How Many Bison?

Goals:
Students use a standard sampling technique to determine a bison population.

Objectives:
- Understand a scientific method of sampling wildlife populations.
- Understand the benefits and limitations of this method.

Grade Level: 7-10

Subject Areas:
math, science, critical thinking

Materials Needed:
- one brown paper bag
- 100+ tokens (polystyrene pieces, craft sticks, macaroni)
- felt-tipped markers in 2-3 colors (be sure to use permanent markers so colors won't transfer to other tokens)
- paper and pencil
- calculator
- copies of the Data Sheet, one per team

Time to Complete:
One class period

Background

How many bison are in a herd? In Yellowstone National Park, wildlife biologists go up in airplanes to count the individual bison. This is a good way to count big animals in open places, but biologists also have other ways to figure out populations. By using percentages and proportions, they can sample a population and estimate its size without counting every animal. This activity simulates this common method.

To sample a population, biologists capture and tag animals in a given location. (A tag is a marking placed on an individual animal.) Later, they recapture animals in the same location and count the number of tagged animals. They might repeat this procedure several times and average the results; this number is the estimate of the population. Its accuracy will depend on factors such as the size of the sample and the number of recounts. (Larger samples and more recounts increase accuracy.) By comparing the results over time, biologists can see how much a wildlife population fluctuates.

Preparation

1. Study the sample data sheet (below) that shows the concept of estimating populations by using proportions.
2. HINT: Test Step 2 of the procedure. The "sample" size will vary with the size of the tokens and the size of your students' hands. You may have to instruct them to scoop two handfuls. The goal: To tag more than 10% of the total in the sample.
3. Decide how many teams you will establish, and prepare a "population" for each team:
   - Choose at least 100 tokens to represent the bison population.
   - Place the tokens in each brown bag.
   - Write down the number of tokens in each bag.

Procedure

1. Divide all the students into teams. Explain that each team will be estimating the size of a bison population and that the tokens represent bison.
2. Hand out the bags and instruct each team to do the following:
   - Scoop out a handful of tokens, then use a crayon or magic marker to mark each piece with the same color. These are now the first group of tagged "bison."
   - Count these pieces and record the number on the data sheet as "A," which represents the number of "tagged" bison.
   - Replace the "bison" back in the bag, and shake the bag. Scoop out another batch of tokens. Count the tokens and write that number on the data sheet as "B," the total number

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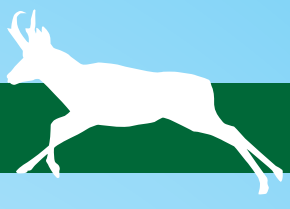

of "bison" that you "captured" this time. Count the number of pieces that are already tagged, and write that number on the data sheet as "C."
- Solve the equation for "y," which is your first estimate of population.

3. Repeat Step 2 at least two more times; be sure to use a different color tag each time.
4. Average the three population estimates to arrive at a final estimate of the population.
5. Compare the estimates of each group with the actual number of tokens placed in the bags..
6. Discuss the following questions:
   - How did the predictions compare with the actual number of "buffalo"?
   - Why might your results be different from the actual number of tokens?
   - Why do biologists need to estimate the size of wildlife populations?
   - What challenges might they face as they try to count animals?
   - What are the pros and cons of this method for estimating population?

Modifications and Adaptations

- Allow students to design their own data sheets .
- Have students try the activity again using a larger sample size (2 or 3 scoops). Discuss why the results might vary between the smaller and larger sample sizes.

Extensions and Assessments

- Ask students to find examples of real wildlife populations that are estimated with this sampling method. They could talk to a wildlife biologist from a local college, or from a state or federal agency, or they could conduct a literature search using a scientific literature database.
- Suggest that some students research other methods of estimating wildlife populations, and compare them to the sampling method they tested.
- For especially mathematically or technologically inclined students, encourage them to research and test population models used by scientists. Some of these models produce beautiful computer images.
- Invite a wildlife biologist to talk to your class about sampling wildlife populations.
- Have the students use this method for predicting how many people in the school have blue eyes or brown hair. What are other methods for determining the number of people with blue eyes (counting, use national average, etc.). Discuss the benefits and limitations of each method.

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Sample Data Sheet

Sample	1st Set	2nd Set	3rd Set	
Color of Tag	Red	Green	Purple	
A = total number in first sample	39	40	51	
B = total number in second sample	40	60	40	
C = number in second sample that were tagged	4	5	5	**Average Population**
Population estimate	390	480	408	426

Example - 1st Set

1. Plug in your data for each set into the following equation:

$$\frac{\text{\# in 1st sample (A)}}{\text{total population (y)}} = \frac{\text{\# in 2nd sample that were tagged (C)}}{\text{\# in second sample (B)}} \qquad \frac{39}{y} = \frac{4}{40}$$

2. Solve for y by cross-multiplying.

AB = Cy
AB/C = Y

39 x 40 = 4y
1560 = 4y
390 = y

Your Data	1st Set	2nd Set	3rd Set	
Color of Tag				
A = total number in first sample				
B = total number in second sample				
C = number in second sample that were tagged				**Average Population**
Population estimate				

1. Plug in your data for each set into the following equation:

$$\frac{\text{\# in 1st sample (A)}}{\text{total population (y)}} = \frac{\text{\# in 2nd sample that were tagged (C)}}{\text{\# in second sample (B)}}$$

2. Solve for y by cross-multiplying.

AB = Cy
AB/C = Y

3. Obtain a final population estimate by averaging the results of all three sets.

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