Denver Botanic Gardens:

Vegetation Monitoring Protocol

for measuring and collecting ecological data

by

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Introduction

This protocol outlines the basic methods for measuring understory percent cover, soil moisture, tree canopy cover, and plant species richness, as well as for collecting plant specimens to be vouchered in the herbarium. These measurements estimate the abundance and presence of plant species in an area, and link them to environmental conditions (soil water and light availability) that may affect their distributions. Together, these data can reveal patterns in plant community or ecosystem processes.

The understory percent cover measurements will be made using the line-point intercept method. In this method, a 25m transect is placed along the ground with a 25m by 1m belt transect to either side of it. Percent cover is measured along the transect, along with soil moisture and tree canopy cover. Plant richness is measured in the belt transect and the plant vouchering is done outside of the transect and belt transect area.

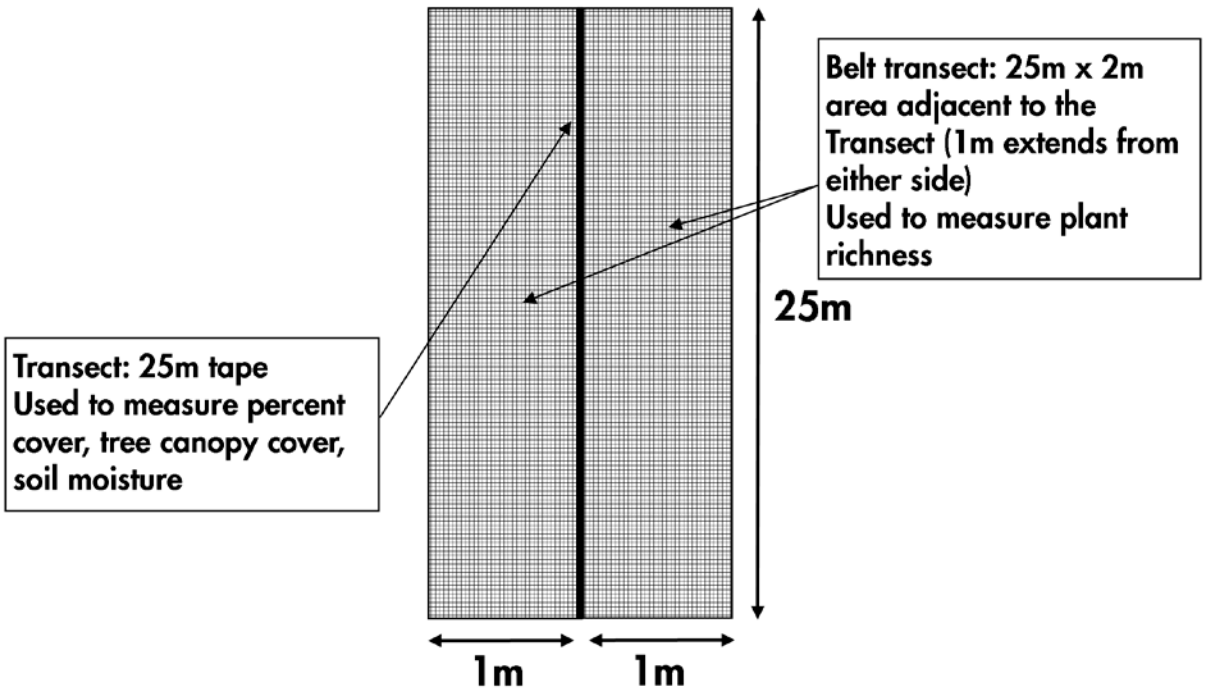

Figure 1. Line-point intercept schematic.

Ecological Sampling Materials

- 25m measuring tape
- Meter sticks
- Pins
- Flags
- Pin flags
- Clipboard
- Pen/pencils
- Soil moisture meter
- Densiometer

Plant Vouchering Materials

- Tool to unearth plants (small shovel, trowel, hori hori)
- Sheets of newspaper
- GPS
- Permanent marker
- Notebook
- Field Press
- Wooden plant press
- Cardboard sheets
- Herbarium blotters or several sheets of newspaper or more cardboard

Describing the Survey Location

Before collecting ecological data, we need to record information describing the survey location in a standardized way. Describe the location with the following physical location descriptors:

- Country
- 1st political division (state)
- 2nd political division (county)
- Nearest population center, town, or village
- Directions and distance to the collection site from that town
- Any physical landmarks or landscape features that would help locate the site
- GPS coordinates, datum, and if possible, uncertainty

Measuring Percent Cover

Understory percent cover is the amount of understory canopy composed of different plant species as well as how much ground surface is covered by vegetation and non-living things such as rocks or dead plants.

Standard Methods

1. Pull out the 25m tape in between two rebar posts.
    a. The line should be taut.
    b. The line should be as close to the ground as possible.
2. Begin at the “0” end of the line, move at 0.25m intervals.
3. Move to the first point on the line. Always stand on the same side (right) of the line.
4. Drop a pin flag to the ground from a standard height of 1m next to the tape.
    a. The pin should be vertical.
    b. The pin should be dropped from the same height every time.
    c. Do not guide the pin to the ground, let it fall freely.
5. Once the pin flag is on the ground, record every species it intercepts.
    a. The first species it hits (the highest one/farthest from the ground) is the “Top canopy”. Record the 6 letter species code of the specimen.
    b. If no leaf, stem, or plant base is intercepted, record “NONE” in the “Top canopy” column.
    c. Record all additional species intercepted by the pin in the “Lower Canopy Layers” column. Record them in order from closest to the top canopy to farthest (highest to lowest).
    d. Record each species only once, even if it is intercepted multiple times.
    e. Canopy can be alive or dead, but only record each species once.
6. Record the surface the pin flag rests on
    a. Litter = L, Herbaceous litter is detached dead stems and leaves that are part of a layer that comes in contact with the ground.
    b. Bare soil = BS, soil that is visibly unprotected by litter, rock, standing dead vegetation, or water.
    c. Rock = R, The pin flag rests on a rock (>5mm or 1/4 inch diameter).
    d. Water = W, Standing water, where the pin is sitting in the water. This could be temporary (i.e., a puddle) or permanent (i.e., the transect crosses a stream).

Figure 2. A transect laid along the ground in Chatfield Farms.

Point 1: Point 2:

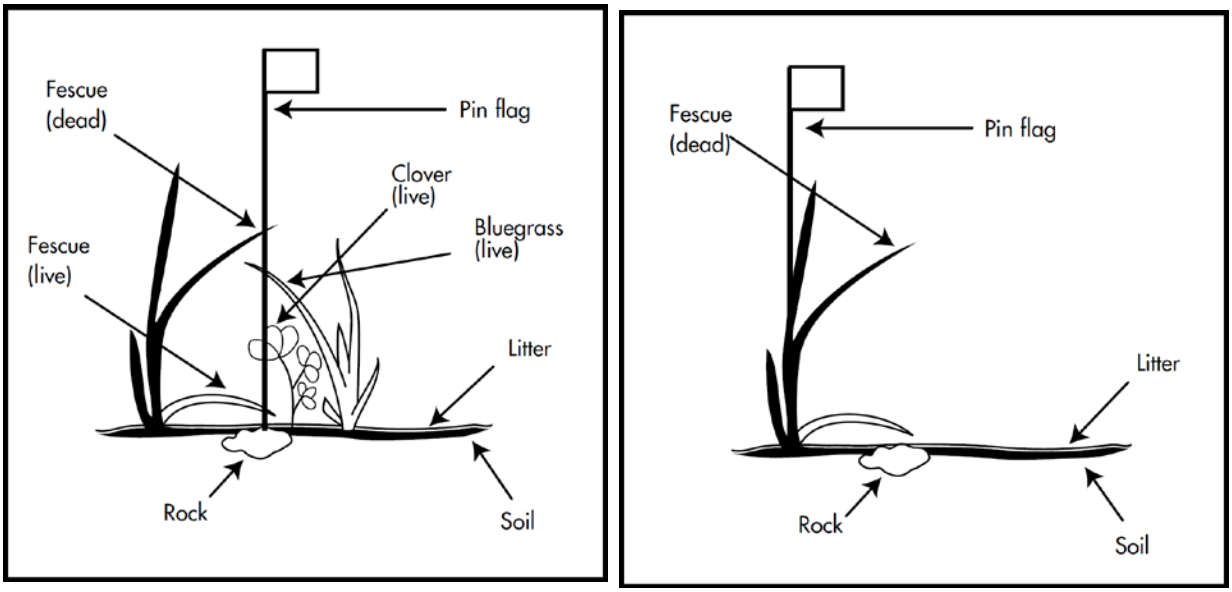

Figure 3. Two visual examples of a flag on a point along the transect.

	Study Site Name	Chatfield Farms				
	Project	Deer Creek Riparian Restoration				
	Transect ID:	4, Tag #1,#98				
	Transect Length (m)/# points:	25 m/100 pts				
	Date:	20180720				
	Start time/ End time	0800/1015				
	Observers:	Margo Paces, Meghan McGill				
	Photo:	004-008				
	Orientation (degrees):	65				
	Meter Mark:	Distance to stream (m)	Bank Height (m)			
	0	3	1			
	12.5	2	0.5			
	25	1.5	0.75			
Transect Point	**Top Canopy**	**Lower Canopy Layers**	**Soil Surface**	**Soil Moisture (%)**	**Canopy Cover (# covered dots/96)**	**Canopy Cover Species**
0	FESTU	PONE18, TRIFO, L	R	35	79	POAN3, ACNE2, PODE3
0.25	FESTU	L	FESTU			
0.5						
0.75						

Measuring Soil Moisture

Percent volumetric soil moisture is one measure of the water content in soil. Soil moisture is a critical resource for plants. It shapes their distributions on the landscape along with light and nutrient availability. As such, we include it as a critical ecological correlate to be measured along our vegetation cover transects.

Standard Methods

1. Beginning at the 0” end of the transect, measure the soil moisture on the right side of the tape at 1m intervals.
2. At each point, insert the soil moisture meter at the right side of the transect 8 inches (20 cm) deep into the soil.
3. Record the percent volumetric soil moisture that appears on the screen.

Specific Instructions for Extech MO750 (8”/20 cm probe)

1. Remove plastic probe tip cover
2. Press “power” button to turn on the meter
3. Insert the probe into the soil until the entire metal probe is in the soil and the plastic part is just above the soil
4. Read the % moisture on the display
5. Once sampling is completed at a location, wipe down the probe and cover with plastic cover until next use.

Notes:

1. If the probe cannot be inserted completely, note how far it was able to be inserted on the data sheet.
2. If the soil moisture content is very high, it may take several minutes to obtain a stable reading.

Measuring Tree Canopy Cover

Percent tree canopy cover is the percentage of tree cover located above the understory vegetation being measured along the line-point intercept transect. Calculating percent tree canopy cover is a way to indirectly measure the amount of light available to understory vegetation. Here, we will use a spherical densiometer to obtain a number that represents the proportion of area not covered by tree canopy to that covered by tree canopy. That number will be used later to calculate percent tree canopy cover.

Standard Methods

1. Beginning at the 0” end of the transect, measure the tree canopy cover every 0.5m.
2. At each point, open the spherical densitometer.
3. Hold the densiometer out so that the bubble in the corner is in the center of its circle.
    a. This means the densiometer is level with the ground.

4. Hold the densiometer about 12-18 inches away from you and low enough so you can see all 24 squares.
5. Imagine 4 dots at each corner of each of the 24 squares. Count the number of dots that are “open” (not covered by tree canopy).
    a. In a dense area, there will be fewer dots that are uncovered, so it is easiest to count the open dots.
    b. In an open area with few trees, you may count the dots that are covered to save time and simply subtract the number of covered dots from 96.
        i. 96 – covered dots = open dots
6. Record the number of open dots.
7. Additionally, record the 6-letter species code of every tree that appears in the densiometer window.

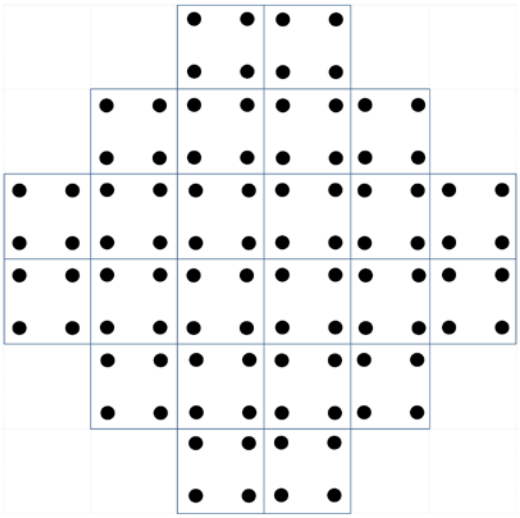

Figure 5. A diagram of the spherical densiometer, with 4 dots that the user must imagine on every one of the 24 squares.

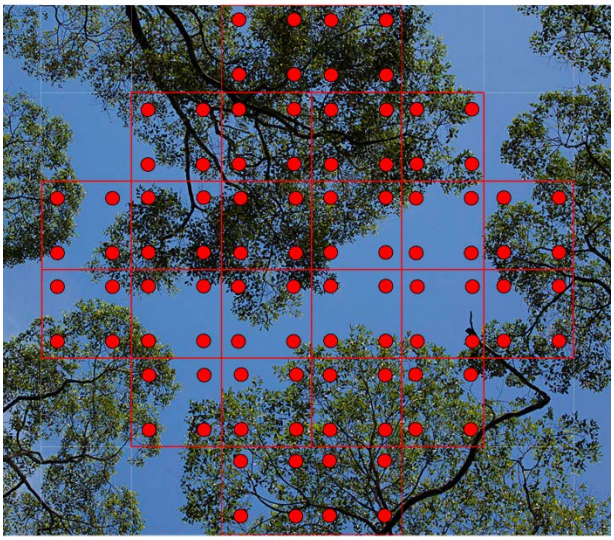

Figure 4. How the densiometer may look in the field. The dense canopy means there will be fewer open dots than covered dots, so it will be easiest to count the open dots. 17 dots are open, so the number 17 would be recorded.

Measuring Plant Species Richness

Plant species richness is the presence of plant species within the belt transect in addition to identified species on the transect.

Standard Methods

1. After measuring for percent cover, search the belt transect area for any species that were not recorded while measuring percent cover.
2. Record the 6-letter species code for additional species identified.

Collecting Plant Specimens: Making Vouchers

Making vouchers has not historically been prioritized in ecological field work. Having a curated physical specimen is highly preferred as it allows verification of species identification and updating of nomenclature over time. To increase the accuracy, repeatability, and transparency of ecological data, Denver Botanic Gardens will include voucher collection within the standard ecological protocol. Vouchers should be made when time and resources allow.

Standard Methods

1. Before collecting an individual, ensure that this will not have negative consequences.
    a. Is the population very small? A rule of thumb is that you should not collect if there are less than 20 individuals in the survey area.
    b. If it is on the federal Threatened and Endangered Species List, do not collect it.

2. In the field notebook, assign the plant a collection number. Next to this collection number, record:
    a. Location (lat/long)
    b. Slope, aspect, elevation
    c. Plant community type and dominant co-occurring species
    d. Other points of interest about the plant's immediate surroundings (e.g., growing on a prairie dog mound)
    e. Make note of plant characteristics that may be lost after pressing/drying the specimen including plant height, habit, and fruit/flower color
3. Choose a specimen that has a number of flowers or fruits, or ideally, both. For grasses, sedges, and rushes, roots and rhizomes are essential.
4. For herbaceous plants, dig deep enough to remove underground parts.

Figure 6. Recording the location of a specimen using a GPS.

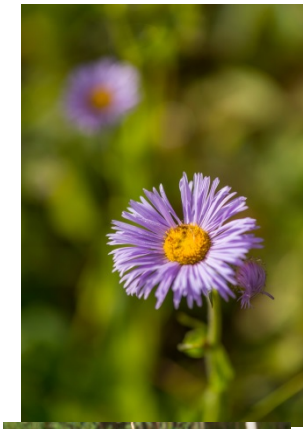

Figure 8. The bright yellow petals on this specimen may be lost after pressing, and should be recorded in the field.

   a. For shrubs and trees, clip specimens that capture branching morphology, buds, bark characteristic, etc., that are necessary for identification
5. Remove dirt and debris from the specimen.
   a. If there is a nearby water source, use it to remove any excess dirt.
6. Place the specimen in a sheet of newspaper in the field press. Write the collection number on the newspaper.
7. Position the specimen so that the diagnostic features of the plant are visible.
   a. Think about how to best convert its three-dimensional characteristics into only two dimensions.
   b. All specimens must fit on a standard sheet of herbarium paper(11½ x 16½).
   c. Flip leaves, flowers, and other important features to display the front and backside.
8. Sandwich the newspaper that contains the specimen between two pieces of cardboard and close within the field press.
9. The next specimen will be placed on top of the previous one within the field press.

Figure 9 (left). Digging up a plant specimen.

Figure 10(left). Newspaper labeled with the specimen's collection number.

Figure 11. A specimen being arranged on newspaper.

10. Once finished collecting in the field, transfer the specimens, still in newspapers, to the wooden plant press.
    a. Because of movement and shifting during the collection process, you may need to readjust the plants within the newspaper sleeves.
    b. Place one specimen at a time, still in its original newspaper sleeve, between two blotters or several pieces of newspaper to help absorb moisture.
    c. Continue to stack specimens in layers like a sandwich.
    d. Periodically insert cardboard to help stabilize the press and to facilitate airflow.
    e. Cardboard should also be used to sandwich woody or bulkier specimens.
11. Cinch the press as tightly as possible using ropes or straps.
12. Place the pressed plants in a hot, dry, place or use an herbarium oven if one is available.
13. After 24 hours, remove the blotters and replace cardboard with dry ones to prevent mold.
    a. Depending on the level of moisture in the specimens, you may have to replace cardboard every couple of days until the plants are dry.
    b. Loosely bundle damp blotters and cardboard in a hot, dry place (or herbarium oven) to dry before returning them to their storage area.

14. Check plants periodically to ensure they are not molding or that they are otherwise not damaged.

Figure 12. Materials for wooden press. Source: University of Florida Herbarium