

Contents

	Page
SOP Source and How It Was Modified	3
Definitions.....	3
Data Collection Procedures.....	3
Plot Establishment Years: Species, Diameter, Health, and Maps	3
Module #.....	4
Sapling Subplot	4
Species Code	4
Tagging Trees.....	5
DBH.....	5
Tree Status	8
Crown Class, Tree Vigor, Tree Dieback, Tree Condition or Damage Codes	9
Decay Class and Snag Height.....	14
Tree Map	2
Plot Revisit Years: Species, Diameter, Health, and Maps.....	2
Equipment List.....	5
Literature Cited	8
Appendix A. Field Data Forms	9
Appendix B. Modifications to CUPN SOP 6 for SFCN SOP 6	10
Reduction in the minimum DBH stem size.....	10
Measurement of Both Tree and Non-tree Growth Forms.....	10
Tree Condition or Damage Codes and Foliage Condition	11
Crown Class, Vigor, Dieback, and Tree Condition.....	11
Tree Map	11
Literature Cited.....	11

SOP Source and How It Was Modified

This SOP is an adaptation of SOP 6 *Tree Measurements—Version 1.4* of the *Cumberland Piedmont Network Vegetation Monitoring Protocol* (White et al. 2011). For a general explanation of how the South Florida/Caribbean Network (SFCN) modified the Cumberland Piedmont Network (CUPN) protocol and its SOPs, see the *South Florida/Caribbean Network Forest Vegetation Monitoring: Protocol Implementation Plan* (Whelan et al. 2020). Additionally, this SOP used *SOP 1.4.11 Tree Measurements—Version 1* of the *Terrestrial Vegetation Monitoring in Southeast Coast Network Parks* (Boyle 2019) as a guide. The South Florida/Caribbean Network made five specific modifications to the CUPN SOPs: (1) combining trees and lianas (DBH $\geq$ 5 centimeters [2 in] and clearly rooted in the plot) into a single woody stem category; (2) damage codes for woody stems were updated for South Florida and Caribbean vegetation issues (3) changing the DBH cutoff from greater than or equal to 10 centimeters (4 in) to greater than or equal to 5 centimeters, (4) DBH measurements are rounded off to 0.1 centimeters not to 1.0 centimeters (0.04 in not to 0.4 in), and (5) using bearing and distance to map tree locations. The detailed list of modifications to CUPN SOP 6 is in Appendix B of this SOP.

Definitions

Plot size will be 400 square meters (4,306 square feet [sq ft]) with dimensions of 20 × 20 meters (65.6 feet × 65.6 ft) for all forest vegetation monitoring plots within SFCN parks.

Diameter-at-breast-height (DBH) is measured at 1.37 meters (4.5 ft) above the ground line on the uphill side of a tree. In this protocol, only woody stems with DBH greater than or equal to 5 centimeters (2 in) are measured. The DBH is measured to the nearest 0.1 centimeter (0.04 in).

Woody stems that reach 1.37 meters (4.5 ft) above the ground and are at least 5 centimeters (2 in) DBH at that height are measured. Woody stems are plant species that produce wood as a structural tissue and include trees, and lianas (woody vines). Shrubs are excluded and are instead captured in SOP FVM07 *Species Diversity and Seedling/Sapling Measurements—Version 1.0* (Shamblin 2019a).

Live woody stems are individuals with any living parts (leaves, buds, cambium) present at or above 1.37 meters (4.5 ft) from the ground. These include trees that have been temporarily defoliated.

Standing dead trees (snags) are dead stems that are standing and lean less than 45° from vertical. They need not be self-supported. Dead snags are measured until they have fallen or are leaning greater than 45° from vertical.

Data Collection Procedures

Plot Establishment Years: Species, Diameter, Health, and Maps

Beginning in module 1, visually determine the best strategy for measuring woody stems in a coherent pattern so that each stem greater than or equal to 5 centimeters (2 in) DBH is measured and recorded on the datasheet (SFCN Veg Form 7—*Tree Measurements*). This is done by measuring and tagging

the woody stems starting in one corner of each module and working through the whole module in either a circular or linear pattern, depending on the arrangement of woody stems.

Aluminum tree tags are used to mark stems that have been recorded. **Do not skip around from one side of the module to the other when recording woody stems.** In particularly dense foliage, flagging may be helpful to mark the starting measured stems and the boundary between stems that have been recorded and those that have not.

Once a strategy has been determined, one field crew member (the ‘measurer’) measures the location of 1.37 meters (4.5 ft) from the ground using a tree DBH height guide pole. This will allow for rapid but consistent estimation of this height when measuring a stem’s diameter. Once DBH has been established using the guide pole, that individual can begin recording, or calling woody stem information out to another crew member (the ‘recorder’). 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 check for consistency.

The recorder records the data on SFCN Veg Form 7 *Tree Measurements*:

Module #

Record the module where the stem is located (e.g., 1, 2, 3, 4). If a stem falls along the boundary between two modules, it is recorded for the module that its base center occurs in. If a stem falls along the boundary of the plot, then the horizontal distance from the plot centerline tape to the front of a crew member standing adjacent to the tree base center is measured. If the tree base center is determined to be mostly outside the plot boundary then it is not tallied or measured.

Sapling Subplot

Saplings are woody tree species that have achieved a height of 1.37 meters (4.5 ft) from the ground but have not reached a DBH of 5 centimeters (2 in). Saplings will be identified and tallied by species within each of the 3.16 × 3.16 meter (10.4 × 10.4 ft) subplots, however, they will not be measured or tagged. See SOP FVM07 *Species Diversity and Seedling/Sapling Measurements—Version 1.0* (Shamblin 2019a) for additional information. To maintain consistency with other protocols, when trees between 5 and 10 centimeters (2 and 4 in) DBH occur within a sapling subplot, the subplot number is recorded with the tree data.

Species Code

Record the species code of a measured tree using the taxonomic standard identified in SOP FVM07 *Species Diversity and Seedling/Sapling Measurements—Version 1.0* (Shamblin 2019a). Unique codes generally consist of the first four letters of the genus and the first three letters of the species (an extra eighth digit is used when there would be duplicate seven letter codes). This seven- or eight-letter code is better than a six-letter code, because some genus and species names are similar and would be duplicated. An example is of the common persimmon (*Diospyros virginiana*) and Virginia buttonweed (*Diodia virginiana*) that would have the same six-letter code, so the former’s seven-letter code is DIOSVIR and the latter’s code is DIODVIR.

Tagging Trees

As you work through each plot module, attach a pre-printed aluminum tree tag consistently to each tree with a DBH equal to or greater than 5 centimeters (2 in) at a location about 10 centimeters (4 in) below breast-height (1.37 meters [4.5 ft]). All tags within a plot are unique, and the first tag in a plot will begin at the top of a 100-number series (e.g., 300 or 400), and continue sequentially until all trees are tagged. Leftover tags in a series are saved and can only be used for the given plot for future recruits. Tags are affixed using a hammer and nail, with the nail head lower than the point at which it goes into the tree so that the tag slides down the nail as the tree grows. Attach a tag using an aluminum tree nail by inserting the nail through the tag hole with the nail slanted slightly downward. Leave at least 3 centimeters ([1.2 in] of a 5 centimeter [2 in] nail) of nail protruding to allow the tag to slide down. This will reduce the chance that the tag will be enveloped by the tree as the tree grows. Attach the tag to the tree with a single nail making sure that the numbered side of the tag faces out. The nail must reach through the bark to the wood to be secured. Avoid locations with decay or peeling bark. The tags should generally face the center of the plot. If there is no good location facing plot center, find a suitable location on another side of the tree—it is more important that the tag be attached securely than facing plot center. One exception to this rule is when the trees are very close to a trail. In this case, tags should be on the opposite side of the tree from the trail to avoid drawing the casual visitor's eye to it.

Snags are tagged similar to live trees; however, do not nail a tag to a snag that is rotten or swaying when touched (for safety). Also, do not tag a snag if the tag cannot be securely attached because the wood is too soft and decayed. Note in the Tree Notes of Veg Form 7—*Tree Measurements* that the snag was not tagged, and proceed to record data as usual. The snag is assigned the appropriate number, so be careful to skip the numbered tag corresponding to the snag ID number as you proceed through the plot.

Keep unused tree tags organized. Hang unused tags at the end of the set. Use a permanent marker to record both the park and plot where each tree tag set has been used on the back of last unused tree tag, so that the set can be easily found for future measurement cycles. Store unused tree tags in a box and clearly label it based on the park and group of plots to which it applies. Crews must carry the corresponding tree tag set with them when resampling the plot. Do not use the same tree tag number more than once in a plot. Damaged or missing tags will be replaced with a tag of the same number. Crew members will bring along a set of blank aluminum tags that will be hand stamped in the field with steel marking tools.

DBH

Using a DBH tape, measure the stem diameter at a position on the stem of 1.37 meters (4.5 ft) above the ground (use a DBH height guide pole to help with consistency), on the uphill side of tree (Figure 1). Do not measure from a pit or atop a mound or emergent rock. Spray paint a short line on the tree where the DBH measurement has been taken. The diameter value is reported to the nearest millimeter. In other words, if measured DBH is 10.38 centimeters (4.08 in), then it would be recorded as 10.4 centimeters (4.09 in).

Make certain 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 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 when it is difficult to determine where DBH should be located on the stem, use the guidelines in Figure 1 and “DBH Notes” below. Record the location of unusual DBH measurements in the Tree Notes section of the datasheet.

Lianas are measured the same as trees. Lianas that are rooted within the plot are tagged and measured for DBH (if they have attained a DBH of at least 5 centimeters [2 in]). Follow the same procedures as trees for standard and irregular locations for reporting a woody stem diameter measurement (Figure 1). The DBH measurements for lianas will be 1.37 meters (4.5 ft) from the base and the stem is spray-painted where the DBH measurement occurred.

Measurements typically follow instructions for trees when measuring DBH for palm species that do not have remnant leaf bases (boots) on the trunk. Palm species with remnant leaf bases (boots) are difficult to measure using a DBH tape. In these cases, measure the DBH with calipers and note in the comment section if measured with boots on (Gunderson et al. 1982). Use the comment section to note how DBH was measured. Since palms do not have secondary growth in which the diameter expands as the stem grows, palm growth is estimated by determining the growth of the stem length. Stem length is measured from the soil surface to the leaf scar (palm leaf boot) of the oldest leaf using a meter tape or a tree pole (Oyama 1990). On taller palms, this may require two crew members; one to hold the tape or height pole while the second person stands far enough away to read the height of the oldest leaf scar. Record stem length in the comments section for this individual. The database will have a required height field when a palm species is entered.

DBH Notes:

Trunk abnormality: If a trunk abnormality occurs at breast height (1.37 meters [4.5 ft]), take the diameter measurement just below the abnormality, if possible. If the abnormality extends far below breast height (1.37 meters [4.5 ft]), then take the measurement just above breast height (1.37 meters [4.5 ft]). Record the height where measured in Tree Notes.

Missing wood or bark: Do not reconstruct (i.e., hypothetically guess) the DBH of a tree that is missing wood or bark. Record diameter of the stem in its current condition, and note that wood or bark was missing in Tree Notes.

Leaning tree: Diameter is always measured perpendicular to the bole axis. Find the point equivalent to breast height (1.37 meters [4.5 ft]) by measuring along the uphill side of the tree. Measure diameter perpendicular to the tree trunk (bole) as shown in Figure 1. If a living tree is leaning more than 45 degrees, find the point equivalent to breast height (1.37 meters [4.5 ft]) 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 measured).

Curved bole: Find the point equivalent to breast height (1.37 meters [4.5 ft]) by measuring along the curvature of the bole on the uphill side of the bole as shown in Figure 1 and measure diameter perpendicular to the bole.

Live windthrown tree: Find the point equivalent to breast height (1.37 meters [4.5 ft]) by measuring along the uphill side of the tree starting with the root collar and measure diameter perpendicular to the bole (see Figure 1).

Swollen base: Trees with swollen bases rising higher than 0.91 meters (3 ft) are measured 0.46 meters (1.5 ft) above the top of the swelling. Trees with swelling below 0.91 meters (3.0 ft) 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 meters) are tallied and measured as one tree. Diameter should be measured below the point at which forking affects DBH (see Figure 1). For trees that fork below breast height, each trunk greater than or equal to 5 centimeters (2 in) is tallied as a separate tree. Measure the diameter of each trunk 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 should be 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 mark forked trees on the tree diagram. Record any unusual tree features or the relative position of each of the stems of a clumped tree or copse if applicable.

Trees with vines: 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.

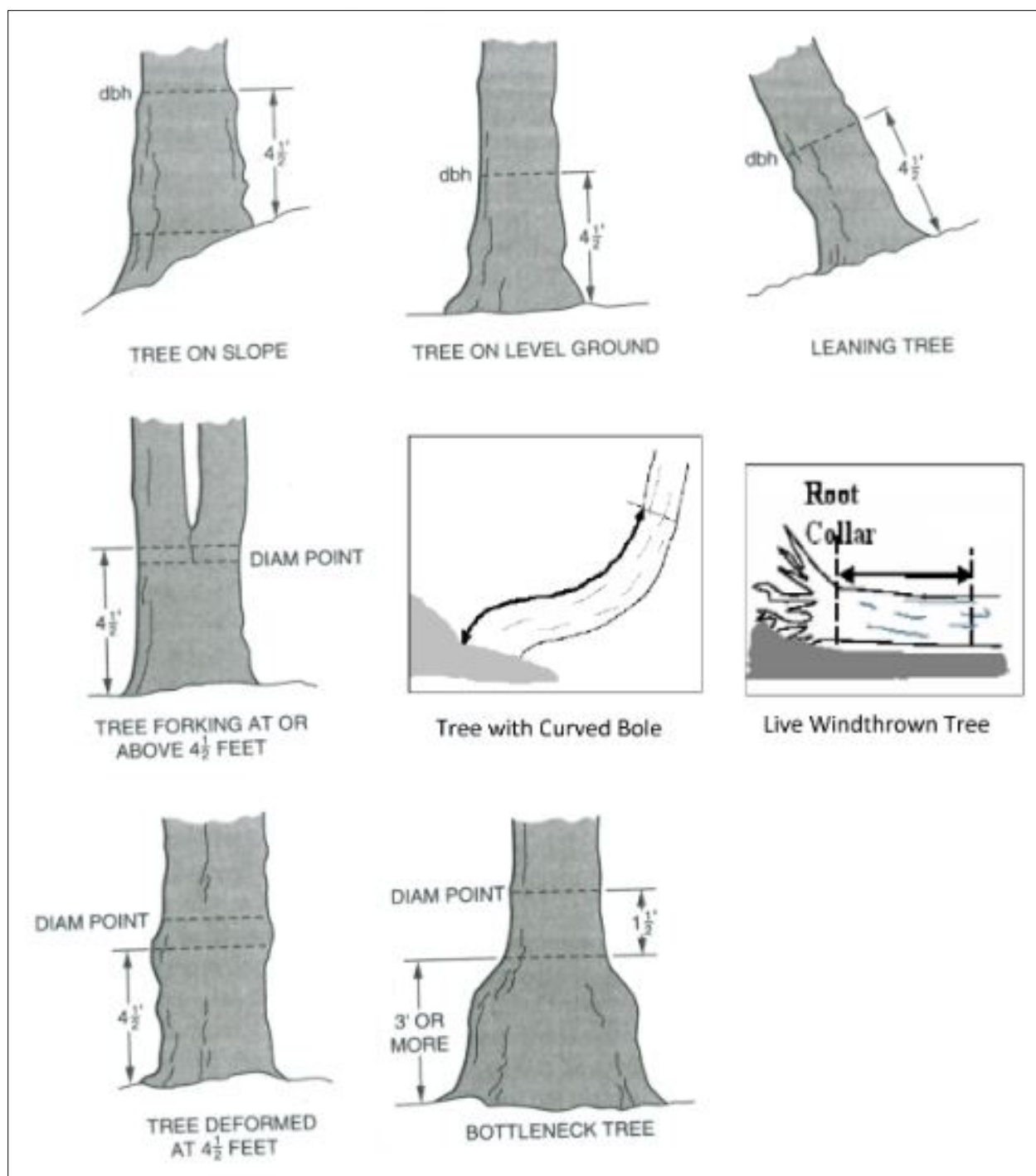


Figure 1. Standard and irregular locations for reporting a woody stem diameter measurement.

Tree Status

Determine the tree status of each recorded tree (see below). In differentiating whether a tree should be 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 the Decay Class measurement.

1. Live tree (1): The stem has living parts (i.e., leaves, buds, or cambium) at or above breast height (1.37 meters [4.5 ft])
 - a. Live tree (Resprout) (11): Same as live tree but is a tree that has sustained severe damage, especially canopy loss, and the main leader appears dead but now has sprouted a new leader in growth. Coppicing is very common in cypress (*Taxodium distichum*) and in white mangroves (*Laguncularia racemosa*).
2. Standing dead tree (2): Tree lacks any living parts (i.e., leaves, buds, or cambium) at or above breast height (1.37 meters [4.5 ft]), and leans less than or equal to 45° away from vertical, or straight up and down. Cause of mortality is unknown and not obvious.
 - a. Standing dead tree (Hit by fallen debris) (21): Standing dead tree with evidence of damage from debris falling from other trees.
 - b. Standing dead tree (Lightning) (22): Standing dead tree with lightning scar. Trunk scarred or burnt.
 - c. Standing dead tree (Fire) (23): Standing dead tree with evidence of damage from fire. Trunk usually burnt without a lightning scar.
 - d. Standing dead tree (Freeze) (24): Standing dead tree with evidence of freeze event. Tree will have dead brown leaves and dry, sometimes brittle, stems.
 - e. Standing dead tree (Suppression) (25): Standing dead tree with evidence of being out-competed by other trees.
 - f. Standing dead tree (Hurricane) (26): Standing dead tree with evidence of hurricane damage. Tree can be blown over or have canopy loss due to high winds. Note which hurricane or storm (if known) in the comment section.
 - g. Standing dead tree (Flooding) (27): Standing dead tree with evidence of flooding event or prolonged inundation. This is more prominent in upland forested communities.

Crown Class, Tree Vigor, Tree Dieback, Tree Condition or Damage Codes

Each live tree's crown, vigor, degree of dieback, and condition will be assessed using a consensus of each metric from two observers observing the tree from different locations. Metrics are described below.

Crown Class

Every live tree will receive a Crown Class Code. Assign codes by describing the tree crown position in the canopy and amount of sunlight received (see Figure 2). If there is any uncertainty in assigning this code to a stem, make a note in Tree Notes about why.

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 resulting 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: Stem 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.

Tree Vigor

Every live tree will receive a Tree Vigor Code. Vigor is a measure of overall tree health and vitality. This measure compares the subject stem to an ideal healthy specimen of that species. Record the general overall health of the tree using the codes below. Estimate vigor before estimating Tree Dieback or Tree Condition/Damage Codes.

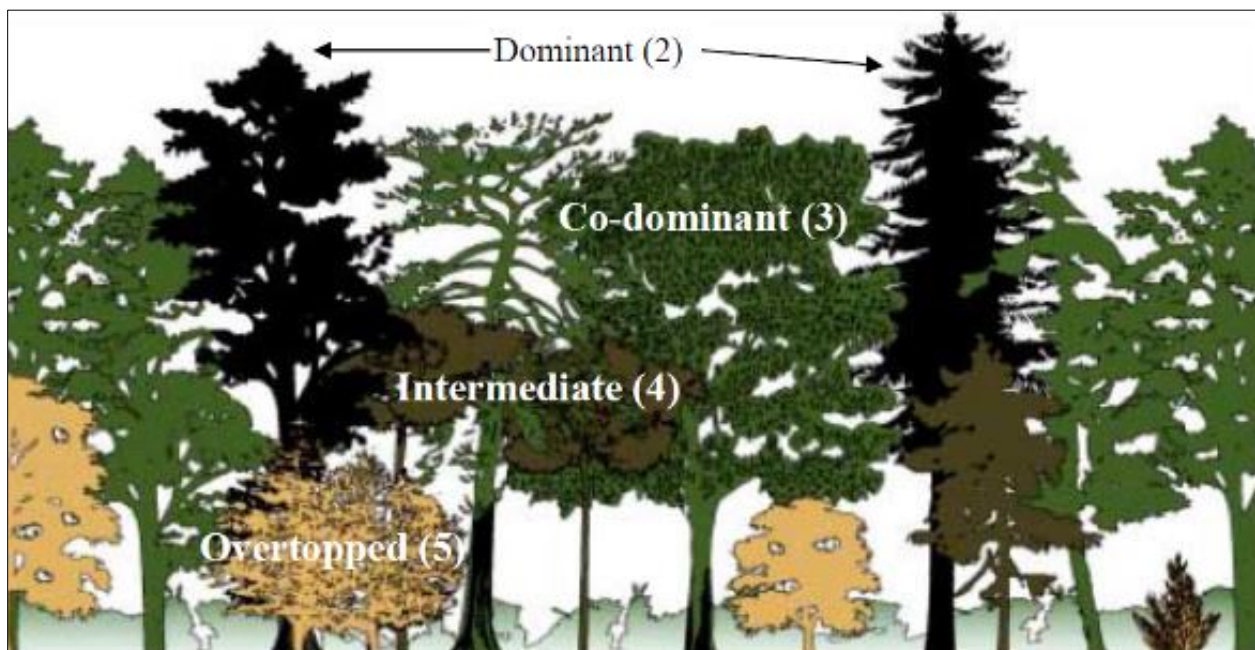


Figure 2. Crown Class examples and codes that will be used by the South Florida/Caribbean Network Forest Vegetation Monitoring Protocol (Whelan et al. 2020). Figure taken from the Cumberland Piedmont Network Vegetation Monitoring Protocol (White et al. 2011).

1. Healthy: Tree appears to be in reasonably good health with less than 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 still present to indicate that the tree is alive.
5. Functionally dead: There may be a few epicormic shoots on the bole, but a majority of crown branches are missing or dead and leaf-less. Phloem under bark has brown streaks.

Several factors are considered when assessing vigor:

- How much of the crown is missing or damaged from recent or long past disturbances? Old injuries are 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 less than 2.5 centimeters (1 in) 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 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.

Tree 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 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%

Exclude the following from the dieback percentage:

- Snag branches (large branches without small twigs less than 2.5 centimeters (1 in) 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. Figure 3 illustrates what to include and exclude when assessing dieback.

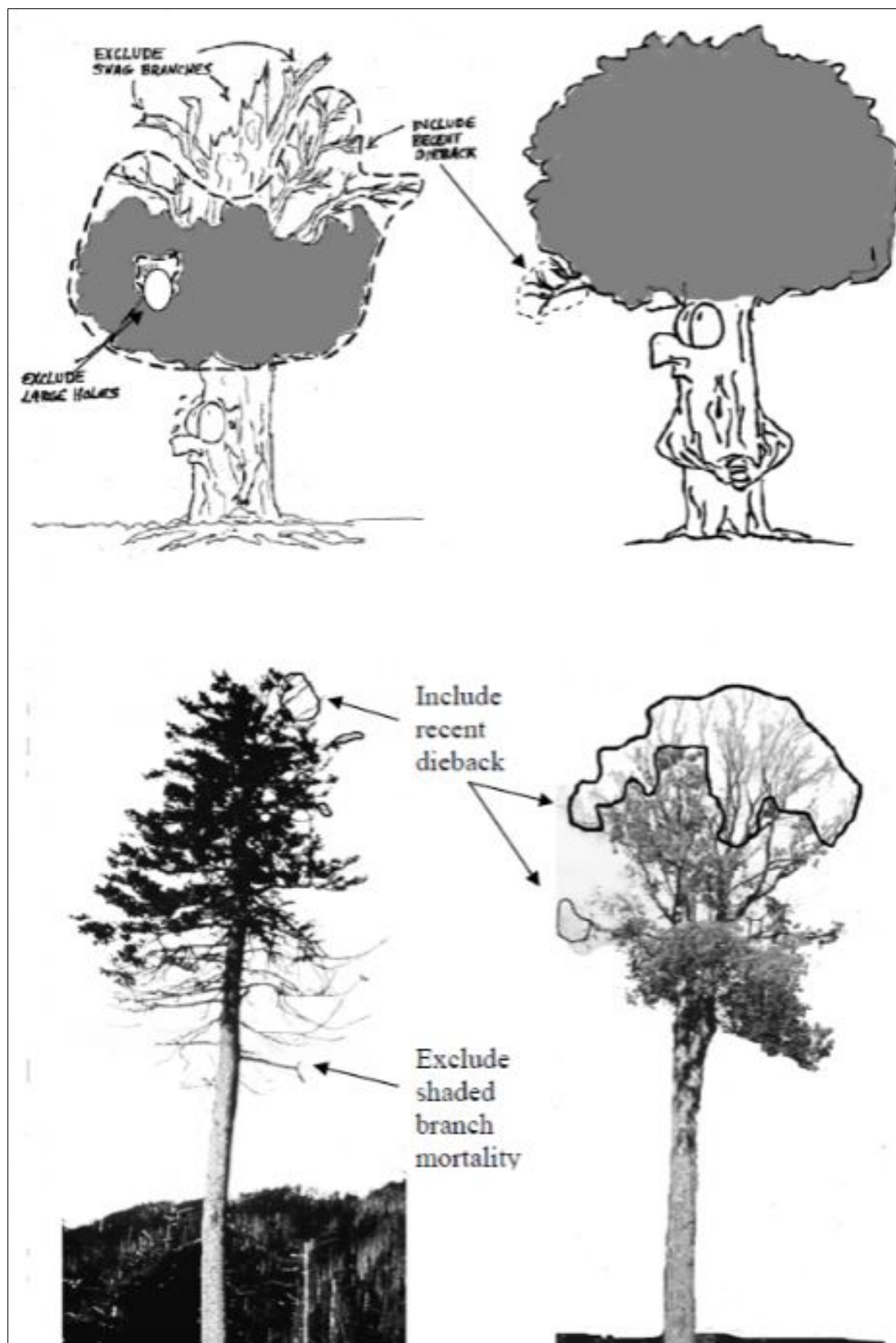


Figure 3. Examples of tree dieback.

Tree Condition/Damage Codes

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 letter code in the Tree Condition/Damage Code 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 are used to record damage in this protocol:

- **BEN** Bent under debris—tree trunk or canopy bent over due to due to fallen trees or debris from other trees
- **FAL** Fallen over—trunk is greater than 45° from perpendicular
- **FOR** Forked tree
- **FUN** Fungus—unknown type
- **HIT** Hit by debris—tree has substantial damage due to being hit by fallen debris from other trees. Usually the fallen limbs or trees are still present within the canopy of the tree
- **INS** Insect—unknown type
- **LEA** Leaning tree—tree leaning 30° to 45° from perpendicular
- **LWD** Laurel Wilt Disease (a specific fungal disease)
- **PBB** Pine Bark Beetle
- **RAB** Redbay Ambrosia Beetle
- **SNP** Snapped off—trunk of tree is snapped off. Estimate the height of the snap off
- **SPB** Southern Pine Beetle
- **TER** Termites—numerous termite tunnels on outside of tree or termite nest in tree – common at US Virgin Island parks
- **VIN** Vines—tree partly or completely covered in vines or lianas (estimate tree canopy coverage by vines using one of three categories <10%, 10 to 50%, > 50%)

Decay Class and Snag Height

If the woody stem is a dead standing tree (see definitions at beginning of this SOP), then collect information on Decay Class and Snag Height (visual estimate in meters, to the nearest 5 meters [16.4 ft]). 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 (Table 1).

Table 1. Decay class codes used in the South Florida/Caribbean Network Forest Vegetation Monitoring protocol.

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	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
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 woody stems (live or dead) are mapped. We will determine the compass bearing and distance from the plot center stake to the midline of the tree using a compass and the Haglöf DME Distance Range Finder (ultrasonic DME). See SOP FVM16 *Using Haglöf DME Distance Ranger Finder—Version 1.0* (Shamblin 2019b) for specific instructions.

Repeat the above procedures in modules 2, 3, and 4. It is a good practice to periodically have someone else on the field crew re-measure a stem or two within the plot to check for consistency.

Plot Revisit Years: Species, Diameter, Health, and Maps

For plot revisits, the SFCN Veg Form 7—*Tree Measurements* datasheet and gridded map is prepopulated with recorded species, diameters, status assessments, and stem locations from the previous sampling event. Crews should work in a pattern that ensures all trees are measured efficiently, that minimizes missed trees, and detects trees that reached 5 centimeters (2 in) since the last sample event. When resampling plots that have already been established, the crew only needs to tag recruits and trees with missing tags.

Tags must be checked at every re-measurement. Nailed tags which are in danger of being enveloped by bark are gently released by pulling the nail back, or the nail and tag are removed and the tag reattached. If a tree tag has been removed between surveys, reattach a tag using a nail.

Note the added classes to the Tree Status category during Plot Revisit Years:

1. No status (0): Previously tallied tree is no longer in sample because the tree: (a) shrunk below 5 centimeters (2.0 in) DBH (i.e. 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.
2. Live tree (1): Live trees have living parts (i.e., leaves, buds, or cambium) at or above breast height (1.37 meters [4.5 ft]). 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 25 trees [tagged 1–25] documented in the plot, then a new tree would be assigned tree number 26). Sub-codes for this category include:
 - a. Live tree (Resprout) (11): Same as live tree but is a tree that has sustained severe damage, especially canopy loss, and the main leader appears dead but now has sprouted a new leader in growth. Coppicing is very common in cypress (*Taxodium distichum*) and in white mangroves (*Laguncularia racemosa*).
 - b. Live tree (Recruit) (12): a tree that has newly appeared within the tree plot since the last plot census.

3. Standing dead tree (2): Tree lacks any living parts (i.e., leaves, buds, or cambium) at or above breast height (1.37 meters [4.5 ft]), and leans less than or equal to 45° away from vertical, or straight up and down. See additional subcategory codes:
 - a. Standing dead tree (Hit by fallen debris) (21): Standing dead tree with evidence of damage from debris falling from other trees.
 - b. Standing dead tree (Lightning) (22): Standing dead tree with lightning scar. Trunk scarred or burnt.
 - c. Standing dead tree (Fire) (23): Standing dead tree with evidence of damage from fire. Trunk usually burnt without a lightning scar.
 - d. Standing dead tree (Freeze) (24): Standing dead tree with evidence of freeze event. Tree will have dead brown leaves and dry, sometimes brittle, stems.
 - e. Standing dead tree (Suppression) (25): Standing dead tree with evidence of being out-competed by other trees.
 - f. Standing dead tree (Hurricane) (26): Standing dead tree with evidence of hurricane damage. Tree can be blown over or have canopy loss due to high winds. Note which hurricane or storm (if known) in the comment section.
 - g. Standing dead tree (Flooding) (27): Standing dead tree with evidence of flooding event or prolonged inundation. This is more prominent in upland forested communities
4. Removed (3): 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.
5. Fallen dead tree (4): Previously tallied tree has fallen and will no longer be tracked as a live tree. This includes dead trees leaning and greater than 45° from vertical.

Other items to keep in mind during plot revisit years include:

1. 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.
2. 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 are given the next tree tag available. In other words, if there were 20 tagged trees (given tags 1-20) measured during the last sampling event then the first new tree will receive tag number 21.

3. There will also likely be trees that have grown to 5 centimeters (2.0 in) DBH since the previous survey that will need to be added to the datasheet. These new trees are given the next tree tag number available.
4. 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 tree tag number, previous DBH, location within plot, 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 (field crew leader) for confirmation, as the botanist (field crew leader) on the plot is the final authority.
5. Similarly, if tree DBH appears grossly different from the previous survey (such as increasing by 5 centimeters [2.0 in]), recheck the tree tag and consult the previous survey's field forms to ensure you are measuring the correct tree. It is also possible 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.
6. If a tree note written on the datasheet during a previous survey is no longer relevant, cross it off to prevent confusion during the next revisit, because tree notes get carried over to subsequent visits.

Equipment List

- DBH Tape (w/ centimeter units)
- Tree tags (# appropriate hundred series, and a few blank tags with hand stamps to fix damaged or missing tags)
- Hammer
- Aluminum nails
- Stainless steel nails (for coastal plots)
- Nail apron and belt-mounted hammer holder
- Orange or green tree marking paint
- Small binoculars, for identifying trees based on hard-to-see canopy leaves
- Fiberglass measuring tapes
- Field datasheets Veg Form 7 *Tree Measurements*
- Pencil
- Haglöf DME Distance Range Finder (ultrasonic DME)
- Compass
- DBH height guide pole

Table 2. Datasheet Field Descriptions Veg Form 7—*Tree Measurements*.

Field Name	Field Description
Data Taker Initials	Initials of individual collecting the data. In some cases, one person will call out data, while another records data. Data taker initials should be the one with greatest knowledge and experience in tree identification, condition codes, etc.
Reviewed by	Initials of individual who reviewed completed data sheet for SOP VEG 6 elements. Ideally, this should be someone other than individual who recorded data on this portion of datasheet.
Module #	Module (1, 2, 3, or 4) where woody stem occurs. For revisit plots, a pre-populated stem list will be provided. Update/correct as necessary.
Sapling subplot #	Sapling subplot (8 within the tree plot) where trees ≥ 5 but ≤ 10 cm DBH are recorded if tree occurs within a sapling subplot. If trees of this size occur outside a sapling subplot then record a “—” in this space. Saplings (trees less than 5 centimeters DBH) will be tallied here as well (see SOP 7).
Tree #	Recorded sequentially beginning with 1 until completed. For revisit plots, a pre-populated stem list will be provided. Update/correct as necessary.
Species	Seven or in some cases eight letter species code, typically comprised of first four letters of genus and first three letters of species. Refer to park species list to determine which species require the eight letter tie breaker codes. In instances where a species does not occur on the species list (i.e., no known species code), write out the entire scientific name. Ask field crew leader for assistance with spelling. For revisit plots, a pre-populated stem list will be provided. Update/correct as necessary.
DBH	Record DBH of measured stem to nearest millimeter. Stem must measure 5.0 cm before it is recorded. For revisit plots, previous DBH will be provided as well.
Distance	Record distance from center stake to centroid of tagged tree for use in generating a tree map. Record to nearest tenth of a meter.
Bearing	Record bearing from center stake to center of tagged tree (using declination correction; SOP 3 Table 1) for use in generating a tree map. Record to nearest degree.
Tree Status	Record stem status where 0=No status, previously tallied tree no longer in sample, 1=Live stem, Sub categories: 11=Resprout, 12=Recruit, 2=Standing dead stem, Sub categories: 21=Hit by fallen debris, 22=Lightning scarred, 23=Fire, 24=Freeze, 25=Suppression, 26=Hurricane, 27=Flooding At a resurvey: 3=Removed, 4=Fallen dead stem. For revisit plots, previous tree status will be provided as well.
Crown Class	For all live stems only – record crown class where 1=Open-grown, 2=Dominant, 3=Co-dominant, 4=Intermediate, and 5=Overtopped.
Tree Vigor	For all live stems only – record tree vigor where 1=Healthy, 2=Light decline, 3=Moderate decline, 4=Severe decline, and 5=Functionally dead.
Tree Dieback	For applicable live stems only – record tree dieback where 1=1-10%, 2=10-25%, 3=25-50%, 4=50-75%, and 5=75-100%.
Tree Condition/ Damage Codes	For live stems only – record one or more of the 3-letter tree condition codes, as appropriate, from the provided list.

Field Name	Field Description
Decay Class	<i>For dead stems only</i> – record snag decay class (1-5) based on provided table and associated descriptions.
Snag Height	<i>For dead stems only</i> – record estimated snag height to nearest 5 meters.
Tree Notes	Record any noteworthy information, as well as use this area as overflow to record additional damage codes, etc. Tree notes from previous survey will be carried over for revisit plots-update/correct/cross out as needed.

Literature Cited

- Boyle, M. F. 2019. Tree measurements—Version 1.0. Southeast Coast Network Standard Operating Procedure NPS/SECN/SOP—1.4.11. Southeast Coast Network, Athens, Georgia. Available at: <https://irma.nps.gov/DataStore/Reference/Profile/2260351> (last accessed December 2019).
- Gunderson, L. H., L. L. Loope, and W. R. Maynard. 1982. An Inventory of the Plant Communities of the Turner River Area, Big Cypress National Preserve, Florida. *Everglades Natl. Park South Fla. Res. Cent. Rep.* No. T-648.
- Oyama, K., 1990. Variation in growth and reproduction in the neotropical dioecious palm *Chamaedorea tepejilote*. *The Journal of Ecology*, pp.648–663.
- Shamblin, R.B. 2019a. Species diversity and seedling/sapling measurements—Version 1.0. South Florida/Caribbean Network Standard Operating Procedure NPS/SFCN/SOP—FVM07. South Florida/Caribbean Network, Palmetto Bay, Florida. Available at: <https://irma.nps.gov/DataStore/Reference/Profile/2267809> (last accessed December 2019).
- Shamblin, R.B. 2019b. Using Haglöf DME Distance Ranger Finder —Version 1.0. South Florida/Caribbean Network Standard Operating Procedure NPS/SFCN/SOP—FVM16. South Florida/Caribbean Network, Palmetto Bay, Florida. Available at: <https://irma.nps.gov/DataStore/Reference/Profile/2267809> (last accessed December 2019).
- Whelan, K. R. T., R. B. Shamblin, M. Prats, J. M. Patterson, M. Londono, and R. Muxo 2020. South Florida/Caribbean Network forest vegetation monitoring: Protocol implementation plan. Natural Resource Report NPS/SFCN/NRR—2020/2064. National Park Service, Fort Collins, Colorado. Available at: <https://irma.nps.gov/DataStore/Reference/Profile/2271719> (last accessed February 2020).
- White, R., C. Nordman, L. Smart, T. Leibfreid, B. Moore, R. Smyth, and T. Govus. 2011. Vegetation Monitoring Protocol for the Cumberland Piedmont Network, Version 1. Natural Resource Report NPS/CUPN/NRR—2011/XXX. National Park Service. Fort Collins, Colorado. Available at: <https://irma.nps.gov/DataStore/Reference/Profile/2192468> (last accessed December 2019).

SFCN Forest Vegetation Monitoring
Protocol Veg Form 7– Tree Measurements

Plot ID _____
 (park code + community code + plot #)

Visit Date _____
 (mm/dd/yyyy)

Page ____ of ____

SOP 06 – Tree Measurements (> 5cm dbh)
Data taker initials _____
Reviewed by: _____

(Tree measurement and health assessment code symbols occur on a separate laminated doc)

Data on all trees dead and alive								Data on living trees only					Dead Standing Trees		Tree Notes
Module #	Sapling subplot #	Tree #	Species Code	DBH > 5 cm	Distance	Bearing	Tree Status	Crown Class	Tree Vigor	Tree Dieback	Tree Condition/ Damage Codes	Decay Class	Snag Height m (estimated)		
														Tree Notes - If ID confidence is not "certain" record this as well, (i.e., Probable or Uncertain)	

SFCN_Form_7_Tree_Measurements.docx
9/20/2019

9

Appendix B. Modifications to CUPN SOP 6 for SFCN SOP FVM06

CUPN SOP 6 *Tree Measurements—Version 1.4* of the *Cumberland Piedmont Network Vegetation Monitoring Protocol* (White et al. 2011) was modified to create SOP FVM06 *Tree Measurements—Version 1.0* (Shamblin 2019a). The major modifications to these SOPs are listed and explained.

Reduction in the minimum DBH stem size

The South Florida/Caribbean Network will tag and measure stems equal to or greater than 5 centimeters (2 in) DBH instead of tracking only stems greater than 10 centimeters (4 in) DBH. Small size stems can be far older than might be suspected (see examples below), may be affected by different drivers than larger trees. For example, smaller trees may be consumed by fire when larger trees will be more protected due to their larger height and bole size, and smaller trees may have different access to water, nutrients and light, and be impacted differently by storms). Smaller diameter trees are therefore most likely to respond to some management actions such as changes in hydrology, fire, or grazing. In many tropical forests, the small diameter stems are the advance regeneration pool from which the future forest canopy develops. Even if the smaller stems do not dominate the current structure of the forest, they are important for understanding the potential future forest composition. Thus, monitoring smaller trees in addition to larger trees provides a more comprehensive picture of the direction of change in the forest and will assist managers with choosing appropriate actions and assessing results.

In Big Cypress National Preserve, a 10 centimeter (4 in) DBH cypress tree was estimated to be approximately 200 years old (T. Pernas pers. comm.). Mangrove species growth estimates vary from 12 to 35 years (*Rhizophora mangle* and *Avicennia germinans* respectively) to reach a 2-centimeter (0.8 in) DBH in Venezuela (López-Hoffman et al. 2007). In Everglades National Park, under closed canopy conditions, *R. mangle* seedlings took 6 to 21 years to reach the sapling stage (defined as greater than 85 centimeters [33.5 in]), depending on site nutrient level (Koch 1997). At extremely low nutrient sites, even in open canopy conditions, *R. mangle* seedlings can take an estimated 27 to 61 years to reach the sapling stage (Koch 1997).

In addition, the South Florida/Caribbean Network will record the tree DBH to the nearest 0.1 centimeter (0.04 in) instead of rounding DBH measurements to the nearest centimeter. The South Florida/Caribbean Network also added instructions on how to measure DBH of palms.

Measurement of Both Tree and Non-tree Growth Forms

Lianas (woody vines) are an important component of SFCN habitats, and are treated similarly to trees with respect to tracking diameter and health conditions over time if the stem is clearly rooted in the plot and DBH greater than or equal to 5 centimeters (2 in), otherwise they are monitored in SOP FVM07 *Species diversity and Seedling/Sapling Measurements—Version 1.0* (Shamblin 2019b). It should be noted, however, that we do not expect to measure many lianas, as the South Florida/Caribbean Network uses the 5-centimeter (2 inches) diameter cut-off.

Tree Condition or Damage Codes and Foliage Condition

The South Florida/Caribbean Network focuses on detecting conditions common in South Florida and the Caribbean forest along with forest pests and pathogens on woody stems. The South Florida/Caribbean Network does not record damages such as fire scars, burls, and conks like the Cumberland Piedmont Network. The South Florida/Caribbean Network focuses on well-documented exotic (and the occasional native) pests and pathogens. Furthermore, Foliage Condition is not measured by the South Florida/Caribbean Network.

Crown Class, Vigor, Dieback, and Tree Condition

These metrics are evaluated by two observers viewing the tree from different vantage points, and who arrive at a consensus value for each metric. This approach should reduce sampling variability due to observer differences.

Tree Map

The South Florida/Caribbean Network has replaced the mapping of stems using the grid method that the CUPN uses with mapping tree stems by determining the bearing and distance of each tree from the plot center. This information is used with geosphere in R or the 'Bearing Distance to Line' tool in ArcGIS that can facilitate creating x-y locations for each stem, which can then be used to generate the tree maps.

Literature Cited

- Koch, M. S., 1997. *Rhizophora mangle* L. Seedling Development into the Sapling Stage across Resource and Stress Gradients in Subtropical Florida 1. *Biotropica*, 29(4), pp.427–439.
- López-Hoffman, Laura, Ackerly, D.D., Anten, N.P., Denoyer, J.L. and Martinez-Ramos, M., 2007. Gap-dependence in mangrove life-history strategies: a consideration of the entire life cycle and patch dynamics. *Journal of ecology*, 95(6), pp.1222–1233.
- Shamblin, R. B. 2019a. Tree measurements—Version 1.0. South Florida/Caribbean Network Standard Operating Procedure NPS/SFCN/SOP—FVM06. South Florida/Caribbean Network, Palmetto Bay, Florida. Available at: <https://irma.nps.gov/DataStore/Reference/Profile/2267809> (last accessed December 2019).
- Shamblin, R. B. 2019b. Species diversity and Seedling/Sapling Measurements—Version 1.0. South Florida/Caribbean Network Standard Operating Procedure NPS/SFCN/SOP—FVM07. South Florida/Caribbean Network, Palmetto Bay, Florida. Available at: <https://irma.nps.gov/DataStore/Reference/Profile/2267809> (last accessed December 2019).
- White, R., C. Nordman, L. Smart, T. Leibfreid, B. Moore, R. Smyth, and T. Govus. 2011. Vegetation Monitoring Protocol for the Cumberland Piedmont Network, Version 1. Natural Resource Report NPS/CUPN/NRR—2011/XXX. National Park Service. Fort Collins, Colorado. Available at: <https://irma.nps.gov/DataStore/Reference/Profile/2192468> (last accessed December 2019).