CB 16 Sustaining a Population

Can you grow a population on your own? What does a population need to keep it growing? In this activity, you will grow and care for a population. You can choose one of several small, rapidly growing organisms for your population. Decide whether you want to grow bacteria, algae, protists, yeast, meal worms, duckweed, Fast Plants®, flour beetles, fruit flies or another population. Growing vertebrates is not a good idea because their reproductive cycle takes too long.

You will need to find out about the needs of your population before you begin to grow it. For example, what will your population eat? Guidelines on how to maintain various populations in your classroom are provided here. You can also consult the resources listed at the end of this unit.

As you establish and grow your population, you will keep track of the number of organisms in your population, as well as how they are distributed. You will also write down observations of the environment in which the population is growing. You will use this data later in the unit when you make graphs and reports describing the growth of your population.

In this inquiry, you will begin a population growth activity. You should try to maintain your population as long as possible, throughout this unit or the school year.

Materials (per student or group)
- organisms to grow
- culture containers (baby food or other jars for fruit flies or organisms grown in liquid, trays for flour beetles, pots and soil for plants)
- dissection microscope (for insects or tiny plants such as duckweed)
- compound microscopes (for microscopic organisms such as algae, bacteria and yeast)
- Casio fx2 Graphing Calculator
- Casio QV2800 Digital Camera

Procedure
1. Decide which organism you will use. Your teacher can tell you which organisms are available or practical for classroom use. Select an organism that will grow quickly in just a few weeks.
2. Your teacher will help you decide if you will work independently, in groups of 2-4, or as a class, studying and maintaining one large population in the classroom.
3. As you set up your population, record observations in your *Log* about your population's appearance (color, shape, smell, activity level of the individuals, etc.) and the environment surrounding it (room temperature, light, food available, moisture, etc.).
4. Create a table such as the one below or on a computer spread sheet to record data about your population. Include columns for the date on which you sampled the population, the population size and appearance, environmental factors, and other relevant information.

Population Data Table

Date	Population Size	Observations	Environment	Comments

5. Count or estimate the number of individuals in your population every day or every few days for at least several weeks. It is best if you can continue growing your population throughout this unit and as long afterwards as possible.
6. Take frequent digital images of the changes in your population.

Interpretations

1. Describe any patterns that you see in the growth of your population.
2. Evaluate whether or not your population was successfully sustained and discuss possible reasons for the population's success or failure.
3. What, if anything, would you differently if you were to attempt to grow these organisms again?

Applications

1. What is the value of knowing the number of individuals in a population?
2. If someone tells you that "there are 150,000 humans present,"what else do you need to know to make this information useful?
3. A population density figure does not take distribution into account. The United States, for example, represents a large area of land, almost 3.6 million square miles. You read that "the population of the U.S. is estimated to be 300 million by the year 2000." Calculate the population density per square mile for the U.S. for that year. Explain why this figure may be misleading.
4. Calculate the population density for Japan. (Recall that there are 110 million people in Japan and approximately 91 million acres of land.) What must you do to the units if you want to accurately compare the U.S. population density to Japan's population density.
5. Find the population of (a) your town or city, (b) your county, and (c) your state.
6. The population densities for your town, county, and state are probably quite different. What would account for these differences?
7. How could changes in distribution patterns change the ways living organisms interact?

Methods of Describing and Studying Populations

The most basic way to describe a population is by its size, either the actual size or an estimate. For example, you could describe the population of your classroom by counting the number of individuals in the room. This is a direct count or census. However, you could also multiply the number of individuals in your classroom population by the number of classrooms in the school to determine the size of the school population; this is an estimate.

Another useful way to talk about population is to describe population density, the number of individuals in a given area or volume. For example, the number of trees per acre is a tree population density. The density of fish in a farm pond is described in terms of the number of fish per cubic meter of pond volume.

A third characteristic, population distribution, describes the way that individuals are distributed within their geographic boundaries. There are three basic distribution patterns. First, individuals of a population might remain together in clumps or groups. Second, when the organisms are spread evenly throughout an area, the distribution is described as uniform. Farm fields provide excellent examples of uniformly distributed organisms. Uniform distributions can also be found in natural populations. Schools of fish, as you know, keep approximately even distances between individual fish. The territorial behavior of birds also creates uniform distribution. A third type of distribution is called random because it is unpredictable.

If you have only a few organisms in your population, or if the individual organisms are large enough, then count them directly. This will be your population census. If you have many organisms, or if they are microscopic, or move around too rapidly to count, you may need to estimate population size. To do this, you will take a subsample, a small part of the total population, count it, and then use this direct count to make the population estimate. In order to go from a direct count of a subsample to an estimate of the total population size, you must know the relationship between the size of the subsample and the total population size

For example, let's say that you are growing yeast cells in a 100 mL water environment. You might take a 0.1 mL subsample and, using a microscope, count all the yeast cells in that subsample. Since 100 mL is 1000 times larger than 0.1 mL, then the yeast population size estimate would be calculated as 1000 times the number of yeast cells that you counted in the subsample.

Another example is a plant population growing in a 0.5 square meter tray. Choose a 5 square centimeter section of the tray and count all the plants in it. Notice that 0.5 square meters is equal to 5000 square centimeters. Since 5000 square centimeters is 1000 times larger than the 5 square centimeter section you chose to examine, you can estimate the plant population of the entire 0.5 square meter tray by multiplying your direct plant count from the 5 square centimeter region by 1000. This is effective if the 5 square centimeter region you chose to examine is fairly representative of any 5 square centimeter region in the 0.5 square meter tray. This kind of reasoning is called proportional reasoning and it is an important estimation tool often used for estimating the size of a large population.

When you are estimating something like population size from observations of subsamples, make sure that your subsample really represents your total population.

Techniques for Growth and Maintenance of Live Organisms

This appendix gives instructions for maintaining several organisms that are appropriate for use in the Guided Inquiries and Extended Inquiries. This list is by no means comprehensive or restrictive. With the permission of your teacher, seek out and maintain other organisms in which you have a special interest. Check all safety considerations associated with maintaining such living organisms in class. Some present allergy problems. Follow all guidelines provided by your teacher.

Kingdom: MONERA

BACTERIA (various nonpathogenic species)
(EUBACTERIA)

Grow bacteria in liquid nutrient broth or on nutrient agar in test tubes or petri plates. Cultures can be stored for extended periods (six months) in a refrigerator.

Autoclave cultures before discarding them. If an autoclave is not available, spray the culture surface or treat the broth with a 10 percent solution of chlorine bleach.

BLUE-GREEN ALGAE (CYANOBACTERIA)

Grow blue-green algae in liquid nutrient media in test tubes, flasks, or a fish tank. Provide a low-intensity light source (less than 10 percent full sunlight). Shade the container with window screening if it is placed near a sunlit window.

Kingdom: PROTISTA

GREEN ALGAE (various genera, including
Scenedesm us, Chlorella, Selanastrum)

Grow green algae in liquid nutrient media in test tubes, flasks, or a fish tank. Provide a medium-intensity light source (50 to 10 percent full
sunlight). Shade the container with window screening if it is placed near a sunlit window.

Kingdom: FUNGI

BAKER'S YEAST *(Saccharomyces cerevisiae)* This is one of the simplest of all organisms
to grow, but may be difficult to maintain for long periods of time, if only because of the rapid growth rate. Inoculate baker's yeast into a dilute sugar solution, and add sugar periodically to maintain the culture.

Kingdom: PLANTAE

DUCKWEED *(Lemna minor)*

1. Set up a 10-gallon aquarium with a single air pump and a light (or l[6]cate the tank near a sunny window). Fill the aquarium with tap water. Operate the pump for several days before adding the *Lemna* to the tank. If you use an aquarium light hood, fill the tank only halfway so that the *Lemna*, which floats on the water surface, will not be too close to the light.
2. Obtain *Lemna* from a field collection, an aquarium supply store, or a scientific supply company.

3. Float *Lemna* plants in the tank.
4. Continue to provide light to the *Lemna,* either continuously or by setting the aquarium light to an 8 hours dark: 16 hours light schedule with a timer.
5. If you maintain the *Lemna* population for an extended period of time, add a small amount of plant fertilizer (20:20:20) to the tank on a monthly basis to maintain the nutrient level. Don't overfertilize. If you do, you will encourage algae to grow.

FAST PLANTS® (or other fast-growing plants) Plants of the genus *Brassica* are well-adapted for classroom use because of their hardiness and rapid growth cycles. Several generations of Fast Plants® can be produced during a school year. Consult the detailed instructions that come with Fast Plants® kits for growing information.

Kingdom: ANIMALIA

PLANARIA

Maintain planaria in spring water or pond water in small, shallow containers at room temperature. Feed them weekly by introducing small strips of fresh liver into jar. Remove uneaten liver.

EARTHWORMS

If you set up a compost pile in Unit 1, you can cultivate earthworms or redworms in the compost. Either add the worms to the class compost or remove some of the compost to a smaller container and add worms. Obtain worms from either local bait shops (the most economical source) or a biological supply company. Maintain the worms just as you maintain the compost pile: Add vegetable material, leaves, and grass, and turn the pile periodically.

To obtain a direct count of the worm population, dump the worms and compost into a white pan, and sort each worm from its surrounding soil. Segregate the worms into a separate pan until they are counted.

If you grow worms in a large compost pile, it may be more practical to estimate the number of worms in the pile by counting only the worms in a sample of the compost. To obtain this estimate, first thoroughly mix the compost.

BUTTERFLIES AND MOTHS

Cultivate butterflies and moths in a screened enclosure or a perforated box covered with muslin netting. The caterpillars should be kept dry and provided with a continuous supply of fresh leaves. Paper egg cartons provide good surfaces for the pupae. Maintain humidity at 60 percent.

Monarch Watch is an excellent source of information for cultivating butterflies and for obtaining monarch butterfly pupae. Contact Monarch Watch, University of Kansas, Department of Entomology, Lawrence, KS 66045. URL: http://monarch.bio.ukans.edu

GRASSHOPPERS, CRICKETS, AND SMALL INSECTS

Maintain populations in glass or plastic containers or a fish tank with a tight-sealing screen top. Provide screen-covered air holes. Egg cartons provide internal living areas. Maintain the temperature at 21—31^{0}C (70—90^{0}F) and humidity at around 60 percent.

Feed them dried food pellets, such as those sold for rabbits or dogs. Provide water in the form of a wet sponge in a shallow dish. Small pieces of fresh fruit and vegetables can also be used but should be removed before they rot.

WOWBUGS *(Melittobia digitata)*

Also known as "fast wasps," these blind, flightless insects are quite responsive in behavior experiments and will reproduce quickly enough for inheritance studies. Maintain them at room temperature and humidity. For more information, contact the Riverview Press, P.O. Box 5955, Athens, GA 30604-5955.

TADPOLES AND FROGS

Collect tadpoles from nearshore areas of local shallow bodies of water. Maintain them in a 10-gallon aquarium or similar container that is slightly tilted or that provides both water and dry (pebbles) habitats. Provide about 1 to 2 inches of water at one end of the tank. Feed them small crickets two or three times a week. Keep the tank covered to prevent escape. Place the tank in a suitable location away from direct sunlight and excessive temperature.

GERBILS, HAMSTERS, AND MICE

Maintain the population in a fish tank with a wire-screened lid or a cage. Put cedar shavings to a depth of about 3 centimeters on the bottom of the enclosure. Change the bedding weekly. Provide cotton balls for nest making. House the animals at room temperature, 21—23^{0}C (70—74^{0}F). Use a commercial water bottle introduced through the cage top. Feed the animals commercial pellet food or a mixture of seeds, cereals, and fresh fruit and vegetables.

GOLDFISH

Maintain populations in various sized aquaria (10 to 20 gallons). Allow about 500 cubic centimeters of water for each inch (length) of fish. Aerate the water. Maintain a water temperature of 20—24^{0}C (68—75^{0}F). Feed the fish daily using commercially prepared food. Remove uneaten food.

GUPPIES

Maintain populations in various sized aquaria (10 to 20 gallons). Allow about 500 cubic centimeters of water for each inch (length) of fish. Aerate the water. Maintain water at 24—27^{0}C (70—85^{0}F). Feed the fish daily using commercially prepared food. Remove uneaten food.

Detailed instructions for maintaining populations of various organisms are given in the following manuals from Carolina Biological Supply Company (2700 York Road, Burlington, NC 272 15-3398; Phone: 1-800-334-5551):

Techniques for Studying Bacteria and Fungi (order # 45-8296)
Carolina Protozoa and Invertebrates Manual (order #45-3904)
Culturing Algae (order # 45-8192)
Carolina Arthropods Manual (order # 45-4401)
Carolina's Freshwater Aquarium Handbook (order # 45-1785)

Casio FX2.0 Calculator Procedures for CB 16

Estimating the Population in Your School

Suppose you want to estimate the population of your school. If you are in a small school, you could do this directly by simply counting each person in your school. However, if you attend a large school and you have limited amount of time to estimate the population, you could accomplish this using a subsample of the school population. That is, take a small part of the entire population, count it, and use this to determine the whole population amount. In order for this to work, you must know the relationship between the subsample population and the total population. In your school, if you counted the number of students in your classroom, and if you knew the number of classrooms in the school, you could make a valid estimate. Remember that an estimate is not exact, but is rather a “ball park” amount, which gives us an idea of the exact amount. Suppose there were 25 students in your classroom and there were 40 classrooms in your school. Then there would be approximately 25 x 40 students in your school, or about 1000 students. This calculation is simple enough to be done without a calculator, however if you wanted to do it with the calculator, you would perform the operations from the RUN-MAT menu.

Suppose you knew that five of the classroom were used for small classes of less than 10 students, or suppose that some of the classrooms are not used every period. You will need to make adjustments in your estimate for such situations.

Estimating Population Density

The United States represents an area of land, which is almost 3.6 million square miles. The population according to the last census was roughly 300 million people. One possible way to determine a population density of the United States is to determine how many people could be evenly distributed per square mile. To do this you would divide 300 million by 3.6 million to get about 83 people per square mile. This figure is somewhat misleading since there are vast areas in national parks and wildlife reserves where there are no people and there are large cities like New York and Los Angeles where people are literally stacked on top of each other in the high-rise sky scraper apartments and businesses.

To estimate the population density for Japan you would need to divide110 million people by 91 million acres of land. This would be approximately 1.2 people per acre (or about 12 people per 10 acres). To compare the density of Japan to that of the U.S. the rate units must be the same. The rate used for the U.S. above, was 83 people per *square mile,* while for Japan it was 1.2 people per *acre.* To convert 1.2 *people per acre* to *people per square mile*, we will use a conversion factor of *640 acres per square mile*. That is, multiply 1.2 people per acre by 640 acres per square mile as shown below:

$$\frac{1.2\text{people}}{\text{acre}} \text{x} \frac{640\text{acres}}{\text{sq. mile}} = \frac{768\text{people}}{\text{sq. mile}}$$

The acres will "cancel out" and you will be left with 1.2 people times 640 per square mile, or 768 people per square mile. Notice the extreme differences in population density between the two countries when you compare in like units. It is very important when making comparisons that you compare like units, otherwise the comparison may be very misleading.