Allegheny Carbon Inventory Methodology

Note – This document outlines procedures necessary for collecting data pertinent to a carbon project. Other types of data (e.g. merchantability specs, invasive species, seedling regeneration, etc.) may be collected but are not explicitly needed for carbon calculations and monitoring.

Project Boundary

Allegheny Rural NMTC Forestlands, LLC owns 46,673 acres. Non-forested acres were removed from the project, including mines, roads, non-forested portions of utility right-of-ways, and streams. All excluded areas were removed within a minimum mapping unit of 2.5 acres. After these areas of non-forest were excluded, the total project area included 42,812 acres. To ensure no neighboring properties encroached into the Project Area, ownership extent has been confirmed by property managers and was further verified in the field.

Stratification

The Project is to be stratified into distinct strata, based on conversations with foresters on a logical stratification of the property. The pre-inventory stratification was based on the most recent geospatial file and inventory data. Post-inventory stratification was conducted using remote sensing approach described in more detail in accompanying stratification reports.

Plot Number and Locations

In 2016, a network of systematically placed *permanent* inventory plots were installed across the project area. Using the Fishnet tool in ArcGIS, systematic grids of plots were placed into pre-inventory strata. The total number of plots sampled was the number of plots needed to reach a 90% statistical confidence interval of sampling of no more than ±5% of the mean.

Cruise Design and Statistical Standards

- Sampling Method: Permanent, fixed-radius plots were established across the project area to facilitate precise tracking of individual tree growth and ease of verification. At each plot location, a 1/15th-acre (30.4’ radius) fixed-radius plot was established to measure all trees greater than or equal to 5.0” in diameter at breast height (DBH); and a 1/100th-acre (11.8’ radius) sub-plot was taken to capture woody trees and saplings less than 5” (1.0 to 4.99” DBH). This plot design will give forest managers the opportunity to consistently track the growth and development of specific trees over an extended timeline and will allow for improved ease of plot location during field work and site verifications.

  Note: The protocol defines trees as “A woody perennial plant, typically large and with a well-defined stem or stems carrying a more or less definite crown with the capacity to attain a minimum diameter at breast height of 5 inches and a minimum height of 15 feet with no branches within 3 feet from the ground at maturity.” As a result, please measure all species >=1” DBH that meet this definition

- Statistical Standard: Mean volume estimates (e.g. above ground carbon per acre) for the ownership were reported with a minimum statistical precision of +/– 5% of the mean at the 90% confidence level. These objectives may be adjusted for more or less precision based on a property-specific analysis of data collection cost relative to return.

- Stratification/Sampling Intensity (Blue Source Lead): Inventory stratification and the total number of plots in each stratum was determined based on what is needed to achieve a desired level of statistical precision (see previous bullet). Plots were spatially distributed in systematic grids in each pre-inventory strata using ArcGIS. Post-inventory stratification was conducted using remote sensing approach described in more detail in accompanying stratification reports.
- Sampling Frequency: Full project-level inventories of the carbon project will be conducted at 5-10 year intervals. Inventories of select portions of the Project Area will be updated periodically in response to natural disturbance or significant forest management activities.
- Harvest Re-Measurement: Blue Source will determine which plots have been harvested during the reporting period by requesting harvest boundary shapefiles and completing a spatial overlap analysis. If a plot is harvested, the plot will be re-measured within 6 months of yarding to assess which trees were taken out so that the inventory can be updated for the current reporting period.
- Data Collection Materials: Data will be collected on hand held electronic data recorders. If data recorders are not available, field data can be collected on paper tally sheets and manually entered into a computer for data analysis. All data sheets will be scanned and sent to Blue Source.

  Field personnel will use the following equipment for obtaining forest-carbon inventory data:

  - 75' or longer Logger's Tape designed to measure in 10ths of feet and 10ths of inches for diameter
  - Clinometer capable of measuring height in feet and slope angle
  - Laser rangefinder capable of measuring height to the nearest +/- 1', as well as distance (+/-1')
  - Electronic data recorder (EDR)
  - Compass
  - GPS handheld unit with point locations
  - Distance Measuring Equipment (DME) or rangefinder
  - Cover type maps and Aerial Photographs
  - Pencils and Permanent Marker
  - Flagging
  - Aluminum tree tags
  - Aluminum Nails (cannot contain iron as this may damage the tree)
  - Hammer
  - Tube paint or spray paint for marking DBH measurement and tree number
  - Rebar poles and caps for marking plot centers (.5 in diameter, 2 ft. length)
  - Species Code List
  - Paper tally sheets (in case EDR fails)
  - Overview and point location maps.

- Permanent plot locations were mapped from ArcGIS point files and uploaded into the field forester's GPS unit. Paper plot location maps will also be provided.
- All sample points were located as close as possible to the corresponding map point using a commercial grade GPS unit.
- Plots that are located in areas devoid of forest cover were recorded as non-forested and will not be relocated. Notes describing the land type were added to the notes column (meadow, rock outcrop, landslide, marsh, pond, cropland, etc.).
- Trees are considered live if there are any green leaves, needles, or other indicators of life present.
  - If a tree or sapling has been hacked within the last 3 years, it was denoted as standing dead, even if indicators of life are present. A hack is identified as a man-made, chest-height cut or series of cuts deep enough to expose the cambium and form a small cup that can hold herbicide. In this case, hacked will also include a tree that has been manually girdled, likely with a chainsaw,

with circumferential cuts that expose the cambium. Hacked trees do not include those with damage caused by wildlife or natural causes.

- If a tree or sapling has been hacked more than 3 years ago, and indicators of life are present, it was recorded as live.

Data Collection

- Plot locations were mapped from ArcGIS point files and uploaded into the field forester's GPS unit. Paper plot location maps will also be provided.
- All sample points were located as close as possible to the corresponding map point using a GPS unit capable of 3-meter accuracy (Glonass-capable receivers are preferred).
- For plots located near the project boundary as depicted on the maps and shapefile, use the **walkthrough procedure,** described below (with graphical examples at the end of this methodology:
    1. Establish the plot center, measure and record all trees that fall inside the plot and are also inside the boundary of the stand that is being measured.
    2. For each tree in the plot that is closer to the boundary than it is to the center of the plot, record that tree twice.
    3. To decide whether a tree is closer to the boundary than to the plot center, measure the distance (x feet) from the plot center to the tree. Continue along the same bearing for x feet past the tree. If after walking x feet past the tree you are outside the stand that is being measured, then the tree is counted twice. If you are inside the stand then it is counted only once.
    4. Please note, it does not matter how many times you cross the boundary. It is whether the end of the line is inside the stand that you are measuring or outside it that counts. It is only necessary to walk the full line if it is not obvious whether the end falls inside the stand being measured or not.
    5. Also, please note that you must consider any boundary that is less than one plot radius from the edge of the plot. Keep an eye on the map for boundaries. This is not like a mirage plot where you only consider boundaries that pass through the plot.
    6. Please see the graphical examples at the end of this methodology for further detail on implementation of this method.
- Do NOT move a plot for any reason, even if it can't be located completely within the project area, as long as the plot center is within the project area. If plot center falls outside of the project area, do not measure and make a note.
- If a plot falls in an area that is unsafe to measure where it falls, note the reason for the safety issue. If the safety issue is temporary and can be addressed by the addition of specific safety equipment or returning at a later time, then revisit the plot once these issues can be addressed. If a plot is deemed permanently unsafe and in such a way that safety equipment or revisiting at a later time cannot address, do not measure the plot. Please contact Bluesource for guidance on how to address any plots deemed permanently 'unsafe'.
- Plots that are located in areas devoid of forest cover was recorded as such and will not be relocated.
- A tree is considered within the plot if the center of the tree at DBH is within the radius/border (corrected for slope) of the plot.
- All borderline trees were measured with the logger's tape or range finder (whatever is most accurate) to confirm whether they are in or out (see method outlined below).
- On each plot, sampling should begin with the tree that is the closest to north from plot center, and sampling should continue clockwise.
- Trees 5" in diameter and above was recorded for:
    - Species and the associated FIA code or two letter FVS Alpha Code (see FVS species list)
        - If FVS species code is not listed, write down the species. Blue Source will assign an alternate species code.

- Status – Live/Dead
- DBH (to nearest tenth of an inch)
  - Unless the cruiser encounters one of the special situations listed in the "Diameter Measurements for Irregular Trees" section, measure DBH at 4.5 feet above the ground line on the uphill side of the tree. Round each measurement **down to the last 0.1 inch** (For example, a reading of 3.68 inches is recorded as 3.6 inches)
- Total height (to nearest foot)
  - For trees with heights that are difficult to measure, please record feet to nearest +/- 5'.
  - For any trees that total height cannot be measured (e.g. if visibility makes exact measurement impossible), total height was estimated using surrounding trees and the cruiser will make a note indicating that the total height was estimated
- 4" top height (to nearest foot for every tree)
- Phantom Total Height – The height as tree originally stood (if tree is snapped or has missing segments)
  - Nearby live trees of same species and DBH should be used in the estimation of phantom height
  - Please note that every phantom height should have a measured height recorded as well and will generally also have defect recorded.
- Phantom 4" Top Height – The 4" top height as tree originally stood (if tree is snapped or has missing segments)
  - Nearby live trees of same species and DBH should be used in the estimation of phantom 4" height
  - Please note that every phantom height should have a measured height recorded as well and will generally also have defect recorded.
- Live Tree Defect - If there are portions of the tree that are missing/rotten, percent defect (cull) was estimated with the following procedure:
  - While measuring the tree in the field, divide the tree into thirds, and estimate the percentage that is missing or rotten in each third, and record these values
  - These estimates were used in the office to determine the total defect (See Defect section for greater detail)
  - Record Defect by thirds of the tree.
- Dead Tree Defect – Dead trees will only have **bole defect** estimated (from a 1' stump to 4" top)
  - While measuring the tree in the field, divide the bole into thirds, and estimate the percentage that is missing or rotten in each third, and record these values
  - These estimates were used in the office to determine the total bole defect (See Defect section for greater detail)
  - Record Defect by thirds of the bole.
  - Missing portions of the rest of tree were accounted for with the structural loss factor, applied to the data post-inventory
- Decay Class – For standing dead only (classes 1-5)
- Tree Class code:
  - 2 – Growing Stock: (All live trees of commercial species that meet minimum merchantability standards. In general, these trees have at least one solid 8-foot section, are reasonably free of form defect on the merchantable bole, and at least 34 percent or more of the volume is merchantable. Excludes rough or rotten cull trees.
  - 3 – Rough Cull: All live trees that do not now, or prospectively, have at least one solid 8-foot section, reasonably free of form defect on the merchantable bole, or have 67 percent or more of the merchantable volume cull, and more than half of this cull is due to sound dead wood cubic-foot loss or severe form defect volume loss. This class also contains all trees of noncommercial species. For dead trees, this code indicates that the tree is salvable (sound).

        - 4 – Rotten Cull: All live trees with 67 percent or more of the merchantable volume cull, and more than half of this cull is due to rotten or missing cubic-feet volume loss. For dead trees, this code indicates that the tree is non-salvable (not sound).
    - Notes on irregularities and other relevant notes
- Trees 1" to 4.9" trees (live only) will only be recorded for:
    - Species and the associated two letter FVS Alpha Code (see FVS species list)
    - DBH (in 1/10th inches)
    - No height measurement is needed

QA/QC Field Procedures

At least 5% of the plots were checked by a different forester than cruised the plot, preferably by someone senior to the field crew. This will involve full plot measurement to identify any problems with determining in/out trees, species calls, defect measurements, DBH measurements, and height measurements. Any consistent height, species, DBH, or defect errors was resolved by talking with the foresters and removing crew members if need be.

QA/QC Desk Procedures

The following QA/QC approach is designed to ensure that field data, once input, is appropriately managed and maintained, and that subsequent calculations using that data to determine onsite carbon stocks and associated ARBOC issuance are correctly implemented.

A three-stage QA/QC process with a defined review group for the project was established, engaging both personnel intimately familiar with all project files and documentation, as well as independent reviewers who are able to bring "fresh eyes" to key outputs.

Independent Forester Review: The project implementation team (Blue Source) has a team of foresters with intimate knowledge of the files, models and documents. The development of quantitative components, such as Access databases, FVS model runs and Excel workbooks, are led by one of these foresters. Prior to finalization, a second forester who did not lead development of that component is tasked with a QA/QC review including random examinations and data checks to identify and fix any errors.

Technical Review: Once quantitative outputs are finalized, exported from Access/FVS to Excel, and are ready to be transferred into the Offset Project Data Report (OPDR)) and other project documents, an independent manager reviews these outputs. This individual performs data checks by tracing key outputs back from final ARBOC calculations though the chain of Excel documents to the underlying Access/FVS database.

Senior Management Review: Once outputs have been transferred from Excel to the OPDR and other project documents, a senior manager reviews these documents and checks that all quantitative elements have been correctly exported from the underlying workbook. At this stage, the senior manager (or other individual not involved in document preparation) also reviews text, grammar and formatting for presentation and accuracy.

Data Processing and Storage

Manually and electronically filed data are stored and archived. Backup copies of all electronically stored data are maintained in a separate data center with scheduled archiving to assure data protection. Future revisions to project documents after initial verification and registration are clearly identified by saving them as separate files and including the date of revision in any modified documents. All data is stored on Dropbox or similar online cloud storage service as well as on an external hard drive and kept by Blue Source for a minimum of 15 years.

Monumentation

- Locate plot center using GPS coordinates provided in the plot shapefile. Permanent inventory plot centers were monumented with a rebar pole pounded into the ground and topped with a small rebar cap flush with the ground. The rebar cap should be either embossed/engraved (ahead of time) with the plot number or labeled using permanent marker, if practical.

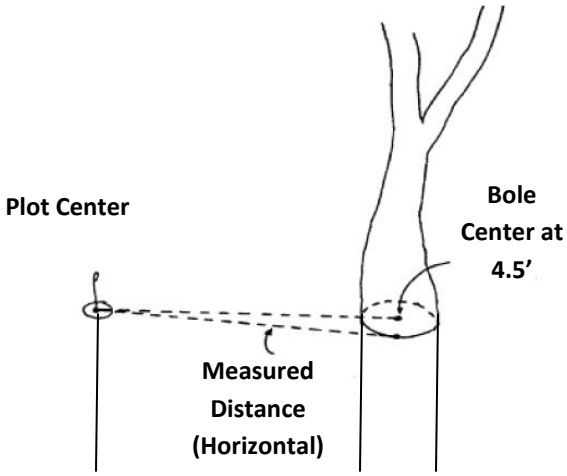
Other Considerations:

- If a plot falls within an ephemeral watercourse, the plot shall be sampled as is.
- If a plot falls in an area with no trees, a note will be taken to describe why it is non-stocked (i.e. in a field or rock outcropping).
- All inventoried saplings and trees of 1" DBH or greater will be marked with a paint line at breast height (4.5 feet), unless one of the special situations is encountered where the diameter is measured somewhere else. In these cases, mark where the diameter measurement was taken.
- If a diameter is taken somewhere that cannot be painted, write in the notes section where the diameter measurement was taken.
- All trees 5" DBH or greater will be numbered with paint at 4.5-feet facing plot center according to the order within the plot in which they were measured. Trees numbered out of order will be numbered last.
- Witness Trees – Three witness trees will be established for each plot.
    - Nails with metal tags will be placed at ground level into the inward facing base of three trees (larger trees are preferred) to allow for triangulation of plot center.
    - A solid stripe will be painted around one of the Witness Trees.
    - For each Witness Tree the distance to plot center and azimuth (recorded as the direction looking from the tree towards plot center) will be recorded in the notes column.
- An additional piece of flagging should be hung from a branch near plot center to aid in locating center from a distance.

Determining "In" Trees

- Trees and saplings are selected for tally (measurement) only when the HORIZONTAL DISTANCE from the plot center to the bole center at 4.5'is less than or equal to the radius of that plot. For very close trees, measure from the plot center to the front of the tree at 4.5'. Take a diameter measurement at 4.5' and divide by 2 and convert the inches to feet. Add this to the distance to the front of the tree to determine whether the tree/sapling is in. If there are any obstacles between the tree and plot center that prevent accurate measurement of the distance from tree face to plot center; move the point of diameter measurement up the tree bole until you can accurately measure the distance. If there are major irregularities (fluting, defects, etc.) at 4.5' that abnormally affect the diameter measurement, move up the bole until you are just outside this irregularity.
- For all multi-stemmed trees, the horizontal distance is measured from subplot or microplot center to the "geographic center" of the tree. The geographic center is a point of equal distance between all tallied stems for a given woodland tree. All stems in the geographic center are considered in.

Determining "In" Trees

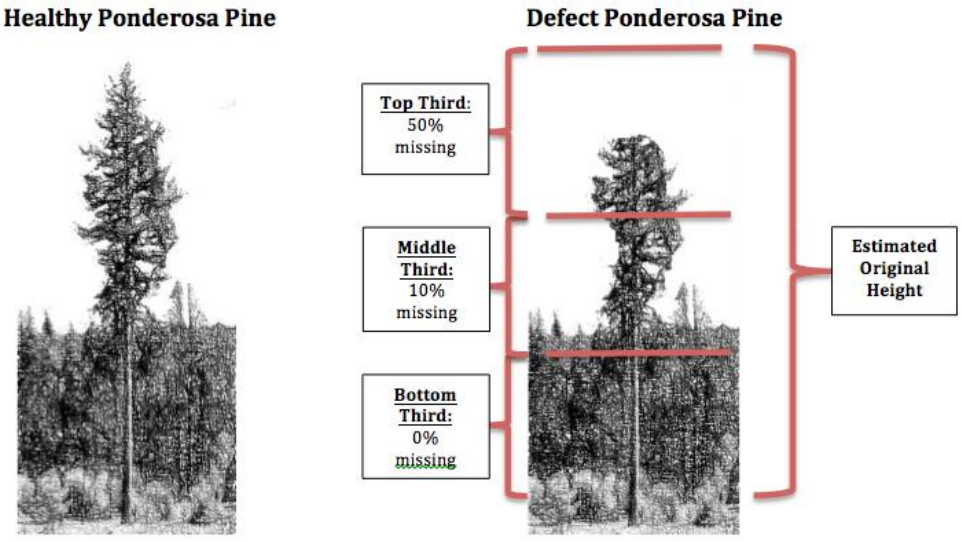


Please note, if a tree goes into the duff layer and re-emerges, measure to where the tree reemerges and determine if the tree is in at this point.

Live Tree Defect

If there are portions of the live tree that are missing/rotten, the defect (cull) should be estimated with the following procedure:

- Dividing the tree into thirds (considering the height of the tree as it originally stood, based on the height of similar nearby trees), estimate the percentage that is missing or rotten in each third (see pictures on following page for greater detail)*



*Please note that the defect for the tree in the picture above right would be recorded as 50/10/0 in the data recorder. Weighting the tree as described above (65/25/10) should not be done in the field and will be done in post-processing the data.

- For trees with a visible conk (indicating rot), assume that there is rot 2 feet above and below the conk and that 50% of this area is rotten. For example, if the bottom 1/3 is 25 feet and the conk is approximately 1

foot tall, then we'd assume that 5 feet of the bottom is 50% rotten. This would mean there is 10% rotten wood in the bottom third (1/5 of this portion has 50% rot = 10%)

- Use your best judgment and be alert to indicators of rot such as the following:
  - Cankers or fruiting bodies
  - Swollen or punky knots
  - Dull, hollow sound of bole
  - Large dead limbs, especially those with frayed ends
  - Sawdust around the base of the tree
  - Metal imbedded in the wood

- If tree has a hollow portion, please use any visual and/or physical cues to estimate how much is rotten. Please take notes on how the hollow portion was determined.

Standing Dead Measurements

- All standing dead trees of 5" DBH or greater and at least 15' of height will be recorded for species (if possible), height as the tree originally stood (phantom height), broken top height (in feet), DBH (in inches), decay class, and bole defect (see bole defect method above).

Decay classes:

- **Decay Class 1**: Limbs and branches all present, top pointed, all bark remaining, sapwood intact, heartwood sound, hard, original color.
- **Decay Class 2:** Few limbs and no fine branches present, top may be broken, bark variable, sapwood sloughing, heartwood sound at base incipient decay in outer edge of upper bole, hard, light to reddish brown.
- **Decay Class 3:** Branches absent with only limb stubs, top broken, bark variable, sapwood sloughing, heartwood with incipient decay at base, advanced decay throughout upper bole, fibrous to cubical, soft, dark, reddish brown.
- **Decay Class 4:** Branches absent with few or no stubs, top broken, bark variable, sapwood sloughing, heartwood with advanced decay at base, sloughing from upper bole, fibrous to cubical, soft, dark, reddish brown.
- **Decay Class 5:** No limbs or branches, top broken, bark less than 20 percent, sapwood gone, heartwood sloughing, cubical, soft, dark brown, or fibrous, very soft, dark reddish brown, encased in hardened shell.

Height Measurements

For every tree, a 4" top height measurement will be attempted. If the top of the tree can be viewed and an accurate measurement taken, the height estimate will be recorded in the height column. If the tree height is obscured and an estimate must be made, the height estimate will be recorded in the THT_EST column. In these cases, the heights of nearby trees with similar DBHs will be used to obtain the estimated height.

- If a tree is broken and a new leader has formed, measure to the top of the new leader
- If a tree has snapped and the top can be found on the ground, measure the piece on the ground with logger's tape to obtain the phantom height estimate
- Trees with previously broken tops are considered recovered (no phantom height) when a new leader is 1/3 the diameter of the broken top at the point where the top was broken (not where the new leader originates from the trunk).

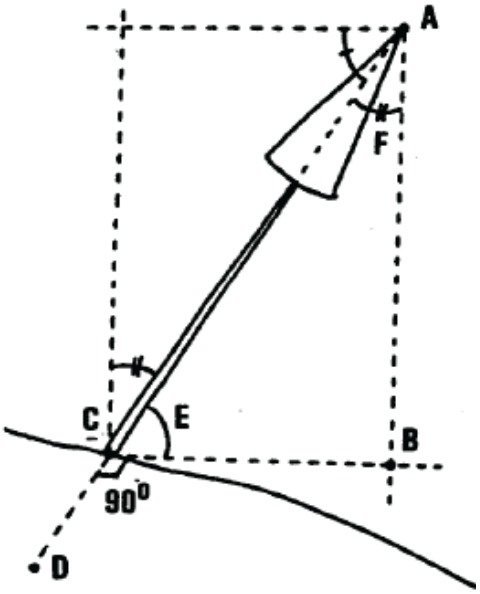
- Laser rangefinders are preferable whenever they are generating accurate readings. However, in some situations excessive foliage or technical malfunctions can make the use of a laser rangefinder impractical or impossible.
- In cases where a rangefinder is not practical, please use a clinometer or similar device

Height on leaning trees:

Measure or estimate total bole length (from the base to the tip of the tree), and not the perpendicular from the ground to the tip. To measure heights of leaning trees using a laser rangefinder or clinometer and tape, follow these steps (see following figure):

- Step 1. Determine the lean angle.
- Step 1a. Using a clinometer, determine Angle E in degrees, which is the angle of the lean from horizontal. The back of a standard clinometer has a rotating wheel that displays degree angles from vertical. Many standard hand compasses have a similar display that works when the compass is set to 180 degrees.
- Step 1b. Subtract the degrees of lean (step 3) from 90 degrees. This gives you the degrees of angle E.
- Step 2. Using your loggers tape measure the distance from the tree base (C) out under the lean until you are directly below the 4" top (towards point B on the diagram).
- Step three. Take the measured distance in step 2 and divide by the Cosine of E and record this as the height to a 4" top.

Diagram for Height on Leaning Trees:

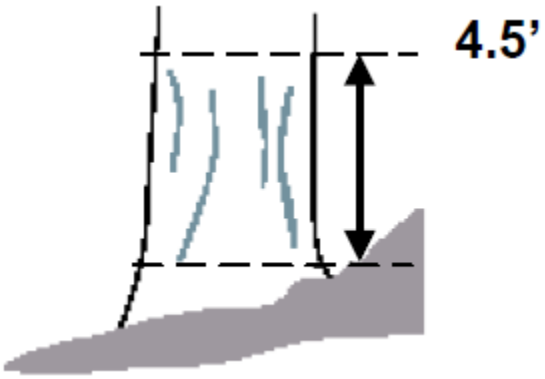


Diameter Measurements for Irregular Trees

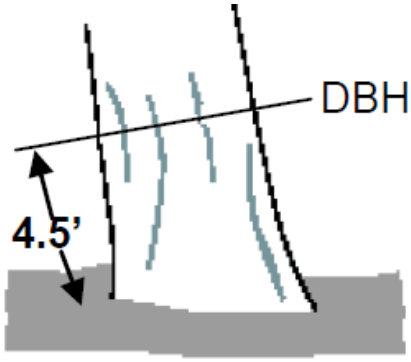
NOTE: Every tree should be marked with a paint line at breast height (4.5 feet), unless the diameter is measured somewhere else due to one of the special situations outlined below. In these cases, please mark where the

diameter measurement was taken. If a diameter is taken somewhere that cannot be painted, please write in the notes section where the diameter measurement was taken, and paint the number of the tree at 4.5'.

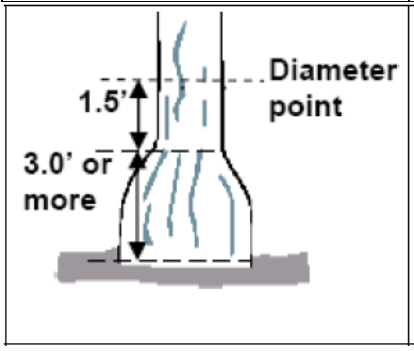
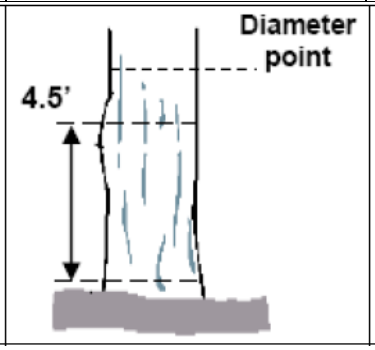
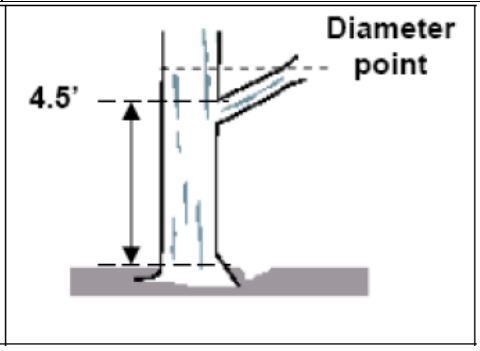
Trees on Slope: DBH should be measured on the upslope side of trees at 4.5 feet



Leaning Tree: Measure diameter at 4.5 feet from the ground along the bole. The 4.5-foot distance is measured along the underside face of the bole



Tree with irregularities at DBH: On trees with swellings, bumps, depressions, and branches at DBH, diameter will be measured immediately above the irregularity at the place it ceases to affect normal stem form (see examples below)

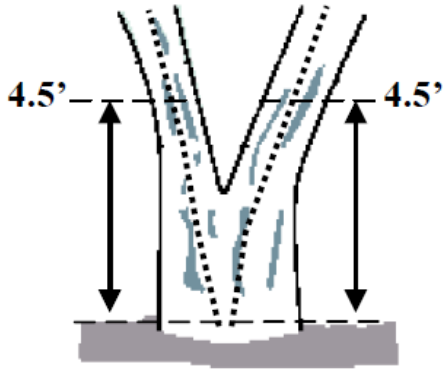
Butt Swell	Swell at 4.5 ft.	Tree with branch at 4.5 ft.
		

Forked Trees:

In order to qualify as a fork, the stem in question must be at least 1/3 the diameter of the main stem and must branch out from the main stem at an angle of 45 degrees or less. Forks originate at the point on the bole where the piths intersect. Forked trees are handled differently depending on whether the fork originates below 1.0 foot, between 1.0 and 4.5 feet, or above 4.5 feet.

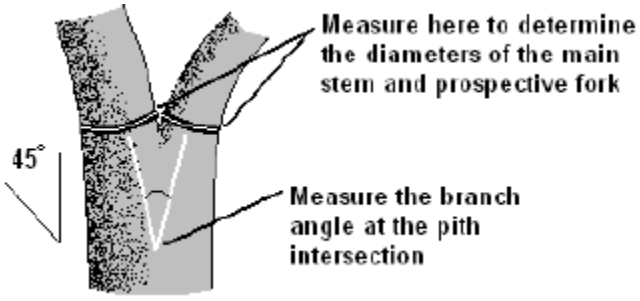
1. **Trees forked below 1.0 foot:**
    a. Trees forked below 1.0 foot *(see Figure below)* are treated as distinctly separate trees. The diameter and angle rules (see Trees forked between 1.0 foot and 4.5 feet, below) do not apply. However, lateral branches (e.g., a branch whorl) below one foot on a single-stemmed tree are not stems and should not be tallied. DBH is measured for each stem at 4.5 feet above the ground. If stems originating from forks that occur below 1.0 foot fork again between 1.0 and 4.5 feet, the rules in the next paragraph apply.

Trees forked below 1 foot:



2. **Trees forked between 1.0 foot and 4.5 feet:**
    a. In order to qualify as a fork, the stem in question must be at least 1/3 the diameter of the main stem and must branch out from the main stem at an angle of 45 degrees or less. The size of the prospective fork is measured at the point of separation (crotch), above any abnormal swelling at the crotch (see Figure below). The angle of branching for the prospective fork is measured in the immediate vicinity of pith intersection (see Figure 8.8). Trees forked between 1.0 foot and 4.5 feet *(see Figure 8.8)* are *tallied* as separate trees. The DBH of each fork is measured at a point 3.5 feet above the pith intersection.

Trees forked between 1' and 4.5':

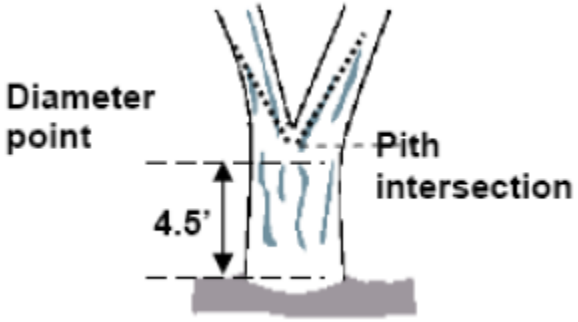


- **Multiple forks** are possible if they all originate from approximately the same point on the main stem. In such cases, measure DBH on all stems at 3.5 feet above the common pith intersection.
- Once a stem is tallied as a fork that originated from a pith intersection between 1.0 and 4.5 feet, do not recognize any additional forks that may occur on that stem. Measure the diameter of such stems below the base of stem separation (i.e., do not move the point of diameter the entire 3.5 feet above the first fork).

3. **Trees forked at or above 4.5 feet:**

   a. Trees forked at or above 4.5 feet count as one **single tree.** If a fork occurs at or immediately above 4.5 feet, measure diameter below the fork <u>just beneath any swelling that would inflate DBH.</u>

Trees forked at or above 4.5 feet:



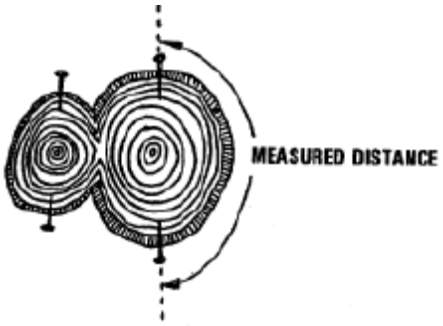
Stump sprouts:

- Stump sprouts originate between ground level and 4.5 feet on the boles of trees that have died or have been cut. Stump sprouts are handled the same as forked trees, with the exception that stump sprouts are not required to be 1/3 the diameter of the dead bole. Stump sprouts originating below 1.0 feet are measured at 4.5 feet from ground line. Stump sprouts originating between 1.0 feet and 4.5 feet are measured at 3.5 foot above their point of occurrence

Independent Trees that Grow Together

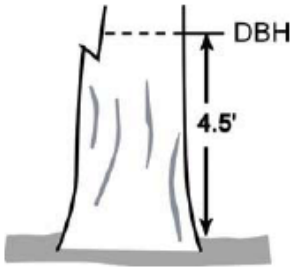
- If two or more independent stems have grown together at or above the point of DBH *(see figure below)*, <u>continue to treat them as separate trees.</u>

    - **Measurement Procedure:** Set two diameter nails at DBH halfway around the tree's circumference from each other (after placing 1st nail, stand back from bole; take azimuth to nail; on opposite side of bole, place nail where the back azimuth of the first nail lines up). Measure the distance between the nails with a diameter tape making sure zero is aligned and not the hook at the end of the diameter tape with one diameter nail. Multiply the measurement by 2 and record the result as the current diameter. Please retain nails in the tree so that the measurement can be verified in the future. Example:
        - Diameter = Measured Distance X 2 = 12.8 inches (12.8 X 2) = 25.6 inches.

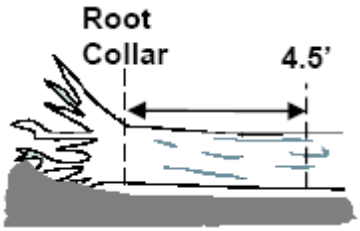


- If unable to use the "Double Nail Method" estimate the diameter of each with a Biltmore stick, relascope, or other diameter measurement device and explain the situation in tree notes (e.g. impossible or dangerous measurement).

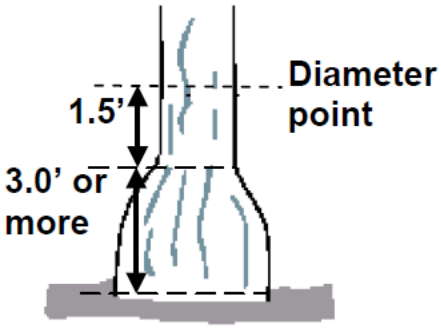
DBH with Missing Wood or Bark: Do not reconstruct the DBH of a tree that is missing wood or bark at the point of measurement. Record the diameter, to the nearest 0.1 inch, of the wood and bark that is still attached to the tree. If a tree has a localized abnormality (gouge, depression, etc.) at the point of DBH, apply the procedure described for trees with irregularities at DBH (i.e. measure just above the irregularity).



Live fallen (wind-thrown) tree: Measure from the top of the root collar along the length to 4.5 feet



Tree with butt-swell or bottleneck: Measure these trees 1.5 feet above the end of the swell or bottleneck if the swell or bottleneck extends 3.0 feet or more above the ground



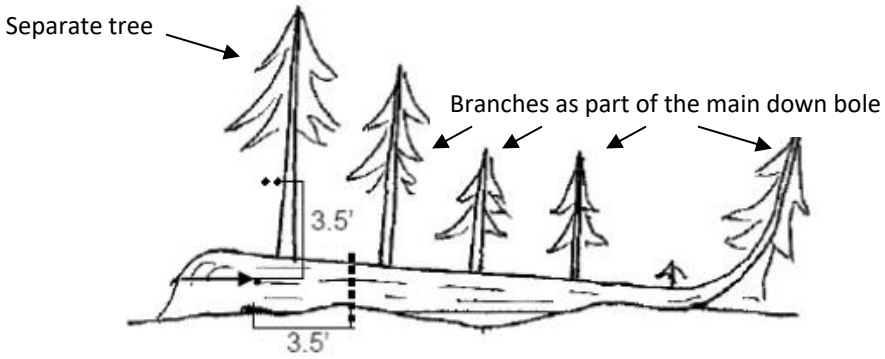
Down live tree with tree-form branches growing vertical from main bole

When a down live tree, touching the ground, has vertical (less than 45 degrees from vertical) tree-like branches coming off the main bole, determine whether or not the pith of the main bole is above or below the duff layer.

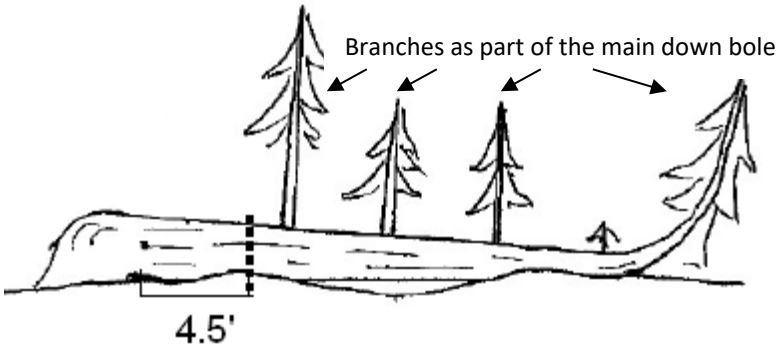
1. If the pith of the main bole is above the duff layer, use the same forking rules specified for a forked tree, and take all measurements accordingly unless:

    a. If the pith intersection of the main down bole and vertical tree-like branch occurs below 4.5ft from the stump along the main bole, treat that branch as separate tree, and measure DBH 3.5 feet above the pith intersection for both the main bole and the tree like branch.
    b. If the intersection between the main down bole and the tree-like branch occurs beyond the 4.5ft point form the stump along the main bole, treat that branch as part of the main down bole.

Down Tree above Duff with Tree before 4.5 Feet

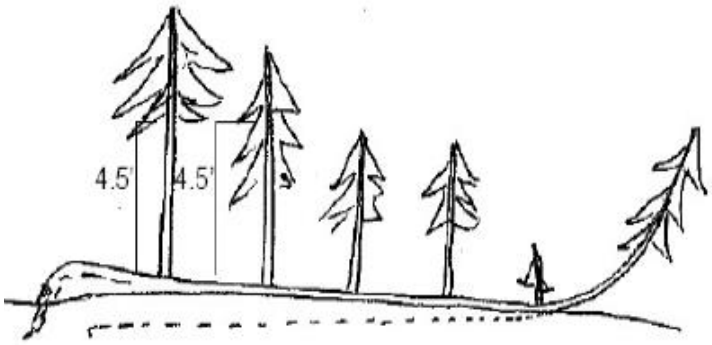


Branch beyond 4.5 Feet from Stump

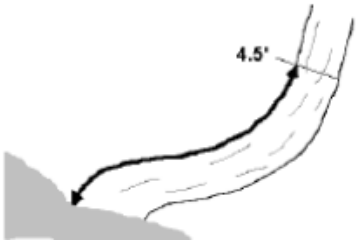


2. **Down tree below Duff**: If the pith of main tree is below the duff layer, ignore the main bole, and treat each tree-like branch as a separate tree; take DBH and length measurements from the ground, not necessarily from the top of the down bole. However, if the top of the main tree bole curves out of the ground towards vertical angles, treat that portion of that top as an individual tree originating where the pith leaves duff layer.

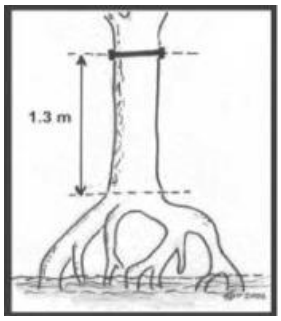
Down Tree below Duff



Tree with curved bole (pistol butt tree): Measure along the bole on the uphill side (upper surface) of the tree.



Exposed Root Ball: If a tree has an exposed root ball, the base is at the top of the root ball, and diameter is measured at 4.5 feet above this point, unless the root ball extends past 4.5 feet. If this is the case, diameter is measured at directly above the root ball.



Trees with stilted roots or growing on nurse logs: On trees with stilted roots (e.g., redwood), growing on nurse logs or on top of stumps (not stump sprouts), DBH should be taken at 4.5 feet above the highest point of the root collar of the new tree.

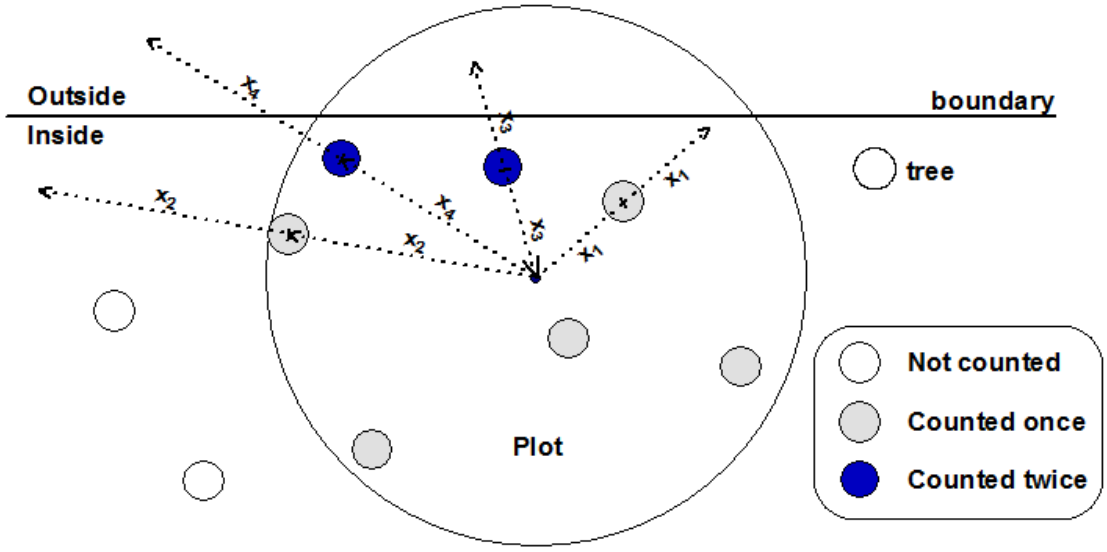
Impossible DBH measurement: In cases where it is unsafe or impossible to take a DBH measurement at the proper location, estimate the diameter of each with a Biltmore stick, relascope, or other diameter measurement device and explain the situation in tree notes.

Leaning Standing Dead: Standing dead trees must not have a lean greater than 45 degrees from vertical. (However, please remember that if trees are alive with a lean greater than 45 degrees, it is still counted as in.

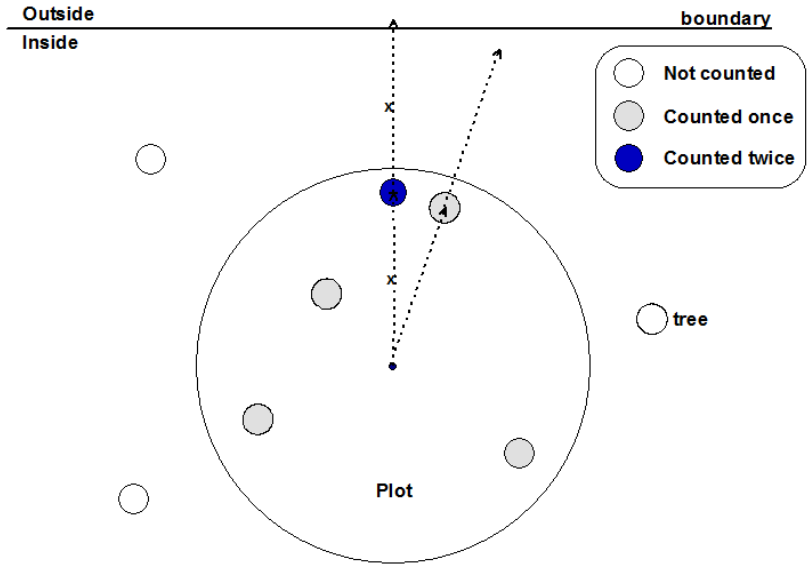
Walkthrough Method Examples

- For plots located near the project boundary, as depicted on the shapefile, use the walkthrough procedure:
    1. Establish the plot center, measure and record all trees that fall inside the plot and are also inside the boundary of the stand that is being measured.
    2. Then, for each tree in the plot that is closer to the boundary than it is to the center of the plot, record that tree twice.
    3. To decide whether a tree is closer to the boundary than to the plot center, measure the distance (x feet) from the plot center to the tree. Continue along the same bearing for x feet past the tree. If after walking x feet past the tree you are outside the stand that is being measured, then the tree is counted twice. If you are inside the stand then it is counted only once.
    4. Please note, it does not matter how many times you cross the boundary. It is whether the end of the line is inside the stand that you are measuring or outside it that counts. It is only necessary to walk the full line if it is not obvious whether the end falls inside the stand being measured or not.
    5. Also, you must consider any boundary that is less than one plot radius from the edge of the plot. Keep an eye on the map for boundaries. This is not like a mirage plot where you only consider boundaries that pass through the plot.

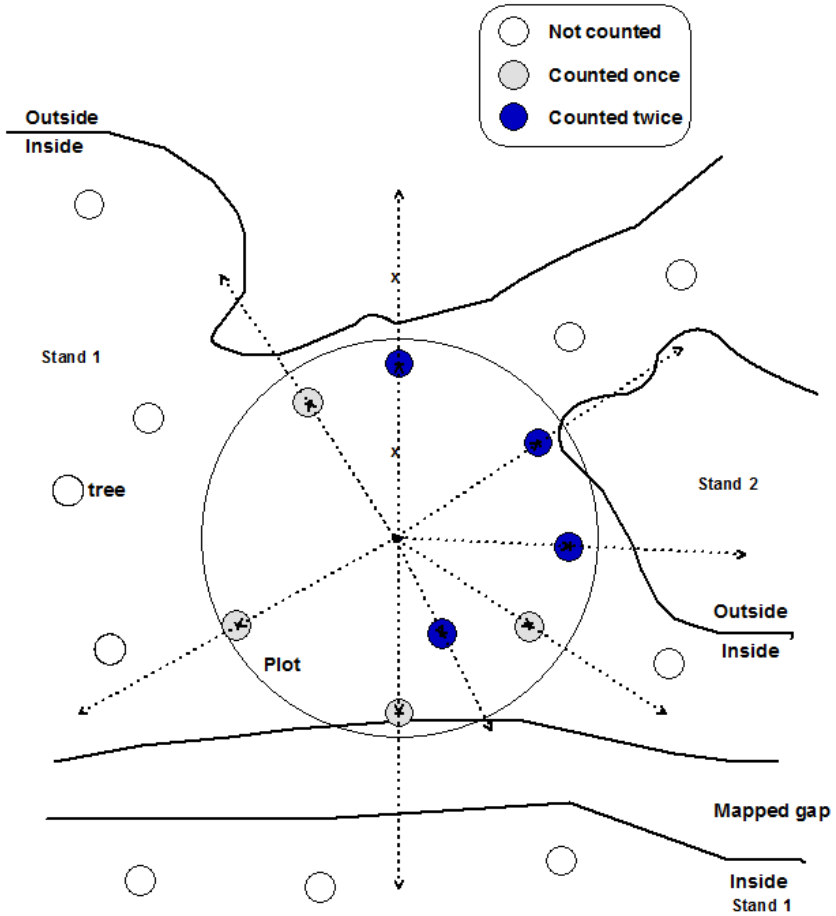
Example 1: Straight line boundary through plot



Example 2: Straight Line boundary away from plot



Example 3: Complex boundary



bluesource

FIA/FVS Species Codes (species mix may change for different locations)

Species Group	FVS Number	Alpha Code	Common Name	FIA Code	PLANTS Symbol	Scientific Name
1	1	BF	balsam fir	012	ABBA	Abiesbalsamea
2	2	TA	tamarack	071	LALA	Larixlaricina
3	3	WS	white spruce	094	PIGL	Piceaglauca
4	4	RS	red spruce	097	PIRU	Picearubens
4	5	NS	Norway spruce	091	PIAB	Piceaabies
4	6	BS	black spruce	095	PIMA	Piceamariana
4	7	PI	other spruce species	090	PICEA	Picea spp.
5	8	RN	red pine	125	PIRE	Pinusresinosa
6	9	WP	eastern white pine	129	PIST	Pinusstrobus
7	10	LP	loblolly pine	131	PITA	Pinustaeda
8	11	VP	Virginia pine	132	PIVI2	Pinusviginiana
9	12	WC	northern white-cedar	241	THOC2	Thujaoccidentalis
9	13	AW	Atlantic white-cedar	043	CHTH2	Chamaecyparisthyoides
9	14	RC	eastern redcedar	068	JUVI	Juniperusvirginiana
9	15	OC	other cedar species	057	JUNIP	Juniperus spp.
10	16	EH	eastern hemlock	261	TSCA	Tsugacanadensis
10	17	HM	other hemlock species	260	TSUGA	Tsuga spp.
11	18	OP	other pine species	100	PINUS	Pinus spp.
11	19	JP	jack pine	105	PIBA2	Pinusbanksiana
11	20	SP	shortleaf pine	110	PIEC2	Pinusechinata
11	21	TM	Table-mountain pine	123	PIPU5	Pinuspungens
11	22	PP	pitch pine	126	PIRI	Pinusrigida
11	23	PD	pond pine	128	PISE	Pinusserotina
11	24	SC	scotch pine	130	PISY	Pinussylvestris
11	25	OS	other softwood species		298	2TE
12	26	RM	red maple	316	ACRU	Acer rubrum
13	27	SM	sugar maple	318	ACSA3	Acer saccharum
13	28	BM	black maple	314	ACNI5	Acer nigrum
13	29	SV	silver maple	317	ACSA2	Acer saccharinum
14	30	YB	yellow birch	371	BEAL2	Betulaalleghaniensis
14	31	SB	sweet birch	372	BELE	Betulalenta
14	32	RB	river birch	373	BENI	Betulanigra
15	33	PB	paper birch	375	BEPA	Betulapapyrifera
15	34	GB	gray birch	379	BEPO	Betulapopulifolia
16	35	HI	hickory species	400	CARYA	Carya spp.
16	36	PH	pignut hickory	403	CAGL8	Caryaglabra
16	37	SL	shellbark hickory	405	CALA21	Caryalaciniosa
16	38	SH	shagbark hickory	407	CAOV2	Carya ovata
16	39	MH	mockernut hickory	409	CAAL27	Caryatomentosa
17	40	AB	American beech	531	FAGR	Fagus grandifolia
18	41	AS	ash species	540	FRAXI	Fraxinus spp.
18	42	WA	white ash	541	FRAM2	Fraxinusamericana
18	43	BA	black ash	543	FRNI	Fraxinusnigra
18	44	GA	green ash	544	FRPE	Fraxinuspennsylvanica
18	45	PA	pumpkin ash	545	FRPR	Fraxinusprofunda
19	46	YP	yellow-poplar	621	LITU	Liriodendron tulipifera
19	47	SU	sweetgum	611	LIST2	Liquidamberstyraciflua

19	48	CT	cucumbertree	651	MAAC	Magnolia acuminata
20	49	QA	quaking aspen	746	POTR5	Populustremuloides
20	50	BP	balsam poplar	741	POBA2	Populusbalsamifera
20	51	EC	eastern cottonwood	742	PODE3	Populusdeltoides
20	52	BT	bigtooth aspen	743	POGR4	Populusgrandidentata
20	53	PY	swamp cottonwood	744	POHE4	Populusheterophylla
21	54	BC	black cherry	762	PRSE2	Prunusserotina
22	55	WO	white oak	802	QUAL	Quercus alba
22	56	BR	bur oak	823	QUMA2	Quercusmacrocarpa
22	57	CK	chinkapin oak	826	QUMU	Quercusmuehlenbergii
22	58	PO	post oak	835	QUST	Quercusstellata
22	59	OK	other oak species	800	QUERC	Quercus spp.
23	60	SO	scarlet oak	806	QUCO2	Quercuscoccinea
23	61	QI	shingle oak	817	QUIM	Quercusimbricaria
23	62	WK	water oak	827	QUNI	Quercusnigra
23	63	PN	pin oak	830	QUPA2	Quercuspalustris
24	64	CO	chestnut oak	832	QUPR2	Quercusprinus
24	65	SW	swamp white oak	804	QUBI	Quercus bicolor
24	66	SN	swamp chestnut oak	825	QUMI	Quercusmichauxii
25	67	RO	northern red oak	833	QURU	Quercusrubra
25	68	SK	southern red oak	812	QUFA	Quercusfalcata
26	69	BO	black oak	837	QUVE	Quercusvelutina
26	70	CB	cherrybark oak	813	QUPA5	Quercus pagoda
27	71	OH	other hardwoods	998	2TD	
27	72	BU	buckeye species	330	AESCU	Aesculus spp.
27	73	YY	yellow buckeye	332	AEFL	Aesculusflava
27	74	WR	water birch	374	BEOC2	Betulaoccidentalis
27	75	HK	hackberry	462	CEOC	Celtisoccidentalis
27	76	PS	common persimmon	521	DIVI5	*Diospyrosvirginiana*
27	77	HY	American holly	591	ILOP	*Ilex opaca*
27	78	BN	butternut	601	JUCI	*Juglanscinerea*
27	79	WN	black walnut	602	JUNI	*Juglansnigra*
27	80	OO	osage-orange	641	MAPO	*Maclurapomifera*
27	81	MG	magnolia species	650	MAGNO	*Magnolia spp.*
27	82	MV	sweetbay	653	MAVI2	*Magnolia virginiana*
27	83	AP	apple species	660	MALUS	*Malus spp.*
27	84	WT	water tupelo	691	NYAQ2	*Nyssa aquatica*
27	85	BG	blackgum	693	NYSY	*Nyssa sylvatica*
27	86	SD	sourwood	711	OXAR	*Oxydendrumarboreum*
27	87	PW	paulownia	712	PATO2	*Paulownia tomentosa*
27	88	SY	sycamore	731	PLOC	*Platanusoccidentalis*
27	89	WL	willow oak	831	QUPH	*Quercusphellos*
27	90	BK	black locust	901	ROPS	*Robiniapseudoacacia*
27	91	BL	black willow	922	SANI	*Salix nigra*
27	92	SS	sassafras	931	SAAL5	*Sassafras albidum*
27	93	BW	American basswood	951	TIAM	*Tiliaamericana*
27	94	WB	white basswood	952	TIAMH	*Tiliaamericana var. heterophylla*
27	95	EL	other elm species	970	ULMUS	*Ulmus spp.*
27	96	AE	American elm	972	ULAM	*Ulmusamericana*
27	97	RL	slippery elm	975	ULRU	*Ulmusrubra*
28	98	NC	non-commercial hardwoods			
28	99	BE	boxelder	313	ACNE2	*Acer negundo*
28	100	ST	striped maple	315	ACPE	*Acer pensylvanicum*

28	101	AI	ailanthus	341	AIAL	*Ailanthus altissima*
28	102	SE	serviceberry	356	AMELA	*Amelanchier*
28	103	AH	American hornbeam	391	CACA1	*Carpinuscaroliniana*
28	104	DW	flowering dogwood	491	COFL2	*Cornusflorida*
28	105	HT	hawthorn species	500	CRATA	*Crataegus spp.*
28	106	HH	eastern hophornbeam	701	OSVI	*Ostryavirginiana*
28	107	PL	plums, cherry species	760	PRUNU	*Prunus spp.*
28	108	PR	pin cherry	761	PRPE2	*Prunuspensylvanica*