Population Density and Dispersion

If you have ever traveled from a rural area to a city, you may have noticed a change in population density. Cities have more dense populations, while rural areas have more widely dispersed, or scattered, populations. Species populations are measured in a similar way. What can we learn from population data?

FIGURE 2: Cities have dense human populations.

Population Density

You may be familiar with the term *density* in the context of matter. It is the amount of matter in a given space. Population density is very similar: it is the number of individuals living in a defined space. When scientists such as wildlife biologists observe changes in population density over time, one of the things they study is whether the causes are due to environmental changes or natural variations in the life history of the species. The biologists use this information to decide whether it is necessary to make changes to maintain a healthy population.

One tool that biologists can use to make this decision is to calculate the ratio of individuals living in an area to the size of that area.

Population density is calculated using the following formula:

$$\frac{\text{number of individuals}}{\text{area (units}^2\text{)}} = \text{population density}$$

To calculate this ratio for the deer herd shown in Figure 3, a biologist would first determine the size of the herd's territory. Then the scientist would count all of the individuals in that population within the defined area.

Collaborate With a partner, discuss whether the area where you live has a dense or dispersed population. Explain your reasoning.

FIGURE 3: Deer gather in a field to graze.

Math Connection A scientist and her team counted 200 individual deer in an area of 10 square kilometers.

1. What is the population density?
2. Ten years later, scientists return to the same area and find that the population density has declined to 5 deer per square kilometer. What might a decrease in the density of a deer population tell scientists about the habitat in the area?

Population Dispersion

You may have noticed that people tend to separate themselves in different ways—some hang out in large groups, some gather in twos and threes, while others prefer to be alone. There are also patterns in the way different populations of other organisms separate themselves. Figure 4 shows three main patterns of population dispersal: clumped, uniform, and random.

Clumped dispersion occurs when resources are spread unevenly within an ecosystem. Individuals gather into groups where resources are available. Clumped dispersion helps protect individuals from predators and makes finding a mate easier. Uniform dispersion occurs when individuals of the same species must compete for limited resources and territory. Random dispersion is the least common pattern of distribution. It occurs when resources are evenly distributed within an ecosystem. In plants, this type of dispersion often occurs when seeds are scattered by wind or water, resulting in seeds being dropped randomly. The seeds will only sprout if conditions are right, which increases the randomness of the distribution.

FIGURE 4: Population Dispersion Patterns

a Clumped dispersion

b Uniform dispersion

c Random dispersion

Analyze Why might a population exhibit uniform dispersion? Think about why having a defined space might be beneficial.

Model Draw a diagram showing an overhead view of a population with each type of dispersion: clumped, uniform, and random.

Measuring Population Size

Measuring population size over a large area may seem like an impossible task. Sometimes, a complete count of every individual can be done, particularly if the species lives in an enclosed area. However, what if you needed to count a very large population over many square kilometers? In this case, biologists can use a variety of sampling techniques to estimate the size of a population.

One method scientists use to measure the size of a population of animals is the mark–recapture technique. Biologists capture individuals within a population, tag them, and then release them. After a period of time, a second sample is captured, and biologists look for and count the tagged individuals as well as any newly-captured animals. They may also fit animals with radio collars or GPS devices to track their movements. Another method is called quadrat sampling, in which ecologists use quadrats—typically square or rectangular grids of a known size—to collect data about population numbers in an ecosystem. Quadrat sampling works best with species that do not move, such as plants and corals.

Hands-On Lab

Quadrat Sampling

Use a quadrat sampling method to collect data about population numbers.

Predict Does quadrat sampling provide an accurate estimated of a population size within a defined area?

PROCEDURE

1. Obtain a quadrat frame. Measure, calculate, and record the area of the quadrat on a piece of paper or in your notebook.
2. Stand at the edge of the area you will sample and randomly throw your quadrat. Make sure your quadrat does not overlap with another.
3. Count how many individuals of each species are in your quadrat. Record your data in a data table. Repeat this procedure three times.

ANALYZE

1. Combine your data with that of your classmates. Find the average number of each species for all of the samples.
2. Obtain the area of the sampling plot from your teacher. Calculate how many quadrats would fit in the area of the sampling plot. Multiply this value by the average number of each species found in one quadrat to estimate the population of each species.

Scale, Proportion, and Quantity

1. Calculate the density of each species. Which species had the highest density? Which had the lowest? Why do you think that is? Compare your population estimates to the actual population number that your teacher provides. Was your estimate accurate? Why or why not?
2. How can you make sure that your estimate of population size will be as close to the actual population size as possible?
3. Why do scientists only gather data for a part of the population, instead of the entire population? How does this affect the accuracy of the final population count?

FIGURE 5: Quadrat sampling is most often used to survey populations of plants.

MATERIALS

- calculator
- meterstick
- quadrat

Explain In Yellowstone National Park, scientists track and gather data on many species to study population dynamics within the park, and to monitor the health of each population. Describe the types of data that scientists would need to gather to study the effects of reintroducing a population, such as wolves, on other populations in the park.