SOP 6: Tree Measurements

Version 1.42 (August 2020)

Estimated time: 60 Minutes

Overview

This SOP documents procedures for recording species, diameter, and various measures of condition of all live and standing dead trees ≥10 cm diameter at breast height in the entire 20 x 20 meter plot. The data are collected separately for each of the four 10 m x 10 m modules. These data will provide information on tree growth through time, mortality, condition, stand structure and stand composition. ***If this is a plot revisit or a QA/QC resampling event, make sure that the list of trees and the map of trees found during the last sampling are taken out into the field to match up present day trees with ones measured previously.*

Definitions

Trees are woody species with a diameter ≥10 cm at breast height (1.37 m) and capable of attaining heights >7 m. Field teams are provided a list which delineates species classified as trees. This will make it easier to quickly determine whether a species being recorded is considered to be a tree, shrub, or vine. When in doubt, go ahead and record the DBH since the data on non-trees can always be discarded later.

Diameter at breast height (DBH) is the diameter of the tree trunk (also called bole) at 1.37 m (4.5 feet) above the ground line on the uphill side of the tree. It is very important that the DBH is measured at 1.37 m height. The DBH is measured and rounded to the nearest centimeter for trees ≥10 cm diameter at breast height. The one exception to rounding is that CUPN does not round up from 9.5 cm. In other words, a trunk or bole must be ≥ 10 cm in order to count as a tree.

Live trees have living parts (i.e., leaves, buds, or cambium) at or above breast height (1.37 m). Trees that have been temporarily defoliated or are leaning or fallen are considered live trees. Live trees do not have to be self-supported – they may be supported by other trees, branches, or their crown. Pay attention to overtopped evergreen tree species that may appear dead but actually have green foliage at the very top of the tree that is embedded in neighboring trees or mistaken for brown foliage.

Standing dead trees (also called snags) lack any living parts (i.e., leaves, buds, or cambium) at or above breast height (1.37 m), and lean <45 degrees from vertical, as measured along the trunk (bole). Standing dead trees need not be self-supported. Once included, standing dead trees are tracked until they no longer qualify as standing dead. Dead trees leaning >45 degrees from vertical are considered coarse woody debris and are measured according to the Coarse Woody Debris SOP.

Step by Step Instructions

For plot revisits: after reviewing these step by step directions, field teams, particularly those involved in tree data collection, should review the "Notes on Plot Revisits" section at the end of this SOP which highlights common data collection/recording errors during plot revisits.

For new plots, beginning with module one, visually determine your strategy for measuring trees in a coherent pattern so that each tree of ≥10 cm DBH is recorded on the datasheet. This can be done by measuring the trees starting in one corner of each module and working through the whole module. You can work in a circular or linear pattern depending on the arrangement of trees in a module but do so in a logical manner. In other words, do not skip around from one side of the module to the other. In particularly dense foliage, flagging may be helpful to mark the starting tree and the boundary between trees that have been recorded and those that have not. For plot revisits, start with the first pre-recorded tree on the datasheet (labeled "Tree 1") and work in order of the pre-recorded trees, keeping an eye out for any newly recruited trees (grown to >10 cm since last plot sampling event) as you methodically work through the module. .

A tree on the plot boundary will be included only if the center of the tree base lies directly on or within the plot boundary (i.e., at least half of the tree is within the boundary). To determine if the center of the tree base falls in the plot, measure the horizontal distance from the centerline tape to the front of a crew member, standing adjacent to the tree base center. If the distance from the plot centerline to the center of the tree base is greater than 10.0 meters, then the tree falls outside the plot and is not tallied. The lean of the tree bole into or out of the plot does not affect whether the tree is tallied. For revisits, if it is obvious that the previous field crew included a tree then it should be included for your sampling event as well even if you think a tree may be "mostly" out. Also, if a tree falls just outside the plot, it is good practice to map this tree on the plot's tree diagram to assist future field crews in plot layout (refer to Tree Map section, below).

For revisit or QA/QC plots, field teams will have the tree map from the previous event. It is critical that teams reference this provided map when mapping and tallying trees. Specifically, your tree #1 should be their tree #1 and should be mapped accordingly on a new clean tree map that is included in the field datasheet packet. When resampling a plot for QA/QC, the tree map completed at the end of your sampling event should look like the map produced by the other team (given +/- 0.5m on the exact mapping). This comparison is made for <u>every</u> tree before moving on to the next tree. Do not add or drop trees from plot boundaries as the decision on whether to include was already made by the previous team. This means tapes are laid out to match the previous sample and that trees on edges of modules/plot are in the same place for the current sampling event. If the previous team called a tree in or out of a module/plot, do the same unless it is an obvious un-reconcilable error. In those rare instances where you believe the previous team made an egregious error, collect the data as the previous team did and then make detailed notes detailing why it should be done differently, including the "corrected" data as well.

For plot revisits, every tree recorded during the previous sampling event and recruited trees (those that are now ≥10 cm but were not during the previous 5-yr cycle) will receive a value for module #, tree #, species, and status. From that point on, recorded values will depend on the tree's status. Each of the subsequent sections in this SOP will define which trees receive which values. Refer to Table 6.1 below for an overview of which values are required for which tree statuses, and which values are given only if applicable.

Table 6.1. Overview of tree values by tree status.

	Tree Status x=Required Field I=If applicable				
	0	1	2	3	4
Module #	x	x	x	x	x
Tree #	x	x	x	x	x
Species	x	x	x	x	x
Tree Status	x	x	x	x	x
DBH >10 cm		x	x		
Crown Class		x			
Vigor		x			
Dieback		I			
Condition/Damage		I			
Foliage Condition		I			
Foliage %		I			
Decay Class			x		
Snag Height			x		

Verify Plot Layout

There are currently (*as of April 2018*) no plans to establish new plots in the foreseeable future. Therefore, it is assumed that all upcoming sampling events will be regularly scheduled 5-yr revisits or QA/QC events. This means the trees in your plot have been previously mapped and measured. Therefore a plot tree map and plot footprint (i.e., which trees are included in which modules) have already been established. This map/footprint should have already been consulted during plot layout, ensuring module boundaries align with the previous event(s). Before beginning data collection do a reconnaissance of each module to ensure that all trees that should be in each module can be accounted for and/or any discrepancies can be accounted for (e.g., fallen tree). If it was discovered that a tape was laid out incorrectly (i.e., included a tree that should not have been included or vice versa), stop data collection for the plot and have the field team correct the error by realigning the tapes.

Species

Once you have reviewed the tree map from the previous sampling event and feel confident module boundaries are correctly delineated, locate tree #1 from the previous sampling event. Tree number is consecutive for the plot beginning with tree #1. For each species, record the 7-8 letter code that corresponds to the scientific name. Refer to park species list provided to field crew. If for some reason the park species list is inaccessible or a species is not included on the list, spell out the ENTIRE species name, no abbreviations. Unique codes generally consist of the first 4 letters of genus and first 3 letters of species of that tree with an extra 8th digit where there would be duplicate seven letter codes. For example, shagbark hickory, (*Carya ovata*) and red hickory (*Carya ovalis*) would have the same 7-letter code, as such the former's 8-letter code is CARYOVAT and the latter's correct code is CARYOVAL. In assigning species names and uncertainty values, refer to SOP 14: Recording Species Nomenclature and Reference. In instances where species identification is not 100% certain, ask the botanist. If for some reason you believe the previous team made a species identification error, consult the botanist before

changing the species ID. In all cases, the botanist on the plot is the final authority when making species identification calls.

Diameter at Breast Height (DBH)

Before beginning it is good practice to measure 1.37 m on your chest, using the plot meter sticks to aid in consistency of measurement. It is also good practice (and highly encouraged) to periodically have someone else on the field crew re-measure a tree or two within the plot to again check for consistency.

All trees, living or dead, ≥10 cm DBH will be recorded on the datasheet. Using a DBH tape, measure DBH, which is 1.37 m above the ground, on the uphill side of tree (Figure 6.1). Do not measure from a pit or atop a mound or emergent rock. Use the DBH tape measure and round to the nearest 1 cm. In other words, if measured DBH is 10.4, then it would be rounded to 10. If measured DBH is 10.5, it would be rounded up to 11. The one exception to rounding is that a tree must be at least 10 cm DBH to be recorded. So, if it measures 9.9 cm or less, it should not be rounded up to 10. In any case where a tree branches above 1.37 m (breast height) from its base or more, you will only record the main stem. In contrast, if the tree branches less than 1.37 m (breast height) from the base, you will measure all stems ≥10 cm DBH.

Make certain that you are reading the correct side of the DBH tape; often one side has standard centimeters and the other side has units calibrated to give the diameter in centimeters when wrapped around the circumference of the tree. Press the hook at the end of the tape into the bark and then run the tape around the trunk, ensuring that the tape is straight, pulled tight (no kinks) and perpendicular to the axis of the trunk. Tapes that are not run straight will overestimate the trunk diameter. Read the number where the tape crosses the zero mark at the hook end of the tape. For unusual situations, determine where DBH should be located on the tree, using the guidelines in Figure 6.1 and "further notes" below. Note the location of the DBH measurement in Tree Notes, using distances and unique tree characteristics.

Further notes on measuring DBH:

<u>Trunk abnormality</u> If a trunk abnormality occurs at breast height (1.37 m): Take the diameter measurement just below the abnormality if possible. If the abnormality extends far below breast height (1.37 m), then take the measurement just above breast height (1.37 m). Put the height where measured in the Tree Notes.

<u>Missing wood or bark</u> Do not reconstruct the DBH of a tree that is missing wood or bark. Record diameter of the wood and bark as the tree is, and note that wood or bark was missing in Tree Notes.

<u>Leaning tree</u> Diameter is always measured perpendicular to the bole axis. Find the point equivalent to breast height (1.37 m) by measuring along the uphill side of the tree. Measure diameter perpendicular to the tree trunk (bole) as shown in Figure 6.1. If a living tree is leaning more than 45 degrees, find the point equivalent to breast height (1.37 m) by measuring along the uphill side of the tree starting with the root collar and measure diameter perpendicular to the bole. Note that a dead tree leaning more than 45 degrees is not counted or measured as a tree but is counted as coarse woody debris.

Curved bole Find the point equivalent to breast height (1.37 m) by measuring along the curvature of the bole on the uphill side of the bole as shown in Figure 6.1 and measure diameter perpendicular to the bole.

Live windthrown tree Find the point equivalent to breast height (1.37 m) by measuring along the uphill side of the tree starting with the root collar and measure diameter perpendicular to the bole (see Figure 6.1).

Swollen base Trees with swollen bases rising higher than 0.91 m (3 feet) are measured 0.46 m above the top of the swelling. Trees with swelling below 0.91 m are measured at standard DBH. Make a note in Tree Notes about the swelling and diameter location.

Independent trees that grow together If two or more independent stems have grown together at or above the point of DBH, continue to treat them as separate trees. Estimate the diameter of each, and explain the situation in Tree Notes.

Forked tree Trees which fork at or above breast height (1.37 m) are tallied and measured as one tree. Diameter is measured below the point at which forking affects DBH (see Figure 6.1). For trees that fork below breast height (1.37 m), each stem ≥10 cm is tallied as a separate tree. Measure the diameter of each stem at breast height unless the fork affects the diameter of the stem, in which case measure above breast height where the fork does not affect the diameter of the stem and make a note in Tree Notes of measurement location. For consistency, multiple stems are recorded from left to right when facing the trees from plot center. Note the spatial relationship of forked trees to each other in Tree Notes and on tree map. Record any unusual tree features or the relative position of each of the stems of a clumped tree/copse if applicable.

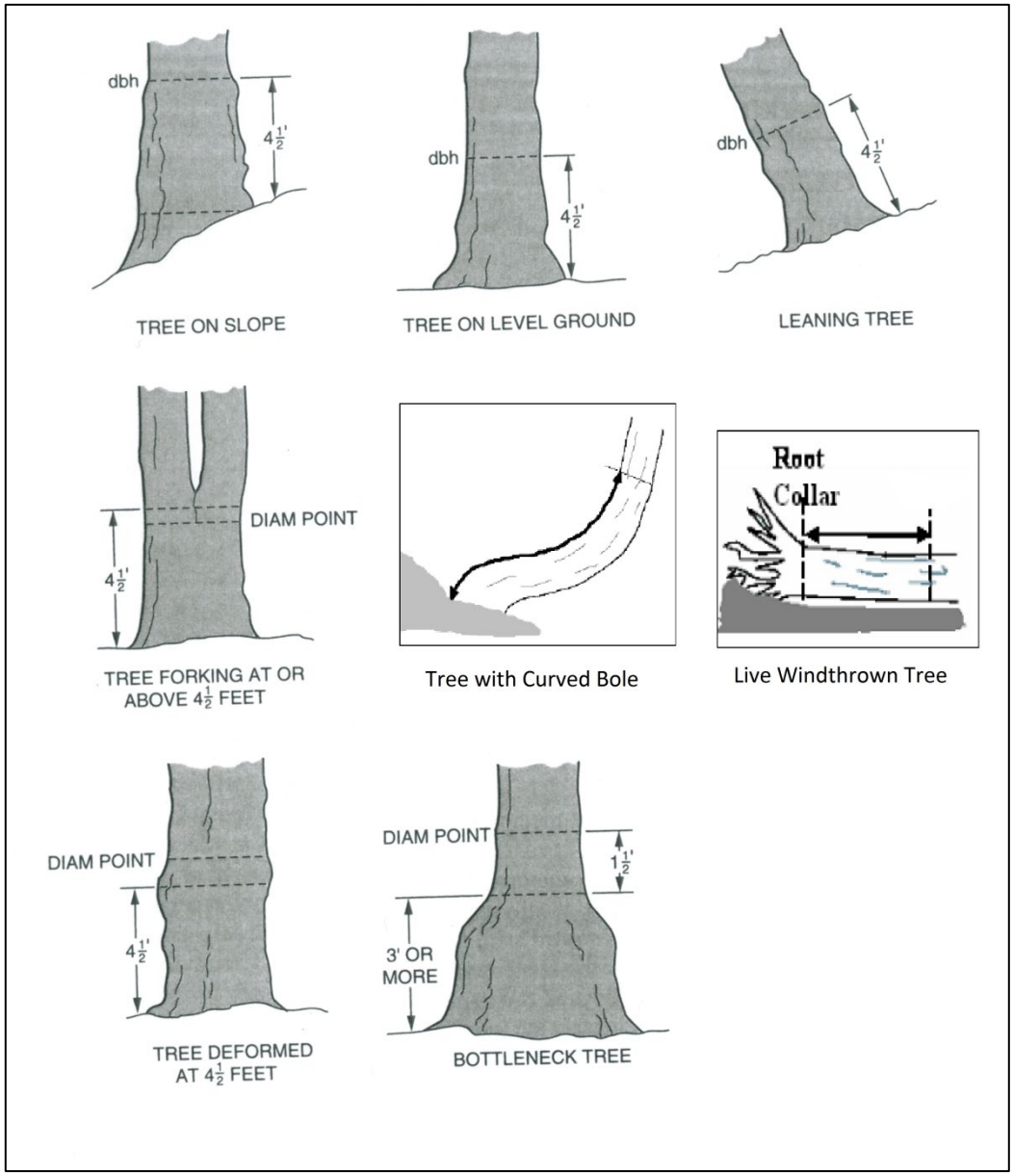

Figure 6.1 Irregularities in DBH measurement.

<u>Trees with vines</u> It is imperative that trees with vines climbing the bole at breast height have the DBH measured underneath the vines. The easiest way to remove the vine is by prying it away from the tree with the hammer to get underneath it. Be especially careful when handling poison ivy vines (use gloves) because the hairs on the vine can cause a reaction similar to the leaves. Note there is not enough precision using the Biltmore stick to estimate DBH for this method to be recommended.

Tree Status

Determine the tree status of each recorded tree (see below). In differentiating whether a tree is alive or dead, refer to the definitions at the beginning of this SOP. If the tree in question is

determined to be dead, move on to Decay Class. Information on decay class is found near the end of this SOP.

0. No status. Previously tallied tree is no longer in sample because the tree: a) shrunk below 10 cm DBH (e.g. tree damage), b) after a thorough search the tree cannot be found due to natural causes (don't forget to look on the ground), c) was incorrectly tallied last time, or d) a change in procedure now excludes this tree. Record the reason in Tree Notes.
1. Live tree. New live trees in revisit plots are assumed to be in-growth. If a tallied new tree was obviously missed during a previous inventory, note this in Tree Notes. New trees will be given the next tree number available (if there are already 25 trees documented in the plot, then a new tree would be assigned tree number 26). Live trees have living parts (i.e., leaves, buds, or cambium) at or above breast height (1.37 m).
2. Standing dead tree. Tree lacks any living parts (i.e., leaves, buds, or cambium) at or above breast height (1.37 m), and leans <45 degrees away from vertical, or straight up and down.
3. Removed. Previously tallied tree has been cut and removed by humans during harvest, forestry treatment, hazard tree removal, or land clearing. Signs of cut/destroyed tree such as stump or chips can be found.
4. Fallen dead tree. Previously tallied tree has fallen and will no longer be tracked as a live tree. This includes dead trees leaning >45 degrees from vertical.

If tree is alive, follow the steps below to pick the appropriate codes for crown class and tree vigor. All live trees will receive a crown class and vigor code. Additional codes are added for trees that exhibit dieback, damage, foliage problems, or other various conditions. It is important to thoroughly inspect each tree by looking up and down the tree, as well as around the entire bole.

Crown Class

Every live tree will receive a crown class code. Assign the crown class code describing tree crown position in canopy and amount of sunlight received (see Figure 6.2). If there is any uncertainty in assigning a canopy class to a tree, make a note in Tree Notes about why.

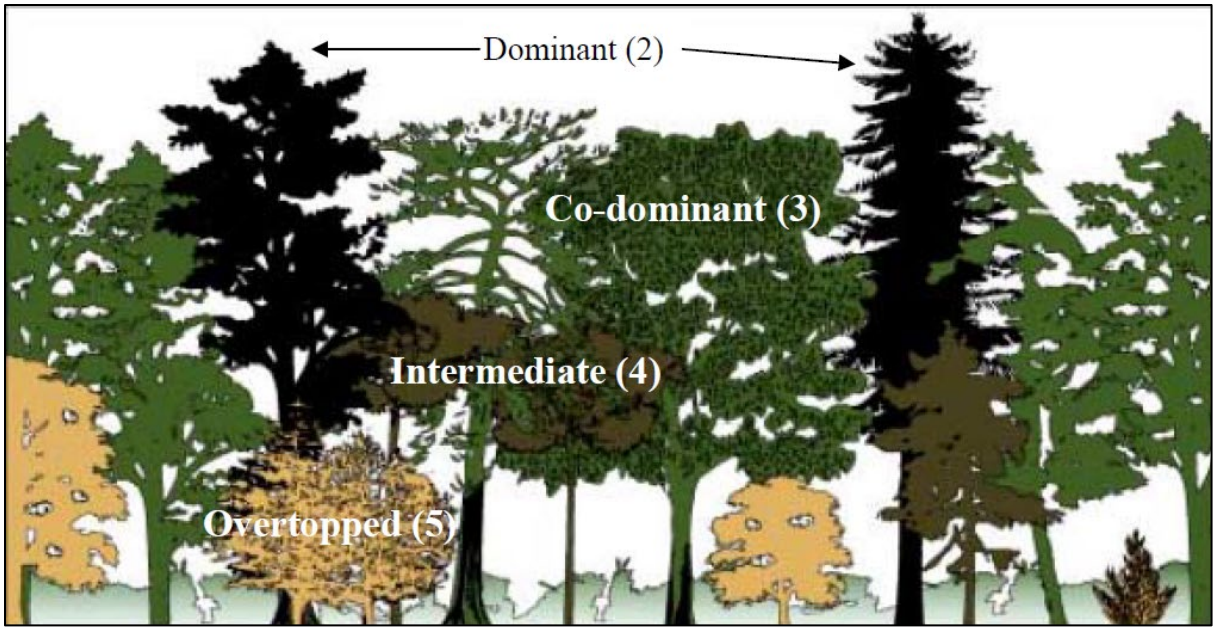

Figure 1.2. Crown class examples for classes 2-5.

1. Open-grown – crown has received full sunlight from above and all sides through much of its life, particularly during early development, as seen by well-developed lower branches. Open-grown trees may be present at different positions within the general canopy, but are identified by their form. They are much older and larger than all the other trees in the plot, with unusually spreading branches indicative of a past that included growing in a full-sun, low competition environment. This results in a much more rounded (as opposed to linear) crown.
2. Dominant – crown extends above canopy, receiving full light from above and some light from sides. Taller than the average tree in stand and has well-developed crown.
3. Co-dominant – crown at the general level of the canopy, receiving full light from above but little direct light from sides. Typically, co-dominant trees have medium-sized crowns and are crowded on the sides; in dense stands, co-dominant trees have small crowns.
4. Intermediate – tree is shorter than co-dominant trees but with a crown that extends into the general canopy. Tree has small crown and is very crowded from the sides.
5. Overtopped – crown is entirely below the general level of the canopy.

Vigor

Every live tree will receive a vigor code. Vigor is a measure of overall tree health and vitality. This measure compares the subject tree to an "ideal" healthy specimen of that species. Record the general overall health of the tree using the codes below. Estimate vigor before estimating dieback or recording tree or foliage conditions.

1. Healthy. Tree appears to be in reasonably good health with <10% missing/damaged crown, branch or twig mortality, discoloration, or dwarfed leaves present.
2. Light Decline. Less than 25% of the crown is missing or damaged. Branch mortality, twig dieback, foliage discoloration, or dwarfed leaves are present on 10 – 25% of the crown.

3. Moderate Decline. Branch mortality, twig dieback, foliage discoloration or dwarfed leaves on 26 – 50% of the crown. Between 26 and 50% of the crown is missing or damaged.
4. Severe Decline. More than half of the crown is missing, damaged, or contains branch mortality, dieback, discoloration or leaf dwarfing, but foliage is still present to indicate that the tree is alive.
5. Functionally Dead. There may be a few epicormic shoots on the bole, but the vast majority of the crown branches are missing or dead and leaf-less

Several factors should be considered when assessing vigor:

- How much of the crown is missing or damaged from recent or long past disturbances? Old injuries should be considered in the vigor assessment until the tree builds a new crown that makes the old injury largely invisible.
- How much of the crown is composed of dead snag branches? Snag branches are large branches without small twigs <2.5 cm (1.0 inch) in diameter, usually with the bark absent or with dead bark peeling away.
- How much of the crown contains foliar discoloration or dwarfed or misshapen leaves?
- Current defoliation should NOT be considered in the vigor assessment. A defoliated tree does not necessarily have low vigor. Vigor is difficult to assess for trees that are currently undergoing partial or severe defoliation. For those trees, make the best assessment possible by considering crown structure, snag branches, and any intact foliage that may remain.

Dieback

Only live trees displaying dieback will receive a dieback code. Branch and fine twig dieback is defined as branch mortality that begins at the terminal portion of a limb and progresses downward (Figure 6.3). This measurement is an estimate of the proportion of the crown silhouette involved in dieback. Assume the perimeter of the crown is a two-dimensional outline from branch-tip to branch-tip. Then estimate the amount of the outline that includes dieback. Record the proportion of the crown with crown dieback using the following categories:

1) 1–10%, **2)** 10–25%, **3)** 25–50%, **4)** 50–75%, **5)** 75–100%.

The following should be **excluded** from the dieback percentage:

- **Snag branches** (large branches without small twigs <2.5 cm in diameter, usually with the bark absent or with dead bark peeling away). Snag branches are assumed to have died much earlier and should not be included in the dieback percentage.
- **Large holes or gaps in the crown** where branches never developed.
- **Branch mortality at the base of the crown**, assumed to be the result of shading.

Dieback should ideally be estimated when leaves are mature, but before the appearance of fall color. One crew member is required to make the estimate of dieback from two different sides of each tree, standing at a minimum of a 90° angle apart around the tree. The diagram below (Figure 6.3) illustrates what to include and exclude when assessing dieback.

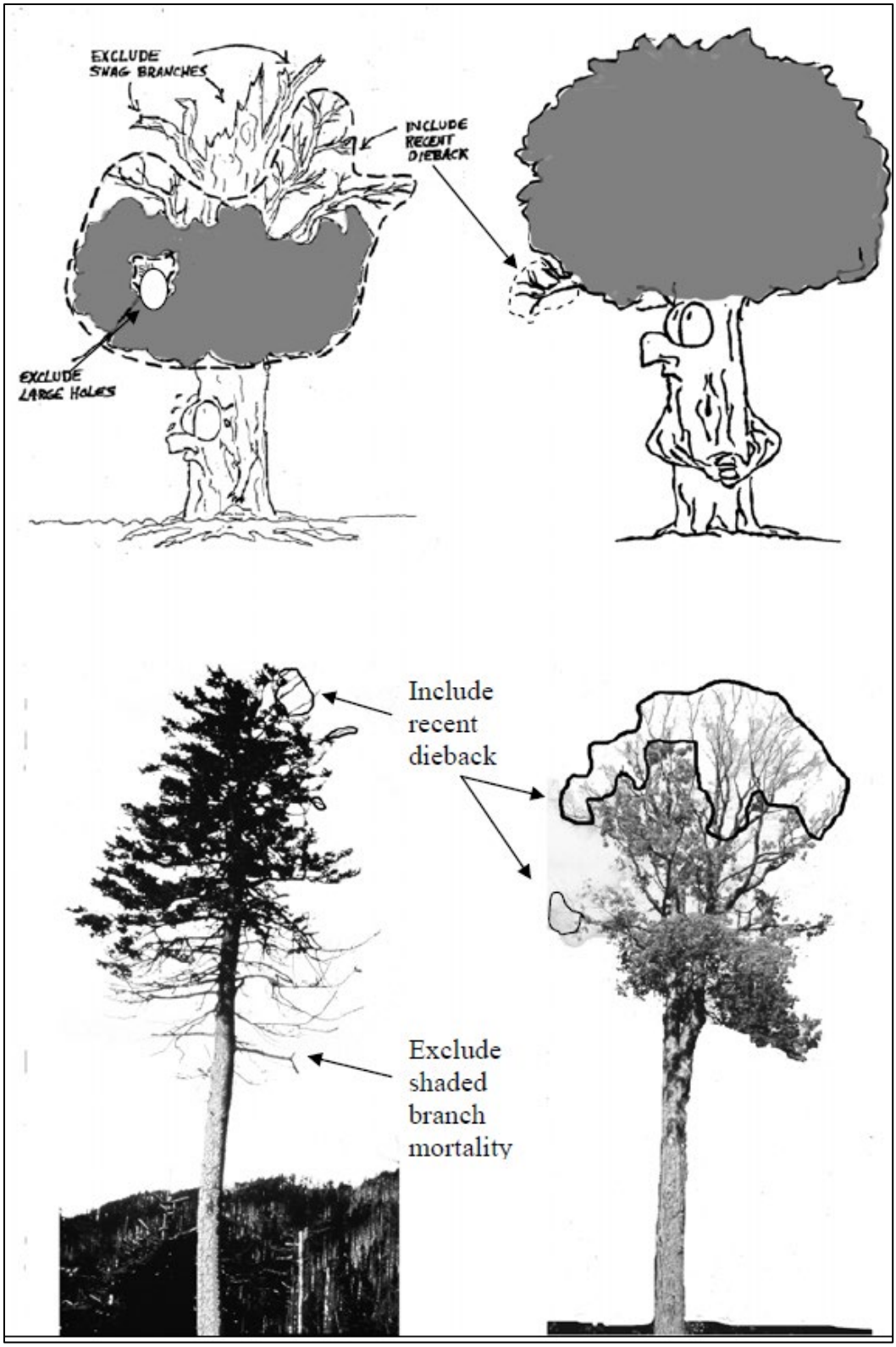

Figure 6.3. Examples of tree dieback.

Condition/Damage

Only live trees exhibiting conditions/damages listed below will receive a code. Field teams need to have some familiarity with the identification of these codes before assessing. Specific tree damage types will be indicated by placing the appropriate three- or four-letter code in the "tree condition/damage codes" column. You can add up to three codes in this column (if you need to write more than three codes, add the additional codes in the "Tree Notes" section). The following codes cover the **Pests and Pathogens**:

ALB Asian Longhorned Beetle
BBD Beech Bark Disease
BTC Butternut Canker
CHB Chestnut Blight
CPB Common Pine Shoot Beetle
DWA Dogwood Anthracnose
EAB Emerald Ash Borer
ETC Eastern Tent Caterpillar
GPM Gypsy Moth
HWA Hemlock Wooly Adelgid
RAB Redbay Ambrosia Beetle
SOD Sudden Oak Death
SLF Spotted Lanternfly
SWW Sirex Woodwasp
TCD Thousand Cankers Disease

***Note: For ALB, EAB, GPM, RAB, and SLF, please take photographic evidence of the forest pest/pathogen. These are all very serious pests that have either not been found in most parks or are very sporadic within the parks, so any identification in the field needs to be verified by a third party.**

Refer to Appendix E: "Field Guide" to CUPN Potential Forest Pests, Pathogens and Invasive Exotic Plant Species of Concern, as a starting place. Additionally, CUPN began implementing an Invasive Species Early Detection (ISED) protocol in 2014 (Keefer et al. 2014). The protocol contains early detection lists for both plants and pests for each of the 14 CUPN parks. These lists are updated annually and identification information is provided to field teams during each year of fieldwork. If a forest pest or pathogen that is new to the park being monitored is detected, or suspected of occurring, a specimen of the pest, or a photo of the pest or symptoms is taken. Blank "Incidental Observation" forms (Figure 6.4) must also be completed as part of the ISED protocol and accompany the evidence of the forest pest. These vouchers are provided as quickly as possible to:

Clare Bledsoe, Biologist
Mammoth Cave National Park
P.O. Box 8
Mammoth Cave, KY 42259
clare_bledsoe@nps.gov
This information will then be used to help with the early detection of forest pests.

☐ **Invasive Exotic Plant** ☐ **Forest Pest** ☐ **Rare/ Tracked Species** ☐ **Other**

Species: _____ **Observer(s):** _____ **Park:** _____ **Date:** _____

ID Confidence: certain probable uncertain **Evidence Collected:** photo voucher other _____

plant only

Infested Area (ft2/m2/acre/ha): _____ (if dense)
Gross Area (ft2/m2/acre/ha): _____ (if scattered)
Canopy Closure: Trace (<1%) Low (1-5%) Med (5-25%) High (25-100%)
Abundance: Single Scattered Dense Patches Dense monoculture Linear Pattern
Description: In Flower In Fruit Seedlings/Rosettes Dormant/Dead Bolting Unknown
Stem Count: _____

forest pest only

Host Species _____
DBH _____ *(if tree)*

Type of Evidence
crown dieback
foliar injury (chlorosis/necrosis...)
sawdust
exit holes
other _____

Host Species Stem Count: _____

Field UTM X _____ m E **Field UTM Y** _____ m N **Datum** _____ **Zone** ___

How were coordinates obtained (e.g. phone, GPS, etc.)? _____ **GPS error** _____ m
Location Description: _____

Habitat Description (e.g. forest edge, mixed forest, open field): _____
Other comments: _____

Figure 6.4. Blank "Incidental Observation" form which must be completed if an early detection plant or pest is found during vegetation monitoring.

In addition to pests and pathogens, the field teams will also be called upon to assess each tree for several damage codes (Table 6.2). Some damage codes may not be applicable to all species. For example, some species of oak are characterized by complex forking above BH, so the FORK code would not indicate damage or abnormality and would not be of use. For vines, record the species of vine present if the vine reaches the tree crown. During a revisit, if a vine was present during the previous sampling event but is no longer there, cross off the old note in tree notes to avoid confusion during the next sampling event.

Table 6.2. List of tree damage codes, excluding pests and pathogens.

Damage Code	Description of Damage
ABGR	Abnormal growth pattern for the species. This category would include a range of physical deformities not included in the remainder of the damage codes.
BIRD	Bird damage such as woodpecker or sapsucker holes.
BLIG	Blight is generally defined as any plant disease or injury that results in general withering and death of the plant without rotting. Blight can result from a wide variety of needle, cone, and stem rusts, as well as canker diseases, and is often species- or genus-specific.
BROK	Broken top of the tree.
BROM	Witches' broom diseases are characterized by an abnormal cluster of small branches or twigs on a tree as a result of attack by fungi, viruses, or insects.
BURL	A hard often rounded outgrowth on a tree that is made up of woody material. This occurs naturally in some tree and shrub species, and is a sign of an internal infection or disease in other species.
CONK	The knobby fruiting body of a tree fungal infection visible on a tree bole, such as a shelf fungus.
CROK	Crooked or twisted bole for species **in which this is uncharacteristic**.
DECY	Advanced decay of bole and limbs.
DTOP	Dead top.
EPIC	Epicormic sprouting for species **in which this is uncharacteristic**, adventitious shoots arising from suppressed buds on the stem.
FIRE	Fire scar or cambial damage due to fire.
FORK	Forked top of a tree or multiple primary leaders in a tree crown **for species in which this is uncharacteristic**. Forks assume vertical growth and should be distinguished from branches, which assume horizontal growth.
FRST	Frost crack or other frost damage.
GALL	Galls found on stems, leaves or roots. Galls are formed by infection of the plant by bacteria or fungi, or by an attack by certain mites, nematodes, or insects, most notably wasps.
HOLW	Hollowed-out trees. Repeated hot fires can burn through the bark and the tree's core may then rot out, especially in trees with tough bark, but soft heartwood. These hollowed-out trees are sometimes called "goose pens" because early settlers kept poultry in them.
INSE	Visible insects in the tree bole or the canopy, or their sign, such as frass, pitch tubes or bark beetle galleries.
LEAN	Tree is leaning significantly. If on a slope, tree deviates considerably from plumb.
LIGT	Lightning scar or other damage to the tree caused by lightning.
MAMM	Damage caused by mammals, such as bear claw marks, porcupine or beaver chewings, and deer or elk rubbings.
OZON	Ozone damage. Ozone injury is often seen in the form of stippling or speckling on the leaves or needles of trees. This discoloration varies among species and ranges in color from red or purple to yellow or brown. Susceptible species often drop their leaves prematurely.
ROOT	Large exposed roots.
ROTT	A rot of fungus other than a conk, often associated with a wound or crack in a tree.
SPAR	Unusually sparse foliage for that species and size of tree.
SPRT	Basal sprouting; new shoots arising from the root collar or burl.
UMAN	Human-caused damage such as axe marks, embedded nails or fence wire, or vandalism.
VINE	Vines present in canopy. List vine species or genus in the Notes section of the paper data sheet or the Vine Species section of the database. Vine should reach the tree canopy in order to be counted.
WOND	A wound to a tree that cannot be identified by one of the other damage codes, including wounds or cracks of unknown cause.

Foliage Condition and Foliage Percentage

Only live trees displaying foliage conditions will receive a code. Visually assess canopy foliage and record up to three (3) problems: **chlorosis** (**C**), **necrosis** (**N**), **holes** (**H**), **small leaves** (**S**), **wilting** (**W**), **leaf loss** (**L**), or **other** (**O** – describe in Tree Notes). **Chlorosis** is a condition where leaves produce insufficient chlorophyll and instead appear ghostly white. **Necrosis** is the premature death of cells and can occur in some leaves, which appears as dark watery spots on leaves to dry papery spots that may be tan or black. Only record **L** for needle loss if fine twigs in the canopy are affected – disregard lower branches and large dead branches. Current defoliation should also be recorded under foliage conditions. If the defoliating pest is known and recorded under Tree Conditions, record **O** (other) for Foliage Conditions. If the defoliating pest is unknown or not listed under Tree Conditions, record **L** (leaf loss). Estimate amount of crown affected for each foliage condition using the following classes:

1) 1–10%, **2)** 10–25%, **3)** 25–50%, **4)** 50–75%, **5)** 75–100%.

Decay Class and Snag Height (Dead Trees Only)

If the tree is a dead standing tree (see definitions at beginning of this SOP), then collect information on the decay class and snag height (visual estimate in meters). If tree is dead, you are not required to name the species, though if you can determine it based on bark and twigs, then please do so. Recording genus only on snags is also helpful but it is important to be right-do not simply guess. For each standing dead tree, record the code indicating the tree's stage of decay (see Table 6.3 below).

Table 6.3. List of decay class codes.

Snag decay class	Bark	Log shape and integrity	Color of exposed wood	Texture of rotten portions	Primary surface substrate	Branches and twigs
1	Firmly attached	Round and solid. Freshly fallen, intact logs	Fresh color, not stained by weathering	Intact, no rot or conks. Stem decay absent.	Sound, tight bark	Branches retain many small twigs
2	If present, decayed, faded and not firmly attached	Round and solid	May be bleached and relatively smooth (like driftwood)	Mostly intact, sapwood partly soft and starting to decay, but can't be pulled apart by hand	Decayed bark and hard wood - impenetrable with fingernail or pen point	Branches retain some small twigs, often with peeling bark
3	Generally absent, except in Betula and Prunus	Round and firm, piece supports its own weight	Reddish-brown, or original color	Hard, large pieces of sapwood can be pulled apart by hand.	Soft wood - will spring back if compressed, easily penetrated with fingernail or pen point	No small twigs, but branch stubs will not pull out
4	Absent	Oval or flattened, no longer a solid piece, though some hard chunks remain. Piece does not support its own weight, but maintains its shape	Reddish or light brown	Soft, small blocky pieces, a metal pin can be pushed into heartwood	Very spongy wood - responds to finger pressure and may exude moisture. Powder wood flows through fingers like coarse sawdust	No small twigs, branch stubs pull out

Snag decay class	Bark	Log shape and integrity	Color of exposed wood	Texture of rotten portions	Primary surface substrate	Branches and twigs
5	Absent	Quite flat or flat with some rounding. Piece no longer maintains its shape, but spreads out on the ground	Red-brown to dark brown	Soft, powdery when dry	Loosely aggregated powder wood	No small twigs. Branch stubs and pitch pockets have usually rotted down

Tree Map

All recorded trees (live or dead) should be mapped on the tree diagram, included in the plot datasheets (see Figure 6.5 for an example). The tree diagram is gridded in one meter increments. It is important that trees are mapped correctly, as this will give future monitoring teams an easy way of determining whether the tree they are measuring is the same as the one you measured or a different one. To most accurately plot the trees, use the meter marks on the tape measures surrounding the module. Also, make sure you know which direction is north and that you have the tree diagram oriented correctly before marking trees on the map. It is also helpful to map trees that lie just outside the plot, as this can aid in future plot layout during revisits.

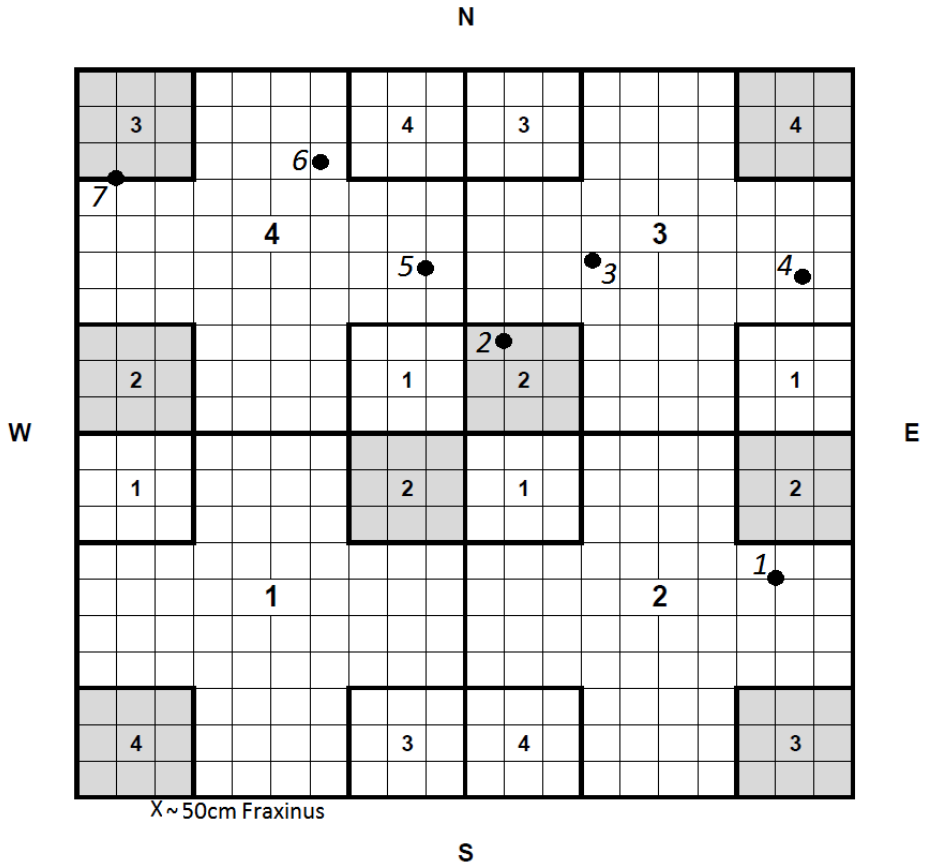

Figure 6.5. Example of a tree diagram with all trees (live or standing dead) over 10 cm DBH mapped. Note large *Fraxinus* in bottom left mapped on boundary but outside plot to aid the next survey team in plot layout.

Notes on Plot Revisits

For plot revisits, there are several notes to keep in mind when taking tree data:

1. Write large and dark. Small or lightly written notes can be very difficult to discern, particularly on scanned images.
2. There will likely be trees that have died since the previous survey and are no longer standing, in which case the tree may be standing and dead, fallen, or gone. Update tree status according to tree status definitions.
3. If a tree was obviously missed during the previous survey (e.g., in the middle of the module), note this in Tree Notes. New trees will be given the next tree number available. In other words, if there were 20 trees measured during the last sampling event then the first new tree will receive #21.
4. There will also likely be trees that have grown to 10 cm DBH since the previous survey that will need to be added to the datasheet. These new trees will be given the next tree number available.
5. Make sure to note in tree notes which trees are tag trees and include the tag # if not already done during plot establishment (this helps to make sure the DBH of the tag tree in SOP3 matches that of the same tree in SOP6).
6. If species ID was incorrect or missing during the previous survey, cross out the incorrect species code and write the correct code; if needed make note in tree notes about why it was corrected. Utilize information such as previous DBH, location on tree map, and any other available data from the previous survey to make certain that you are confident in your decision. Before making any species ID changes consult the botanist for confirmation as the botanist on the plot is the final authority.
7. Similarly, if tree DBH appears grossly different from the previous survey (such as increasing by 10cm), consult the previous survey's field forms to ensure that you are measuring the correct tree. It is possible that the correct diameter was written on the field form during the previous survey and the erroneous DBH was a data entry error in the database.
8. For the second five years of monitoring, you will need to fill out a blank tree diagram to include all measured trees. The first five years of monitoring only required mapping trees of at least 20 cm DBH, but surveys from 2016 on require mapping of all measured trees. This includes trees between 10 and 20cm DBH, new trees (those that have grown to at least 10cm DBH since the last survey), and previously missed trees. It will also be helpful to future teams to map trees on, but just outside the plot boundary. This can be done by marking these trees just outside the plot with an "x" and note indicating species and approximate DBH (see Figure 6.5 for an example).
9. If a tree note written on the datasheet during a previous survey is no longer relevant, cross it off in order to prevent confusion during the next revisit, as tree notes get carried over to subsequent visits.

Equipment List

DBH Tape (in cm)
Small binoculars
Hand lens (optional)
Tree identification references
Plant press and newspapers (should not be carried in the field)
Zip seal plastic bags in case you need to collect plant specimens

Compass
Hammer with prongs (for removing vines when needed)

References

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Revision History

Version numbers are incremented by decimals where minor grammatical changes or textual clarifications are incremented by hundredths (e.g., 1.01, 1.02, 1.03, …, etc.) and moderate changes, such as equipment updates or changes in methodology that do not impact analysis are incremented by tenths (e.g., 1.1, 1.2, 1.3, …, etc.). Whole number increments (e.g., 1.0, 2.0, 3.0, …, etc.) are reserved for major revisions. Of course, differentiating between what is moderate vs. major may not always be clear, but it is anticipated that with a little "common sense" and discussion protocol leads can adequately document and track revisions through time to the benefit of future data users. It should be noted that prior to 2020 all revisions were incremented by tenths.

Revision History Log

Version #	Date	Revised by	Changes
1.1	01/15/12	B. Moore and R. White	- Clarified that a full park species list would be provided to field crews indicating whether each woody species is classified as a tree. Previous text indicated only a "cheat sheet" of "woody plants for which life form is not obvious" would be provided. - Removed Horizontal distance definition - Added text for VINE (tree damage) code "Vine should reach above dbh in order to be counted." - Added text that it is not a requirement to provide a species ID for a snag where it is no longer discernable
1.2	09/27/12	B. Moore and R. White	All edits within track changes are attributed to "Rickie_White" - Text changed for measuring DBH of Live windthrown tree: DBH should be measured "where tree breaks the plane" of 1.37 meters above the forest floor" as opposed to measuring from top of root collar along the bole, which was previous direction. - Changed binoculars to an optional item in the equipment list
1.3	03/29/2017	C. Bledsoe	- "Time allotted: 50 minutes" changed to "Time estimate: 60 minutes" - Added clarifications for revisits including: o Importance of using previous team's map to utilize the previously assigned tree numbers and to make determinations as to whether trees on boundary should be included (if previous team included than it should be included in currently sampling as well even if you believe it is "mostly" out) o Should begin with tree #1 and move through data collection in a coherent fashion o Good idea to map trees just outside boundary to aid future teams with plot set up o Added text to definition of Tree Status=0 - Added more description to Necrosis in Foliage Conditions section. - "Cleaned up" text under Decay Class and Snag Height sections - Clarifications to reporting tree pests and pathogens including who to contact and updates to species list to more accurately reflect CUPN region. Species list changes include removing the pest species (Asian Ambrosia Beetle, Elongate Hemlock Scale and Redhaired Pine Bark Beetle) and adding one

			species (Spotted Lantern Fly). - Removed sentence from snag section regarding the recording of vines (vines have never been recorded for snags)
1.4	04/03/2018	C. Bledsoe and B. Moore	- Added table of "required" and "if applicable" data elements to be recorded in field by Tree Status - "Substantially" reorganized sections of SOP - Changed foliage % code from 0-10% to 1-10% (*note field forms always had 1-10% as the category and this was the category used in field*) - Clarified reference in table that vines are only recorded if in canopy (This change was first implemented during the plot establishment years, 2011-2015) but not sure exactly which year. - Added text emphasizing need to measure DBH under any vines on the bole - Added hammer <u>with prongs</u> to equipment list (aid in moving vines for DBH measurements) - Added "Notes on Plot Revisits" Section which contains several tips for revisit teams - Added clarifications for revisits including: o Additional emphasis on need to record same trees as previous team o Consult botanist before changing species ID o Be sure to cross off previous tree notes on revisit form regarding vines if vine no longer present/visible in canopy o Added instructions to map all stems (trees) ≥ 10 cm DBH. This was done to aid revisit teams with matching up previous tree numbers. - Removed all references to measuring DBH of trees that fork below breast height, at 1.0 meter above the fork. This was not practiced in field instead teams followed alternate (and conflicting) directions in SOP to generally measure as near DBH as possible and record location taken in tree notes. - Clarified text on Tree Damage Code 'EPIC' limiting its use to trees where this condition is uncharacteristic - Added text to definition of 'Open Grown Tree' - Updated Tree Diagram Figure with better resolution image (digital vs. scanned)
1.41	3/23/2020	B. Moore	- Moved Revision History to end of SOP and added much more detailed list of changes made to date - Minor editorial changes
1.42	8/16/2020	B. Moore	- Address grammatical changes and clarifying comments made by IMD regional program manager - Removed meter stick and Biltmore Stick from equipment list as these are not acceptable methods for measuring tree DBH