Southeast Coast Network

National Park Service
Inventory and Monitoring Division

Standard Operating Procedure 1.4.14

Species Diversity and Seedling/Sapling Measurements—Version 1.0

Please cite this as:

Boyle, M. F. 2019. Species diversity and seedling/sapling measurements—Version 1.0. Southeast Coast Network Standard Operating Procedure NPS/SECN/SOP—1.4.14. Southeast Coast Network, Athens, Georgia.

Summary

This standard operating procedure (SOP) provides instruction for how to collect and record species diversity and seedling/sapling data in Southeast Coast Network (SECN) parks. Vascular plant composition and abundance data are collected using 20 × 20 meter (m; 65.6 × 65.6 feet [ft]) plots in natural and semi-natural habitats. Collectively, these data describe the current condition of plant communities and their responses to key stressors. This is accomplished using metrics of species richness, per-species frequency, and per-species cover. Data on seedling and sapling abundance provide information on advance regeneration and future seral stage development of the vegetation community.

The datasheets used for this SOP include SECN *Veg Form 5—Species Diversity* and *Form 6—Seedling/Sapling Measurements.* They are included in Appendix A of this SOP.

Revision Log

Revision Date	Author	Changes Made	Reason for Change	New Version #

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Overview

This standard operating procedure (SOP) details how to measure the composition and abundance of vascular plants in Southeast Coast Network (SECN) parks using 20 × 20 meter (65.6 × 65.6 ft) plots in forested and non-forested habitats, including uplands and wetlands. The plot format for collecting vascular plant presence consists of four 10 × 10-meter (32.8 × 32.8 ft) modules and eight sets of nested subplots containing two spatial depths (10 square meters [107.6 ft^2] and 100 square meters [1,076 ft^2]), and follows a modified Carolina Vegetation Survey (CVS) approach (Peet et al. 1998; Lee et al. 2008). In addition to describing species composition across multiple spatial scales, this modified CVS design is also used to assess individual species abundance at the modular-scale (100 square meters) through estimates of areal cover percentage. The nested subplots are also used to describe abundances of woody stem seedlings and saplings via individual plant counts. Collectively, these data will help discern trends over time in native and nonnative species patterns and regeneration rates of woody species. These trends will help detect rates of species turnover in park vegetation communities and plant community response to key environmental stressors.

This SOP is designed to be used during peak growing season for each site, which is between late April and late September for SECN parks. Timing site visits to coincide with flowering or fruiting will be necessary for identification of many plant species. Efforts are made to revisit plots within two-weeks of the original sample date to reduce the confounding of seasonal variation with annual variation. Most of the SOPs associated with terrestrial vegetation monitoring in the network can be completed with basic plant identification skills. However, this SOP requires at least one team member to have demonstrated expertise and experience with the full diversity of vascular plant species in a given park, and to be able to quickly identify each plant species as data are collected. To avoid over-trampling of the vegetation in the subplots, all crew members must be aware of the corner nested subplot locations and, to the extent practical, avoid walking in these areas.

SOP Source and How It Was Modified

This SOP is an adaptation of SOP 7 *Herbaceous Plant and Seedling/Sapling Measurements—Version 1.3* and SOP 14 *Recording Species Nomenclature and Data Field Descriptions of the Cumberland Piedmont Network Vegetation Monitoring Protocol* (White et al. 2011). For a general explanation of how the Southeast Coast Network modified the Cumberland Piedmont Network (CUPN) protocol and its SOPs, see *Terrestrial Vegetation Monitoring in Southeast Coast Network Parks Protocol Implementation Plan* (Boyle et al. 2019). With regards to this SOP, the network made five specific modifications to the CUPN SOPs:

1. combination of the two CUPN protocols into one
2. use of the latest version of the *Flora of the Southern and Mid-Atlantic States* (Weakley 2015) as an acceptable taxonomic standard reference
3. inclusion of shrub and woody vines (lianas) in the seedling/sapling measurements

4. assignment of cover class values at the modular level rather than the plot level
5. use of two observers to determine cover class values

The detailed list of modifications to CUPN SOPs 7 and 14 is in Appendix B of this SOP.

Definitions

Cover is the vertical projection of vegetation from the ground as viewed from above, and in this protocol is estimated as a percentage of area that covers the ground above the ground surface (areal cover). This is based on the CVS methods of recording cover, which states "We record canopy cover (as opposed to foliar cover) where the tiny gaps in the canopy are considered filled when estimating cover. The canopy of a plant, if reasonably continuous in outline, is considered completely continuous. However, if there are significant gaps within an individual canopy, it is not considered continuous. Cover ignores the vertical distribution of leaves and includes all leaves from those crawling along the ground to those in a very tall overhead canopy" (Lee et al. 2008). Cover percentage is recorded as a 10-category cover scale, developed by the CVS (< 0.1, 0.1–1, 1–2, 2–5, 5–10, 10–25, 25–50, 50–75, 75–95, and 95–100%; Peet et al. 1998).

A **module** is a 10 × 10-meter (32.8 × 32.8 ft) sampling unit of the SECN vegetation plot. The module is the scale at which vegetation cover and large woody stems (≥ 10 centimeters [3.9 inches {in}] DBH [diameter at breast height]) are reported, and is the second largest scale (the full plot is the largest) that species presence is reported. There are four modules located within a plot.

Nested subplots are contained within a SECN vegetation plot module and consist of two sampling depths (units)—3.16 × 3.16 meter (10.4 × 10.4 ft) and 1 × 1 meter (3.3 × 3.3 ft). There are two nested subplots located within a module. These are also referred to as "corners."

The SECN **plot** is the standard unit used to capture information on plant and abiotic data with this vegetation monitoring protocol. The SECN vegetation plot is 400 square meters (4,306 ft^2) with dimensions of 20 × 20 meters (65.6 × 65.6 ft) for all locations within SECN parks.

Saplings are live juvenile woody stems that are more than 1.37 meters (4.5 ft) in height but less than 10 centimeters (3.9 in) in diameter at breast height (DBH). If a sapling forks or branches above 0.5 meter (1.6 ft), measure the height of the tallest terminal bud and count the sapling as one; if a sapling forks or branches below 0.5 meter, measure each fork or branch as a separate sapling. Saplings are alive if there are any living parts (i.e., leaves, buds, cambium) at or above 1.37 meter (breast height). Saplings that have been temporarily defoliated are considered alive. A sapling is counted only if it is rooted in the nested subplot.

Seedlings are live juvenile woody stems with at least two true leaves that are less than 1.37 meters (4.5 ft) tall. A seedling is counted only if it is rooted in the nested subplot. Seedlings less than 5 centimeters (2 in) in height are not counted in the tally. Seedlings that originate at a common root collar but branch under the leaf litter are independent seedlings. If a seedling forks or branches above ground, measure the height of the tallest terminal bud and count the seedling as one. Do not count

stump sprouts from a larger woody stem as seedlings. Tally stump sprouts from standing dead trees, counting each sprout as a separate seedling.

Seedling/sapling height is the distance from the soil surface to the top of the terminal bud (the large bud at the top of the stem). This measurement does not include leaves or needles, and should be measured vertically from the ground to the tip of the terminal bud, not along the axis of the stem (i.e., stems should **not** be straightened for measurement).

Data Collection Procedures

Follow a Nomenclature Standard

Species names must follow a nomenclature standard. The SECN terrestrial vegetation monitoring project standard is the *Flora of the Southern and Mid-Atlantic States* (Weakley 2015). The implementation of the nomenclature standard will promote efficient project data analysis and reporting. The project data can be brought up to date, to the current standard on a regular basis, perhaps annually or once every several years. Before the project data set is updated to new nomenclature, the old data set must be saved and archived.

At the end of the field day, or later in the office, be sure to review your list and make the nomenclature and levels of certainty as clear as possible. In addition, any plant field guides used for work on the vegetation plot must be recorded on the SECN Veg Form 5—*Species Diversity* datasheet. This will vary depending upon the park in which a field crew works. Field guides can be obtained through the project manager.

Recording Species Presence

Each of the 10 × 10 meter (32.8 × 32.8 ft) modules (1–4) contains four numbered corners with teams sampling two of the corners within each of the modules for a total of eight corners sampled (Figure 1). Corners sampled are 1-2, 1-4, 2-2, 2-3, 3-2, 3-4, 4-2, and 4-3, where the first number refers to module number and the second refers to the specific corner within that module. In other words: corners two and four are sampled in module one; corners two and three in module two; corners two and four in module three; and corners two and three in module four. It is important for the field crew to keep themselves oriented, so that the correct corners are completed and documented. When in doubt, check with other crew members and/or the plot diagram included in the field datasheets.

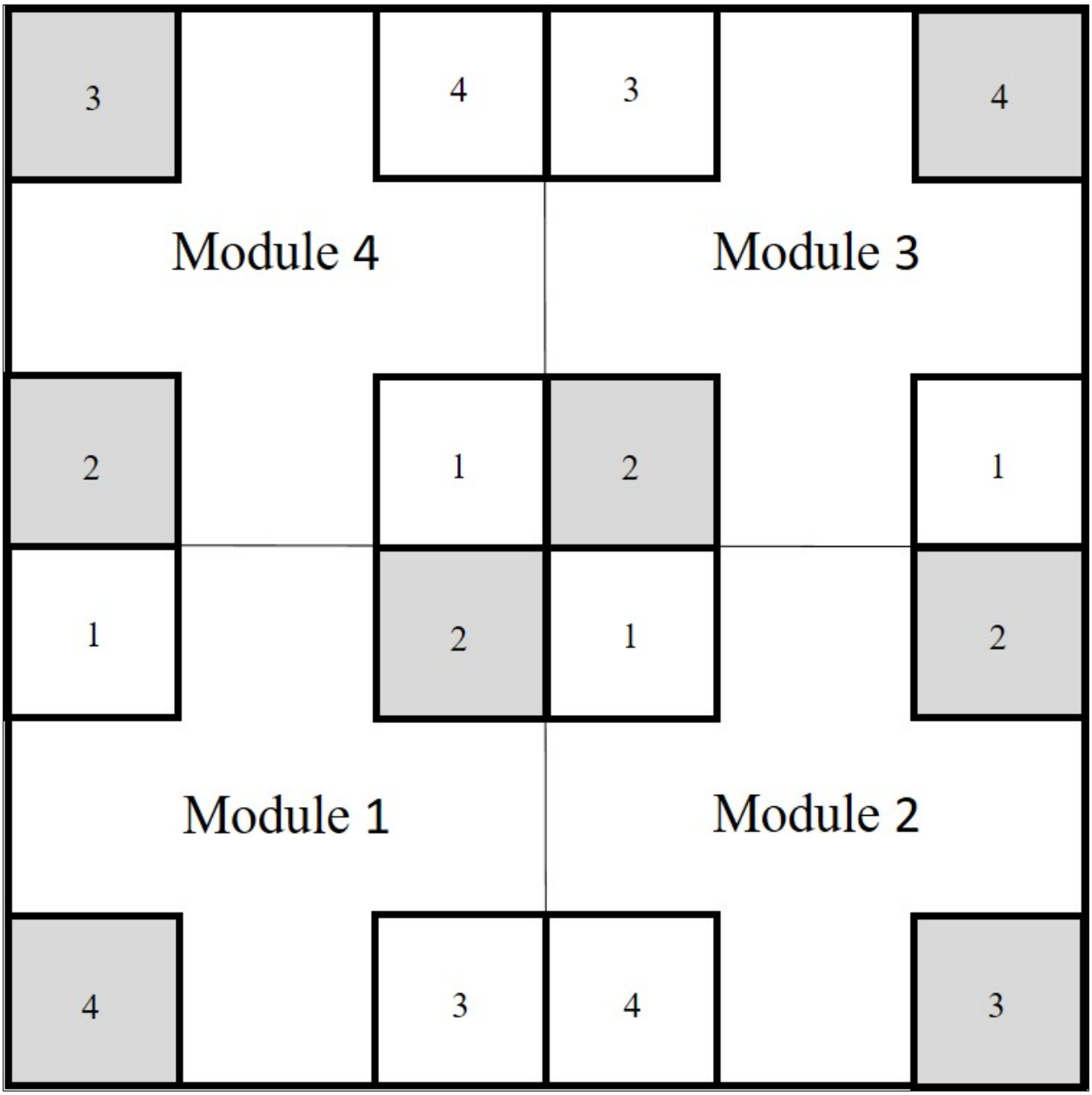

Figure 1. The Southeast Coast Network 20 × 20-meter (65.6 × 65.6 ft) vegetation plot diagram illustrating the location of the sampled subplots (darker shade).

Following the Carolina Vegetation Survey protocols (Peet et al. 1998; Lee et al. 2008), nested subplots in eight corners are sampled in a particular pattern. This is so that each corner sampled is not adjacent to another sampled corner and there is a permanent post anchoring each intensive module. The corners are indicated at the top of the columns on the datasheet, as pairs, module number and corner number (e.g., 1–2, 1–4). Once at the nested corner location, take two meter sticks and use them along with the previously laid out tapes to form a perfect square 1 square meter (10.8 square feet [ft^2] nested subplot, which corresponds to depth three for that corner (Figure 2). If for some reason you cannot sample a particular corner, make a note in Corner Notes.

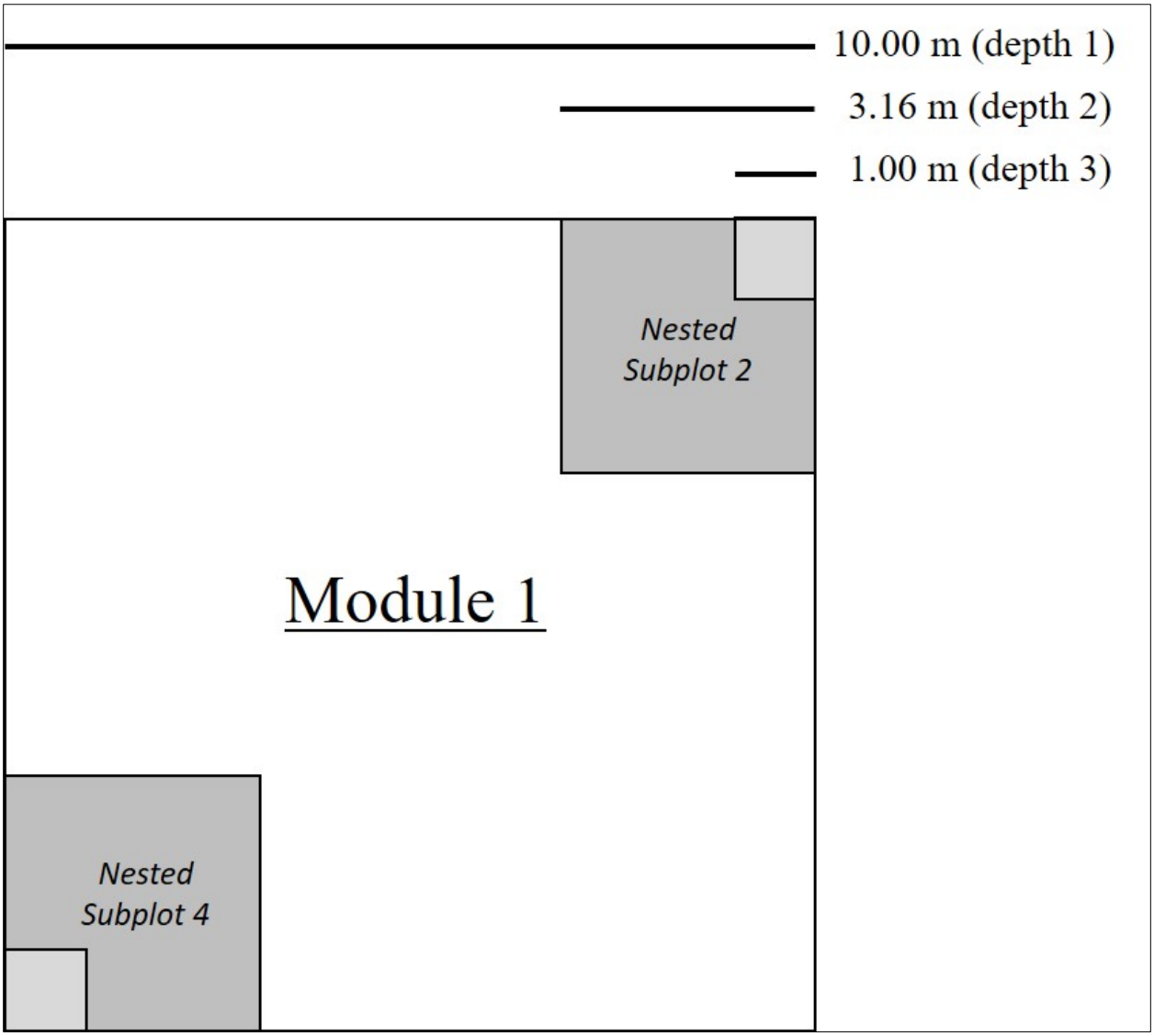

Figure 2. The Southeast Coast Network 10 × 10-meter (32.8 × 32.8 ft) vegetation module diagram illustrating the nested subplot corners.

Once the 1 square meter (10.8 ft^2) corner nested subplot is laid out, species presence data are collected. First, identify and record all plant species in the first 1 × 1 meter (3.3 × 3.3 ft) nested subplot for module 1 (refer again to Figure 2). Skip over any plants that are very small (less than 5 centimeters [2 in])) which cannot be attributed to a species. In the box for the nested subplot on the datasheet, mark a "3" to indicate that the species is present in module one, corner/subplot two at the 1 ×1-meter level. For plot revisits, the datasheets for the plot will be filled with a preprinted species list from the last survey, with species codes listed in alphabetical order and extra blank rows to add species not encountered during the last survey. See below for procedure for recording species nomenclature. Record your confidence in the identification value under the field of identification

confidence (Table 1). If the species cannot be determined in the field, collect a sample (if approved by the park resource manager) with foliage, buds, cones, or flowers, and/or a photograph to make a positive identification later. Put a check in the collected column on the data sheet to indicate that a specimen was collected. For more information on species collecting and identification, refer to collection notes section at the end of this SOP. Once you have collected species data at the 1 × 1 meter level (depth 3) for a given nested subplot, then tree seedling tallies should be conducted.

At this point, the field crew has completed the 1 × 1 meter nested depth but still must complete the 3.16 × 3.16 meter (10.4 ×10.4 ft) nested depth in the same subplot (corner). The 3.16 × 3.16-meter (depth 2) grid includes the 1 ×1-meter (depth 3) grid that was already examined, so the crew simply needs to expand the size to 3.16 meters (10.4 ft) on each side (there are various ways to lay this out, such as to place meter sticks and pin flags at the module corners). Once laid out, identify, and record only new species that were not already documented at depth three in this corner. Instead of writing a "3" in the box for the corner to indicate presence, write a "2" to indicate the new "depth" (modified from Lee et al. 2008). Skip over any plants that are very small (less than 5 centimeters) which cannot be attributed to a species.

Take up all nested subplot markers and repeat the steps above in the second nested subplot for the module. Remember to start over with recording of species in the new corner. In other words, if a species occurs in both sampled corners within the module then it should be recorded in both corners (i.e., a "3" or "2" will be recorded for each corner). If you are recording data and are unsure about how to code a species presence on the datasheet, do not hesitate to stop and ask questions of other field team members. It is extremely important to get it right as there are no second chances to record the data.

Finally, move on to the whole 10 × 10-meter (32.8 ×32.8 ft) module, which is referred to as depth "1" (where 3.16 × 3.16 meters was depth "2" and 1 × 1 meter was depth "3"). Now identify and write down any new species that were not already documented in either corner of the module. Skip over any plants that are very small (less than 5 centimeters) which cannot be attributed to a species. This time, instead of writing a "2" in the box for the corner to indicate presence at that depth, write a "1" in the column for the first corner to indicate depth of 1 (modified from Lee et al. 2008). This is also a good time to look up at the trees in the module and consult with the team member surveying trees to make sure that you agree on species ID and have accounted for species that may not be present as seedlings or saplings. While there is no strict time limit established on searching for residual species at level 1, the goal is to be thorough but at the same time recognize that invariably some species will be missed. As a general guideline, the field crew leader should keep track of the amount of time spent since they added a species to the module. If it has been two or more minutes of active searching then this is probably a good indicator that it is time to move on to the next module. Finally, record any species that overhangs the module but is not rooted in the plot, and assign a presence value of depth "0" in the column for the first corner of that module. Record cover classes for each species recorded as present in the module (see Assigning Cover Classes section below).

Repeat the above procedures on the other remaining modules.

Recording Species Nomenclature

Whenever a species name is written on a field form, the presumption is that you are reasonably certain of the name. For each species, please use the 7–8 letter code that corresponds to the full scientific name for that species. The code consists of the first four letters of the genus and the first three letters of the species for the genus and species of that plant plus an extra fourth letter or number as a tiebreaker where two species have similar names. When in doubt or in a hurry, write the full scientific name with no abbreviations. No other variations will be accepted. Use neat block letters. If the person doing data entry cannot read your writing, then the data quality is undermined and the work is wasted. Some plant species have identical 7-letter codes, so the full species names must always be written out or the longer code must be used (i.e., *Carya ovata—Carya ovalis*, *Polygonum hydropiper—Polygonum hydropiperoides*).

In addition to recording the species name, an overall identification confidence estimate must be included (Table 1). The confidence in the identification of a species is independent of the level of taxonomic specificity. The field crew leader can be very confident in a plant identified only to family, (e.g. Family = Orchidaceae; Confidence = C) because they are sure that it is in that family, but have no idea which genus it is. Similarly, they could be very unsure of a genus or species level call (e.g. Species = Dryopteris sp.; Confidence = U), especially if the specimen is obscure, small, or somehow uncollectable. Any plant that is given a confidence code of Probable (P) or Uncertain (U), or identified to any taxonomic level other than species, should have its photograph taken if the field crew is certain that the digital image can be used to identify the record to species upon return from the field. If the crew member does not know if a photograph will aid in identification, a specimen from outside the plot should be collected.

Table 1. Species identification confidence codes used by the Southeast Coast Network

Confidence	Code	Description
Certain	C	The person(s) making the taxon interpretation has a high confidence in the accuracy of the field or herbarium identification.
Probable	P	The person(s) making the taxon interpretation has a moderately high confidence in the accuracy of the field or herbarium identification, but uncertainly is typically recorded as “cf” or “?” (e.g., taxon is most likely the species named; occasionally another taxa may be listed as a possibility–it can be named in a comments field).
Uncertain	U	The person(s) making the taxon interpretation has only moderate confidence in the accuracy of the field or herbarium identification, as shown by “??” or other comments about uncertainty. For example, taxon may be one of two or more species and although one name is chosen, it could as easily be another.

Also include indicators of uncertainty in how you write the species name. For example:

- Simply record “CORNFOE” or “*Cornus foemina”* if species level is certain, and “*Cornus* sp.” if only genus level is certain. If you’re not certain of the species identification, give some indication of your uncertainty using the confidence level codes.

- If the specimen might be one of two or a few species, record the two or three that it might be. Indicate, if possible, which one is most likely. If you're not sure, indicate that as well. For example, *Viola* spp. (*conspersa* or *rostrata*).

- If there are several distinct species within a genus, and you are uncertain of their name, but you can clearly see they are distinct, do use ad hoc names to separate them, such as "*Carex*-fuzzy red base" vs. "*Carex* - green base." They will be entered as *Carex* sp. 1 and *Carex* sp. 2 along with your description.

- If you don't know the genus or species, record family if known. Beyond family, simply use broad growth forms, such as *tree sp., shrub sp., herb sp., aquatic sp., moss sp., lichen sp., algae sp.,* or *vine sp*. Record some additional note characterizing the plant, such as: "*Shrub* sp (opp lv)", for shrub with opposite leaves.

- If the specimen consists of only cotyledons or is so small (less than 5 centimeters [2 in]) as to be difficult to identify with any certainty, you may ignore the specimen and move on without recording anything on the datasheet.

- Where there is uncertainty noted with the species identification, as indicated by "cf." or "?" in the species names, or by other comments, use the **Confidence Level** field to record that the identification is **Probable.**

- Where there is greater uncertainty indicated, e.g., multiple species are listed, even though one is designated as the primary name, record the identification as **Uncertain**. Field crews must always indicate which name is primary, if more than one is listed.

Assigning Cover Classes

After a species list has been developed for each module, cover classes need to be assigned for each plant species. Cover classes are assigned to approximate the total percent cover of each species across a single module. The cover classes are assigned rapidly (completed in 10 minutes or less) using the same percent cover class scale used by NatureServe and the Carolina Vegetation Survey for vegetation plots (Lee et al. 2008). These data are recorded as classes which represent ranges of percent cover and will be analyzed using multivariate analysis. Cover classes are estimated from two observers, standing on opposite ends of the module, and reaching a consensus. Observers should stand at a location where they each can best view the vegetation (trees, shrubs, and ground plants) within the module.

The cover classes are as follows; cover class 1= < 0.1%, 2=0.1–1%, 3=1–2%, 4=2–5%, 5=5–10%, 6=10–25%, 7=25–50%, 8=50–75%, 9=75–95%, 10= > 95%. Canopy percent cover is used, not foliage percent cover. Canopy percent cover is the total canopy cover of a species' leaves, stems, and trunks over the 10 × 10-meter (32.8 × 32.8 ft) module, and considers the tiny gaps in the canopy foliage as filled. If there are significant gaps within the individual canopy, it is not considered continuous. For more information, refer to the Definitions section. **Do not** assign separate cover classes for the canopy, subcanopy, shrub, and herbaceous strata. When done correctly, the

assignment of these cover classes is within one class when estimated by separate observers. Field workers should not spend time equivocating about which of two cover classes to assign, but rather should come up with a simple system to make decisions quickly and move on to the next species. When assigning cover classes, the field crew leader should consult with the team member that surveyed the trees to make sure that all tree species are accounted for correctly in the cover values.

Descriptions of data fields located on the species diversity datasheet are in Table 2.

Table 2. Datasheet field descriptions for *Veg Form 5—Species Diversity*.

Field Name	Field Description
Taxonomic Standard and Guide book used.	Taxonomic standard refers to source of taxonomic names. In almost all cases this will be Weakley 2015. Guidebook used refers to primary key used for plant identification.
Data Taker Initials	Initials of individual collecting the data. In most cases will have one person identifying species (field crew leader), while another records. Data taker initials should be the field crew leader, who is responsible for correct species ID.
Reviewed by	Initials of individual who reviewed completed data sheet for SOP 1.4.14 elements. In most situations, this should be someone other than individual who recorded data on this portion of datasheet. Field crew leader can conduct this review while recording cover values.
# Corners Sampled	Default value should be eight. However, is less than eight are sampled record this number. Be sure to record justification in corner notes.
Corner Notes	If less than eight corners sampled or if different from default corners sampled, record information in this block. Be sure to include the identification of all corners that were sampled (e.g., 1-3, 2-4, etc.)
Species Code	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. Field crew leader confirms spelling. For revisit plots, a pre-populated species list will be provided. Update/correct as necessary.
ID Confidence	In cases where species identification is not certain record confidence level as either C=certain, P=probable, or U=uncertain
Collect	Place a check mark in this column if field crew leader collects plant specimen for later identification and/or to make a species voucher.
Module 1-2, 1-4, 4-3	For each corner, record the level at which a species is first recorded where 3=1 × 1 meter subplot and 2=3.16 × 3.16-meter subplot. If a species is not recorded in either corner but is detected in the 10×10-meter module, record it as a 1 in the first corner for that module; if a species is providing cover to the module, but is not rooted in that module, record it as a 0 in the first corner for that module.
Cover Class (20 × 20 meter)	Field crew leader records a cover class for each species for the overall plot where 1=trace, 2=0.1–1%, 3=1–2%, 4=2–5%, 5=5–10%, 6=10–25%, 7=25–50%, 8=50–75%, 9=75–95%, and 10= >95%.

Notes on Plot Revisit Years

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

1. When identifying additional plant species at depth 1, do not add additional search time to locate species found during the previous sampling event but not in the current sampling event at depths 2 or 3. In other words, don't go back just to locate species found in previous sampling events. Consistency in effort and independence between sampling events are important.

2. If the previous sample excluded a corner for a temporary reason (such as the presence of a yellow jacket nest) that is not applicable during the revisit, sample the corner during the revisit.

3. During plot revisits, there will be an established species list for the plot from the previous sampling event. This list will be in alphabetical order on the datasheet. If you notice obvious species ID errors or incorrect species code usage, cross out the original code on the datasheet and write in the correct code. It is also helpful to identify a previously identified genus to species if possible. Refer to "Changing/Amending Previous Sampling Event's Data" section below for more information.

4. For those species on the pre-populated species list that were detected during previous sampling events but not the current one, it is good practice to draw a horizontal line through the entire row of the datasheet to indicate this species was not observed for the current sampling event. It is expected that some species found during previous surveys will not be seen during current surveys and that new species will be seen during the current survey. Add new species to the bottom of the species list.

Changing or Amending Previous Sampling Event's Data

While changes to previous sampling event data should be rare, there are circumstances where such changes are valid. For instance, an obvious misidentification occurred or a data entry error was discovered in the field. Some examples include:

- Based on the presence of fertile material that was not present in the plot during the previous survey, the botanist changes an identification from *Lonicera standishii*-**P**robable to *Lonicera maackii*-**C**onfident.

- The botanist realizes they made an obvious mistake on previous plot visit, such as using an incorrect code-an example is writing CHAMMAC instead of CHIMMAC.

One piece of evidence that may sway the decision on whether to make a taxonomic change is to consult the presence and cover values recorded during the previous sampling event. For instance, if a species was found in one and only one corner during both sampling events, or if a species was widely dispersed throughout the plot with a relatively high cover value during both sampling events, this would add greater evidence that both botanists were looking at the same taxon. Note the botanist should not consult presence and cover values from the previous sampling event until after data

collection for the current event is concluded. If the botanist concludes that a species name should be changed, they indicate this by marking through the species code on the field form in pencil and writing the new "corrected" species code next to it. However, before such a change the botanist must consider the following questions:

1. How do you know the proposed species change is not just a second species that was either missed or not present during the previous sampling event?

2. If the previous field crew was present, would they quickly and easily agree that a data error occurred and should be corrected?

3. Does the change improve the quality of the data, both in terms of accuracy and consistency?

In determining whether to make a species change, the botanist must also keep in mind that there are some taxonomic concepts where accurate identification from vegetative material alone is difficult at best, and that there is going to be some disagreement even among trained, experienced botanists. A few examples where there appears to be some ambiguity in species calls include *Acer barbatum* versus *Acer saccharum* and just about anything in the genus *Carex*. These are examples of "errors" that not every botanist may quickly agree upon. Also, because there is some ambiguity with these taxonomic concepts, the data are likely to be lumped for most, if not all, analyses. A proposed change may not necessarily improve the quality of the data. What we're trying to avoid are situations where taxonomic concepts are constantly changing and in the grand scheme these changes would have little impact on the overall quality of the data and subsequent analyses. Instead of making the change, another possible solution for consideration is to lower the **ID conf** from **C**ertain to **P**robable or **U**ncertain and adding a note that the "YYYY botanist believes species X may be species Y." The updated **ID conf** and note would then be on the field form for the next sampling event. The future botanist would thus be alerted to the fact that there was some uncertainty regarding that taxonomic concept.

Notes on Collecting

It is very important that all data collectors for this SOP attempt to thoroughly catalog the species within each of the nested subplots and the plot as a whole. By doing this, we hope to minimize the error associated with differences in data collectors' abilities to find the same specimens and maximize the power to detect change over time. A secondary goal of monitoring efforts is to enhance plant species lists for each park, so any unusual plant that is suspected of being new to the park should be collected. Following are notes on specimen collection and subsequent identification:

- Do not collect specimens for unknown identification or for permanent vouchers without the permission of the park resource manager. If you do not have permission to collect, take photographs to document unknown or unusual plants.

- Do not collect any plants represented by three or fewer individuals (i.e., locally sparse) in the general vicinity of the plot. If a plant is considered locally sparse and there are individuals outside of the plot, consider taking your collection from outside of the plot.

- Do not remove entire plants (including roots) from within the plot. If the plant occupies greater than 2% cover and is sufficiently robust, a portion of the plant may be removed from within the plot such that the overall cover of the plant within the plot is not significantly affected.

- If it is not possible to collect a specimen, take a photograph instead. First take a photo of the plot sheet so that we can easily determine which plot the specimen photo is from. Then place a ruler or an object of known size like a pencil or pen in the photograph for scale, and allow the camera to automatically select the appropriate aperture for the given light conditions. Use the Macro setting or Super Macro setting to take detailed close-up photographs of smaller plants.

- If a specimen from what you believe is the same species has already been collected in a previous plot, then mark which plot it was from in the 'Collected' column and rely on that previous specimen for specimen identification.

- For a specimen that isn't identifiable to species (particularly vegetative *Carex* sp. and *Dichanthelium* sp. specimens), it is ok to collect, but mark it clearly as not identifiable and continue to look for a viable specimen in other plots in the park that you can link this specimen to. Do not spend a lot of time on species identification, particularly if spikes or other distinguishing characters are absent. The recommended approach is to use **P** or **U** for ID confidence or write the genus, with notes on characters used to distinguish it from other species in the plot, and move on. Spending less time on these genera will increase efficiency both on the plot and during data validation, and reduce turnover between plot samples.

- Keep only quality specimens for vouchers. Voucher specimens must have clearly distinguishable features, such as flowers or fruit. Do not voucher specimens that were given an ID confidence of **P** or **U**. Work with park curatorial staff to submit the required documentation for a natural resource collection and determine where to archive the vouchers (must be a safe, climate-controlled location).

- If you collect a specimen and check the 'Collected' column, but later realize that you cannot use the specimen and discard it, please ensure that you cross out the checkmark in the 'Collected' column so that other workers do not mistakenly think that a specimen has been lost.

Specimens or digital images of unknown taxa should be identified as soon as possible following field work. Species that are identified prior to data entry should be annotated on the field datasheet. If species are not able to be identified prior to data entry, they should be corrected in the front-end database.

Recording Woody Stem Seedling Tallies

Once you have collected species data at the 1 × 1 meter (3.3 × 3.3 ft) level (depth 3) for a given nested subplot, then tree seedling tallies should be conducted. Blank datasheets will be provided both

for plot establishment and plot revisit surveys. Identify woody stem species and tally (by species) all individual seedlings in the 1 × 1 meter depth that are 5–15, 15–30, 30–50, or 50–137 centimeters (2–5.9, 5.9–11.8, 11.8–19.7, or 19.7–53.9 in) tall. Skip over any plants that are very small (less than 5 centimeters [2 in]) which cannot be attributed to a species. Use the dots and square method described at the top of the seedling and sapling datasheet to most easily document numbers of seedlings (Figure 3).

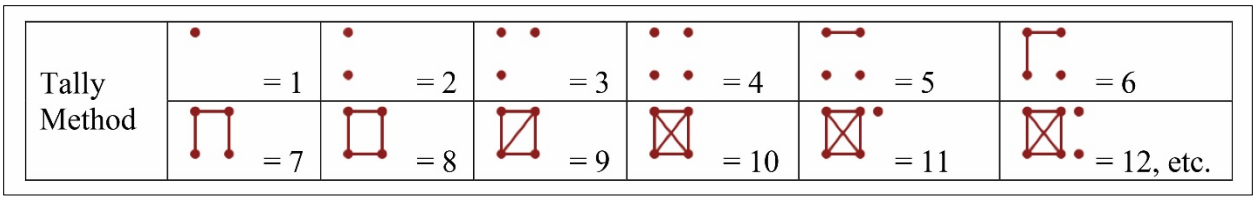

Figure 3. Tally method for recording (counting) seedling and saplings occurring within sampled corners.

Recording Woody Stem Sapling Tallies

Once you have collected species data at the 3.16 × 3.16-meter size (depth 2) for a given nested subplot, then woody stem sapling tallies are conducted. Sapling size ranges include 0–1 centimeters (0–0.4 in) DBH, 1.0–2.5 centimeters (0.4–1 in) DBH, 2.5–5 centimeters (1–2 in) DBH, and 5–10 centimeters (2–3.9 in) DBH. **Do not** collect any data on **seedlings** (woody plants below 1.37 meters [4.5 ft] tall) for the 3.16 × 3.16 meter (10.4 ×10.4 ft) nested depth, as these are only recorded at level 3 in each corner. If after sampling a subplot at both depth 3 and 2 you do not encounter any seedlings or saplings at all, write "none" on the datasheet in the species name field for that module and corner in the seedling and sapling data so it is documented that the field team did survey that corner for seedlings/saplings and that the corner was not unintentionally missed. It is imperative that the field team takes the time to tally all seedlings/saplings in each subplot because these are important data used for regeneration analysis. A quick check of stem species written on the species list for that subplot will let you know if there might be any seedlings or saplings missed in the seedling/sapling tally.

Descriptions of data fields located on the seedlings/saplings measurement datasheet are in Table 3.

Table 3. Datasheet field descriptions for *Veg Form 6—Seedling/Sapling Measurements*.

Field Name	Field Description
Data taker Initials	Initials of individual collecting the data. In some cases, will have one person calling out data, while another records. Data taker initials should be individual who is primarily making decisions on what is written on the datasheet.
Reviewed by	Initials of individual who reviewed completed data sheet for SOP 5 elements. Ideally this should be someone other than individual who recorded data on this portion of datasheet.
Module & Corner	Record the module and corner combination where the seedling or sapling species is found.
Species Code	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. Field crew leader should confirm spelling.
Seedling Height Classes (cm): 5-15cm 15-30cm 30-50cm 50-137cm	Within the 1×1-meter nested subplot (i.e., level 3), use tally method (outlined on bottom of datasheet) to record the number of individuals within each height category for the species in question within the specified corner.
Tree Saplings by DBH (cm) 0-1cm DBH 1-2.5cm DBH 2.5-5cm DBH 5-10cm DBH	Within the 3.16 × 3.16 m nested subplot (i.e., level 2, which includes the level 3 nested subplot), use tally method (outlined on bottom of datasheet) to record the DBH of tree species which are at least 137 centimeters (53.9 in; i.e., DBH height) tall and less than 10 centimeters (53.9 in) DBH into the appropriate size category. Note, all trees 10 centimeter DBH or above will be recorded on the tree data sheet (SOP 6).

Equipment List

- DBH Tape (w/ centimeter units)
- Three meter sticks
- Wire pin flags
- Camera
- Hand lens
- Plant identification references
- Plant press and materials or plant collection bag
- Field datasheets (SECN Veg Form 5—*Species Diversity* and SECN Veg Form 6—*Seedling/Sapling Measurements*)
- Pencil

Literature Cited

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Peet, R. K., T. R. Wentworth, and P. S. White. 1998. The North Carolina Vegetation Survey protocol: a flexible, multipurpose method for recording vegetation composition and structure. Castanea 63:262-274.

Weakley, A.S. 2015. Flora of the southern and mid-Atlantic states: working draft of 21 May 2015. University of North Carolina Herbarium (NCU), Chapel Hill, North Carolina. 1320 pp.

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 May 2019).

Appendix A: Field Data Forms

SECN Vegetation Monitoring Protocol
Veg Form 5 – Species Diversity

Plot ID _____ (plot acronym + GRTS Order #)

Start Date_____ (mm/dd/yy)

SOP VEG05 – Species Diversity and Seedling/Sapling Measurements

Data taker initials_____

Reviewed by: _____

Datasheet 1 of 3 **# of corners sampled**_____ (If < 8, or if other than default corners are sampled include a justification in notes)

Taxonomic Standard Used _____ Guidebooks Used _____

Corner Notes:

Species Code (7-8 letters)	ID Con	Coll ✓	Module and Corner No. (default corners, make note if different) C = Cover Class											
			1-2	1-4	C	2-2	2-3	C	3-2	3-4	C	4-2	4-3	C
		1												
		2												
		3												
		4												
		5												
		6												
		7												
		8												
		9												
		10												
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		12												
		13												
		14												
		15												
		16												
		17												
		18												
		19												
		20												
		21												
		22												

Confidence Level Codes
C – certain
P – probable
U – uncertain

Sample depth codes: 3 = 1x1 m, **2** = 3.16x3.16 m, **1** = 10x10 m
Cover class key: 1=trace, **2**=0.1-1%, **3**=1-2%, **4**=2-5%, **5**=5-10%, **6**=10-25% **7**=25-50%. **8**=50-75%, **9**=75-95%, **10**>95%

SECN_Vegetation_Monitoring_Protocol
Data_Form_20190306

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Figure A-1. Sample Form 5—Species Diversity, page 1 of 3.

SECN Vegetation Monitoring Protocol
Veg Form 5 – Species Diversity

Plot ID _____ (plot acronym + GRTS Order #)

Start Date_____ (mm/dd/yy)

SOP VEG05 – Species Diversity and Seedling/Sapling Measurements

Datasheet 2 of 3

Species Code (7-8 letters)	ID Con	Coll ✓	Module and Corner No. (default corners, make note if different) C = Cover Class											
			1-2	1-4	C	2-2	2-3	C	3-2	3-4	C	4-2	4-3	C
		23												
		24												
		25												
		26												
		27												
		28												
		29												
		30												
		31												
		32												
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		37												
		38												
		39												
		40												
		41												
		42												
		43												
		44												
		45												
		46												

Confidence Level Codes
C – certain
P – probable
U – uncertain

Sample depth codes: 3 = 1x1 m, **2** = 3.16x3.16 m, **1** = 10x10 m
Cover class key: 1=trace, **2**=0.1-1%, **3**=1-2%, **4**=2-5%, **5**=5-10%, **6**=10-25%
7=25-50%. **8**=50-75%, **9**=75-95%, **10**>95%

SECN_Vegetation_Monitoring_Protocol
Data_Form_20190306

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Figure A-2. Sample Form 5—Species Diversity, page 2 of 3.

SECN Vegetation Monitoring Protocol
Veg Form 5 – Species Diversity

Plot ID _____ Start Date_____
(plot acronym + GRTS Order #) (mm/dd/yy)

SOP VEG05 – Species Diversity and Seedling/Sapling Measurements

Datasheet 3 of 3

Species Code (7-8 letters)	ID Con	Coll ✓	Module and Corner No. (default corners, make note if different) C = Cover Class											
			1-2	1-4	C	2-2	2-3	C	3-2	3-4	C	4-2	4-3	C
		47												
		48												
		49												
		50												
		51												
		52												
		53												
		54												
		55												
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		64												
		65												
		66												
		67												
		68												
		69												
		70												

Confidence Level Codes
C – certain
P – probable
U – uncertain

Sample depth codes: **3** = 1x1 m, **2** = 3.16x3.16 m, **1** = 10x10 m
Cover class key: **1**=trace, **2**=0.1-1%, **3**=1-2%, **4**=2-5%, **5**=5-10%, **6**=10-25%
7=25-50%. **8**=50-75%, **9**=75-95%, **10**>95%

SECN_Vegetation_Monitoring_Protocol
Data_Form_20190306

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Figure A-3. Sample Form 5—Species Diversity, page 3 of 3.

SECN Vegetation Monitoring Protocol
Veg Form 6 – Seedling/Sapling Measurements

Plot ID _____ (plot acronym + GRTS Order#)

Start Date_____ (mm/dd/yy)

SOP VEG05 – Species Diversity and Seedling/Sapling Measurements

Data taker initials_____

Reviewed by: _____

Datasheet 1 of 2

Module & Corner	Species Name (or 7 letter code)	Tree Seedlings by Height Classes from Depth 3 (1.0 m² subplots)				Small Tree Saplings by DBH from Depth 2 (10 m² subplots)			
		5-15 cm tall	15-30 cm tall	30-50 cm tall	50-137 cm tall	0-1.0 cm dbh	1 -2.5 cm	2.5-5 cm	5-10 cm

Tally Method	= 1	= 2	= 3	= 4	= 5	= 6
	= 7	= 8	= 9	= 10	= 11	= 12, etc.

SECN_Vegetation_Monitoring_Protocol
Data_Form_20190306

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Figure A-4. Sample Form 6—Seedling/Sapling Measurements, 1 of 2.

SECN Vegetation Monitoring Protocol
Veg Form 6 – Seedling/Sapling Measurements

Plot ID _____
(plot acronym + GRTS Order #)

Start Date_____
(mm/dd/yy)

SOP VEG05 – Species Diversity and Seedling/Sapling Measurements

Datasheet 2 of 2

Module & Corner	Species Name (or 7 letter code)	Tree Seedlings by Height Classes from Depth 3 (1.0 m² subplots)				Small Tree Saplings by DBH from Depth 2 (10 m² subplots)			
		5-15 cm tall	15-30 cm tall	30-50 cm tall	50-137 cm tall	0-1.0 cm dbh	1 -2.5 cm	2.5-5 cm	5-10 cm

SECN_Vegetation_Monitoring_Protocol
Data_Form_20190306

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Figure A-5. Sample Form 6—Seedling/Sapling Measurements, 2 of 2.

Appendix B: Modifications to CUPN SOP7 and SOP14 for SECN SOP 1.4.14

The CUPN SOPs 7 and 14 were modified to create SECN SOP 1.4.14. The major modifications to these SOPs are listed and explained below.

Combination of SOP 7 and 14

The Cumberland Piedmont Network wrote two separate SOPs describing the methods to capture species diversity and the importance of using a taxonomic standard. Because of the linkage between these elements during the field data collection process, the Southeast Coast Network decided to combine these two SOPs into a single SOP.

Adoption of a Second Taxonomic Standard Reference—Weakley's Flora

For the CUPN vegetation monitoring project, a single taxon standard was identified—the Integrated Taxonomic Information System (ITIS). Although the Southeast Coast Network recognizes that ITIS provides national-scale coverage of taxonomic information across all biotic taxa, current IMD (Inventory and Monitoring Division) guidance has directed networks to not use ITIS as a taxonomic standard. Integrated Taxonomic Information System, however, can still be used for reporting. Over the past decade, the *Flora of the Southern and Mid-Atlantic States* (Weakley 2015) has become the standard for vascular plant identification in the Southeastern U.S. One advantage of using Weakley's flora is that it contains explicit mapping of the taxonomic concepts used by authors of over 1,000 taxonomic treatments, thereby facilitating incorporation of legacy data and updating nomenclature. There are currently efforts underway to map the species list located in the Flora to ITIS.

All Woody Stems Counted in the Seedling/Sapling Tallies

The CUPN vegetation monitoring effort counts only species identified as trees in their seedling and sapling tallies, largely because their sampling framework includes only forests and woodlands across their network parks. The Southeast Coast Network has chosen to include shrubs and woody vines (lianas) in their abundance estimates for woody plants. In certain vegetation communities across coastal parks, these growth forms may represent later-stage seral structure that tree forms would represent for forests.

Species Cover at the Modular Scale

Cover is estimated for each species found in CUPN vegetation monitoring plots at the plot-level scale. The Southeast Coast Network has chosen to estimate cover at the modular scale due to the error inherent in visually estimating species cover at 400 square meters (4,306 ft^2)-scale in many of the network's vegetation communities.

Species Cover Estimated from Consensus

Cover is estimated for each species found in CUPN vegetation monitoring plots by a single observer. The Southeast Coast Network has chosen to estimate cover using two observers, who stand at opposite ends of a module to come to a consensus of cover class value.