**Water**

**MARK-RECAPTURE ACTIVITY: "ONE FISH, TWO FISH, RED FISH, BLUE FISH" (ANSWER KEY)**

*This lesson will teach students one way that biologists can estimate population size.*

**MATERIALS:**

- Fish-shaped gummy candies (approx. 20 per group)
- 1 jar or container per group
- 1 knife or scalpel per group
- 1 spoon or other device that easily fits into the jar and can collect a "sample" of fish
- Paper towels, gloves, etc. as needed

**INTRODUCTION:**

The one basic question that population biologists are faced with is: How many individuals of a particular species occur on a given site at a given time? To answer that question, a biologist would simply need to **count** the organisms of the species of interest. For a plant biologist, the task is relatively easy because plants **don't move** and they "wait" to be counted. Animal population biologists are not so fortunate because the species of interest is typically highly **mobile**, thus complicating the counting procedure. Still, determining the population size of an animal species is important, both for basic studies, as well as for applied work as in wildlife or fisheries biology. For example, many biologists study fish populations and the environmental factors that affect them such as temperature, dissolved oxygen, pH, and nutrients (e.g., nitrates and phosphates). Techniques must therefore be utilized that allow one to determine the population size of animals in an **area**. One indirect technique is the mark-recapture method using the Lincoln-Peterson Index. The Lincoln-Peterson Index is used widely to estimate population abundance and density.

**LINCOLN-PETERSON EQUATION**:

$$N = \frac{n \times M}{m}$$

**N** = your estimate of population density (per jar).

**M** = the number of individuals captured, marked, and released during the first capture session.

**n** = the number of individuals you capture in the 2$^{nd}$ capture session.

**m** = the number of marked individuals you caught in the 2$^{nd}$ capture session.

**EXAMPLE:**
Imagine that you wanted to estimate the number of sturgeon in a river. Suppose that on the first day, you collected a sample of 100 individuals, tagged them, and released them. Then suppose that five days later, you collected 80 fish, and of those 20 were tagged. Using the Lincoln-Peterson equation you could then estimate the total population to be **400** sturgeon. Now, let's say one month later there is an oil spill in the river and you want to determine the effects of the oil spill to the sturgeon population. Suppose that you went to same location and collected 80 fish, and of those 40 were tagged. Using the Lincoln-Peterson equation you could then estimate the total population to be **200** sturgeon.

**ACTIVITY:**
In today's activity, you will work together in groups to estimate the population abundance of the rare Sweet-tooth minnow, *Hungari forcandee*, occupying a mason jar. By using the Lincoln-Peterson Index, you will arrive at your best estimate of the number of *H. forcandee* in each jar. You will work in groups for this activity. **Your group will have to determine the methods, do the calculations, and arrive at your best estimate.** Your objective is to obtain a better understanding of this method and how this relates to studying fish populations. Is just one sample enough?

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Jar #:

Group Name:

## First Sample

1st attempt: how many *H. forcandee* did you capture? ______________________ (M)
*Collect a sample using your spoon. Count the fish. "Mark" them by cutting off a fin. Release them back into the jar.*

2nd attempt:how many *H. forcandee* did you capture? ______________________ (n)
*Collect a sample using your spoon. Count the fish. "Mark" them by cutting off a fin. Release them back into the jar.*

2nd attempt:how many of those *H. forcandee* were "recaptures'? ______________ (m)
*How many fish from the 2nd attempt are "marked"?*

Here's the formula again. Fill out the values and calculate your estimate:

$$N = \frac{n \times M}{m}$$

N = _____

## Second Sample

$1^{st}$ attempt: how many *H. forcandee* did you capture? ______________________ (M)
*This number will be the same as in the First Sample, $1^{st}$ attempt.*

$2^{nd}$ attempt:how many *H. forcandee* did you capture? ______________________ (n)
*Collect a sample using your spoon. Count the fish. "Mark" them by cutting off a fin. Release them back into the jar.*

$2^{nd}$ attempt:how many of those *H. forcandee* were "recaptures'? ______________ (m)
*How many fish from the $2^{nd}$ attempt are "marked"?*

$$N = \frac{n \times M}{m}$$

N = _____

## Third Sample

$1^{st}$ attempt: how many *H. forcandee* did you capture? ______________________ (M)
*This number will be the same as in the First Sample, $1^{st}$ attempt.*

$2^{nd}$ attempt:how many *H. forcandee* did you capture? ______________________ (n)
*Collect a sample using your spoon. Count the fish. "Mark" them by cutting off a fin. Release them back into the jar.*

$2^{nd}$ attempt:how many of those *H. forcandee* were "recaptures'? ______________ (m)
*How many fish from the $2^{nd}$ attempt are "marked"?*

$$N = \frac{n \times M}{m}$$

N = _____

| Sample Number | Lincoln-Peterson Index Estimate (N) | Difference from the mean estimate (Subtract) | Multiply this difference by 2 and record the sum below |
|---|---|---|---|
| 1 | | | |
| 2 | | | |
| 3 | | | |
| **Sum of all three estimates** | | | **Sum:** <br> **(Called the variance)** |
| **Mean (Divide the sum by 3)** | | | **Square root of sum:** <br> **(Called the standard deviation)** |

Your group's mean estimate is: ______________________________ *H. forcandee*.

The standard deviation from your estimate is: ___________________ .

Thus, your formal estimate is stated as:____________________ ± __________ *H. forcandee*.

**Questions to ponder when writing your lab report:**

1. How close were your estimates to the actual number?

2. Which group had the highest estimate? Which group had the highest standard deviation? What factors would/could account for this **variation**?

3. What factors would account for any differences in **estimates**?

4. What would happen to your estimates if a group of marked individuals died between samples?