Teacher Sheet 1

PROBLEM SOLVING ACTIVITY: STAND UP AND BE COUNTED!

All population growth, from bacterial division to human procreation are models of ***exponential growth***. As important parts of the world's ecosystem, human beings are key movers of change to that ecosystem. Since the first humans walked the planet, humans have changed ecosystems as they searched for food, fuel, shelter and living space. However, with the start of the Industrial Revolution in the late 1700s, the human influence on the global ecosystem has been seriously increased. A rapidly increasing human population has changed Earth's ecosystems through advancements in technology and rampant resource consumption. Human destruction of habitats through direct harvesting, pollution, atmospheric changes, and other factors is threatening current global stability, and, if not addressed, ecosystems will be irreversibly affected.

OBJECTIVES: **S**tudents will:

- Develop a model of the exponential nature of population growth.
- Consider the population growth of plant and animal species and the resultant stresses that contribute to natural selection.
- Create a graph showing the result of their model;

MATERIALS/ EQUIPMENT: Each group of three or four students will need:

- Approximately 2,000 small, uniformly shaped objects (kernels of corn, dried beans, wooden markers, plastic beads)
- 10 paper cups or small beakers
- 250-ml or 400-ml beaker
- Graph paper/pencil
- calculator

Teacher Sheet 2

PRE-LAB DISCUSSION-

1. Initiate a discussion on human population with such questions as:
   - How long have humans been on the earth?
   - How do you think the early rate of human population growth compares with the population growth rate today?
   - Why did this rate change?

2. Tell students that this investigation represents a model of population growth rates.

INVESTIGATION: Have student groups complete the following activities. Post the steps for the class to see.

1. Place the glass beakers on their desks.

2. Begin by placing two objects (e.g., corn or plastic beads) in it. **[The beaker represents the limits of an ecosystem or ultimately the earth.]**

3. Place 10 cups in a row on their desk.
   - In the first cup, place two objects.
   - In the second cup, place twice as many objects as the first cup (four).
   - Have students record the number of objects on the outside of the cup.

4. Continue this procedure by placing twice as many objects as in the former cup, or doubling the number, in cups 3 through 10.
   - Be sure students record the numbers on the cups.

5. Take the beaker and determine its height.
   - Have students indicate the approximate percentage of volume that is *without* objects.
   - Record this on the table as 0 time.

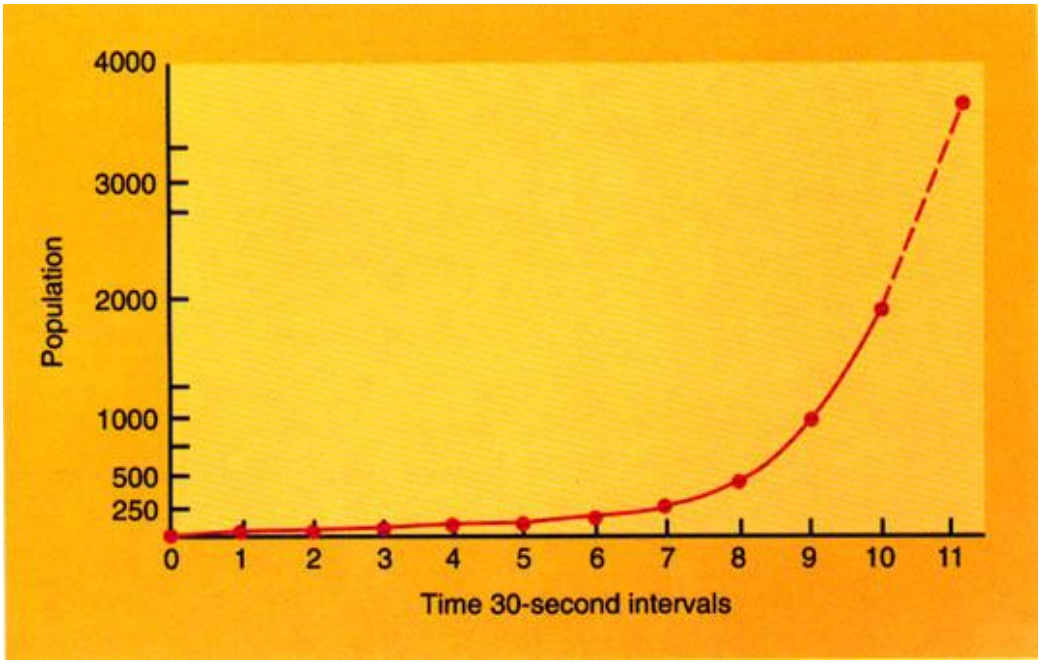
6. At timed intervals of 30 seconds, add the contents of cups 1 through 10 to the beaker.

   - Students should record the total population and approximate percentage of volume in the beaker that is without objects.

7. Students should complete the procedure and graph their results as total population versus results.

Note: Students may question the need for the 30-second intervals. The length of the time interval is arbitrary. Any time interval will do. Preparation of the graph can be assigned as homework.

Figure 1:Sample population growth graph



Teacher Sheet 4

ANALYSIS:

- Ask the students to explain the relationship between population growth and biological evolution in populations of microorganisms, plants, and animals.
- Through questions and discussion, help them develop the connections stated in the learning outcome for the activity. Evolution results from an interaction of factors related to the potential for species to increase in numbers, the genetic variability in a population, the supply of essential resources, and environmental pressures for selection of those offspring that are able to survive and reproduce.

DRAWING CONCLUSIONS:

1. Begin by having students explain the results of their activity.

2. During the discussion of the graph, have the students consider some of the following:

   - Are there any limitations to the number of people the earth will support?
   - Which factor might limit population growth first?
   - How does this factor relate to human evolution?
   - Are there areas in the world where these limits have been reached already?
   - Have we gone beyond the earth's ideal population yet?
   - What problems will we face if we overpopulate the earth?
   - How might human influence on, for example, habitats affect biological evolution?

****Note: Students' answers to these questions will vary, depending on their background and information. The outcome, however, should be an intense discussion of some vital problems and should provide opportunities to introduce some fundamental concepts.**

Teacher Sheet 5

PART V: EVALUATION

1. Human population on the earth is thought to have had a slow start, with doubling periods as long as 1 million years. The current world population is thought to be doubling every 37 years. How would this growth rate compare with the rates found in your investigation?

Answer: Both the population in the investigation and on the earth increase in a geometric progression. This means the graphs have the same shape. You can substitute 37 years for every 30-second interval and the numbers will represent actual world population growth. The slope of the graph would remain the same.

2. What happens to populations when they reach the limits to growth?

Answer: The populations stop growing because death rates (or emigration) exceed birth rates (or immigration).