How Many Bluegills?

Grade Level: Upper Elementary, Middle School
Subject Areas: Science, environmental science, math
Duration: 45 minutes

Next Generation Science Standards:

- 3-5-ETS1-3 – Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
- MS-ETS1-4 – Develop a model to generate data for iterative testing and modification of a proposed…process such that optimal design can be achieved.
    - Practices of science
        - Asking questions
        - Developing and using models
        - Analyzing and interpreting data
        - Using mathematics and computational thinking
    - Cross cutting concepts
        - Scale, proportion, and quantity.
        - Systems and system models.

Common Core State Standards:

- Math
    - MP4 – Model with mathematics.
    - 6.RP.A.3 – Use ratio and rate reasoning to solve real-world and mathematical problems.
    - 7.RP.A.2 – Recognize and represent proportional relationships between quantities.
- ELA/Literacy
    - SL.4-5.1 - Engage effectively in a range of collaborative texts, discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade appropriate *topics and* building on others' ideas and expressing their own clearly.
    - SL.6-8.1 - Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade appropriate topics, texts, and issues, building on others' ideas and expressing their own clearly.

Environmental Literacy:

- 1.A.5 – Use data and references to interpret findings to form conclusions
- 2.B.2 – Use models and computer simulations to extend his/her understanding of scientific concepts

Objectives:

- Students will understand how to use a sampling procedure and mathematical formula to estimate the total number of objects in a group.

- Students will understand how the “tag and recapture” procedure is used to estimate fish populations.
- Students will understand one of the difficulties that fisheries biologists face when trying to manage fish populations.

Materials:

- Three bags of small dried white beans
- Six containers large enough to hold half a bag of beans
- Six plastic spoons
- Six markers
- Six paper plates
- Student worksheets

Activity:

- Engage
    - Tell the students that they are fisheries biologists responsible for managing the population of bluegills in a local lake. They are the ones who decide what needs to be done to make sure that the proper balance of bass and bluegills (predator and prey) is maintained in order to provide good fishing. What would they need to know in order to manage the population of bluegills? *Eventually someone will say that they have to have some idea of how many fish there are.*
    - What problems would they face? *How do you count fish that cannot be seen and that are continually moving?* Challenge them to come up with a solution.
    - Tell them that wildlife biologists use a technique called “tag and recapture” to estimate populations. They are going to do an activity to see how it works and how accurate it is.
- Explore
    - Divide the students into six groups.
        - Empty half a bag of beans into each of the six containers.
            - Give each group a container of beans, a spoon, a paper plate and a marker.
            - Tell the students that each container represents a population of fish.
        - Give the group a worksheet.
        - Ask each student to guess how many beans are in the container and write his/her guess on the worksheet.
    - Trial One
        - Tell them to remove one heaping spoonful of beans from the container and dump it out onto the plate.
            - Have someone in the group count the number of beans on the plate and mark each one with the marker. This is the tagged sample. On the worksheet, this number would be

entered as the *M* number. (Note: The *M* number will remain the same throughout the activity.)
- Put all the marked beans back in the container and mix them up thoroughly.
- Now remove another spoonful and count the total number of beans. This number is the *t* number.
- Count the number of beans that are marked. This number is the *m* number.

▪ Have them use the following formula to calculate the total number of beans in the container (*T*). If necessary, round up to the nearest whole number. Enter the number on their worksheet.

$$T = \frac{M \times t}{m}$$

T = total number of beans
M = number of marked beans in the first sample
t = number of beans in the second sample
m = number of marked beans in the second sample

- Is one trial enough to give an accurate estimate? *No.*
  - Have them return the beans to the container, mix them up and take another sample. **Do not mark any more beans.** Fill in the worksheet as before and calculate *T*.
  - Repeat the procedure until 5 trials have been done, calculating the *T* value after each trial.
- Now they have 5 values for *T*. How can they find the most accurate estimate? *Take the average of the 5 trials.*

- Explain
  - How can they find out how accurate their estimate is? *Have them count the beans in their container.*
    - How close were they to their estimate?
    - How close were they to their original guess?
  - What could they do to get even closer to an accurate number? *Do more trials.*
- Extend :
  - Obviously the more trials, the more accurate the estimate, but there is a limit to the number of trials that can be done. Challenge the students to determine the minimum number of trials required to give an accurate estimate.
  - What other methods do fisheries biologists use to estimate fish populations? Check out
    - http://www.dnr.state.md.us/fisheries/juvindex/index.html
    - http://www.sciencedaily.com/releases/2015/02/150218141411.htm

How Many Bluegills? – Student Worksheet

Make a guess; how many beans are in the container?_____

Tag and Recapture Data Form

Trial	Example	1	2	3	4	5
M	20					
t	10					
m	2					
T	100					

The formula for calculating *T* is:

$$T = \frac{M \times t}{m}$$

T = estimated total number of beans
M = total number of beans in the first sample; mark all these beans
t = total number of beans in the second sample
m = number of marked beans in the second sample

- In other words, multiply *M* by *t*, then divide this number by *m*. In the example above, 20 x 10 = 200; 200 ÷ 2 = 100. There is an estimated total of 100 beans.
- If you have a fraction, round up to the nearest whole number (After all, you would not have a fraction of a fish!)

Do not mark any more beans. Return the beans to the container, mix them up and take another sample. Fill in the worksheet as before and calculate *T*. Repeat this until you have 5 values for *T*.

Calculate the average value of *T* for your final estimate._____
(To find the average, add all the values for *T*, then divide this number by 5)

Now count the beans in the container. How many beans were actually in the container?_____

How close was your final estimate?_____

How close was your original guess?_____

MARYLAND DEPARTMENT OF NATURAL RESOURCES