REGIONAL FOREST HEALTH MONITORING PROGRAM

2025 FHM Methods

FEMC

Forest Ecosystem Monitoring Cooperative

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Background

About the Forest Health Monitoring Program

Federal Origins: FIA and CFI

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). Plots consisting of four fixed area subplots, 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, which is 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 a variety of 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 changes that can fluctuate due to weather, disturbance, or pest and pathogen outbreaks. Examples of these changes include seedling abundance, sapling survivorship, ungulate browse, tree crown health, and damages. While periodic inventories allow for a larger number of total plots across the landscape, this is accomplished at the expense of the more detailed information revealed by annual inventories.

FHM in Vermont

The Forest Health Monitoring Program in Vermont was established in 1991 as a joint effort between the Vermont Department of Forests, Parks and Recreation (FPR) and the Vermont Monitoring Cooperative (VMC; now the Forest Ecosystem Monitoring Cooperative or "FEMC") to monitor the condition of a range of tree species in Vermont. Annual measurements of forest plots allow for a better understanding of trends in forest health, as well as potential drivers of decline. Plot design follows the structure set by the National Forest Health Monitoring Program with additional metrics added to reflect improvements in monitoring technologies and additions to monitoring objectives.

In response to this need for more detailed annual measurements to provide a more nuanced and informative understanding of forest health, VMC established 49 FHM plots in Vermont between 1991 and 2018 that span 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 designed to provide information on early symptoms of tree stress and changes in forest structure and composition. The information obtained from the 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.

Monitoring was initiated in 1991 with 8 plots on the west slope of Mt. Mansfield, paired at 4 elevations. An additional 5 plots were added in the Lye Brook Wilderness Area in 1994 and 1995. In 1997, 6 additional plots were added on the east slope of Mt. Mansfield in pairs at 3 elevations. Initially, plots were visited every year, but beginning in 2008, a three-year rotation was established, moving between the east-side Mt. Mansfield plots in the first year, Lye Brook plots in the second year, and west-side Mt. Mansfield plots in the third year. In 2014, VMC and FPR mobilized additional resources to return to a yearly inventory and expand the network of plots across the state in order to better represent Vermont's full range of forest types and ecological habitats. To do this, only sites with existing or historical forest health inventories were considered, allowing the data from these new plots to be compared to earlier measurements, extending the total monitoring record. Specifically, the Forest Inventory and Analysis plots (https://research.fs.usda.gov/programs/fia), Vermont Hardwood Health Surveys plots (*https://www.uvm.edu/femc/data/archive/project/vermont-hardwood-tree-health-survey*), North American Maple Project plots (*https://www.uvm.edu/femc/data/archive/project/forest-health-monitoring-north-american-maple*), and Green Mountain National Forest Long-term Ecosystem Monitoring Program plots were targeted.

FHM Regional Expansion

In 2017 VMC was officially renamed to the Forest Ecosystem Monitoring Cooperative (FEMC). 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 the New England and New York region. In 2019, FEMC collaborated with the Massachusetts Department of Conservation and Recreation (MA DCR) to establish 20 FHM plots on Massachusetts state and private lands to add to its annual FHM network (see Box 1 for further details on integrating existing plots into our network). By 2022, FEMC had expanded to all 7 states in New England and New York. FEMC partnered with various organizations and agencies within each of the seven regional states to gather existing long-term monitoring plot information. Nesting FHM plots on top of or adjacent to these existing networks when available allows for temporal comparisons of metrics monitored at the site.

The new regional plot network comprises a total of 196 plots as of the 2025 season: 15 in Connecticut, 24 in Massachusetts, 35 in Maine, 25 in New Hampshire, 39 in New York, 7 in Rhode Island, and 49 in Vermont.

Methods

Plot Selection

In expanding the FHM Network, FEMC created a sampling concentration similar to that of the plot network in Vermont. The amount of forestland in Vermont, as defined by FIA, was used to calculate the number of acres per plot in Vermont, and that value was applied to the other states' forestland area to define desired plot density. The USFS FIA Forest Type (2008) spatial layer was used as a coarse filter to determine the species composition in certain areas. Ground truth assessments of the species composition were made in the field.

For each state, the overall percentage of each forest type was calculated and combined with the target plot density to identify a target plot number for each forest type within each state. We removed any forest types with a total regional target plot number less than two (2), since these were generally rare forest types or subsets of major forest types.

FEMC partnered with various organizations and agencies within each of the seven states to gather existing long-term monitoring plot information. State partners reviewed plot locations, and changes were made based on plot access, incorrect forest type designation, management considerations, and other factors. Nesting FHM plots on top of or adjacent to existing state networks, when possible, allows for longer temporal assessments of the metrics monitored at those sites. The final location review was confirmed or amended by the crew as they visited each plot for the first time during the field season.

While plots were co-located with existing FIA and CFI plot networks where possible, new plots were established where current networks did not exist or where certain forest types were underrepresented by existing plot locations.

If a plot network was already in place, we prioritized plot locations based upon the following criteria:

1) The plot must be within a natural forest (plantations are not considered natural forests).
    a. We prioritized plots that landed on public lands over those on private lands; however, plots on private lands were not excluded.
    b. All plots located on non-forest land or non-natural forest land were removed.
2) Plots on conserved land or in reserve status were prioritized over lands designated for timber management.
3) Plots had to be more than 200 ft, but less than 10,000 ft, from roads. New plots also had to be no more than 2,000 ft from a trail.
    a. All plots outside of these parameters were removed.
4) Plots had to be on a slope shallower than 15%.

5) Plot distribution across each state had to be representative of the overall forest composition for the state and spatially balanced across the state's forestland.

When a state's historical monitoring plots were not available or were otherwise not suitable to be surveyed as FHM plots, new plots were established. The same criteria as above were used to select randomly generated plot locations for these states.

We buffered from roads to reduce the impact that roads and traffic may introduce to the forest ecosystem. The FHM program's main goal is to measure disturbance impacts driven by climate change and the disturbance from roads and trails can interfere with detection of these impacts.

We also removed plots that were more than 2,000 ft from a trail to allow crews ample time to hike to and sample the entire plot within a 10-hour field day. Without a maximum distance, the majority of our random points landed in remote areas that would be prohibitively too difficult to access given logistical and time constraints. Priority was given to plots with reasonable access for sampling purposes.

Based on the proportion of forest composition by species, we selected a proportional number of plots per species from the resulting plot list generated with the aforementioned filtering steps. We also overlaid plots on Level IV ecoregions (EPA) to ensure that, taken together, plots represent all forested ecoregions across the state. In addition, we implemented a 10-mile buffer between plots to ensure they were spatially distributed across the state. For example, for plots dominated by northern red oak (*Quercus rubra*), we attempted to ensure that selected locations were spatially distributed in northern red oak forests in different locations rather than clustered in a single region.

The final plot selections were then sent to state partners for review. Some changes were made based on plot access, incorrect forest type designation, management considerations, *Box 1. We used the following criteria for FEMC FHM plot selection from the existing states CFI plot networks such as the existing MA CFI network:*

MA DCR provided plot locations for the CFI network (n=1,800 plots; MA DCR, 2019). We selected only those plots deemed Active (n=1,733) and joined resulting plots with the associated fields from the MA CFI database using Type, Sub_type, Last Inventory year, and Landscape Designation. Using look-up tables extracted from the MA CFI methods (MA DCR, 2014), we excluded the major types "swamp hardwood", "swamp softwoods", and "non-commercial" based on the included description of these types (resulting n=1,594). We filtered plots to those with a Sub_type 'forest' by first creating a Sub_type_group field where 'none' indicates 'non-forest'. We also excluded plots with no sub-type designation (resulting n= 1,561). We selected only plots in 'Reserve' status under Landscape Designation (code = 1); this excluded parkland and woodland plots (resulting n = 610).

We used Forest Inventory and Analysis' EVALIDator (Version 1.8.0.01, USFS 2019) to determine the species composition of the state of MA forestland by querying for the number of trees >5 in diameter at breast height (DBH) by species. We summarized the species composition per MA CFI plot using species information for live trees (status = 1 or 2) extracted from the MA CFI database (MA DCR, 2019). For each plot, we summed the number of trees per species to determine which species were the most dominant within the plot and distributed our network accordingly to avoid clusters of plots with similar species. For a plot to be considered dominated by a species, that species had to comprise more than 25% of the trees by count in that plot.

and other factors. The final location review was confirmed or amended by the crew as they visited each plot for the first time during the field season. Individual plots may be moved in future years based upon feedback from the field crew and review of the data. If a plot network was already in place, we selected points representing each of the statewide forest types and scaled the distribution down to represent the percent forest cover of each forest type in each state. In states without an existing plot network, randomly generated points based on the above criteria were generated to match the number of plots required to best represent the particular forest types required for the state. Final plot selections were then visually inspected in Google Earth to exclude plots that: were not within forest land, fell within wetland or other body of water, landed on an unmarked road or man-made feature, and/or were difficult or dangerous to navigate to (i.e., cliff, steep gradient).The resulting plot network is shown on the map in Figure 1.

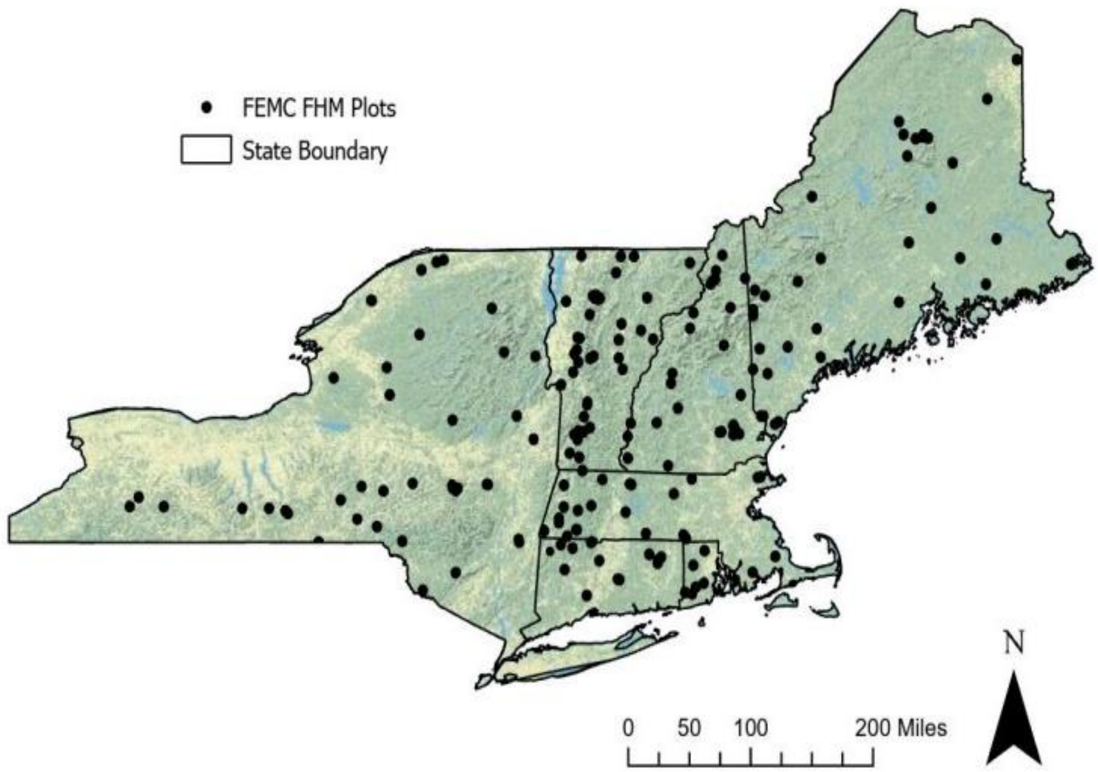
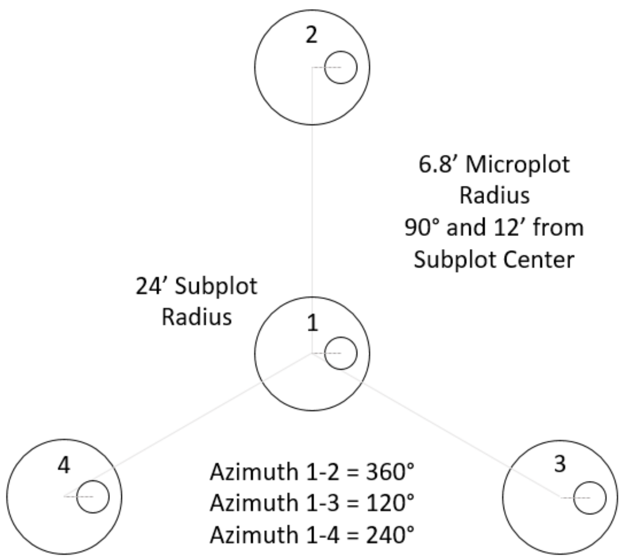


Figure 1. One hundred and ninety-six (196) plot locations across Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont make up the complete FHM plot network.

Plot Styles

Clustered (FIA) Style

New Hampshire, Rhode Island, and Vermont FHM plots follow the layout shown in Figure 2, mirroring the clustered FIA plot layout. The clustered plot style consists of 4 subplots, each with a 24-ft radius and area of 1809.6 ft^2, and one nested regeneration microplot each with a radius of 6.8 feet and an area of 145.3 ft^2. The four regeneration microplots are 12 feet from the subplot center at the 90° (referenced to true north). Three subplots radiate from a central subplot 120° apart, 120 feet from the center of subplot 1. To maintain continuity with historical inventories on these plots, FEMC utilized this same plot design for the plots in New Hampshire, Rhode Island, and Vermont. As it is critical that regeneration subplot locations remain consistent for annual assessments, FEMC technicians marked the regeneration subplot centers of the plots with fiberglass or wooden dowel stakes upon the initial visit (Figure 3).



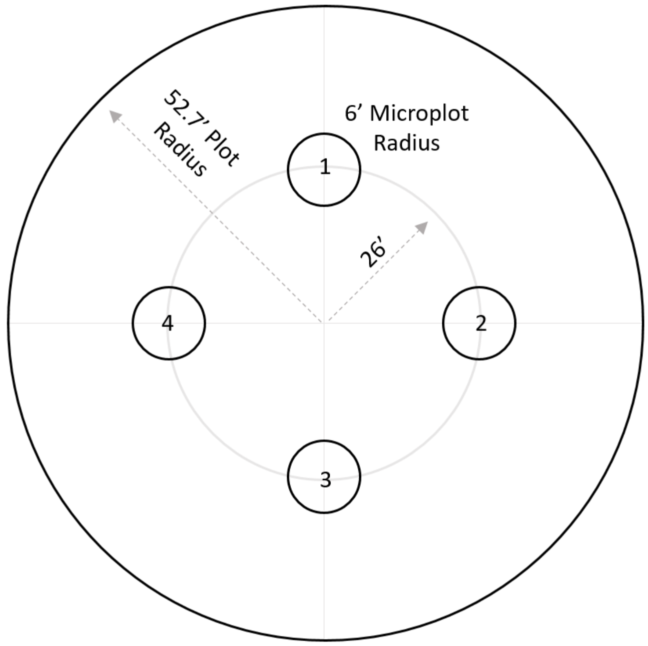
Metric Conversions		
Plot Radius	52.7'	16.06m
Micro-Plot Radius	6'	1.83m
Microplot to Plot Center	26.0'	7.92m

Figure 2. Layout of Clustered-Style FIA and FEMC FHM plots showing the 4 clustered subplots and four regeneration micro-plots within each.

Figure 3. Standard subplot markers seen in the field. **USFS Brass Stakes**: Solid, metallic stakes often inscribed with identifying information. Used in USFS land. **FHM PVC Markers** Durable plastic markers used as plot centers. **Wooden Stake**: Typically wooden stakes are used in wilderness areas to minimize environmental impact. Also used as microplot centers in many plots **Microplot Centers**: Marked by a fiberglass stick or a flat wooden stake

Nested (CFI) Style

Connecticut, Massachusetts, Maine, and New York FHM plots are laid out based on the larger nested style. The large plot style consists of one large overstory plot, with a radius of 52.7 feet and area of 8,725.11 ft^2, and four nested regeneration microplots each with a radius of 6 feet and an area of 113.1 ft^2 (Figure 4). The four regeneration microplots are 26 feet from the overstory plot center at the cardinal directions (referenced to true north). To maintain continuity with historical inventories on these plots, FEMC utilized this same plot design for the plots in Connecticut, Massachusetts, Maine, and New York. State CFI plots typically have the overstory plot center permanently marked, but not the locations of the regeneration subplots. As in the clustered style plots, FEMC technicians marked the regeneration subplot centers of the plots with fiberglass or wooden dowel stakes upon the initial visit.



Metric Conversions		
Plot Radius	52.7'	16.06m
Micro-Plot Radius	6'	1.83m
Microplot to Plot Center	26.0'	7.92m

Figure 4. Layout of Nested-Style CFI and FEMC FHM plots showing the overstory plot (large circle) and four nested regeneration micro-plots (small circles at cardinal directions; MA DCR, 2014).

Plot Metrics

Field Crew and Calibration

Starting in 2022 three crews of 3-4 technicians have conducted monitoring across the region. Crews are trained by Vermont Forests, Parks, and Recreation (VT FPR) personnel on forest health metrics before the FHM field season. FPR forest health specialists also lead calibration of crew members conducting crown health assessments annually to ensure standardization of ratings from year-to-year. Additionally, all technicians are informed of FEMC's standard operating procedure, including inclusivity and outdoor safety while in the field. All technicians are trained in the use of forestry equipment, such as DBH tapes, hypsometers, compasses, GPS units, remote tablets for data entry, prisms, and other tools. Some years monitoring efforts are contracted out to partnering organizations who are able to hire field crews locally. In such cases, these crews are still trained by FEMC staff and calibrated to our crews standards.

Overview of Subplot (Clustered) and Plot (Nested) Measurements

All trees 5 in. (12.7 cm) and greater in diameter at breast height (DBH) in the subplot are measured. A tree is counted as "in" if the center of its pith is 24 ft. (7.32 m) or less from subplot center for clustered plots, and 52.7 ft (16.06 m) or less for nested plots. Trees are marked (either with paint, cold hardy flagging, or metal tags) for future remeasurement with landowner permission. A unique number is assigned on the data sheet for future identification and tracking over time.

The following is a summarized list of measurements that are taken in each subplot (clustered plots) or plot (nested plots) for mature overstory trees. Further detail for each measurement is described in subsequent subsections.

Tree Location and Structure

- Tree ID number
- Magnetic azimuth from plot center
- Species
- Diameter at breast height (DBH)
- Tree horizontal distance and height
- Live crown ratio

Tree Health

- Canopy position
- Crown vigor
- Crown fine twig dieback
- Foliage transparency
- Defoliation

- Foliage discoloration
- Special damages

Other Metrics

- Non-native invasive plant abundance
- Browse presence/absence
- Basal area prism counts

Details of Measurements

Tree Location and Structure Measurements

Unique Tree ID, Magnetic Azimuth, and Species

Overstory trees are assigned an identification number according to their magnetic azimuth relative to subplot center (clustered) or plot center (nested). When establishing a new plot, tree numbering begins with the first tree east of true north from the subplot or plot center and continues in a clockwise direction around the subplot/plot. Magnetic azimuth is calculated using a compass or similar device to pinpoint the tree's location relative to subplot center for clustered plots, and total plot center for nested plots. If two trees have the same azimuth, the tree that is closer to the center is given the lower number. Ingrowth trees are assigned a new ID with the next unused integer during data entry to avoid repeating existing tree numbers. Trees are referred to using this identification number for all subsequent years. Species are recorded using US Forest Service FIA species codes (Appendix A).

Diameter Measurements (DBH)

Tree diameter is traditionally measured at DBH (4.5 ft. / 1.37 m) on the uphill side of each tree 5 in. (12.7 cm) or greater in diameter. For trees with characteristics that may alter where DBH is perceived, such as bulges or forked growth, we use the following rules:

- If there is a bulge at DBH, the tree is measured just above the bulge, where the bole returns to normal.
- Trees forked above 4.5 ft. (1.37 m) are considered as one tree (Figure 5).
- If the tree is forked 1 foot (0.3 m) or greater above ground or at 4.5 ft. (1.37 m), the diameter is measured up 3.5 ft. (1.52 m) from the pith joining forks (Figure 6).
- If the tree is forked below 1 foot, each fork is considered as a separate tree and measured at 4.5 ft. (1.37 m) (Figure 7).
- If a tree is dead, <u>its DBH is recorded the first year it is found to be dead</u>. After that, DBH is not measured again. DBH of dead and down trees are not recorded.

Where allowed, we use a modified DBH measurement method wherein trees are painted at 4.5 ft. (1.37 m) so that they can be measured in the exact same place each year (Figure 8).

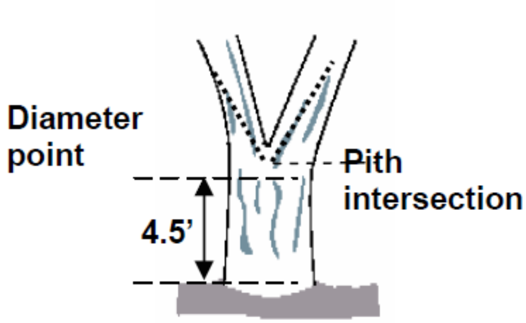


Figure 5. Tree forked above 4.5 feet.

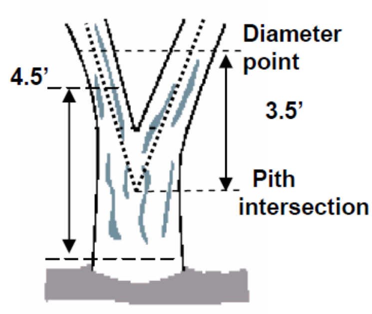


Figure 6. Tree forked between 1 foot and 3.5 feet above ground.

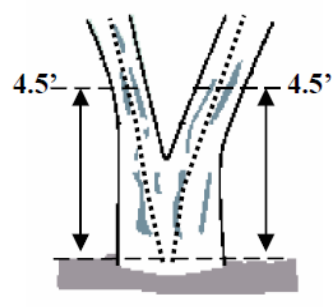


Figure 7. Trees forked below 1 foot.

Figure 8. In locations where permitted, trees that land within the FHM plots are painted to mark the location that DBH was measured to ensure consistency from year to year.

Horizontal Distance, Height and Live Crown Ratio Measurements

Tree horizontal distance is calculated via tape measure or Haglof hypsometer from subplot (clustered) or plot (nested) center. Tree height is measured using a clinometer or a Haglof hypsometer (Figure 9). The ideal location for accurately measuring tree heights is about 100 ft. (30.5 m) from the tree along the same elevation. Since this is not possible in dense forests, strive to find the furthest distance possible from the tree where both the top and live crown are visible. FHM crews are instructed to use the Haglof hypsometer by default, but resort to the clinometer as a backup. Visual estimate is also accepted, but must be noted on the datasheet.

- **Total Tree Height** is the height to the highest point of the tree, either vegetation, twigs, or branches.
- **Height to Live Top** is the height to the highest point of vegetation on the tree.
- **Height to Crown Base** is the height to the lowest point of vegetation on the live crown.

Figure 1. Measuring height with a Haglof hypsometer.

Determining Live Crown

The live crown base is an imaginary horizontal line drawn across the trunk from the bottom of the lowest live foliage of the "obvious live crown." The "obvious live crown" describes the continuous flow of foliage from the top of the crown extending downward to some point below which there is little to no foliage. Most crown branches/twigs are included, but epicormics, twig/sprigs, and straggler branches (more than 5 ft. (1.52 m) below the crown) that usually do not contribute much to the tree's growth are excluded. The base of the live branch/twig bearing the lowest foliage may be above or below this line.

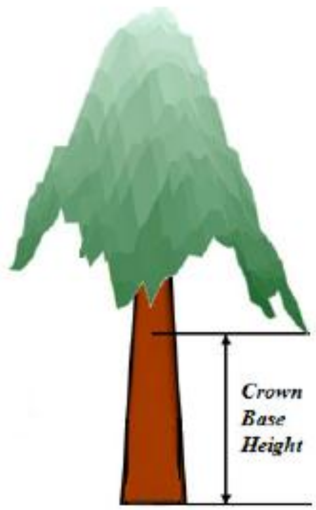


Figure 10. Determining the live crown base. The imaginary line is drawn at the base of live foliage. (Adapted from Jung et al. 2011)

Five Foot Rule

If any live branch is less than 5 feet (1.52 m) below this "obvious live crown" line, a new horizontal line is established as the base of the live crown. The new line is created at the base of live foliage on that branch. This evaluation is continued until no live branches greater than 1 inch (2.54 cm) in diameter at the point of attachment with the trunk are found within 5 feet (1.52 m) of the foliage of the lowest qualifying branch.

Figure 2. Determining new live crown base. Point of branch attachment is less than 5 ft. (1.52 m) from the base of the obvious live crown, so a new crown base must be determined. The new crown base is a horizontal line at the base of the live foliage on that branch. The new crown base is recorded as the crown base (Randolph, 2010).

Tree Health Measurements

Canopy Position (Crown Class)

Canopy position is the relationship of the tree relative to the other trees in the canopy. This is determined based on the amount of sunlight received on the various sides of the canopy and proximity to other trees (Tallent-Halsell, 1994). This is a subjective metric and is based on the comparison of the tree to the canopy surrounding it. Changes in canopy position changes are most likely following a stand disturbance.

Table 1. Canopy position codes and definitions (Tallent-Halsell, 1994).

Code	Definition
1	**Open Grown.** Trees whose crowns have received full light from above and from all sides during early development and most of their life. Their crown form or shape appears to be free of influence from neighboring trees.
2	**Dominant.** Trees with crown extending above the general level of the crown cover and receiving full light from above and partly from the sides. These trees are taller than the average trees in the stand and their crowns are well developed, but they could be somewhat crowded on the sides.
3	**Codominant.** Trees with crowns at the general level of the crown canopy. Crowns receive full light from above but little direct sunlight penetrates their sides. Usually they have medium-sized crowns and are somewhat crowded from the sides. In stagnated standards, codominant trees have small-sized crowns and are crowded on the sides.
4	**Intermediate.** These trees are shorter than dominant and codominant trees, but their crowns extend into the canopy of codominant and dominant trees. As a result, intermediates usually have small crowns and are very crowded from the sides.
5	**Overtopped.** Suppressed trees with crowns entirely below the general level of the crown canopy that receive no direct sunlight either from above or the sides.

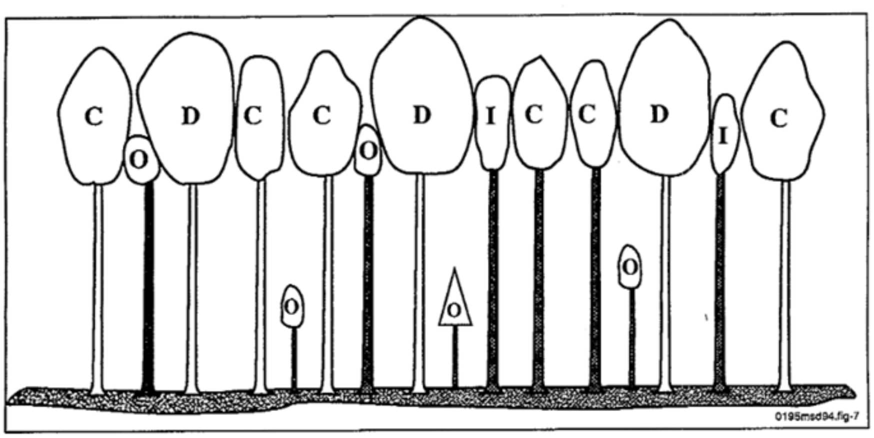


Figure 12. Relative crown positions of dominant (D), codominant (C), intermediate (I), and overtopped (O) trees (Tallent-Halsell, 1994).

Vigor

Tree vigor is a categorical assessment on a 1 to 9 scale that summarizes the overall health or status of the tree (Table 2) and comprises the total impact of a combination of stress-induced characteristics, including branch mortality, dieback, and missing crown area. Dead, cut, and fallen trees were recorded as vigor ratings 5, 6, 7, and 8. Vigor was assessed on all trees in the overstory plot. A vigor code of 9 represented previously recorded trees that could no longer be located. We use vigor categories adapted from Millers et al. (1991).

Table 2. Tree vigor codes and definitions used in FEMC FHM (Millers et al., 1991).

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.

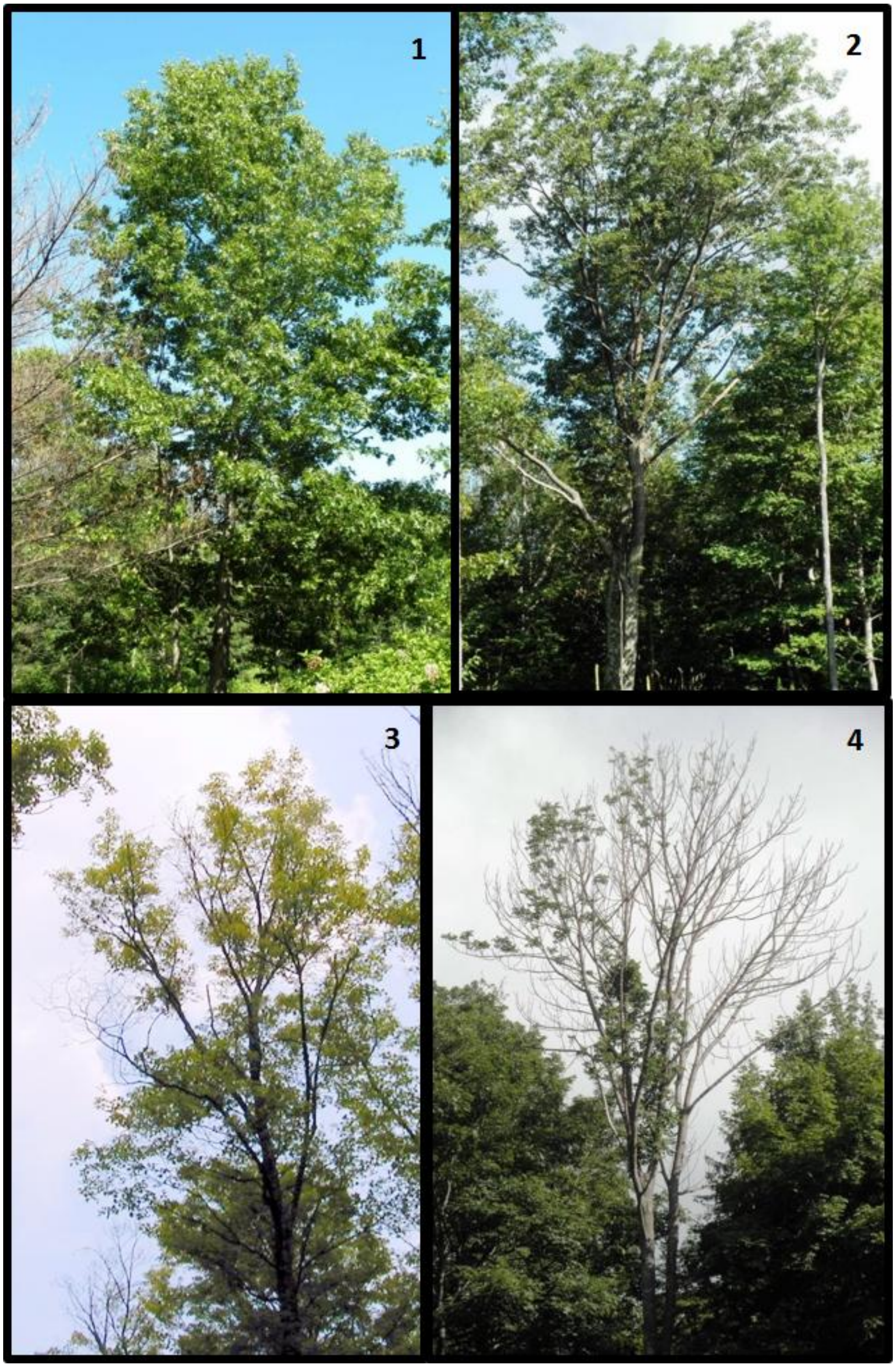


Figure 13. Trees with vigor 1 (top left), 2 (top right), 3 (bottom left), and 4 (bottom right). Vigor ratings are located in top right corner of each photo.

Crown Health Assessments

Visual crown health assessments were conducted on all trees inventoried in the fixed radius overstory plot. Prior to the field season, training and calibration of crew members conducting crown health assessments were led by VT FPR forest health specialists to ensure standardization of ratings from year-to-year. Assessments were conducted by two trained technicians using binoculars to distinguish seeds from leaves and detect the presence of insect defoliation. When the technicians conducting crown health assessments disagree on the rating, they discussed the estimates and moved around the tree to view it from different angles until an agreement could be reached. Crown health metrics include dieback, foliar transparency, discoloration and defoliation.

Percent fine twig dieback

The amount of fine twig dieback in a tree's crown reflects that tree's response to recent stress events. Dieback was visually estimated as a percentage of the total live crown volume occupied by fine twig dieback in 5% classes, rounded up to the nearest 5%. For example, if a tree has 0-5% dieback it was assigned a rating of 5. As some species experience natural dieback of lower and interior limbs that is not stress related, the fine twig dieback assessment in the FEMC FHM protocol only considers dieback *of upper and outer* branches where dieback is likely a result of stress and not due to self-pruning or shading (Figure 14).

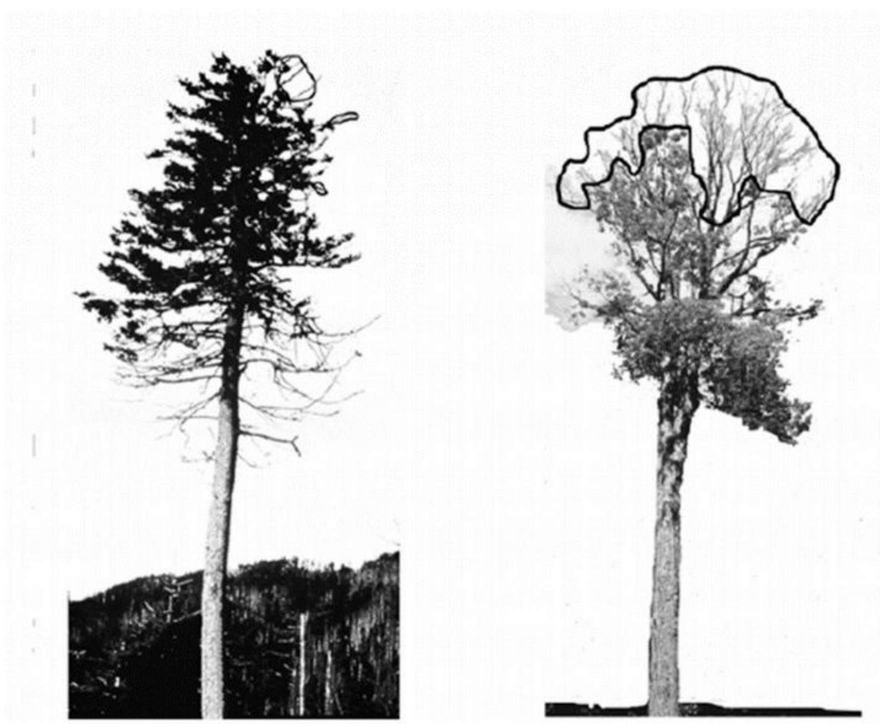


Figure 14. Crown dieback rating outline examples (Randolph, 2010). Dieback of left tree: 5%. Dieback of right tree: 30%.

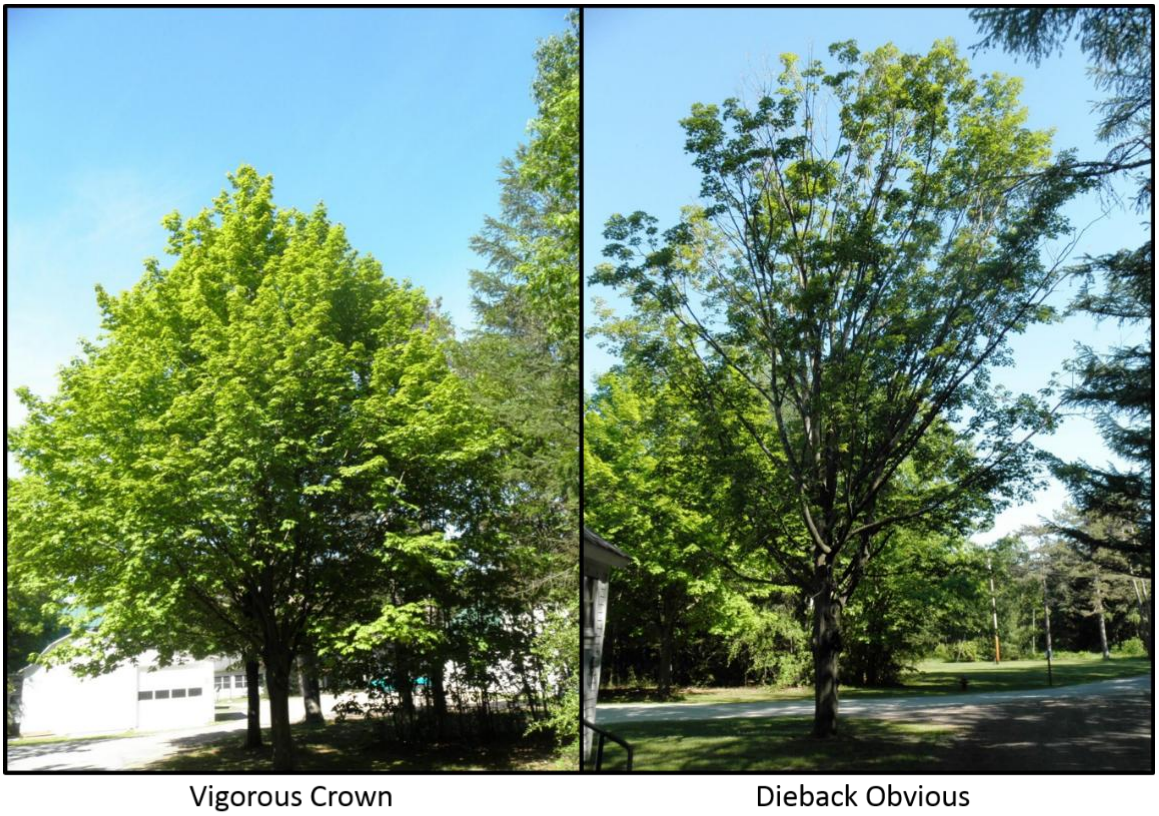


Figure 15. Dieback comparison. Dieback of left tree: 5%. Dieback of right tree: 25%.

Percent foliar transparency

Foliar transparency is the amount of light visible through the live, normally foliated portion of the crown, excluding areas that are occupied by branches. FEMC FHM technicians estimate each tree's crown transparency, rounding up to 5% intervals, such that a rating of 10% indicates that only 6-10% of the total possible skylight is visible through the foliage (Wilmot et al., 2019). To aid with transparency estimates, FHM technicians are provided with cards based on the foliar transparency scale figure adapted from Tallent-Halsell (1994) to aid in foliar transparency ratings. Transparency considers live foliage only; branches and areas of dieback are not included, while areas exhibiting defoliation are.

FHM technicians are trained to account for expected differences in foliar transparency related to tree age and taxonomic classification. For instance, old trees and some hardwood species (e.g. sugar maples) have crowns with densely foliated branches that are naturally widely spaced. These large gaps between branches should not be included in the foliage transparency rating. When foliage transparency in one part of the crown differs from another part, an average foliage transparency is estimated.

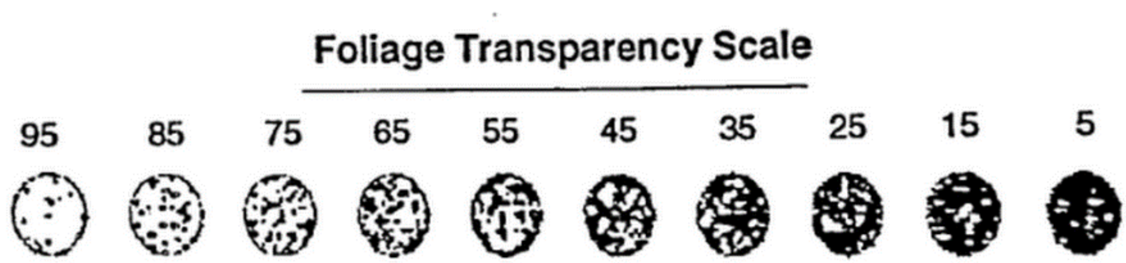


Figure 16. Foliage transparency scale (Tallent-Halsell, 1994).

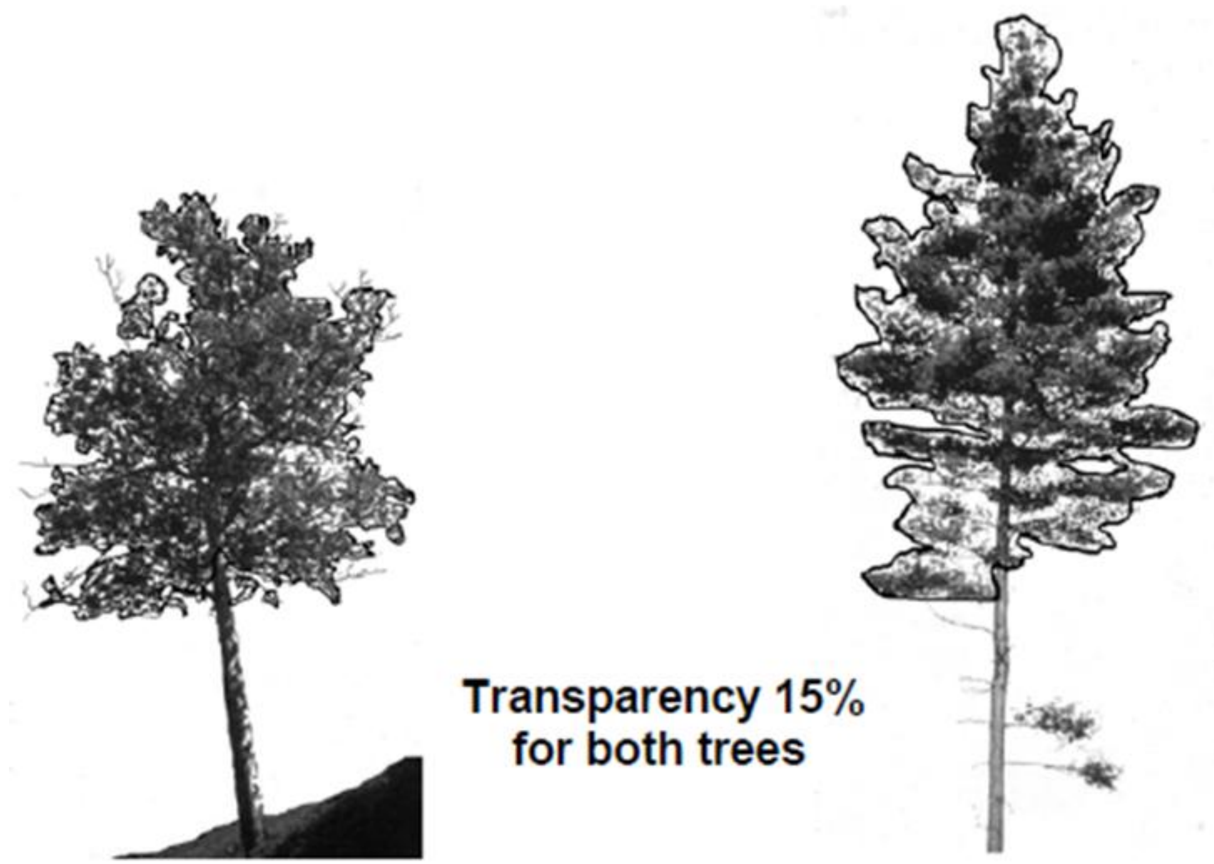


Figure 17. Foliage transparency outline examples (Randolph, 2010).

Percent defoliation and discoloration

Defoliation is an estimate of leaf area missing as a result of leaf-eating insects (e.g., spongy moth caterpillars, pear thrips) or due to weather-related leaf damage (e.g., frost, hail). This metric includes leaves with missing sections or, in severe cases, leaves with only veins intact. Areas of the crown experiencing fine twig dieback where entire leaves are missing were not included.

Foliar discoloration was estimated in the same four percentage classes as defoliation (Table 3). Only foliated portions of the crown were assessed. Foliage was considered discolored when the overall appearance of a leaf was more yellow, red, or brown than green. It is important to note that normal discoloration occurs as deciduous trees prepare for fall leaf senescence; this was noted if monitoring was conducted during this time.

Binoculars were strongly recommended during these assessments, as defoliation in tall canopies can be difficult to observe while masting can be mistaken for discoloration. Defoliation and discoloration were estimated in four broad categories based on the total live crown with reduced leaf area (Table 3), which were adapted from Millers et al. (1991).

Table 3. Foliar discoloration and defoliation classes and definitions (Millers et al., 1991).

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

Figure 18. Defoliation on an American beech.

Figure 19. Example of foliage discoloration (Source: USFS).

Special Damages

For each tree in the overstory plot, any recent bole or crown damage was recorded, if obvious. Note that this damage assessment was not comprehensive, and some damage may not have been recorded if it was not obvious to a technician from the ground. Damage categories assessed included: animals, borers, insects, cankers, conks, diseases, human causes, and weather. Up to three different damage types could be recorded for each tree. Refer to Appendix B for a list of special damage codes and photographic examples.

Other Metrics

Invasive Plants

Non-native invasive plants were recorded on each overstory plot or subplot using a 5-class abundance system for each species on the invasive plant list (Table 4).

Table 4. Invasive plant species list and abundance codes from FEMC FHM Program protocol (Wilmot et al., 2019). Invasive species abundance is determined by searching the entirety of the overstory plot for invasive species and estimating prevalence.

Species Code	**Species Name**	***Latin Name***
1	Barberry, Japanese and common	*Berberis thunbergii, B. vulgaris*

2	Buckthorn: common or glossy	*Rhamnus cathartica, R. frangula*
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*
90	2FERN	*Fern or Fern Ally*
91	2FORB	*Forb (herbaceous, not grass nor grasslike)*
92	2GRAM	*Graminoid (grass or grasslike)*
93	2PLANT	*Plant*
94	2SHRUB	*Shrub (>0.5m)*
95	2SUBS	*Subshrub (<0.5m)*
96	2TREE	*Tree*
97	2VH	*Vine, herbaceous*
98	2VW	*Vine, woody*
99	Other	*Other - please specify*

Code	**Description**	**Density**
1	Infrequent occurrence	1 to a few present
2	Sparsely throughout	1-2 plants together, in a few locations

3	Localized patches	Several plants together, occurring in a few locations
4	Frequent in stands	Dense areas of plants occurring in a few locations
5	Densely throughout	High populations making up understory and/or regeneration

Animal Browse

Evidence of browse on the vegetation in the overstory plot was assessed as either: (1) present or (0) absent. A code designating the amount of animal browse pressure exerted on the regeneration of the accessible forest area within the overstory plot or subplot was recorded on a scale of 1-5 (Table 5).

Table 5. Browse codes and definitions from FEMC FHM Program protocol (Wilmot et al., 2019). A browse code of 1 refers to a site that is within a well-maintained, deer-free exclosure. No FEMC FHM plots are within such conditions, so our scale begins at 2.

Code	Definition
2	Low – No browse evidence observed, vigorous seedlings present.
3	Medium – Evidence of browse observed but not common. Seedlings common.
4	High – Browse evidence common. Seedling presence rare.
5	Very high – Browse evidence omnipresent. Forest floor bare, or severe browse line present.

Figure 20: Example of moose browse. (Photo credit: http://woodlandstewardship.org/wp-content/uploads/ch7/images/animal/moose_browse_damage_on_aspen_large.jpg)

Figure 21: Example of white-tailed deer browse. (Photo credit: http://www.kellytreefarm.com/images/deer%20browse1.jpg)

Jumping Worms

Beginning in 2025, FEMC FHM crews incorporated rapid assessments for jumping worm presence into the monitoring protocol. FEMC worked with UVM Professor Josef Gorres to identify a suitable and efficient detection method that was then deployed across the FEMC FHM sites during summer 2025. The identified method employed visual surveys to note presence or absence of jumping worms or jumping worm castings and added only a few minutes of additional time to the existing FHM protocol.

FEMC's FHM protocol utilizes two different plot layouts, with the style used varying by state (Fig. 2). Spoke-style plots include four subplots; in these plots we ran a transect between each subplot (total 3 transects) and randomly selected 4 locations along each transect for sampling. In nested-style plots we ran a transect in each cardinal direction and randomly selected 3 locations along each transect for sampling. As a result, both plot styles included up to 12 sampling locations. At each sampling site, the duff layer was cleared in a 2'x2' square and the soil surface was inspected for worms or castings. Since the jumping worms method recorded only presence or absence of

evidence of jumping worms at each plot, sampling ended in a plot if evidence of jumping worms was found.

Overview of Microplot Measurements

Microplot measurements measure understory regeneration; seedlings and saplings that fall within microplot boundaries are recorded.

Regeneration

Regeneration assessments were completed on all four microplots within each overstory plot or subplot. At each regeneration microplot, saplings (≥1” and <5” DBH) were assessed for DBH, status (live or dead), and species. Each sapling was given a unique ID and the location (azimuth and distance from microplot center) was also recorded. Sapling status was recorded as follows: 1 indicates that the sapling is alive, 2 indicates that the sapling is dead (DBH is measurable), 7 indicates that the sapling grew into a tree, 8 indicates that the sapling is dead and down, and 9 indicates that the sapling was not surveyed or was missing. Additionally, all live seedlings with at least one true leaf and < 1” DBH were tallied by species and height class (Table 6).

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

Data Entry, Quality Control, and Analysis

Data Entry

Data were collected on paper field forms and/or electronically into a custom online browser-based web-form via tablets. Since 2023, FEMC FHM technicians have been issued tablets to enable digital data archival and enhance real-time data quality control. All paper field forms were scanned and digitally archived; PDF screenshots were digitally archived for plots entered via tablets. Original physical copies of paper datasheets were also retained. Field form templates that FHM crews are issued for data entry can be viewed in Appendix C. The online web form was built using the open source ODK standard and hosted on an open source ODK server implementation. A custom REST component was also developed allowing data to automatically be submitted to FEMC servers and databases and immediately available for review.

Quality Assurance

10% of the plots assigned to each regional field crew were chosen for quality assurance (QA) field visits to check for tool, technique, and human errors. A supervisor or qualified person visited each plot selected for QA checks within two weeks of the original data collection date and recollected data for all metrics for a randomly selected subplot. A QA subplot was said to have failed the data-entry QA protocol if more than 10% of its metrics were outside of the specified tolerance and measurement quality objective (MQO) standards (available upon request). If a plot failed a QA visit, that plot was re-measured and further QA checks were performed on the respective crew's plots.

Quality Control

Several protocols are followed to ensure accuracy of data entry via the online data entry tool. Quality checks were built into the online form to identify errors, typos, large changes to metrics from previous years' data, and duplicate entries. The following are a few examples of features of the online tool implemented for quality control:

- A technician enters a new tree found on the plot as ingrowth (a sapling has become a tree) but enters a DBH of 12.5 cm. The form highlights the DBH with an error warning stating that the minimum DBH of a tree must be 12.7 cm or greater to be considered a tree.
- A technician enters a DBH of a tree that is smaller than last year's tree. A warning message appears and asks the user to double check the measurement.

The online and paper forms also show previous years' data so the technicians collecting and entering data can compare their data in real time to check for typos and errors.

Following the automated quality checks and after all data were submitted to the database, we identified any outlier data that needed to be reviewed. These outliers were identified by querying the data for any measurements outside of a typical range for that metric. These standards were based on the database QA procedures from the VT FEMC FHM program.

The following queries were run on the data:

- Tree heights that exceeded 35 m in total.
- DBH measurements greater than 75 cm.
- Dieback and transparency ratings that exceeded 55%.
- Live or standing dead trees (vigor <5) with missing height measurements.
- Tree diameters that were missing in cases where tree vigor was <5.
- Trees with missing vigor measurements.
- Trees and saplings where IDs were missing.
- Plot, seedling, sapling, tree, and prism counts compared to previous years data.
- Checking for major changes in dieback, transparency, or other crown health metrics from previous year.
- Additional queries to check that spatial measurements were within the plot boundaries, including tree and sapling distance from plot center and azimuths that exceeded the range of 0-360 degrees.

Where outliers or errors were found, appropriate correcting action was taken. Once outlier measurements were identified, technicians compared the raw digital data to corresponding field sheet entries to ensure that data entry errors did not occur.

Data Analysis

Data from the field season are analyzed across all regional FEMC FHM plots each year. The goal of this analysis is to characterize the condition and trajectory of northeastern forests over time: Are forests maintaining their structural integrity and species diversity, or are specific species declining in response to stressors such as invasive pests, disease, or climate-related pressures? By tracking the same permanent plots year after year, we can distinguish short-term fluctuations from sustained directional trends, an essential distinction for informing management decisions and prioritization of conservation resources. At the species level, temporal trends in crown condition indicators such as dieback and transparency reveal whether individual populations are experiencing chronic stress or acute episodes of decline, while shifts in mortality and recruitment rates signal whether a species' role in the forest community is expanding or contracting. At the forest scale, changes in overall stocking, species composition, and size class distributions reflect broader ecosystem-level responses to disturbance regimes and environmental change.

Overstory composition is computed in several different metrics for each species, including: total stems (N), average stems per acre (SPA) or stems per hectare (SPH), basal area (ft^2/acre or m^2/hectare; BA), percent composition, and importance value (IV). These metrics are reported in both imperial and metric units to maintain compatibility with the range of federal, state, and institutional standards used across the northeastern monitoring network. Trees per acre (TPA) and trees per hectare (TPH) provide density metrics that describe how many individuals of each species occupy a given area, making them intuitive measures of stocking and useful for detecting changes in stem density over time, such as the loss of ash stems following emerald ash borer infestation, or increases in shade-tolerant species recruiting into the overstory. Basal area, calculated from diameter at breast height using standard log rules, translates individual tree sizes into a per-area measure of cross-sectional wood area and serves as a more ecologically meaningful indicator of species dominance than stem counts alone, because it accounts for tree size: a single large-diameter sugar maple contributes far more basal area than several small-diameter saplings. Percent composition and importance value further contextualize each species' role relative to the total forest community. 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), particularly when evaluating crown health metrics such as dieback and transparency, where the inclusion of standing dead trees would obscure trends among the living canopy. 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

References

Bechtold, W., Tkacz, B., and Riitters, K. (2007). The historical background, framework, and the application of forest health monitoring in the United States. In: Proceedings of the international symposium on forest health monitoring; 2007 January 30-31; Seoul; Republic of Korea. Available online at https://research.fs.usda.gov/treesearch/27570.

Gillespie, A. 2000. Changes in the Forest Service's FIA program. USDA Forest Service.

Massachusetts Division of State Parks and Recreation (MA DCR). (2014). Manual for Continuous Forest Inventory Field Procedures. Available by request.

Massachusetts Division of State Parks and Recreation (MA DCR). (2019). Massachusetts CFI database. Available by request.

Millers, I., Lachance, D., Burkman, W. G., & Allen, D. C. (1991). North American sugar maple decline project: organization and field methods. USDA Forest Service. https://doi.org/10.2737/NE-GTR-154

Nevins, M., J. Duncan and A. Kosiba. 2020. Comparing Continuous Forest Inventory Programs Across the Northeast. Forest Ecosystem Monitoring Cooperative: South Burlington, VT. https://doi.org/10.18125/d2nh2d. Available online at https://www.uvm.edu/femc/manage/files/file/10906

Jung, S. E., Kwak, D. A., Park, T., Lee, W. K., & Yoo, S. (2011). Estimating crown variables of individual trees using airborne and terrestrial laser scanners. Remote Sensing, 3:2346-2363. https://doi.org/10.3390/rs3112346

Randolph, K. (2010). Phase 3 Field Guide - Crowns: Measurements and Sampling, Version 5.0. USDA Forest Service.

Tallent-Halsell, N. G. (1994). *Forest health monitoring: Field methods guide* (No. PB--95-190419/XAB; EPA--620/R-94/027). Environmental Protection Agency, Las Vegas, NV. Environmental Monitoring Systems Lab.

Wilmot, S., Duncan, J.A., Pontius, J., Gudex-Cross, D., Sandbach, C., and J. Truong. (2019). Vermont Forest Health Monitoring Protocol. Forest Ecosystem Monitoring Cooperative: South Burlington, VT. https://www.doi.org/10.18125/d2c081. Available online at https://www.uvm.edu/femc/file/info/9557.

Appendix A. Common VT Tree Species Codes

Code	Species
12	balsam fir (Abies balsamea)
57	juniper; cedar (Juniperus)
68	eastern red cedar (Juniperus virginiana)
71	tamarack (Larix laricina)
90	spruce (Picea)
91	Norway spruce (Picea abies)
94	white spruce (Picea glauca)
95	black spruce; bog spruce (Picea mariana)
97	red spruce (Picea rubens)
105	Jack pine (Pinus banksiana)
125	red pine (Pinus resinosa)
126	pitch pine (Pinus rigida)
129	eastern white pine (Pinus strobus)
130	Scots pine (Pinus sylvestris)
241	arborvitae; northern white cedar (Thuja occidentalis)
261	eastern hemlock (Tsuga canadensis)
299	dead conifer species
310	maples (Acer)
313	ashleaf maple; boxelder (Acer negundo)
314	black sugar maple (Acer nigrum)
315	striped maple (Acer pensylvanicum)
316	red maple (Acer rubrum)
317	silver maple (Acer saccharinum)
318	sugar maple (Acer saccharum)
319	mountain maple (Acer spicatum)
351	red alder (Alnus rubra)
355	European alder (Alnus glutinosa)
356	serviceberry (Amelanchier)
370	birch (Betula)
371	yellow birch (Betula alleghaniensis)
372	sweet birch (Betula lenta)
375	paper birch (Betula papyrifera)
378	mountain paper birch (Betula cordifolia)
379	gray birch (Betula populifolia)
400	hickory (Carya)
402	bitternut hickory; pignut (Carya cordiformis)
407	shagbark hickory (Carya ovata)
531	American beech (Fagus grandifolia)
540	ash (Fraxinus)
541	white ash (Fraxinus americana)
543	black ash (Fraxinus nigra)
544	green ash (Fraxinus pennsylvanica)
600	walnut (Juglans)
601	butternut (Juglans cinerea)
602	black walnut (Juglans nigra)
660	apple (Malus)
701	eastern hophornbeam; hophornbeam (Ostrya virginiana)
740	cottonwood (Populus)
742	Eastern cottonwood (Populus deltoides)
743	bigtooth aspen (Populus grandidentata)
746	quaking aspen (Populus tremuloides)
761	pin cherry (Prunus pensylvanica)
762	black cherry (Prunus serotina)
766	American plum (Prunus americana)
800	oak (Quercus)
802	white oak (Quercus alba)
804	swamp white oak (Quercus bicolor)
823	bur oak (Quercus macrocarpa)
826	chinkapin oak (Quercus muehlenbergii)
832	chestnut oak (Quercus prinus)
833	northern red oak (Quercus rubra)
837	black oak (Quercus velutina)
901	black locust (Robinia pseudoacacia)
920	willow (Salix)
935	American mountain-ash (Sorbus americana)

951	American basswood (Tilia americana)
972	American elm (Ulmus americana)
975	slippery elm (Ulmus rubra)
998	unknown dead hardwood spp.

Appendix B. Special Damages

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

Bole Damage Code	Bole Damage Agent
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

Animal Damage

Animal Browse—441

Hosts: Any species bark & twigs

Description: Missing twigs, multiple stemmed regeneration; torn bark with teeth marks.

Porcupine damage– 445

Hosts: Bark and twigs of many species, notably eastern hemlock.

Description: Upper bole with bark missing and obvious feeding.

Beaver damage– 444

Hosts: Hardwoods found close to water.

Description: Lower bole with wedge-shaped feeding.

Sapsucker damage– 446

Hosts: Many species.

Description: Rows of small holes which can surround part of nearly all of tree stem.

Other animal damage– 447

Hosts: Any species.

Description: Bark removed from horn/antler rubbings.

Borers and Insects

Asian long horned beetle– 707

Hosts: Many hardwoods

Description: Bark scars at oviposition sites; circular exit holes; insect is large (ca. 1 inch), black with white spots, but no spot where thorax intersects wings, and long antennae.

Beech bark scale only– 104

Hosts: American beech

Description: Tiny insects with woollike wax covering often in bark cracks or other protected areas.

Balsam woolly adelgid– 101

Hosts: Balsam fir

Description: Damage symptoms includes gouting, swellings around buds and branch nodes. Insect is tiny, covered with white wool fibers, usually grouped at bark lenticels or around branch and twig

Defoliation > 20% - 111

Hosts: Any species.

Description: Feeding or loss of leaves or needles that affects more than 20% of the crown.

Hemlock woolly adelgid– 103

Hosts: Eastern hemlock.

Description: Small white fluffy masses covering wingless insects found at base of needles.

Sugar maple borer– 108

Hosts: Sugar maple

Description: insect bores diagonally below bark surface leaving a distinct line, but sometimes a sunken area with bark covering.

Sirex wood wasp– 710

Hosts: Pine species, commonly scots pine.

Description: Small exit holes especially on Scotts Pine boles.

Other bark beetles– 110

Hosts: Any species.

Description: Exit holes

Emerald ash borer– 711

Hosts: All ash species.

Description: Most obvious symptom is bark blonding, woodpecker activity resulting in bark removal. Small emerald colored beetle emerges from wood in early June.

Other borers– 109

Hosts: Any species.

Description: Symptoms include exit holes and galleries.

Cankers, Conks and Diseases

Beech bark disease symptoms– 106

Hosts: American beech.

Description: Diseased trees with craterlike scars.

Butternut canker– 201

Hosts: Butternut.

Description: Sunken bark, oozing brown wounds with internal decay.

European larch canker– 206

Hosts: All larch (tamarack) species.

Description: Bulging stem with black, resin exudate.

Eutypella canker– 203

Hosts: Maple species, including box elder.

Description: Ugly, irregular shaped bulge on bole with wood exposed in non-uniform pattern.

Hypoxylon canker– 204

Hosts: Quaking aspen and other poplars.

Description: Young cankers appear as sunken bark with yellowish-orange areas. Older cankers become blistered with blackened center.

Other canker– 207

Hosts: Any species.

Description: Obvious mycelium conks.

Nectria canker– 202

Hosts: Many hardwoods

Description: Target shaped open wound still actively expanding at outer rim.

Conks– 208

Hosts: Any species.

Description: Fruiting bodies indicating internal decay on the main bole or crownstem.

Dwarf mistletoe-209

Hosts: Primarily black spruce, occasionally other spruces and larch.

Description: Dense clustering of twigs or branches arising from a common point.

White pine blister rust– 210

Hosts: Pine species

Description: Symptoms vary with disease stage including red needled branch flag, depressed branch cankers with color contrast, and resin exudate from bole.

Human-Related and Weather-Related

Logging damage > 20% of circumference– 702

Hosts: Any species.

Description: An opening or series of openings where bark has been removed exposing inner wood. Usually on lower bole, but occasionally higher.

Wind-thrown/uprooted– 501

Hosts: Any species. “Fir waves” common.

Description: Roots torn from ground along with trunk.

Human-Related and Weather-Related

Cracks and seams– 708

Hosts: Any species.

Description: Vertical separations that break out to the surface often called frost cracks >5 feet in length. Seams develop as the tree attempts to heal.

Appendix C. Field Forms

Additional FHM Plot Information

STATE: PLOT: Visit Date:

Directions:

Need 4WD Vehicle? ☐

Updates to Directions:

Parking Info:

Updates to Parking Info:

Parking Coordinates (please fill in if not present in Parking Info or Directions):

Updates to Plot Directions:

Comments:

Current Year Comments:

Date________________________________ Crew______________________

Forest Health Monitoring - 1

PLOT: ___________
SUBPLOT: ___________
LATITUDE: ___________
LONGITUDE: ___________
Coordinate System: ___________

CHECKLIST

____ Subplot GPS
____ Monumented
____ Invasives
____ Prism
____ Seedlings
____ Saplings
____ Trees
____ Painting
____ Dendrobands (opt)
____ Directions written
____ Handwriting legible

DATA ENTRY

BROWSE
Present Absent
BROWSE IMPACT CODE
2 3 4 5

NOTES

INVASIVES

FHM Code	NRCS PLANTS Code	Abundance Code (1-5)

HEMISPHERICAL PHOTOS

Location	Lens Height (x.x m)	File Name

PRISM

FHM Code	Species Abbr.	Live Count	Dead Count

SEEDLING COUNTS

FHM Code	Species Abbr.	Class 1 Count	Class 2 Count

Date________________________________ Crew_______________________

Plot_______________

Forest Health Monitoring - 1 Subplot Data

SAPLINGS										
Sapling ID	Azimuth	Distance (x.x m)	FHM Code	Species Abbr.	Prev Status	Prev DBH (xx.x cm)	Status	DBH (xx.x cm)	Dist Method (h,t)	Notes

Supplemental Forest Health Plots - 1 Tree Data **Date**________________________ **Crew**____________________ Plot______________

Plot	Tree number	Azimuth (xxx)	Distance (xx.x m)	Species	Prev. Trad. DBH (xx.x cm)	Prev. Mod. DBH	Prev. Crown class	Prev. Vigor	Prev. Height (xxx.x m)	DBH Type (M or T)	Traditional DBH (xx.x cm)	Modified DBH (xx.x cm)	Tree Status	Crown class (1-5)	Vigor rating	Total tree height (m)	Height to Live Top (m)	Height to Crown Base (m)	Ht meas method (v, o, h)	Dieback (%)	Transparency (%)	Defoliation (0-3)	Discoloration (0-3)	Special damage 1 code	Notes