

Measuring Spatial Distribution

Much of the research in ecology is ultimately tied to the problems of species distributions and abundance. In some cases, only a single species is of interest. Many of the earlier investigators were content to quantify population parameters for their favorite species in a variety of habitats. Recent research is more often concerned with assemblages of species (e.g. description at the community level). This research attempts to determine the environmental factors (abiotic factors) and species interactions (biotic factors) that may explain the observed patterns

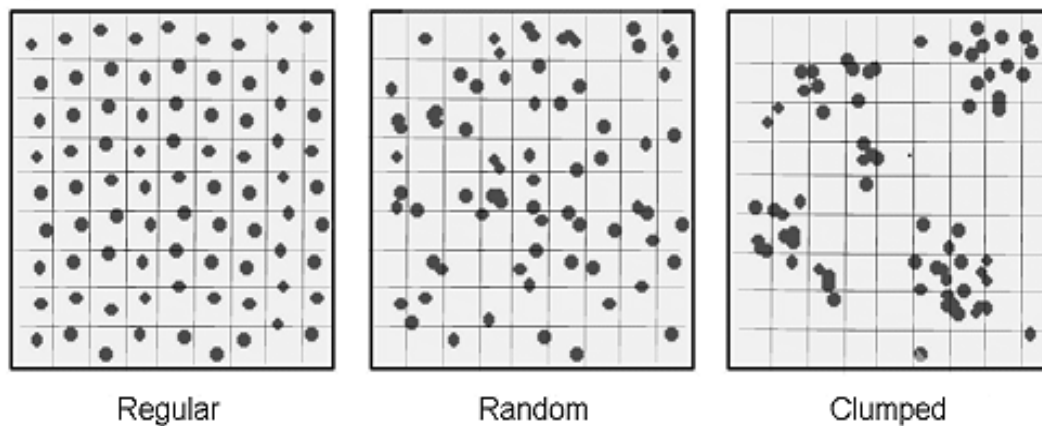


Figure 1

Dispersion patterns are described as regular, random, or clumped (Figure 1). Truly random distributions are uncommon in nature since organisms tend to interact with both their environment and nearby organisms (con- or heterospecific). Regular patterns are often seen in response to dispersed resources (such as telephone poles used as perching sites for birds) or through behavioral interactions (birds on a wire; or penguins in a rookery). Clumped distributions are most commonly seen (paper birch) and may be due to social behavior or habitat structure (for example, paper birch is found near water).

To calculate the dispersion pattern the study area is divided into quadrats. The number of individuals in each quadrat are then counted and the mean number of organisms per quadrat and the variance among quadrats is calculated. Variance (abbreviated " s^2 ") is a measure of the amount of divergence about the average (or mean; abbreviated " \bar{X} "). A sample with widely fluctuating differences in the number of plants in each quadrat will have a large variance while one with a homogeneous data set will have a low variance. If there is little variation from one quadrat to another (more or less the same number of organisms in each plot) then the organisms are said to have a "regular" or "dispersed" distribution and the variance to mean ratio ($s^2:\bar{X}$) will be less than 1.0. If many of the plots are

uninhabited, while other have a large number of organisms, the variance will be much greater than the mean and the organisms are said to exhibit a "clumped" or "contagious" distribution. Clumped distributions have a variance to mean ratio considerably greater than 1.0. Finally, if the variance is very close to the value of the mean, then the population is said to exhibit a random distribution ($s^2:\bar{X} \sim 1.0$).

More on the variance to mean ratio or Coefficient of Dispersion and other methods used to calculate the distribution of organisms:

- Nearest neighbor
- Density-Invariant Indices
- Geostatistical Methods
- Fractal patterns and HERE

Laboratory Procedure:

Download the satellite image here:

<http://cas.bellarmine.edu/tietjen/RootWeb/satimg.gif> and the Excel Spreadsheet from here: <http://cas.bellarmine.edu/tietjen/Laboratories/VAR2MEAN.xls>



Figure 2. Paper birch are the light-colored trees in the image.

Paper birch can be easily identified in the satellite image taken in the fall just outside of the Louisville city limits (Figure 2).



Figure 3. How to deal with trees on the line. (A) Trees that overlap a quadrat on the left or bottom are counted with that quadrat. (B) trees counted as part of quadrat B. (C) Trees counted as part of quadrat C

Some trees will naturally fall on the line for a quadrat. If trees overlap a line they are counted as being within that quadrat if they are on the left or bottom sides of the quadrat. Trees on the top or right portions are either not counted (if they're at the top or right of the image) or counted in another quadrat (Figure 3).

Load the satellite image into MS Paint (or your favorite paint program). Set the paint program to brush mode so you can mark the trees as you count them. For each quadrat (cleverly labeled with rows 1-7 and columns A-P) enter the counts in the corresponding cells of the spreadsheet (the yellow background area). Do not enter data in any other portion of the spreadsheet.

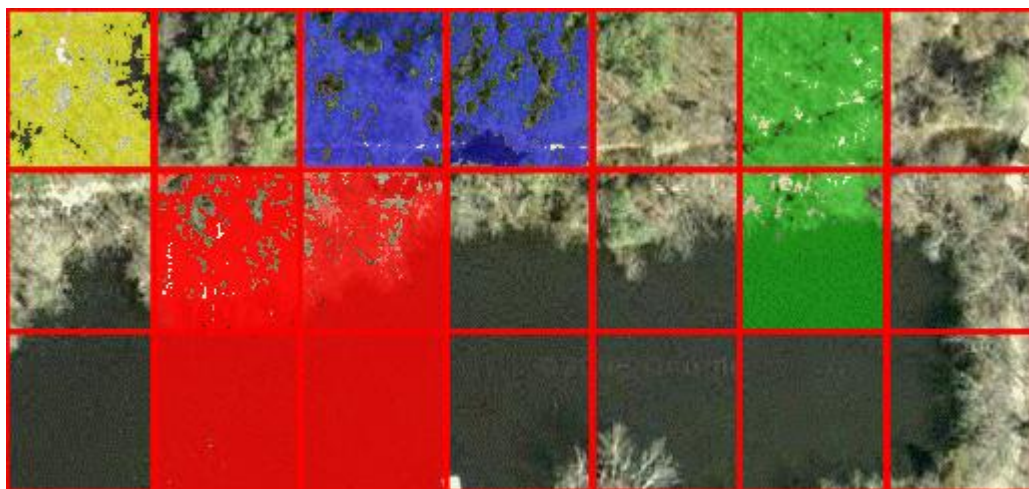


Figure 4. Excel Quadrat Calculator.

Excel will automatically calculate the variance to mean ratio for the original data (Figure 4, yellow), Horizontal pooled data for 2 quadrats (Figure 4, blue), vertical 2 quadrat pool (Figure 4, green) and pooled data for four quadrats (Figure 4 red). The original and pooled data are graphed. The variance to mean ratios for three methods are also graphed (horizontal pooled data for 2 quadrats are omitted). For pooled row data and the pooled data for four quadrates the top row was not used in the calculations (since that didn't have any paper birch and we have an uneven number of rows).

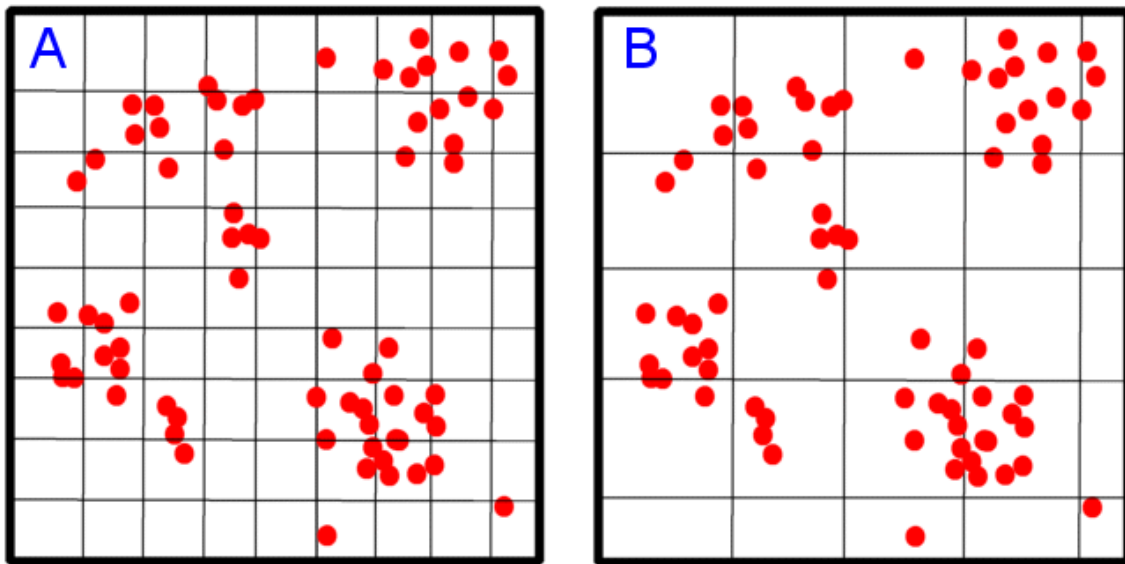


Figure 5

Figure 5 shows how pooling data can provide additional information concerning the structure of the clumps. In A it can be seen that there is clumping but in B you can also see that the clumps are themselves arranged in clumps.

What do the data suggest about the distribution of paper birch in the Louisville area? What factors might affect this distribution (list several)? Why does this lab activity suck so much?