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APHID POPULATION DENSITY / DISPERSION LAB (Field)

Although density is usually an important population characteristic in ecological studies, it is often difficult to accurately measure. There have been many techniques designed for estimating population density, each with their own particular strengths and weaknesses. In this lab, we will examine quadrat sampling. This is most appropriately used for low mobility animal and sessile animal/plant populations.

EXERCISE 1: Quadrat techniques

For low mobility animal and sessile animal/plant populations, our job of estimating density is made somewhat easier. Here, we could simply count up the number of organisms within our known study area and directly calculate the actual population density. In practice, however, it is usually impractical to count an entire population, so we usually do counts in a number of replicated small areas known as **quadrats** and use the average density in these quadrats as our **estimated** (but not necessarily "real") density.

In deciding how to sample our population, we must make a couple of choices. Specifically, we must decide:

1. the number of quadrats we will sample.
2. the size of the quadrats used (e.g. 0.1 m^2, 0.25 m^2, 0.5 m^2, etc.).
3. where we will put the quadrats.

Before proceeding, answer the following questions:

1. What would be the advantage of increasing the **number** of quadrats sampled? What would be the disadvantage or cost of increasing this number?

2. What would be the advantage of increasing the **size** of quadrats sampled? What would be the disadvantage or cost of increasing the size?

3. How should you arrange your quadrats? What would be the best method for determining where they should be placed?

Part 1

1. Lay out a 0.5 m x 0.5 m quadrat in the study area.
2. Within each 0.25 m^2 section, **designate each soybean plant as a quadrat** and count the number of aphids on each plant (in each quadrat). As you count the aphids in each quadrat, keep track of the time it takes. Record your data in Table 2.
3. Combine step 2 data into a 0.75 m x 0.75 m quadrat (= 0.5625 m^2) by using the grid below as a guide. (Distance between plants in one row is about 3 inches, so 3 plants will be about 10 inches = 0.25 m) Distance between rows will vary depending on planter type. See note.

1	4	7
2	5	8
3	6	9

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4. In Table 3, calculate the mean density per section, the variance (range) in density per quadrat (measure of how far a set of numbers is spread out), and the average time spent counting per quadrat for each quadrat size.

Mean number per .25 m^2 section = (mean number per 0.25 m^2) / 0.25, or
(mean number per 0.5625 m^2) / 0.5625
(= 0.5625 m^2) For variances (range), the square of the conversion factor is used:

Variance per .5625 m^2 section = (variance per 0.25 m^2) / $(0.25)^2$, or
(variance per 0.5625 m^2) / $(0.5625)^2$

TABLE 2: Student & Group Quadrat counts

GROUP DATA

Plant quadrats in 0.25 m^2 section	Total # of aphids per quadrat (plant)	Time spent per quadrat (plant)
Student 1		
Student 2		
Student 3		
Student 4		
Student 5		
Student 6		

CLASS

PLANT QUADRATS IN .5625 M^2 SECTION	TOTAL # OF APHIDS PER QUADRAT	TIME SPENT PER QUADRAT
GROUP 1		
GROUP 2		
GROUP 3		
GROUP 4		
GROUP 5		
GROUP 6		
GROUP 7		
GROUP 8		
GROUP 9		

NOTE: STUDENT QUADRAT NUMBERS WILL VARY ACCORDING TO PLANTER. A GRAIN DRILL WITH 8 INCH ROWS WILL HAVE 6 PLANTS PER .25M^2, WHEREAS A 15 INCH PLANTER WILL HAVE 3 PLANTS PER .25 M^2 QUADRAT.

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Table 3: Average quadrat densities and time expenditures

	.5 x .5m section (Group)	.75 x .75m section (Class)
Mean # / quadrat (plant)		
Variance (range) / quadrat		
Mean # / m^2		
Variance / m^2		
Average time spent counting quadrat		

Part 2

Wiegert proposed that one method for determining optimum quadrat size was to minimize the product:

(relative cost of counting quadrat) x (relative variability for quadrat size)

We can calculate **relative cost** for each quadrat size by:

Relative cost = (Ave. time to sample one quadrat) / (Minimum time for all sizes)

and **relative variance (range)** by:

Relative variance = (variance for quadrat size) / (minimum variance for all sizes)

Using these relationships, fill in the table below:

Section Quadrat size	Variance (Range) per .25 m^2	(1) Relative variance	Average time cost	(2) Relative time cost	Product of (1) x (2)
Group .25m^2					
Class .5625 m^2					

Questions:

1. Looking at the variances alone, which quadrat size had the highest variance? Which has the lowest? By this standard, which would be the best quadrat size to use in counting this population?
2. Using Wiegert's method, which would be the best quadrat size? What tradeoff do you make when using this method?
3. Besides the time actually spent counting the quadrats and monetary expenses, what other "costs" might be involved in ecological studies that these calculations don't take into account? How important would these be in designing a study?
4. What problems did you run into when using quadrats? Why might this method be a less than perfect way of estimating population density?

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Exercise 2: Dispersion patterns

In addition to giving us information on population density, quadrat studies can also tell us something about the way the population is spatially distributed. In an evenly distributed population, each quadrat should contain roughly the same number of individuals. So, the variability in the counts should be close to 0 and the ratio of variance/mean should be close to 0 as well. Conversely, some quadrats scattered through clumped populations should have a large number of individuals while others have very few. We can determine the spatial pattern of a population simply by knowing the mean number and variance found in counts of its density.

Variance/mean ratio	Dispersion Pattern
~ 0	Uniform
~ 1	Random
>>1	Clumped

Procedure:

Using your quadrat counts above determine how the aphid population is distributed at different scales:

Quadrat Size	Mean Density	Variance	Variance/mean	Distribution pattern
Group .25m^2				
Class .5625 m^2				

Questions:

1. Would you expect the dispersion pattern you see in a population to change with the section quadrat size? Why or why not? Give an example of how the dispersion pattern seen in a population might change with scale.
2. What dispersion pattern did you find for aphids? Why did you see this pattern? What does this mean for the soybean plant?
3. Do you think the pattern you observed for aphids is the "real" pattern? What other factors might be influencing the distribution of aphids? If you could measure the "real" pattern what do you think it would look like? Why might it look this way?