CVS-EEP Protocol for Recording Vegetation

Level 1-2 Plot Sampling Only

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Contents

1. Introduction

This document is intended primarily for individuals who are new to vegetation sampling for the Carolina Vegetation Survey (CVS, http://cvs.bio.unc.edu) or the North Carolina Ecosystem Enhancement Program (EEP, http://www.nceep.net). It also serves as a reference to current procedures for all workers collecting plot-based data using the CVS-EEP protocol. In addition, this document should be helpful for individuals who wish to interpret data collected for these programs or wish to apply our protocol for other programs. Definitions and explanations should also clarify changes for those familiar with earlier versions of our protocol.

We hope that this guide will facilitate your recording of vegetation plots, and perhaps even help you appreciate more deeply the vegetation that you have the opportunity to observe.

2. Vegetation Plots, Protocols, and Data

2.1: What is a plot?

The ***plot*** is the fundamental record of plant community composition. A plot is a bounded area of land, within which the vegetation and environment are documented. The CVS protocol defines plots as consisting of one or more 100-m^2 ***modules***. While a module typically has a standard shape of 10×10 m, varying the number, shape, and arrangement of modules allows flexible plot design enabling a common methodology to be applied to a broad diversity of vegetation types.

The scientific method requires that measurements be as unbiased as possible, and that they be repeatable. Plots should be designed to achieve both of these objectives; in particular, different people should be able to inventory the same plot and produce similar data. The bounded nature of plots reduces error and bias, as otherwise individual plants might be subjectively included or ignored. Because even with plots, bias can be hard to avoid, care should be taken to locate and record the plot objectively.

2.2: Choice of protocol level

There are many different goals in recording vegetation, and both time and resources for collecting plot data are extremely variable. To provide appropriate flexibility in project design we support five distinct types of vegetation plot records, which we refer to as ***levels*** in recognition of the increasing level of detail and complexity across the sequence. The lower levels require less detail and fewer types of information about both vegetation and environment, and thus are generally sampled with less time and effort.

- **Level 1: Planted stem inventory plots.** Level 1 plots are applicable only for restoration areas with planted woody stems. The primary purpose is to determine the pattern of installation of plant material with respect to species, spacing, and density, and to monitor the survival and growth of those installed plants. Level 1 plots are one module in size.
- **Level 2: Total woody stem inventory plots.** Level 2 plots also are designed specifically for restoration areas and represent a superset of information collected for Level 1 plots. In these plots planted woody stems are recorded exactly as for Level 1, but in addition all woody stems resulting from natural regeneration are recorded by size class using separate datasheets. These plots allow an accurate and rapid assessment of the overall trajectory of woody-plant restoration and regeneration on a site. Level 2 plots are one module in size.
- **Level 3: Community occurrence plots.** Level 3 plots are used to document the overall abundance and vertical distribution of leaf area cover of the more common species in a plot. Cover is estimated for all plant species exceeding a specified lower level (typically 5% cover); species present but with cover lower than the cut-off may be ignored. The information collected meets the Ecological Society of America (ESA) guidelines and Federal Geographic Data Committee (FGDC) standards for plots used to classify vegetation to an association within the U.S. National Vegetation Classification (NVC). The information can also be used to assess vegetation successional status as well as the presence and abundance of undesirable taxa such as invasive exotics. Additional environmental data are collected in Level 3 plots. Optionally, woody stem data required for Level 2 plots (tallies of planted and/or natural woody stems) may be collected for Level 3 plots to allow more accurate assessment of the rate and direction of succession. Level 3 plots are one module in size.
- **Level 4: Community classification plots.** Level 4 plots are similar to Level 3 plots, except that cover values are determined for *all* plant species occurring on the plot, and additional environmental data are collected. As is the case for Level 3 plots, it is optional whether to tally woody stems. These plots conform to the requirements for "classification plots" as defined by the ESA Guidelines and FGDC standards, which are plots of sufficient detail and quality to be used in development and refinement of the NVC. The primary purpose for collecting Level 4 plots is to facilitate rigorous documentation of vegetation composition. An experienced field botanist is required to ensure collection of a complete list of species occurring in the plot. Level 4 plots are one or more modules in size.
- **Level 5: Community classification and structure plots.** Level 5 plots require all the information collected for Level 4 plots, plus additional information on the spatial structure of the vegetation within the plot. Woody stem data remain optional, but are strongly recommended. The primary purpose of Level 5 plots is to facilitate rigorous research and assessment of vegetation composition and structure. Level 5 plots are one or more modules in size.

2.3: Data collection and forms

Field data forms are available for each of the plot levels, as are additional instructions and training aids. Visit http://cvs.bio.unc.edu to obtain forms or additional information.

2.4: Project identification

Each project should have a unique project identifier that ensures that plots will be properly associated with project metadata (information about the project data). There are two sources of unique project identifiers within our data network. For projects contracted by **EEP**, **EEP** assigns project identifiers including both a ***unique project label*** and an official ***project name*** (which may not be unique). To request a unique project label from **EEP**, contact them via their website (http://www.nceep.net). **CVS** assigns ***project numbers*** directly on an as-needed basis for projects independent of **EEP**; to request a **CVS** project number send email to cvs@unc.edu.

2.5: Plot numbering

Plots must be uniquely identified within a project. This is typically done with a couplet consisting of a team number and a plot number. Each field team is assigned a team number unique within the project; where only one team is involved this defaults to 1. Each team within a project will label each plot with a unique number. Normally a team will be assigned an ***initial plot number*** and will number plots sequentially starting with that number. Please be sure to write all plot identifiers (project-team-plot) on every datasheet you fill out. It's very easy to forget this simple activity, but if you forget it can be difficult or impossible to assign these identifiers later. The plot leader is responsible for ensuring that full plot identification is recorded on all datasheets and other samples (e.g., unknown plants, soils) collected in the plots.

2.6: Data management and data submission

CVS has developed a data entry tool within Microsoft Access that allows data entry in computer forms that mimic the datasheets used for the various protocol levels. Quality-control checks are automatically performed to ensure that data entry has been accurate and that field workers did not record logically inconsistent data. Once this process is complete, the Access database may be sent to CVS for inclusion in the central archive database. Instructions for submitting data to CVS may be found within the data entry tool itself (see Main Menu | Options). This data entry tool may be downloaded from http://cvs.bio.unc.edu.

3. Level 1-2 Vegetation Plots

3.1: Project information

3.1.1: Project planning

Project planning is a critical step and includes making decisions about such issues as how many plots to sample, the sampling methodologies to use, how and where plots should be located, what types of stands within certain areas should be targeted, and the level of expertise required of the sampling team. Long-term goals must be balanced with short-term availability of resources and logistics to achieve a successful project. The outcome of the planning process is presented in the Mitigation Plan, which must be reviewed by EEP personnel.

3.1.2: Timing of sampling for EEP projects

For newly constructed EEP projects, ***Vegetation Baseline Data*** (VBD) must be submitted ***within 60 days*** of the EEP/State Construction Office walk-through. To prevent unreasonably short time spans between the collection of VBD and the first collection of ***Year 1 Vegetation Monitoring Data*** (Y1-VMD), all Y1-VMD must be collected during the month of September. The second and all subsequent years of VMD must be collected between June 1 and September 31, unless a different schedule has been approved by the EEP.

3.1.3: Determining the number of required plots for EEP projects

The number of required plots must be calculated separately for each mitigation category: stream enhancement, stream restoration, and wetland mitigation. The data entry tool can aid in calculating the necessary number of plots (see Main Menu | Planning).

3.2: Plot location and placement

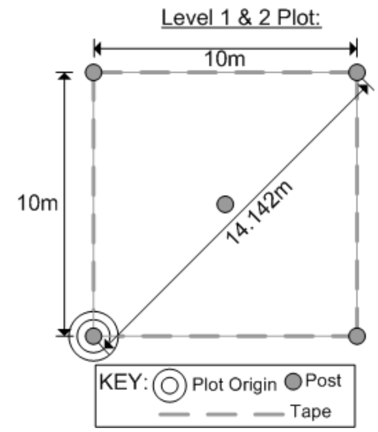
3.2.1: Location selection

Project directors will provide direction as to how to select a stand within which to place a plot or plots. Stands are selected based on available vegetation, project goals, needs of land owners, representativeness of overall vegetation of an area, and sometimes more subjective criteria. Once a stand is selected, the plot or plots should be placed within the stand to minimize effects of the borders of the stand (roads, trails, different vegetation), or other forms of heterogeneity.

Definition
A ***stand*** is "a spatially continuous unit of vegetation with uniform composition, structure, and environmental conditions" (Jennings et al. 2006).

3.2.2: Plot layout and marking

For Levels 1, 2 and 3, we require that plots be 100 m², which is generally accomplished by a 10×10 m square. Other shapes, such as a 5×20 m rectangle, are acceptable if the area for restoration follows a path that does not allow 10 m in width, or if planting zones or topography can be better represented within such a rectangle. You should measure the diagonal of the plot to ensure that the corners are square (the diagonal for a 10×10 m plot is 14.142 m, and for a 5×20 m plot is 20.616 m). Both 10×10 m (illustrated at right) and 5×20 m (not illustrated) plots can be laid out easily using two standard fiberglass tapes. A 50-m tape can serve to delineate the perimeter of a plot of either configuration, and a shorter tape (30 m is a common length) can be used to measure the diagonal distance.



Temporary marking is required but should be minimal. The amount of flagging can be adjusted according to several factors, such as the amount of detail on your map and project location (low in urban parkland versus higher in a remote rural location). Regardless, being discreet will reduce the amount of trampling in the plot. Ideally, the markers will be unnoticeable to the public, but easily recognized by staff with the use of a monitoring plan view sheet.

The corners of each plot must be marked with 12" or greater sections of ½" diameter galvanized steel ***conduit*** driven in the ground, with 4"- 6" exposed. If necessary, larger metal conduit stakes may be used provided no more than 6" of length is exposed. Each stake must be discreetly marked with flagging. Rebar may be used instead of conduit, but only if the rebar is capped with plastic caps to improve visibility and reduce risk of personal injury. The use of PVC is *not acceptable*, and all material except the conduit must be removed upon closeout of the project. An optional additional stake may be placed at the plot center when measuring the diagonal so as to facilitate plot relocation (7.071 m from a corner for 10×10 m plots). If rock or other obstructions prevent a conduit from being driven at a required location, the stake should be displaced along the X or Y axis, and the X-Y coordinates of the displaced stakes should be noted on the plot datasheet. Where 5×20 m plots are used, we recommend that additional stakes be placed at the mid-points of the 20-m sides.

3.3: Woody stem data

3.3.1: Planted woody stems

For Level 1 and 2 plots, newly installed woody plants are inventoried and measured for the purpose of tracking growth and survival. Since plot sampling occurs days or even a few weeks after planting, it is sometimes difficult to determine which stems were planted. A stem is ***considered planted if there is positive confirmation or strong evidence*** (e.g., obvious live-stake, collar, burlap bits), otherwise it is considered natural (a volunteer). Only the largest stem on each individual plant is measured, which is why we refer to these as "planted stems."

The species of each planted stem is recorded, along with its X and Y coordinates relative to the plot origin. A ***source*** code is used to identify where the stem came from (Tr for Transplanted from elsewhere within the project boundary, L for Live stake, B for Ball and burlap, P for Pot, Tu for Tubling, R for bare Root, and M for Mechanically planted with a mechanical tree planter). If the source of the stem cannot be determined, U for Unknown should be used as a source value.

For planted woody stems ***less than 1.37 meters*** in height, two dimensions are measured, the ***height*** (in centimeters) of the longest stem and the ***ddh*** (Diameter at one Decimeter Height above the ground surface, measured in millimeters) of the thickest stem. Calipers (preferably plastic to avoid damage to the stem) should be used to measure the ddh. The abbreviation "ddh" is lowercase to help keep it distinct from DBH, which is described below. ***Height*** refers to the ***length of the woody (perennial) stem*** rather than the height above the ground, which is an important distinction when measuring bent or leaning stems. This also means that height is not measured to the tip of the tallest leaf, but rather the terminal bud of the longest woody stem.

For planted woody stems ***between 1.37 and 2.5 meters*** in height, height and ddh are measured, as described above, and in addition stem ***DBH*** (Diameter at Breast Height, measured in centimeters at a height of 1.37 m above the ground) is also recorded. We recommend use of either a Biltmore stick or a DBH tape (metric units).

For plants in ***excess of 2.5 meters*** in height, DBH is still measured, but ddh is no longer recorded. Height is also recorded and although still measured in cm, the required precision need only be to the nearest decimeter. For planted stems that reach ***4m in height***, the required precision drops to a half-meter.

Live stakes are treated somewhat differently from other planted material in that no ddh is recorded. As with other planted material, the height is measured from the base to the end of the longest stem, even if the longest stem is lying along the ground and must be lifted up for the height measurement. DBH is measured if the stem is tall enough (1.37 m).

Required Measurements				
Plant Height/Type	**ddh (mm)**	**Height (cm)**	**Height Precision**	**DBH (cm)**
<1.37 m tall	yes	yes	cm	no
1.37-2.5 m tall	yes	yes	cm	yes
2.5-4 m tall	no	yes	dm	yes
>4m tall	no	yes	0.5 m	yes
Live stake	no	yes	as above	if tall enough

Height, ddh, and DBH should all be measured by truncating to whole number units, ***not by rounding***. Thus, ddhs of 2.3 mm and 2.9 mm would both be reported as 2 mm. Truncation of measurements to the specified precision apply to all measurements including X and Y coordinates. This is analogous to the way one indicates one's age, saying "I am 20 years old" from the day one turns 20 until the day one turns 21, but never rounding up to the nearest year.

A ***vigor*** code is required for each whole plant. For this purpose use the scale 4=excellent, 3=good, 2=fair, 1=unlikely to survive one year, 0=dead, M=missing. A damage comment may be included for plants with a vigor of 4 or 3, and is required for any plants with a vigor less than 3. A recommended set of ***damage*** categories is provided, though additional categories may be added as needed. The recommended list of damage types includes Removal, Cut, Mowing, Beaver, Deer, Rodents, Insects, Game, Livestock, Other/Unknown Animal, Human Trampled, Site Too Wet, Site Too Dry, Flood, Drought, Storm, Hurricane, Diseased, Vine Strangulation, Unknown.

Vigor Code Definitions	
4, excellent	No more than minor tissue damage to leafy material exists and a generally normal amount of foliage is present.
3, good	Minor damage to both leaf material and bark tissue exists or moderately less than a normal amount of foliage is present.
2, fair	More than minor damage to leaf material and/or bark tissue exists.
1, unlikely to survive yr	Significant damage to leaf and/or bark tissue that is likely to lead to mortality or resprout.
0, dead	The entire plant appears to be dead.
M, missing	Neither the living plant nor any remains could be found.

3.3.1.1: Planted woody stems datasheet (for VBD)

Planted Woody Stem Data: CVS Levels 1 & 2

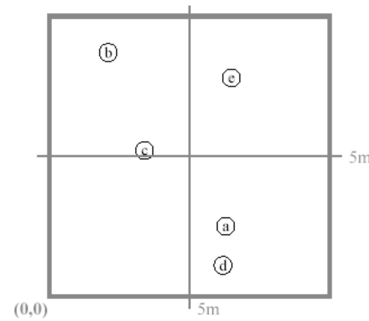
Leader: Smith Project: E615 Team: 1 Plot: 13 Date: JUN /13 /2006 Page 1 of 1

Species Name	Source	Coordinates X (m)	Coordinates Y (m)	ddh (mm)	Height (cm)	DBH (cm)	Vigor	Damage
Ulmus alata	C	6.3	2.5	1	23	---	3	---
Cornus amomum	LS	2.1	8.7	2	34	---	4	---
Salix nigra	LS	3.4	5.2	5	81	---	4	---
Salix nigra	LS	6.2	1.1	3	41	---	4	---
Lirio. tulip.	C	6.5	7.8	---	290	2	4	---

This datasheet is used to record new stems planted on a plot, as described above.

3.3.1.2: Monitoring planted woody stems datasheet (for VMD)

Plot:	E6-01-0013				Last Year's Data			THIS YEAR'S DATA						
ID	Species		X	Y	ddh	Height	DBH	ddh (mm)	Height (cm)	DBH (cm)	Vigor	Respr	Damage	Notes
1	Ulmus alata	ⓐ	6.3	2.5	1	23					0	☐	BEAV	
2	Cornus amomum	ⓑ	2.1	8.7	2	34					M	☐		
3	Salix nigra	ⓒ	3.4	5.2	5	81		2	62		4	☑	HURR	
4	Salix nigra	ⓓ	6.2	1.1	3	41		4	57		2	☐	DEER	
5	Liriodendron tulipifera	ⓔ	6.5	7.8		290	2		350	4	4	☐	---	Y=7.2



If the plot was previously sampled, each plant on the datasheet should be located in the field, using its species, X-Y coordinates, and approximate size. For these plants, measurements of size, vigor, and damage are needed, and errors in species and location (if error is >20 cm) should be noted. If the measurements of height and diameter have decreased because the plant has died back and ***resprouted*** from its base, you are now measuring the resprouted shoot instead of the original stem. In such a case, you should check the resprout box to explain the decrease in size.

This datasheet, generated from the database using the previous year's monitoring data, is used in collection of Vegetation Monitoring Data (VMD) in years after that of initial plot establishment. Corrections in location or species should be indicated in the notes field. Planted stems that may have been missed in previous years should be added. Circled letters are used in a map on the monitoring datasheet that shows the location of all the stems in the plot.

3.3.2: Natural woody stems (levels 2-3)

The intent of recording natural stems is to assess the overall recovery and compositional trajectory (successional trend) of the plot. A tally is made for the number of stems in each size class (height and DBH classes) for each species found. One stem can only be assigned to one cell on the datasheet. Stems that are quite small (and most likely ephemeral) are ignored because they are often too numerous to count and/or too small to locate; for this reason, no stems less than 10 cm in height are recorded. It is also possible to set larger minimum stem sizes to satisfy various project monitoring objectives; the ***height cut-off for stems*** can be set to 10 cm (default), 50 cm, 100 cm, or 137 cm. The reason for selecting a height cut-off other than 10cm must be recording on the datasheet in the "Explanation of cut-off and subsampling" field. Stems reaching the elected cut-off but shorter than 1.37 m are recorded in ***height classes***: 10-50 cm, 50-100 cm, and 100-137 cm. All stems at least 1.37 m in height (breast height) are assigned to DBH (Diameter at Breast Height) classes. The ***DBH classes*** (in cm) are: 0-1, 1-2.5, 2.5-5, 5-10, 10-15, 15-20, 20-25, 25-30, 30-35, and 35-40. Any stem equal to or greater than 40 cm DBH is recorded individually by diameter, truncated to the whole centimeter as described above.

A ***subsampling*** feature has been incorporated into the protocol to provide an alternative to counting numerous woody stems occurring at a consistent density throughout a given one are plot. If necessary, height and sapling size classes can be subsampled for individual species that are too abundant to be efficiently counted. Subsampling may be as low as 1% (1 m^2) for extremely abundant species, or greater for species that can be represented better with larger subsamples, such as 20 or 50%. The percentage subsamples for height and sampling classes should be recorded in the "Sub-Seed" and "Sub-Sapl" columns, respectively. Record or draw the subsampled portion of the plot on the plot diagram on the Plot Datasheet so that the subsample can be repeated. A common and readily repeatable method for subsampling is to record a strip along one of more sides of the plot. For example, two 1m strips along opposite sides of a 10×10 m plot provide a convenient method for taking a 20% subsample. If any subsampling other than 100% was used, ***the reason for and method of subsampling*** should be recorded in the "Explain subsampling" on the Natural Woody Stem Data Form.

Two cautions about subsampling. First, the actual number of stems counted should be recorded on the datasheets, ***never an extrapolated estimate*** of the total number of stems. Secondly, subsampling is only permissible for natural woody stems, ***not planted woody stems***.

An efficient and compact tallying method is shown below, though the particular order of each dot and line is not important. This tallying method is shown at the bottom of the Natural Woody Stem Datasheet for reference.

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

3.3.2.1: Natural woody stems datasheet

Natural Woody Stem Data: CVS Levels 2 & 3

Leader: Smith **Project:** E615 **Team:** 1 **Plot:** 13 **Date:** JUN /13 / 2006 **Ares** (=100m²): 1 Page 1 of 1

Height Cut-Off for Stems (all stems shorter than this height are ignored and not tallied): ☑ 10cm ☐ 50cm ☐ 100cm ☐ 137cm

Species Name	☑ c	Mod*	Seedlings — Height Classes: Sub-Seed	10 cm-50 cm	50 cm-100 cm	100 cm-137 cm	Saplings — DBH: Sub-Sapl	0-1 cm	1-2.5 cm	Trees — DBH: 2.5-	5-	10-	15-	20-	25-	30-	35-	≥40 (write dbh)
Carya cordiformis			__	3	0	1	__											
Quercus alba			__	1	0	0	__											
Ulmus americana			__	0	0	2	__											
Pinus echinata			__				__								1			
Toxicodendron radicans			__				__	2										
Acer rubrum			50	25	8		__											

Note that for simplicity of representation, the tallying method described above is not shown in this diagram. The "**c**" checkbox column should be checked if a specimen was **c**ollected for later identification. Mod (Module) is only filled out for Level 3 plots and higher.

4. Level 3-5 Vegetation Plots

[This section omitted for the Levels 1-2 version of this document. A separate version of this document discusses this topic.]

5. Additional Data

5.1: Taxonomic standard (required)

Taxonomy (the recognition and identification of particular classes of plants such as families, genera, species, subspecies, and varieties) is one of the most difficult aspects of collecting plot data. In addition to the difficulty associated with recognizing small and/or sterile specimens, we are confronted with the problem that not all authorities will agree about which name to apply to a particular plant species or how those species should be defined. This difficulty is increased when considering authorities or data that span many decades. To reduce the ambiguity associated with application of scientific names, we require that you report the taxonomic standard or authority you used to identify the species on your plot. This way we can tell the difference, for example, between *Carya ovata* (northern shagbark hickory) as used in Radford et al. (1968) and Weakley (2006), and *Carya ovata* (shagbark hickory, including southern shagbark hickory of Radford et al.) as used in the *Flora of North America* (Stone 1997).

In our region, there are several manuals and floras often used to identify species, the most commonly used and authoritative for the region-specific are Radford et al. (1968) and Weakley (various dates, e.g. 01-Jan-2006). The project director may specify which taxonomic standard you should use. In the absence of other instruction, we strongly recommend that you follow Weakley (01-Jan-2006, or subsequent versions). Note that ***you must***

include dates with your taxonomic reference, as different versions at different dates will indicate slightly different criteria for identifying plants. For Weakley ***indicate the exact date*** of your version, as multiple versions exist for each year (the current version of Weakley may be downloaded freely from http://herbarium.unc.edu/flora.htm). If some species you have encountered are absent from the authority you follow (as for example, some exotic cultivated species that are not treated in Weakley), or if you disagree with your authority for a particular taxon, please provide a separate note indicating the exceptions to your primary taxonomic authority.

5.2: Document location (required)

Locations should be reported as precisely as possible with either latitude and longitude or UTM coordinates. Some projects may allow use of other coordinate systems, such as state plane, as determined by the project director. The ***type of coordinate system*** should be recorded, as well as the ***units*** used (e.g., degrees, degrees and minutes, meters, feet). With UTM coordinates, care should be taken to report the UTM zone. In either case, the ***datum*** should be reported. We recommend that coordinates be reported in decimal degrees of latitude and longitude using the NAD83 or WGS84 datum.

GPS (Global Positioning Systems) devices are very helpful for accurately mapping plot locations, especially in remote areas. The many details about GPS units cannot all be covered here, but it is important to be familiar with your particular GPS unit and to know how to ensure that the accuracy settings are reliable for a reading. Ideally, the location of the plot origin would be where the GPS receiver collects its data points, but it may be better to move slightly to find an opening in the canopy, or get a better satellite reading. In any case, record on the plot datasheet where the GPS unit was located using X and Y coordinates relative to the plot origin. GPS records or surveyed locations converted to geocoordinates are required for Levels 1 and 2 inventory.

For Levels 3-5, if a GPS device is not available, the plot may be mapped based on ***topographic maps***. Because many plots are located far from any permanent references (e.g., roads, buildings) that can be viewed on a map, it is often somewhat difficult to precisely determine where a plot is on a map. The team leader (or someone gifted in reading and remembering terrain) should attempt to mark the plot location on an accurate map as soon as possible after the plot is sampled. Accuracy for such a method may be between 50 and 500 m, depending on the context.

Because not all geocoordinates are calculated with the same precision, ***location accuracy estimates*** are required. GPS units can give estimates for their accuracy (sometimes to be taken with a grain of salt), and some idea of uncertainty can lead to an accuracy assessment if mapping a plot manually. Inexpensive, hand-held GPS units often deliver accuracy on the order of 10 m or better.

Location Accuracy
The plot origin has a 95% or greater probability of being within this many meters of the reported location. (VegBank 2006)

Location information can be are somewhat sensitive. If there are rare species that may be prone to illegal harvesting (e.g., orchids, ginseng), the plot location may be flagged for ***data confidentiality*** and its location "fuzzed" in public releases of the data to mask its precise whereabouts. This is available for Levels 4-5. If you feel confidentiality is needed, or a land owner requests such confidentiality, it should be indicated on the datasheets. Consult your project director if you are uncertain whether a location should be confidential.

For EEP plots, Levels 1-3, the ***reach*** should be recorded for each plot to reflect the new EEP emphasis on stratification of monitoring plots by reach. Each unique reach label and extent must be consistent with those established in the final version the EEP Mitigation Plan (Table 1). Copies of the final Mitigation Plan for each project are typically included as part of the monitoring contract scope package and are also available upon request from EEP. Ideally, each plot occurs in a single reach, but in the event a plot spans ***multiple reaches***, the plot should be assigned to the reach in which the larger portion of the plot occurs. If the plot is evenly divided into two reaches, the upstream reach should be recorded. Reach may be ignored for non-EEP applications.

5.4: Photographs

For Level 1 and 2 plots, one photograph is required for each plot, generally taken from the plot origin toward the diagonally opposite corner. It is desirable to take photographs before tape measures have been removed from the plot as these serve to clarify the portion of the photograph relative to the plot. Any identification of photos, such as whose camera, which image, or what film roll and frame, should be marked on the plot datasheet. Now that digital cameras are common and media generally large, you may want to simply take a photo of the plot cover sheet before taking photos of the plot (like beginning a scene in a movie) as this should help identifying which photos belong with which plot. Please note the location and bearing of photos (with numbers) on the plot datasheet. For Levels 3-5, photographs are strongly encouraged, but not required.

6. Equipment

This equipment list is designed to be exhaustive for Level 5 plots. Some of this equipment (marked with *) may not be necessary for lower level plots.

6.1: Required field gear

(**+** = only for Levels 1-2, ***** = only for Levels 3-5)

- field pack (with a large open compartment)
- taxonomic manual or flora
- measuring tapes: one 50-m tape, two 30-m tapes (only one of the 30-m tapes for Levels 1 and 2)
- chaining pins (steel arrows), usually 8
- * pin flags
- flagging tape
- stakes for permanent plot marking (electrical conduit only). Allow 6 for Levels 1 and 2, and up to 10 for Levels 3-5.
- mallet or hammer
- diameter tape (metric units)
- Biltmore stick (metric units)
- * meter sticks: 2
- clipboards: two, at least one aluminum with storage compartments (one for Levels 1 and 2)
- datasheets
- sampling instructions
- maps
- pencils and extra lead
- * trowel or other digging tool for soil samples
- * soil auger
- * soil depth probe
- * soil collection bags
- plant collection bags
- permanent marking pen (for soil and plant bags)
- compass
- clinometer (sometimes on compass)
- GPS or survey equipment
- + caliper for ddh (preferably plastic)
- digital camera

6.2: Personal gear

- hand lens
- water
- lunch
- duct tape (has many uses, but gets used mainly for tick/chigger protection)
- additional/alternate flora
- emergency items: small first aid kit, small flashlight, matches
- comfort items: t.p., insect repellent, sunscreen, hat, long-sleeved shirt, rain gear

7. Safety

Safety for the people sampling plots is a high priority. A broad range of hazards could cause harm to participants, but these are best mitigated with good preparation and precaution. The particular hazards vary depending on location, but large and/or common possible hazards include motor vehicle collisions en route, arthropods (e.g., ticks, bees, wasps, ants, chiggers), exposure to heat and sun, wildlife encounters (e.g., bears, snakes), contact with poison ivy, steep terrain, storms, lightning, open water, flying golf balls, whistle pig burrows, and other outdoor hazards. Appropriate clothing should be worn, generally including long pants, layers when in cold weather that may get warmer, and a good hat to protect from the sun. Insect repellent and sun screen may be desirable. The equipment should be treated with care, as some items are sharp and digging and pulling can strain your back. You should always ***bring ample water*** into the field with you.

8. Definitions and Abbreviations

8.1: Field definitions

An online version of definitions may be found at http://cvs.bio.unc.edu/ref/ which may be helpful if downloaded to a mobile device for reference in the field.

8.1.7: Soil drainage (optional)

Follows the 1997 US FGDC Soil Geographic Data Standard. Definitions follow Grossman et al 1998. Identifies the natural drainage conditions of the soil and refers to the frequency and duration of wet periods. The soil drainage classes are defined in terms of (1) actual moisture content (in excess of field moisture capacity) and (2) the extent of the period during which excess water is present in the plant-root zone. This could affect hydrology, but shouldn't be confused with it.

- EXCESSIVELY DRAINED: Soils are free from any evidence of gleying throughout the profile. These soils are commonly very coarse textured (e.g., >35% volume of particles > 2 mm in size) or soils on very steep slopes. Sometimes described as "very rapidly drained."
- SOMEWHAT EXCESSIVELY DRAINED: The soil moisture content seldom exceeds field capacity in any horizon except immediately after water addition. Soils are free from any evidence of gleying throughout the profile. Rapidly drained soils are commonly coarse textured or soils on steep slopes. Sometimes described as "rapidly drained."
- WELL DRAINED: The soil moisture content does not normally exceed field capacity in any horizon (except possibly the C) for a significant part of the year. Soils are usually free from mottling in the upper 3 feet (1 m), but may be mottled below this depth. B horizons, if present, are reddish, brownish, or yellowish.
- MODERATELY WELL DRAINED: The soil moisture in excess of field capacity remains for a small but significant period of the year. Soils are commonly mottled (chroma < 2) in the lower B and C horizons or below a depth of 2 feet (0.6 m). The Ae horizon, if present, may be faintly mottled in fine-textured soils and in medium-textured soils that have a slowly permeable layer below the solum. In grassland soils the B and C horizons may be only faintly mottled and the A horizon may be relatively thick and dark.
- SOMEWHAT POORLY DRAINED: The soil moisture in excess of field capacity remains in subsurface horizons for moderately long periods during the year. Soils are commonly mottled in the B and C horizons; the Ae horizon, if present, may be mottled. The matrix generally has a lower chroma than in the well-drained soil on similar parent material. Sometimes described as "imperfectly drained."
- POORLY DRAINED: The soil moisture in excess of field capacity remains in all horizons for a large part of the year. The soils are usually very strongly gleyed (low chroma colors, such as gray, bluish, or gray-green). Except in high-chroma parent materials the B, if present, and upper C horizons usually have matrix colors of low chroma. Faint mottling may occur throughout.
- VERY POORLY DRAINED: Free water remains at or within 12 inches of the surface most of the year. The soils are usually very strongly gleyed. Subsurface horizons usually are of low chroma and yellowish to bluish hues. Mottling may be present but at depth in the profile. Very poorly drained soils usually have a mucky or peaty surface horizon.
- IMPERMEABLE SURFACE: Soils do not permit water absorption (e.g., hard-packed clay, concrete).

8.2: Definition of terms

Vegetation Baseline Data (VBD): vegetation data collected on a new plot with new plants installed. Must be collected according to the *CVS-EEP Monitoring Protocol* and submitted according to the "NC EEP Mitigation Plan Draft Outline." Sometimes referred to as "Vegetation As-Built."

Vegetation Monitoring Data (VMD): vegetation data collected on a plot that was previously sampled and planted. Often, a year is indicated with this term (such as Y1-VMD for year 1) to indicate the number of years elapsed after collection of the baseline data. VMD must be collected according to the *CVS-EEP Monitoring Protocol* and submitted according to the "NC EEP Mitigation Plan Draft Outline."

8.3: Acronyms

CVS: Carolina Vegetation Survey. This organization plans and conducts research events to sample the natural vegetation of the Carolinas. It also hosts and manages data for their group, as well as similar data for the area. See http://cvs.bio.unc.edu

CWD: Coarse Woody Debris. Standing dead trees (snags), fallen trees, and rotting roots, generally at least 5 cm in diameter. See also FWD.

DBH: Diameter at Breast Height. The diameter of a tree (usually measured in centimeters) at "breast height," which is 1.37 m above the ground.

ddh: diameter at decimeter height. The diameter of a woody stem (usually measured in millimeters) at 10 centimeters above where it emerges from the ground. This is usually measured on small trees that are less than 2.5 m tall.

EEP: Ecosystem Enhancement Program. A North Carolina Program which works to "restore, enhance, preserve and protect the functions associated with wetlands, streams and riparian areas... throughout North Carolina." http://www.nceep.net
ESA: Ecological Society of America. This organization provides guidelines for documenting vegetation that this manual follows for inventory Levels 3-5 http://www.esa.org, http://www.esa.org/vegweb
FGDC: Federal Geographic Data Committee is "an interagency committee that promotes the coordinated development, use, sharing, and dissemination of geospatial data on a national basis." FGDC standards for vegetation sampling provide the basis for inventory Levels 3-5, and in large part derive the ESA guidelines. Some of our soils values derive from FGDC standards. http://www.fgdc.gov
FWD: Fine Woody Debris. Includes dead woody material on the ground that is smaller than Coarse Woody Debris, generally less than 5 cm in diameter. See also CWD.
GPS: Global Positioning System. A system of satellites orbiting the earth and transmitting radio signals that can be interpreted by a receiver on the ground to calculate its geocoordinates (latitude and longitude).
LFI: LandForm Index. One of the two types of measurements for the McNab indices (McNab 1993). A set of eight readings which measure the angle from a point to the horizon. See also TSI.
NVC: National Vegetation Classification of the U.S. The most commonly used vegetation classification in the U.S. Maintained on behalf of the federal government (FGDC Vegetation Subcommittee) by NatureServe (http://natureserve.org).
NWS: Natural Woody Stems. Used to identify the datasheets where stems are tallied according to height and/or DBH classes. See also PWS.
PWS: Planted Woody Stems. Used to identify the datasheet where planted stems are measured individually. See also NWS.
TSI: Terrain Shape Index. One of the two types of measurements for the McNab indices (McNab 1989). A set of eight readings that measure the local shape of the land (for about a 10 m radius from the observer). See also LFI.
VBD: Vegetation Baseline Data. The first sampling of a plot which includes newly planted vegetation. Part of the EEP protocol in restoring vegetation. See also VMD.
VMD: Vegetation Monitoring Data. Sampling of plots that have been previously planted and sampled. Used to determine the success of a restoration effort over a period of years. May be preceded by "Y1" or "Y2" to indicate the year of monitoring after baseline data were collected. Part of the EEP protocol in restoring vegetation. See also VBD.
Y1-VMD, Y#-VMD: see VMD.

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