

An Evaluation of Methods for Long-term Monitoring of Vegetation
on National Historic Sites in the Mid-Atlantic Region

Final Report
for
PX4000-8-0743

For Consideration by:

United States Department of the Interior
National Park Service
Mid-Atlantic Region
143 South Third Street
Philadelphia, Pennsylvania 19106

Submitted By:

Dr. Marc D. Abrams
Assistant Professor
School of Forest Resources
4 Ferguson Building
The Pennsylvania State University
University Park, Pennsylvania 16802
(814) 865-4901

October 3, 1988

For this consulting contract with the Mid-Atlantic Region of the National Park Service I was to complete the following activities:

- A. Critically review the manual developed by Dr. E. W. B. Russell dealing with permanent plots for monitoring vegetation.
- B. Meet with Dr. Russell and Dr. Jeffrey Marion, NPS Research Biologist, to discuss a region-wide system for monitoring vegetation, with special emphasis on the type of information and methods for a "core" data set to be collected at each park.
- C. Make suggestions for revising the vegetation monitoring system at the Friendship Hill site, where a cooperative agreement exists with the National Park Service.

This final report includes a review of the permanent plot manual, an overview of discussions with Drs. Marion and Russell, which took place on 9 September, 1988 at the Delaware Water Gap, and my recommendation for the specific changes to be made in the sampling regime at Friendship Hill.

- A. Review of "Permanent plots for monitoring vegetation" manual by Dr. E. W. B. Russell:

I want to first state that Dr. Russell has put together a very complete and accurate manual that I believe can be of great use to Park Service sites in the Mid-Atlantic region. Many of my comments reflect a slight difference of opinion rather than a statement of error in the manual. More specifically:

- 1. Whenever possible, five plots should be the minimum used to describe a given vegetation type, rather than 3-5 as suggested in the manual. Even at a five plot minimum statistical comparisons will be difficult due to low replication. However, many of the historic sites have a high diversity of vegetation types, each of

which may occupy only a small area. In those areas I believe that it is more important to get some information concerning vegetation from too few plots than from none at all.

3. We should consider the point-quarter method for surveying forest vegetation. Data collection simply involves identifying a single point for a plot center from which the closest tree in each of four quadrants is measured for diameter at breast height and distance to point center. From these data relative density, dominance and frequency and the importance value for each species can be calculated, as well as the vegetation continuum index for the stand. I believe this technique for trees is a bit simpler than a fixed-plot method. Moreover, the plot center for the point-quarter technique can be the same used for the fixed area plots to measure shrub and herbaceous vegetation.
4. I would not recommend locating plots in a totally subjective manner. Total subjective plot placement in a study would destroy much of the statistical credibility. On the other hand, I understand the problems inherent in random plot placement in many areas. I propose a compromise that involves using systematically located plots along transects oriented through representative areas within each vegetation type. Plots that fall on unnaturally disturbed areas will be relocated to the nearest suitable area. This method is less time consuming, it allows for easy mapping and relocation of the plots, and it is statistically valid.
5. I feel that some effort should be made to estimate herb cover in each vegetation type because presence-absence measures may

indicate little about important population changes in space or time. The cover classes listed on page 35 of the manual can be used, and with a little practice it will not significantly increase the effort used for the presence-absence survey.

6. I do not feel that a new sampling technique (the line-intercept method) needs to be introduced for sampling shrubs. Why not simply record shrub cover in the subplots used for seedling counts? Again, this will save time and energy.
 7. If a site manager feels that a very accurate recording of herb cover is important then it probably will be necessary to survey herbs at three times during the growing season: in spring, mid-summer and late summer or early fall. This way plants that develop early (e.g., spring ephemerals) or late in the season will be included. We are using this time-table at Friendship Hill.
 8. I would include measuring aspect (direction of slope) at each plot and the depth of the A + B horizon (not simply the A horizon) in one representative location in each vegetation type. With a little extra effort here you will obtain some important information about moisture relations of the site.
 9. Unless a site manager is interested in site index/productivity estimates, I do not believe that height measurement of the trees are needed due to the increased time involved.
- A. Overview of discussions with Drs. Jeff Marion and Emily Russell concerning my review of the manual:
1. We are in agreement that when possible, five plots should be the minimum used in each vegetation type. If fewer plots are used in

a vegetation type, statistical comparisons with other areas will be difficult due to low replication. Nonetheless, if an important, but small area of vegetation exists on a site, fewer plots can be used with the understanding of the statistical limitations.

2. It was decided that the point-quarter method not be incorporated for sampling overstory trees because it is a plotless measure. I am now convinced of the long-term advantages of Dr. Russell's original recommendation of using fixed area plots, in which all "in" trees would be counted and measured. With this technique specific year-to-year changes in tree populations and population variances can be calculated. Plotless measures, although they are time-saving, are not as robust in yielding exact quantitative changes.
3. Because the point-quarter method is not being incorporated, we also agreed to stay with Dr. Russell's original sampling scheme for understory vegetation; thus concentric circular plots will not be used. By marking all four corners of square permanent plots there will be a decreased likelihood of losing plot markers compared to marking circular plots with only a center stake. These advantages seem to outweigh the slight advantage of reducing the number of "in-out" decisions possible with circular plots compared to square or rectangular plots.
4. We are in agreement that plots within a vegetation type should not be located in a totally subjective manner. As stated above this would decrease the statistical credibility. In most cases, we agreed that plot location should be systematic along transects

oriented through a representative portion of a given vegetation type. Dr. Russell argued correctly that in rugged terrain with varying aspect the above approach would not work well and that plots should be randomly located within a grid system established in preselected, reasonably homogeneous areas. Either of these two options for level or rugged terrain would be statistically valid.

5. We also agreed that herb cover should be measured in 1 m² subplots, in addition to herb species presence-absence (i.e., frequency). The cover classes listed on page 35 of the manual have been revised to include a class 6 for species cover greater than 95%. Class 5 cover now ranges from 75-95% (see below). This will increase the resolution of super-dominant species.
6. We agreed that the line-intercept method originally proposed by Dr. Russell not be used to sample shrub cover. Shrub cover can be more simply estimated in the 1 m² subplots used for seedling counts and herb cover.
7. Herb cover should be measured during the spring, mid-summer and early fall if herbaceous species are dominant and of particular interest to the site (i.e., not just at one time during the growing season).
8. Measurements of aspect and A + B horizon depth should be made in each vegetation type as an indicator of site moisture relations.
9. We do not recommend routine measurements of tree height due to the increased effort involved. Most site managers will not be making management decisions based on site index/productivity.

C. Suggestions for revising the vegetation monitoring system at Friendship Hill.

The following recommendations for Friendship Hill are made with consideration to the fact that a great deal of effort has already been expended to implement the existing system and that the site has a relatively high diversity of habitats and vegetation types, some of which occupy only a small area. Thus, the five plot minimum that Dr. Russell and I recommended in vegetation types occupying a larger area will not always be possible at Friendship Hill. Examples of this at the site include: the overgrown pine/spruce plantation, disturbed (strip-mining) lands, moist seeps, sugar maple stand and upland swamps. Moreover, many of the vegetation types are disjunct, creating other constraints on plot placement.

When the vegetation monitoring system was initiated in 1983 on Friendship Hill, circular plots were located either systematically along transects or randomly in each vegetation type (as suggested in the revised manual). All tree vegetation in plots were counted by species and measured for diameter at breast height. My main concern exists with the measurement of ground-layer vegetation, including woody species (trees and shrubs) less than 4 feet in height and herb species. In the 1983-84 survey these species were simply listed when occurring in a plot. Thus, the existing system only accounts for presence-absence in the ground layer vegetation and does not quantify species number or cover. Therefore, I recommend that two 50 ft² circular subplots be randomly located in each of the 1/5 acre main subplots. The 50 ft² plot should be used to count tree seedlings (<4 feet tall) by species and to estimate shrub and herb canopy cover by species with the following cover classes:

- r Solitary, with small cover
- + Few, with small cover
- 1 Numerous, but less than 5% cover
- 2 5-25% cover
- 3 25-50% cover
- 4 50-75% cover
- 5 75-95% cover
- 6 >95% cover

By quantifying seedling number and shrub and herb cover, specific changes in species temporal and spatial dominance can be discerned.

In summary, if cover measurements are initiated at Friendship Hill, the same types of information outlined in Dr. Russell's manual will be collected. Even though some differences exist in the manner by which data is obtained (English vs. metric units, and 1/5 acre vs. 400 m² size plots at Friendship Hill vs. recommendations by the manual), valid comparisons of the derived ecological parameters can still be made with other sites. I do not believe that these differences in the methods used at Friendship Hill warrants significant changes at the site.