres (ft^2/ac, right axis) each year. Error bars represent the standard error of individual growth in basal area within each species. These growth trends illustrate which species are adding basal area the fastest regionally.

Total composition - Trees (regional)

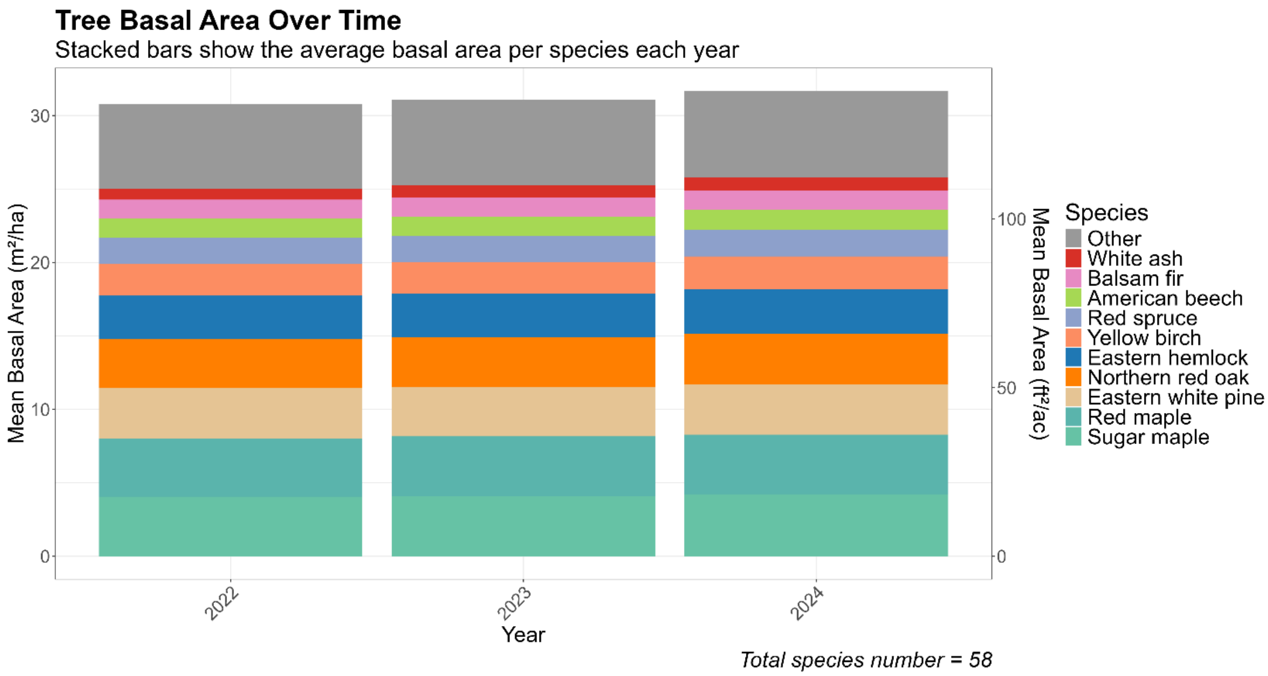

Figure 20. Overall species composition by average live basal area per year across all tree species surveyed in the Northeast region each year. The top ten most represented species by basal area are shown individually, while all species not in the top ten are combined and represented as "Other." The overall 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, thereby affecting regional representation of sugar maple in the dataset.

Section 2. Sapling Analyses (Regional)

Figures 21-24 summarize regeneration trends in the understory. Sapling mortality trends (Figures 21-22) show which species are struggling to survive in the sapling stage, while growth trends (Figure 23) can indicate which species are doing well, though these results may skew to fast-growing or pioneer species. Additionally, overall sapling composition (Figure 24) shows that even species with higher mortality can persist if recruitment rates remain high. For example, while American beech experiences high mortality, its presence in the sapling layer remains high, suggesting ongoing recruitment due to its ability to create root suckers. Conversely, species with both high mortality and low growth may struggle to establish a lasting presence in the understory.

American beech and balsam fir experienced consistent sapling mortality during the 2023-2024 monitoring years (Figures 21-22). Eastern hemlock, eastern white pine, American beech, and yellow birch also comprised significant shares of reported sapling mortality, though there was considerable variability between monitoring years and within plots across states (Figures 21-22). Significant variability between years regarding percent sapling mortality (figure 21) can be attributed to the low count of overall individual sapling deaths observed annually across the plot network. While white pine amounted to close to 20% of all sapling deaths in 2024, that was only due to a small handful of individual saplings (38 total dead saplings observed in 2023 and 28 dead saplings observed in 2024 across all species regionally). White pine needle disease is a likely culprit for the 2024 white pine sapling deaths as saplings may be more susceptible to damage at that stage.

Balsam fir, American beech, and eastern hemlock, which constitute substantial shares of overall sapling composition throughout the region (Figure 24), have seen stable growth in this period (Figure 23). However, growth rates among these species do appear to vary, with black cherry showing notable fluctuations between years (Figure 23).

The persistence of balsam fir and red maple in both the seedling and sapling layers suggests that these species could remain dominant in future forest canopies, provided they can survive deer browse and pest and pathogen pressure. While American beech is also highly represented in the sapling layer, both beech leaf disease and beech bark disease limit its survival into mature trees. Species like eastern hemlock and white pine appear in both the sapling mortality and tree transparency charts, which may be a result of hemlock wooly adelgid and white pine needle damage. Something else to watch as future data accumulates is which sapling species appear to have both relatively low growth as well as higher mortality rates, which could indicate potential declines in their future canopy presence. Mortality and growth trends based on additional years of data will paint a much clearer picture regarding future forest composition.

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)

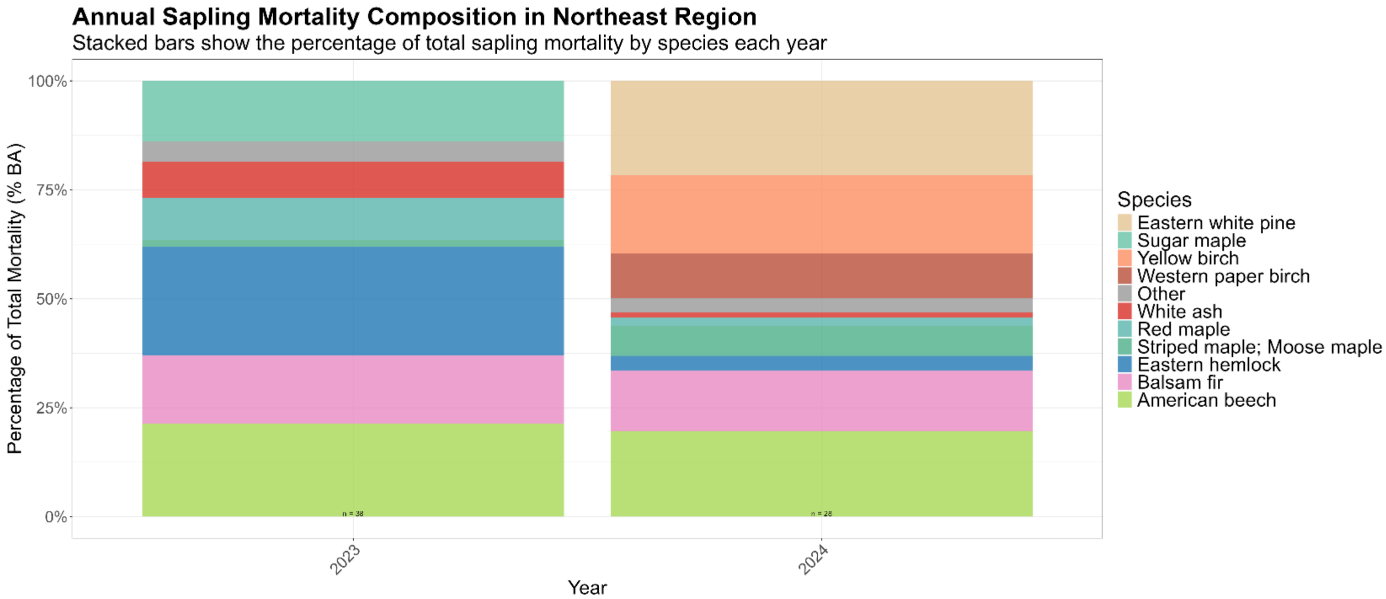

Figure 21. Annual sapling mortality composition in the Northeast region by basal area, shown as the percentage of total regional sapling mortality each species represented in 2023 and 2024. Sapling mortality is counted only once at the time a sapling is observed to be dead. Note the low sample size (38 dead saplings in 2023; 28 in 2024) when interpreting species level results.

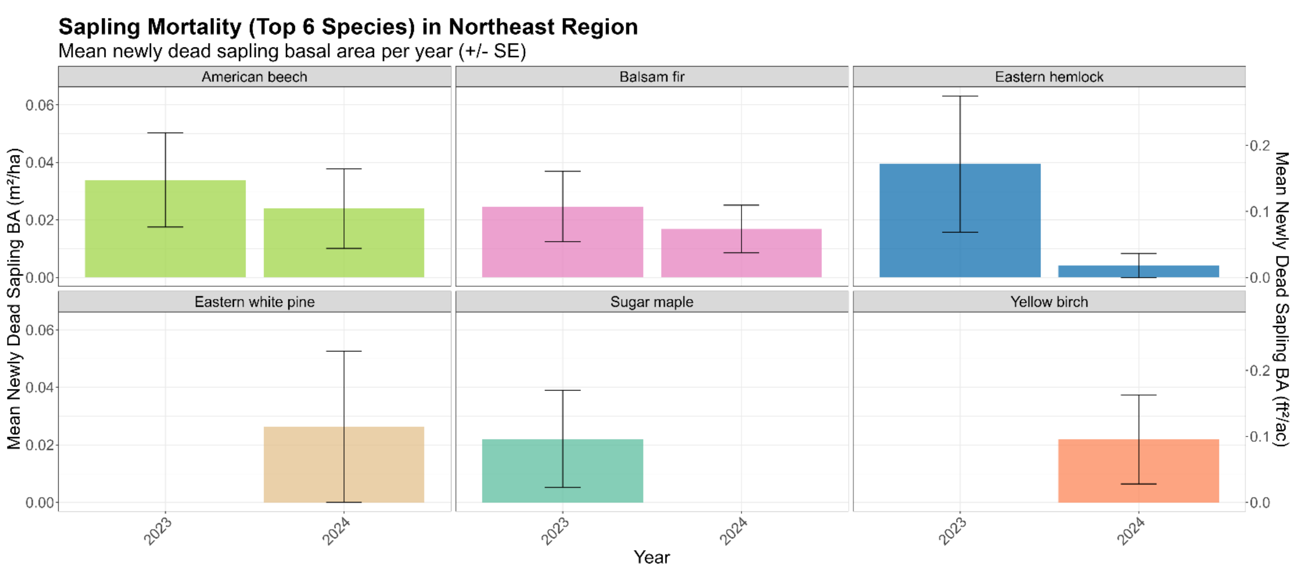

Figure 22. The top six species experiencing the greatest sapling mortality across the Northeast region, shown as basal area per hectare (m^2/ha, left axis) and acre (f^2/ac, right axis) lost per year. Only species with more than ten individuals in the sample were assessed for inclusion in this chart.

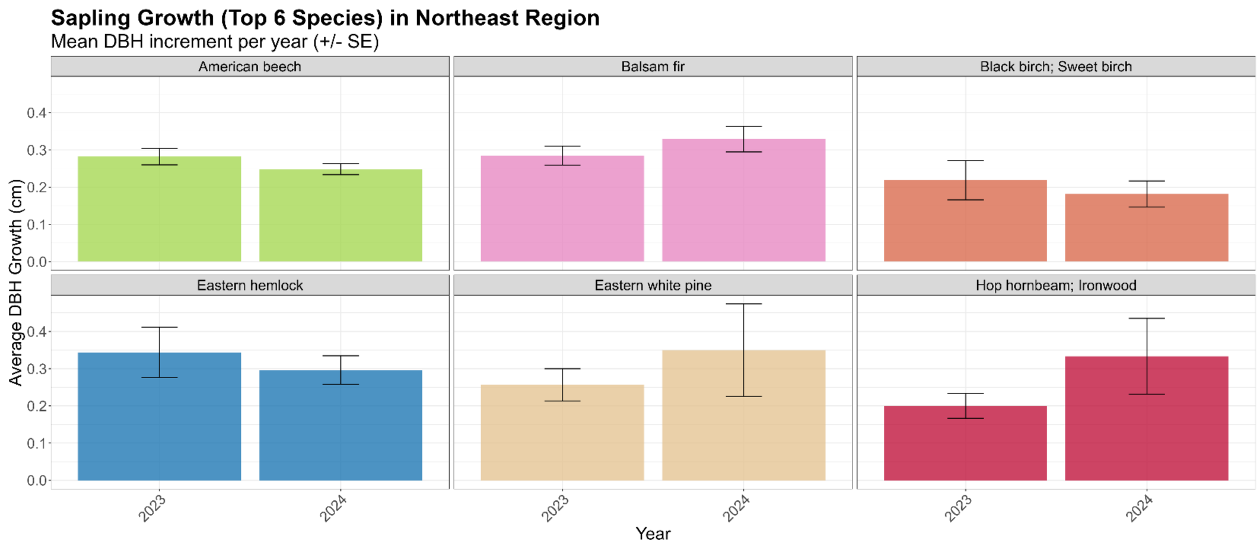

Figure 23. The top six species whose saplings demonstrated the greatest average growth in diameter across the Northeast region. While most species included reflect the top sapling growth averages between states, mountain ash is notable for only appearing in Vermont's top sapling growth ranks. Only species with more than ten individuals in the sample were assessed for inclusion in this chart.

Total composition – Saplings (regional)

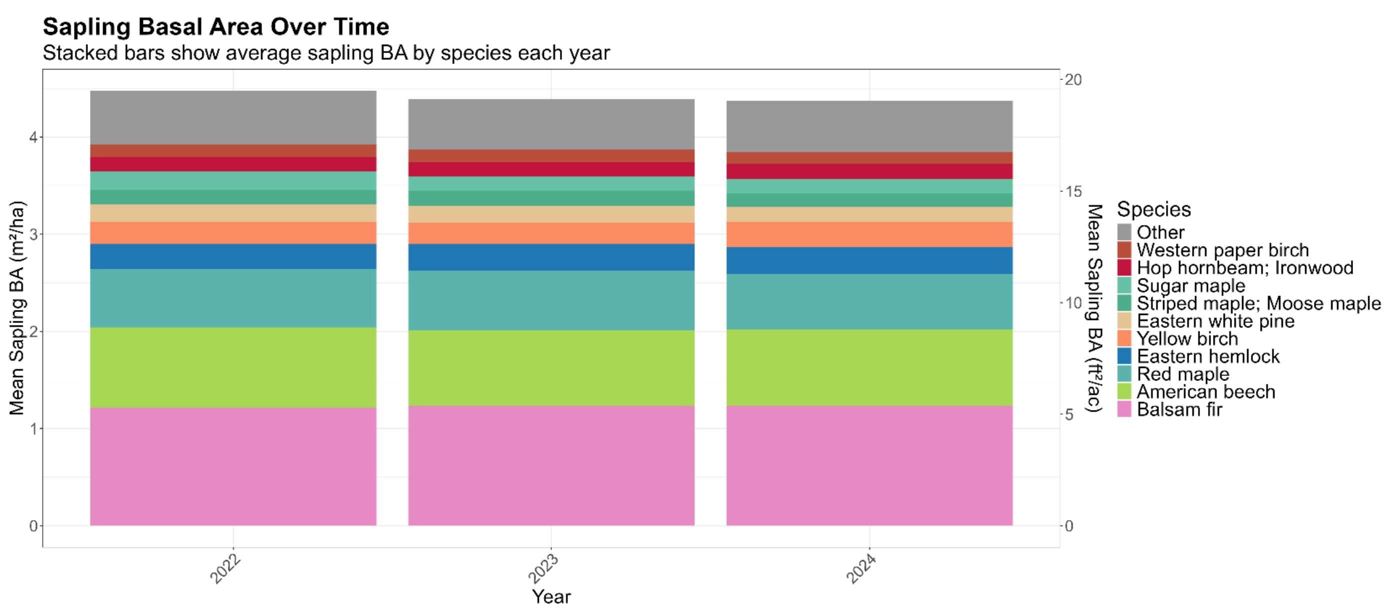

Figure 24. Overall sapling basal area composition in hectares (m^2/ha, left axis) and acres (ft^2/ac, right axis) throughout the Northeast region for all species each year. The ten species with highest basal area are shown individually, while all other species are grouped as "Other." The overall bar height indicates total sapling basal area per hectare and acre regionally for each year.

Section 3. Seedling Analyses (Regional)

Figures 25-30 illustrate region-wide seedling establishment and survival. High seedling mortality (Figure 25) may be more common in species with vulnerable early life stages, while seedling survival beyond the first couple of years (Figure 26), transitioning from Class 1 to Class 2 (see Table 6 for class definitions), can suggest future forest composition trends. Class 1 seedling composition (Figures 27-28) reflects initial recruitment, which may be heavily weighted toward species that produce large seed crops annually as well as those that have true mast years. In contrast, Class 2 composition (Figures 29-30) reflects species persisting beyond the first 1-2 years; this metric provides a better indicator of future forest composition. For example, while red maple shows high seedling mortality, its high recruitment levels due to its high seed output allow enough individuals to survive into Class 2, maintaining its presence in the understory. In contrast, species with both low Class 1 recruitment and high mortality rates may struggle to establish a presence in the understory.

2024 appears to have been a heavier seed crop year for red maple, sugar maple, and eastern white pine. While this pattern may resemble a masting event, red maple, for example, is not known as a strict masting species like oaks or beeches; instead, it produces relatively high seed crops most years with occasional higher yield years based on site conditions. This strategy ensures a steady influx of new seedlings, where a high mortality rate can be expected and still allow many individuals to survive to later stages. White pine is a masting species and the data from 2024 likely reflects a masting event in 2024. Because of high mortality rates among seedlings in their first few years, Class 2 seedling composition paints a clearer picture of longer-term understory composition and potential future forest composition. Notably, the high initial density of class 1 red maple seedlings does not necessarily translate to long-term survival, as mortality levels are also elevated (Figure 25).

The species with the highest rates of recruitment into Class 2 are balsam fir and American beech (Figures 26, 29, & 30). While American beech growth is stable, balsam fir growth exhibits some variation between the 2022-2024 monitoring years (Figure 26), potentially tied to changes in site or climatic conditions.

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)

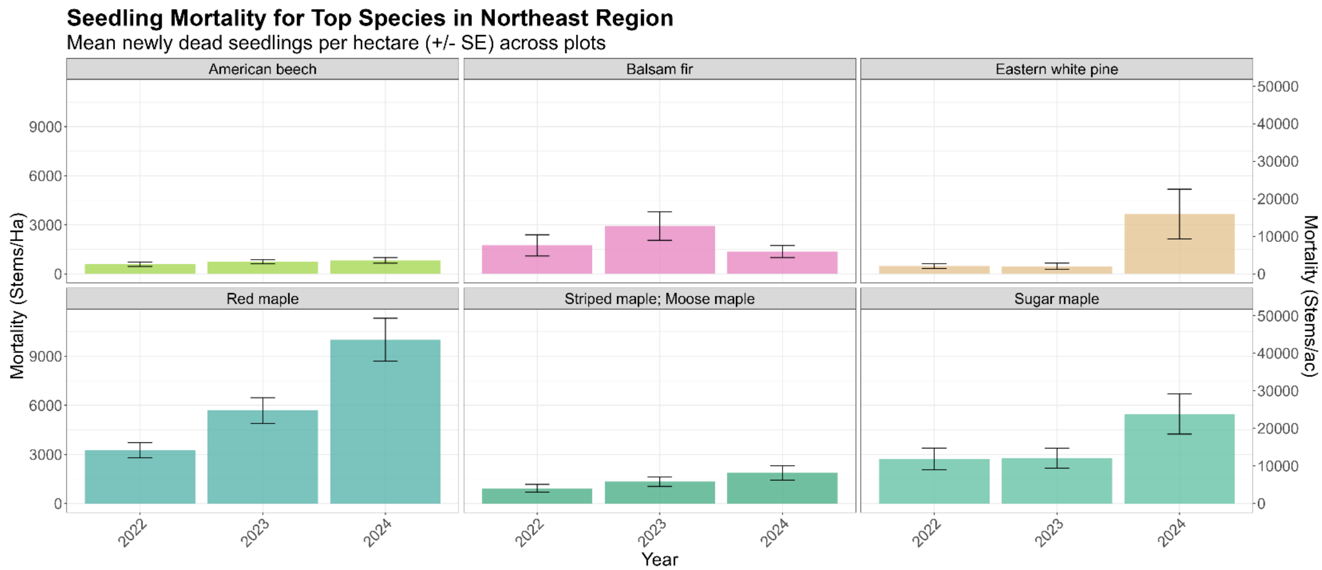

Figure 25. The top six species showing the greatest mortality at the seedling stage by stem count region-wide (stems per hectare, left axis, and stems per acre, right axis). Chart shows the mean number of seedlings transitioning from smaller to larger classes each year. While we do not record seedling mortality, we estimate based on reductions in seedling counts in our seedling sub-plots from one year to the next.

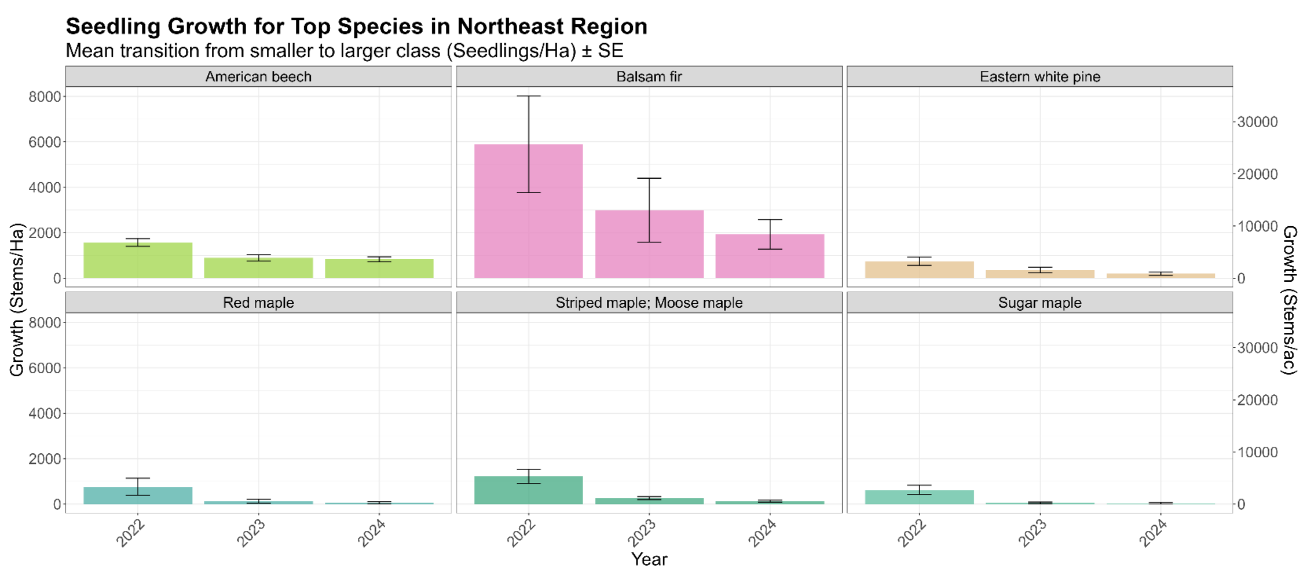

Figure 26. The top six species showing the greatest growth at the seedling stage by stem count region-wide (stems per hectare, left axis, and stems per acre, right axis). Chart shows the mean number of seedlings transitioning from smaller to larger classes each year.

Annual seedling density trends (regional)

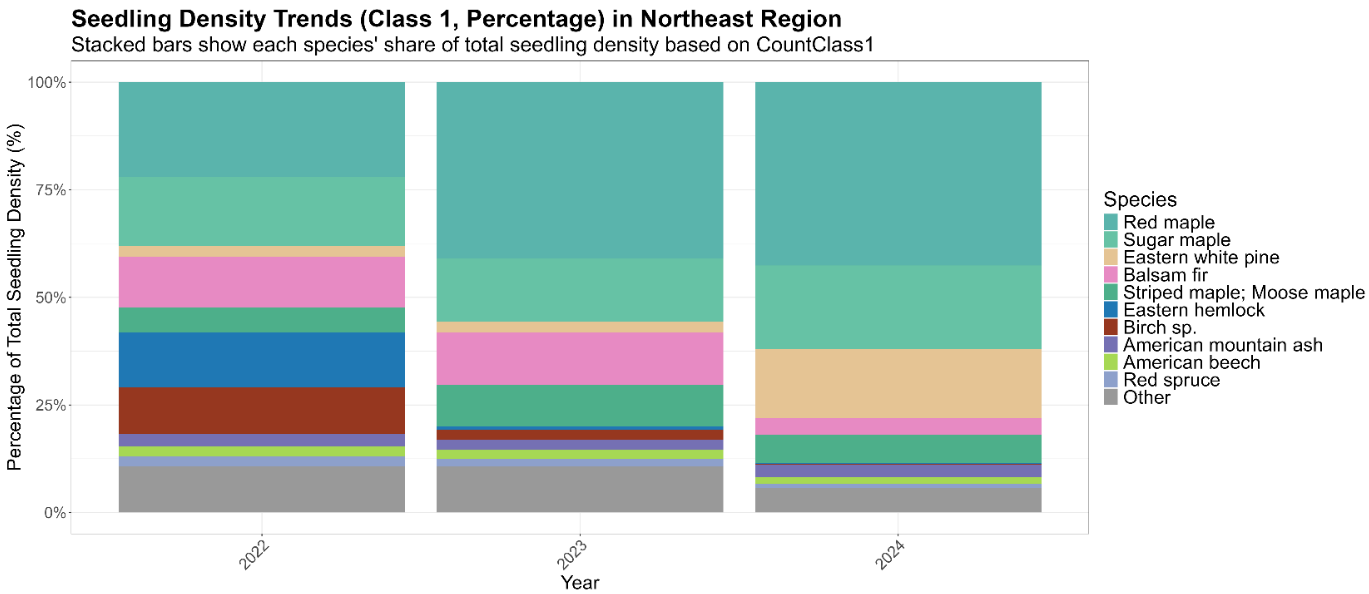

Figure 27. Percent composition of Class 1 seedlings each year throughout the Northeast region. The top ten most representative species by stem count are shown individually, while all species not in the top ten are represented collectively as "Other."

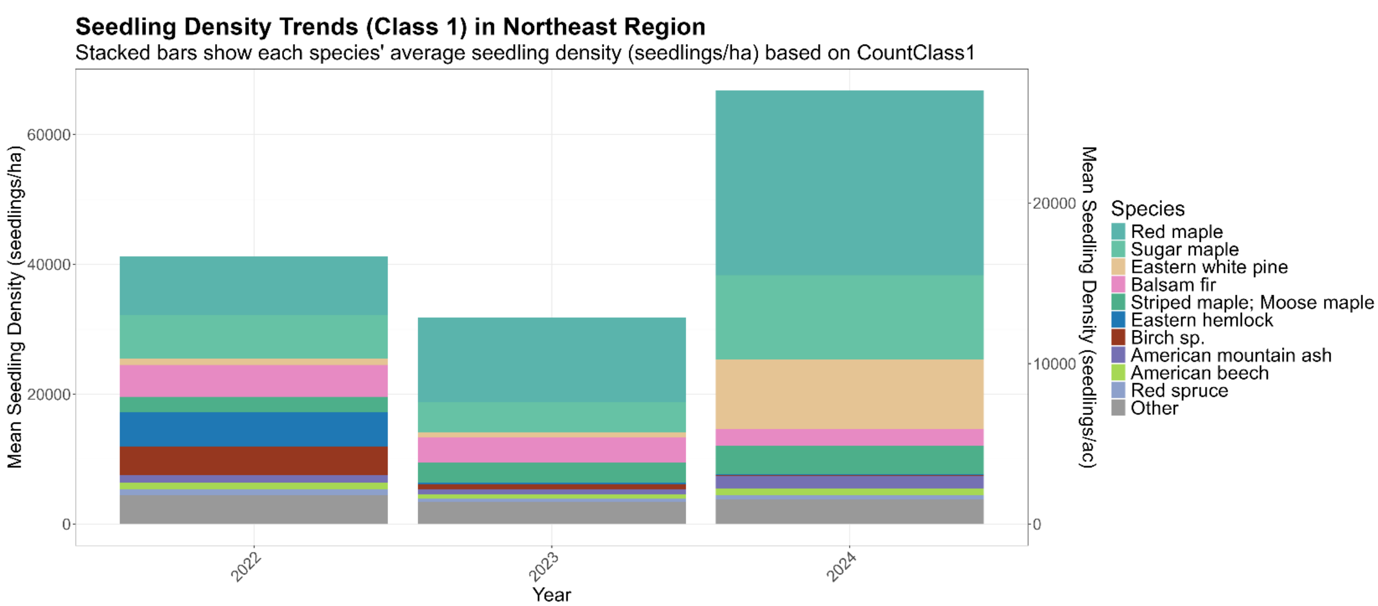

Figure 28. Class 1 seedling counts in stems per hectare (SPH, left axis) and acre (SPA, right axis) for all species surveyed each year throughout the Northeast region. The overall bar height indicates total number of Class 1 seedlings per hectare and acre regionally for each year. The top ten most representative species by stem count are shown individually, while all species not in the top ten are shown collectively as "Other."

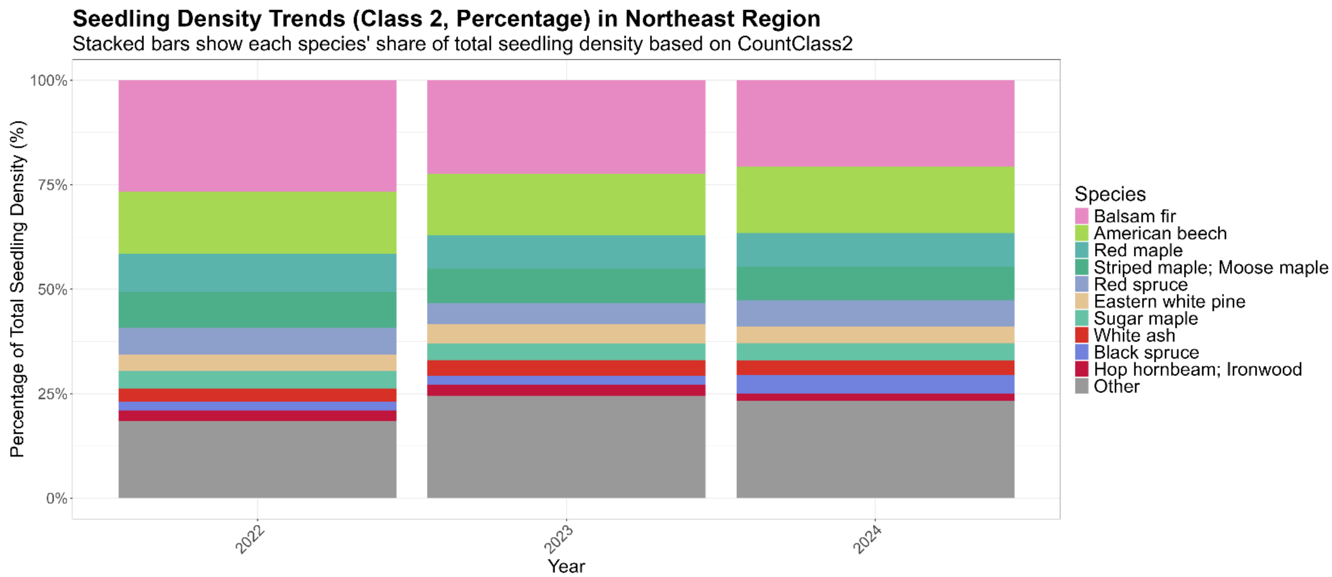

Figure 29. Percent annual composition of Class 2 seedlings each year throughout the Northeast region for all species surveyed each year. The top ten most represented species by stem count are shown individually, while all species not in the top ten are grouped collectively as "Other."

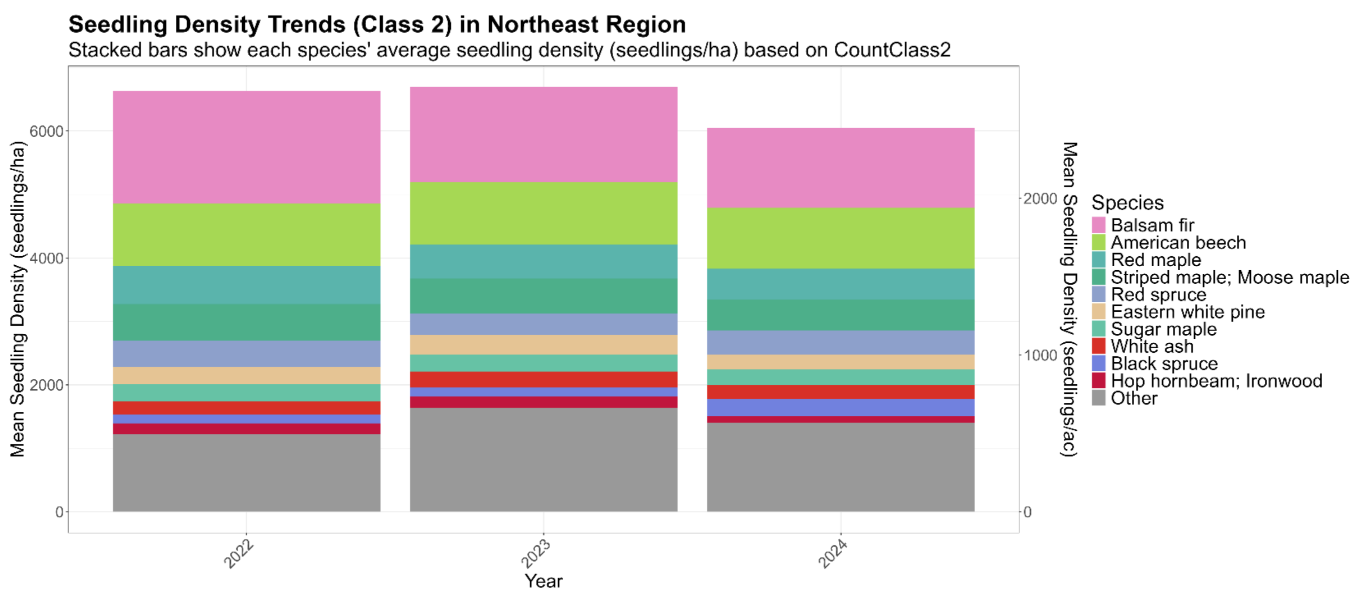

Figure 30. Class 2 seedling counts in stems per hectare (SPH, left axis) and acre (SPA, right axis) for all species surveyed each year throughout the Northeast region. The overall bar height indicates total number of Class 2 seedlings per hectare and acre regionally for each year. The top ten most representative species by stem count are shown individually, while all species not in the top ten are shown collectively as "Other."

Conclusions

With three years of region-wide data, we were able to run time series analyses to identify preliminary trends across the region. State-specific figures are provided in the supplementary figure package. However, we emphasize the importance of using caution when interpreting these results, since three years is a brief window to observe ecological trends. As our program continues to collect data, we will be able to more confidently identify subtle alterations in composition and overall health that might otherwise be missed with longer monitoring intervals of 5-7 years, as well as more dominant trends due to long-term changes in climate. Assessing crown health each year can serve as an early warning system for hidden or widespread stressors, while understory condition and composition can indicate what the future forest may look like. These insights are crucial for forest managers aiming to ensure the future vitality, productivity, and resiliency of these ecosystems.

Although northeastern forests face a broad range of stressors and exhibit significant vulnerabilities, preliminary indicators suggest that they are still in a relatively diverse, robust, and healthy state. Still, there are potential trends emerging that point to recent decline in many aspects of crown health that should be closely watched in coming years to determine whether these indicate true decline or just natural variance.

Both crown transparency and fine-twig dieback appear to be increasing across species region-wide, while vigor is declining between 2022 and 2024. Species diversity is apparent across all three strata, encompassing overstory trees, saplings, and seedlings, although it is slightly lower in the sapling layer. Despite the potential declining trend, on average, the overstory trees were still vigorous with healthy crowns. Defoliation levels of our most affected species, white oak and American basswood, remain below 30% throughout the region. While regeneration is observed in all monitored areas, 15 plots lack saplings. Data from 2024 suggests a significant masting year for red maple and white pine seedlings with large increases in seedlings densities compared with prior years. Longer time series analyses from our VT data appear to show a similar trend with large swings in maple seedling densities from year to year going back to 2014.

Data

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Appendix

Table A1: 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 A2: 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 A3. 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 caused; 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 caused; 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 caused: 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 A4. 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.

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

REGIONAL
FOREST HEALTH MONITORING
PROGRAM

2024 Supplementary State Figures Package

FEMC

Forest Ecosystem Monitoring Cooperative

Last updated: April 2025

State Analyses Supplemental Package

<u>Authors' note:</u> 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 for one year of a mortality time series analysis if no mortality was observed for that species within a given monitoring year. Additionally, some states did not fulfill sufficient parameters for all inclusion criteria in our analyses if too few species were present (e.g., an analysis that would typically survey the top six species for a given forest health metric displaying fewer than six).

Connecticut

Due to the smaller number of plots (i.e., smaller total sample size) compared to other states, Connecticut data may be skewed and thus may show higher variances in composition, as well as growth and mortality rates. Because of the small number of plots within the state fewer total individuals (trees, saplings, and seedlings) and species were observed in Connecticut plots across monitoring years, leading to smaller overall sample sizes relative to other states. As a result, these findings may not be represented of statewide trends.

Section 1. Tree Analyses (Connecticut)

A. Dieback trends (Connecticut)

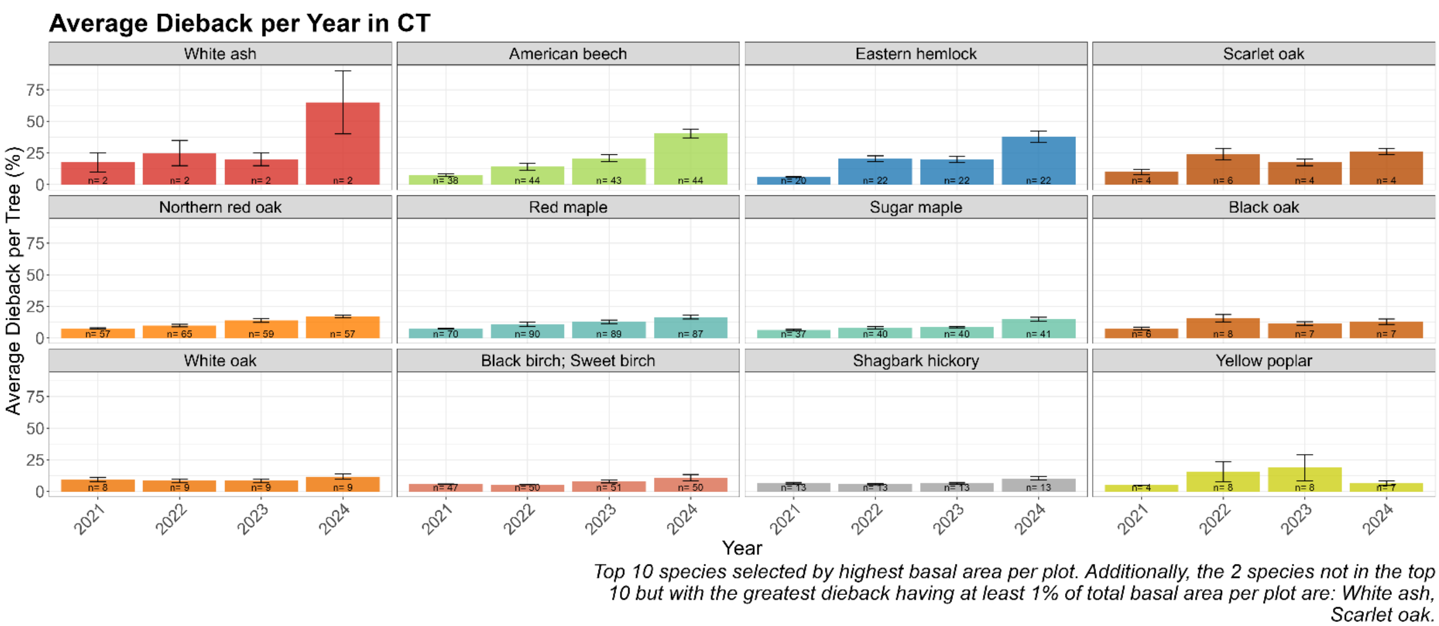

Figure 1A. Connecticut average fine twig dieback trends by species and year for the top ten species by basal area, plus two that are less prevalent by basal area but are nonetheless showing high dieback (white ash, scarlet oak). Species are ordered by highest dieback in 2024.

B. Transparency trends (Connecticut)

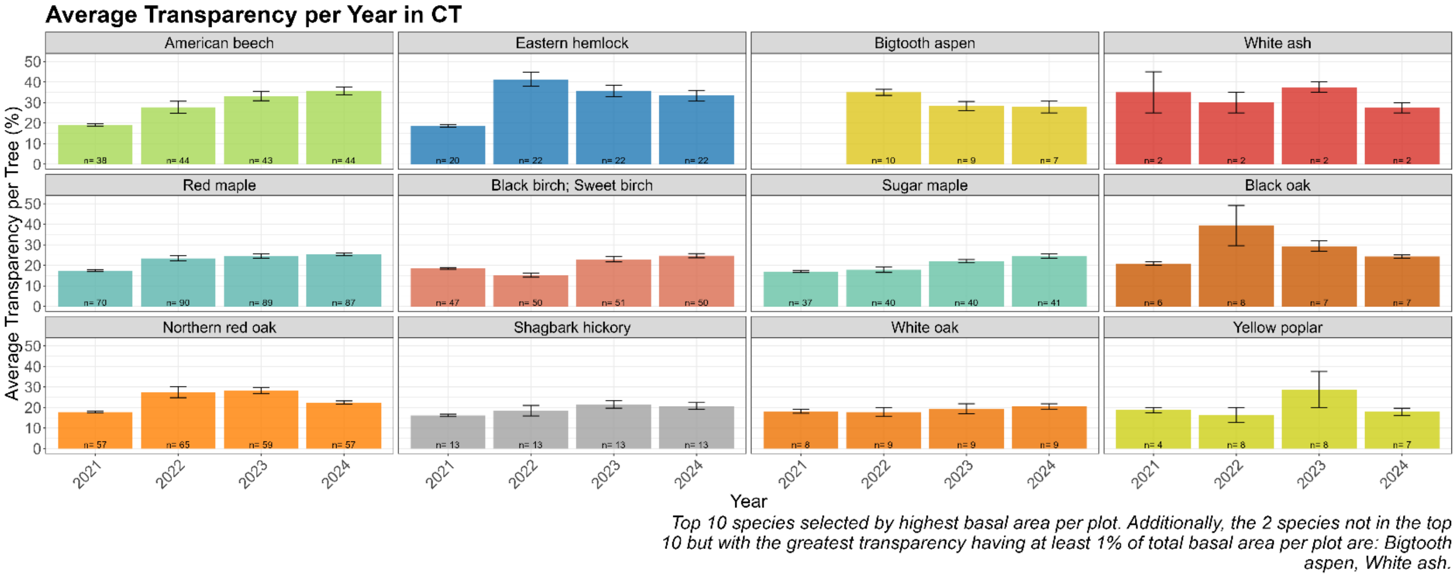

Figure 1B. Connecticut average leaf transparency trends by species and year, for the top ten species by basal area plus two that are less prevalent by basal area but are nonetheless showing high transparency (bigtooth aspen, white ash). Species are ordered by greatest transparency in 2024.

C. Vigor trends (Connecticut)

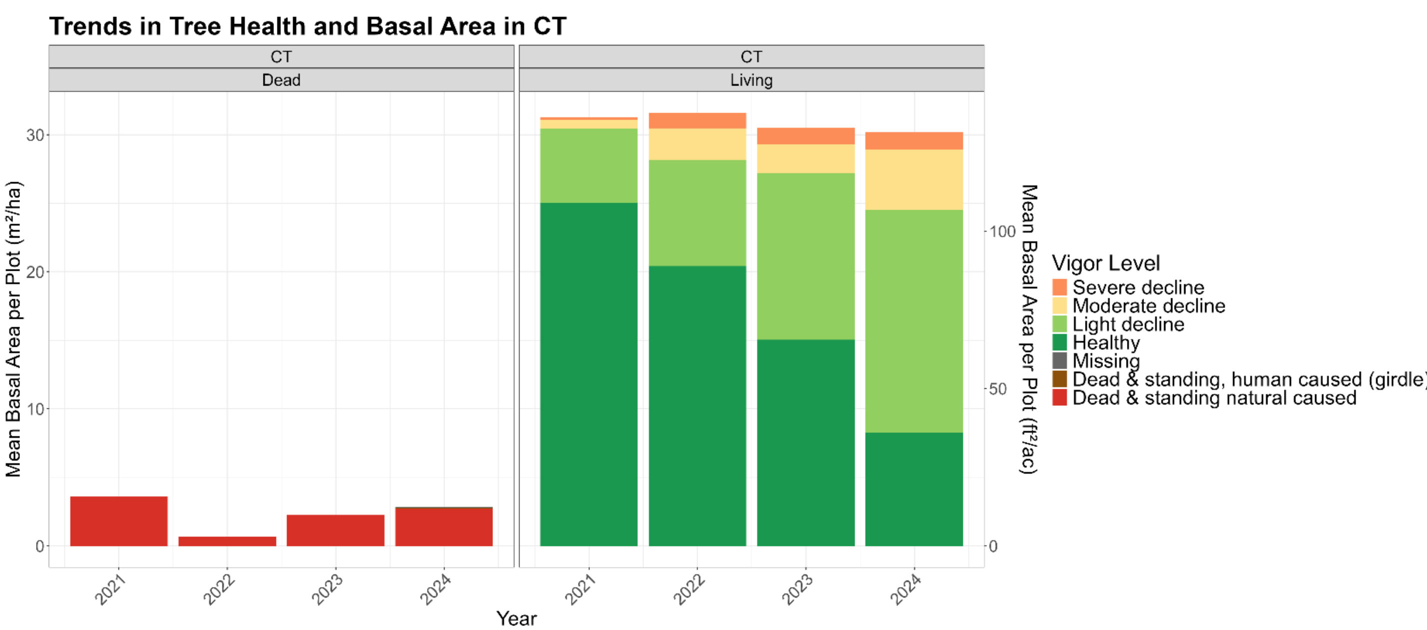

Figure 1C. Mean basal area per plot in hectares (m^2/ha, left axis) and acres (ft^2/ac, right axis) for living and dead trees in Connecticut. Data are grouped by tree status with living classes shown on the right and dead classes on the left. An overall trend toward less vigorous trees is evident.

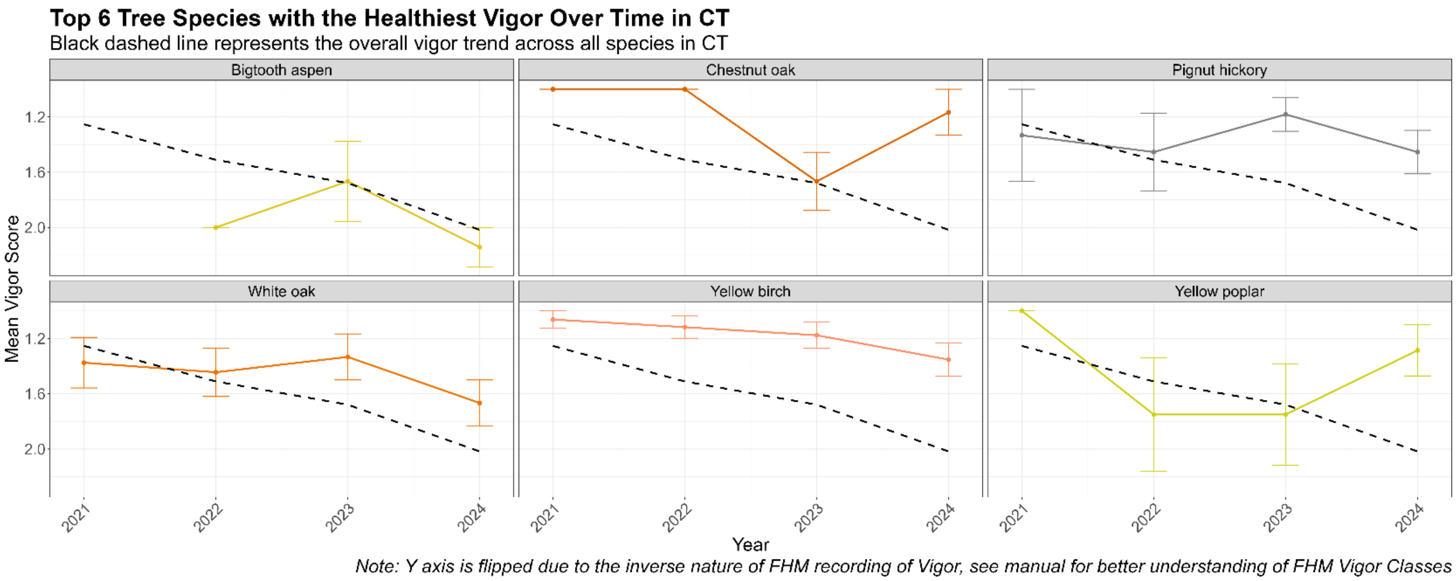

Figure 2C. Top six tree species with the healthiest vigor (lowest stress levels) over time in Connecticut among species comprising at least 0.5% of total basal area statewide. Vigor scores range from 4 (severe decline) to 1 (healthy), with intermediate values for trees in decline. The dashed black line represents the overall vigor trend across all species sampled within the state, providing a reference for general forest condition changes. 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.

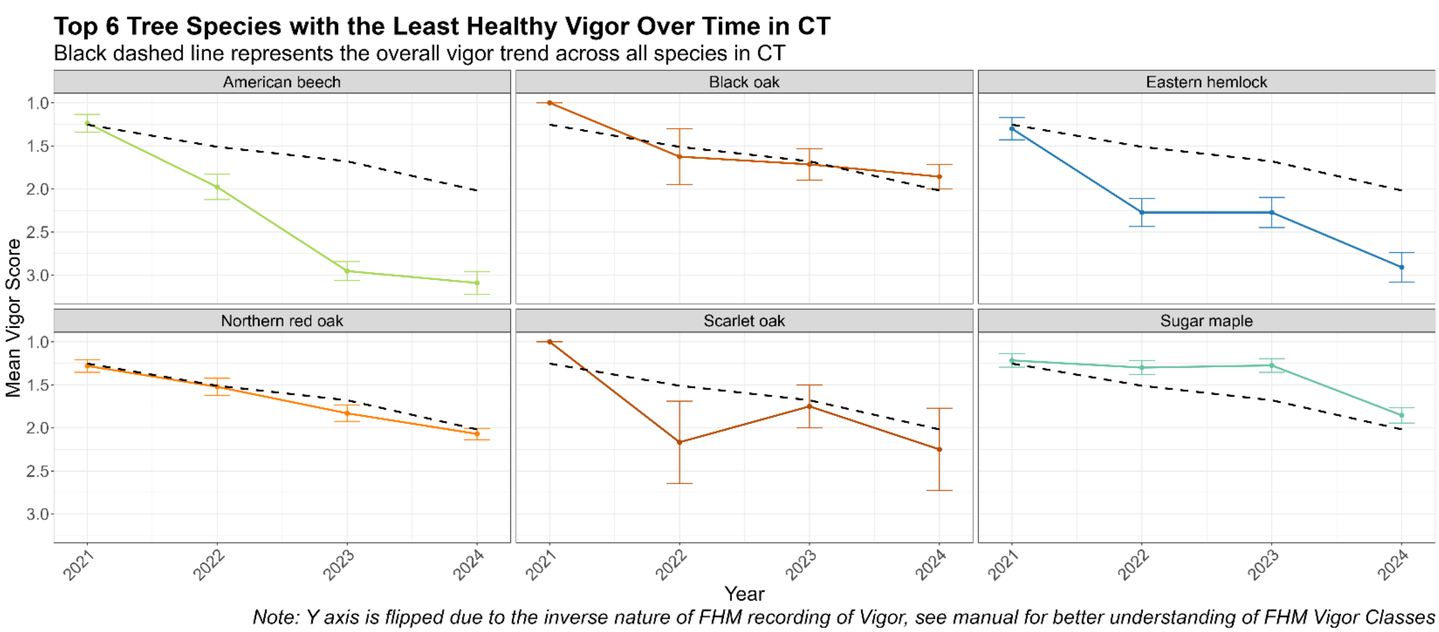

Figure 3C. Top six tree species with the greatest decline in vigor (highest stress levels) over time in Connecticut among species comprising at least 0.5% of total basal area statewide. Vigor scores range from 4 (severe decline) to 1 (healthy), with intermediate values for trees in decline. The dashed black line represents the overall vigor trend across all species sampled within the state, enabling a broader forest health comparison. 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.

D. Annual growth and mortality trends - Trees (Connecticut)

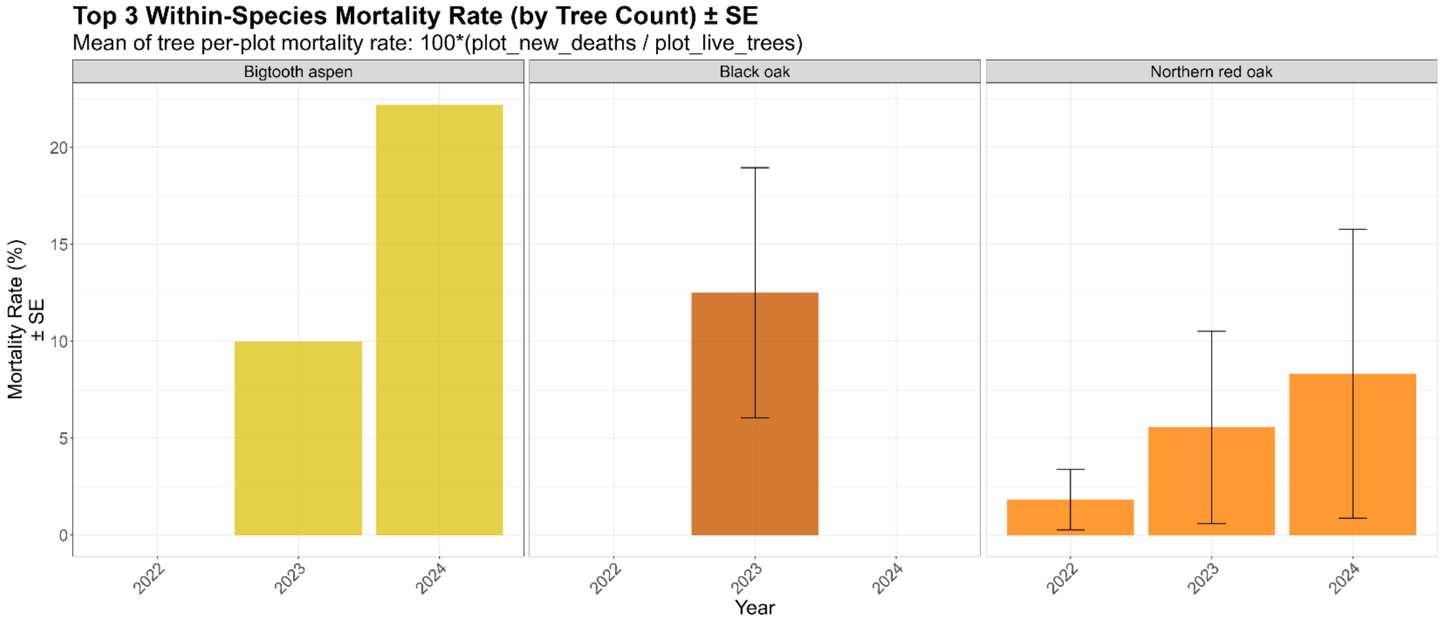

Figure 1D. Within-species mortality trends in Connecticut for the top three tree species with the highest number of newly dead trees among species comprising more than 1% of total basal area statewide. This plot shows the annual number of newly dead trees per species, based on individual tree tracking using unique tree identifiers. 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. This metric reflects the percentage of individual trees transitioning from living to dead within their total species' samples statewide. Note: All dead bigtooth aspen was recorded within one plot in Sharon, CT, and the sample size is insufficient for producing standard error bars.

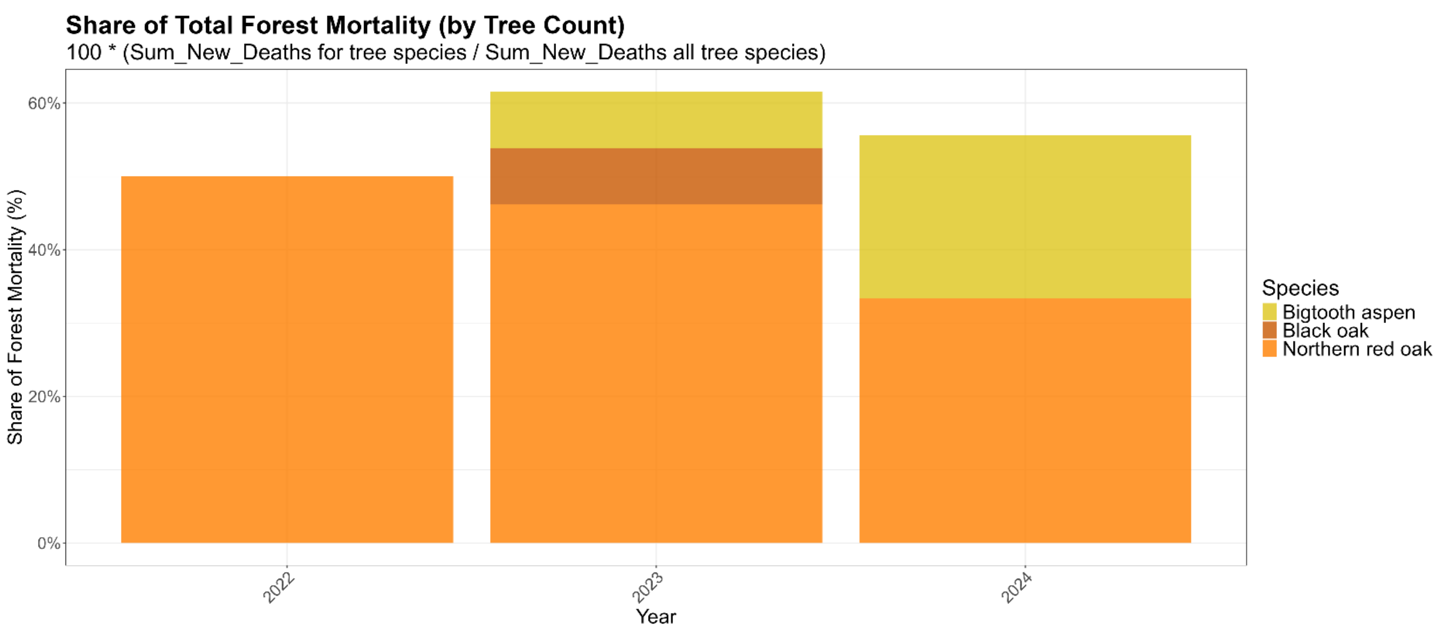

Figure 2D. Share of total forest mortality trends in Connecticut for the top three species with the highest number of newly dead trees, relative to all newly reported tree deaths across all species comprising more than 1% of total basal area statewide.

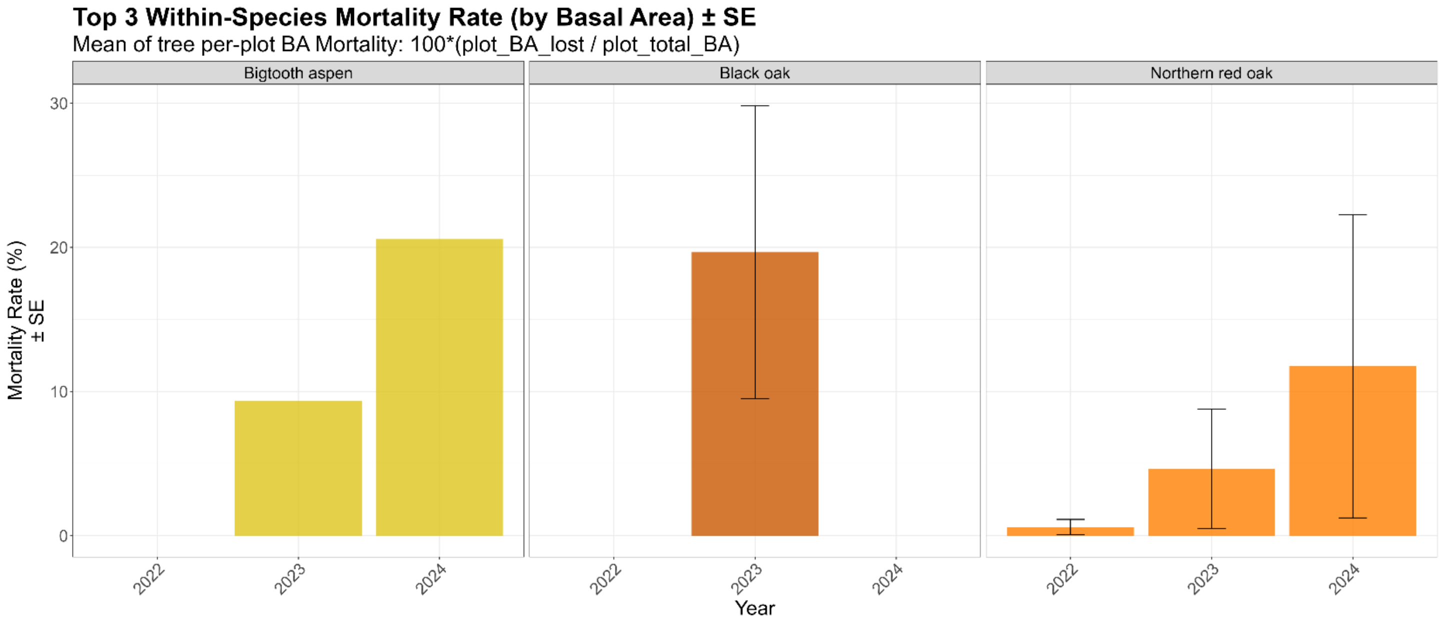

Figure 3D. Within-species mortality trends by basal area in Connecticut for the top three species with the greatest total basal area loss among species comprising more than 1% of total basal area statewide, calculated as the sum of the last recorded basal area of all trees within a given species that transitioned from living to dead each year. Instead of simply accounting for the number of dead trees, basal area loss accounts for tree size, providing a different perspective on the impact to forest structure.

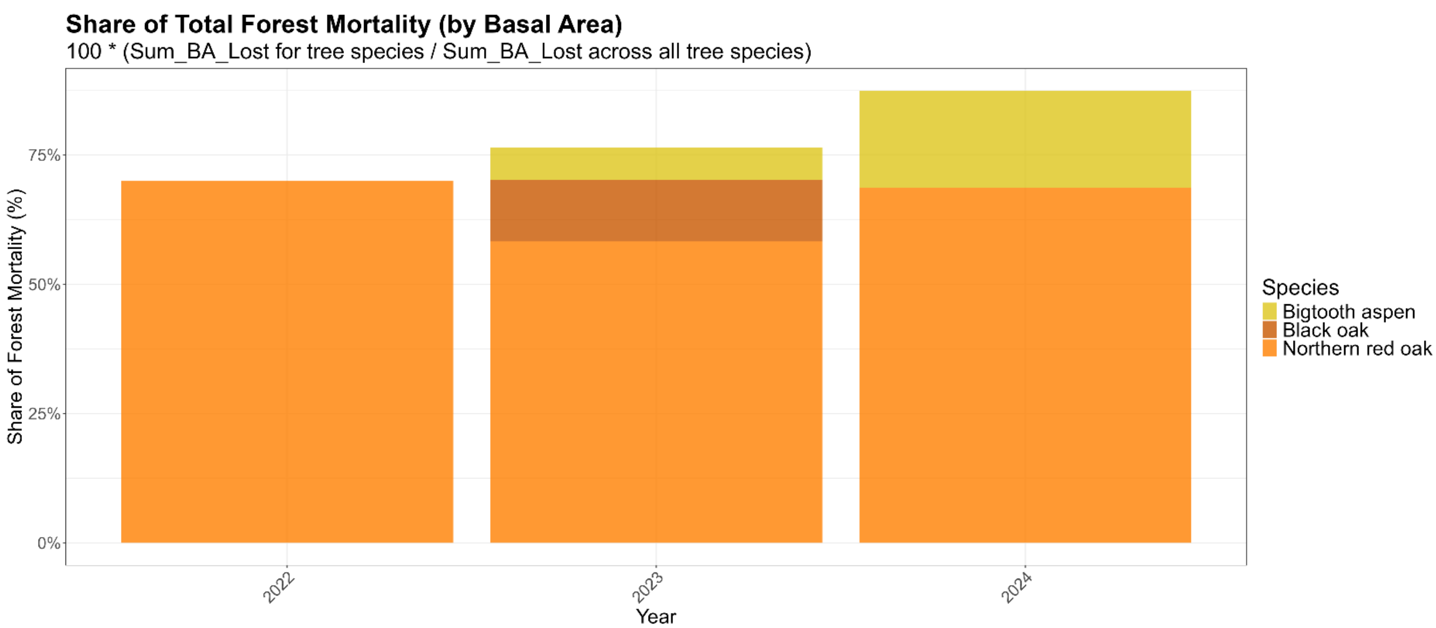

Figure 4D. Share of total lost basal area in Connecticut for the top three species with the greatest basal area loss due to mortality, among species comprising more than 1% of total basal area statewide.

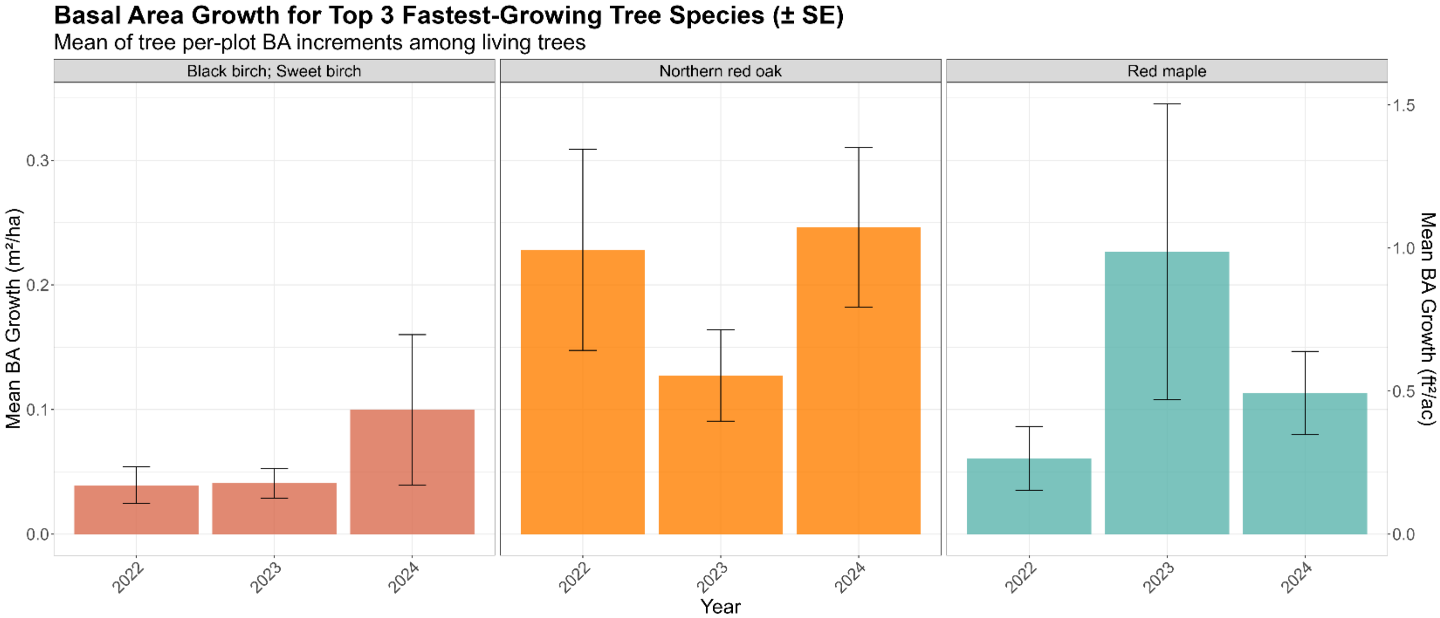

Figure 5D. Top three species with the greatest average basal area growth in Connecticut. Bars represent the mean basal area increment in hectares (m^2/ha, left axis) and acres (ft^2/ac, right axis) each year. These growth trends illustrate which species are adding basal area the fastest, which may be related to species vigor and competitive advantage and has longer-term implications for stand development and forest composition.

E. Total composition - Trees (Connecticut)

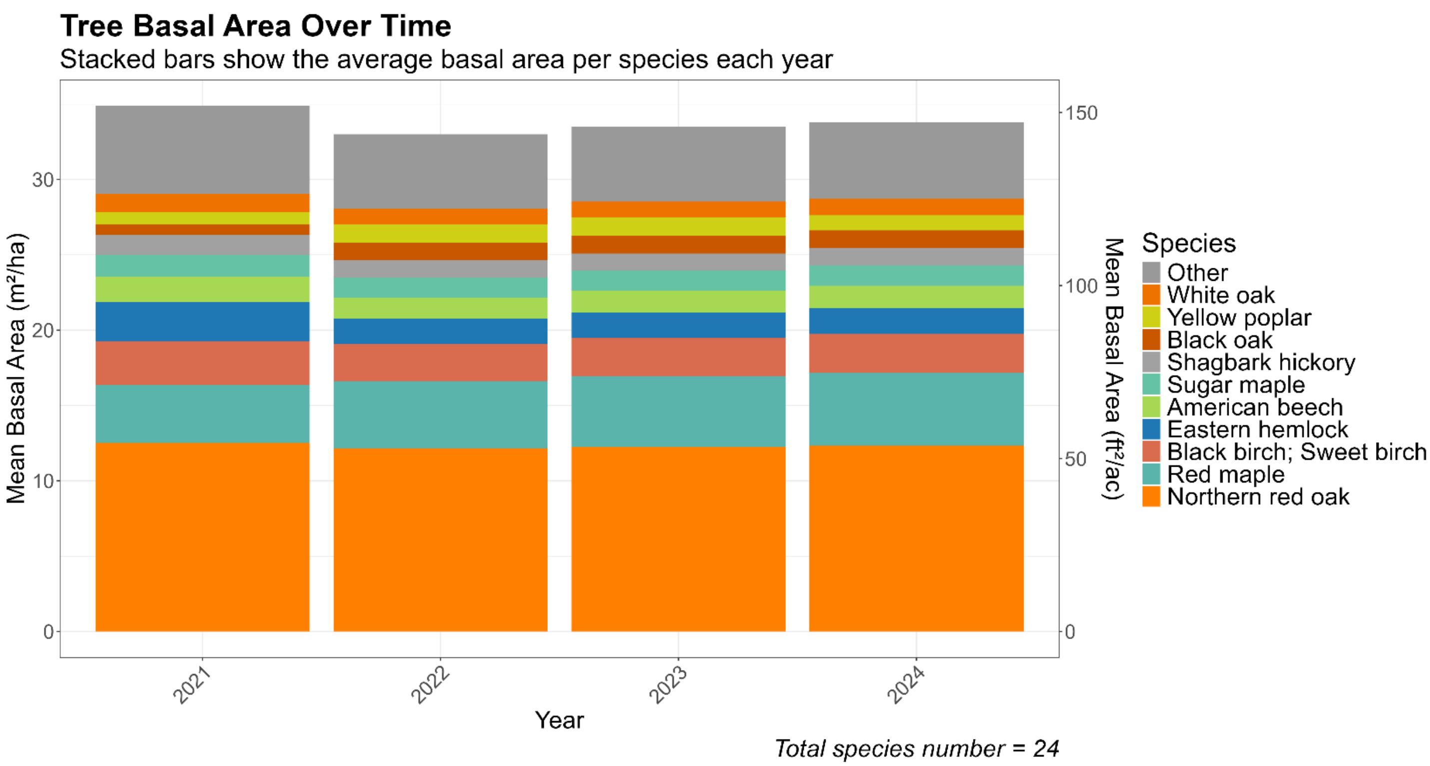

Figure 1E. Overall species composition by average live basal area in hectares (m^2/ha, left axis) and acres (ft^2/ac, right axis) across all tree species surveyed each year in Connecticut. Species that ranked among the top ten for overall basal area are shown individually, while all species not in the top ten are combined and represented as "Other." This figure suggests which tree species are dominant or may be becoming more dominant in overall forest composition.

Section 2. Sapling Analyses (Connecticut)

F. Total composition – Saplings (Connecticut)

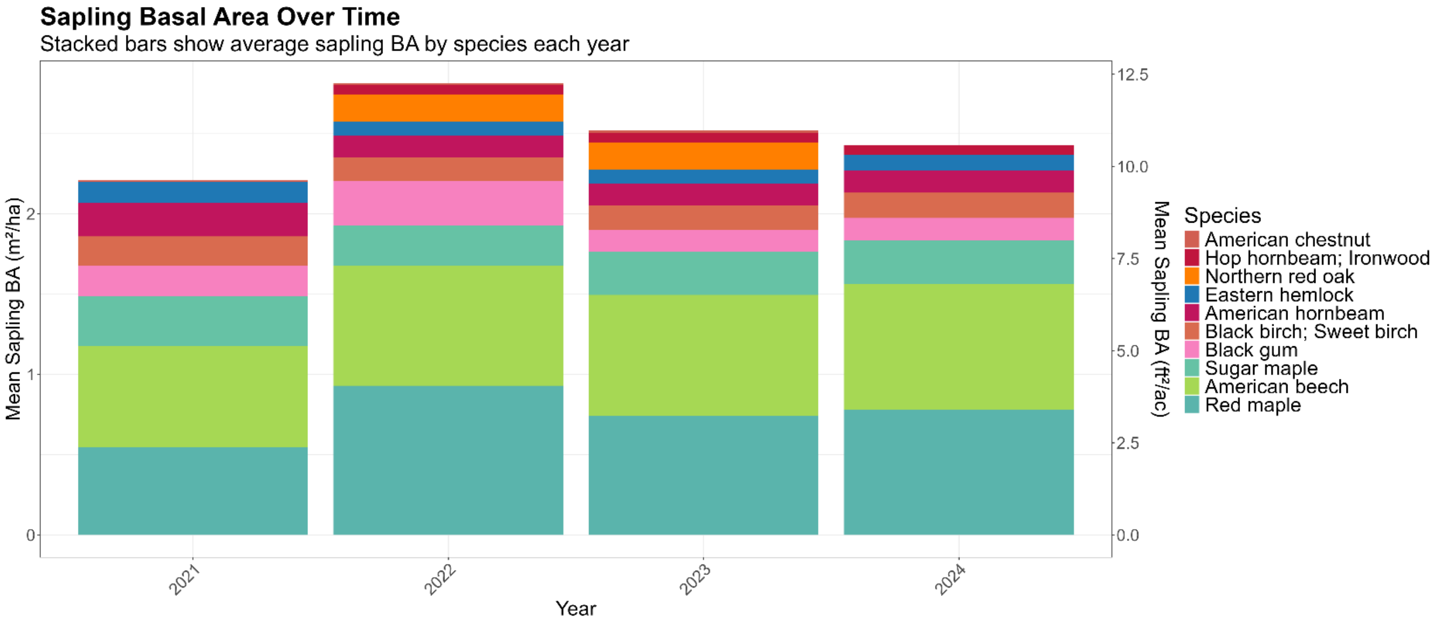

Figure 1F. Overall sapling basal area composition in hectares (m^2/ha, left axis) and acres (ft^2/ac, right axis) for all sapling species surveyed each year in Connecticut. Species that ranked among the top ten for overall basal area are shown individually, while all species not in the top ten are combined and represented as “Other.” This figure suggests which saplings are dominant or may be becoming more dominant in our plot network statewide.

Section 3. Seedling Analyses (Connecticut)

Note that fewer total individual seedlings and species were observed in Connecticut plots across monitoring years, and that Connecticut has a relatively low number of plots; both factors lead to smaller sample sizes in comparison with other states. As a result, we recommend caution in interpreting these figures as indicative of statewide trends.

We have included a seedling class size guide to assist with interpreting the figures in subgroup H.

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

G. Annual growth and mortality trends – Seedlings (Connecticut)

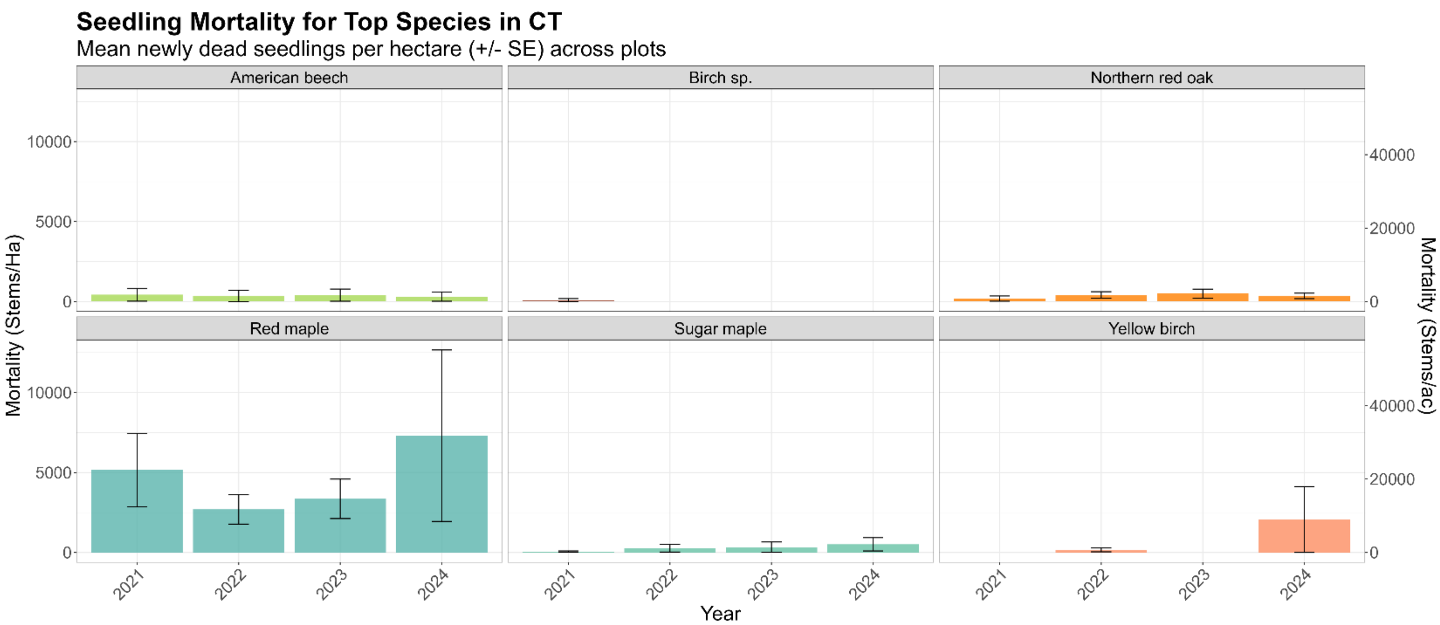

Figure 1G. The top six species showing the greatest mortality at the seedling stage in Connecticut by stem count, presented by the mean number of seedlings transitioning from smaller to larger classes by stems per hectare (SPH, left axis) and acre (SPA, right axis) each year. While we do not record seedling mortality, we estimate based on reductions in seedling counts in our seedling sub-plots from one year to the next.

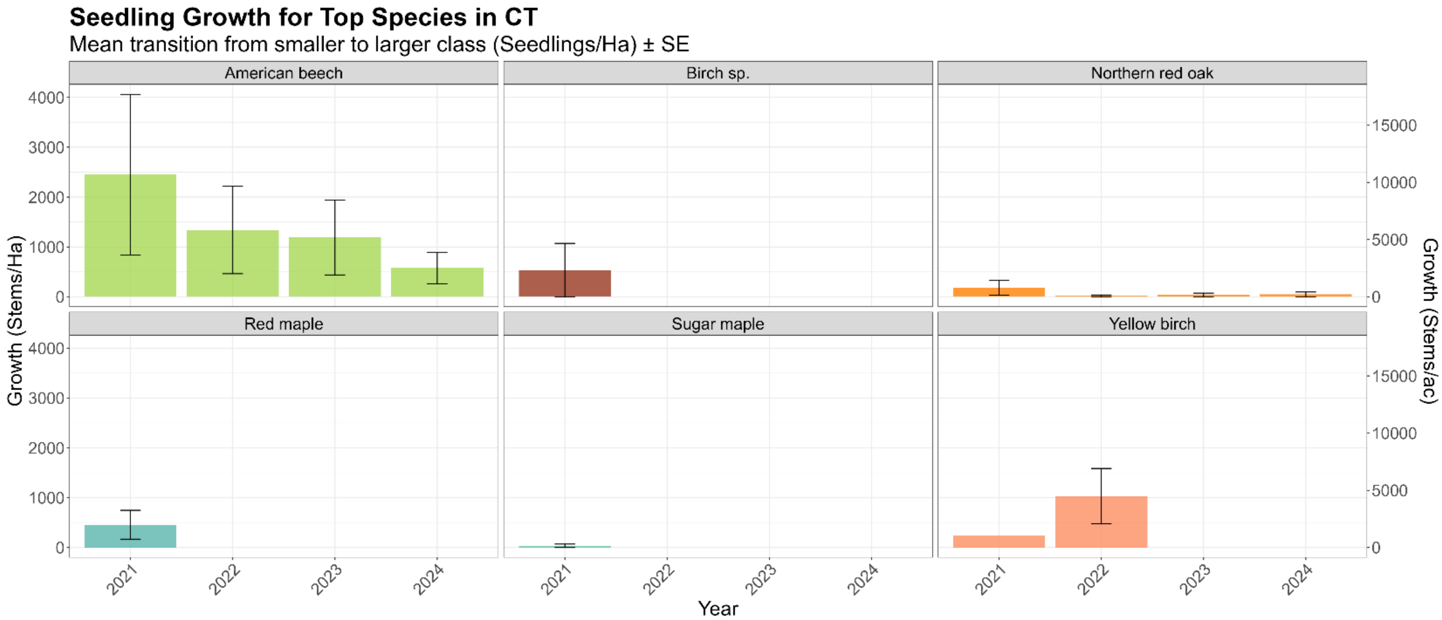

Figure 2G. The top six species showing the greatest growth at the seedling stage in Connecticut by stem count, presented by the mean number of seedlings transitioning from smaller to larger classes by stems per hectare (SPH, left axis) and acre (SPA, right axis) each year.

H. Annual seedling density trends (Connecticut)

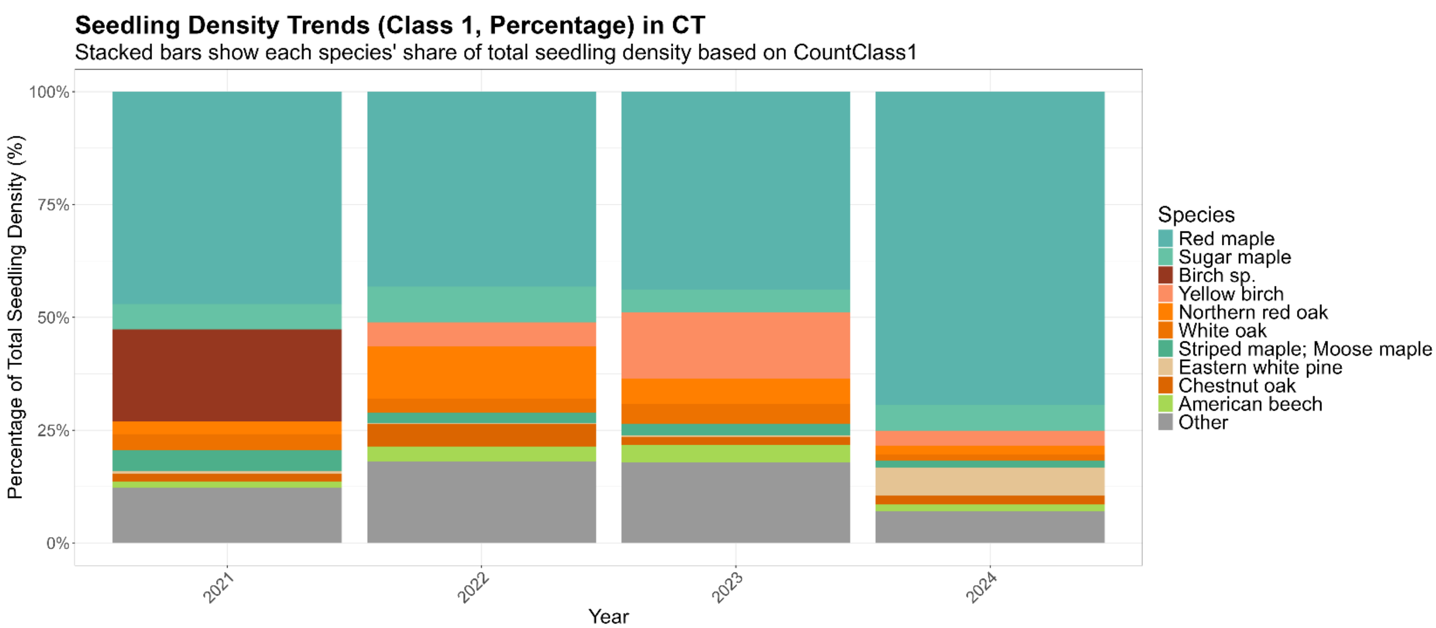

Figure 1H-i. Percent annual composition of Class 1 seedlings for all species surveyed each year in Connecticut. The top ten most represented species by stem count are shown individually, while all other species not in the top ten are combined and represented as “Other.” This figure suggests potential trends in changes in species composition within the seedling layer over time.

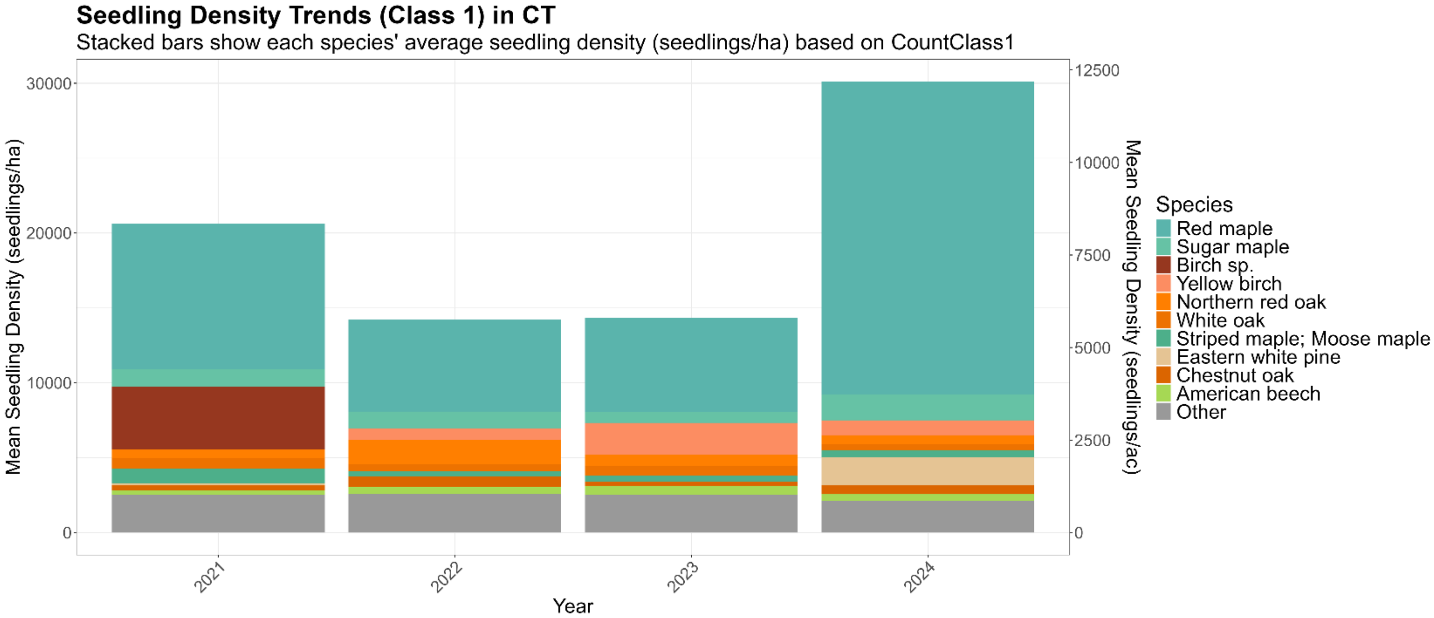

Figure 1H-ii. Class 1 seedling counts in stems per hectare (SPH, left axis) and acre (SPA, right axis) for all species surveyed each year in Connecticut. The top ten most representated species by stem count are shown individually, while all species not in the top ten are combined and represented as "Other." The overall bar height indicates total number of Class 1 seedlings per hectare and acre statewide for each year.

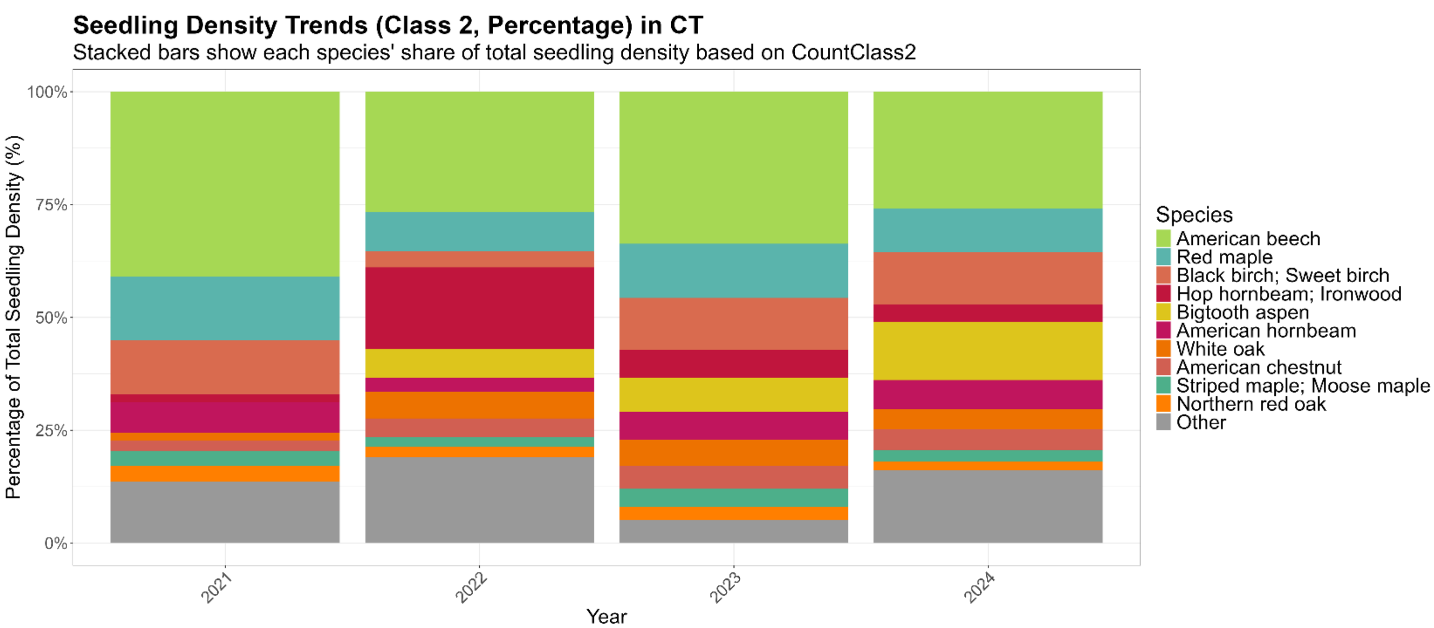

Figure 2H-i. Percent annual composition of Class 2 seedlings surveyed each year in Connecticut. The top ten most representated species by stem count are shown individually, while all species not in the top ten are combined and represented as "Other."

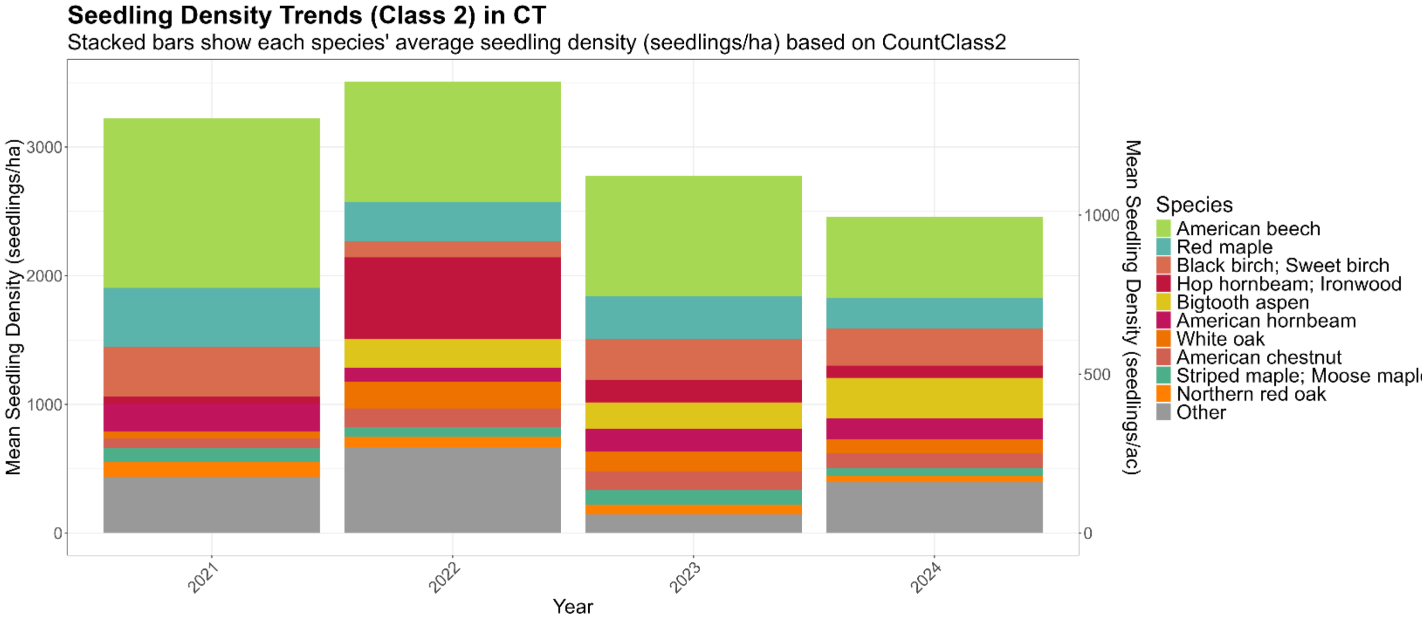

Figure 2H-ii. Class 2 seedling counts in stems per hectare (SPH, left axis) and acre (SPA, right axis) for all species surveyed each year in Connecticut. The top ten most representated species by stem count are shown individually, while all species not in the top ten are combined and represented as "Other." The overall bar height indicates total number of Class 2 seedlings per hectare and acre statewide for each year.

Massachusetts

Section 1. Tree Analyses (Massachusetts)

Note that data was not collected in Massachusetts in 2020 due to COVID-19.

A. Dieback trends (Massachusetts)

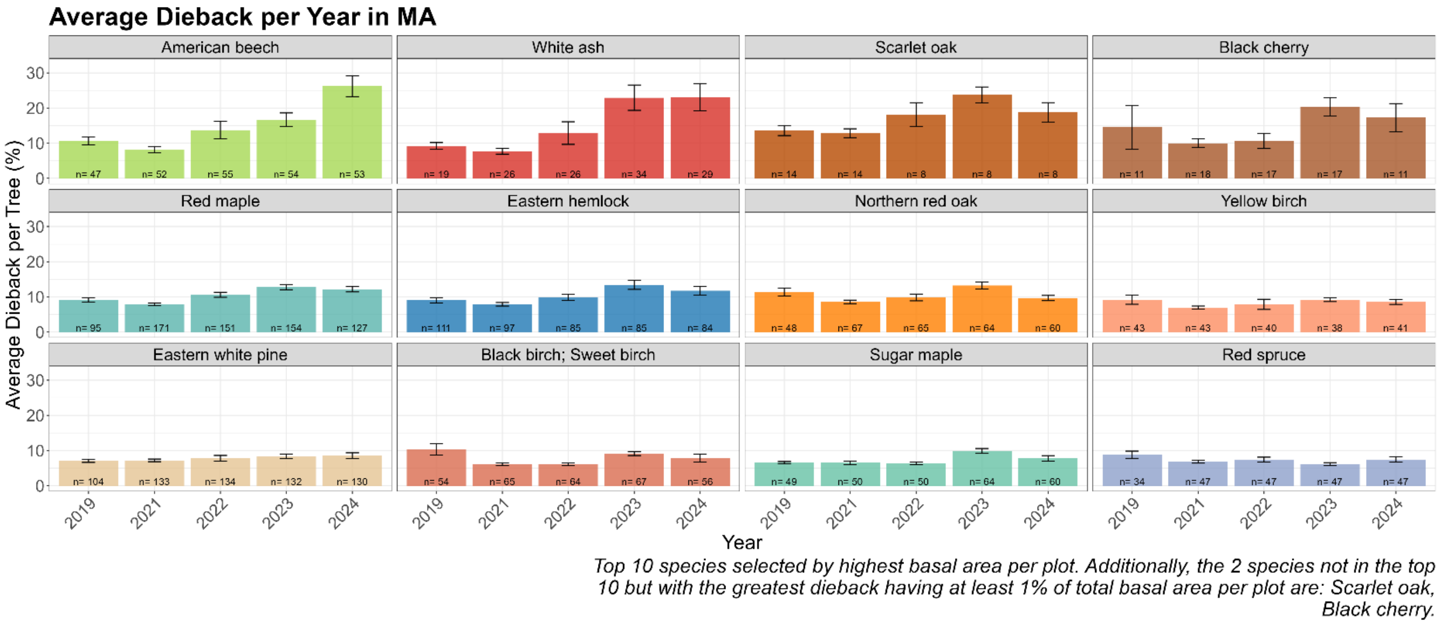

Figure 1A. Massachusetts average fine twig dieback trends by species and year for the top ten species by basal area, plus two that are less prevalent by basal area but are nonetheless showing high dieback (scarlet oak, black cherry). Species are ordered by highest dieback in 2024.

B. Transparency trends (Massachusetts)

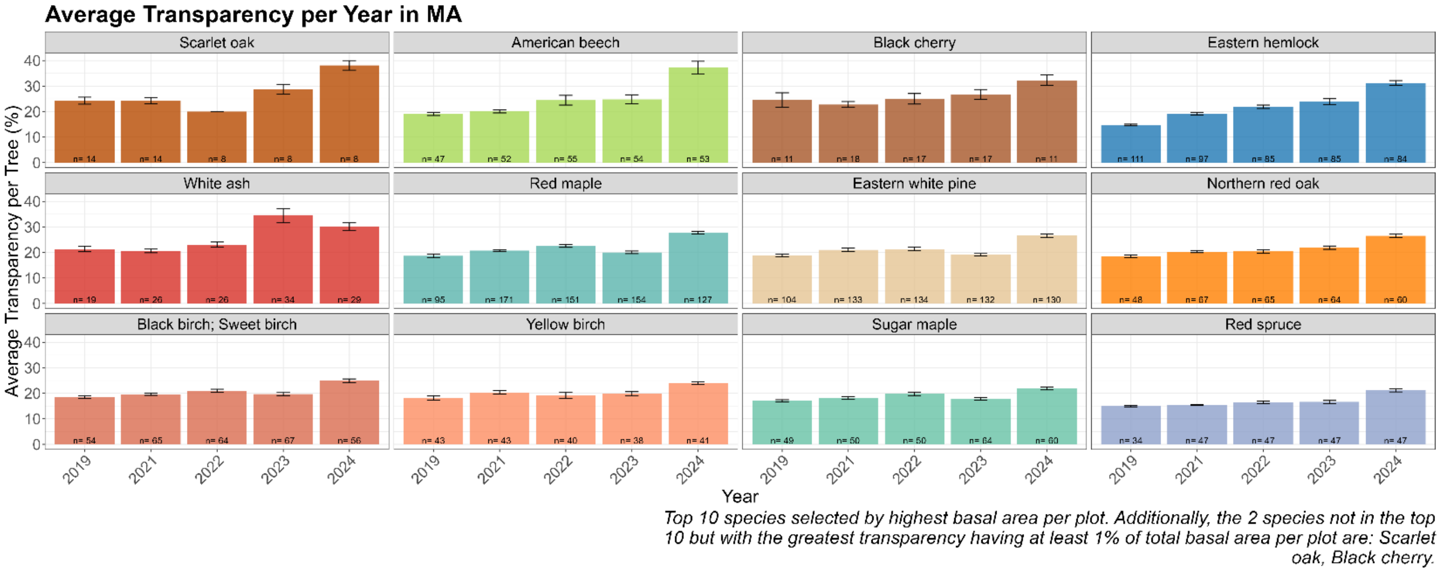

Figure 1B. Massachusetts average leaf transparency trends by species and year, for the top ten species by basal area plus two that are less prevalent by basal area but are nonetheless showing high transparency (scarlet oak, black cherry). Species are ordered by greatest transparency in 2024.

C. Vigor trends (Massachusetts)

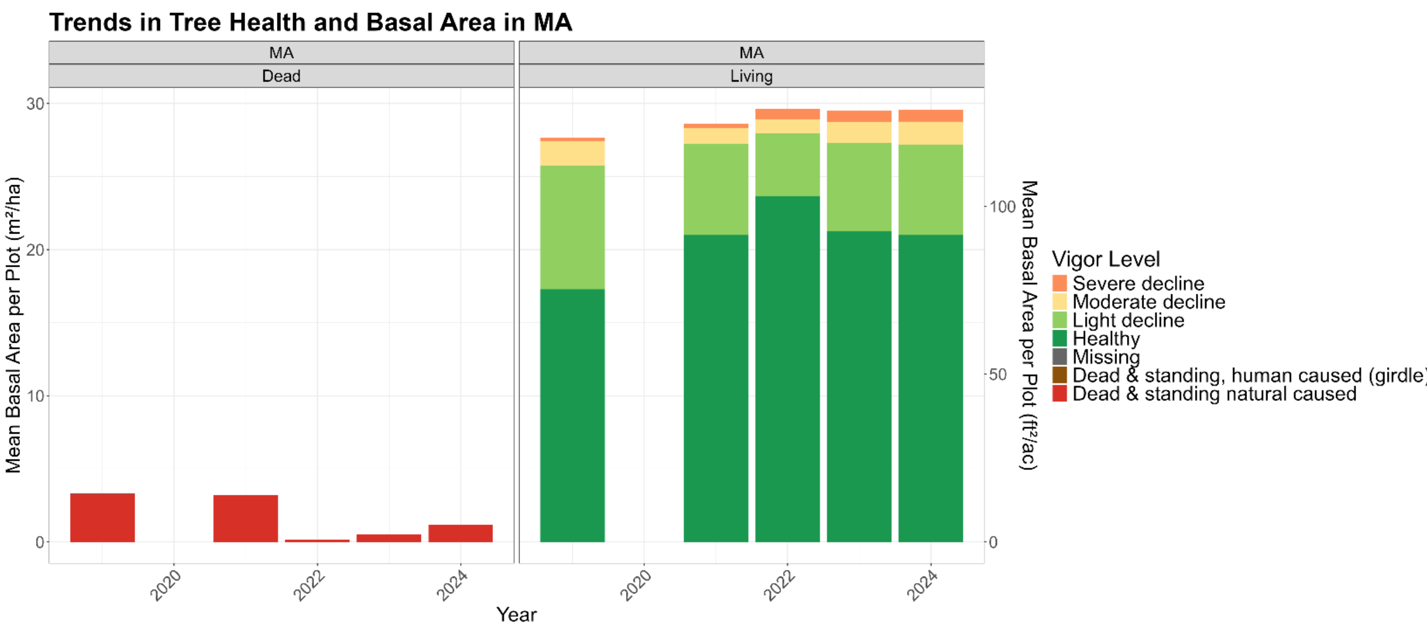

Figure 1C. Mean basal area per plot in hectares (m^2/ha, left axis) and acres (ft^2/ac, right axis) for living and dead trees in Massachusetts. Data is grouped by tree status with living classes shown on the right and dead classes on the left.

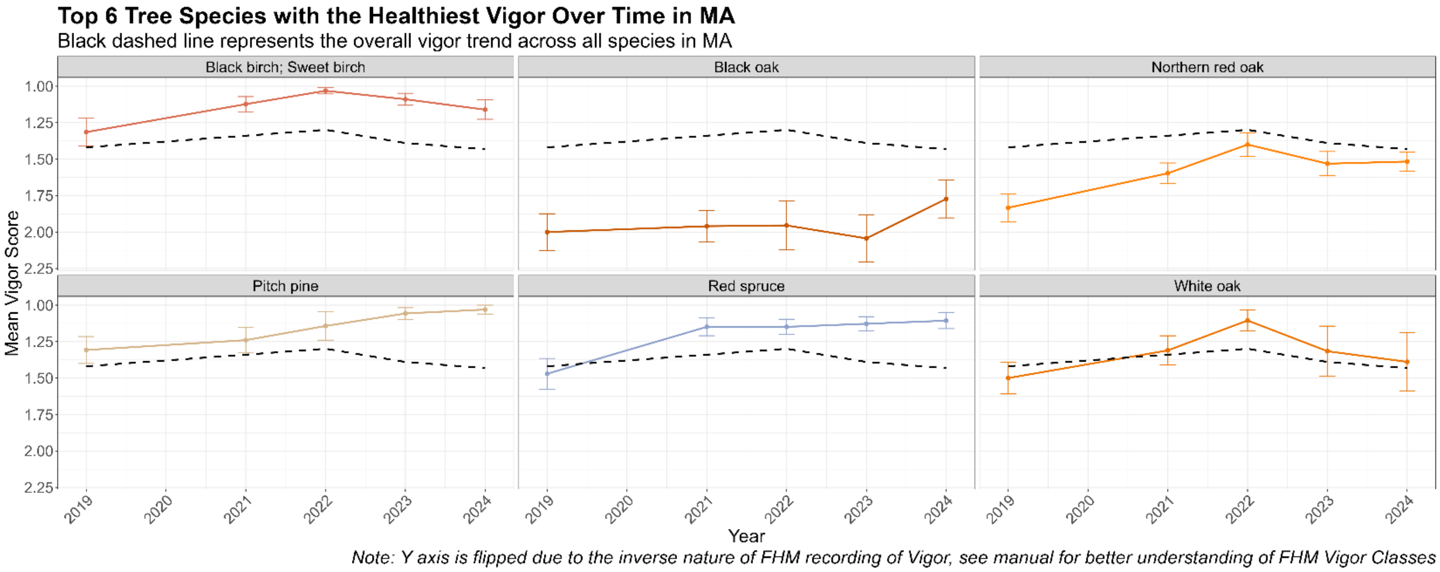

Figure 2C. Top six tree species with the healthiest vigor (lowest stress levels) over time in Massachusetts among species comprising at least 0.5% of total basal area statewide. Vigor scores range from 4 (severe decline) to 1 (healthy), with intermediate values for trees in decline. The dashed black line represents the overall vigor trend across all species sampled within the state, providing a reference for general forest condition changes. 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.

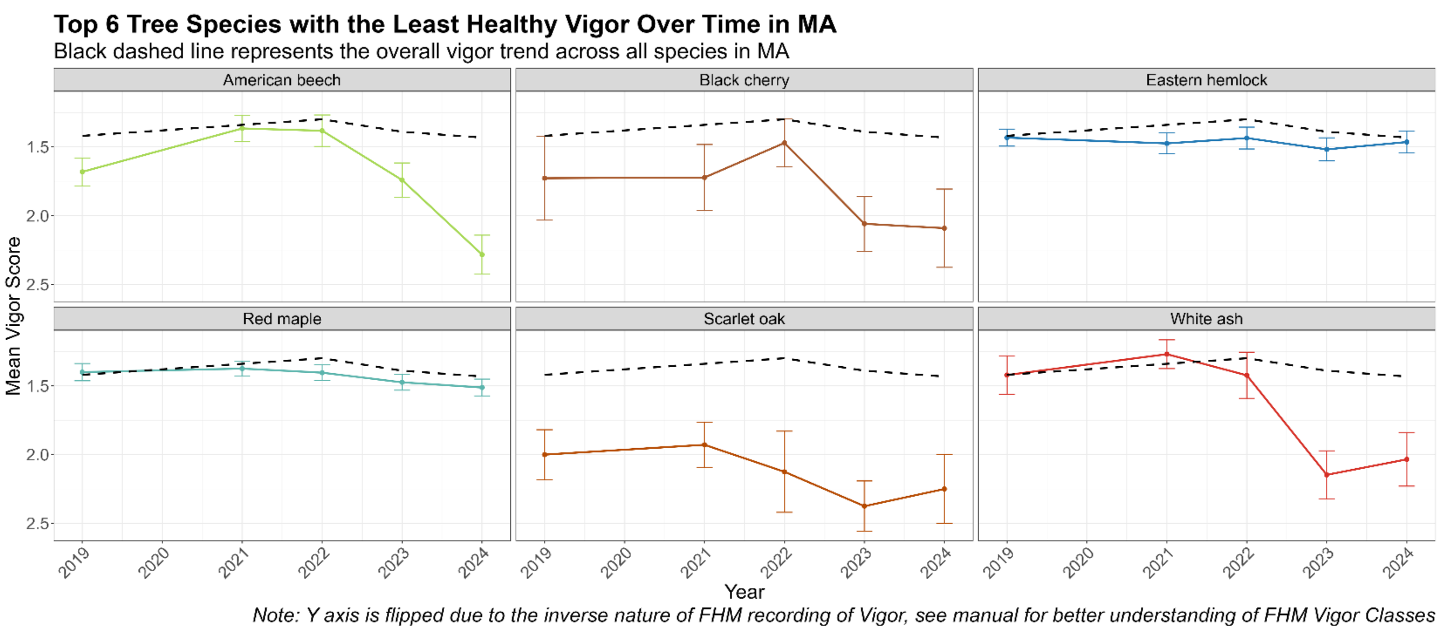

Figure 3C. Top six tree species with the greatest decline in vigor (highest stress levels) over time in Massachusetts among species comprising at least 0.5% of total basal area statewide. Vigor scores range from 4 (severe decline) to 1 (healthy), with intermediate values for trees in decline. The dashed black line represents the overall vigor trend across all species sampled within the state, enabling a broader forest health comparison. 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.

D. Annual growth and mortality trends - Trees (Massachusetts)

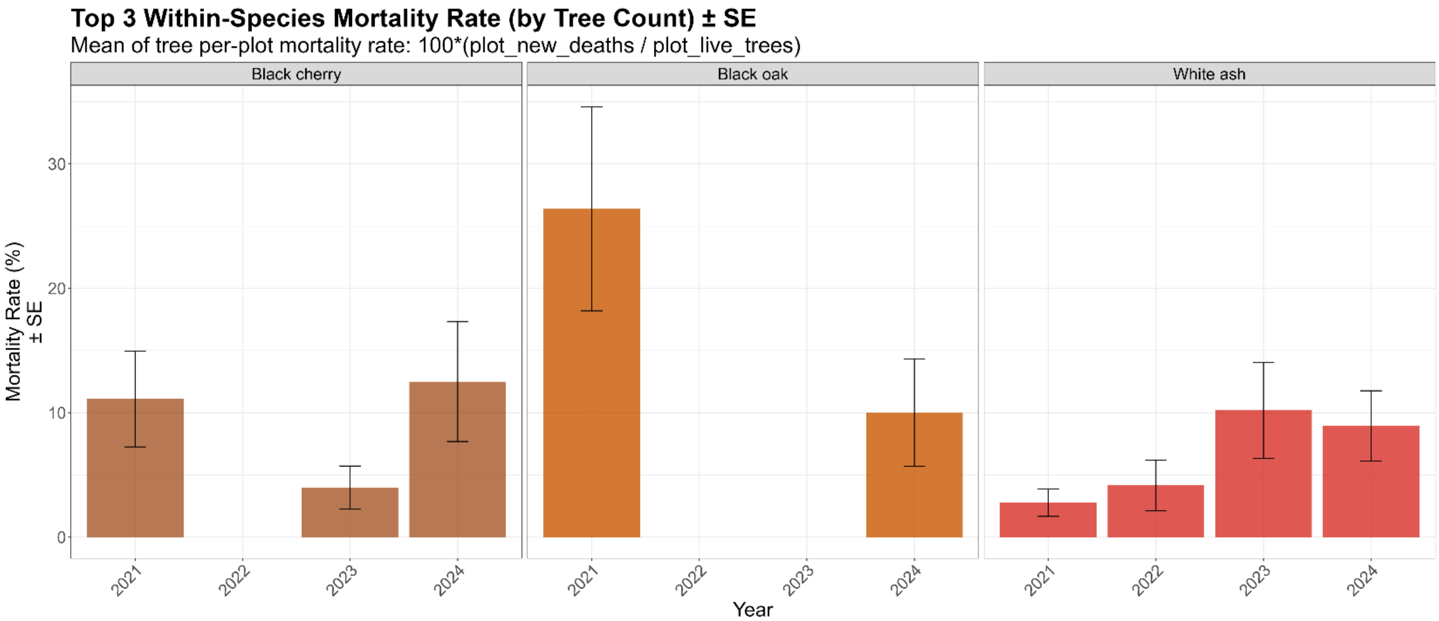

Figure 1D. Within-species mortality trends in Massachusetts for the top three tree species with the highest number of newly dead trees among species comprising more than 1% of total basal area statewide. This plot shows the annual number of newly dead trees per species, based on individual tree tracking using unique tree identifiers. 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. This metric reflects the percentage of individual trees transitioning from living to dead within their total species' samples statewide.

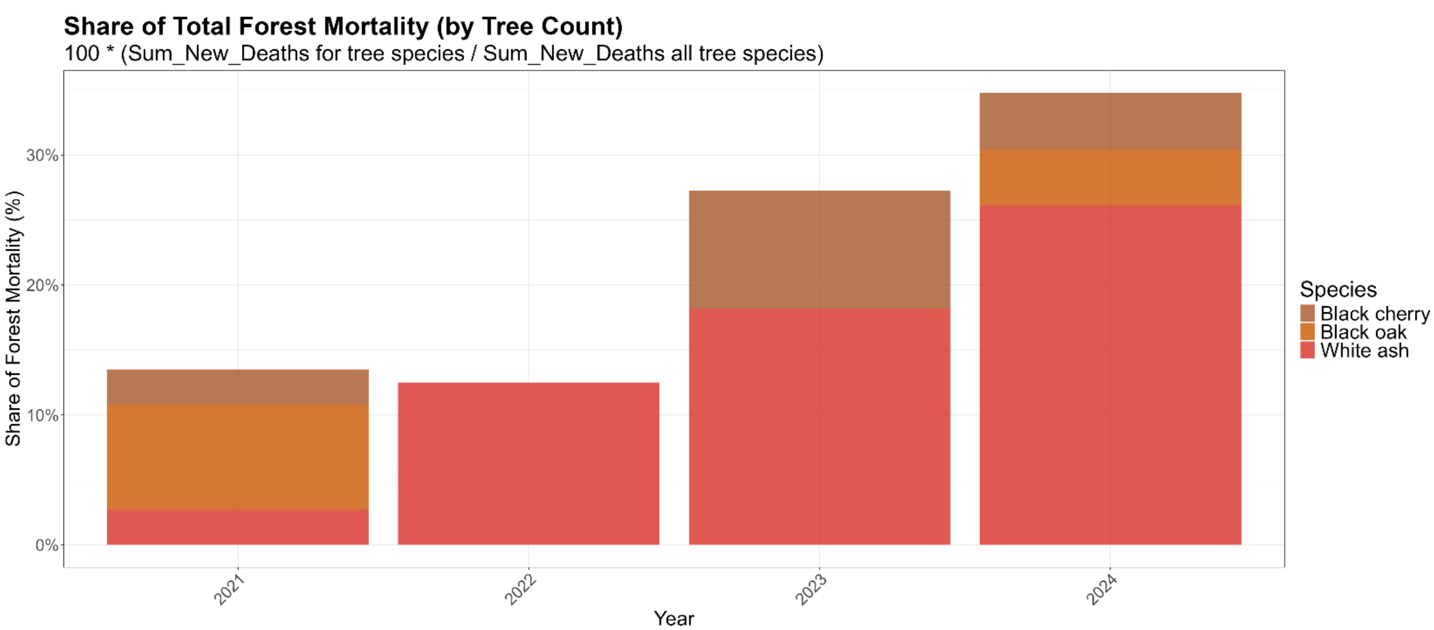

Figure 2D. Share of total forest mortality trends in Massachusetts for the top three species with the highest number of newly dead trees, relative to all newly reported tree deaths across all species comprising more than 1% of total basal area statewide.

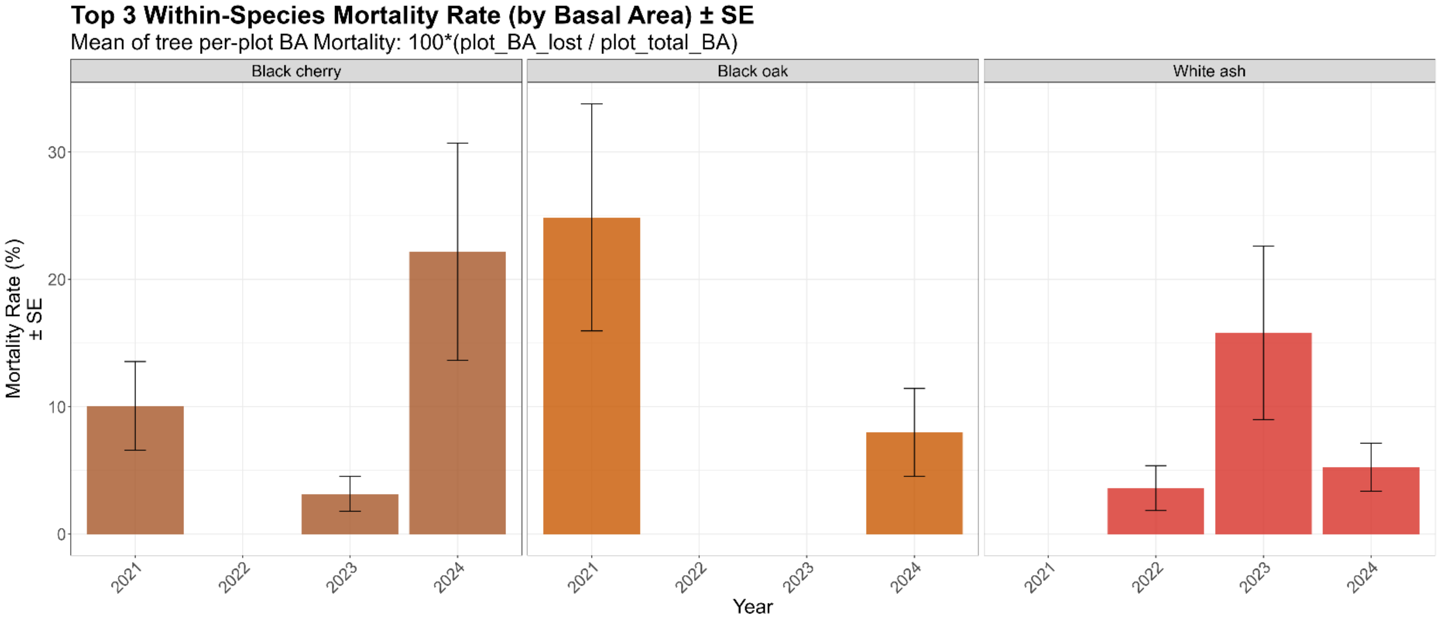

Figure 3D. Within-species mortality trends by basal area in Massachusetts for the top three species with the greatest total basal area loss among species comprising more than 1% of total basal area statewide, calculated as the sum of the last recorded basal area of all trees within a given species that transitioned from living to dead each year. Instead of simply accounting for the number of dead trees, basal area loss accounts for tree size, providing a different perspective on the impact to forest structure.

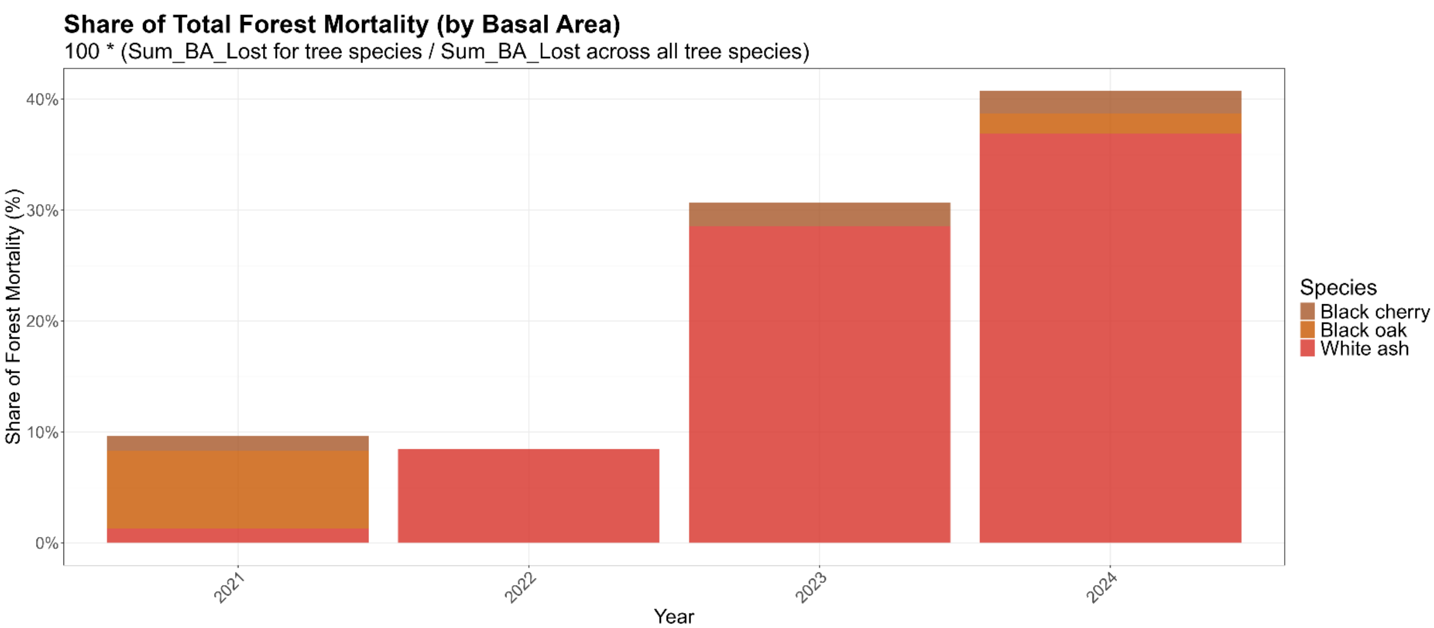

Figure 4D. Share of total lost basal area in Massachusetts for the top three species with the greatest basal area loss due to mortality, among species comprising more than 1% of total basal area statewide.

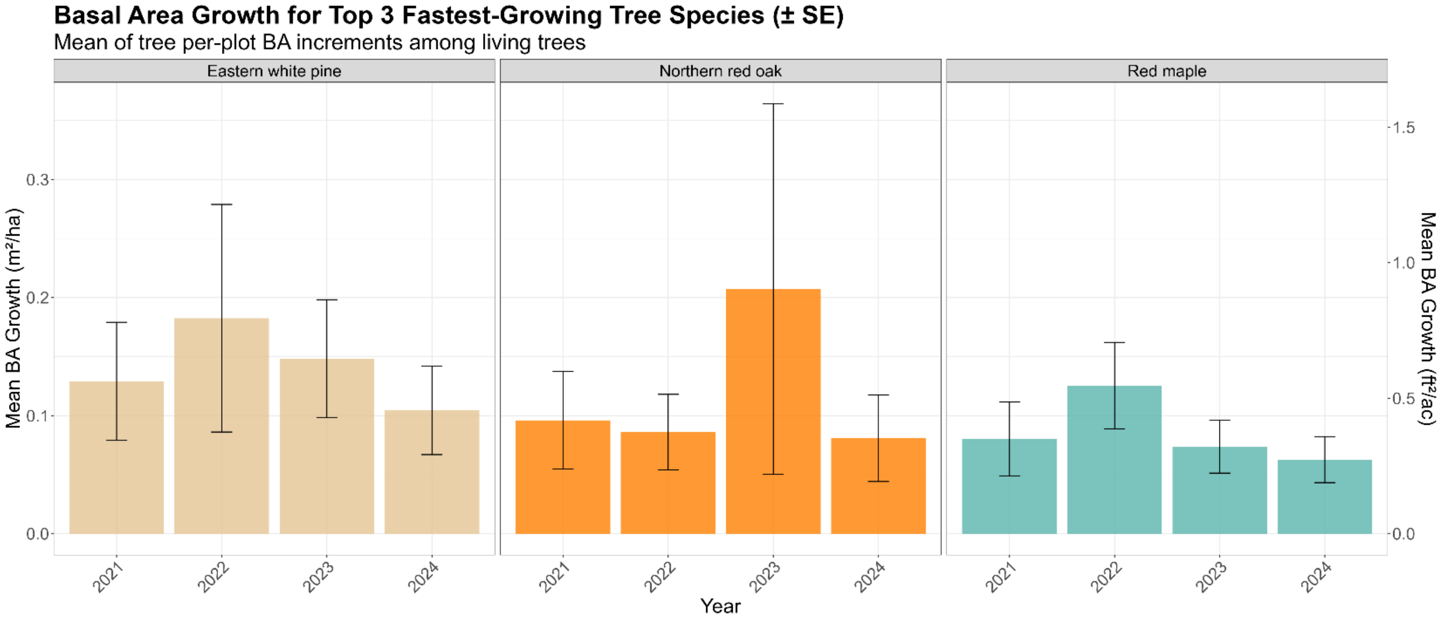

Figure 5D. Top three species with the greatest average basal area growth in Massachusetts. Bars represent the mean basal area increment in hectares (m^2/ha, left axis) and acres (ft^2/ac, right axis) each year. These growth trends illustrate which species are adding basal area the fastest, which may be related to species vigor and competitive advantage and has longer-term implications for stand development and forest composition.

E. Total composition - Trees (Massachusetts)

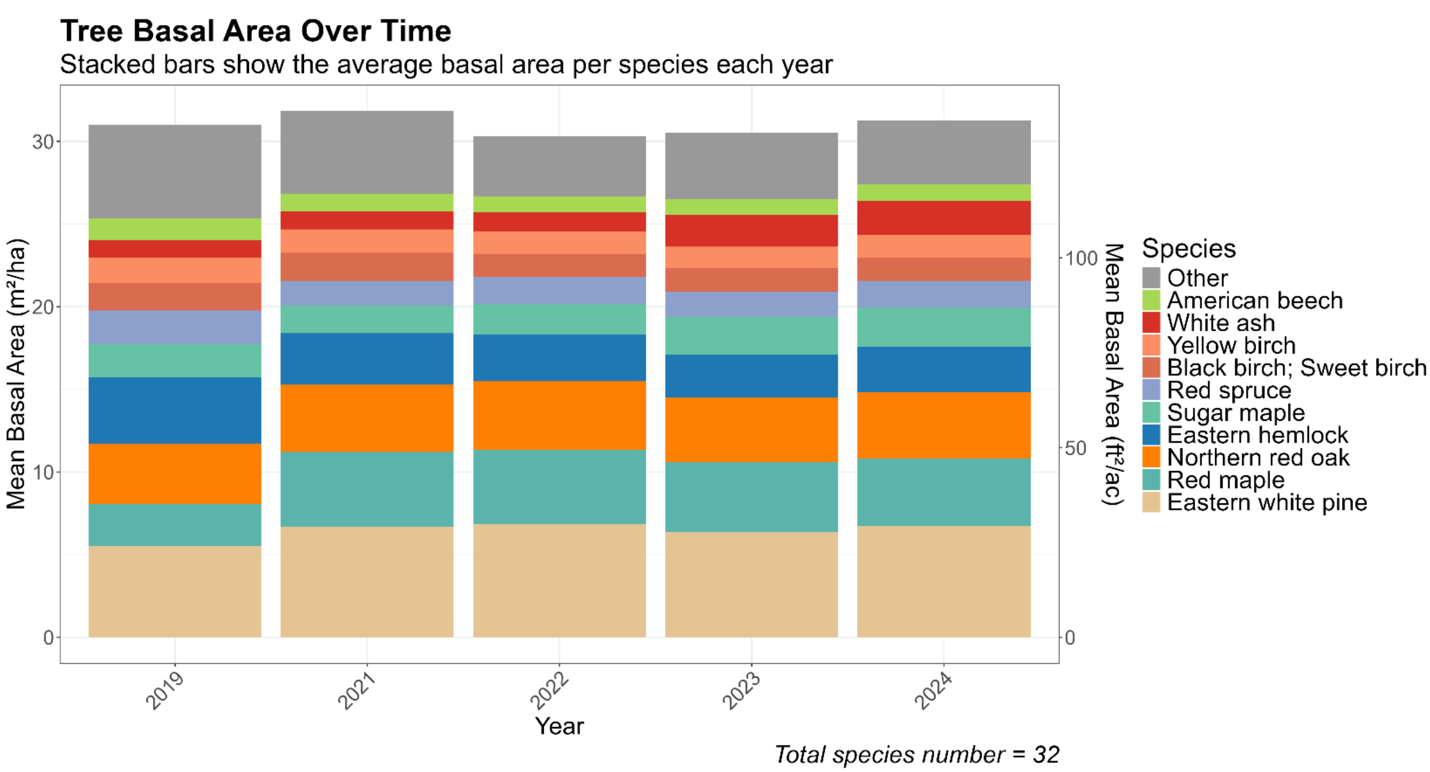

Figure 1E. Overall species composition by average live basal area in hectares (m^2/ha, left axis) and acres (ft^2/ac, right axis) across all tree species surveyed each year in Massachusetts. Species that ranked among the top ten for overall basal area are shown individually, while all species not in the top ten are combined and represented as "Other." This figure suggests which tree species are dominant or may be becoming more dominant in overall forest composition.

Section 2. Sapling Analyses (Massachusetts)

F. Total composition – Saplings (Massachusetts)

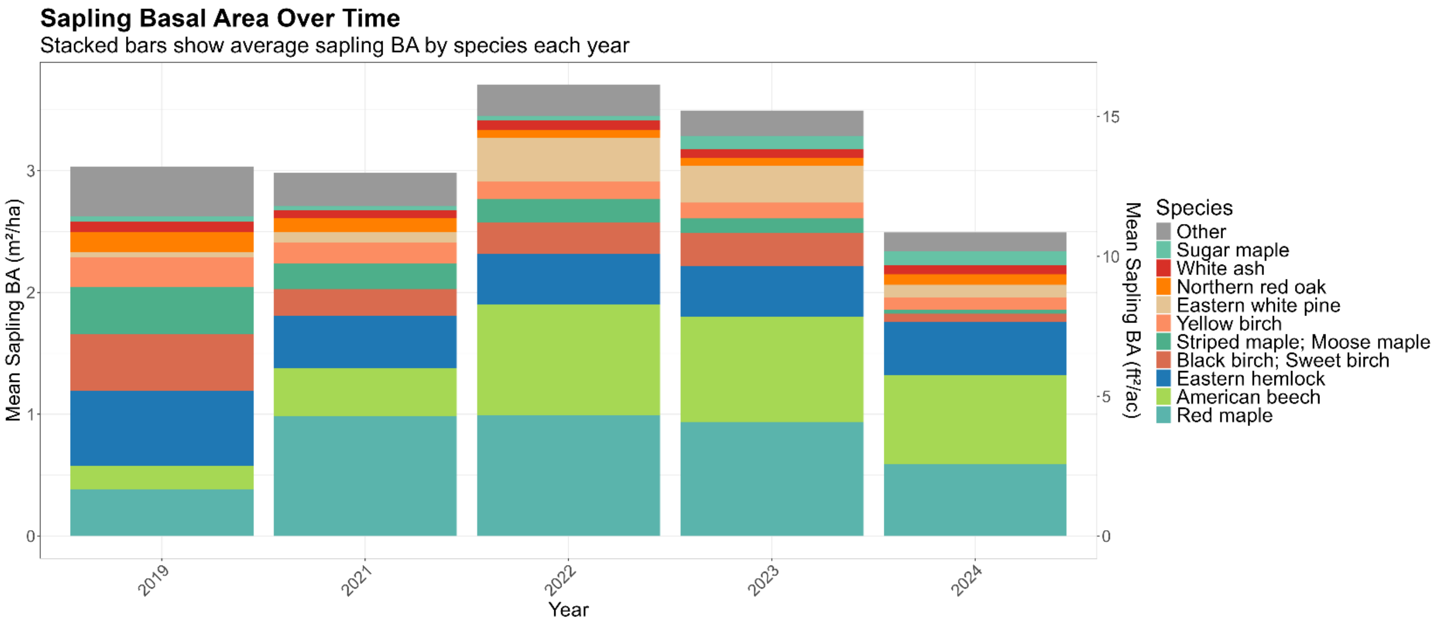

Figure 1F. Overall sapling basal area composition in hectares (m^2/ha, left axis) and acres (ft^2/ac, right axis) for all sapling species surveyed each year in Massachusetts. Species that ranked among the top ten for overall basal area are shown individually, while all species not in the top ten are combined and represented as "Other." This figure suggests which saplings are dominant or may be becoming more dominant in our plot network statewide.

Section 3. Seedling Analyses (Massachusetts)

We have included a seedling class size guide to assist with interpreting the figures in subgroup H.

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

G. Annual growth and mortality trends – Seedlings (Massachusetts)

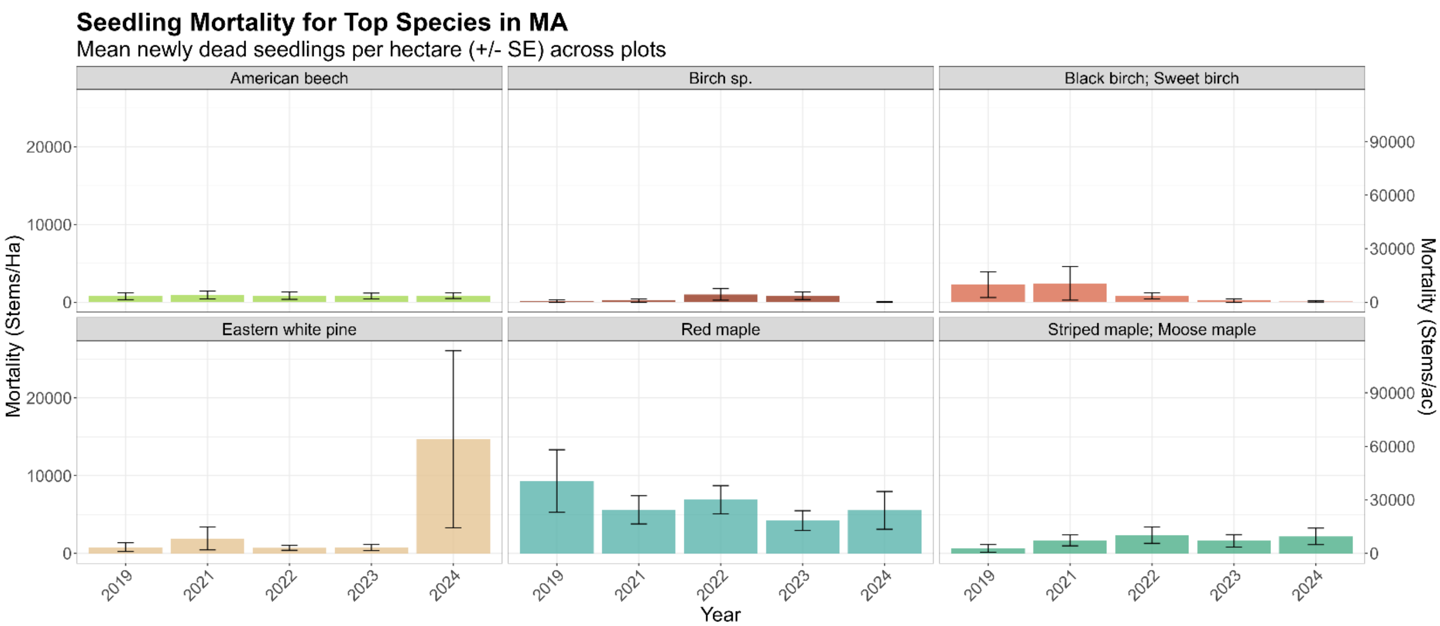

Figure 1G. The top six species showing the greatest mortality at the seedling stage in Massachusetts by stem count, presented by the mean number of seedlings transitioning from smaller to larger classes by stems per hectare (SPH, left axis) and acre (SPA, right axis) each year. While we do not record seedling mortality, we estimate based on reductions in seedling counts in our seedling sub-plots from one year to the next.

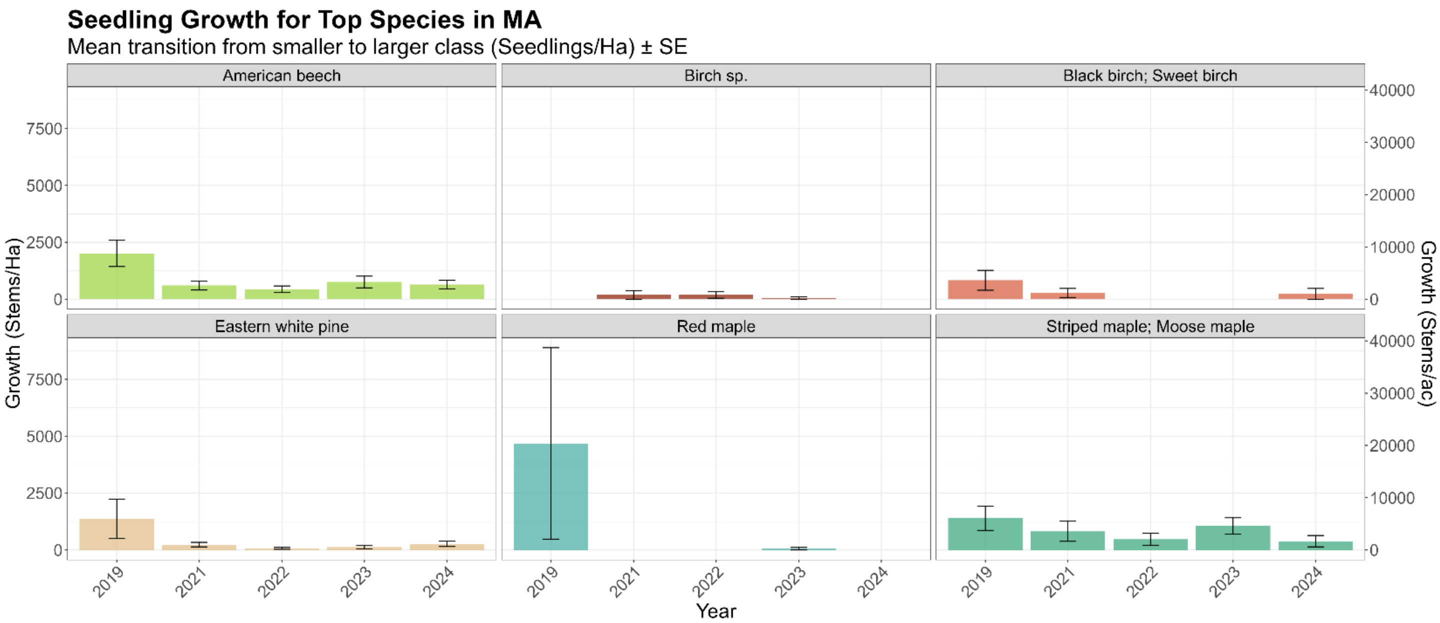

Figure 2G. The top six species showing the greatest growth at the seedling stage in Massachusetts by stem count, presented by the mean number of seedlings transitioning from smaller to larger classes by stems per hectare (SPH, left axis) and acre (SPA, right axis) each year.

H. Annual seedling density trends (Massachusetts)

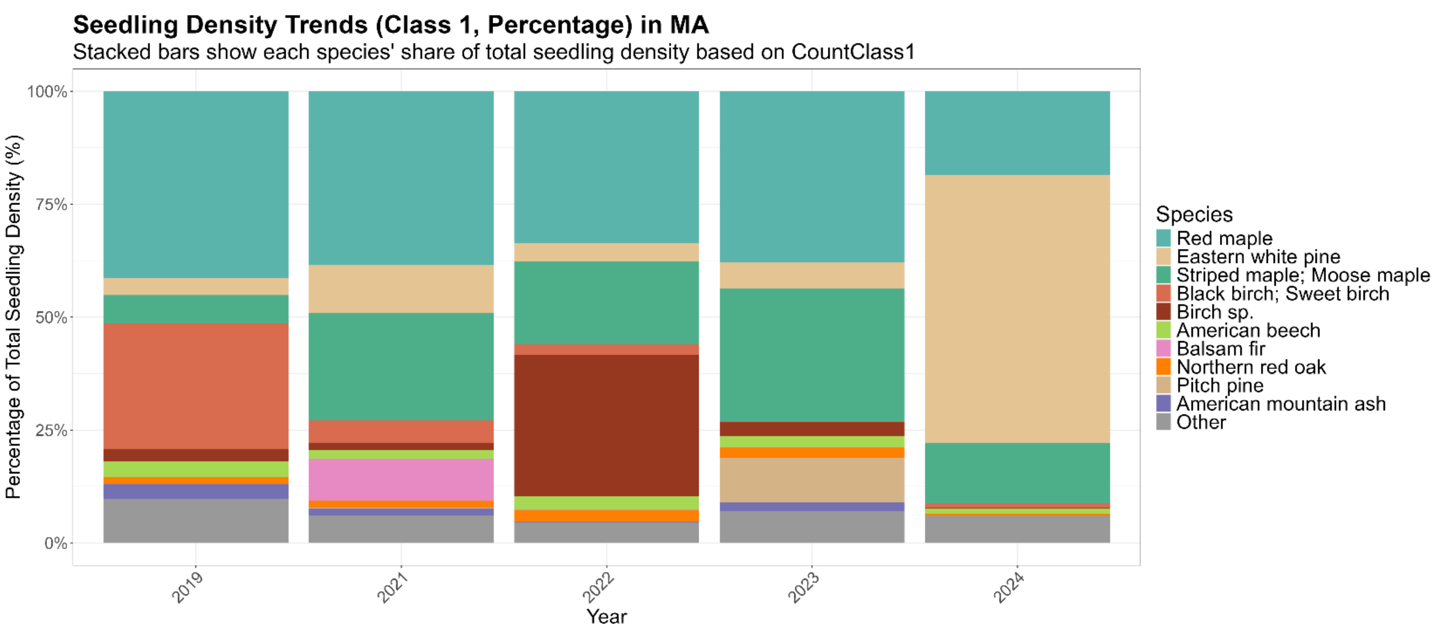

Figure 1H-i. Percent annual composition of Class 1 seedlings for all species surveyed each year in Massachusetts. The top ten most representated species by stem count are shown individually, while all other species not in the top ten are combined and represented as "Other." This figure suggests potential trends in changes in species composition within the seedling layer over time.

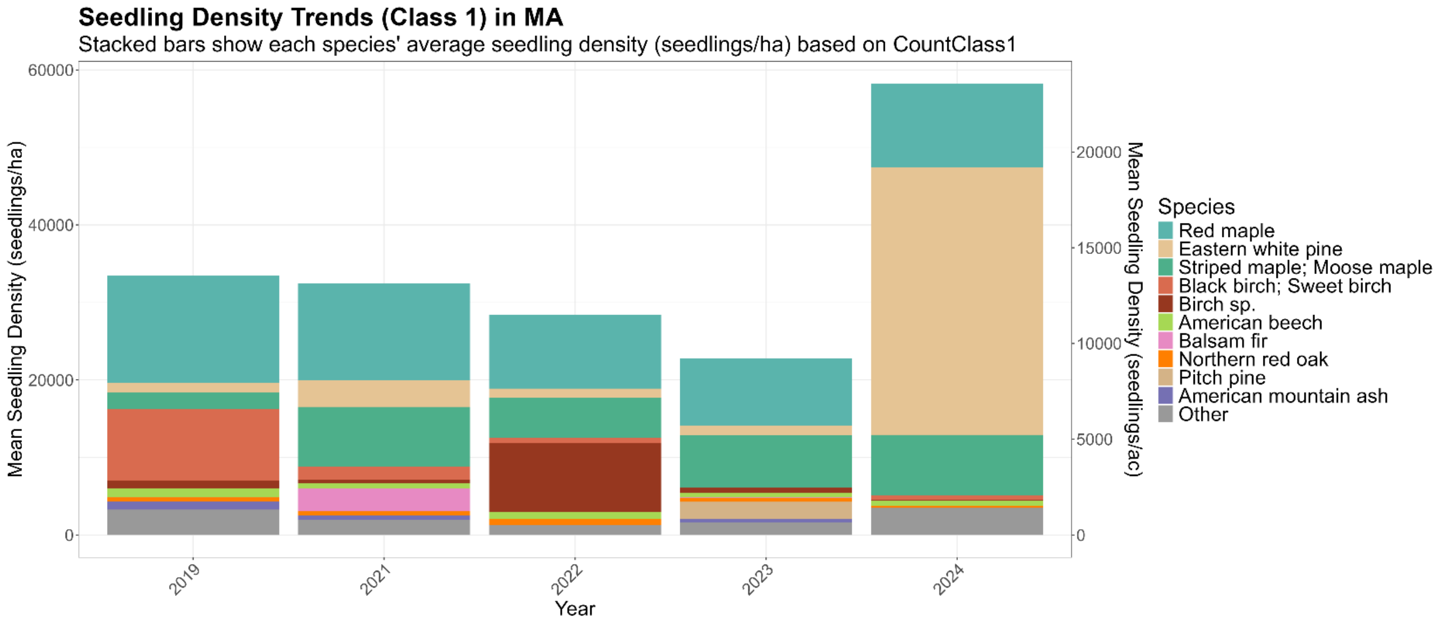

Figure 1H-ii. Class 1 seedling counts in stems per hectare (SPH, left axis) and acre (SPA, right axis) for all species surveyed each year in Massachusetts. The top ten most representated species by stem count are shown individually, while all species not in the top ten are combined and represented as “Other.” The overall bar height indicates total number of Class 1 seedlings per hectare and acre statewide for each year.

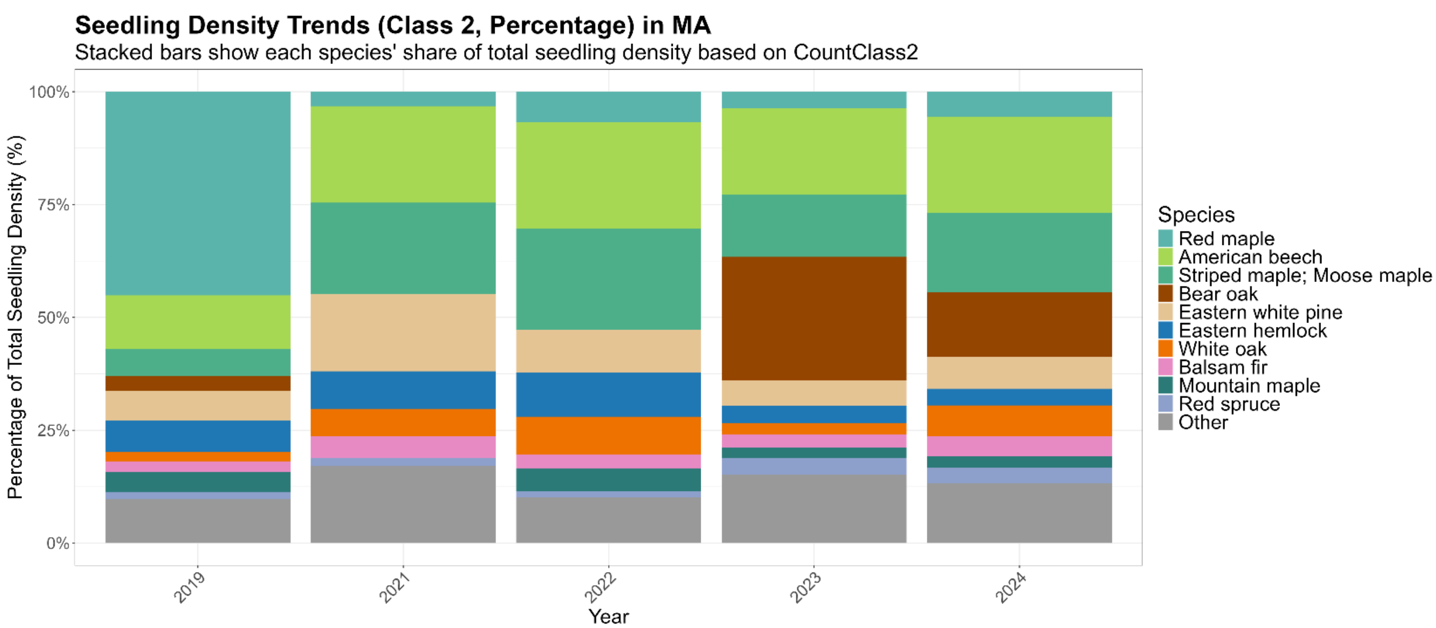

Figure 2H-i. Percent annual composition of Class 2 seedlings surveyed each year in Massachusetts. The top ten most representated species by stem count are shown individually, while all species not in the top ten are combined and represented as “Other.”

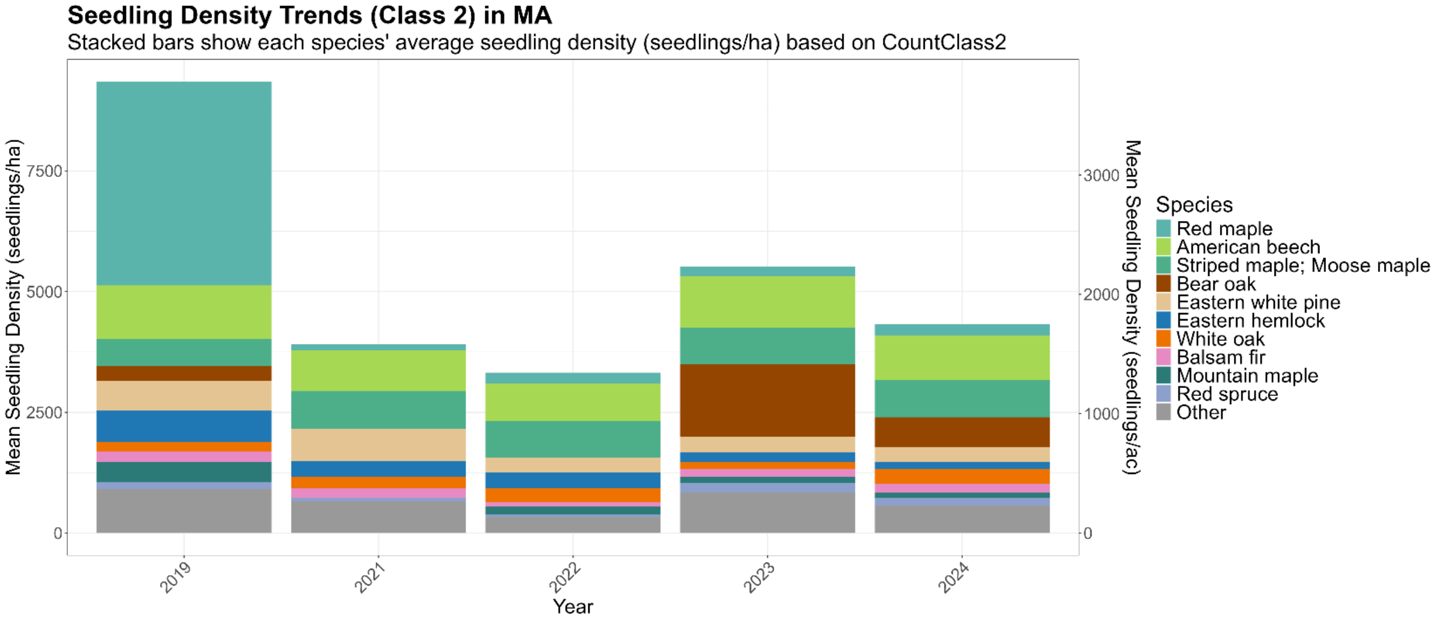

Figure 2H-ii. Class 2 seedling counts in stems per hectare (SPH, left axis) and acre (SPA, right axis) for all species surveyed each year in Massachusetts. The top ten most representated species by stem count are shown individually, while all species not in the top ten are combined and represented as "Other." The overall bar height indicates total number of Class 2 seedlings per hectare and acre statewide for each year.

Maine

Section 1. Tree Analyses (Maine)

A. *Dieback trends (Maine)*

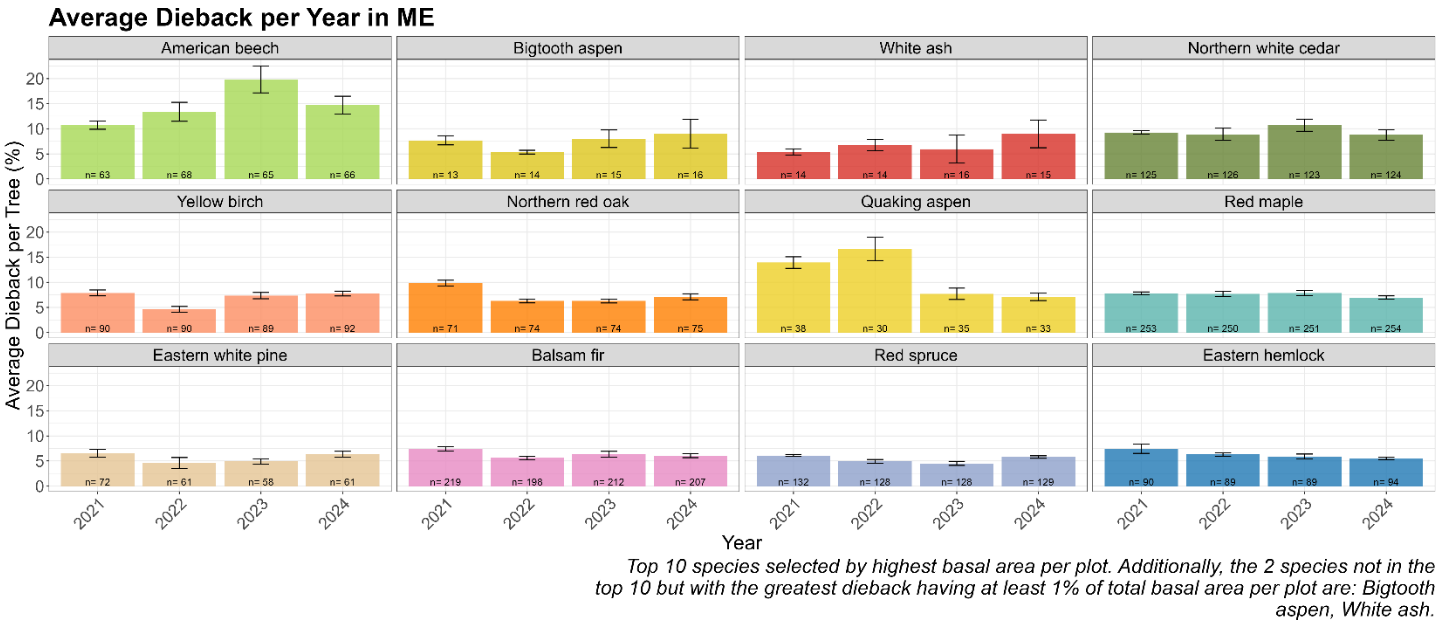

Figure 1A. Maine average fine twig dieback trends by species and year for the top ten species by basal area, plus two that are less prevalent by basal area but are nonetheless showing high dieback (bigtooth aspen and white ash). Species are ordered by highest dieback in 2024.

B. *Transparency trends (Maine)*

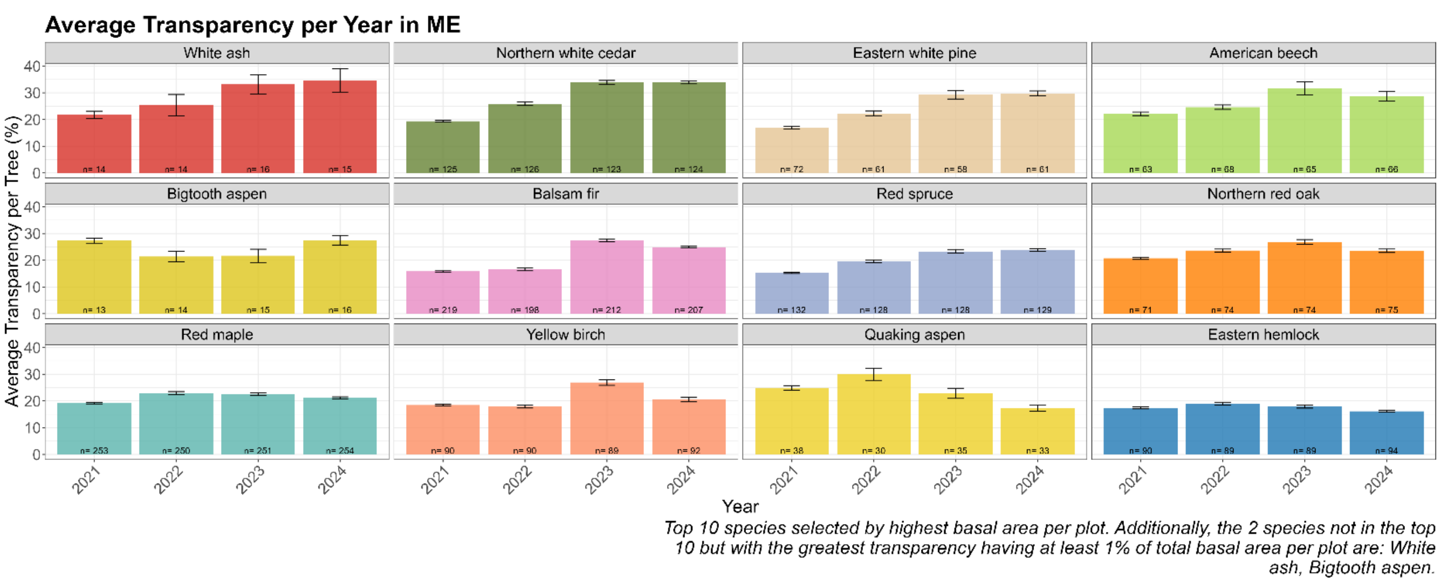

Figure 1B. Maine average leaf transparency trends by species and year, for the top ten species by basal area plus two that are less prevalent by basal area but are nonetheless showing high transparency (white ash, bigtooth aspen). Species are ordered by greatest transparency in 2024.

C. Vigor trends (Maine)

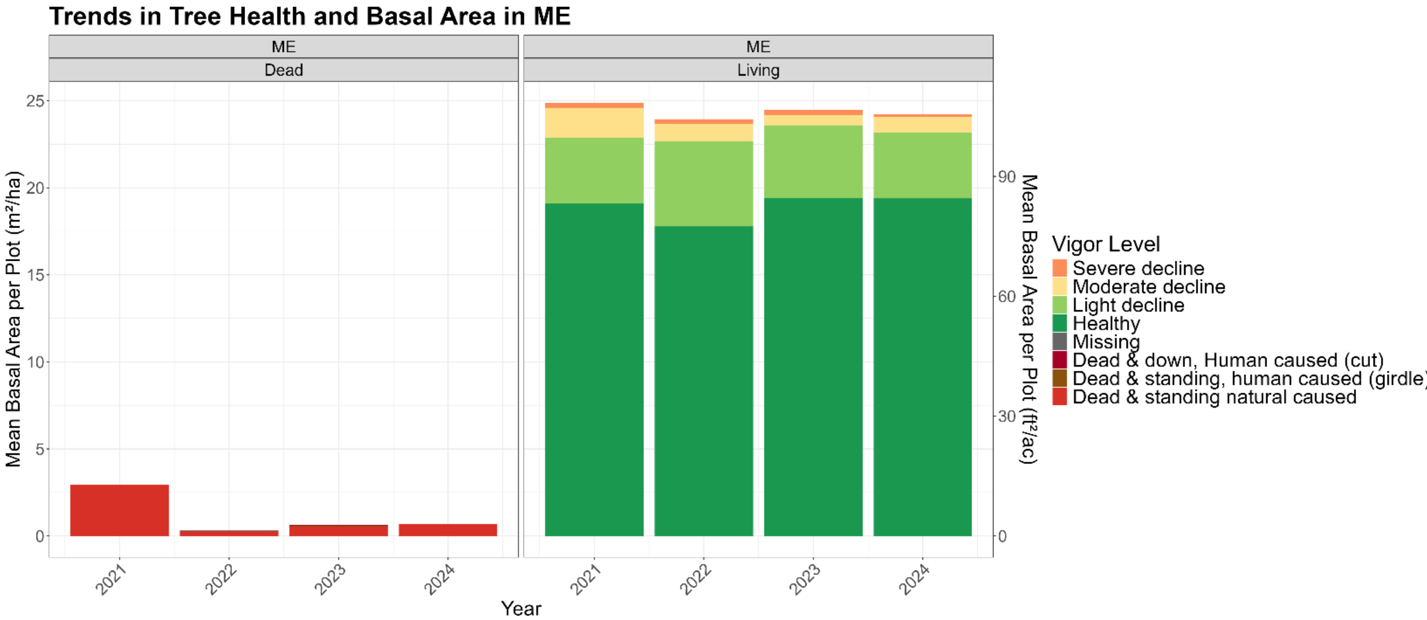

Figure 1C. Mean basal area per plot in hectares (m^2/ha, left axis) and acres (ft^2/ac, right axis) for living and dead trees in Maine. Data is grouped by tree status with living classes shown on the right and dead classes on the left.

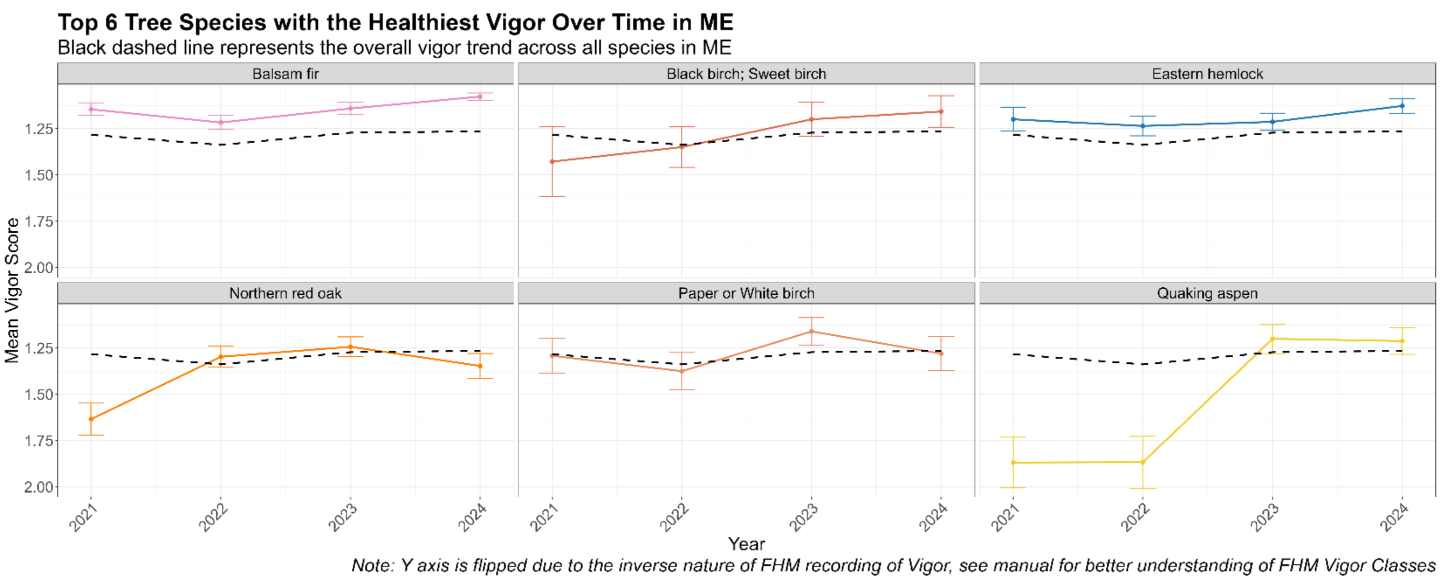

Figure 2C. Top six tree species with the healthiest vigor (lowest stress levels) over time in Maine among species comprising at least 0.5% of total basal area statewide. Vigor scores range from 4 (severe decline) to 1 (healthy), with intermediate values for trees in decline. The dashed black line represents the overall vigor trend across all species sampled within the state, providing a reference for general forest condition changes. 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.

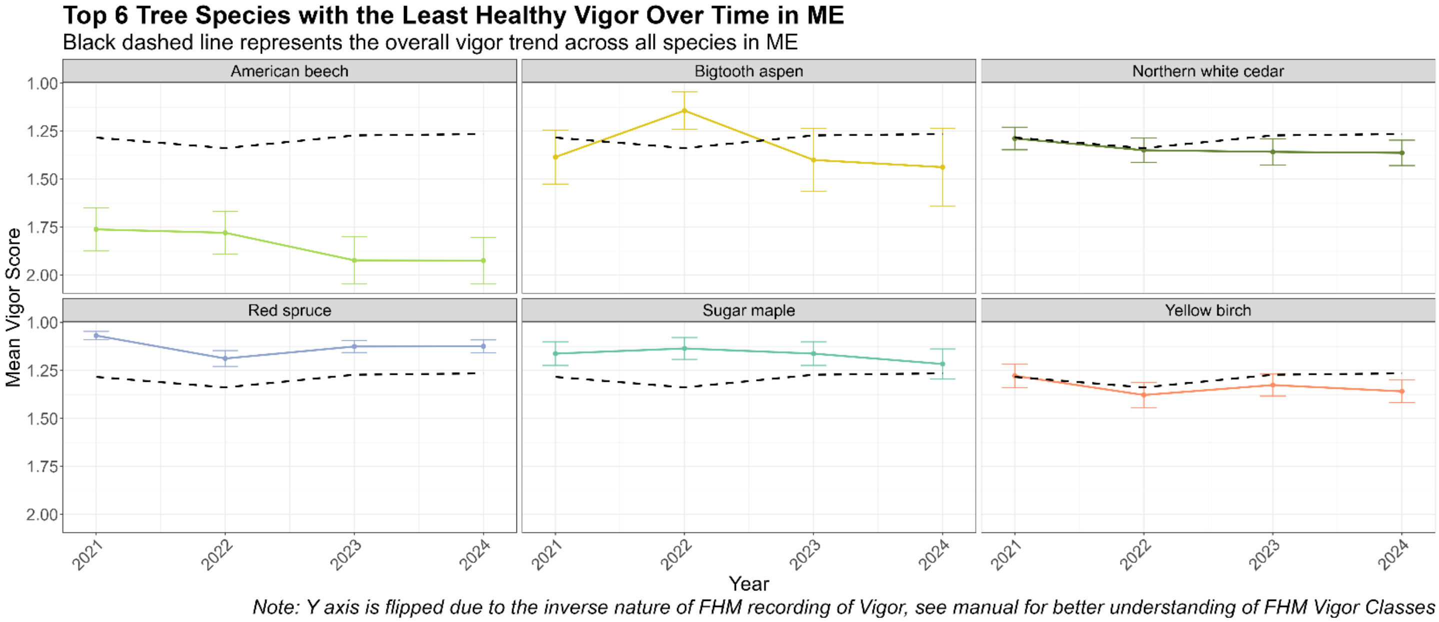

Figure 3C. Top six tree species with the greatest decline in vigor (highest stress levels) over time in Maine among species comprising at least 0.5% of total basal area statewide. Vigor scores range from 4 (severe decline) to 1 (healthy), with intermediate values for trees in decline. The dashed black line represents the overall vigor trend across all species sampled within the state, enabling a broader forest health comparison. 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.

D. Annual growth and mortality Trends – Trees (Maine)

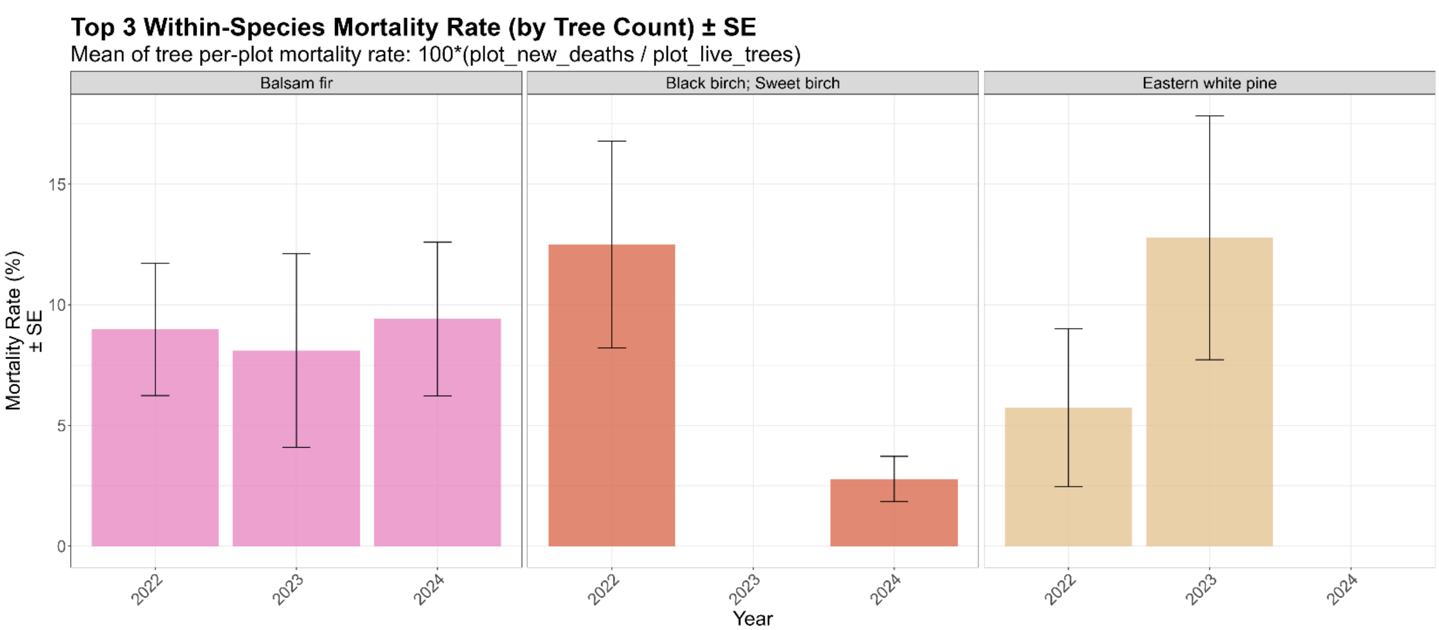

Figure 1D. Within-species mortality trends in Maine for the top three tree species with the highest number of newly dead trees among species comprising more than 1% of total basal area statewide. This plot shows the annual number of newly dead trees per species, based on individual tree tracking using unique tree identifiers. 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. This metric reflects the percentage of individual trees transitioning from living to dead within their total species' samples statewide.

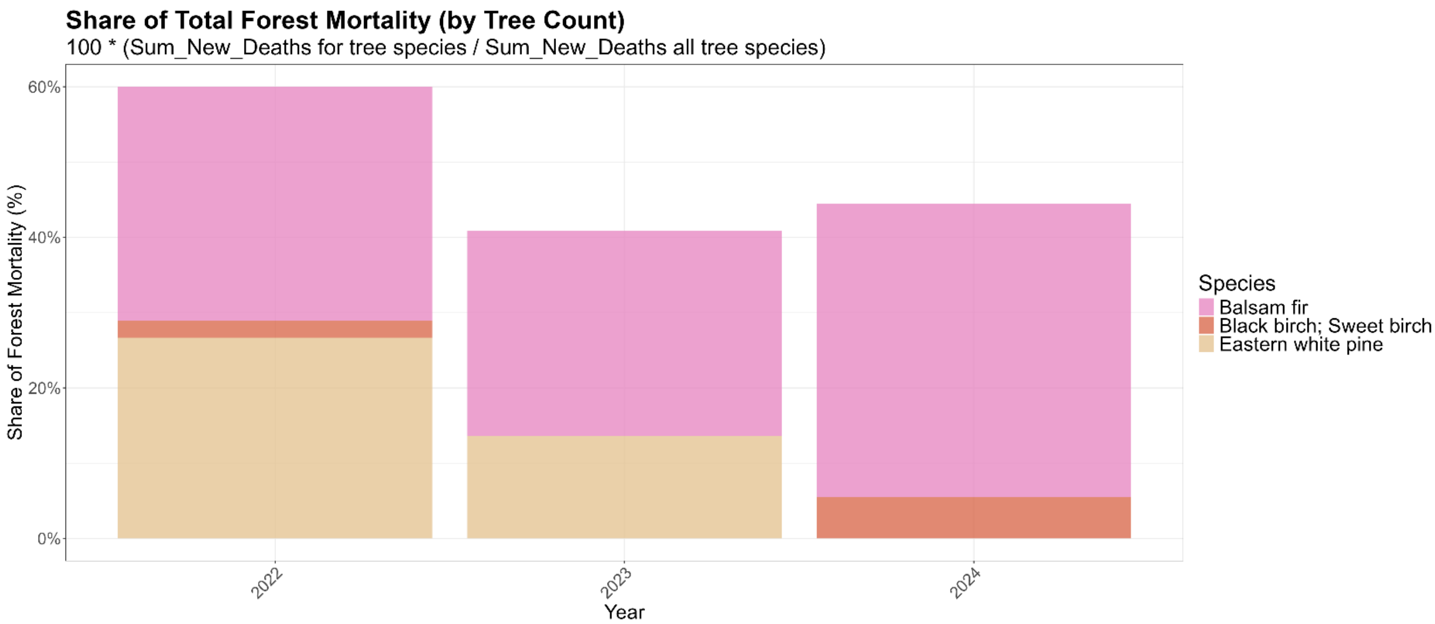

Figure 2D. Share of total forest mortality trends in Maine for the top three species with the highest number of newly dead trees, relative to all newly reported tree deaths across all species comprising more than 1% of total basal area statewide.

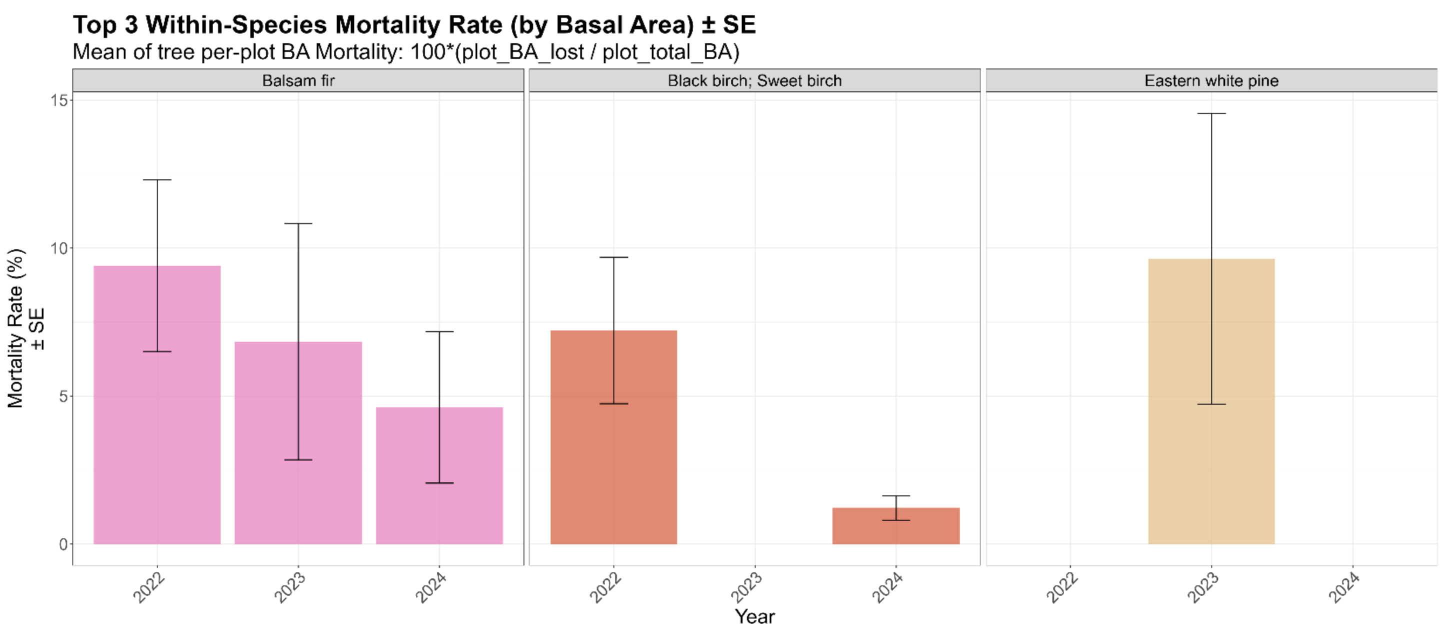

Figure 3D. Within-species mortality trends by basal area in Maine for the top three species with the greatest total basal area loss among species comprising more than 1% of total basal area statewide, calculated as the sum of the last recorded basal area of all trees within a given species that transitioned from living to dead each year. Instead of simply accounting for the number of dead trees, basal area loss accounts for tree size, providing a different perspective on the impact to forest structure.

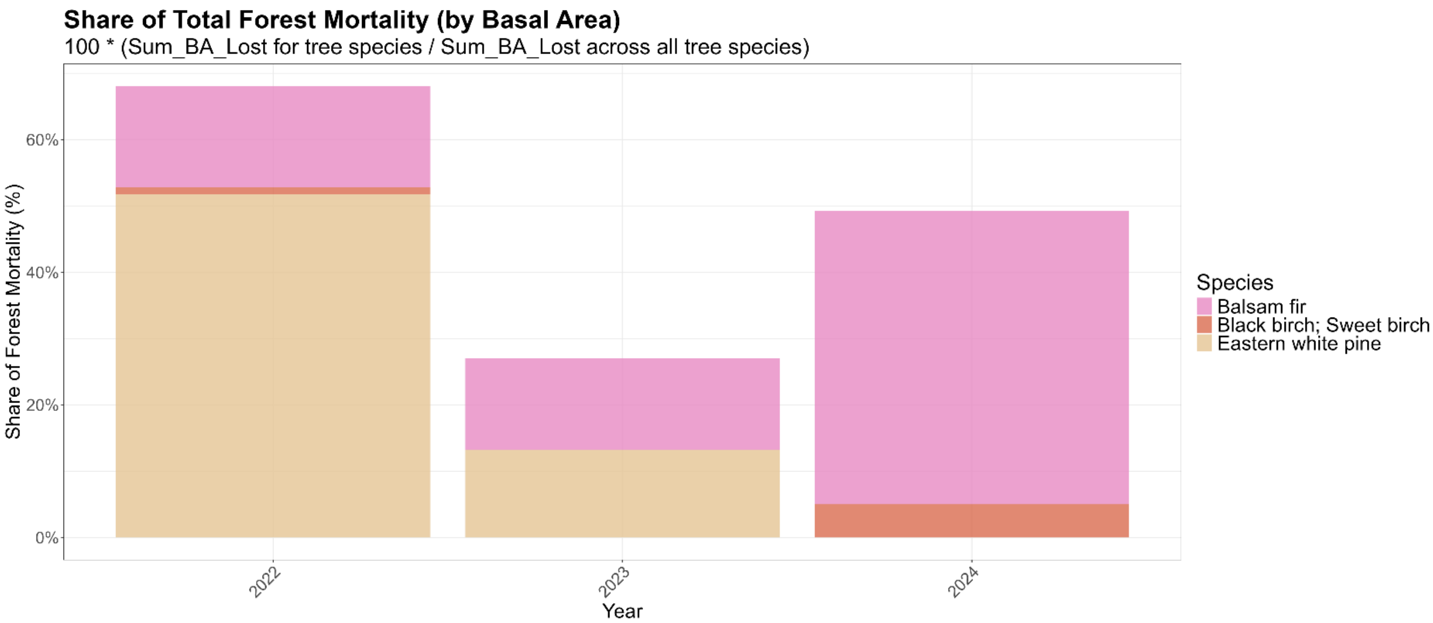

Figure 4D. Share of total lost basal area in Maine for the top three species with the greatest basal area loss due to mortality, among species comprising more than 1% of total basal area statewide.

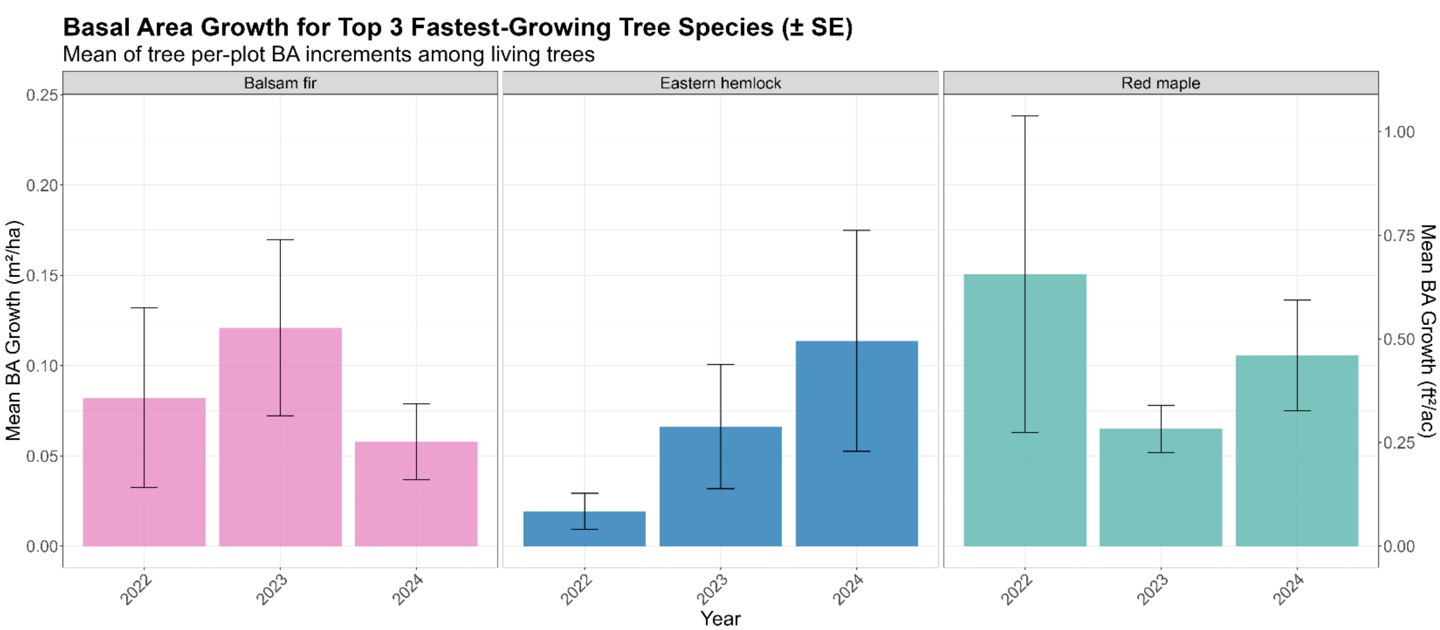

Figure 5D. Top three species with the greatest average basal area growth in Maine. Bars represent the mean basal area increment in hectares (m^2/ha, left axis) and acres (ft^2/ac, right axis) each year. These growth trends illustrate which species are adding basal area the fastest, which may be related to species vigor and competitive advantage and has longer-term implications for stand development and forest composition.

E. Total composition – Trees (Maine)

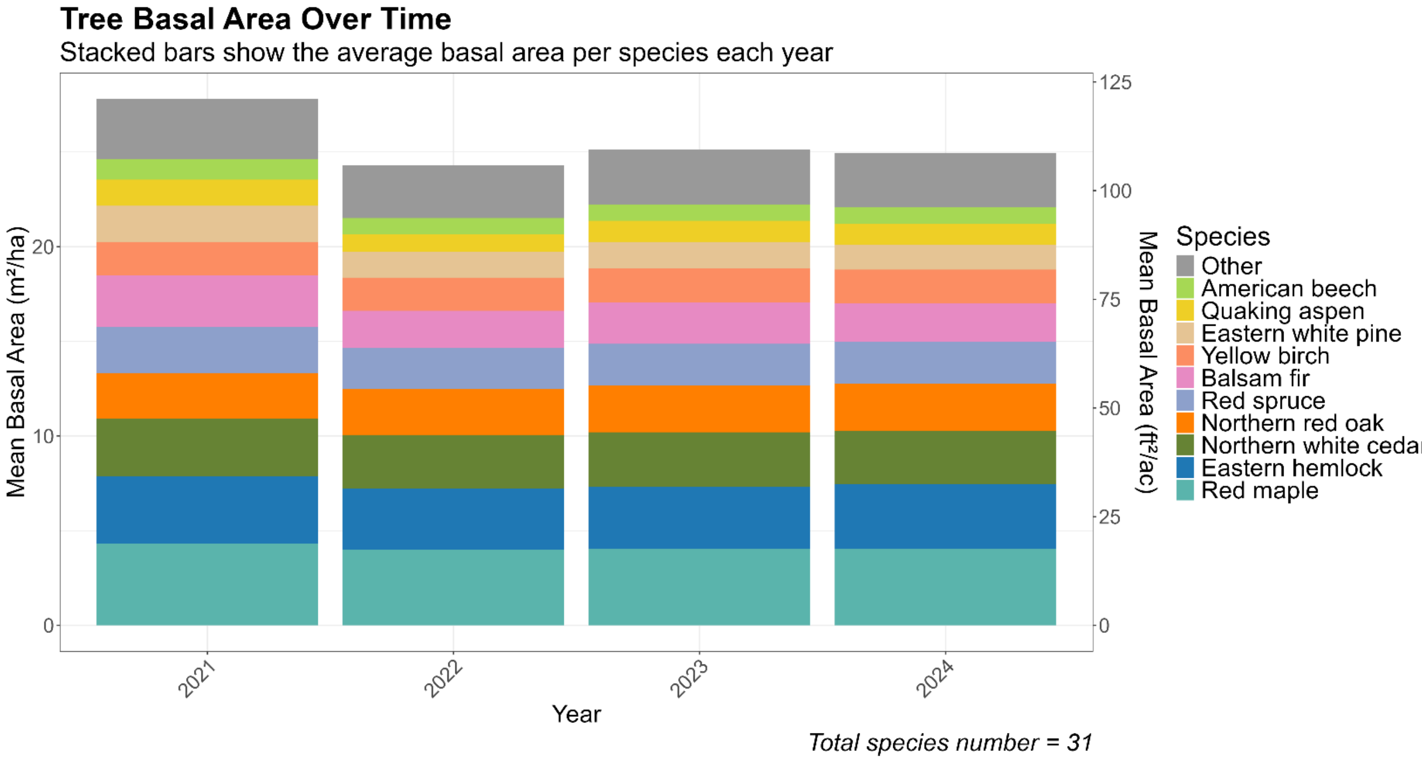

Figure 1E. Overall species composition by average live basal area in hectares (m^2/ha, left axis) and acres (ft^2/ac, right axis) across all tree species surveyed each year in Maine. Species that ranked among the top ten for overall basal area are shown individually, while all species not in the top ten are combined and represented as "Other." This figure suggests which tree species are dominant or may be becoming more dominant in overall forest composition.

Section 2. Sapling Analyses (Maine)

F. Total composition – Saplings (Maine)

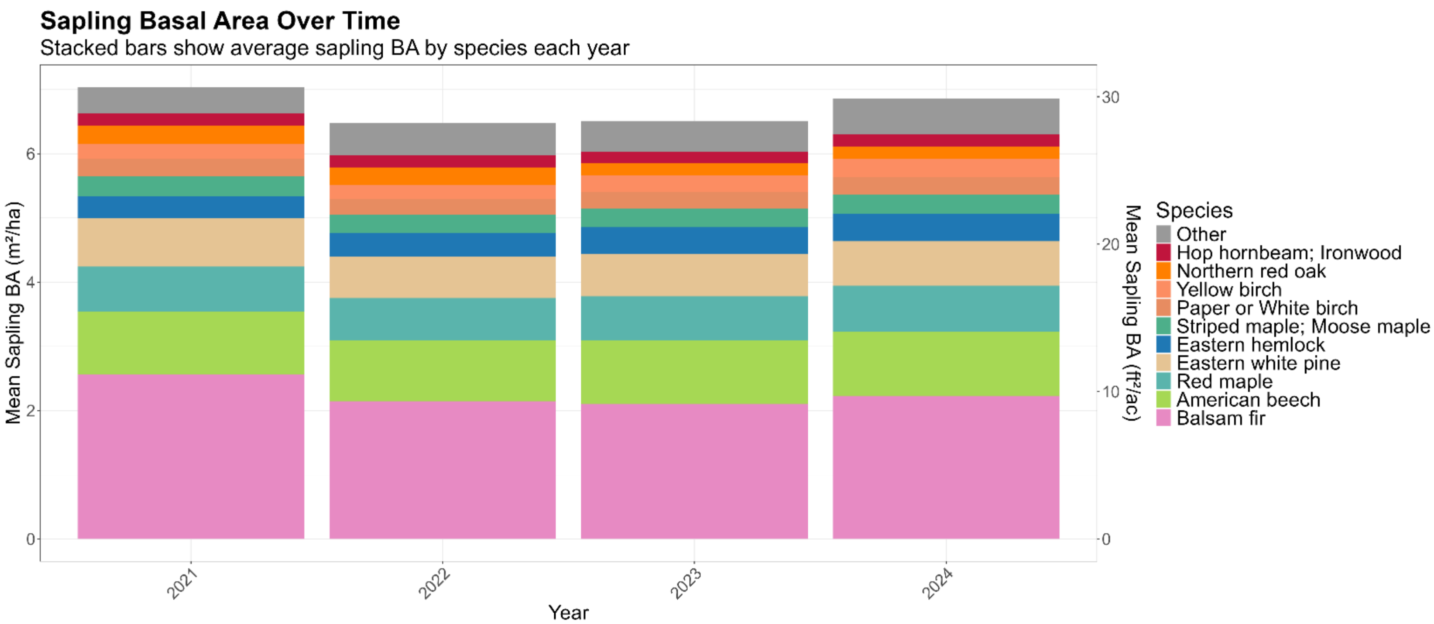

Figure 1F. Overall sapling basal area composition in hectares (m^2/ha, left axis) and acres (ft^2/ac, right axis) for all sapling species surveyed each year in Maine. Species that ranked among the top ten for overall basal area are shown individually, while all species not in the top ten are combined and represented as "Other." This figure suggests which saplings are dominant or may be becoming more dominant in our plot network statewide.

Section 3. Seedling Analyses (Maine)

We have included a seedling class size guide to assist with interpreting figures in subgroup H.

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

G. Annual growth and mortality trends – Seedlings (Maine)

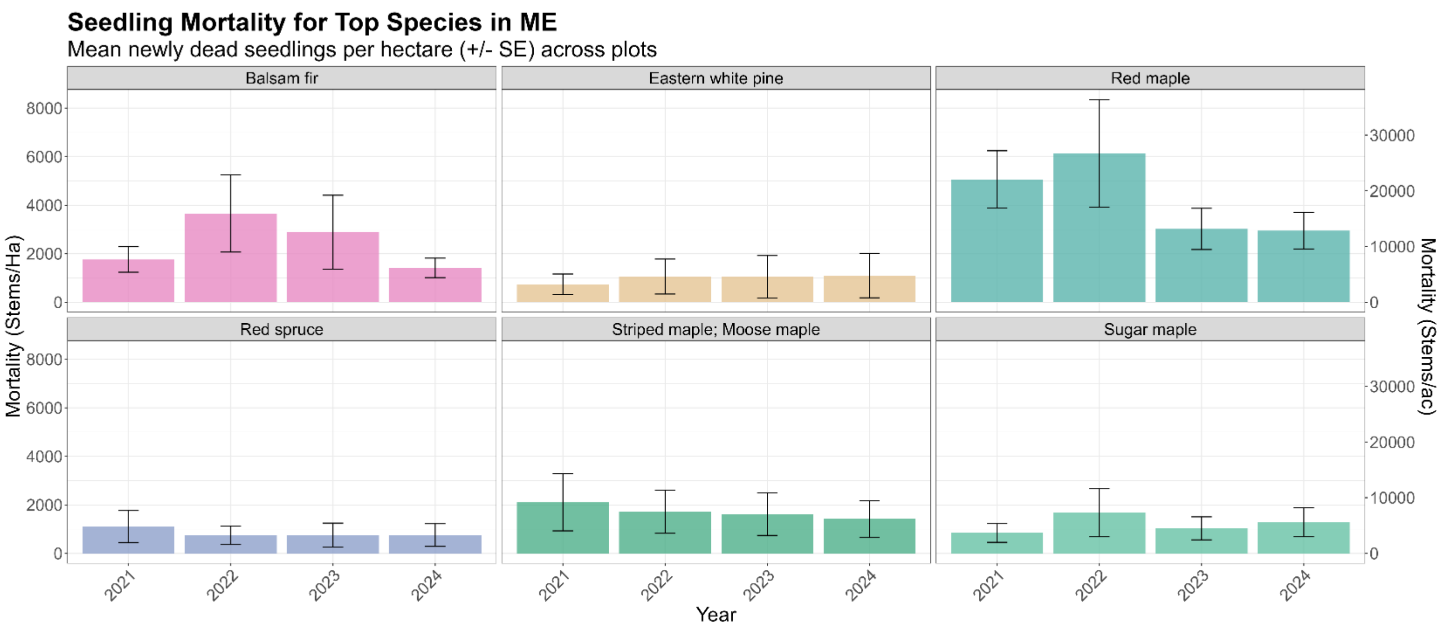

Figure 1G. The top six species showing the greatest mortality at the seedling stage in Maine by stem count, presented by the mean number of seedlings transitioning from smaller to larger classes by stems per hectare (SPH, left axis) and acre (SPA, right axis) each year. While we do not record seedling mortality, we estimate based on reductions in seedling counts in our seedling sub-plots from one year to the next.

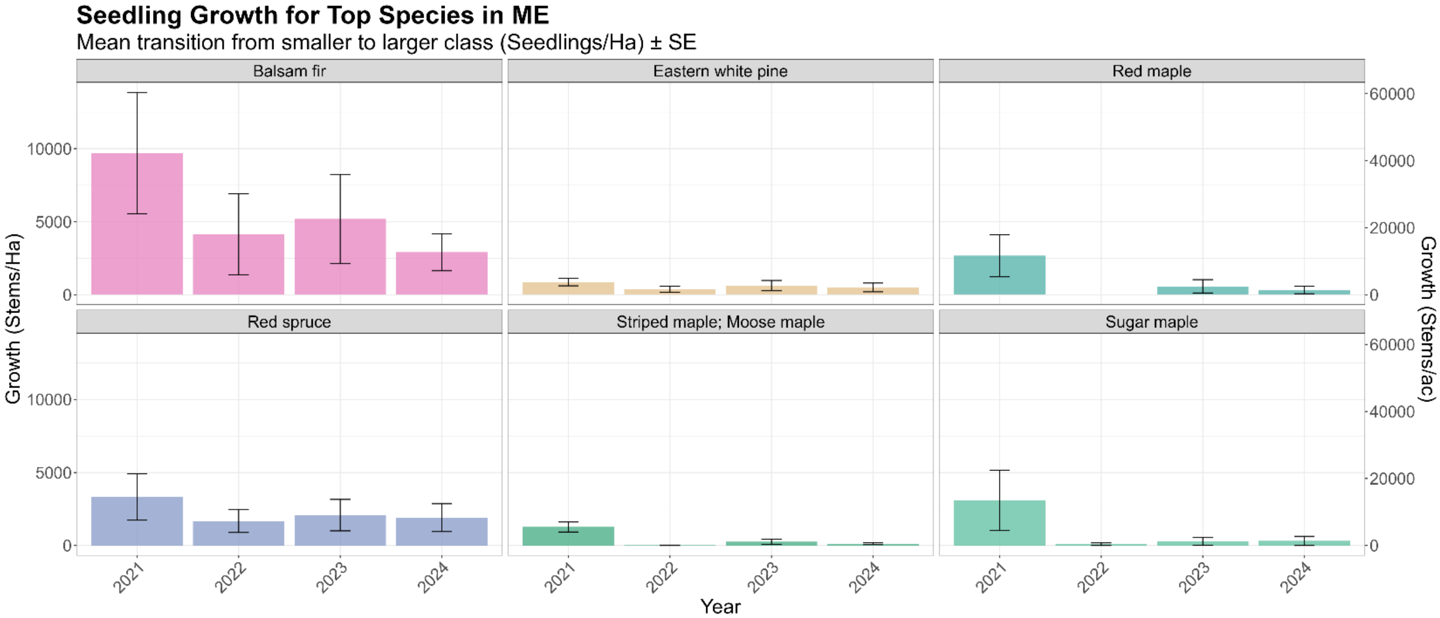

Figure 2G. The top six species showing the greatest growth at the seedling stage in Maine by stem count, presented by the mean number of seedlings transitioning from smaller to larger classes by stems per hectare (SPH, left axis) and acre (SPA, right axis) each year.

H. Annual seedling density trends (Maine)

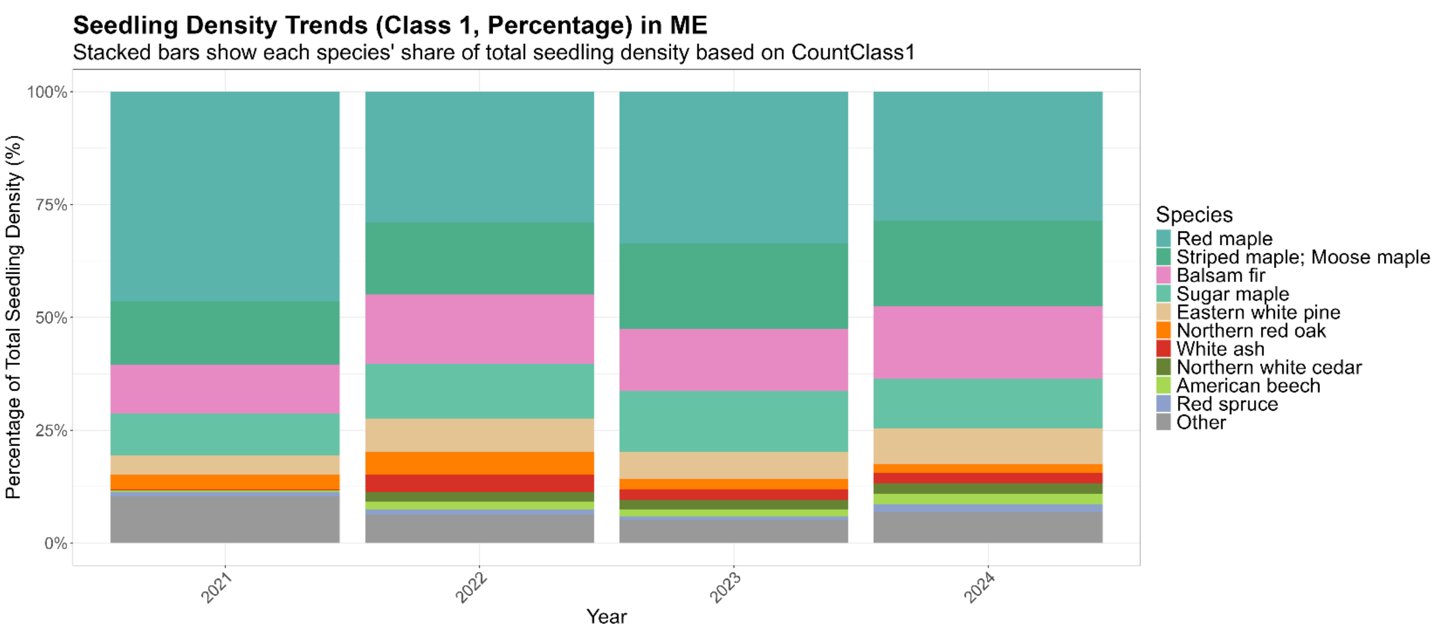

Figure 1H-i. Percent annual composition of Class 1 seedlings for all species surveyed each year in Maine. The top ten most represented species by stem count are shown individually, while all other species not in the top ten are combined and represented as "Other." This figure suggests potential trends in changes in species composition within the seedling layer over time.

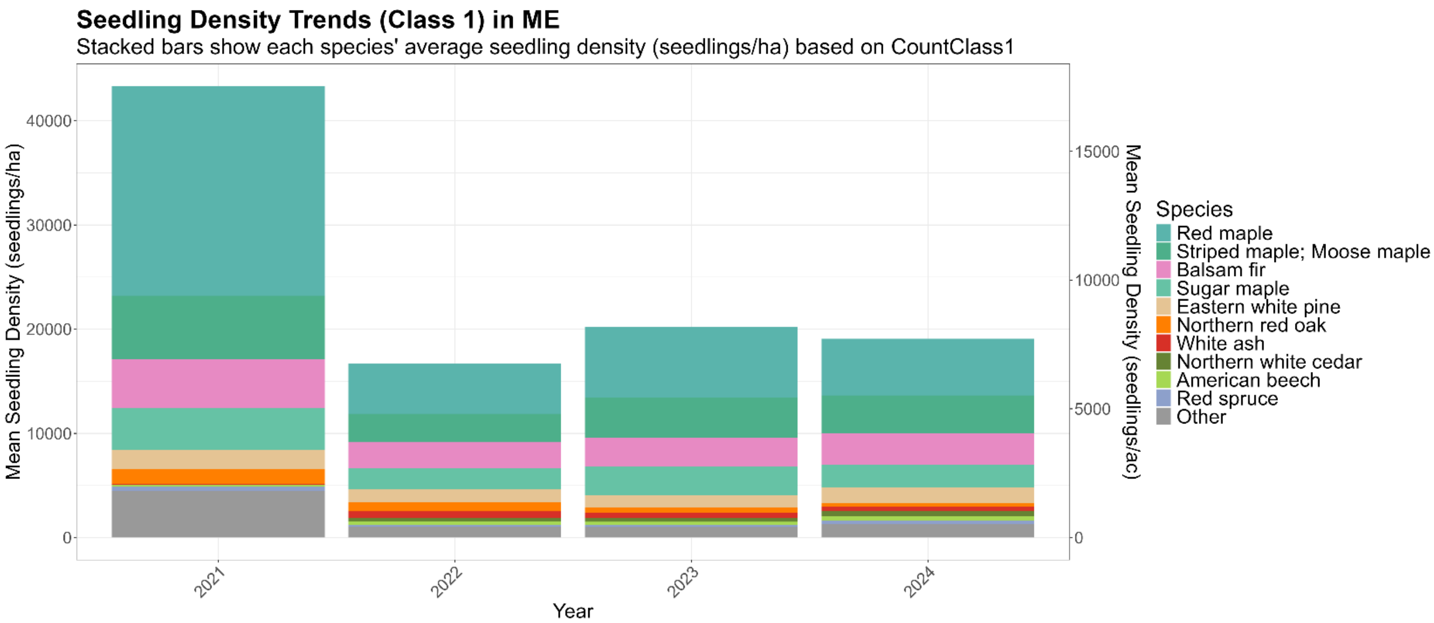

Figure 1H-ii. Class 1 seedling counts in stems per hectare (SPH, left axis) and acre (SPA, right axis) for all species surveyed each year in Maine. The top ten most represented species by stem count are shown individually, while all species not in the top ten are combined and represented as “Other.” The overall bar height indicates total number of Class 1 seedlings per hectare and acre statewide for each year.

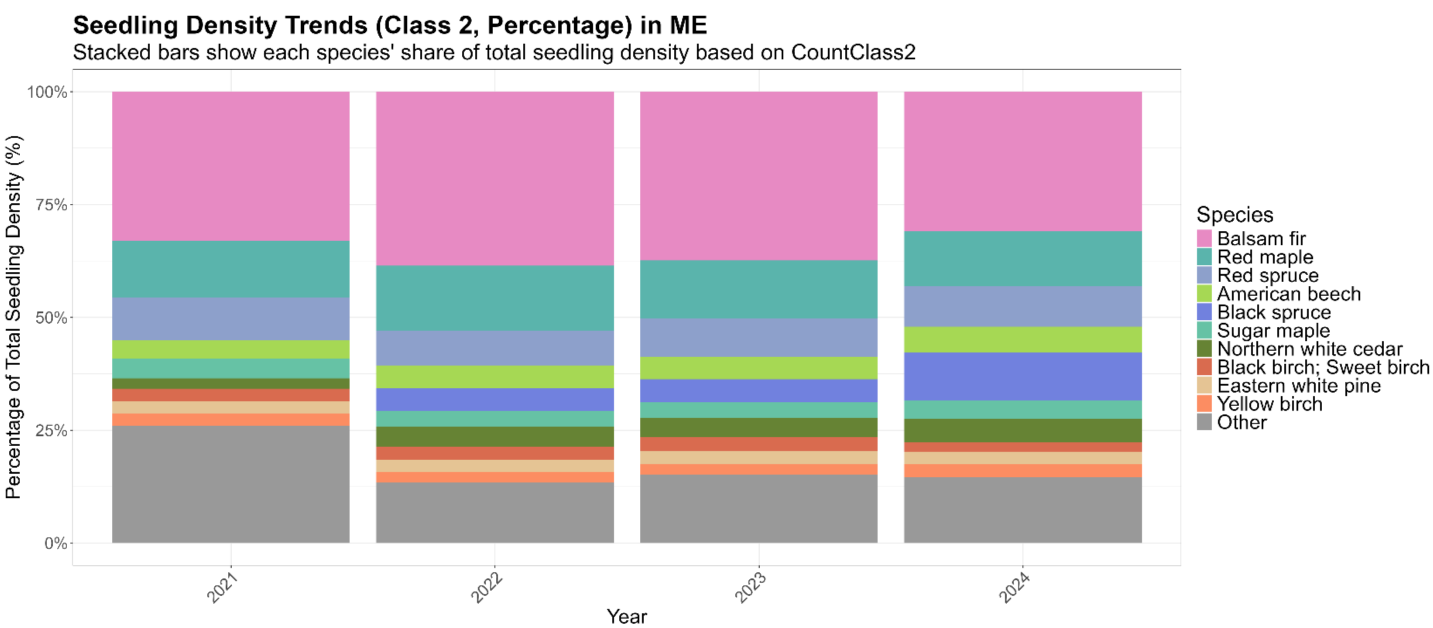

Figure 2H-i. Percent annual composition of Class 2 seedlings surveyed each year in Maine. The top ten most represented species by stem count are shown individually, while all species not in the top ten are combined and represented as “Other.”

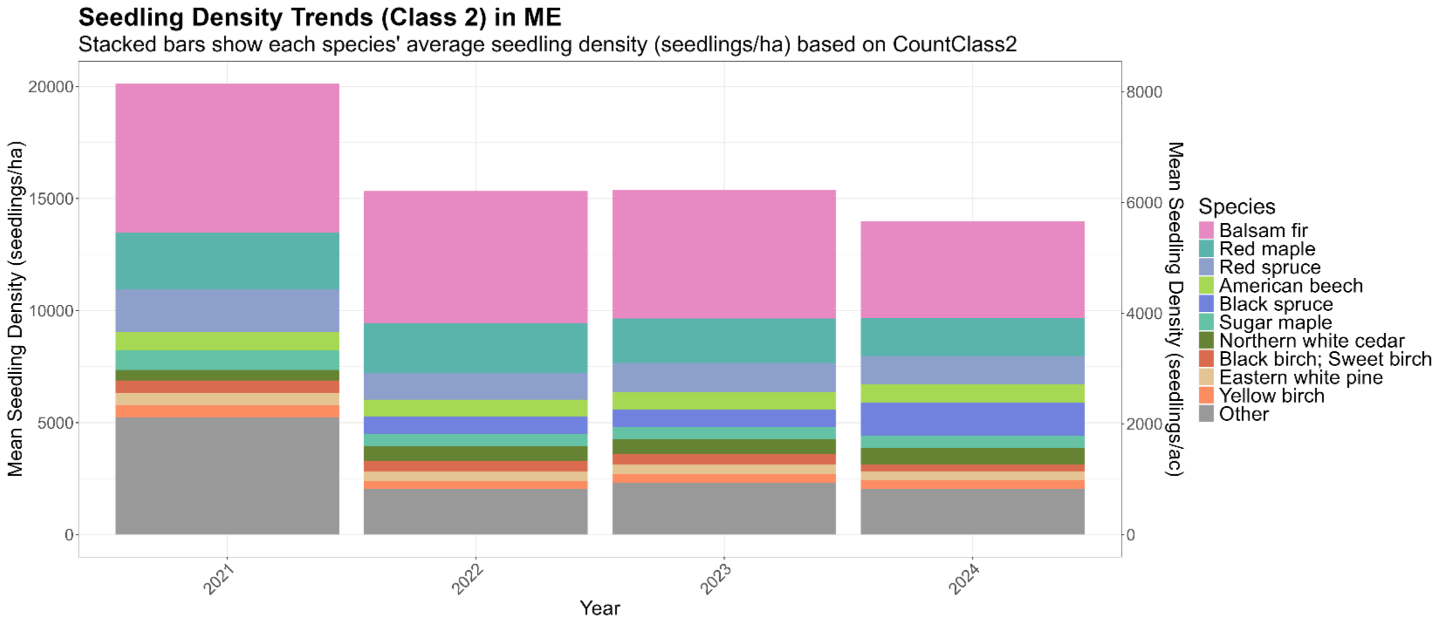

Figure 2H-ii. Class 2 seedling counts in stems per hectare (SPH, left axis) and acre (SPA, right axis) for all species surveyed each year in Maine. The top ten most represented species by stem count are shown individually, while all species not in the top ten are combined and represented as “Other.” The overall bar height indicates total number of Class 2 seedlings per hectare and acre statewide for each year.

New Hampshire

Section 1. Tree Analyses (New Hampshire)

A. *Dieback trends (New Hampshire)*

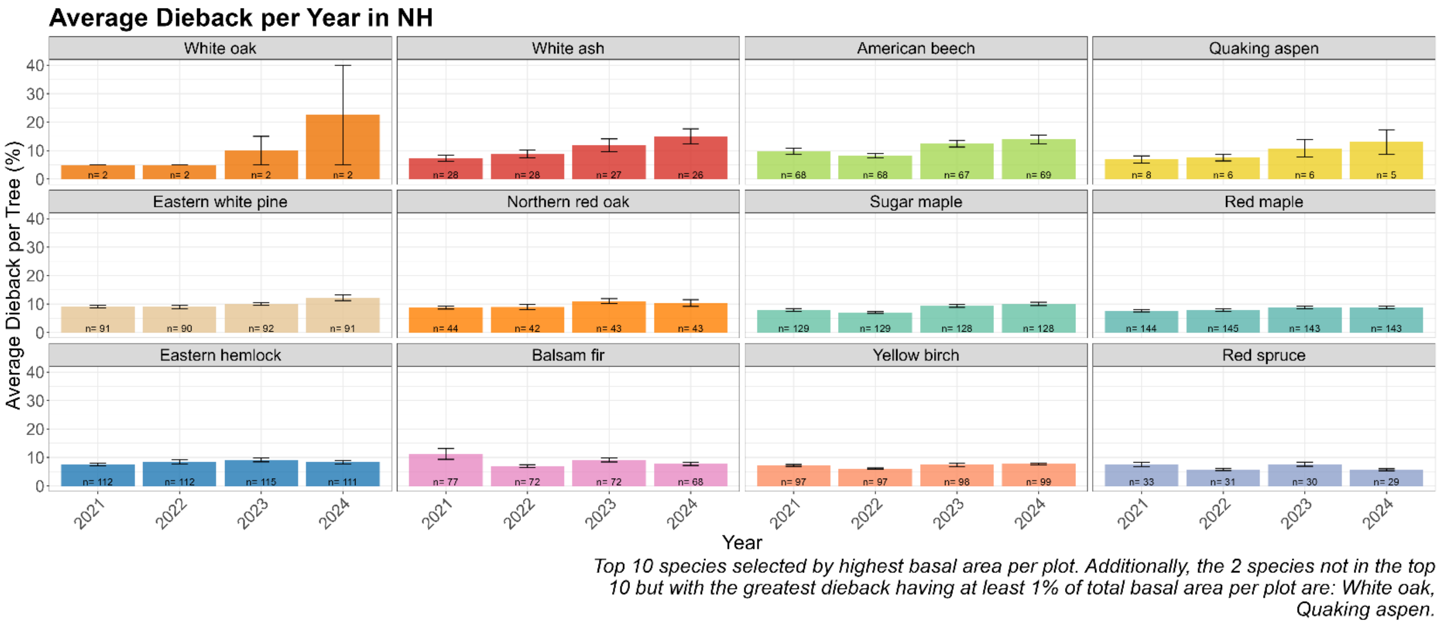

Figure 1A. New Hampshire average fine twig dieback trends by species and year for the top ten species by basal area, plus two that are less prevalent by basal area but are nonetheless showing high dieback (white oak, quaking aspen). Species are ordered by highest dieback in 2024.

B. *Transparency trends (New Hampshire)*

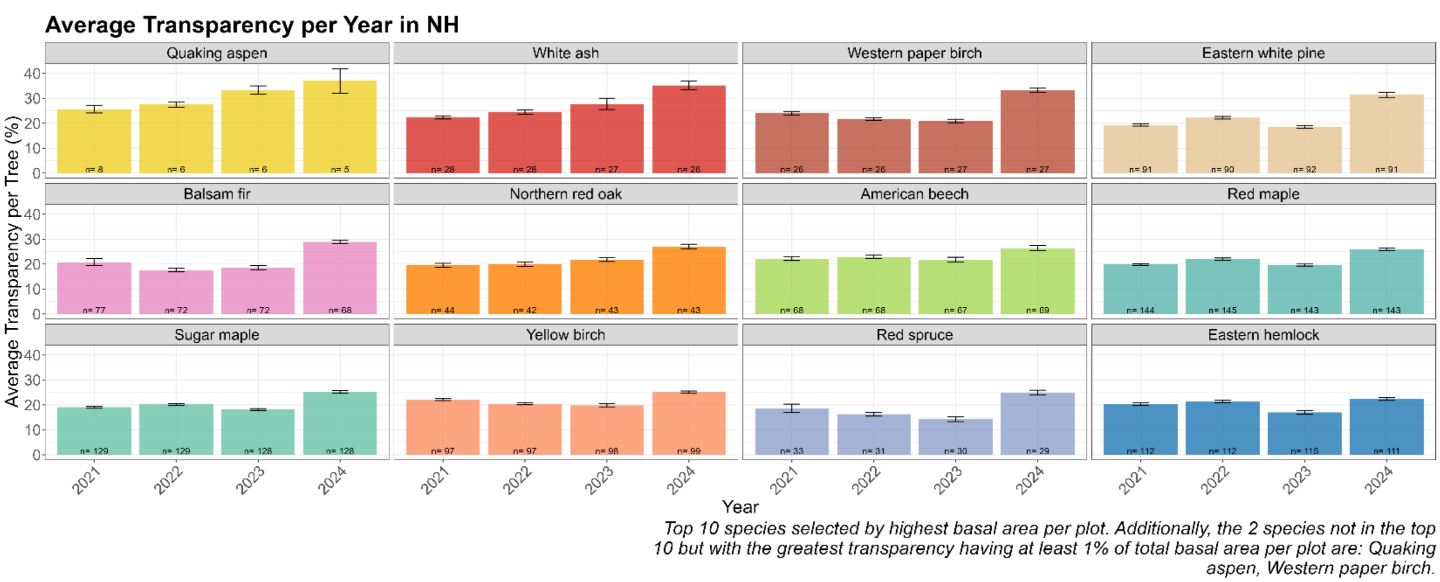

Figure 1B. New Hampshire average leaf transparency trends by species and year, for the top ten species by basal area plus two that are less prevalent by basal area but are nonetheless showing high transparency (quaking aspen, Western paper birch). Species are ordered by greatest transparency in 2024.

C. Vigor trends (New Hampshire)

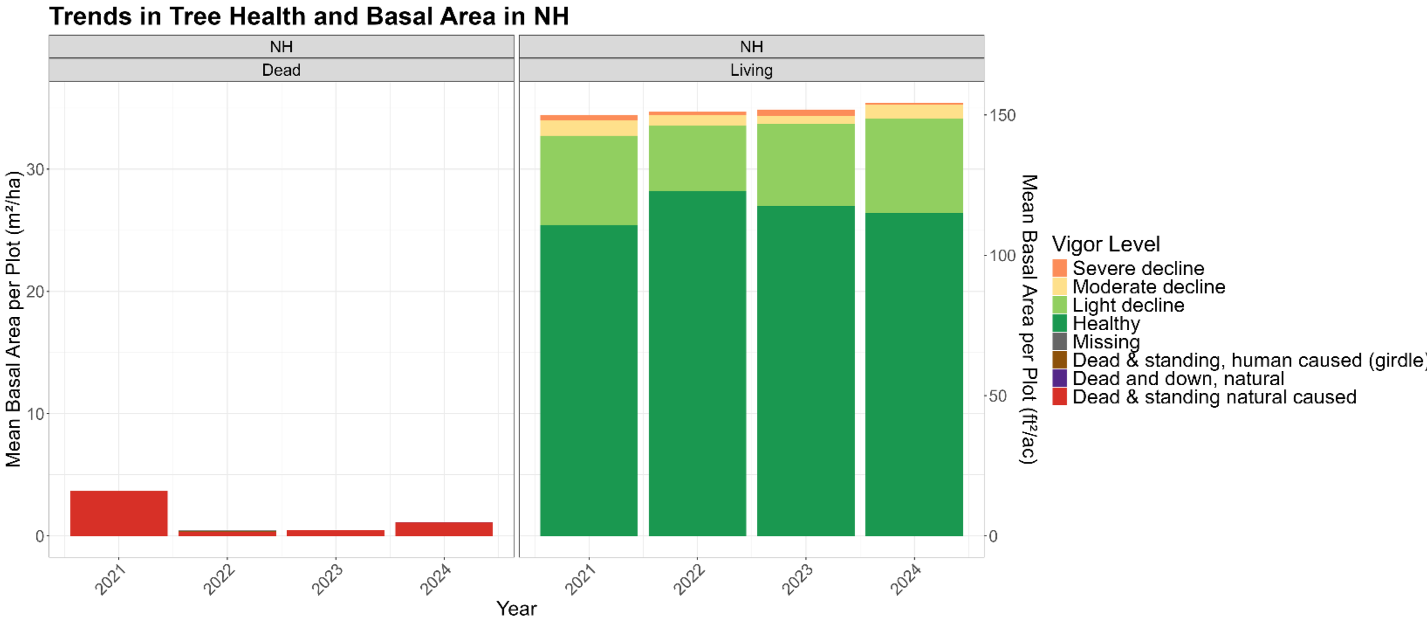

Figure 1C. Mean basal area per plot in hectares (m^2/ha, left axis) and acres (ft^2/ac, right axis) for living and dead trees in New Hampshire. Data is grouped by tree status with living classes shown on the right and dead classes on the left.

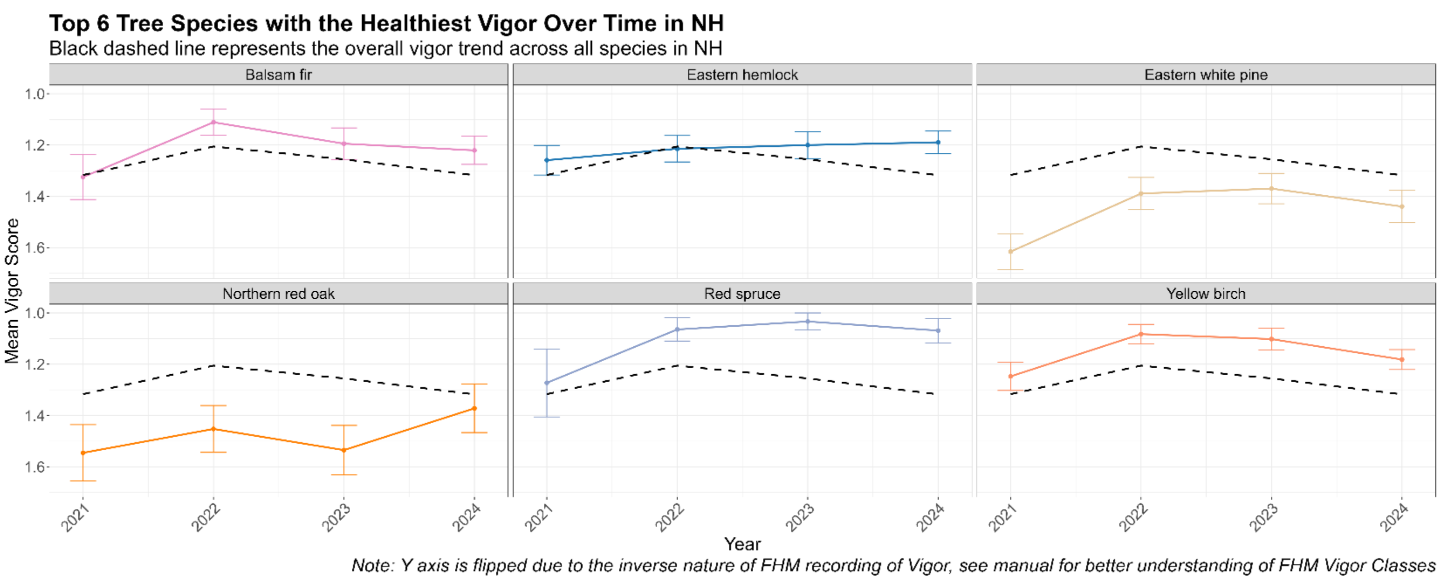

Figure 2C. Top six tree species with the healthiest vigor (lowest stress levels) over time in New Hampshire among species comprising at least 0.5% of total basal area statewide. Vigor scores range from 4 (severe decline) to 1 (healthy), with intermediate values for trees in decline. The dashed black line represents the overall vigor trend across all species sampled within the state, providing a reference for general forest condition changes. 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.

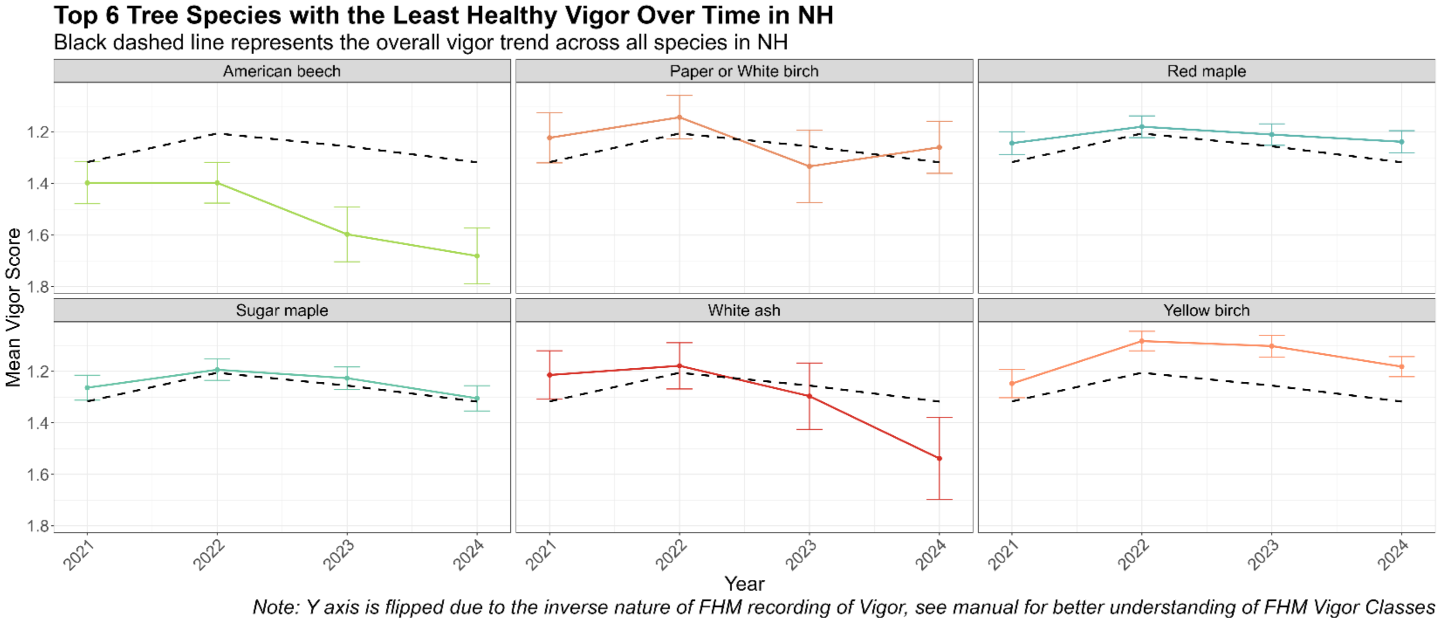

Figure 3C. Top six tree species with the greatest decline in vigor (highest stress levels) over time in New Hampshire among species comprising at least 0.5% of total basal area statewide. Vigor scores range from 4 (severe decline) to 1 (healthy), with intermediate values for trees in decline. The dashed black line represents the overall vigor trend across all species sampled within the state, enabling a broader forest health comparison. 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.

D. Annual growth and mortality trends - Trees (New Hampshire)

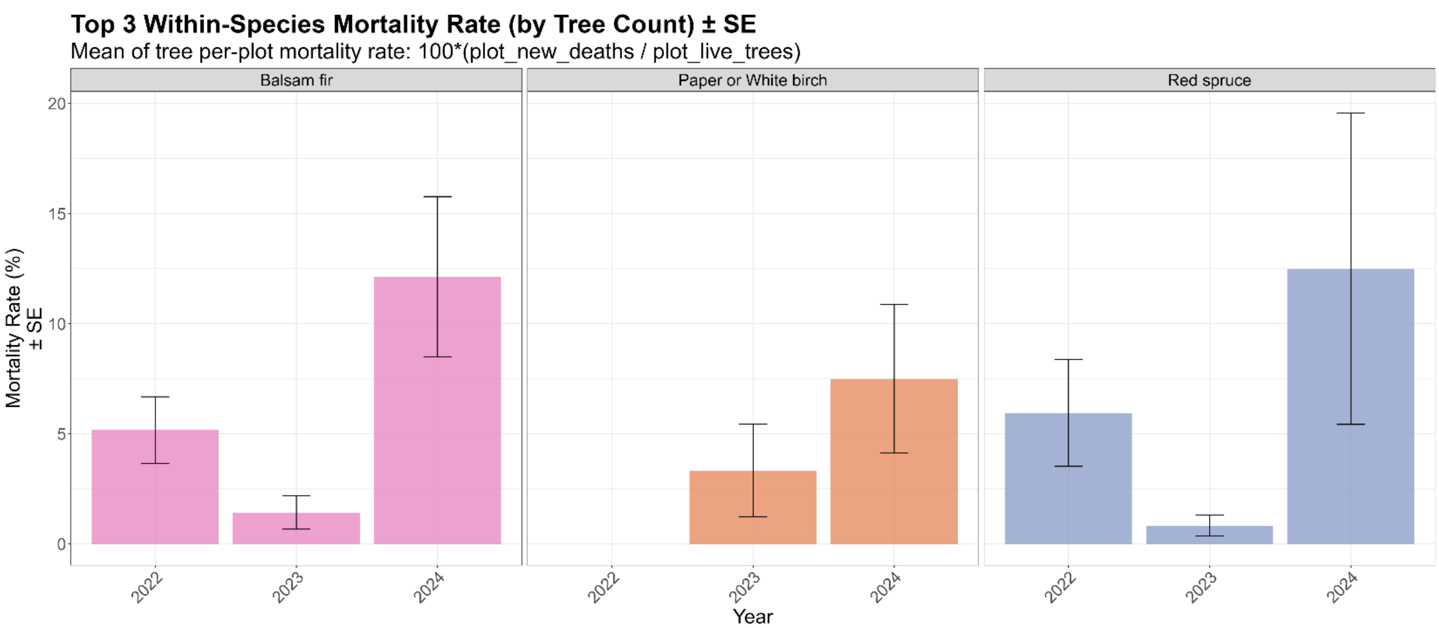

Figure 1D. Within-species mortality trends in New Hampshire for the top three tree species with the highest number of newly dead trees among species comprising more than 1% of total basal area statewide. This plot shows the annual number of newly dead trees per species, based on individual tree tracking using unique tree identifiers. 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. This metric reflects the percentage of individual trees transitioning from living to dead within their total species' samples statewide.

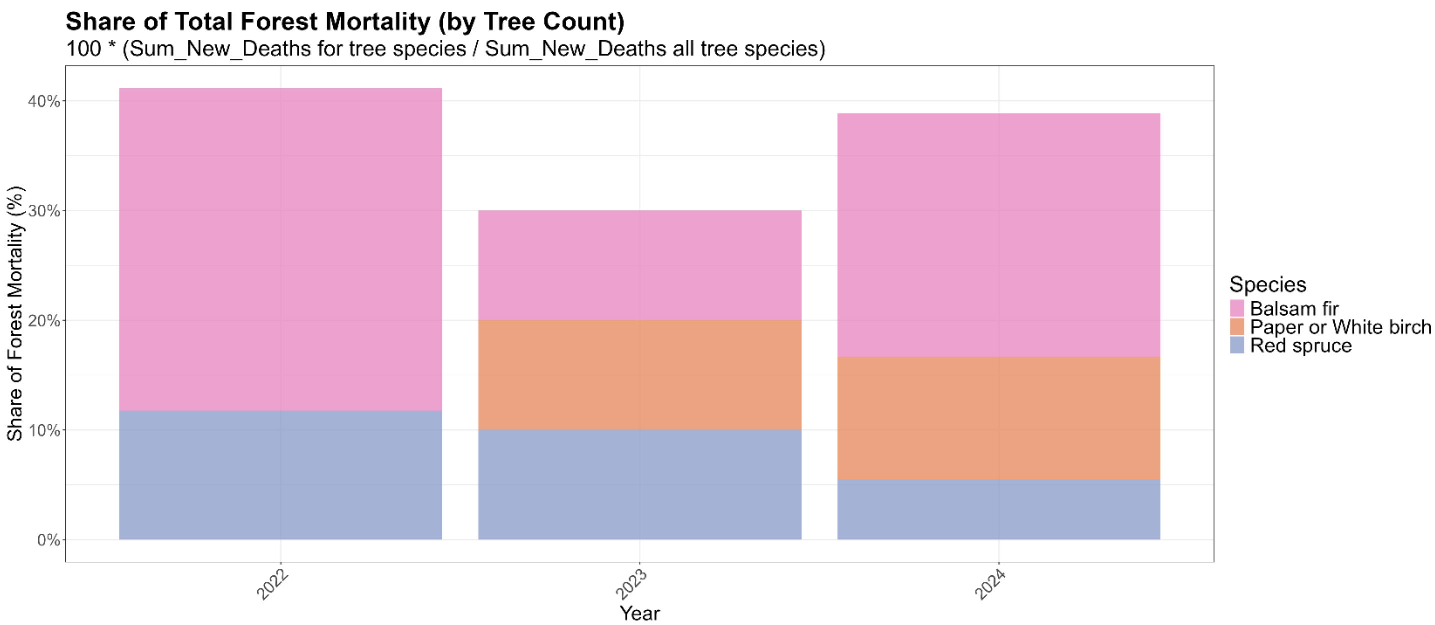

Figure 2D. Share of total forest mortality trends in New Hampshire for the top three species with the highest number of newly dead trees, relative to all newly reported tree deaths across all species comprising more than 1% of total basal area statewide.

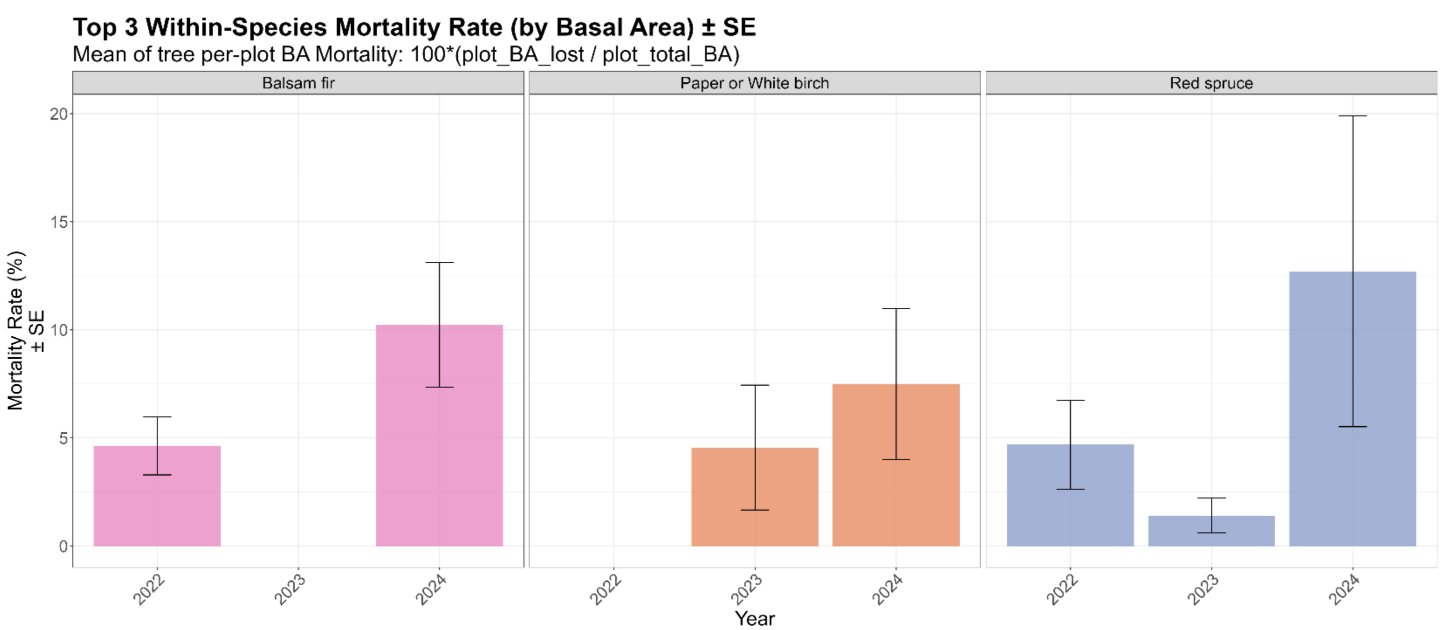

Figure 3D. Within-species mortality trends by basal area in New Hampshire for the top three species with the greatest total basal area loss among species comprising more than 1% of total basal area statewide, calculated as the sum of the last recorded basal area of all trees within a given species that transitioned from living to dead each year. Instead of simply accounting for the number of dead trees, basal area loss accounts for tree size, providing a different perspective on the impact to forest structure.

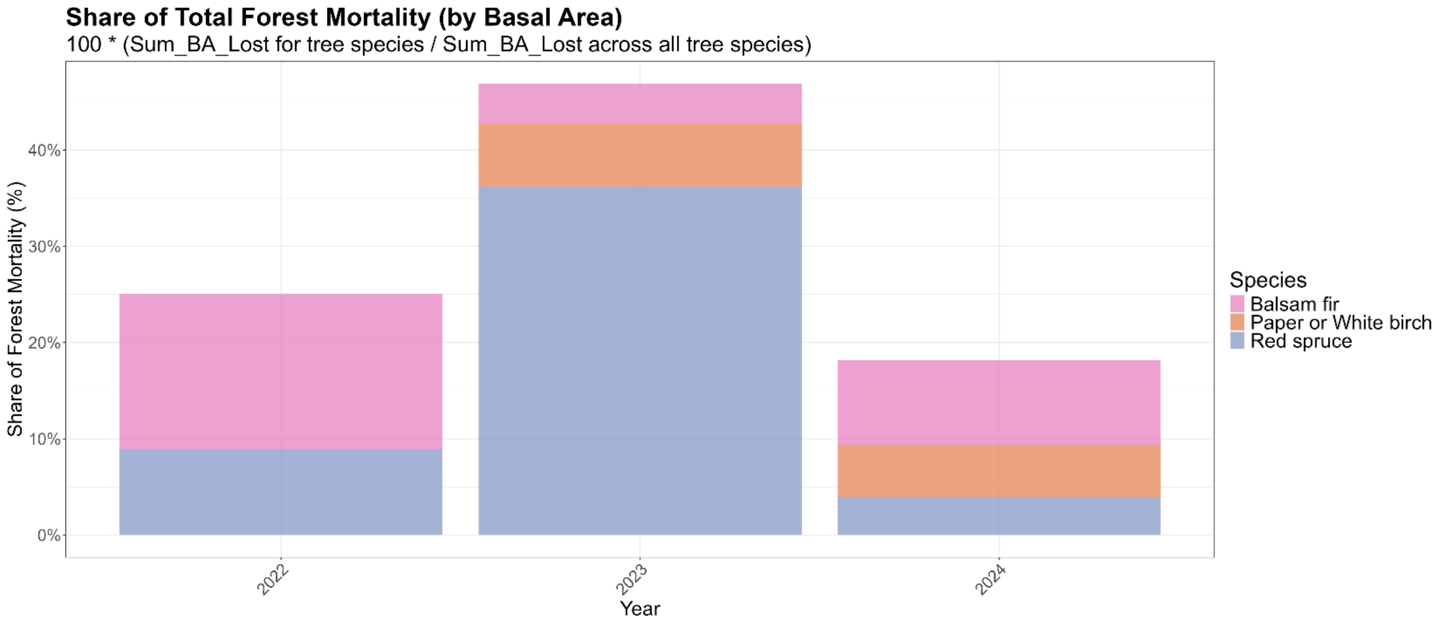

Figure 4D. Share of total lost basal area in New Hampshire for the top three species with the greatest basal area loss due to mortality, among species comprising more than 1% of total basal area statewide.

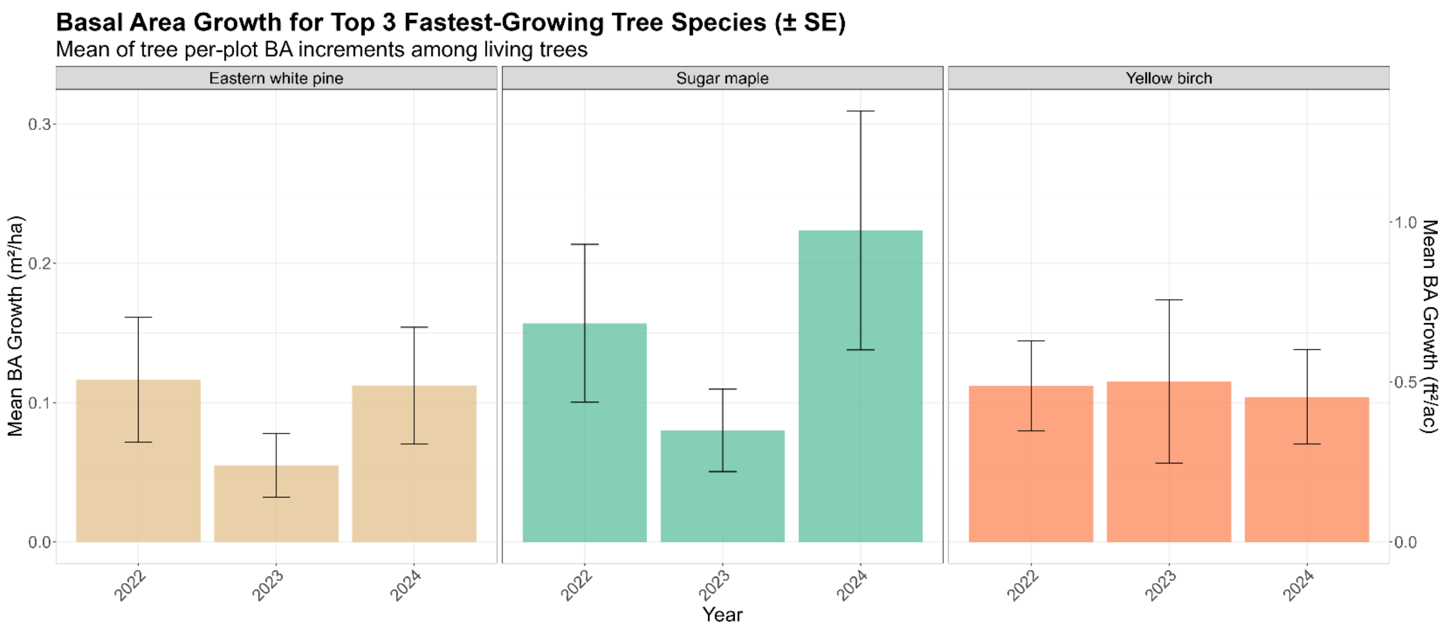

Figure 5D. Top three species with the greatest average basal area growth in New Hampshire. Bars represent the mean basal area increment in hectares (m^2/ha, left axis) and acres (ft^2/ac, right axis) each year. These growth trends illustrate which species are adding basal area the fastest, which may be related to species vigor and competitive advantage and has longer-term implications for stand development and forest composition.

E. Total composition - Trees (New Hampshire)

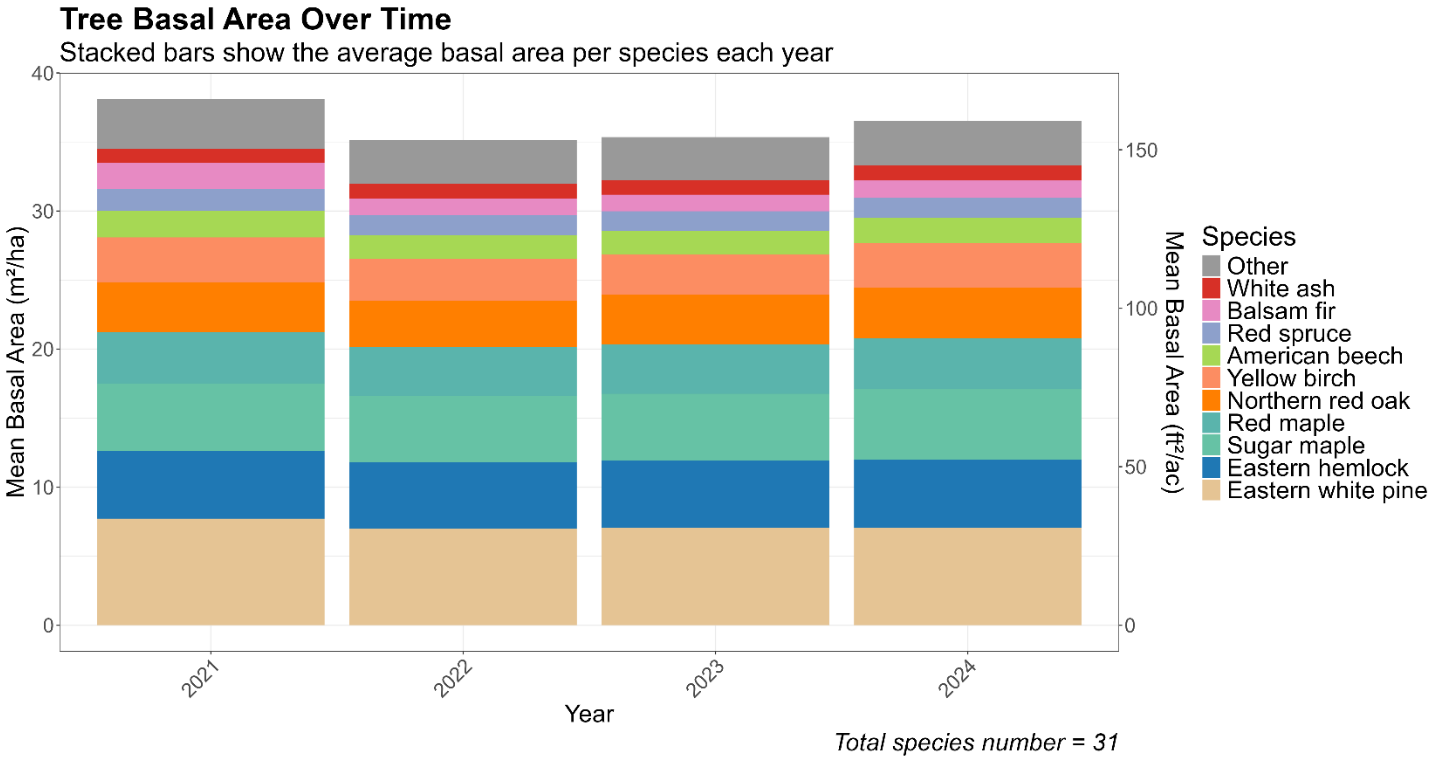

Figure 1E. Overall species composition by average live basal area in hectares (m^2/ha, left axis) and acres (ft^2/ac, right axis) across all tree species surveyed each year in New Hampshire. Species that ranked among the top ten for overall basal area are shown individually, while all species not in the top ten are combined and represented as "Other." This figure suggests which tree species are dominant or may be becoming more dominant in overall forest composition.

Section 2. Sapling Analyses (New Hampshire)

F. Total composition – Saplings (New Hampshire)

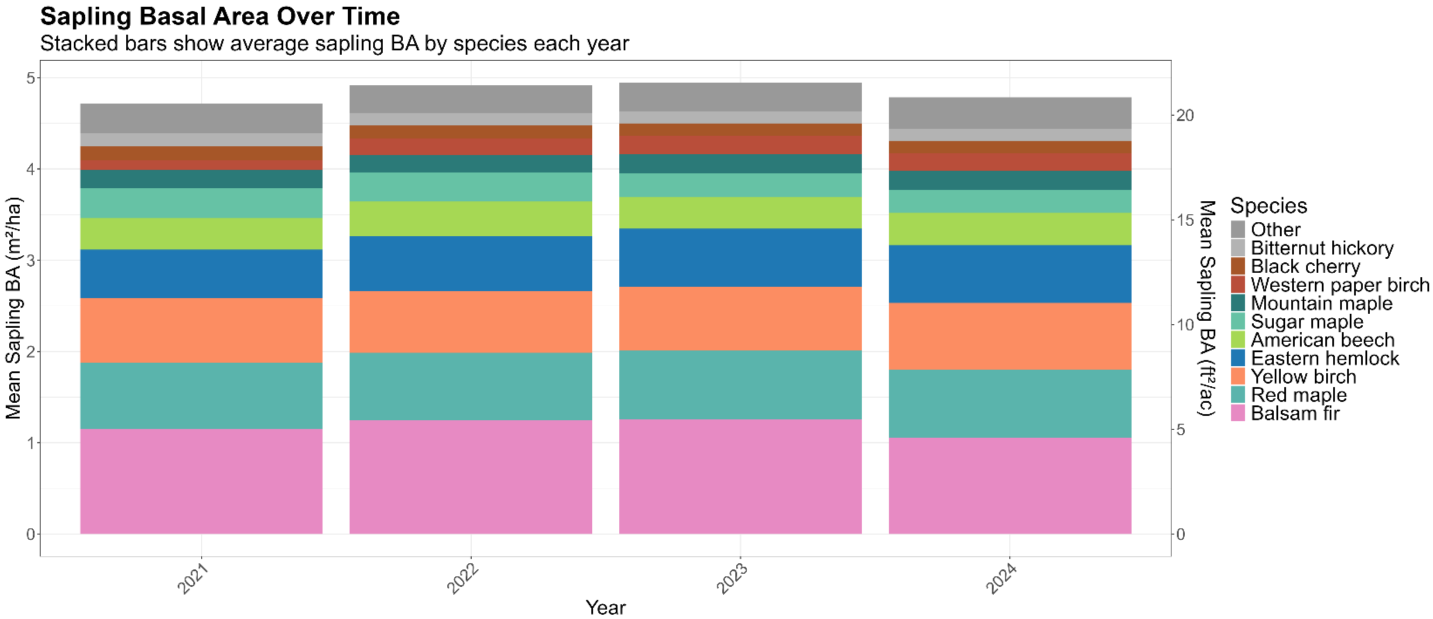

Figure 1F. Overall sapling basal area composition in hectares (m^2/ha, left axis) and acres (ft^2/ac, right axis) for all sapling species surveyed each year in New Hampshire. Species that ranked among the top ten for overall basal area are shown individually, while all species not in the top ten are combined and represented as “Other.” This figure suggests which saplings are dominant or may be becoming more dominant in our plot network statewide.

Section 3. Seedling Analyses (New Hampshire)

We have included a seedling class size guide to assist with interpreting the figures in subgroup H.

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

G. Annual growth and mortality trends – Seedlings (New Hampshire)

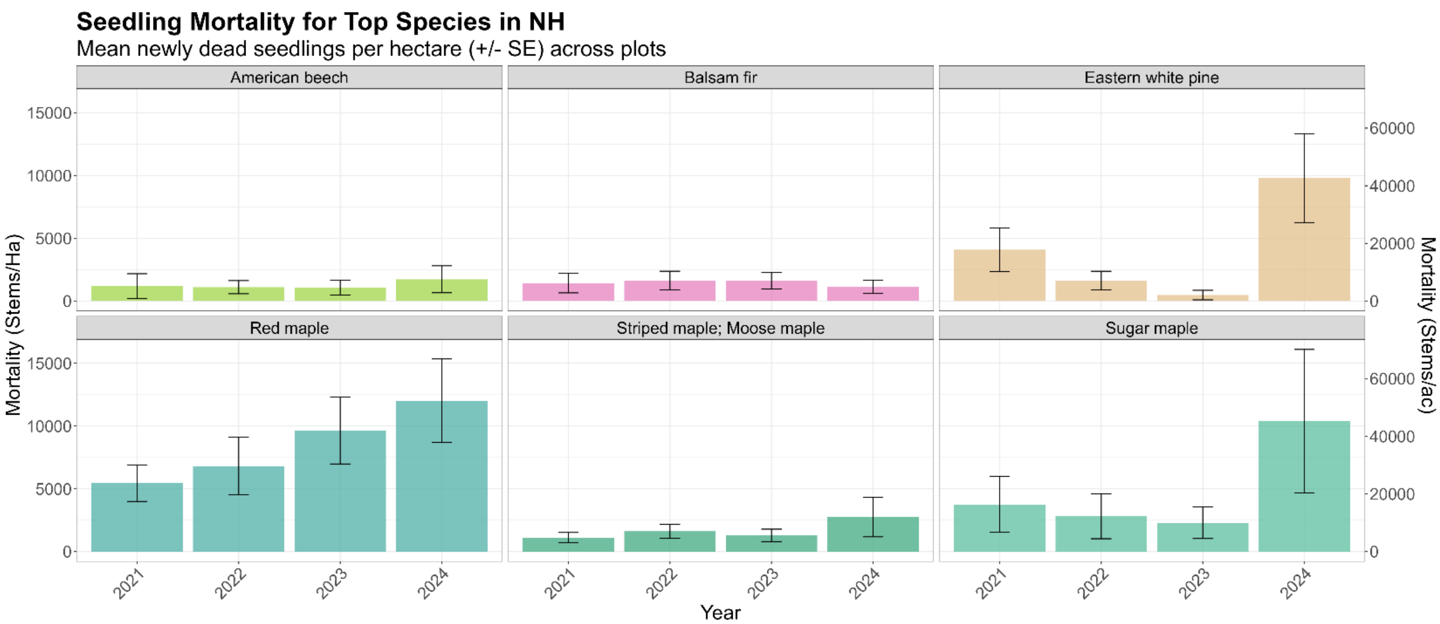

Figure 1G. The top six species showing the greatest mortality at the seedling stage in New Hampshire by stem count, presented by the mean number of seedlings transitioning from smaller to larger classes by stems per hectare (SPH, left axis) and acre (SPA, right axis) each year. While we do not record seedling mortality, we estimate based on reductions in seedling counts in our seedling sub-plots from one year to the next.

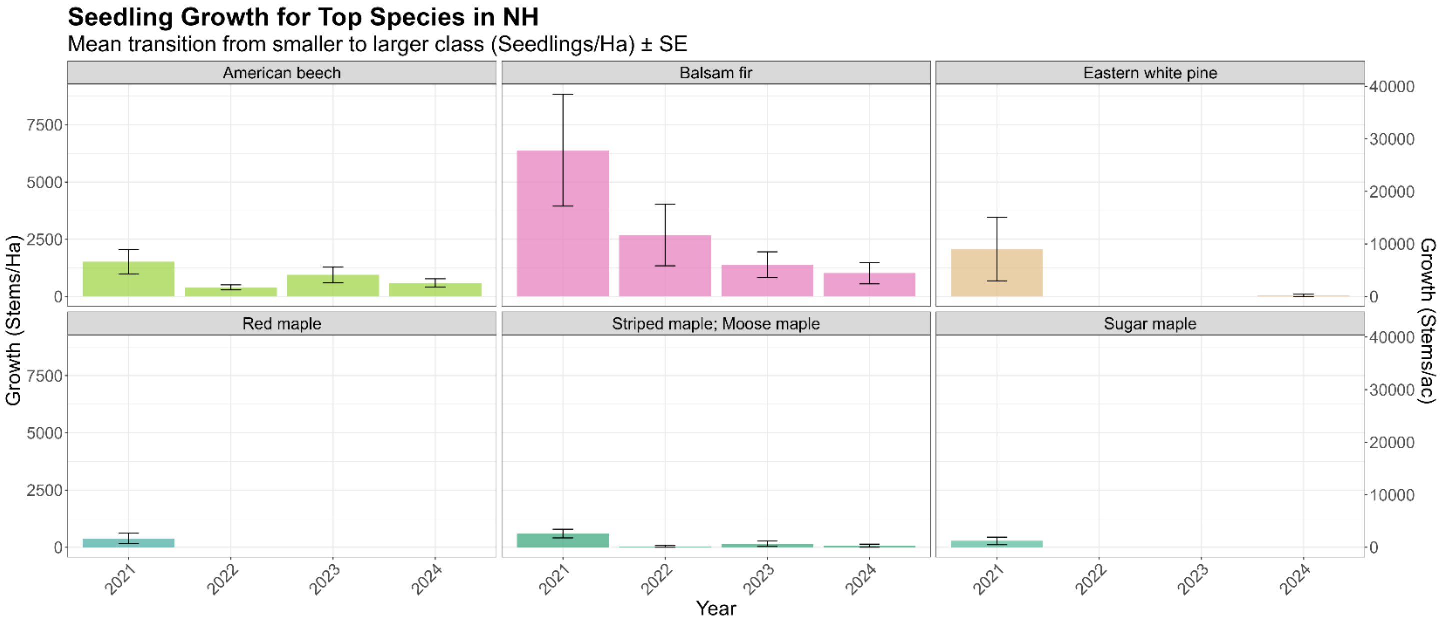

Figure 2G. The top six species showing the greatest growth at the seedling stage in New Hampshire by stem count, presented by the mean number of seedlings transitioning from smaller to larger classes by stems per hectare (SPH, left axis) and acre (SPA, right axis) each year.

H. Annual seedling density trends (New Hampshire)

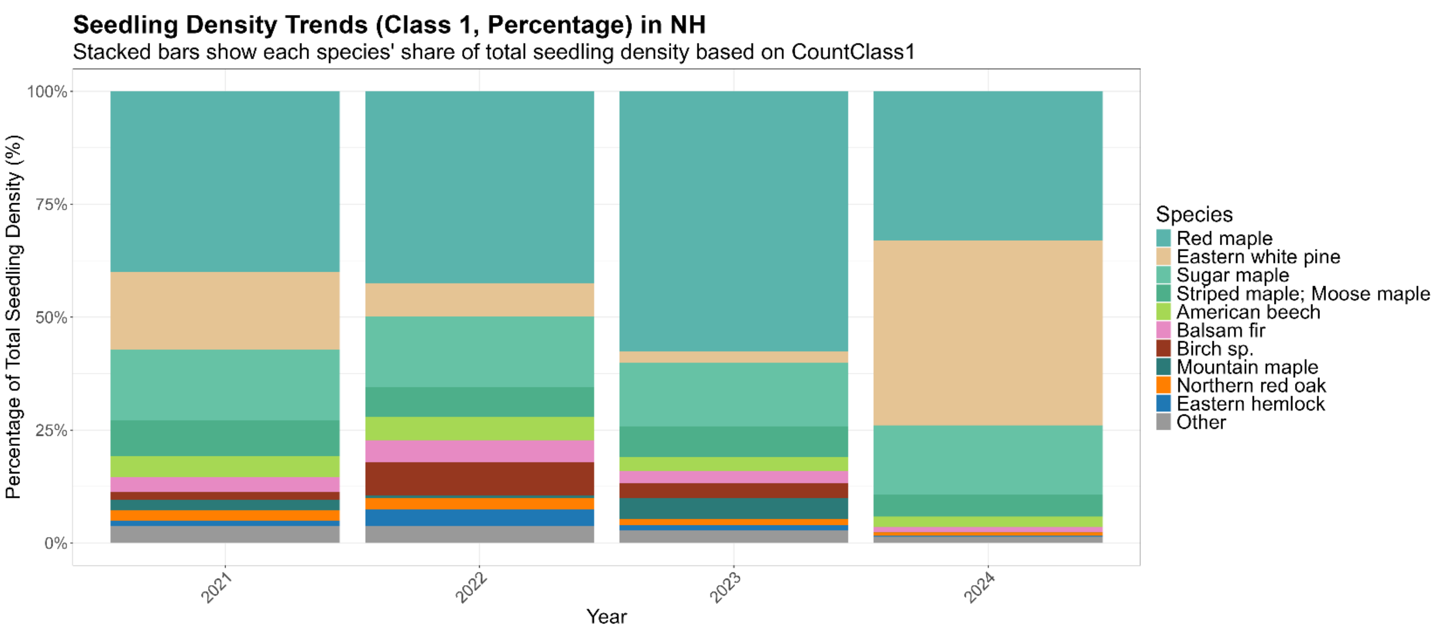

Figure 1H-i. Percent annual composition of Class 1 seedlings for all species surveyed each year in New Hampshire. The top ten most represented species by stem count are shown individually, while all other species not in the top ten are combined and represented as “Other.” This figure suggests potential trends in changes in species composition within the seedling layer over time.

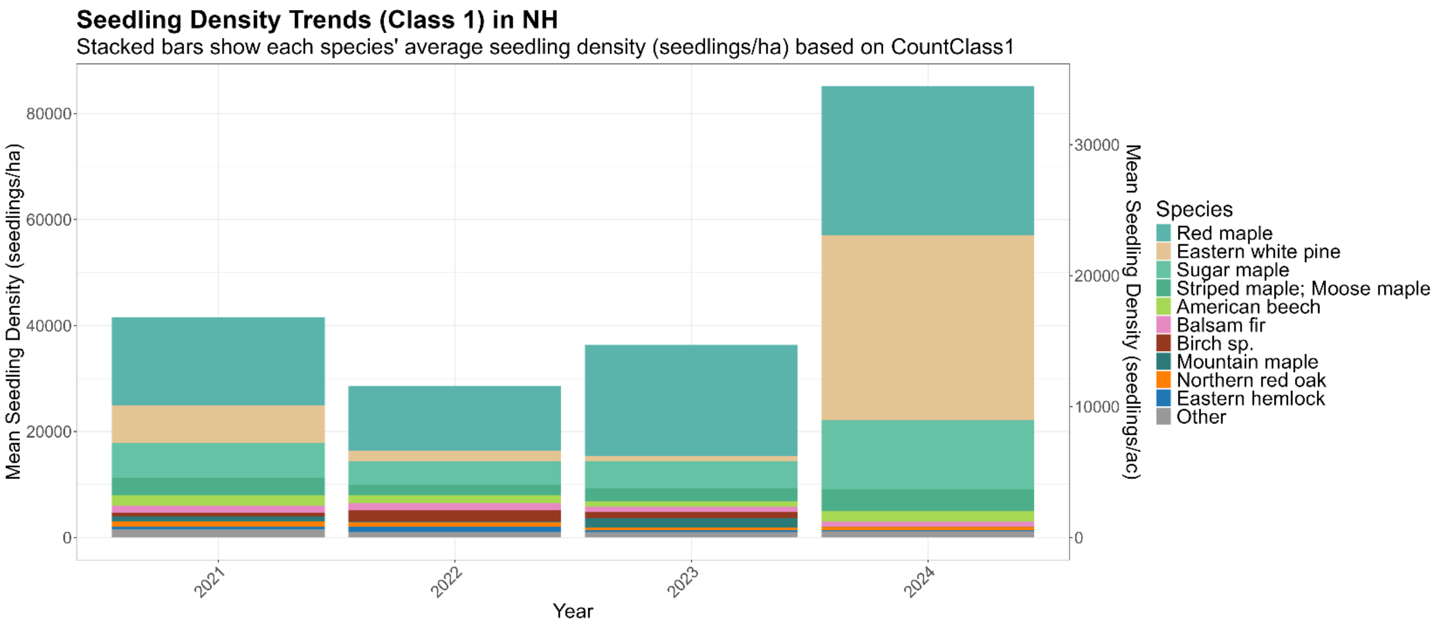

Figure 1H-ii. Class 1 seedling counts in stems per hectare (SPH, left axis) and acre (SPA, right axis) for all species surveyed each year in New Hampshire. The top ten most represented species by stem count are shown individually, while all species not in the top ten are combined and represented as "Other." The overall bar height indicates total number of Class 1 seedlings per hectare and acre statewide for each year.

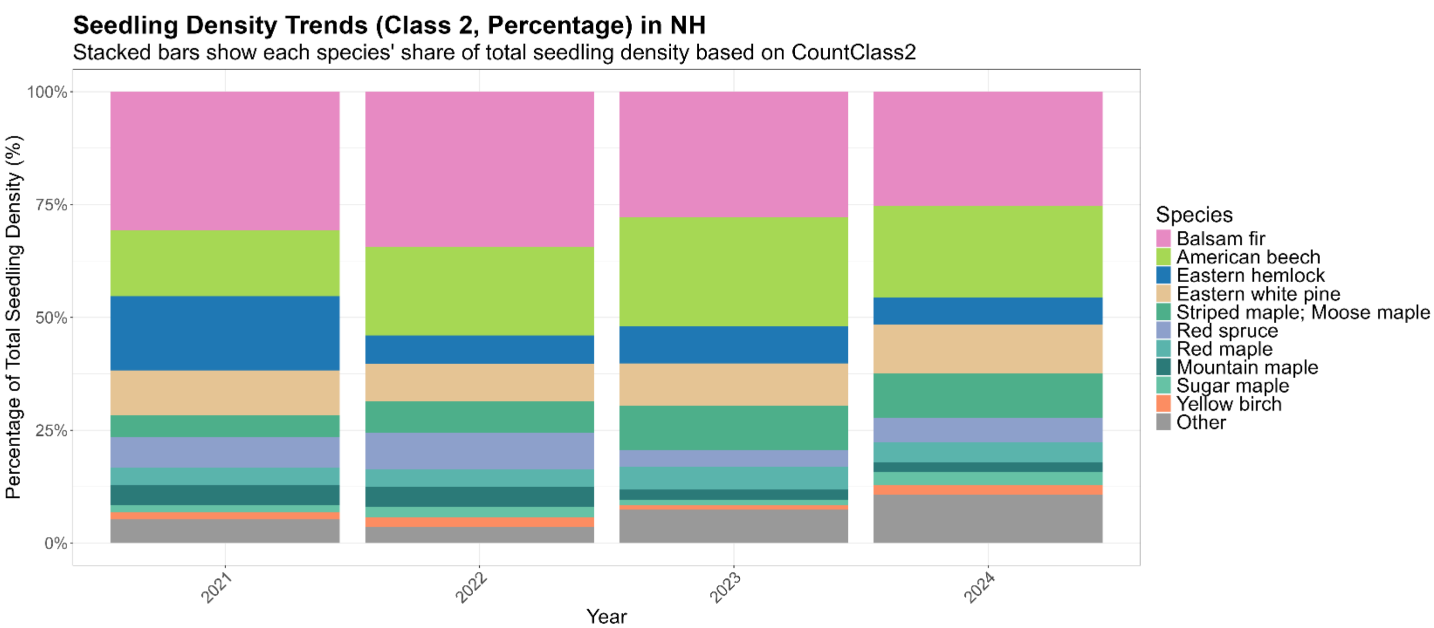

Figure 2H-i. Percent annual composition of Class 2 seedlings surveyed each year in New Hampshire. The top ten most represented species by stem count are shown individually, while all species not in the top ten are combined and represented as "Other."

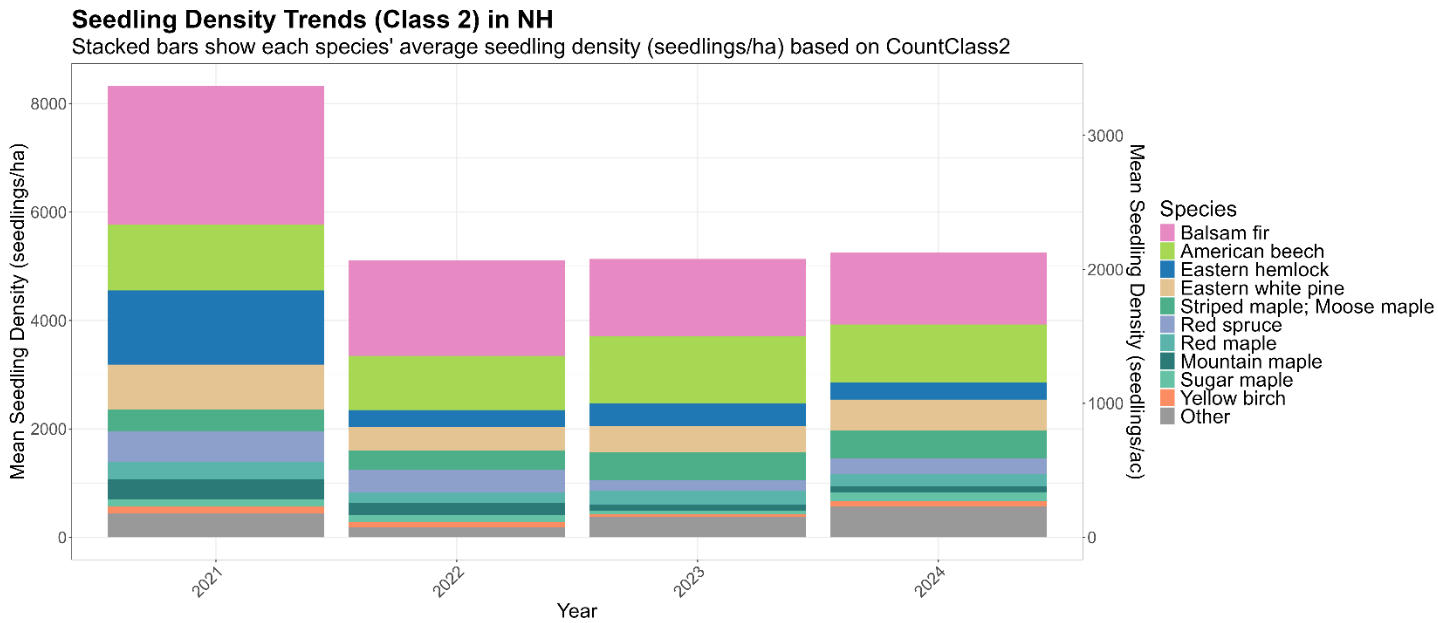

Figure 2H-ii. Class 2 seedling counts in stems per hectare (SPH, left axis) and acre (SPA, right axis) for all species surveyed each year in New Hampshire. The top ten most represented species by stem count are shown individually, while all species not in the top ten are combined and represented as "Other." The overall bar height indicates total number of Class 2 seedlings per hectare and acre statewide for each year.

New York

Section 1. Tree Analyses (New York)

A. Dieback trends (New York)

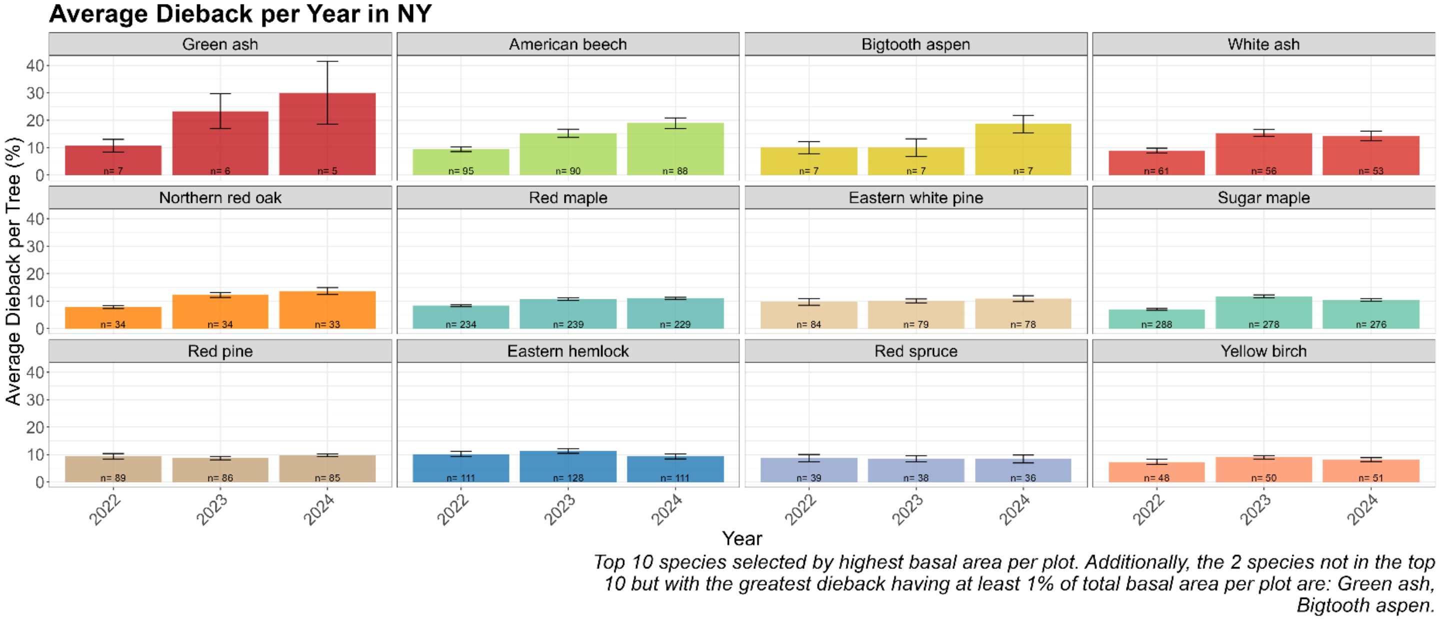

Figure 1A. New York average fine twig dieback trends by species and year for the top ten species by basal area, plus two that are less prevalent by basal area but are nonetheless showing high dieback (green ash, bigtooth aspen). Species are ordered by highest dieback in 2024.

B. Transparency trends (New York)

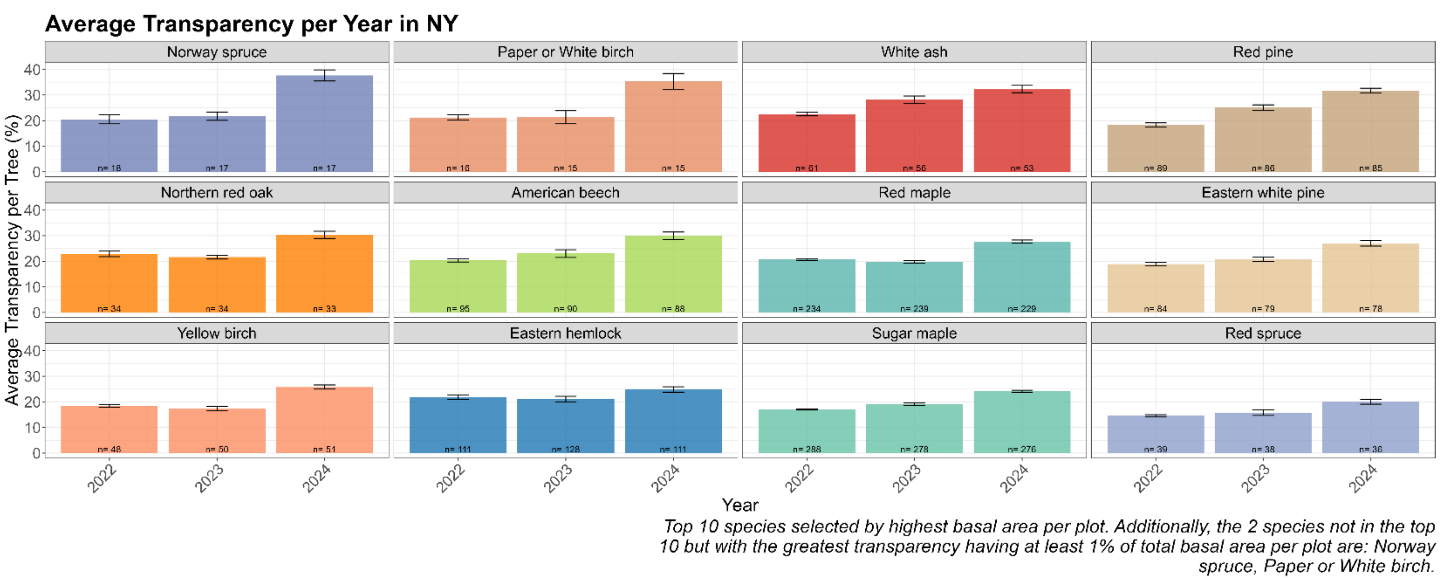

Figure 1B. New York average leaf transparency trends by species and year, for the top ten species by basal area plus two that are less prevalent by basal area but are nonetheless showing high transparency (Norway spruce, paper birch). Species are ordered by greatest transparency in 2024.

C. Vigor trends (New York)

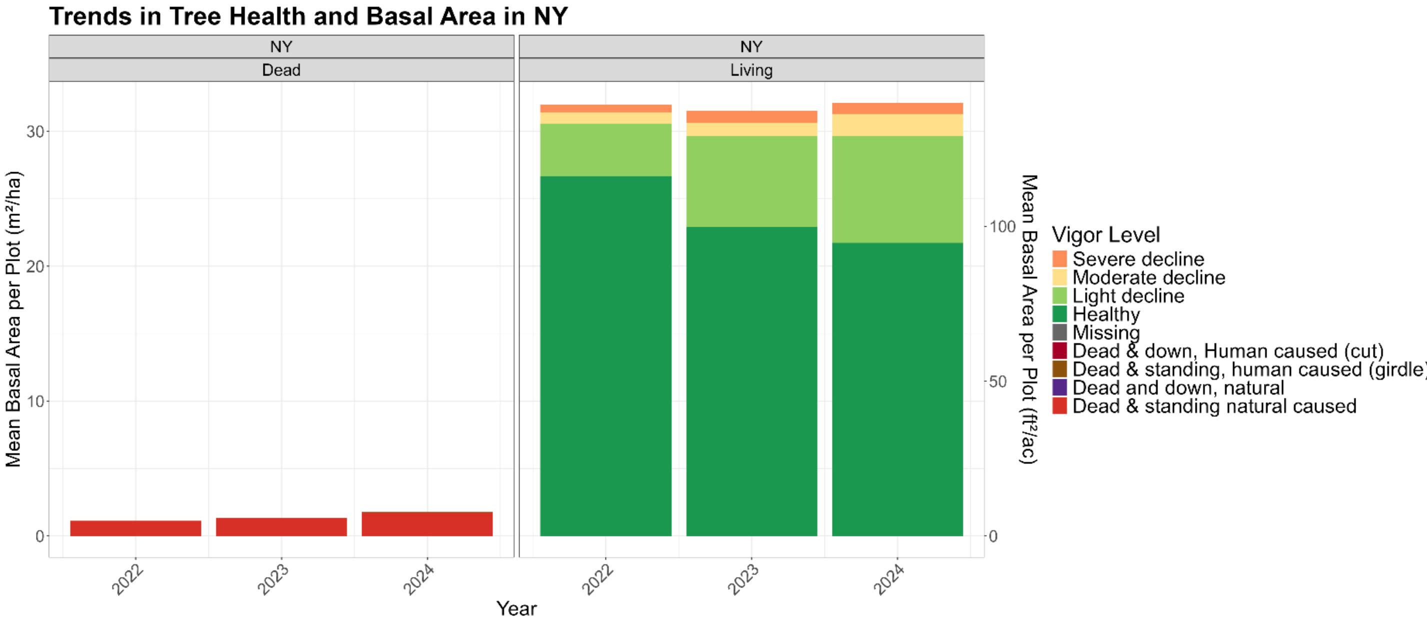

Figure 1C. Mean basal area per plot in hectares (m^2/ha, left axis) and acres (ft^2/ac, right axis) for living and dead trees in New York. Data is grouped by tree status with living classes shown on the right and dead classes on the left. An overall trend toward less vigorous trees is evident.

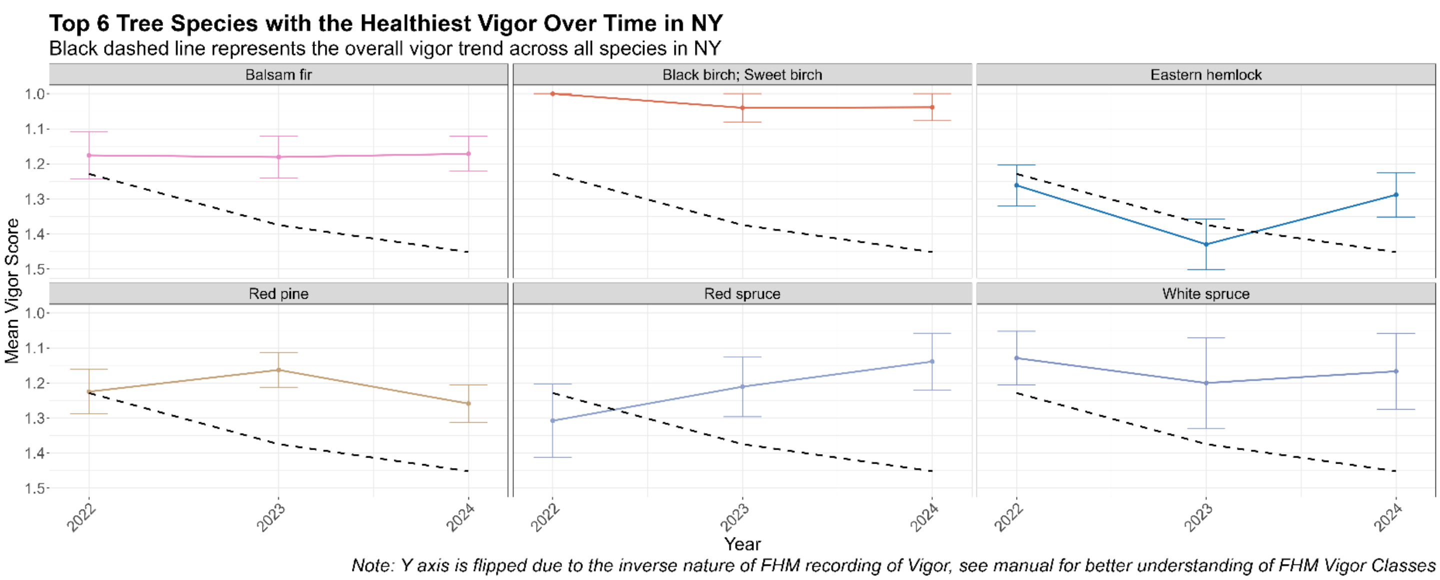

Figure 2C. Top six tree species with the healthiest vigor (lowest stress levels) over time in New York among species comprising at least 0.5% of total basal area statewide. Vigor scores range from 4 (severe decline) to 1 (healthy), with intermediate values for trees in decline. The dashed black line represents the overall vigor trend across all species sampled within the state, providing a reference for general forest condition changes. 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.

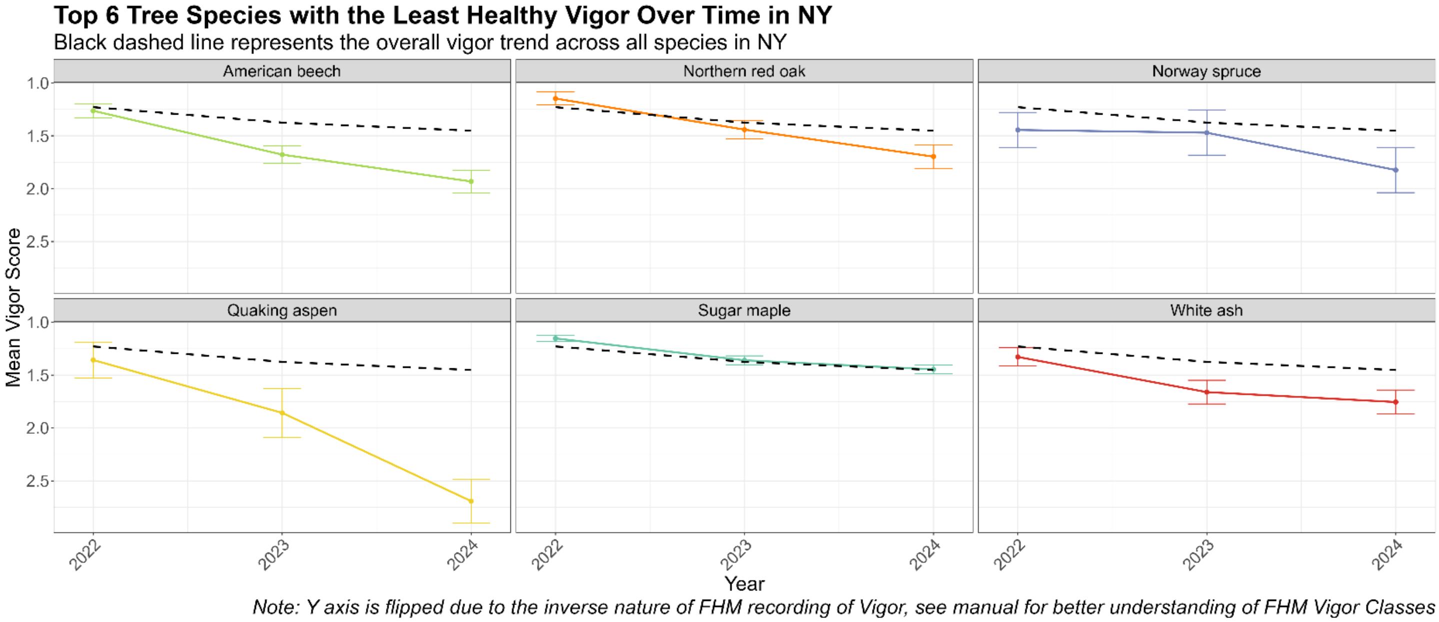

Figure 3C. Top six tree species with the greatest decline in vigor (highest stress levels) over time in New York among species comprising at least 0.5% of total basal area statewide. Vigor scores range from 4 (severe decline) to 1 (healthy), with intermediate values for trees in decline. The dashed black line represents the overall vigor trend across all species sampled within the state, enabling a broader forest health comparison. 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.

D. Annual growth and mortality trends - Trees (New York)

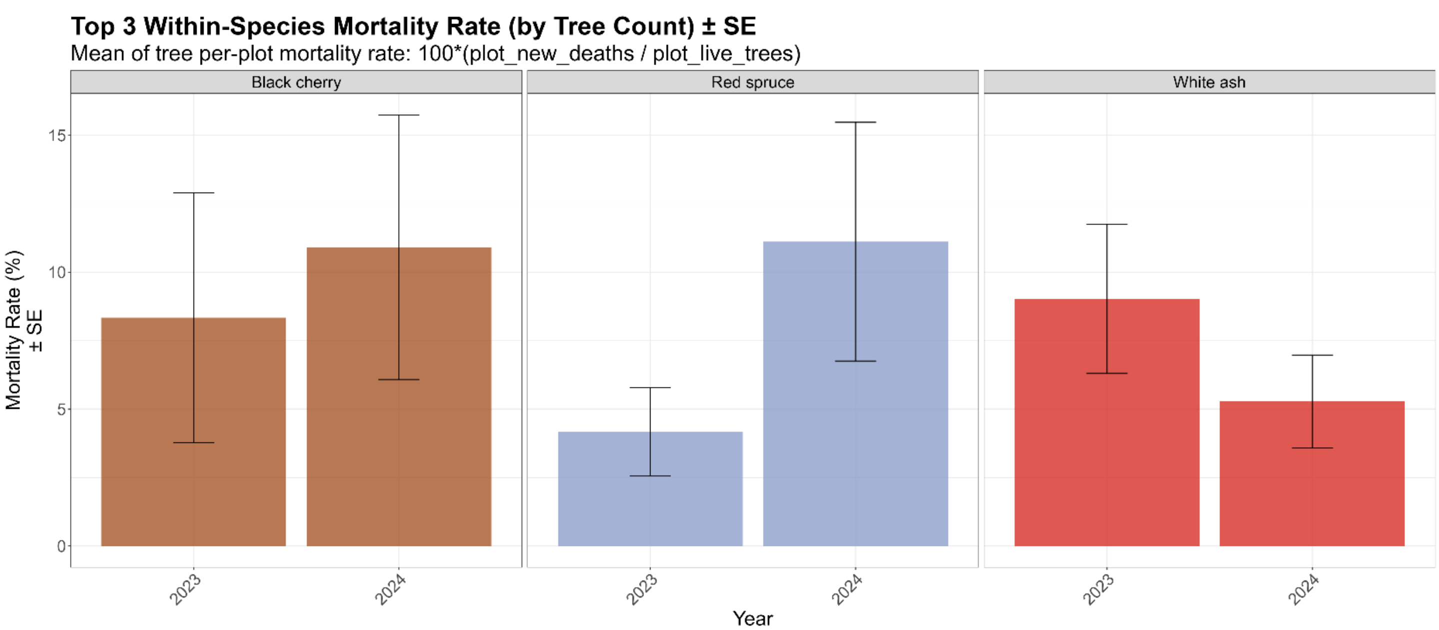

Figure 1D. Within-species mortality trends in New York for the top three tree species with the highest number of newly dead trees among species comprising more than 1% of total basal area statewide. This plot shows the annual number of newly dead trees per species, based on individual tree tracking using unique tree identifiers. 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. This metric reflects the percentage of individual trees transitioning from living to dead within their total species' samples statewide.

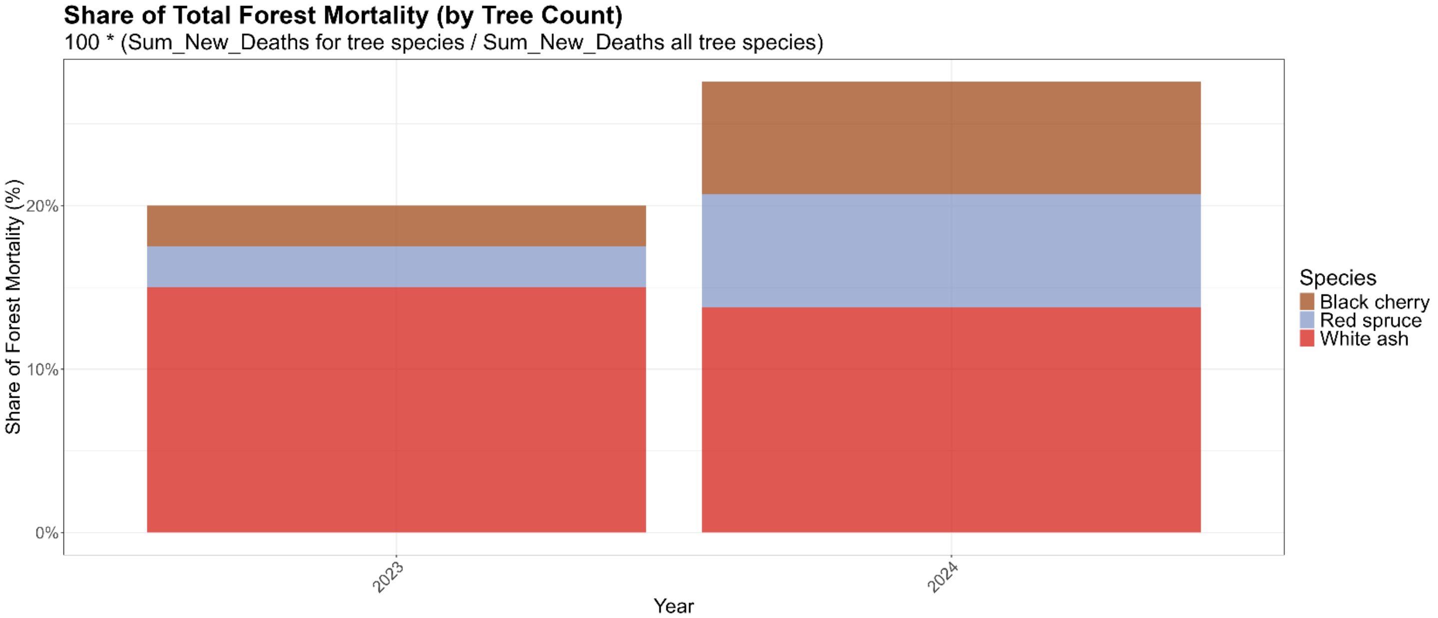

Figure 2D. Share of total forest mortality trends in New York for the top three species with the highest number of newly dead trees, relative to all newly reported tree deaths across all species comprising more than 1% of total basal area statewide.

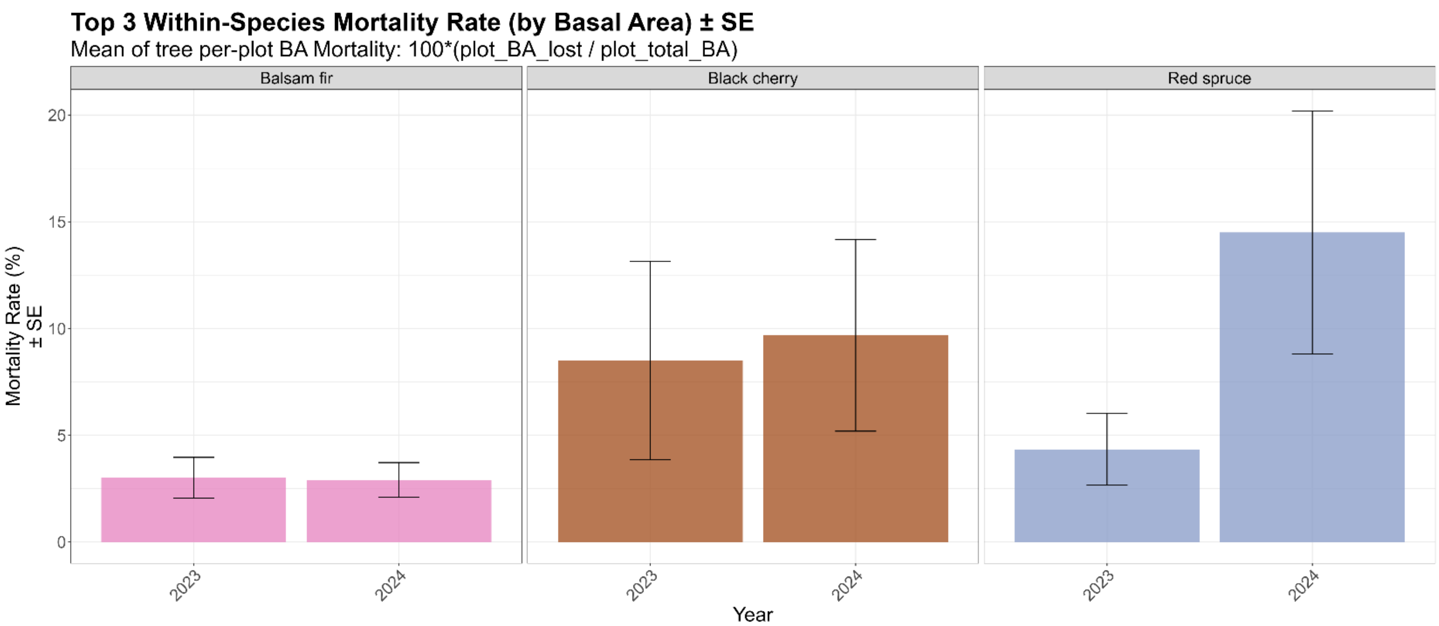

Figure 3D. Within-species mortality trends by basal area in New York for the top three species with the greatest total basal area loss among species comprising more than 1% of total basal area statewide, calculated as the sum of the last recorded basal area of all trees within a given species that transitioned from living to dead each year. Instead of simply accounting for the number of dead trees, basal area loss accounts for tree size, providing a different perspective on the impact to forest structure.

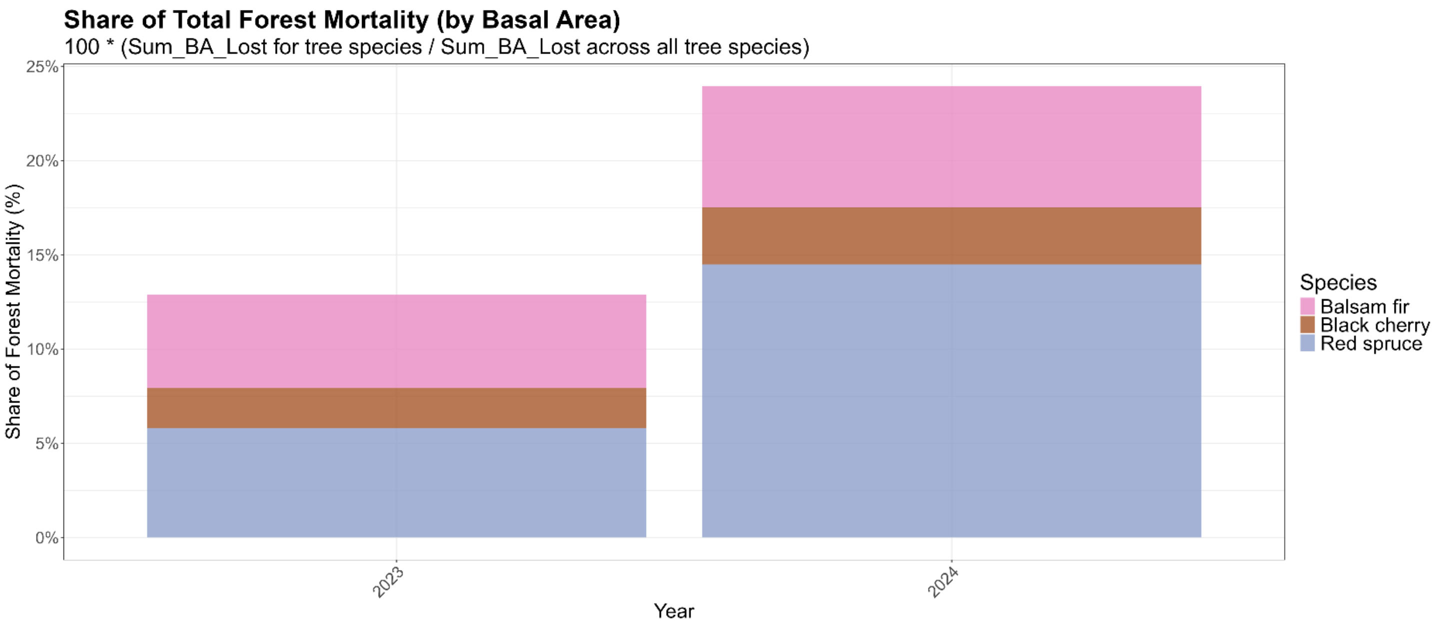

Figure 4D. Share of total lost basal area in New York for the top three species with the greatest basal area loss due to mortality, among species comprising more than 1% of total basal area statewide.

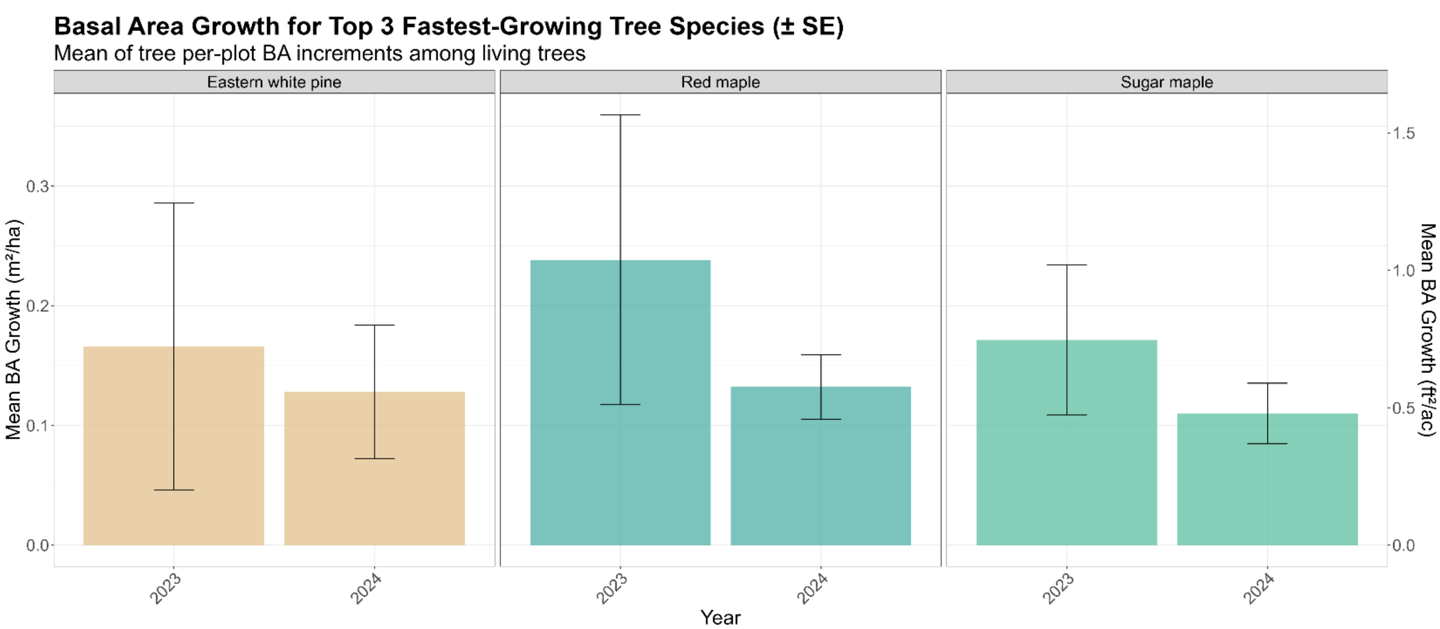

Figure 5D. Top three species with the greatest average basal area growth in New York. Bars represent the mean basal area increment in hectares (m^2/ha, left axis) and acres (ft^2/ac, right axis) each year. These growth trends illustrate which species are adding basal area the fastest, which may be related to species vigor and competitive advantage and has longer-term implications for stand development and forest composition.

E. Total composition - Trees (New York)

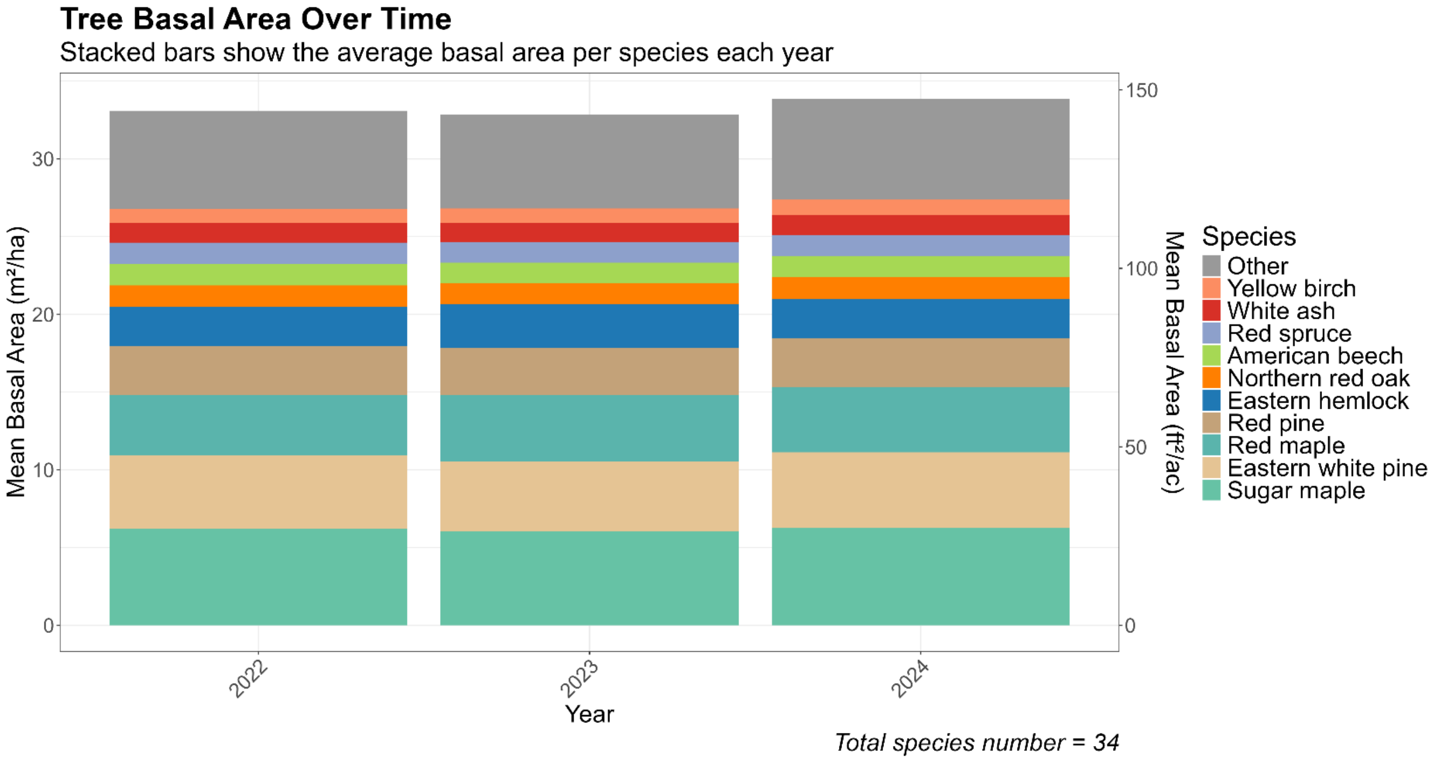

Figure 1E. Overall species composition by average live basal area in hectares (m^2/ha, left axis) and acres (ft^2/ac, right axis) across all tree species surveyed each year in New York. Species that ranked among the top ten for overall basal area are shown individually, while all species not in the top ten are combined and represented as "Other." This figure suggests which tree species are dominant or may be becoming more dominant in overall forest composition.

Section 2. Sapling Analyses (New York)

F. Total composition – Saplings (New York)

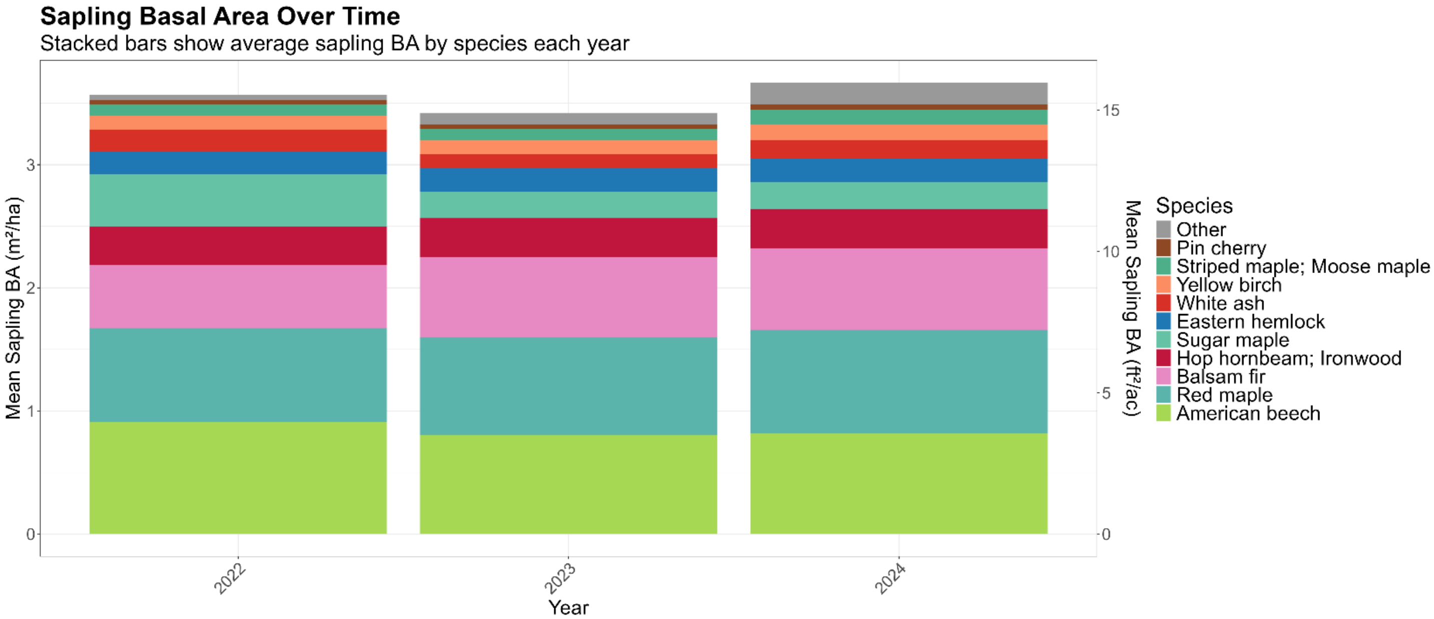

Figure 1F. Overall sapling basal area composition in hectares (m^2/ha, left axis) and acres (ft^2/ac, right axis) for all sapling species surveyed each year in New York. Species that ranked among the top ten for overall basal area are shown individually, while all species not in the top ten are combined and represented as "Other." This figure suggests which saplings are dominant or may be becoming more dominant in our plot network statewide.

Section 3. Seedling Analyses (New York)

We have included a seedling class size guide to assist with interpreting the figures in subgroup H.

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

G. Annual growth and mortality trends – Seedlings (New York)

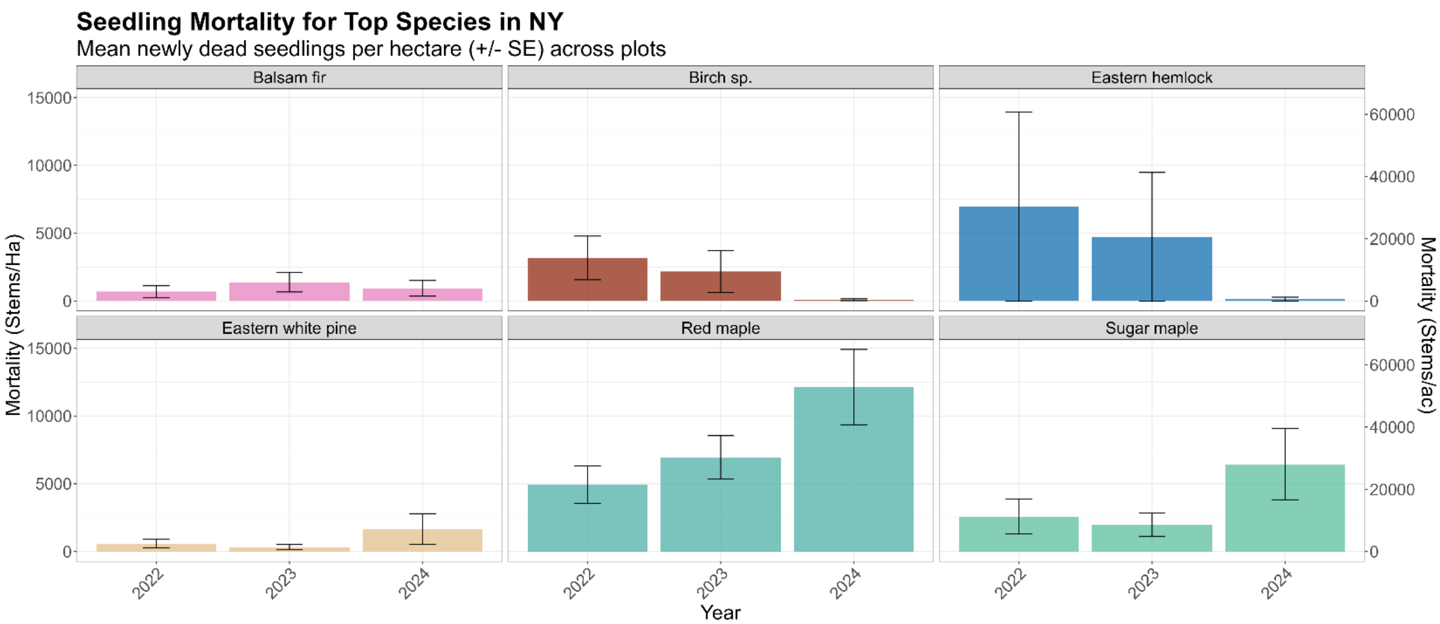

Figure 1G. The top six species showing the greatest mortality at the seedling stage in New York by stem count, presented by the mean number of seedlings transitioning from smaller to larger classes by stems per hectare (SPH, left axis) and acre (SPA, right axis) each year. While we do not record seedling mortality, we estimate based on reductions in seedling counts in our seedling sub-plots from one year to the next.

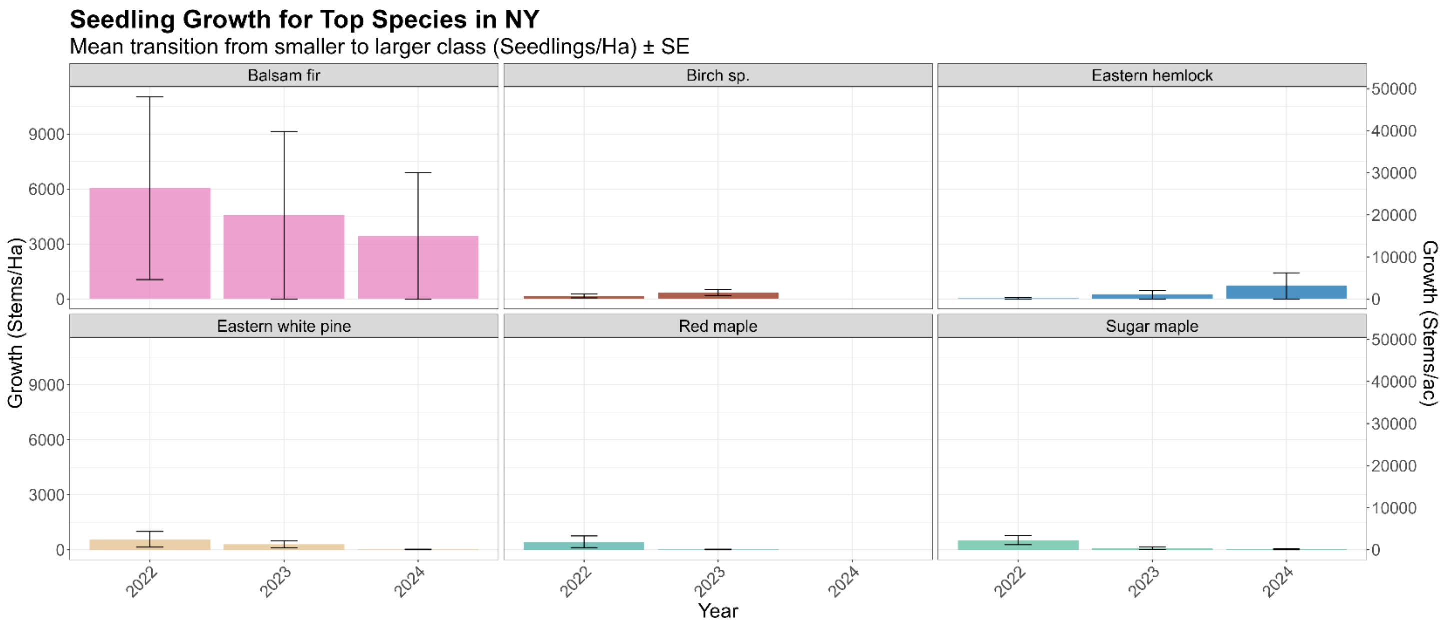

Figure 2G. The top six species showing the greatest growth at the seedling stage in New York by stem count, presented by the mean number of seedlings transitioning from smaller to larger classes by stems per hectare (SPH, left axis) and acre (SPA, right axis) each year.

H. Annual seedling density trends (New York)

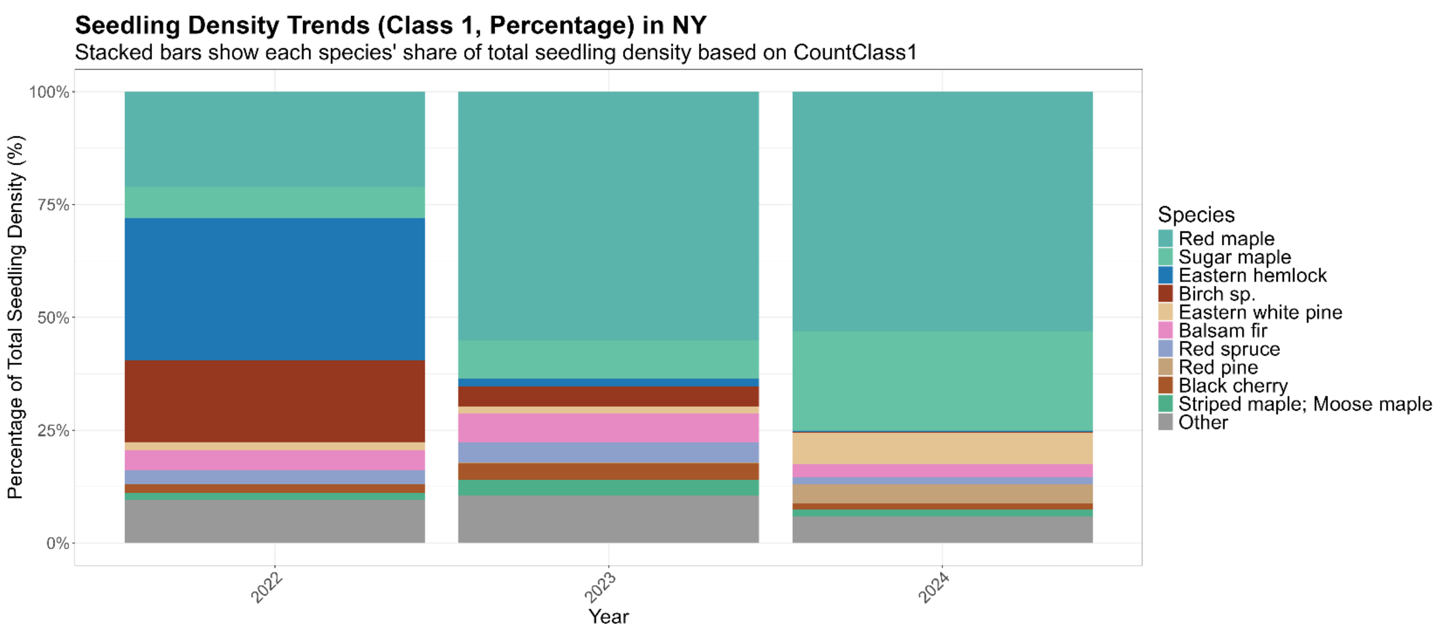

Figure 1H-i. Percent annual composition of Class 1 seedlings for all species surveyed each year in New York. The top ten most represented species by stem count are shown individually, while all other species not in the top ten are combined and represented as "Other." This figure suggests potential trends in changes in species composition within the seedling layer over time.

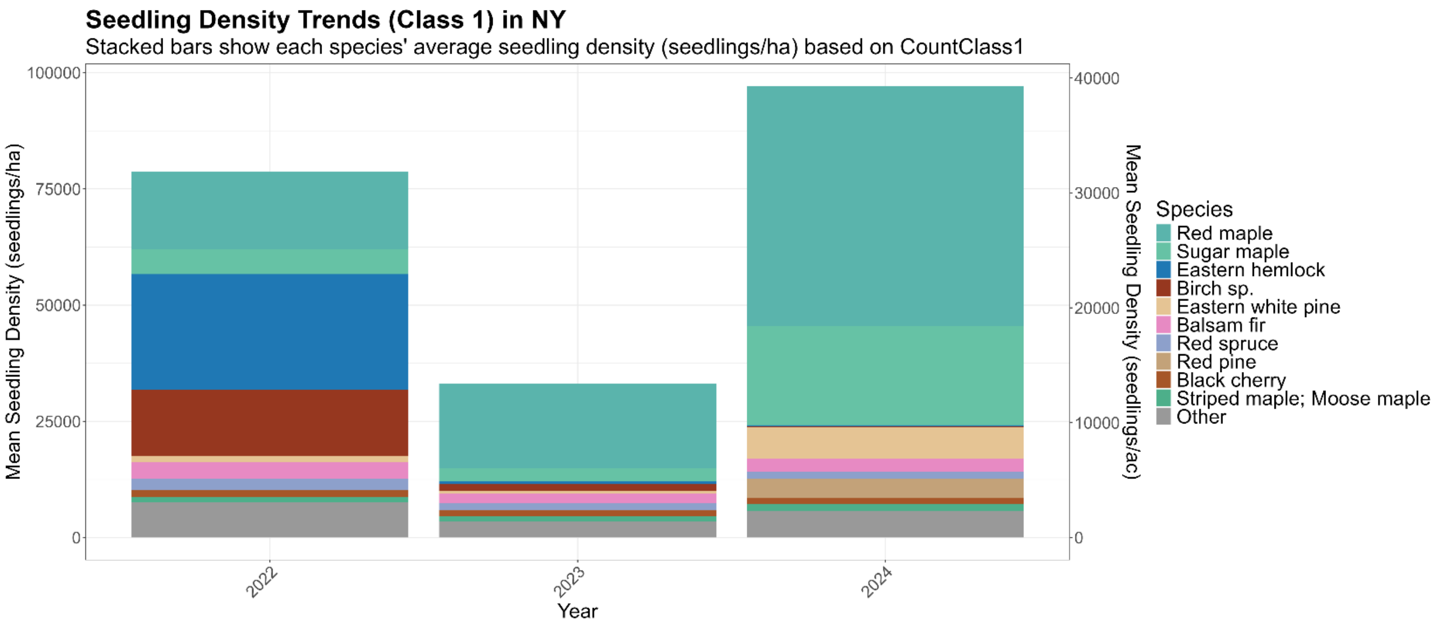

Figure 1H-ii. Class 1 seedling counts in stems per hectare (SPH, left axis) and acre (SPA, right axis) for all species surveyed each year in New York. The top ten most represented species by stem count are shown individually, while all species not in the top ten are combined and represented as "Other." The overall bar height indicates total number of Class 1 seedlings per hectare and acre statewide for each year.

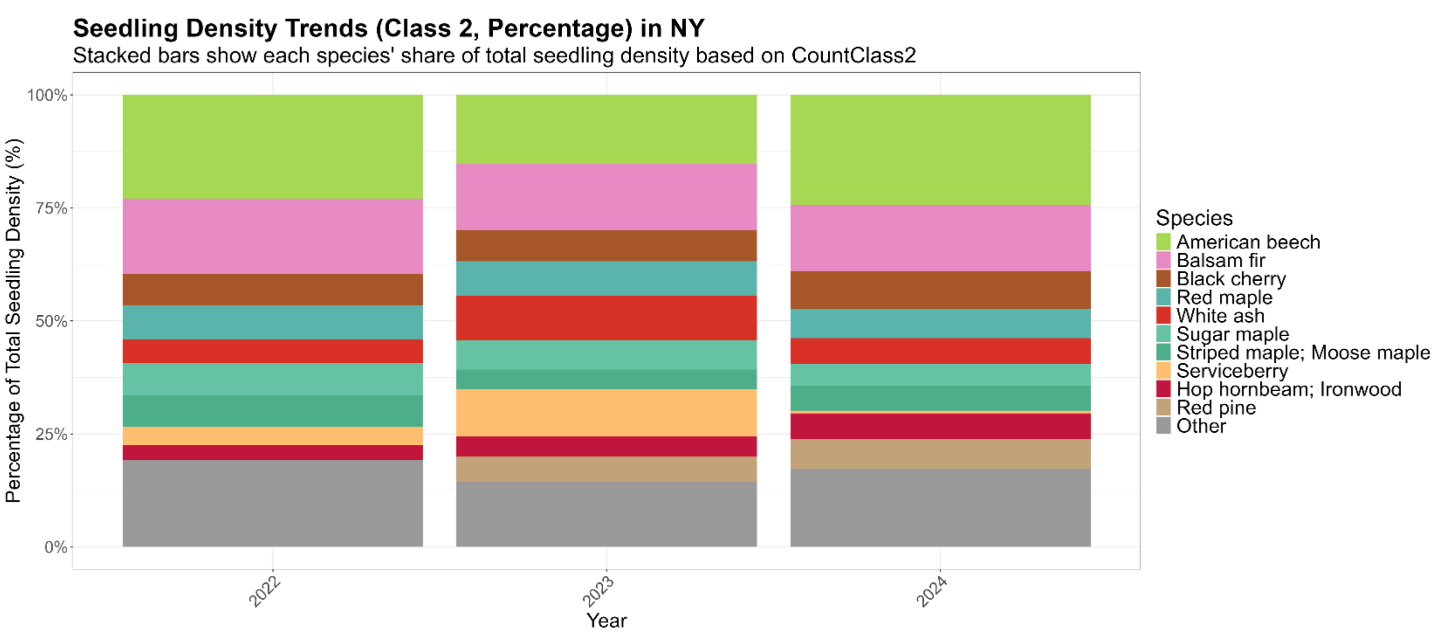

Figure 2H-i. Percent annual composition of Class 2 seedlings surveyed each year in New York. The top ten most represented species by stem count are shown individually, while all species not in the top ten are combined and represented as "Other."

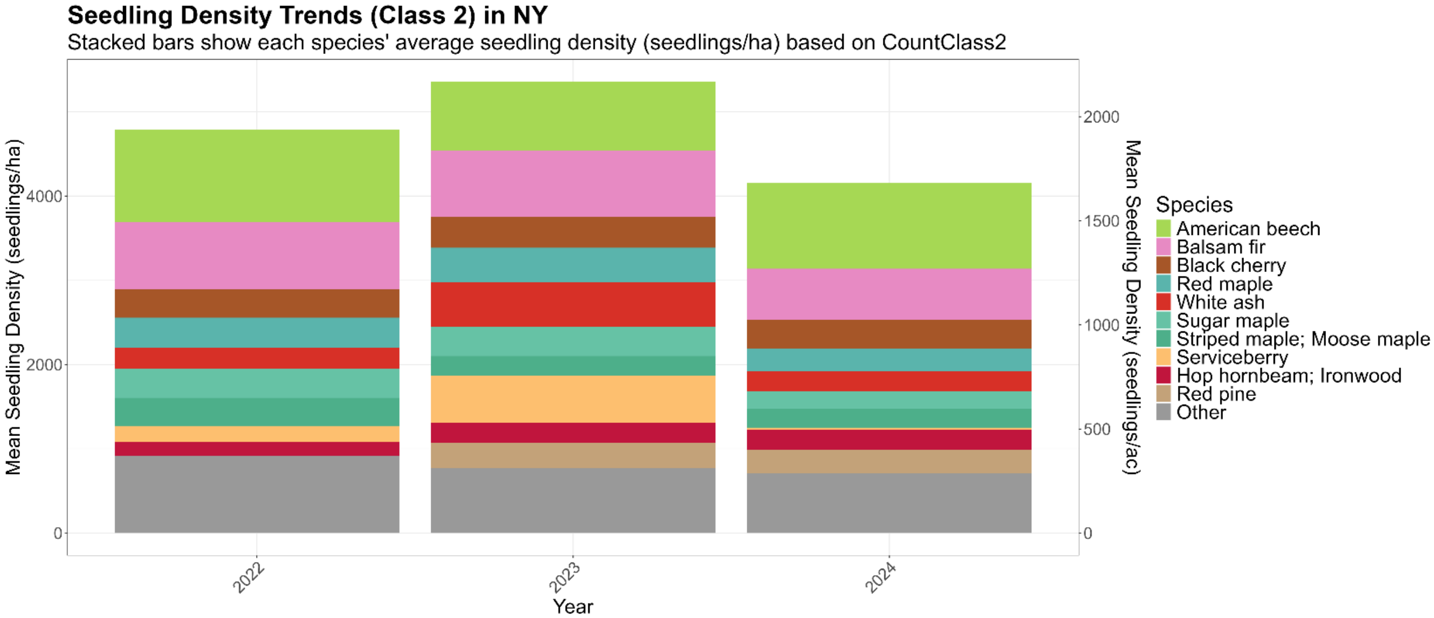

Figure 2H-ii. Class 2 seedling counts in stems per hectare (SPH, left axis) and acre (SPA, right axis) for all species surveyed each year in New York. The top ten most represented species by stem count are shown individually, while all species not in the top ten are combined and represented as “Other.” The overall bar height indicates total number of Class 2 seedlings per hectare and acre statewide for each year.

Rhode Island

Due to the smaller number of plots compared to other states, Rhode Island data may reflect greater extremes attributable to smaller sample sizes. Consequently, increased weight for each data point leads to higher variances with calculated composition, growth, and mortality rates. As a result, these findings may not be represented of statewide trends.

Section 1. Tree Analyses (Rhode Island)

A. Dieback trends (Rhode Island)

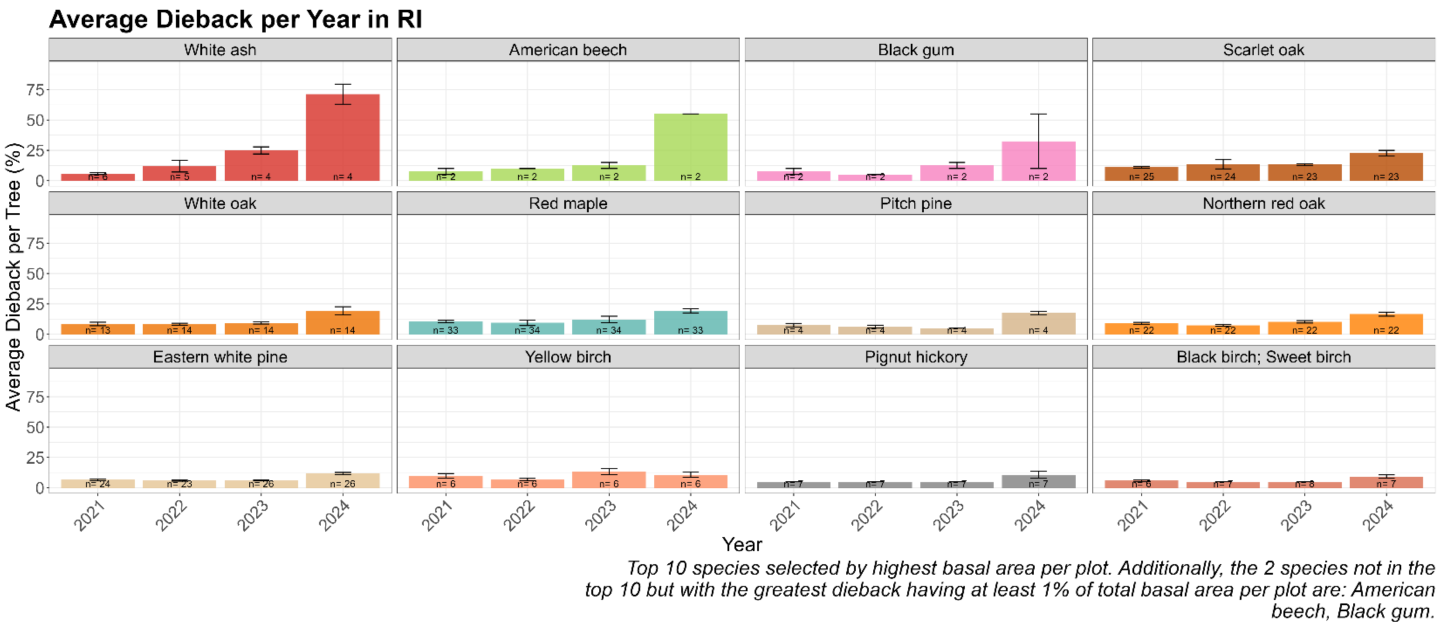

Figure 1A. Rhode Island average fine twig dieback trends by species and year for the top ten species by basal area, plus two that are less prevalent by basal area but are nonetheless showing high dieback (American beech, black gum). Species are ordered by highest dieback in 2024.

B. Transparency trends (Rhode Island)

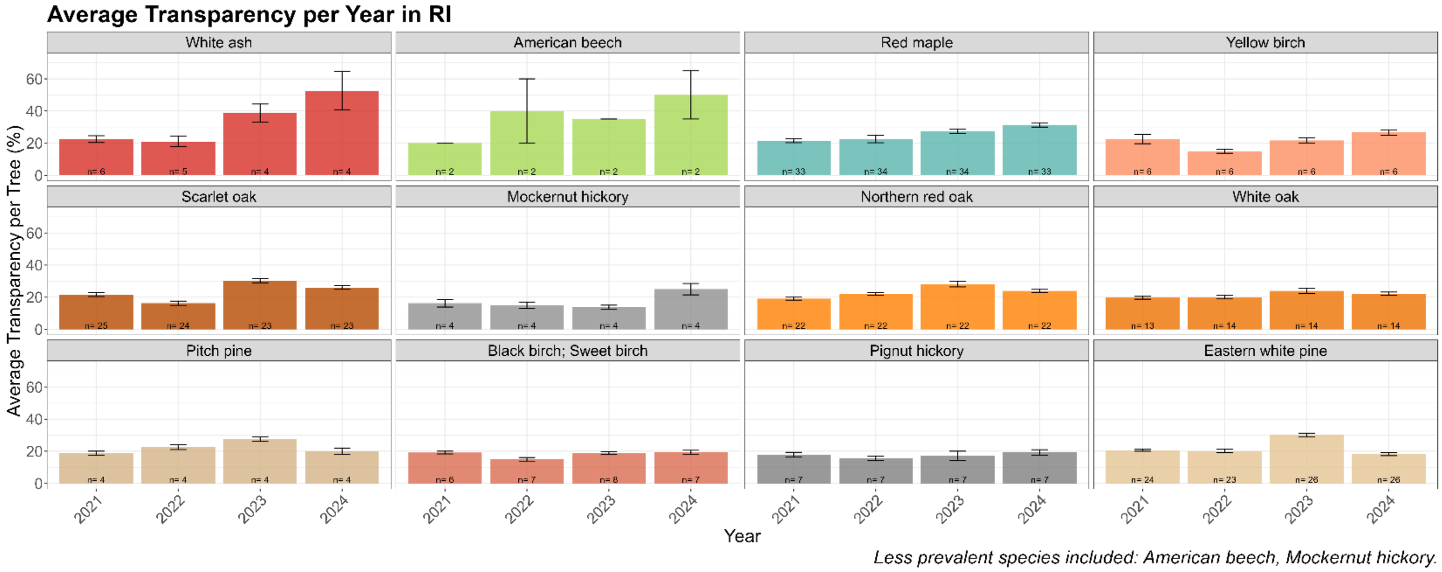

Figure 1B. Rhode Island average leaf transparency trends by species and year, for the top ten species by basal area plus two that are less prevalent by basal area but are nonetheless showing high transparency (American beech, mockernut hickory). Species are ordered by greatest transparency in 2024.

C. Vigor trends (Rhode Island)

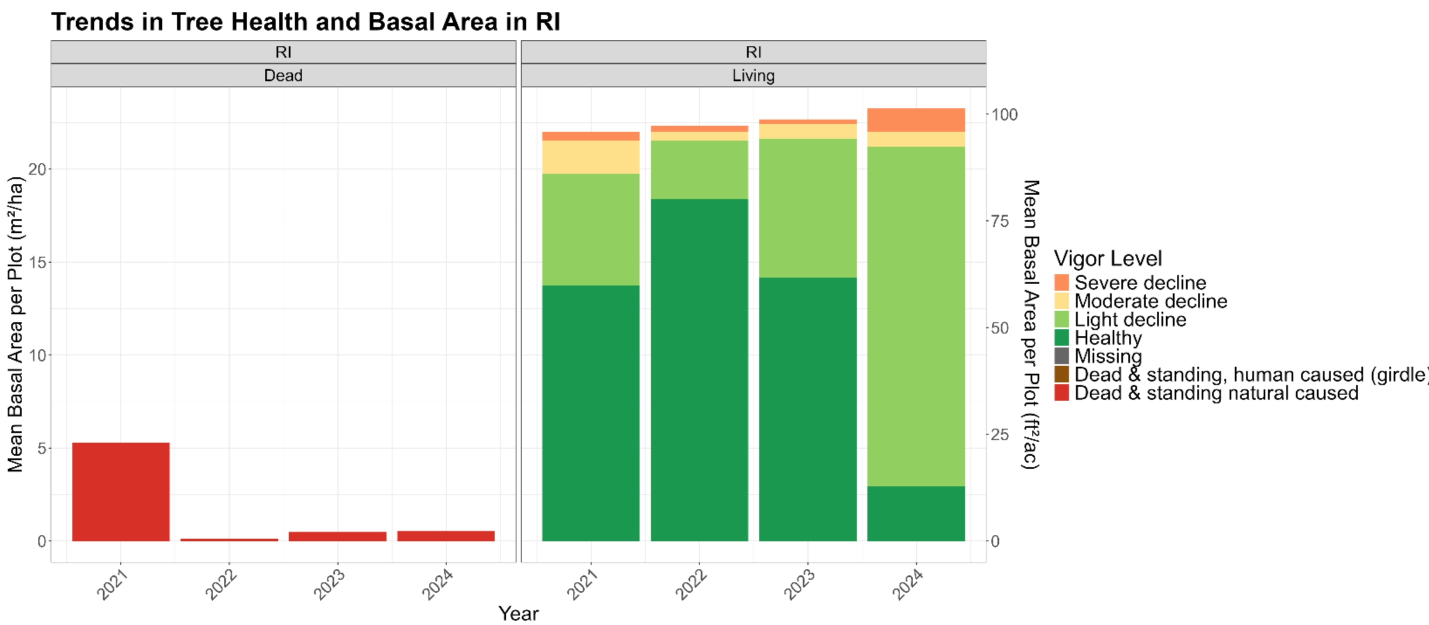

Figure 1C. Mean basal area per plot in hectares (m^2/ha, left axis) and acres (ft^2/ac, right axis) for living and dead trees in Rhode Island. Data is grouped by tree status with living classes shown on the right and dead classes on the left. An overall trend toward less vigorous trees is evident.

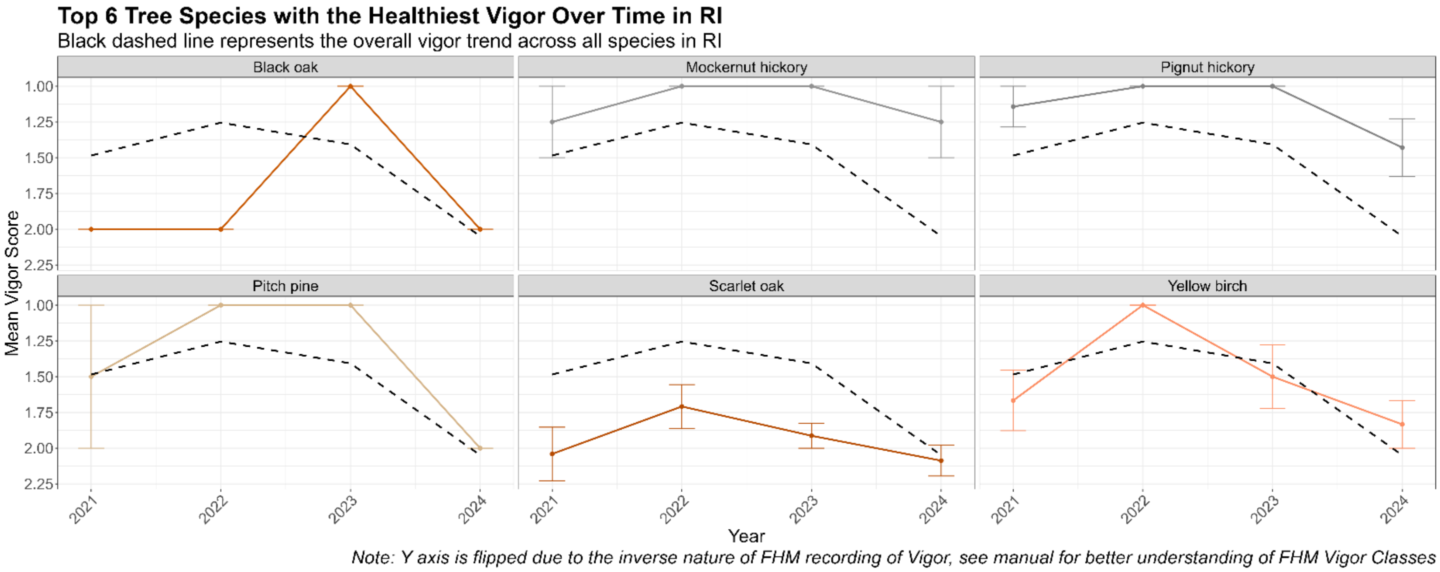

Figure 2C. Top six tree species with the healthiest vigor (lowest stress levels) over time in Rhode Island among species comprising at least 0.5% of total basal area statewide. Vigor scores range from 4 (severe decline) to 1 (healthy), with intermediate values for trees in decline. The dashed black line represents the overall vigor trend across all species sampled within the state, providing a reference for general forest condition changes. 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.

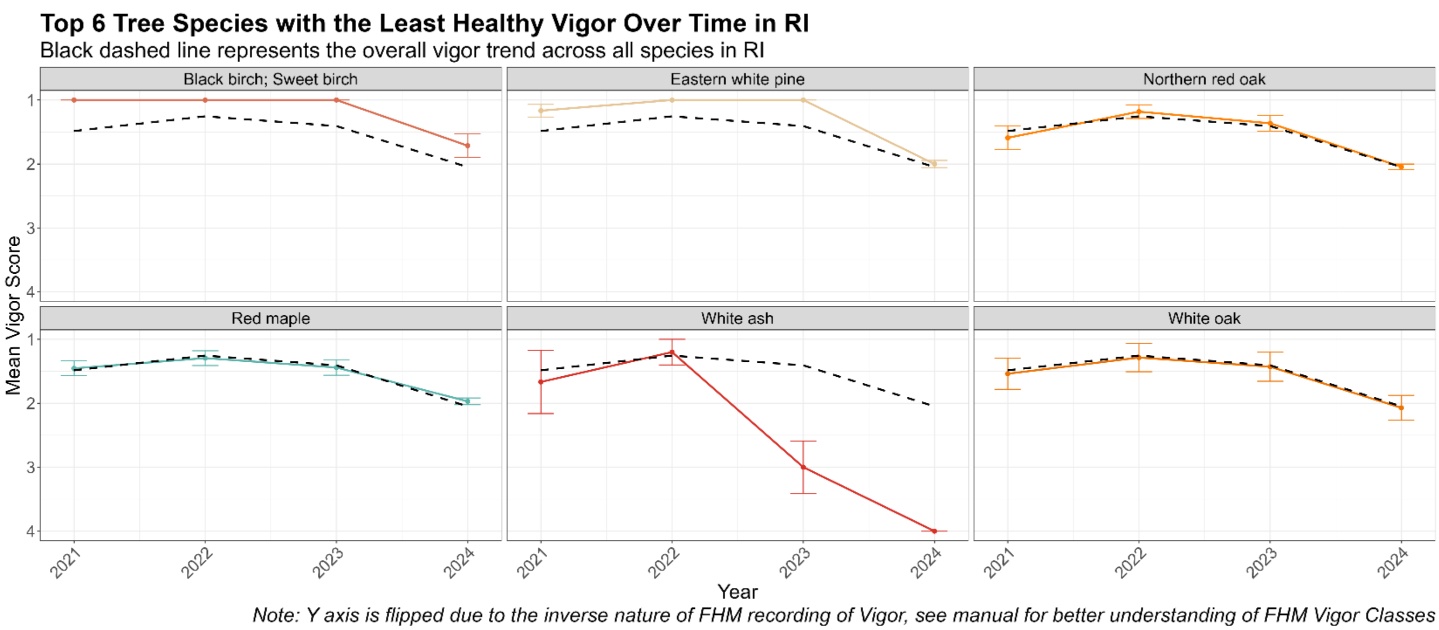

Figure 3C. Top six tree species with the greatest decline in vigor (highest stress levels) over time in Rhode Island among species comprising at least 0.5% of total basal area statewide. Vigor scores range from 4 (severe decline) to 1 (healthy), with intermediate values for trees in decline. The dashed black line represents the overall vigor trend across all species sampled within the state, enabling a broader forest health comparison. 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.

D. Annual growth and mortality trends - Trees (Rhode Island)

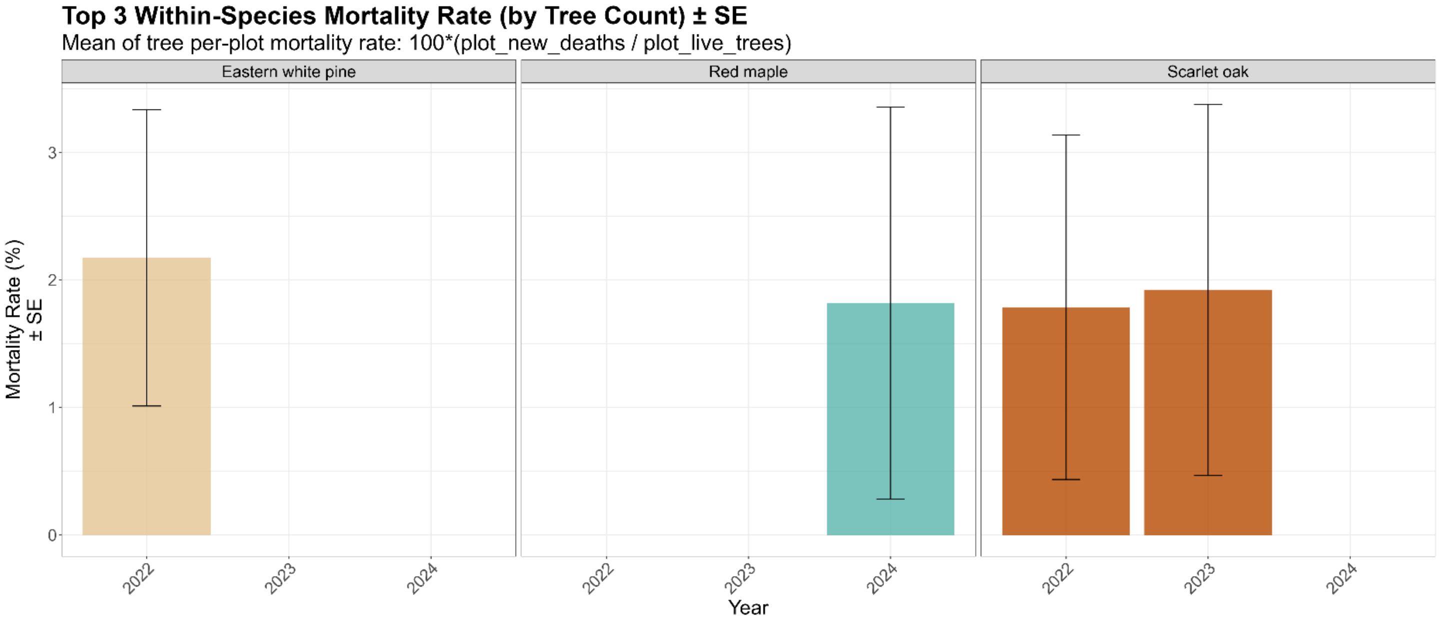

Figure 1D. Within-species mortality trends in Rhode Island for the top three tree species with the highest number of newly dead trees among species comprising more than 1% of total basal area statewide. This plot shows the annual number of newly dead trees per species, based on individual tree tracking using unique tree identifiers. 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. This metric reflects the percentage of individual trees transitioning from living to dead within their total species' samples statewide.

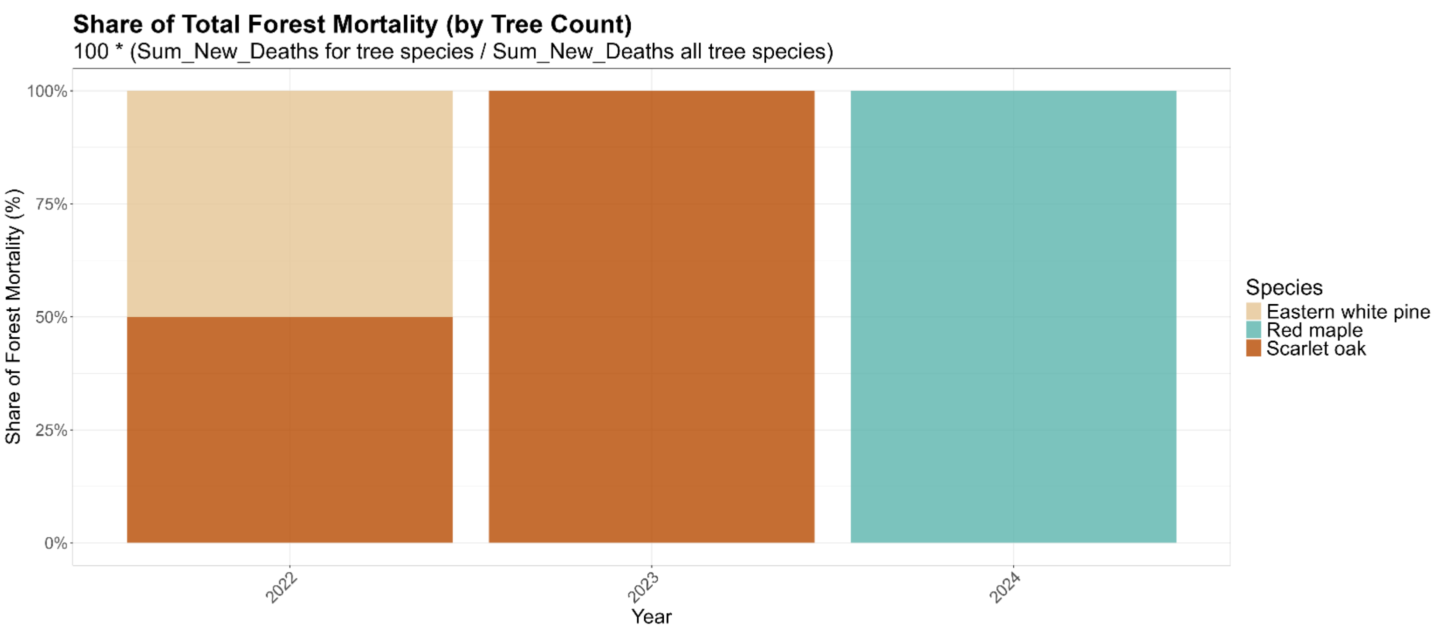

Figure 2D. Share of total forest mortality trends in Rhode Island for the top three species with the highest number of newly dead trees, relative to all newly reported tree deaths across all species comprising more than 1% of total basal area statewide.

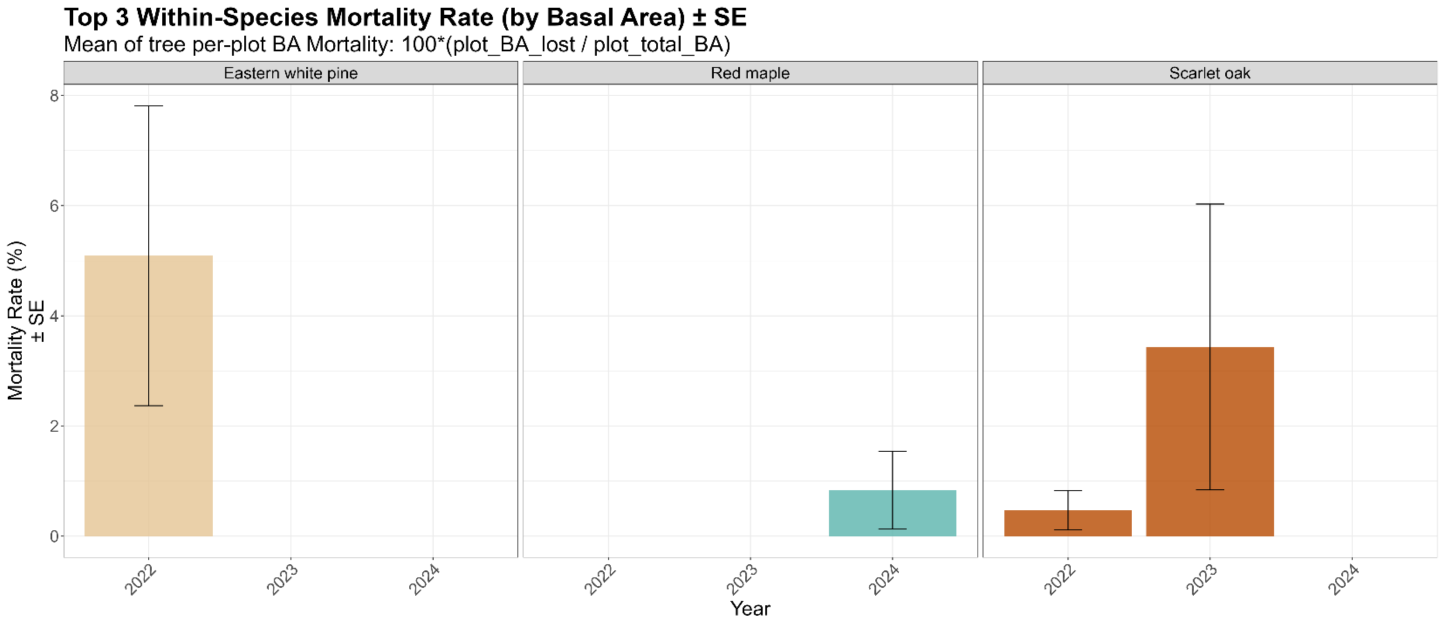

Figure 3D. Within-species mortality trends by basal area in Rhode Island for the top three species with the greatest total basal area loss among species comprising more than 1% of total basal area statewide, calculated as the sum of the last recorded basal area of all trees within a given species that transitioned from living to dead each year. Instead of simply accounting for the number of dead trees, basal area loss accounts for tree size, providing a different perspective on the impact to forest structure.

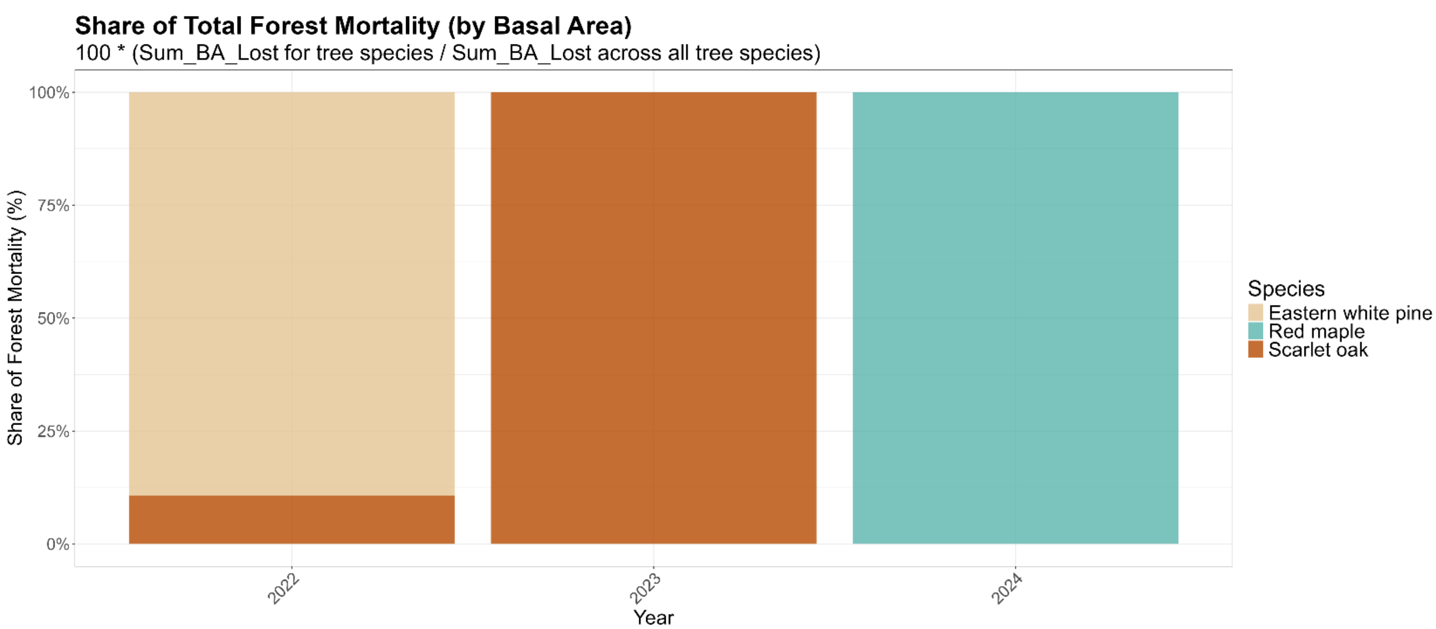

Figure 4D. Share of total lost basal area in Rhode Island for the top three species with the greatest basal area loss due to mortality, among species comprising more than 1% of total basal area statewide.

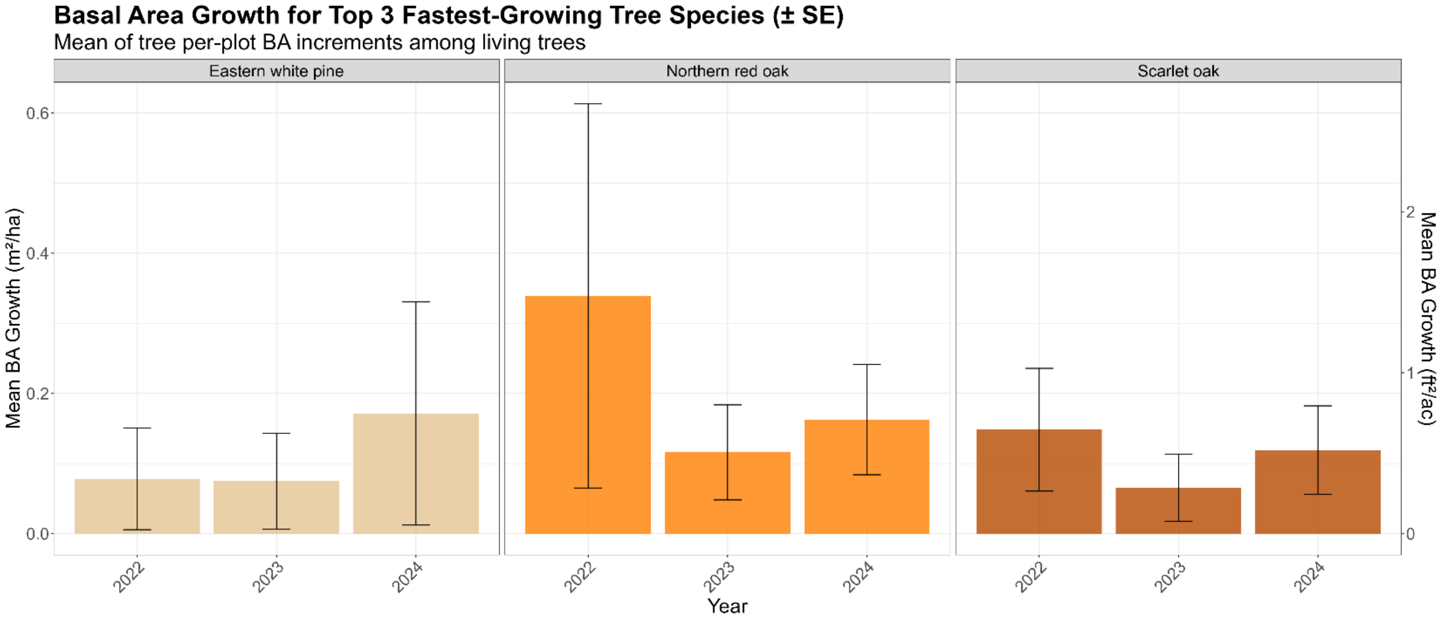

Figure 5D. Top three species with the greatest average basal area growth in Rhode Island. Bars represent the mean basal area increment in hectares (m^2/ha, left axis) and acres (ft^2/ac, right axis) each year. These growth trends illustrate which species are adding basal area the fastest, which may be related to species vigor and competitive advantage and has longer-term implications for stand development and forest composition.

E. Total composition - Trees (Rhode Island)

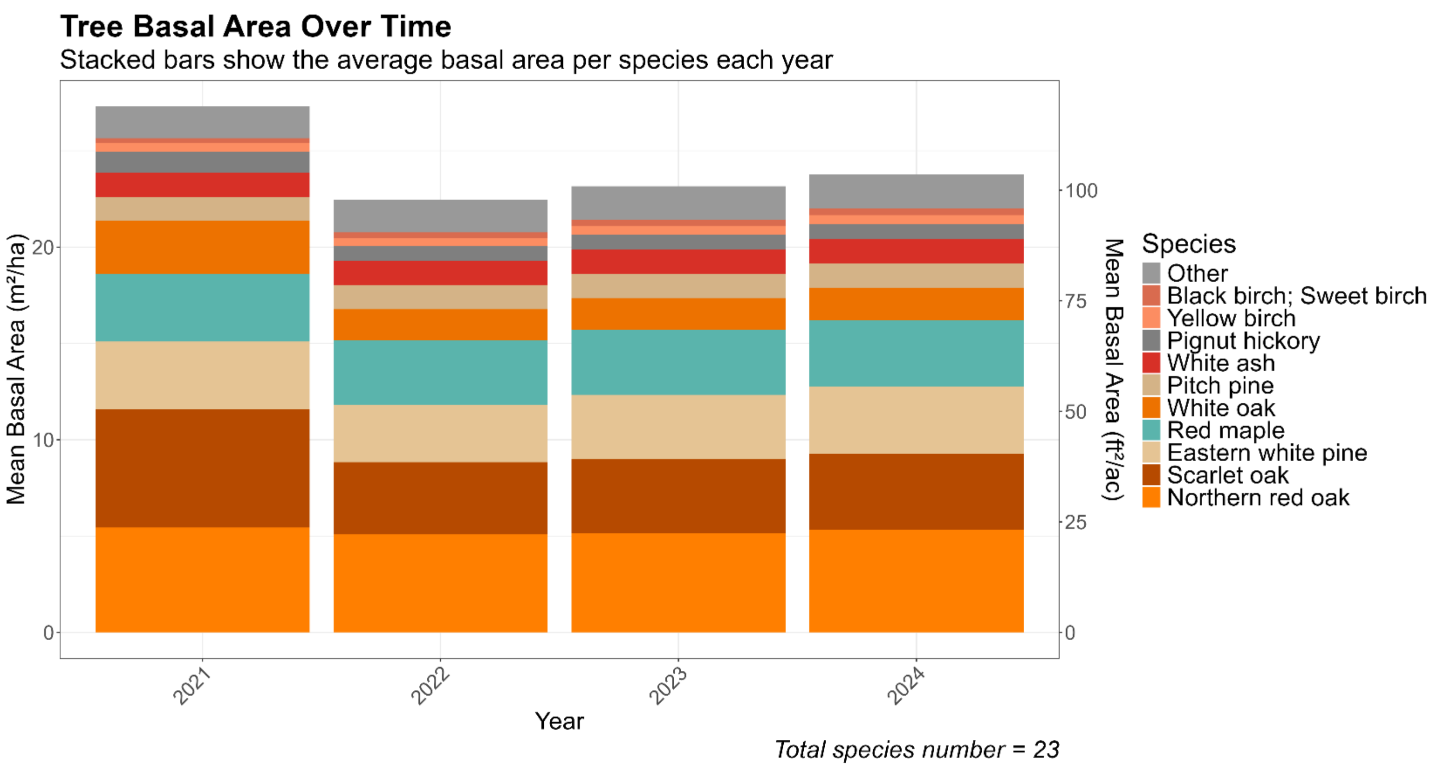

Figure 1E. Overall species composition by average live basal area in hectares (m^2/ha, left axis) and acres (ft^2/ac, right axis) across all tree species surveyed each year in Rhode Island. Species that ranked among the top ten for overall basal area are shown individually, while all species not in the top ten are combined and represented as "Other." This figure suggests which tree species are dominant or may be becoming more dominant in overall forest composition.

Section 2. Sapling Analyses (Rhode Island)

F. *Total composition – Saplings (Rhode Island)*

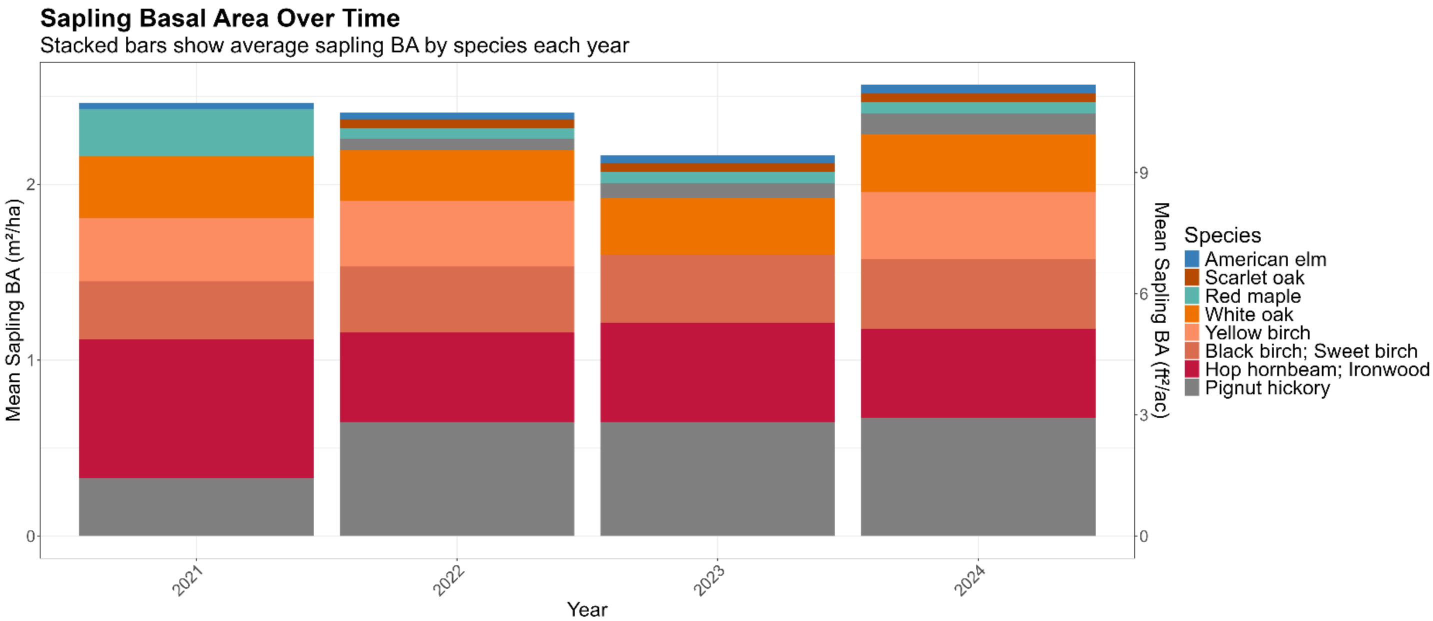

Figure 1F. Overall sapling basal area composition in hectares (m^2/ha, left axis) and acres (ft^2/ac, right axis) for all sapling species surveyed each year in Rhode Island. Species that ranked among the top ten for overall basal area are shown individually, while all species not in the top ten are combined and represented as “Other.” This figure suggests which saplings are dominant or may be becoming more dominant in our plot network statewide.

Section 3. Seedling Analyses (Rhode Island)

Note that fewer total individual seedlings and species were observed in Rhode Island plots across monitoring years, and that Rhode Island has a relatively low number of plots; both factors lead to smaller sample sizes in comparison with other states. As a result, we recommend caution in interpreting these figures as indicative of statewide trends.

We have included a seedling class size guide to assist with interpreting the figures in subgroup H.

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

G. Annual growth and mortality trends – Seedlings (Rhode Island)

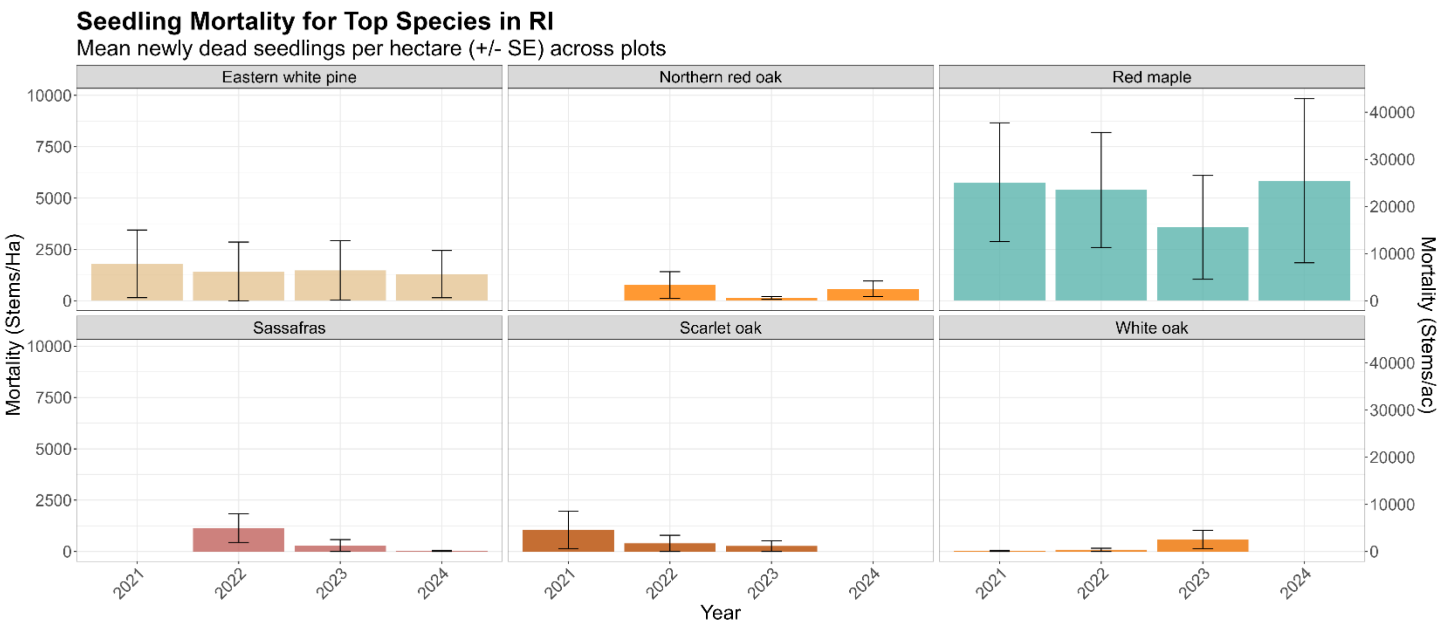

Figure 1G. The top six species showing the greatest mortality at the seedling stage in Rhode Island by stem count, presented by the mean number of seedlings transitioning from smaller to larger classes by stems per hectare (SPH, left axis) and acre (SPA, right axis) each year. While we do not record seedling mortality, we estimate based on reductions in seedling counts in our seedling sub-plots from one year to the next.

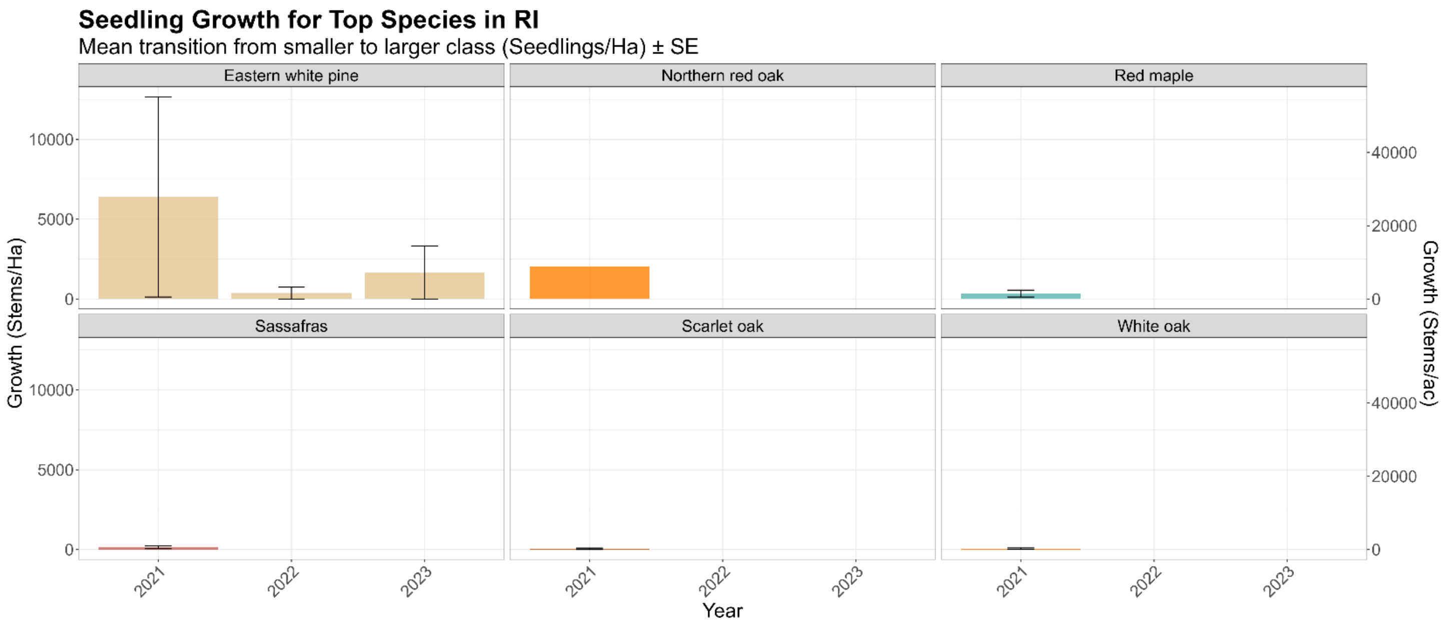

Figure 2G. The top six species showing the greatest growth at the seedling stage in Rhode Island by stem count, presented by the mean number of seedlings transitioning from smaller to larger classes by stems per hectare (SPH, left axis) and acre (SPA, right axis) each year.

H. Annual seedling density trends (Rhode Island)

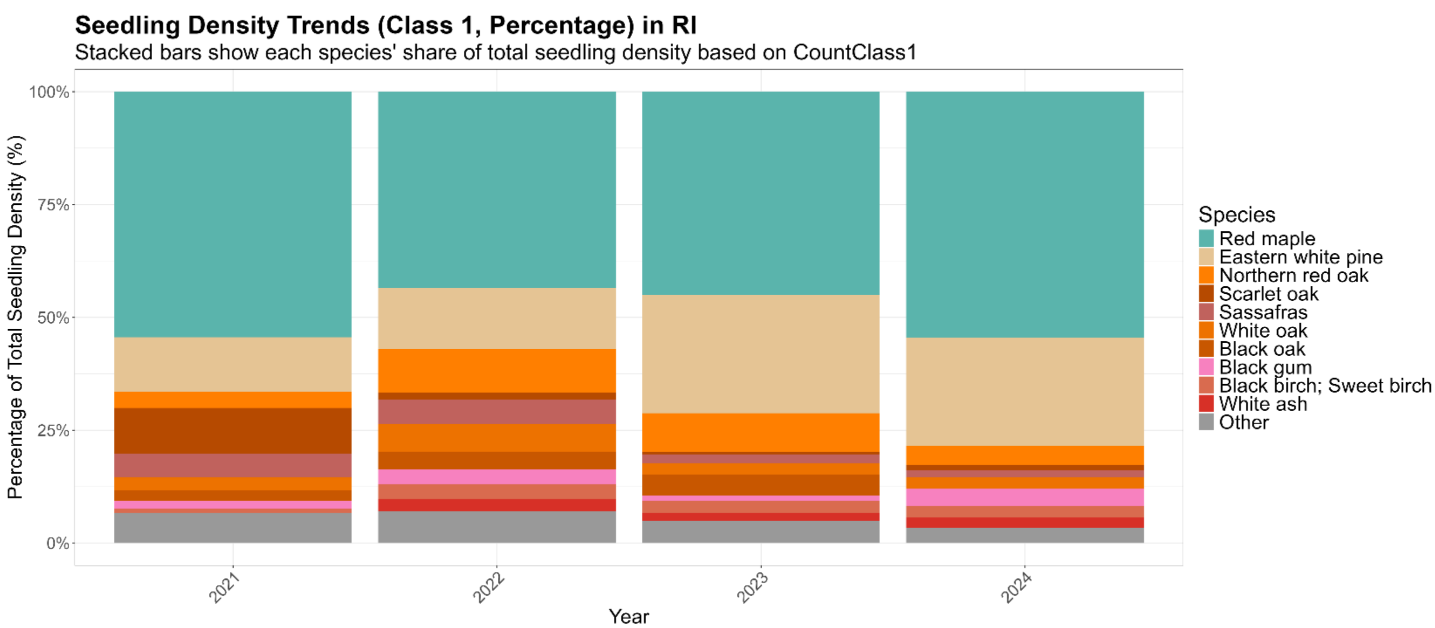

Figure 1H-i. Percent annual composition of Class 1 seedlings for all species surveyed each year in Rhode Island. The top ten most represented species by stem count are shown individually, while all other species not in the top ten are combined and represented as “Other.” This figure suggests potential trends in changes in species composition within the seedling layer over time.

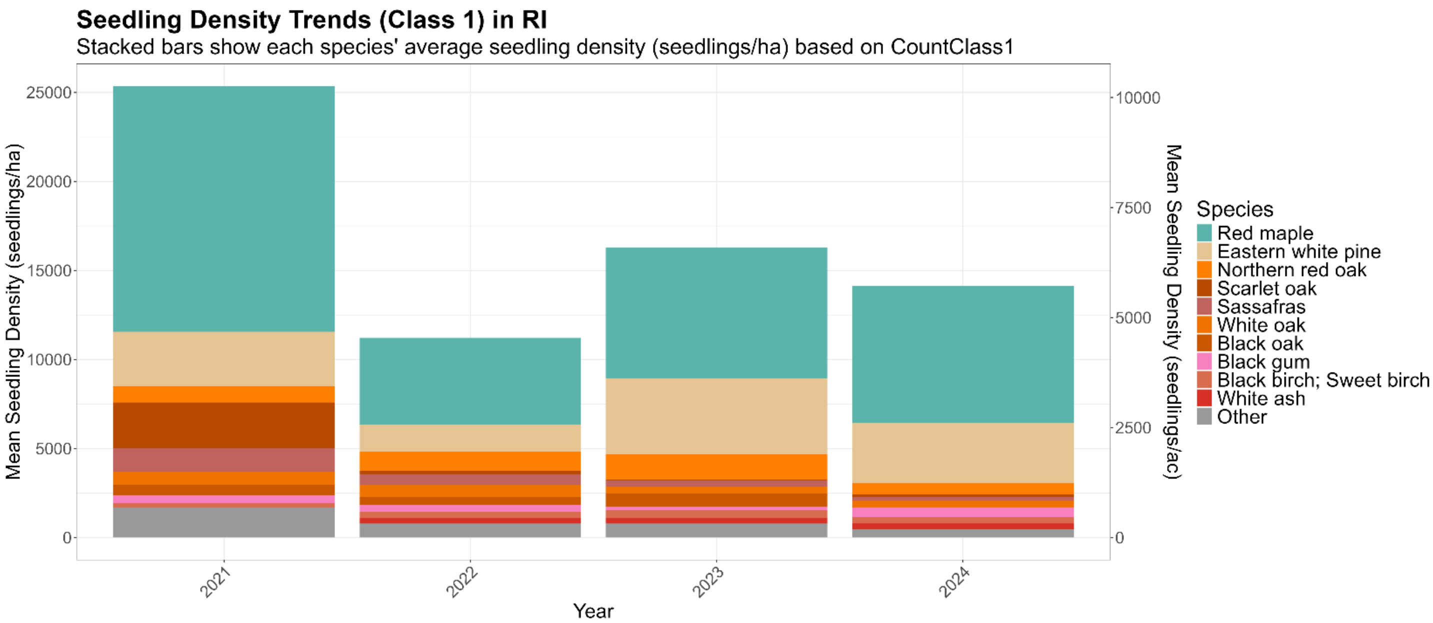

Figure 1H-ii. Class 1 seedling counts in stems per hectare (SPH, left axis) and acre (SPA, right axis) for all species surveyed each year in Rhode Island. The top ten most represented species by stem count are shown individually, while all species not in the top ten are combined and represented as "Other." The overall bar height indicates total number of Class 1 seedlings per hectare and acre statewide for each year.

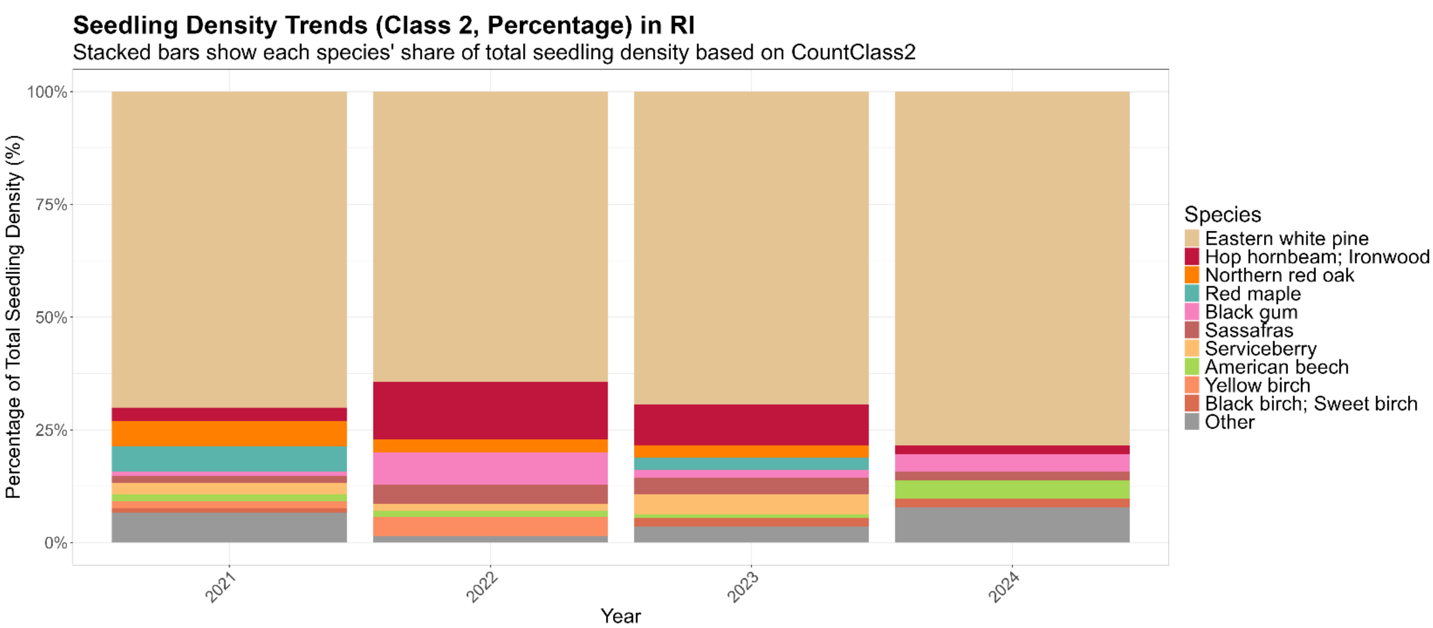

Figure 2H-i. Percent annual composition of Class 2 seedlings surveyed each year in Rhode Island. The top ten most represented species by stem count are shown individually, while all species not in the top ten are combined and represented as "Other."

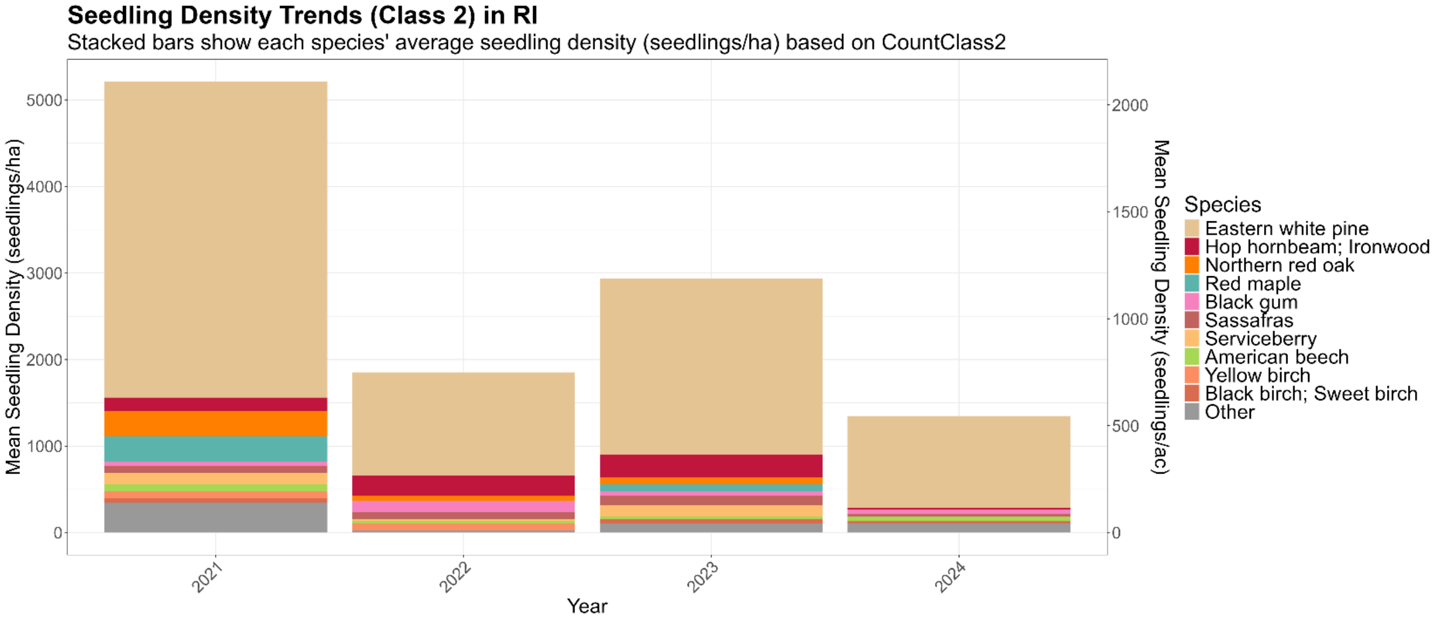

Figure 2H-ii. Class 2 seedling counts in stems per hectare (SPH, left axis) and acre (SPA, right axis) for all species surveyed each year in Rhode Island. The top ten most represented species by stem count are shown individually, while all species not in the top ten are combined and represented as "Other." The overall bar height indicates total number of Class 2 seedlings per hectare and acre statewide for each year.

Vermont

Section 1. Tree Analyses (Vermont)

A. *Dieback trends (Vermont)*

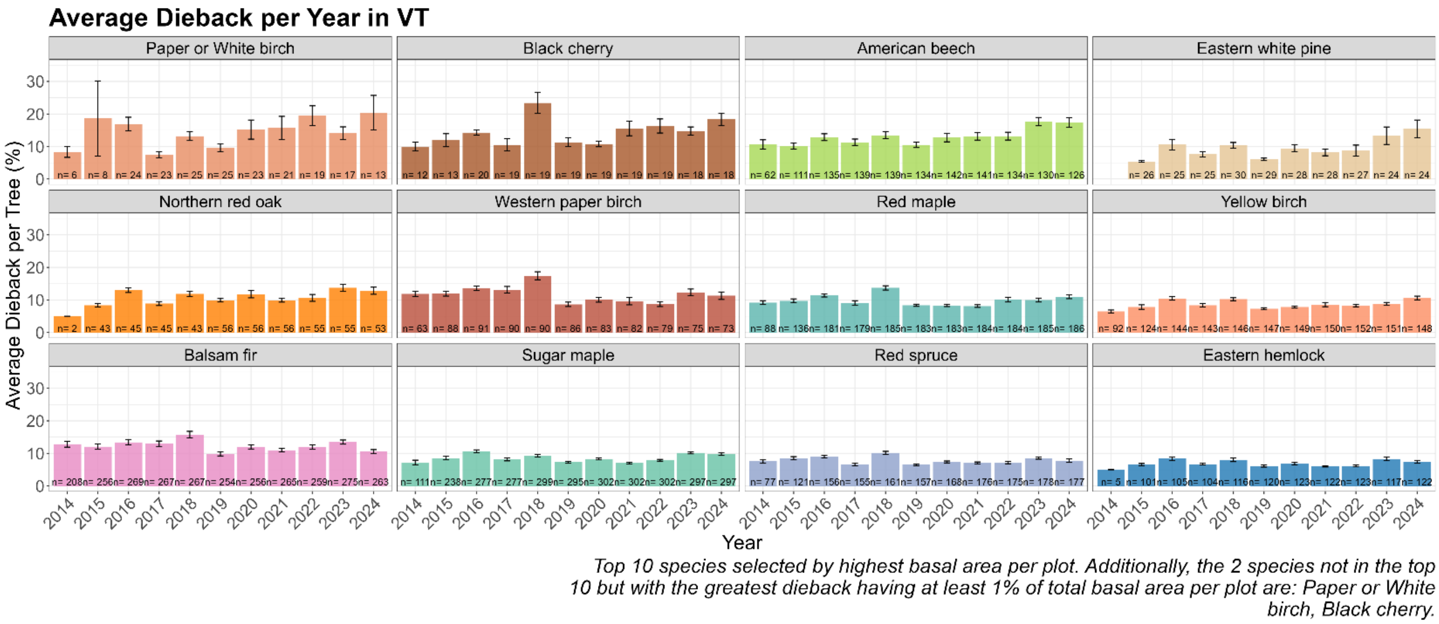

Figure 1A. Vermont average fine twig dieback trends by species and year for the top ten species by basal area, plus two that are less prevalent by basal area but are nonetheless showing high dieback (paper birch, black cherry). Species are ordered by highest dieback in 2024.

B. *Transparency trends (Vermont)*

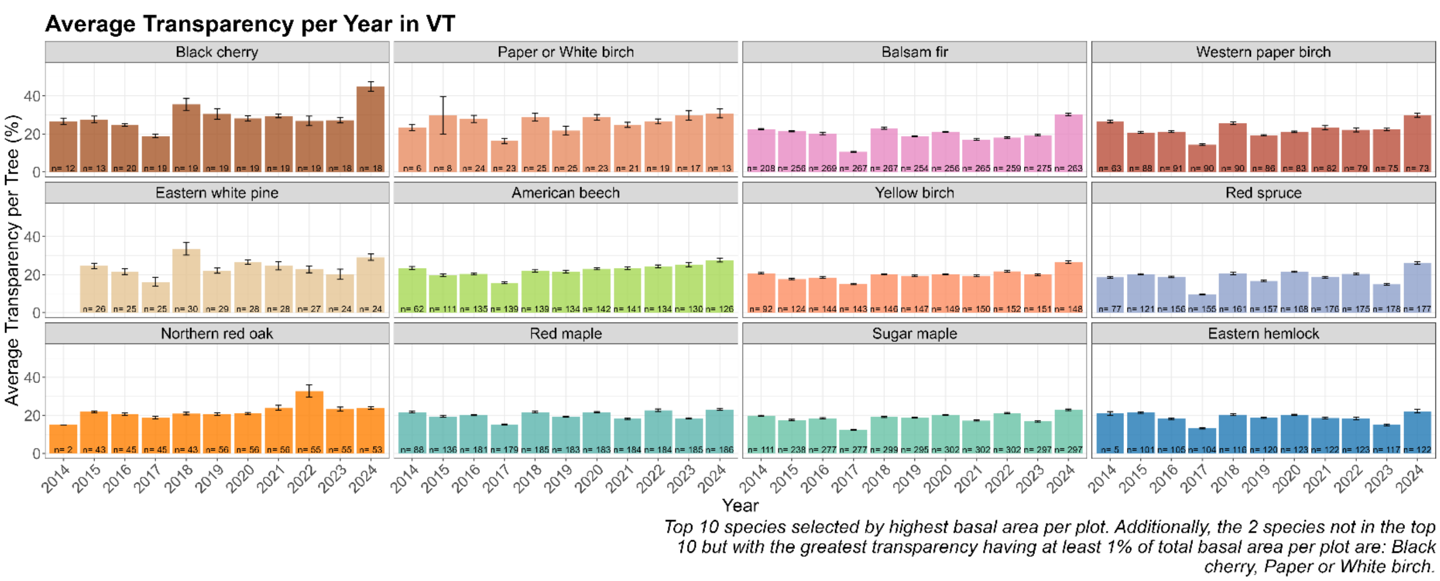

Figure 1B. Vermont average leaf transparency trends by species and year, for the top ten species by basal area plus two that are less prevalent by basal area but are nonetheless showing high transparency (black cherry, paper birch). Species are ordered by greatest transparency in 2024.

C. Vigor trends (Vermont)

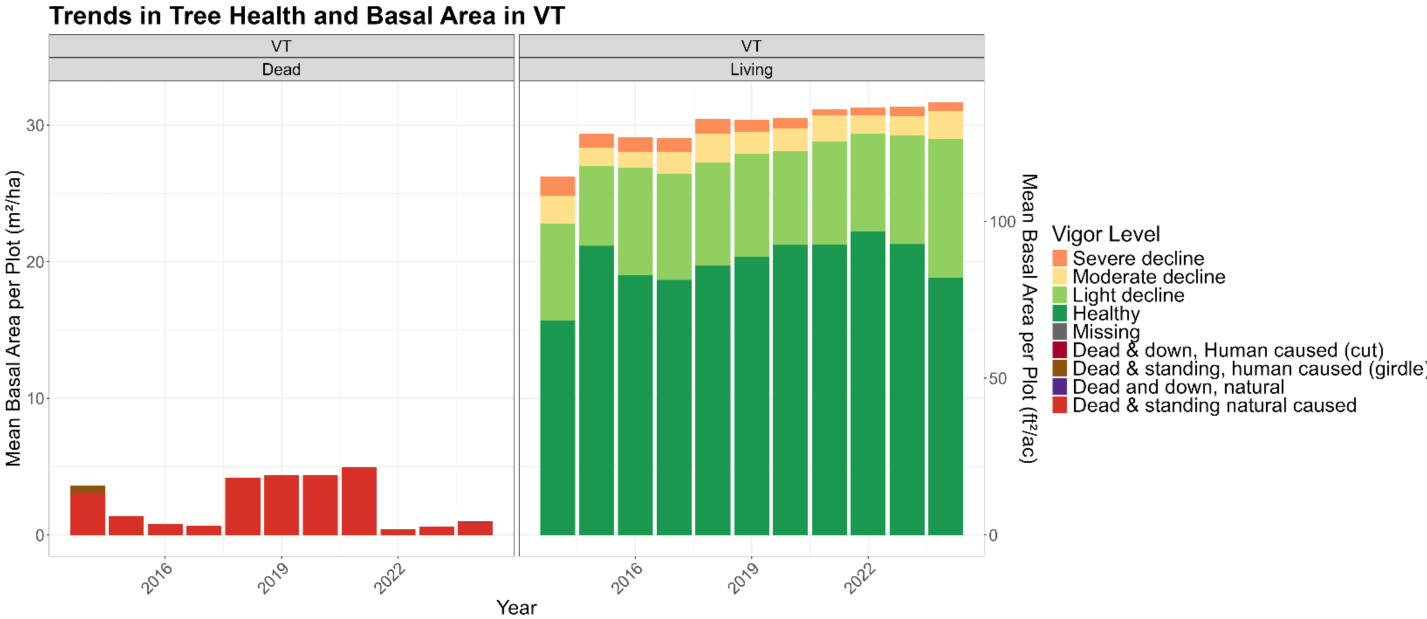

Figure 1C. Mean basal area per plot in hectares (m^2/ha, left axis) and acres (ft^2/ac, right axis) for living and dead trees in Rhode Island. Data is grouped by tree status with living classes shown on the right and dead classes on the left.

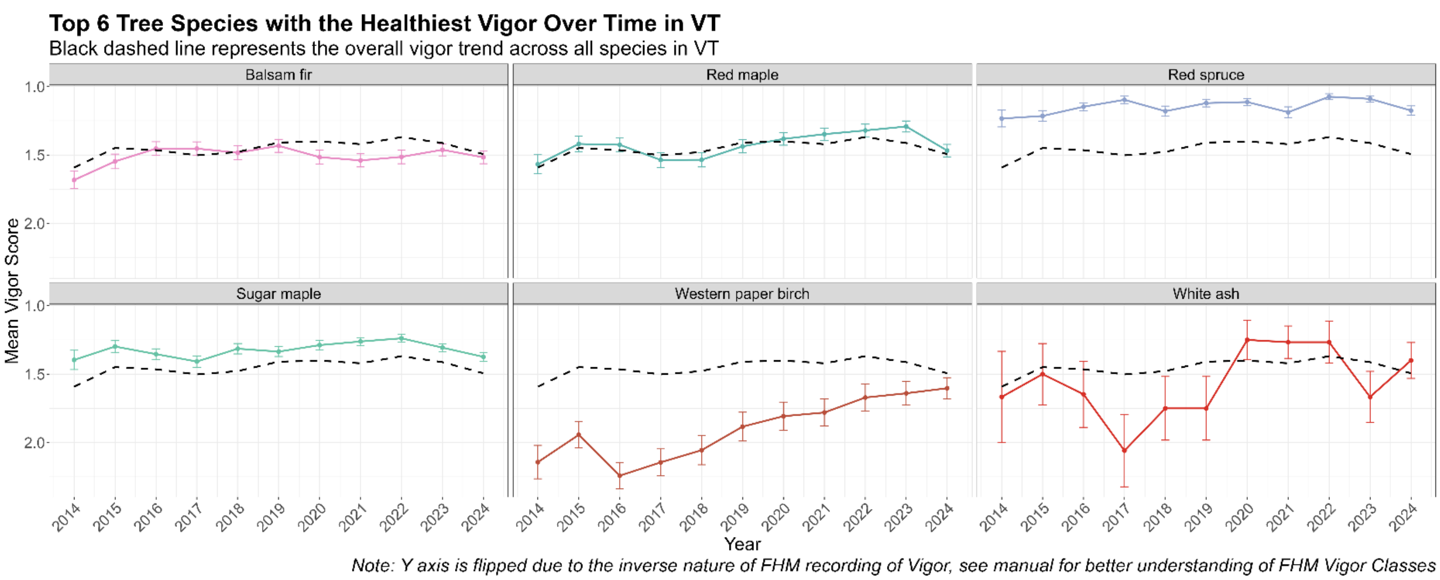

Figure 2C. Top six tree species with the healthiest vigor (lowest stress levels) over time in Vermont among species comprising at least 0.5% of total basal area statewide. Vigor scores range from 4 (severe decline) to 1 (healthy), with intermediate values for trees in decline. The dashed black line represents the overall vigor trend across all species sampled within the state, providing a reference for general forest condition changes. 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.

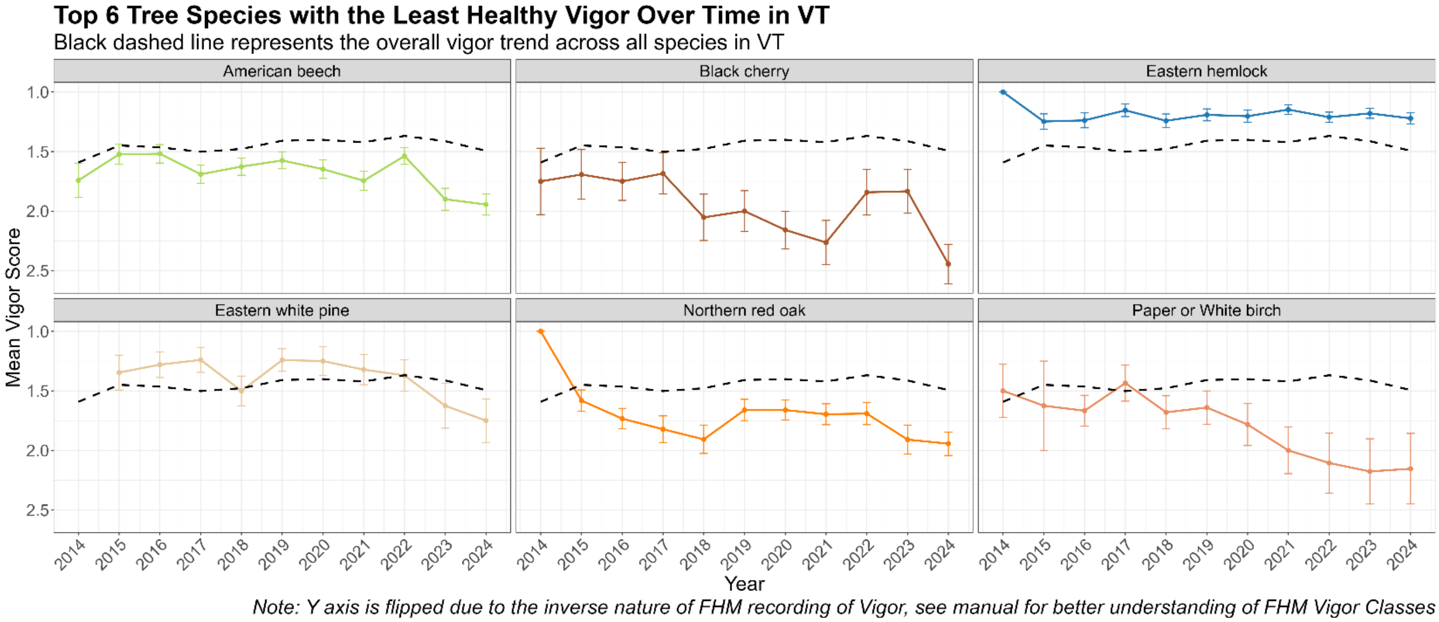

Figure 3C. Top six tree species with the greatest decline in vigor (highest stress levels) over time in Vermont among species comprising at least 0.5% of total basal area statewide. Vigor scores range from 4 (severe decline) to 1 (healthy), with intermediate values for trees in decline. The dashed black line represents the overall vigor trend across all species sampled within the state, enabling a broader forest health comparison. 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.

D. Annual growth and mortality trends – Trees (Vermont)

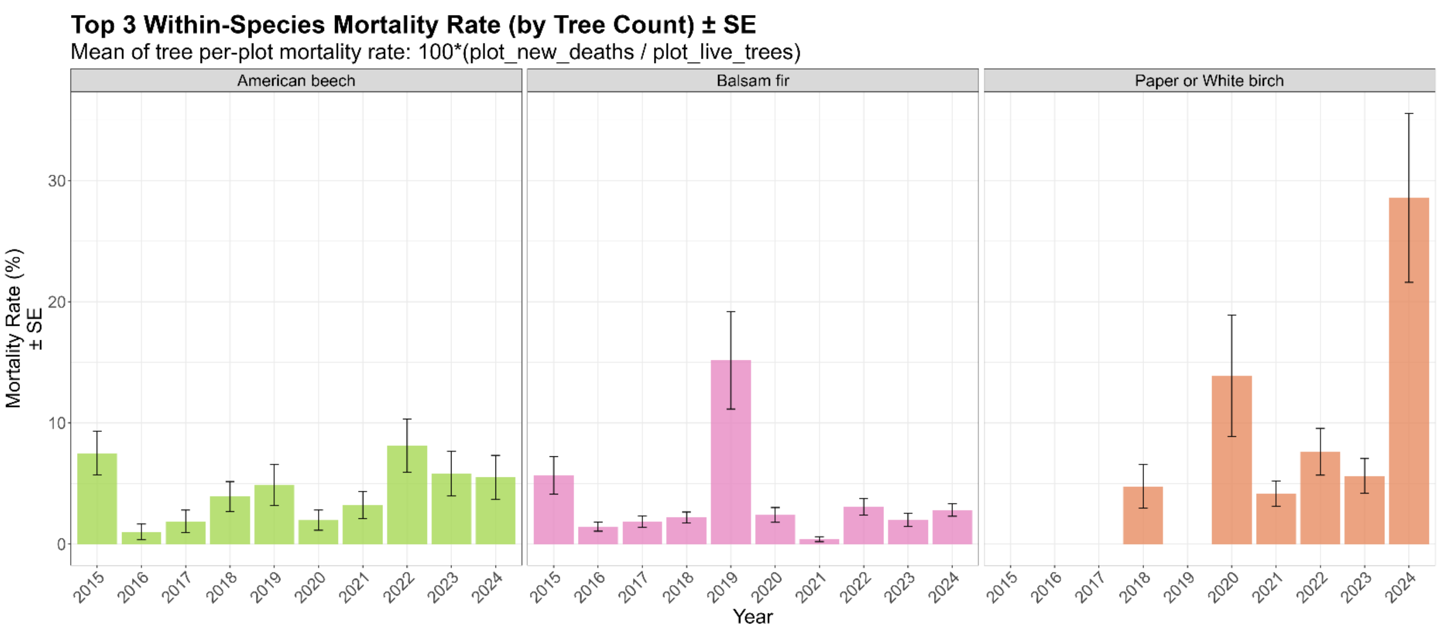

Figure 1D. Within-species mortality trends in Vermont for the top three tree species with the highest number of newly dead trees among species comprising more than 1% of total basal area statewide. This plot shows the annual number of newly dead trees per species, based on individual tree tracking using unique tree identifiers. 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. This metric reflects the percentage of individual trees transitioning from living to dead within their total species' samples statewide.

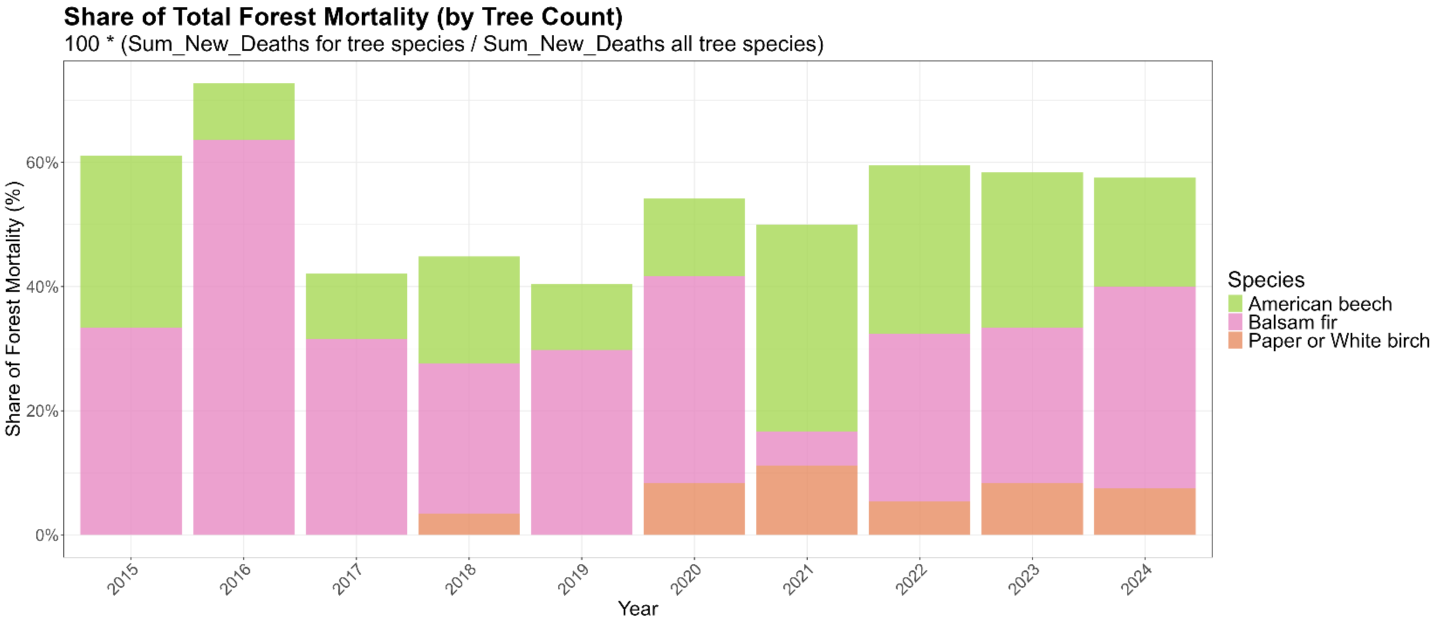

Figure 2D. Share of total forest mortality trends in Vermont for the top three species with the highest number of newly dead trees, relative to all newly reported tree deaths across all species comprising more than 1% of total basal area statewide.

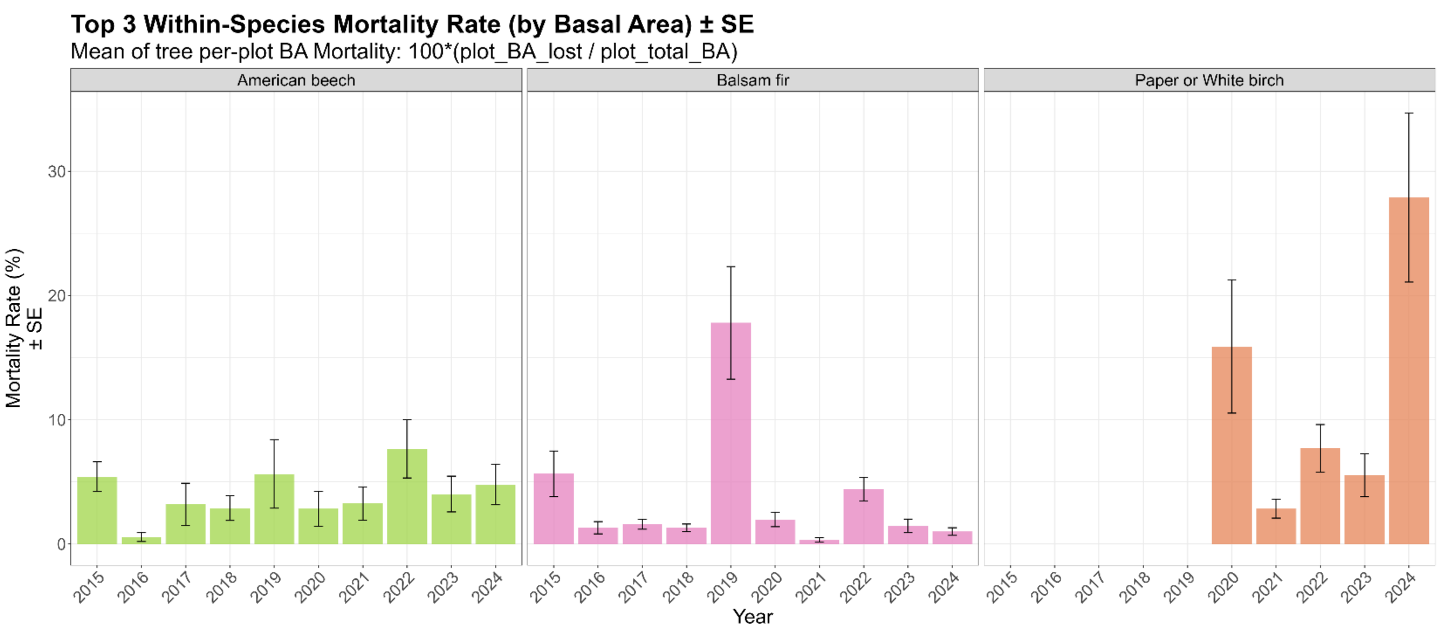

Figure 3D. Within-species mortality trends by basal area in Vermont for the top three species with the greatest total basal area loss among species comprising more than 1% of total basal area statewide, calculated as the sum of the last recorded basal area of all trees within a given species that transitioned from living to dead each year. Instead of simply accounting for the number of dead trees, basal area loss accounts for tree size, providing a different perspective on the impact to forest structure.

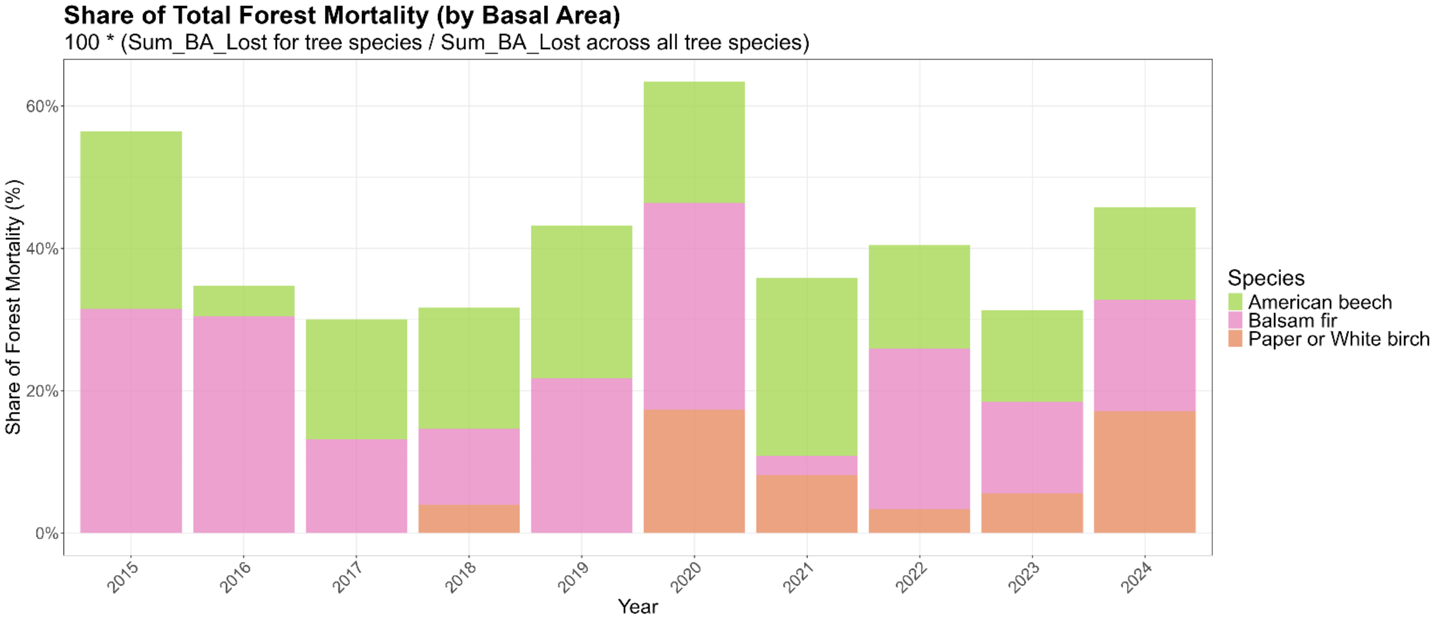

Figure 4D. Share of total lost basal area in Vermont for the top three species with the greatest basal area loss due to mortality, among species comprising more than 1% of total basal area statewide.

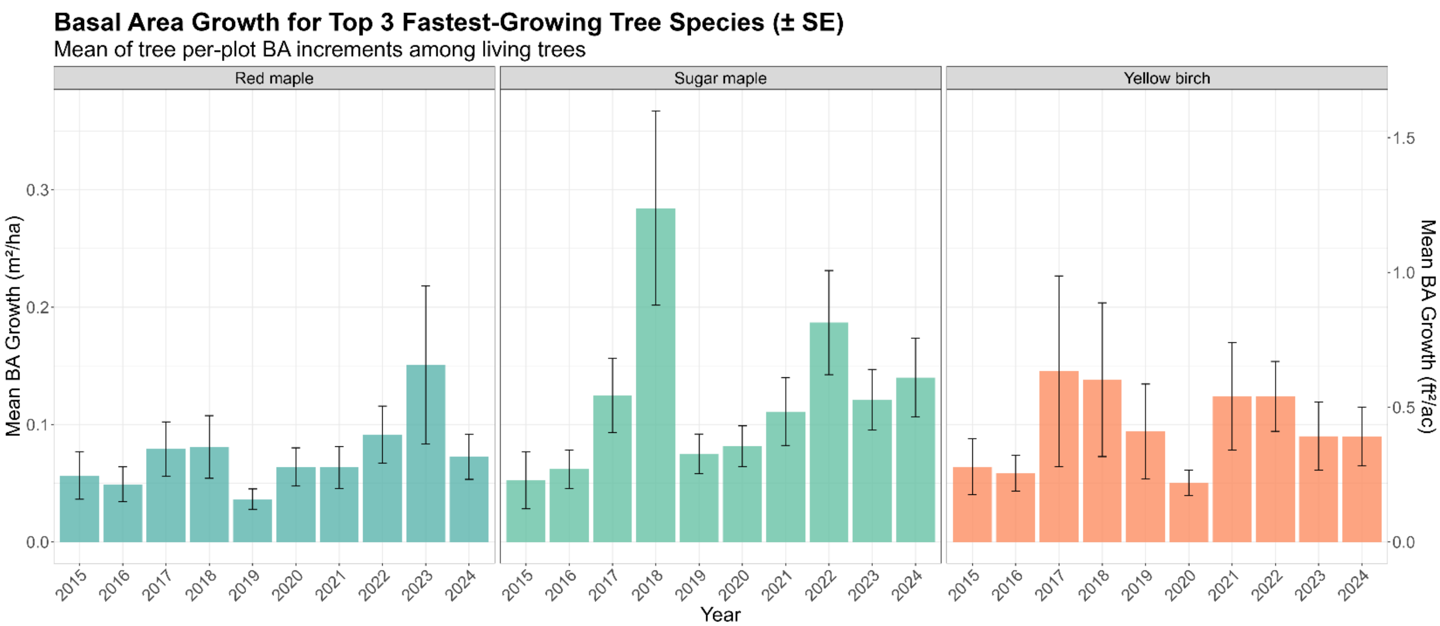

Figure 5D. Top three species with the greatest average basal area growth in Vermont. Bars represent the mean basal area increment in hectares (m^2/ha, left axis) and acres (ft^2/ac, right axis) each year. These growth trends illustrate which species are adding basal area the fastest, which may be related to species vigor and competitive advantage and has longer-term implications for stand development and forest composition.

E. Total composition - Trees (Vermont)

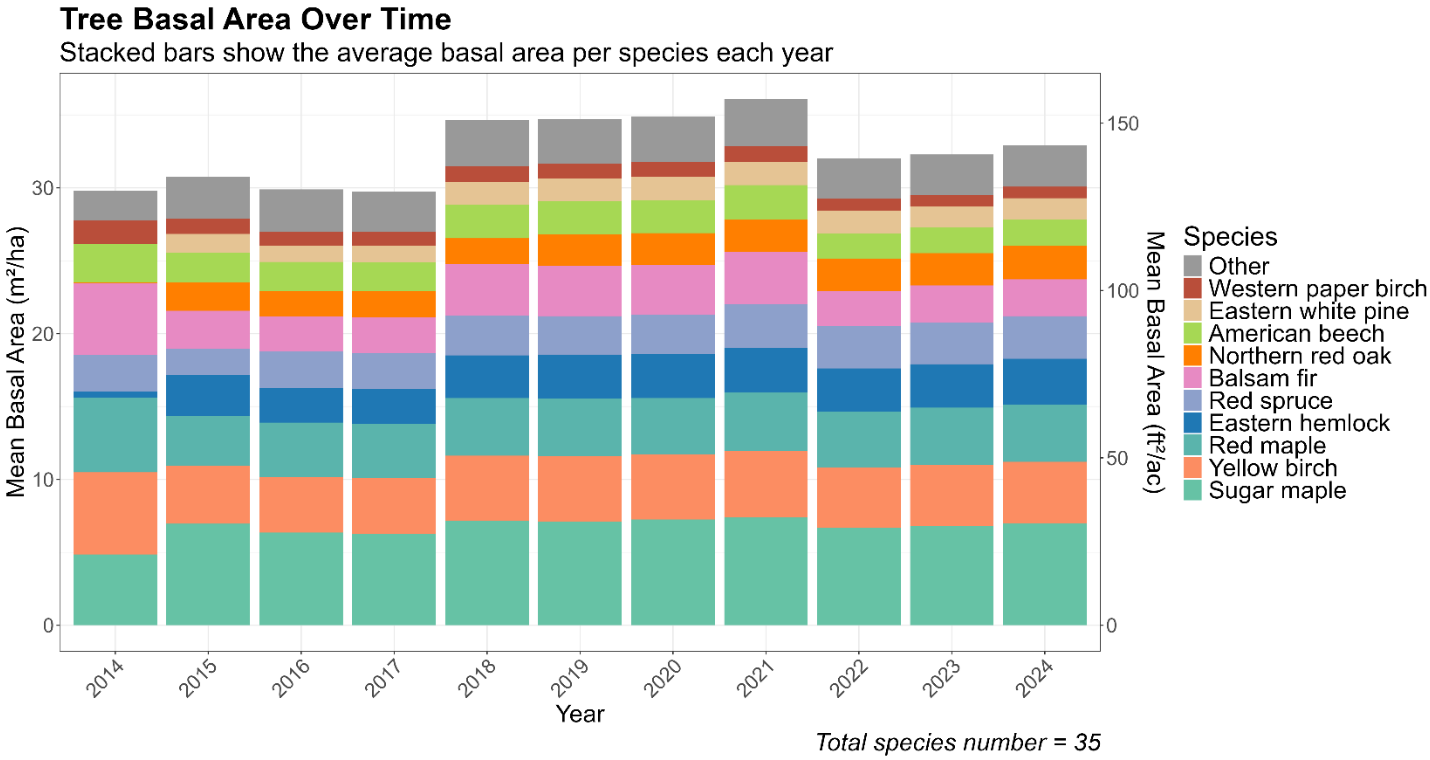

Figure 1E. Overall species composition by average live basal area in hectares (m^2/ha, left axis) and acres (ft^2/ac, right axis) across all tree species surveyed each year in Vermont. Species that ranked among the top ten for overall basal area are shown individually, while all species not in the top ten are combined and represented as "Other." This figure suggests which tree species are dominant or may be becoming more dominant in overall forest composition.

Section 2. Sapling Analyses (Vermont)

F. Total composition – Saplings (Vermont)

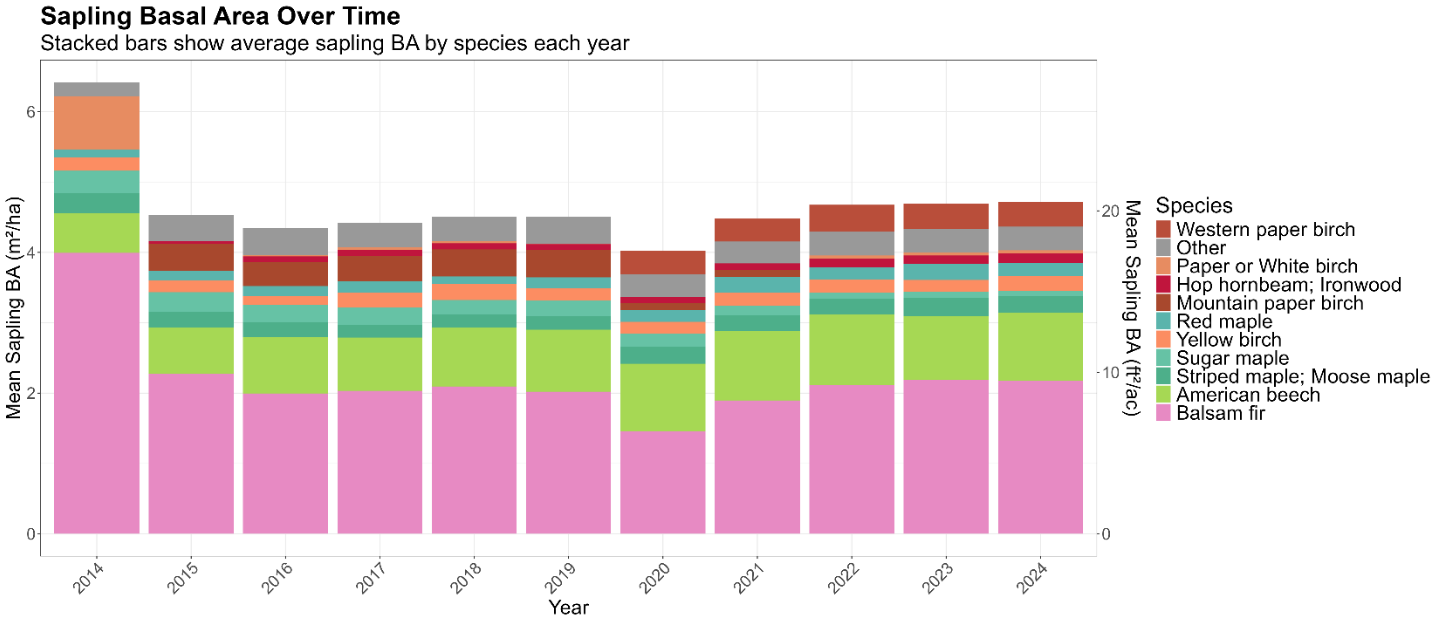

Figure 1F. Overall sapling basal area composition in hectares (m^2/ha, left axis) and acres (ft^2/ac, right axis) for all sapling species surveyed each year in Vermont. Species that ranked among the top ten for overall basal area are shown individually, while all species not in the top ten are combined and represented as “Other.” This figure suggests which saplings are dominant or may be becoming more dominant in our plot network statewide.

Section 3. Seedling Analyses (Vermont)

We have included a seedling class size guide to assist with interpreting the figures in subgroup H.

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

G. Annual growth and mortality trends – Seedlings (Vermont)

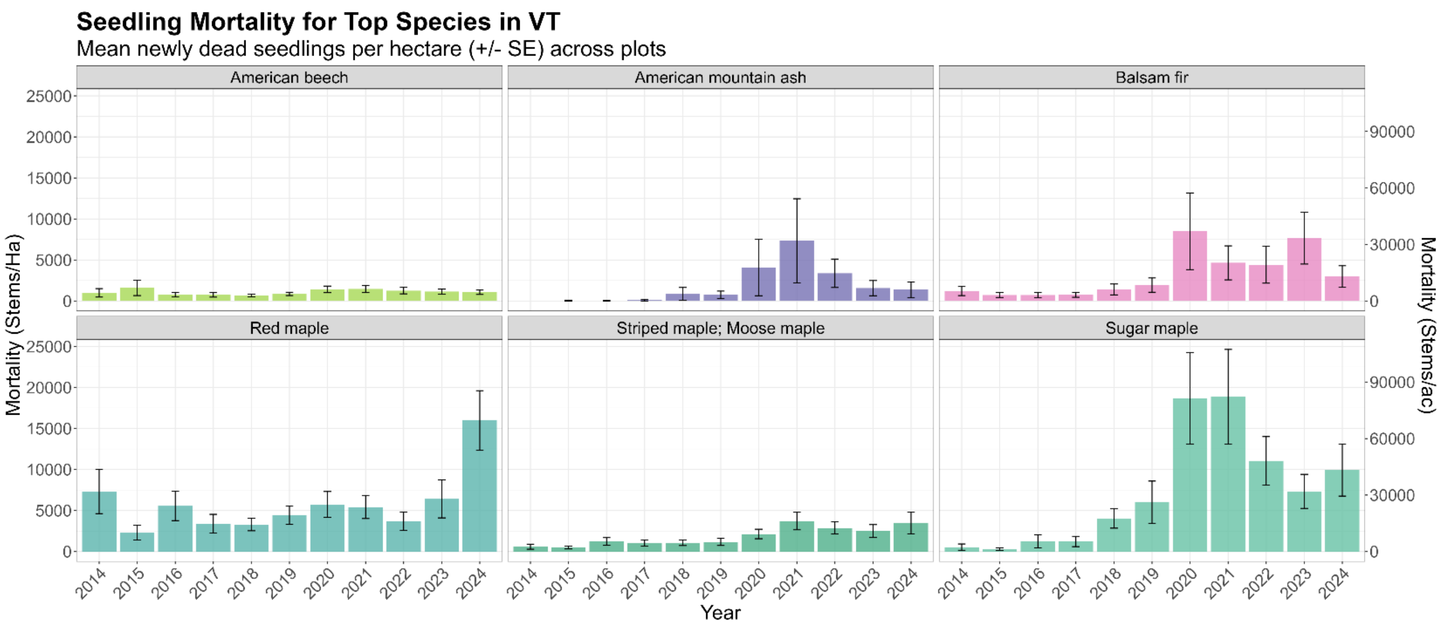

Figure 1G. The top six species showing the greatest mortality at the seedling stage in Vermont by stem count, presented by the mean number of seedlings transitioning from smaller to larger classes by stems per hectare (SPH, left axis) and acre (SPA, right axis) each year. While we do not record seedling mortality, we estimate based on reductions in seedling counts in our seedling sub-plots from one year to the next.

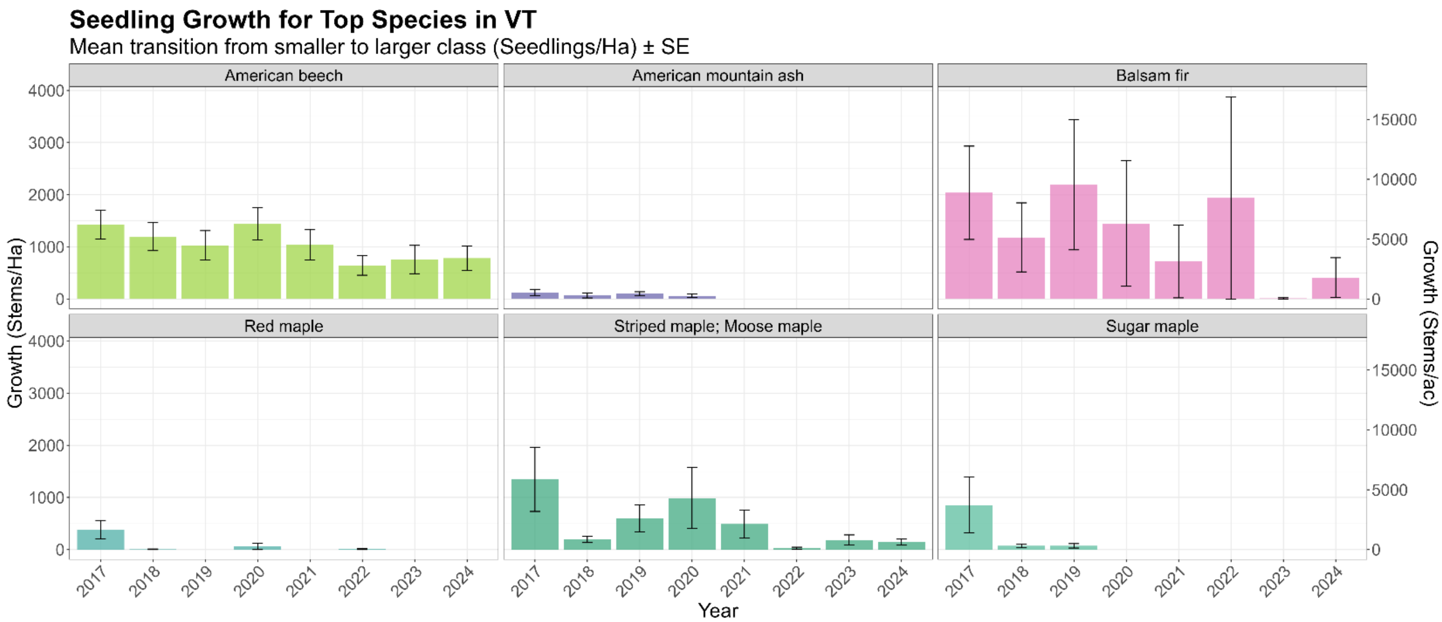

Figure 2G. The top six species showing the greatest growth at the seedling stage in Vermont by stem count, presented by the mean number of seedlings transitioning from smaller to larger classes by stems per hectare (SPH, left axis) and acre (SPA, right axis) each year.

H. Annual seedling density trends (Vermont)

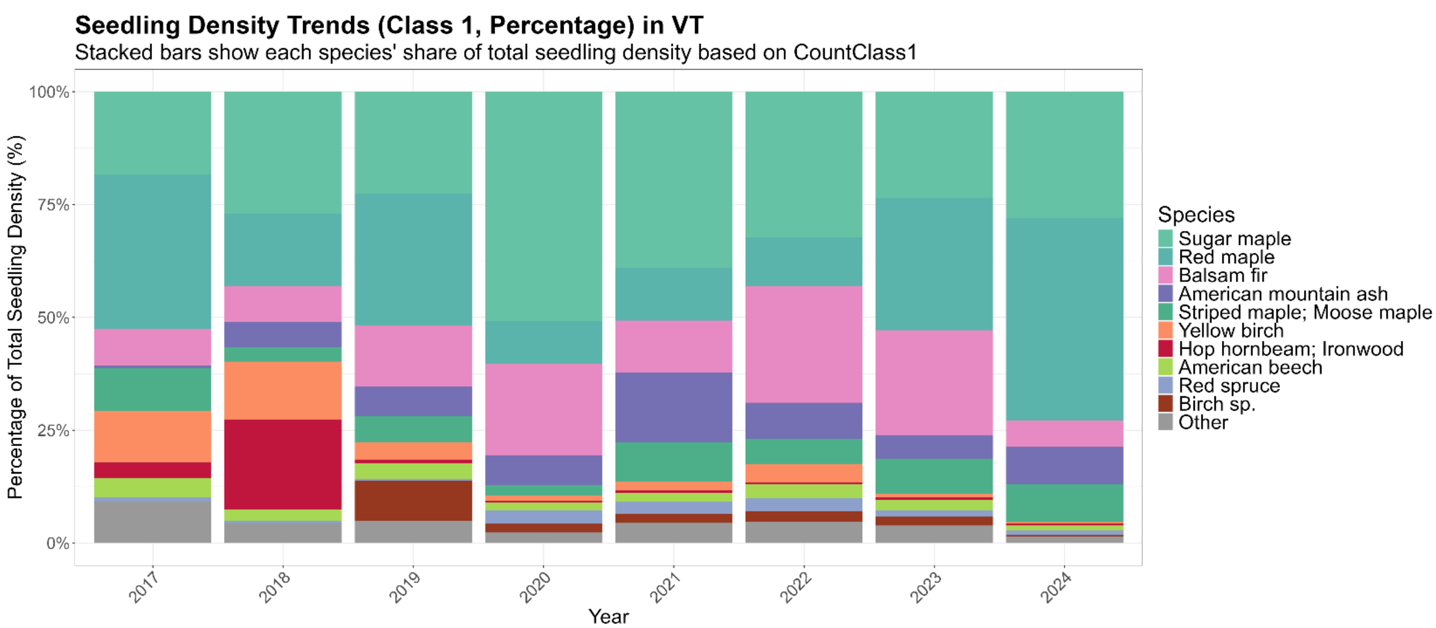

Figure 1H-i. Percent annual composition of Class 1 seedlings for all species surveyed each year in Vermont. The top ten most represented species by stem count are shown individually, while all other species not in the top ten are combined and represented as "Other." This figure suggests potential trends in changes in species composition within the seedling layer over time.

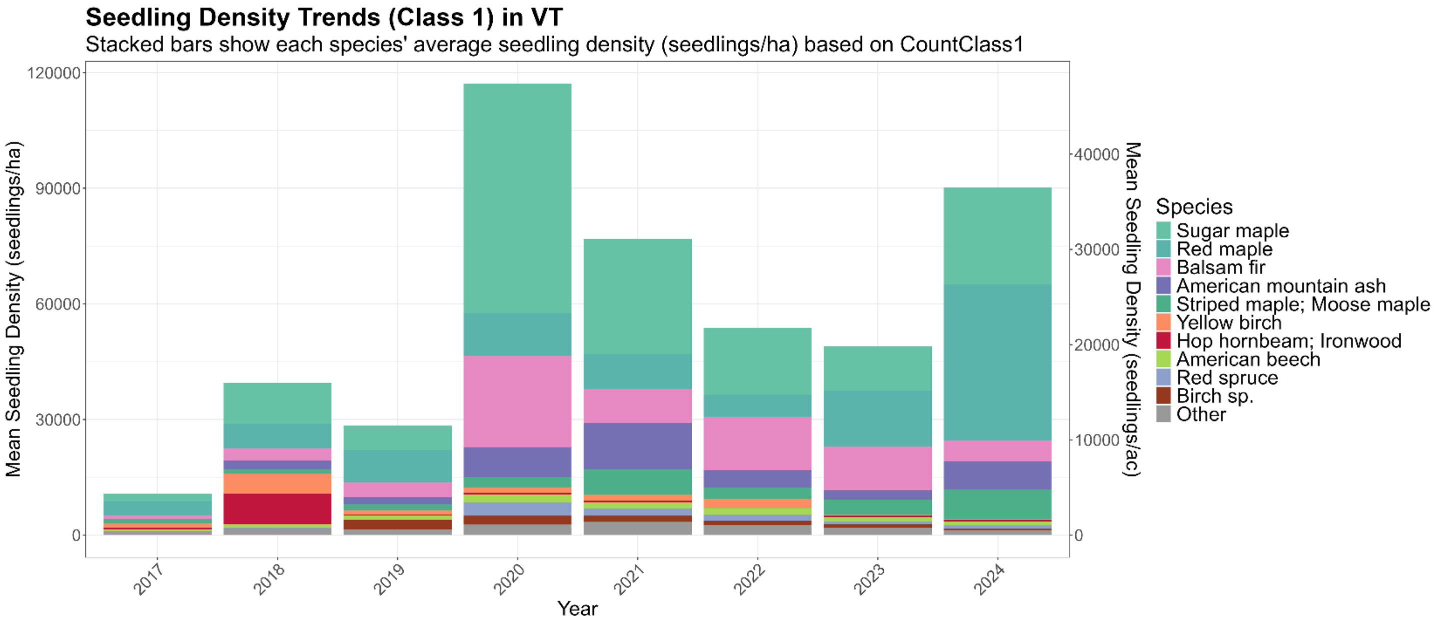

Figure 1H-ii. Class 1 seedling counts in stems per hectare (SPH, left axis) and acre (SPA, right axis) for all species surveyed each year in Vermont. The top ten most represented species by stem count are shown individually, while all species not in the top ten are combined and represented as “Other.” The overall bar height indicates total number of Class 1 seedlings per hectare and acre statewide for each year.

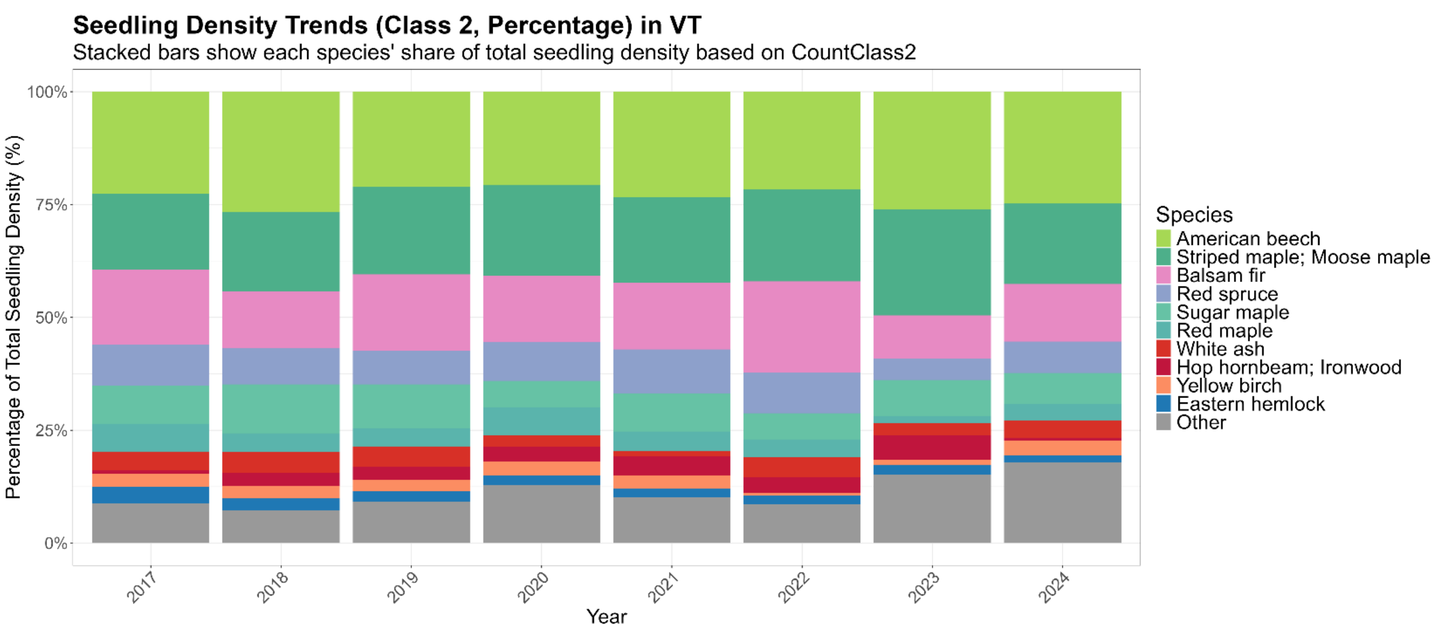

Figure 2H-i. Percent annual composition of Class 2 seedlings surveyed each year in Vermont. The top ten most represented species by stem count are shown individually, while all species not in the top ten are combined and represented as “Other.”

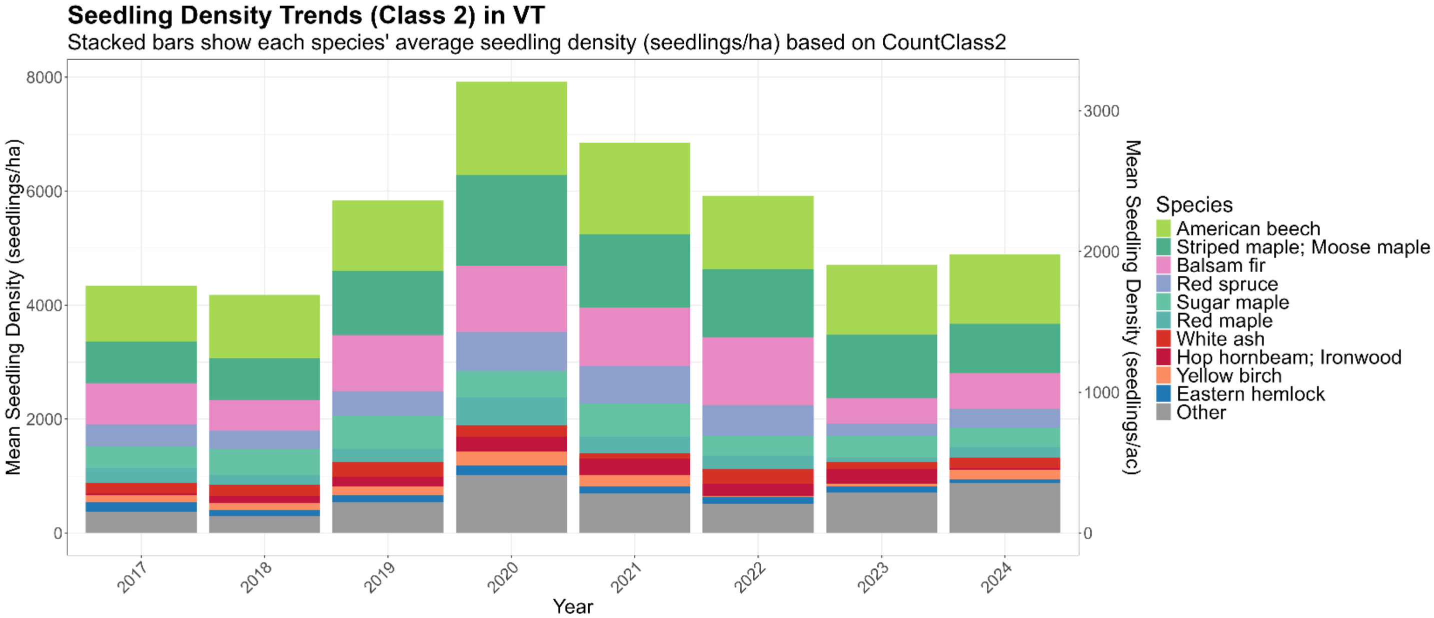

Figure 2H-ii. Class 2 seedling counts in stems per hectare (SPH, left axis) and acre (SPA, right axis) for all species surveyed each year in Vermont. The top ten most represented species by stem count are shown individually, while all species not in the top ten are combined and represented as "Other." The overall bar height indicates total number of Class 2 seedlings per hectare and acre statewide for each year.