Note: These protocols were developed for the Lehigh Gap Wildlife Refuge – a restoration project being conducted at the largest Superfund site east of the Mississippi. You can learn more about the project @ http://lgnc.org/conservation. A number of undergraduate students and faculty members from Moravian College (Bethlehem, PA) have conducted research at the site. The protocols can easily be adapted for a variety of research and monitoring purposes.

Total Cover Analysis (% Vegetative Cover)

Diane Husic, Moravian College, Dan Kunkle, Lehigh Gap Nature Center; Jennifer Lansing, Arcadis BBL

In restoration projects, percent vegetative cover is often determined by environmental consulting firms using infrared imagery or an apparatus involving a 10 meter board with 20 holes, a pair of tripods, and laser pointers. For the later, randomly selected sites within test plots or a study area are chosen to do the analysis and the board is set up on the tripods. A laser pointer was turned on and inserted into each hole in the board such that the laser beam pointed toward the ground. For each of the 20 lasers, observations are made of what the beam hits first and this is recorded on a data sheet.

A simple, low cost version of this type of analysis can easily be done. Ideally, you work in teams of 4 to perform the total cover analysis. Randomly select a point to start do your first trial in your "test plot", then the other two points will be at the points of an equilateral triangle that is approximately 10 meters on a side. Starting at the first point, two team members stretch the rope that simulates the board and lasers, so that the knots simulate the spots where the laser beams would have first touched something. A third team member should "read" the data of the knots to the fourth team member, the recorder. (If there are 3 members of a group, then the data "reader" must also record the results.) The reader must tell the recorder the number of the knot and whatever it touches first on the way to the ground. For instance, in an area being restored as a grassland, the choices might be: standing grass (dead or alive), plant litter (dead grass, dead leaves, dead plants,), compost, dead wood, rock <2" or soil (bare ground or pebbles/stones up to 2 inches long), and rock >2" (including boulders). In a more established area, instead of just grass, the vegetation might include forbs, shrubs, or small trees, or a succession plot analysis (see below) might be more appropriate.

As the "reader" reads the information (point 1 - standing grass; point 2 – rock >2", etc.) the recorder checks the appropriate box on the data sheet. The group then moves to the next point and records a second set of checkmarks on the next section of the data sheet. Repeat this at the third point. You should have 3 sets of 20 check marks when finished.

After completing the measurements, count the number of checkmarks under each column for each group of 20. Then add up the 60 checkmarks and place those numbers on the data sheet. Finally, do the calculations to determine the % cover of

each of the 6 types of cover, and of the combinations listed. Record the results. Sample data sheets are included in the appendix below.

Succession monitoring

Diane Husic, Moravian College, Dan Kunkle, Lehigh Gap Nature Center; Jennifer Lansing, Arcadis BBL

In order to monitor successional changes in an area (often an area undergoing restoration, revegetation, or some other management where succession is to be monitored), permanent monitoring transects are established. Three pairs of 200 meter transect lines are installed using metal posts at 50-meter intervals. Each transect includes a beginning post, an ending post, and three monitoring posts at 50, 100 and 150 meters respectively. The GPS coordinates of the posts are recorded.

Tree plot monitoring. All trees (defined as tree species one meter or more in height) within a 30-meter diameter circle centered on the monitoring post are identified to species and recorded. Using a 15-meter rope affixed to the monitoring point stake, the monitoring team walks along the radius represented by the rope, recording the trees as they walk a full 360 circle around the plot. Three monitors is an optimal number for walking the radius line. A beginning point is established and a marker placed on the ground to avoid going beyond 360° and double counting trees. Monitors walk along the radius line carrying a meter stick or one of the one-meter tubes from the frame used in the herbaceous plot monitoring. Trees are recorded on the data sheet by a recorder using slash marks and totaled later.

Shrub plots monitoring. All shrubs (defined as multi-stemmed woody plants *and* trees less than 1 meter in height) within two randomly selected 10-meter diameter shrub plots are recorded. The shrub plots are selected by tossing a beanbag over the shoulder of a person standing at the monitoring post. Using the point where the beanbag lands as the pivot point, monitors use a 5-meter rope as a radius and walk 360 degrees recording every "shrub" encountered. As in the tree plot, a beginning point is to be established to avoid double counting. Monitors must carry a meter stick or one-meter tube to measure tree heights to decide whether the trees are included in the shrub count. All shrubs (multiple-stemmed, woody plants such as spiraea and elder) are to be counted regardless of height. Herbaceous plants sometimes have wood-like stems, but those stems are not persistent from year to year. Shrub stems do not die back and re-grow each year. Goldenrod is not considered a shrub, for example. As with trees, shrubs can be recorded with tally marks on the data sheet and totaled later. Whenever possible, identify the shrub species or at least genus.

Herbaceous plot monitoring and % cover. Five randomly selected herbaceous plots are monitored, with the plots selected by tossing a beanbag over the shoulder while standing at the monitoring plot point. The one-meter square frame is then placed on the ground with the beanbag at its center. From a vantage point looking straight down at the plot center, an estimate should be recorded for the amount of ground

covered by live vascular plants vs. ground cover such as bare soil, rock, gravel, or un-decomposed wood. For the purposes of this study, the pioneering layer of moss and lichen that sometimes covers the ground before vascular plants become established is considered ground cover, even though it is living plant material. It is helpful to superimpose a grid over the square meter frame, or at least to imagine such a grid. Monitors should each arrive at estimates independently, and then average the estimates for the recorded percentage. Since these are estimates, precision to less than 5% intervals in not possible, so round off any averages to the nearest 5%.

After the % vascular plants and "non-living" ground cover are recorded, then each must be broken down into its component parts. For non-living, take the percentage recorded and divide it among the various components. If 30% of the ground was "non-living," you have 30 points to assign. There may be one large rock covering 20% of the test plot, so you would record 20% for solid rock. The remaining 10% can be divided up between the rest of the items. Here, you may use a value of 1 or 2% to denote a very small amount of coverage. Make sure the numbers in the ground cover category add up to the % you estimated for ground cover (in this example, 30)

Now the vascular plant cover should be recorded as well. Note that plants may be growing up next to a large rock or in bare soil and spread out over the non-living material. In this case, record whatever would be seen from a vantage point of 50 cm above the ground. If you see vegetative cover from that height, record it as vegetation. If you see the rock, record the rock. As with the ground cover, distribute the percentage points for vascular plants among the categories on the chart. Again, generally stick with 5% intervals unless there is a very small amount of a particular category and then adjust accordingly. *In addition, identify the grass species and record the dominant grass species in the plot.*

Repeat the three kinds of monitoring at the remaining monitoring points in the transect. Repeat for all transects.

Sample data sheets can be found in Appendix H-1 of the Lehigh Gap Wildlife Refuge Ecological Assessment II at http://lgnc.org/resources/reports/lgwr-assessment-ii.

Note: This protocol could be adapted for determining the extent of invasive species in transects.

Appendix: Data Sheets for Total Cover Analysis

Test Plot #	Grass (standing)	Plant litter	Compost	Wood	Rock <2" or soil	Rock >2"
Point 1						
Point 2						
Point 3						
Point 4						
Point 5						
Point 6						
Point 7						
Point 8						
Point 9						
Point 10						
Point 11						
Point 12						
Point 13						
Point 14						
Point 15						
Point 16						
Point 17						
Point 18						
Point 19						
Point 20						
Total checks						

Test Plot #	Grass (standing)	Plant litter	Compost	Wood	Rock <2" or soil	Rock >2"
Point 1						
Point 2						
Point 3						
Point 4						
Point 5						
Point 6						
Point 7						
Point 8						
Point 9						
Point 10						
Point 11						
Point 12						
Point 13						
Point 14						
Point 15						
Point 16						
Point 17						
Point 18						
Point 19						
Point 20						

Total checks

Test Plot #	Grass (standing)	Plant litter	Compost	Wood	Rock <2" or soil	Rock >2"
Point 1						
Point 2						
Point 3						
Point 4						
Point 5						
Point 6						
Point 7						
Point 8						
Point 9						
Point 10						
Point 11						
Point 12						
Point 13						
Point 14						
Point 15						
Point 16						
Point 17						
Point 18						
Point 19						
Point 20						
Total checks						
Total checks for 3 tests						

Calculations	**% Cover**
Formula: # of checkmarks on three trials/60 X 100 = % cover	
Test plot#	
Total cover standing grass	
Total cover plant litter	
Total cover compost	
Total cover wood	
Total cover soil/rocks <2"	
Total cover rocks > 2"	
Total cover standing grass and rock > 2"	
Total cover standing grass, rock>2", and wood	
Total cover standing grass, grass litter, rock > 2", and wood	