

Diversity and Distribution of Trees in the Ottawa River Floodplain.

Introduction

Riverine floodplain forests are among the most dynamic ecosystems on earth. They are generally characterized by seasonal floods that promote the exchange of nutrients and organisms among different habitats in the floodplain. Such periodic flooding and drying, as well as sediment deposition and erosion, may contribute to high spatial and temporal diversity in these floodplains. The periodic change from terrestrial to aquatic conditions also causes physiologic stress for floodplain plants and animals. The amplitude, duration, and timing of inundation are particularly important stress factors that determine which species can successfully establish themselves in this land-water transition zone. The floodplain of the Ottawa River in northwest Ohio is commonly inundated during the spring when river discharge is high (Figure 1; Nelson 1998). Flooding is less likely during other seasons. We will discuss other relevant field conditions on-site.

Objectives

The goal of this field exercise is to determine the species composition of the tree community in two areas in the Ottawa River floodplain. Because these two areas are at different elevations (Figure 2; Nelson 1998), they are subject to differences in the duration and amplitude of seasonal inundation. Other environmental factors (for instance soil texture) may also differ between these two areas. We will record all trees species (> 10 cm dbh) in two designated field plots and calculate indices of diversity and similarity. A second objective is to evaluate the spatial distribution of two particular tree species in these plots. We will test whether this distribution is random, contagious, or regular (Figure 3).

Methods

Species diversity: Record all trees (> 10 cm dbh) by species in a designated 30 x 30 meter plot by systematically counting trees in 10 x 30 meter strips. In the southern plot, at a somewhat higher elevation and with a more dense tree cover, a single 10 x 30 meter strip will suffice.

Spatial distribution: In the northern plot, we will determine the pattern of distribution of the dominant tree species (*Acer saccharinum* or silver maple) in a 30 x 30 meter plot. You will do this by counting the number of *A. saccharinum* trees in each of nine 10 by 10 subplots. The null hypothesis is that the silver maples are randomly distributed among these subplots. This hypothesis seems reasonable in the absence of any prior knowledge about the pattern of distribution. We will do the same for *Aesculus glabra* (Ohio buckeye) in the southern plot.

Field measurements of environmental conditions: We will record several field conditions in both the lower elevation (north) and the higher elevation (south) plots. For example, we will take a soil core and evaluate soil texture by hand at 30 and 60 cm depth and determine soil pH. We will estimate canopy cover using a spherical crown densitometer. Using on-site wells, we will also determine the depth to the groundwater. And finally, we will compare soil color between the north and south plot. The color of soils may be compared with standard soil color charts (e.g. Munsell).

These charts categorize soils in relation to standard spectral colors, soil lightness (darker with a lower value), and soil chroma (color strength or purity). Chromas of 2 or less generally indicate wetland soils.

Calculations

Perform all your calculations in a spreadsheet. This is particularly useful for the χ^2 ("Chi-square")-test calculations.

Index of diversity in each of the two plots

Species richness may be measured by simply recording the number of species in a community. If species are weighted, however, by some measure of their importance (such as their abundance, productivity, or size) we speak of species diversity. The most frequently used index of diversity is the Shannon index

$$H' = - \sum p_i \ln (p_i)$$

Where p_i = the fractional abundance of the i^{th} species (n_i/N)

Index of similarity between the two plots

$$S = \frac{2C}{A+B}$$

Where A = number of species in the north plot

B = number of species in the south plot

C = number of species common to both plots

Density of trees by species in each of the two plots

For each of the species encountered, calculate the density (per 100m²) as the ratio of the number of trees of that species and the area of the plot. Also calculate the density of all trees combined for each plot.

Spatial distribution

We will use a χ^2 -test to detect whether the spatial distribution of silver maples and buckeyes is nonrandom (i.e. not due to chance alone) in two areas of this floodplain. The χ^2 -test is used to ascertain how well observed frequencies compare to expected frequencies. In our case, we observed the number of silver maples (or buckeyes) in each of nine subplots in the floodplain. The expected frequency in each subplot (if there was no site preference for the trees to grow) would be average number of trees of a species per subplot. In the case of the silver maples, this would be the total number of silver maples divided by the total number of subplots. The χ^2 -test statistic is then calculated as

$$\chi^2 = \sum_{x=1}^N \frac{(Obs_x - Exp)^2}{Exp}$$

where N = the total number of subplots
 Obs = the observed number of trees in each subplot
 Exp = the expected number of trees in each subplot

Since there are nine subplots, we have 9-1 degrees of freedom. We can then look up the calculated value of χ^2 in Figure 4. Values inside the region with the hatch marks indicate at least a 95% probability level ($p < 0.05$) that the distribution of the trees is due to chance. Values outside this range indicate that the trees show a significant preference for certain sites.

Report

Include the following in your report (in addition to a hardcopy of the spreadsheet you developed for all computations):

(1) For both the North and the South plots, report the calculated diversity indices, the density (# of trees/100m²) for each tree species, and the density for all trees combined. Also report the index of similarity between both plots. Compare the North and South plots and explain the difference in diversity and tree density. Why is the species composition between both sites so different? Pay particular attention to your field measurements of environmental conditions.

(2) For both the North and the South plots, indicate whether you accept or reject the null hypothesis regarding the spatial distribution of silver maples (North plot) and buckeyes (South plot). If your calculated χ^2 values indicate a non-random distribution, indicate whether the tree distribution is more contagious or more regular than random. Speculate which ecological factors may account for such a pattern?

Your report is due on November 10 at the start of lab.

References

- Nelson, K.M. 1998. *Environmental correlates of tree species distribution within a Northwest Ohio riparian floodplain forest*. M.S. thesis, University of Toledo, Ohio: 92 pp.
- Shannon, C.E. and W. Weaver. 1963. *The mathematical theory of communication*. University of Illinois Press, Urbana: 117 pp.