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Summary of: "A Quantitative Description of a Deciduous Forest Canopy Using a Photographic Technique"

Definitions

Leaf Area Index (LAI) - one sided leaf area per unit ground area
point quadrats - passing vertical lines through vegetation to determine surface area and relative frequency of foliage
aspect - compass direction that a slope faces
watershed - land where all of the water that is under it or drains off of it goes into the same place
atmospheric deposition - process whereby precipitation, particles, aerosols and gases move from the atmosphere to the earth's surface
Beer-Lambert Law - relates attenuation of light to the properties of the material through which the light is traveling
forest stand - a contiguous community of trees distinguishable from an adjacent community
understory / overstory - area below the canopy / the canopy itself
elevational gradient - trends in biodiversity occur at different elevations.

The authors' goals in writing this paper are to determine a quantitative description of the forest canopy to assist in the study of atmospheric deposition. This description includes measurements of Leaf Area Index (LAI), distribution of leaf area and canopy presence. There are multiple methods available for determining each of these measurements, but the authors ultimate choice would be restricted by the following conditions: 1) research had to be non-destructive, 2) use of minimal labor and equipment, and 3) achieve highest possible accuracy.

The research took place at the Shaver Hollow Watershed through the years of 1986, 1987, 1988 and 1989. 237 circular 0.08 ha vegetation plots were randomly selected throughout the watershed. Three meteorological towers were placed throughout the watershed at different elevations(1014m, 716m, 524m), and the nearest vegetation plots to each of the towers were chosen as representative of the forest stand at those elevations. LAI, vertical distribution of LAI and canopy presence were determined at each of these three plots. Four locations within each plot were randomly chosen for measurements in 1987, and six new locations, in addition to the original four, were used for measurements in 1988.

Distribution of Leaf Area was measured using the MacArthur and Horn technique during the 1988 growing season only (see page 384). The data gathered using this technique were plugged into the equation $X = \ln(\%h1/\%h2)$, where %h1 and %h2 are the proportion of imaginary vertical lines that extend above heights h1 and h2. This equation yields an X value which is representative of the leaves in the vertical layer between height h1 and h2 that fall within the camera's field of view. Vertical distribution of leaf area was determined by converting X for each canopy level to a proportion of the total number of leaves in the canopy.

Canopy presence is a quantitative term referring to what percent of the deciduous forest canopy is present at any given point in time. Photographs of the canopy were obtained from the three sample plots during the spring and summer of 1987 and 1988 (see page 384). A baseline photograph, taken under leafless conditions, was used as comparison to subsequent photographs, according to the equation: $\%CP = ((P_x-P_{min})/(P_{max}-P_{min}))*100$. P_x is the number of dark pixels in a given image, P_{min} is the number of dark pixels in baseline image and P_{max} is the number of dark pixels in a fully leafed image. 0% CP signifies a leafless canopy, while 100% CP signifies a fully leafed canopy.

LAI was determined during 1987 and 1988 for 5 different techniques that all fit the limiting conditions. Monk's equation calculates LAI using tree diameter: $\log Y=0.4702+1.8280*\log x$, where Y is the leaf surface area in m^2 and x is the tree diameter in cm at breast height (dbh). Aber's equation is based on the Beer-Lambert Law and is as follows: $LAI=\ln(N_{f1}/N_{f2})$. N_{f1} and N_{f2} are the number of imaginary vertical lines not intersected by leaves above heights f1 and f2. A modified version of Campbell's equation is used: $P_2/P_1 = e^{-LAI}$, where P_2 is the intensity of light entering a layer of the canopy, P_1 is the intensity of light exiting that layer. Instead of using irradiance values as input, the equation is modified to apply to the entire canopy as a single layer using photographs of leafless and fully leafed canopy as input. Litter traps were set up as described on page 386. Since the literature supported the accuracy of the described litter trap technique, it was used as the standard against which the other techniques were compared. Finally, the authors developed their own technique and called it the McIntyre technique. It is governed by the following equations: $P_2/P_1 = e^{(c*LAI)}$ and $c=1-e^{(0.18x-3.99)}$, where P_2 is the dark pixel count of fully developed canopy, P_1 is dark pixel count of leafless canopy, c is the extinction coefficient and x is the canopy height.

In regard to vertical distribution of leaf area, the authors found that site 1 consisted of 25% of the distribution in the 0-3m understory and 40% at 9-12m. Site 2 consisted of 70% distribution between 12-21m, with little in the understory. Site 3 consisted of 60% distribution in the 12-21m layer. They explain that these values are expected due to the species of trees found at each site.

Canopy presence measurements are given on page 387, and sources of error are listed. Four improvements were made during the 1988 season: 1) picture were taken under uniformly blue or overcast sky conditions to improve the contrast to the stems and leaves, 2) photographs were taken during morning and afternoon hours to avoid overexposure from direct sunlight, 3) 10 photograph locations were used, as opposed to 4 in 1987, and 4) a more sophisticated software (ERDAS) was used for image processing. These improvements served to decrease error and provide a clearer picture of canopy presence over the growing season.

To conclude, the authors discuss LAI in regard to the five techniques used. Table 2 lists LAI values determined for each technique. Notably, Monk is least suitable, as it's LAI value is much higher than the standard litter trap value, and its confidence intervals are the largest. Aber requires more data to calculate confidence intervals. Confidence intervals were smaller for 1988, as explained by the improved data gathering techniques. McIntyre is the most suitable, as its values most closely match the litter trap data. This is expected since McIntyre uses the litter trap data in its calculations.

The authors did a good job of keeping their discussion of information succinct. Unfortunately, there was so much information that seemed relevant to a good summary that I had trouble deciding what to discuss. Also, this paper is about the extent of my knowledge in this area, so I can't really say if their findings are acceptable.