

## BIOL 370L—Spatial distribution of *Ilex glabra* and *Lyonia lucida*

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The spatial pattern of a species can be very informative about its ecological requirements. In nature, individuals of a population may be distributed in their habitat in a random, a clumped (aggregated), or a regular (uniform) pattern. Spatial patterning is not always a simple thing to detect, and numerous methods have been devised to distinguish among these different general patterns. In this lab, we will use two different techniques to examine how individuals of inkberry (*Ilex glabra*) and fetterbush (*Lyonia lucida*) plants are distributed in space.

### I. Procedures

1. Mark out a 2 m X 2 m quadrat from some random starting point in the forest where natural populations of inkberry and fetterbush occur. Use flags to mark the corners of the quadrat.
2. Count the number of plants of each species in the quadrat, and record the data in the table below.
3. Repeat Step 1 for three new quadrats.
4. Return to the lab for data analyses. We'll pool all of our groups' data for the analyses below.

Quadrat #	Inkberry ( <i>Ilex glabra</i> )	Fetterbush ( <i>Lyonia lucida</i> )
1		
2		
3		
4		

### II. Random, clumped, or uniform?

A. One of the statistics most commonly used to make this decision is called **Morisita's Index of Dispersion**:

$$I_d = n \left( \frac{\sum X^2 - N}{N(N-1)} \right)$$

where  $n$  = total number of plots

$X$  = number of individuals of **one** species in a **single** plot

$\sum X^2$  = sum of all values of  $X^2$  (Hint: square each  $X$  separately, *then* sum)

$N$  = **total** number of individuals in **all** plots

Values of  $I_d = 1$  indicate a random dispersion

Values of  $I_d < 1$  indicate a uniform dispersion

Values of  $I_d > 1$  indicate a clumped dispersion

However, you still need to examine whether these index values are *significantly* different from 1.0 using a statistical test to reach the correct conclusion. Significant deviations from 1.0 (random) are assessed by calculating a value of **chi-square** ( $\chi^2$ ) in this fashion:

$$\chi^2 = ((n * \sum X^2)/N) - N$$

This value is then compared with a "critical value" (see table from instructor's handout), using the appropriate degrees of freedom  $v$  (which is  $n - 1$ ) and your pre-chosen level of  $\alpha$ . If your calculated  $\chi^2$  is greater than the critical value, then your value of Morisita's index is significantly different from 1.0, and the population likely has either a uniform or clumped distribution.

Complete Table #1 on the next page.

**Table 1.** Calculate Morisita's index ( $I_d$ ) for each species:

Parameter	Inkberry ( <i>Ilex glabra</i> )	Fetterbush ( <i>Lyonia lucida</i> )
Number of plots (n)		
Sum of the squares ( $\sum X^2$ )		
Total number of all individuals (N)		
Morisita's Index ( $I_d$ )		
Calculated $\chi^2$		
v		
$\alpha$		
Critical value of $\chi^2$		
<b>Random, clumped, or uniform?</b>		

**B.** An even simpler index of dispersion is the **Variance to mean ratio** (I). If the variance to mean ratio is approximately 1, then the species of interest is considered to be distributed randomly. This property (i.e., variance = mean) is ideally a feature of the Poisson distribution.

The variance to mean ratio can be calculated in the following way:

$$I = s^2 / \bar{x}$$

Where  $s^2$  = variance, which is calculated as:  $(\sum X^2 - \bar{x} * \sum X) / (n - 1)$ .

Note that  $\sum X$  is the same as N in the Morisita's Index calculation above.

And  $\bar{x}$  (the mean) is calculated as:  $N/n$ .

- Values of I close to 1.0 indicate a random dispersion
- Values of I < 1 indicate a uniform dispersion
- Values of I > 1 indicate a clumped dispersion

In order to determine whether I is significantly different than 1, we will use the following formula for the t-test:

$$t = \frac{|s^2 / \bar{x} - 1|}{\sqrt{2I(n-1)}}$$

This value is then compared with a "critical value" (see table from instructor's handout), using the appropriate degrees of freedom v (which is n - 1) and your pre-chosen level of  $\alpha$ . If  $|t_{\text{calc}}|$  is greater than  $t_{\text{crit}}$ , then I is significantly different than 1, meaning the distribution is likely to be either uniform or clumped.

Complete Table 2 on the next page.

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 Write your lab report using the usual format to address the spatial distribution of each species with respect to both indices. No graph is required for this report. Just be sure to express your essential results in other ways (i.e., as text in the Results or as data in a table plus Results text). In the discussion, be sure to explain **why** (ecologically) you found what you did.  
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**Table 2.** Calculate the variance to mean ratio (I) for each species:

<b>Parameter</b>	<b>Inkberry (<i>Ilex glabra</i>)</b>	<b>Fetterbush (<i>Lyonia lucida</i>)</b>
Number of plots (n)		
Variance ( $s^2$ )		
Mean number of individuals ( $\bar{x}$ )		
Variance to mean ratio (I)		
$t_{\text{calc}}$		
v		
$\alpha$		
$t_{\text{crit}}$		
<b>Random, clumped, or uniform?</b>		