# Lab: Population Density of an Ecosystem

Background: Many populations of organisms interact in a biological community. An environment can successfully support a certain number of individuals of each population. The number of individuals in a population in a certain area is known as the population density. The largest population density that a certain environment can support is called its carrying capacity.

Biologists often attempt to measure the population densities of an area. Although fluctuations in population densities are normal, large changes can indicate a serious problem – one that could harm the whole community. Human interference in the natural balance of biological communities has often resulted in unexpected and undesirable consequences.
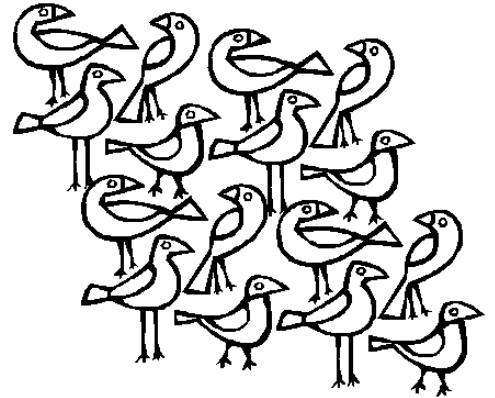
During this investigation you will practice measuring the population density of several different organisms. During the portion of the lab that will be completed outside, the population density of plants such as dandelion, plantain, and clover will be calculated using the quadrat sampling technique. Inside, population densities of deer and humans will be calculated.

Hypothesis: We think that… *(tell me if you think the population density of different forms of flora and fauna can be calculated.)*

Procedure:

Part 1 – Measuring Population Density

1. One way to measure the population density of an area is to divide the area up into smaller areas called quadrats. The number of organisms in each quadrat is counted. The numbers are added up and then divided by the combined area of the quadrats to calculate the population density.

2. Biologists first decide on the area to be studied. The size of the quadrats is then determined – they can be large or small, depending on the organisms to be studied. The population density of raccoons in a forest could not be measured in quadrats of 1 m^2. Much larger quadrats would be used in that situation.

3. Determine the population densities of three kinds of weeds in an area by studying a 1 m^2 quadrat and pooling your results with those of your classmates.

4. Go to the location assigned by your teacher. Set up a quadrat of 1 m^2. Measuring carefully, place four Popsicle sticks 1 m apart at the corners of the square. Refer to **Figure 1** to see what your quadrat should look like.

5. Then tie a piece of string around the perimeter of the quadrat.

6. Draw the quadrat to scale in the Quadrat Diagram space provided on your data collection worksheet. The box has 10-cm sides, so your drawing will be on a scale of 1:10. Include biotic and abiotic ecosystem factors that happen to fall within your sample plot.
Make sure to either create a key for symbols used or label everything drawn on your diagram!

7. Study the pictures on the next page of the three easily identified weeds that commonly grow in fields and lawns that we will study for the population density calculations.

Fig. 1
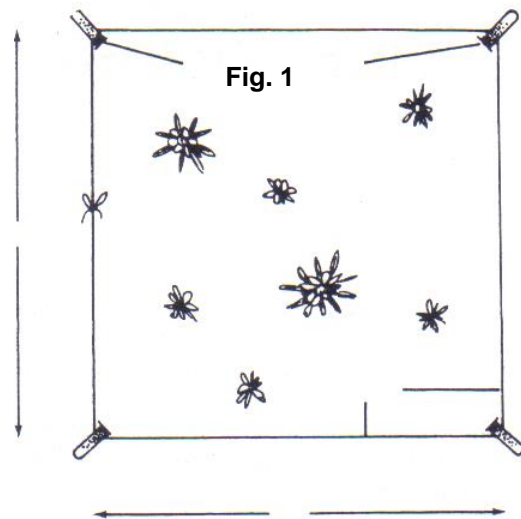
8. To count the plants in your quadrat accurately, you will have to divide the quadrat into smaller areas. Lay the meter stick along one side of the quadrat. Refer to **Figure 2** to see how things should be set up at this point.

9. Now lay a piece of string across the quadrat 10 cm from the edge. Count the number of dandelion, plantain, and clover plants in section 1 of the quadrat.

10. Record the number of each of the three types of plants found in section 1 in Table 1 on your data collection worksheet.

11. Repeat step 9 until you have counted and mapped the 10 sections of your quadrat. Use the meter stick and string to mark off the section you are counting.

12. Don't forget to record all data in the table on the next page!

13. Once you have all 10 sections counted and mapped, total the numbers of dandelion, plantain, and clover plants counted in your quadrat. **Record all totals in your lab report and on the class computer spreadsheet once you are back in the classroom.**
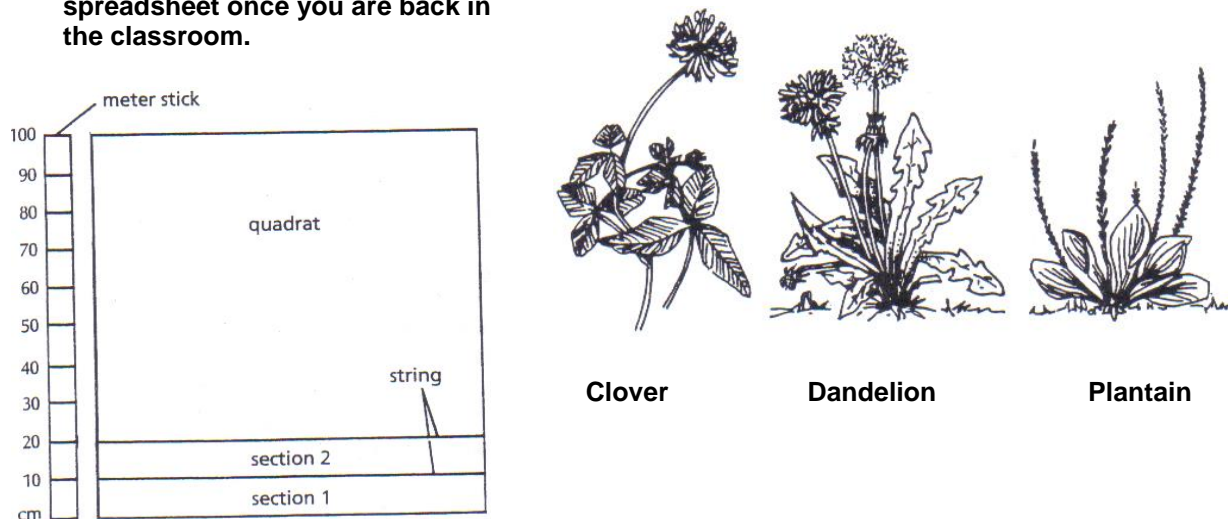

Fig. 2

14. **Copy the class data in Table 2 on your data collection worksheet.**

15. Add up the data reported in each column to get the class totals for each plant. Divide each total by the number of groups in the class to calculate the population densities of the three types of plants / m^2.

16. Record the population densities (plants / m^2) of dandelion, plantain, and clover.

Part 2 – Balance of Population Densities in a Community

17.   Read the following scenario regarding changes in a deer population in Arizona.

The sizes of populations in a community are regulated in many ways. The story of Kaibab deer shows how populations were balanced in one community and how humans upset this natural balance. In the early 1900s, the Kaibab plateau, north of the Grand Canyon in Arizona, supported a population of about 4,000 deer on over 700,000 acres. Predators such as coyotes, wolves, and pumas helped to keep the deer population in check. It was estimated at that time that the plateau had a carrying capacity of about 30,000 deer; there seemed to be plenty of food for the population that existed.

Ranchers who moved into the area lost many sheep and cattle to the predators. In an effort to save livestock and increase the deer population the predators were hunted. With the successful removal of many of the natural predators, the deer herd increased dramatically in size. In 1924 there were 100,000 deer, as shown on the graph. This number was far in excess of the carrying capacity of the Kaibab plateau. As a result, 40,000 deer died in 1925 from starvation and disease. The population continued to decrease over the years and in 1940 returned to near its original level.

18.   Examine the graph and determine the approximate population density in deer / 1,000 acres for each year listed.

Example for 1905: $\dfrac{4,000\ \text{deer}}{700,000\ \text{acres}}$ = $\dfrac{X\ \text{deer}}{1,000\ \text{acres}}$ **X = 5.7 deer / 1,000 acres**

1905

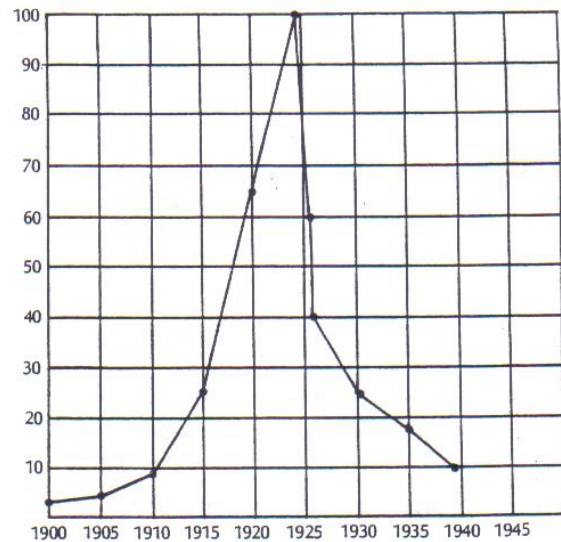**1915**   *Perform your calculations for the years listed to the left. Use the graph to figure out the Kaibab deer population for each year.*

1920

1925   ***Record your calculations on the back of your lab cover sheet or on a sheet of lined paper stapled to your lab report.***

1935

Kaibab deer population 1905–1940 (In thousands)

Part 3 – Calculating the Population Density Where We Live

19. The area of Pulaski, New York is 3.3 square miles. According to the most recent census there are 1,118 males and 1,280 females living there. **Calculate the total population density of Pulaski in people / square mile. Show work and circle your final answer.**

20. Now convert the calculation you just performed into data that can be understood by scientists around the world. You will have to convert the results from people / square mile to people / square km. **In order to do this you must multiply an area in reported in square miles by 2.59 to convert to square km; your final answer should be reported in people / square km.**

Analysis questions on next page!

Analysis:

A. What is a quadrat?

B. Why are quadrats used for estimating populations rather than just walking around and counting?

C. Why is the class average a better measure of population density than an individual quadrat?

D. Which plant had the highest population density?

E. Given the time of year at which this lab was completed, name an environmental factor that may have limited the growth of the plant with the lowest population density.

F. What other environmental factors affect the densities of the dandelion, plantain, and clover populations?

G. How would you measure the density of a mobile population, such as mice on a prairie or fish in a pond?

H. What caused the rapid decline in the Kaibab deer population?

I. How could the deer population crash have been avoided?

J. How do you think the population density of Pulaski would compare to that of a city such as Syracuse or Watertown?

New York State Population Density