Estimating Bighorn Sheep Populations

Objectives:
Students will understand one method biologists use to estimate the size of bighorn sheep populations (Mark and Recapture Method). After collecting data, students will graph their results.

Next Generation Science Standards:

Grade level: suggested 4th to high school
Duration: 1-2 class sessions

- CCSS.MATH.CONTENT.4.MD.B.4
  Make a line plot to display a data set of measurements
- CCSS.MATH.CONTENT.5.MD.B.2
  Make a line plot to display a data set of measurements
- CCSS.MATH.CONTENT.6.SP.A.1
  Recognize a statistical question as one that anticipates variability in the data related to the question and accounts for it in the answers.
- CCSS.MATH.CONTENT.6.SP.B.4
  Display numerical data in plots on a number line, including dot plots, histograms, and box plots.
- CCSS.MATH.CONTENT.7.SP.C.8
  Find probabilities of compound events using organized lists, tables, tree diagrams, and simulation.
- CCSS.MATH.CONTENT.HSS.IC.A.1
  Understand statistics as a process for making inferences about population parameters based on a random sample from that population.

Background:
Mark and recapture is a method commonly used in ecology to estimate an animal population's size where it is impractical to count every individual. A portion of the population is captured, marked, and released. Later, another portion will be captured and the number of marked individuals within the sample is counted. Since the number of marked individuals within the second sample should be proportional to the number of marked individuals in the whole population, an estimate of the total population size can be obtained by dividing the number of marked individuals by the proportion of marked individuals in the second sample. The method is most useful when it is not practical to count all the individuals in the population.

The mark and recapture method in biology is important beyond knowing how many animals are in the population. The data collected helps scientists estimate current populations which can then be compared with earlier studies to figure out if a population is expanding or decreasing. The information collected can lead to important animal protection programs. For example, if a population is growing well, some bighorn could be captured and moved to a different range where wild sheep historically lived, helping to re-establish a new herd.

Materials:

- Container, such as brown paper bag, with 100 pinto beans for each research team
- a jar with beans of a different color, but about the same size. These could be painted pinto beans and will represent the "marked" sheep
- Student Data Sheet and Graphing Data sheet

Procedures:

Adapted from California State Parks: PORTS from www.ports.parks.ca.gov

The teacher is the lead biologist and will assign each research team a number of Bighorn sheep (pinto beans) they are going to "mark". (15, 20, 25, or 30) The more they mark, the more accurate their population estimates will be. The teacher can have the whole class mark the same amount or set up half (Team A) which will mark 20 and half (Team B) mark 40. Scientific teams could then do averages within Team A and B and compare the results.

1. Have the teams pull out the number of pinto beans you have chosen to "mark" and replace this amount with the different colored beans, which will represent the "marked Bighorn sheep". They can fill the Marked (M) column on the Bighorn Sheep Population Count Data Sheet with this number all of the way down. This symbolizes how scientists will capture an animal, mark it and then re-release it into the wild.
2. You are going out to see how many sheep you can find. Field biologists do this with binoculars and radio collars. The number they find each year will vary but their goal is to find between 20 and 40 and scientists use consistent territory ranges each year.
3. Walk the teams through the first count and capture, then have them repeat 9 more times for a total of 10 samples.
4. Without looking, have one student "capture approximately 30 sheep" by pulling a handful of beans out of the bag. Have your students make an estimation of the amount while doing this. This is their first sample (Year #1). Have them record this number in the Captured column (C). This represents how scientists will count animals and record those with tags or radio signals to get a population estimate. If any of the captured Bighorn sheep are "marked", record them in the Recaptured column (R).

IMPORTANT NOTE: If there are no marked Bighorn sheep, they put a 1 in the Recaptured column (R).

5. Replace all the beans (marked and unmarked Bighorn sheep) to the bag.
6. Explain that one year of data is not very useful. Successive years are necessary and scientists have to use consistent territory ranges each year.
7. You will now do 9 more samples, representing the next 9 Years of population counts. Record the number captured each time in the Captured column (C) and the number that were marked in the Recaptured column (R)
8. After they have done 10 samples have them do the math for each sample.

   Population Estimate = M x C/R
   Marked animals x captured animals/recaptured equals population estimate.

9. Have students find an average from their 10 population estimates.

Student Directions and Data Sheet

Mark & Recapture

The mark and recapture method is a process used by scientists to estimate animal populations. They capture a specific number of animals of the chosen species, then collar, mark or tag these animals and release them so that they can be recognized later. The scientists then go back and count animals in a given area where they had collared, marked or tagged them. Some of these animals may be marked and some of them may not. The scientist uses a simple ratio to calculate the total population of the species.

Bighorn Sheep Population Field Study

The lead biologist (your teacher) is going to give you a population of Bighorn sheep and the number of Bighorn sheep to capture and "mark".

Pull out the number of Bighorn sheep (beans) you are supposed to capture. Replace them with "marked Bighorn sheep" (beans of another color). Fill the Marked (M) column on your chart with this number of marked sheep all of the way down. This symbolizes how scientists captured an animal, marked it and then re-released it into the wild.

Now you are going out in the field to find as many Bighorn sheep as you can to try to get an estimate of their population. Field biologists do this with binoculars, radio collars, and often fly over areas using helicopters and airplanes. The number they find each year will vary but their goal is to find between 20 and 40 and scientists use consistent territory ranges each year.

SAMPLE #1 - Have one member of your team carefully capture 20-30 Bighorn sheep by pulling out a handful of 30 beans. Make an estimation to try to get as close to 30 as possible. This is your first count, Year 1. Record this number in the Captured column (C) for Year #1. If any of the beans are of the different color (marked Bighorn sheep), record them in the Recaptured column (R) for Year #1.

NOTE: If there are no marked Bighorn sheep in your sample put a 1 in the Captured column.

Replace all the beans (marked and unmarked Bighorn sheep) to the bag. Repeat the capturing process 9 more times. Each time represents another year of population counting and capturing. For each year, record the total number Captured (C) and the Recaptured (R).

Use the following formula to find the population estimate.

M x C/R = Population Estimate

Marked animals x captured animals/recaptured equals population estimate

Scientist Name _____

Bighorn Sheep Population Count Data Sheet

Sample	(M) Marked Same # for all	(C) Captured	(R) Recaptured	Population Estimate (MxC/R)
Year #1				
Year #2				
Year #3				
Year #4				
Year #5				
Year #6				
Year #7				
Year # 8				
Year #9				
Year # 10				

What is the average of your 10 population estimates? _____

(Hint: Add up the POPULATION ESTIMATES for the 10 years and then divide by 10)

Count the total amount of beans in your bag to get the actual population. Do you feel this method came close to the actual population? Why or why not?

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_____

Scientist's Name _____

Graphing Data

Directions: Make a graph of each of the sample population estimates.

Title of Graph:

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