



Name: _____ Date: _____

Student Exploration: Estimating Population Size

Vocabulary: percent error, population, sample

Prior Knowledge Questions (Do these BEFORE using the Gizmo.)

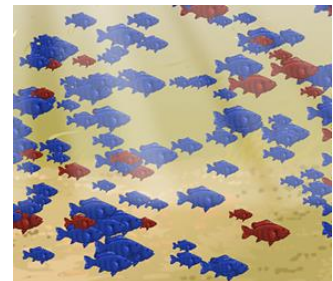
1. A jar contains 100 marbles total. Some are black. If you pull 4 marbles out and 1 is black, how many out of the 100 marbles would you guess are black? _____ Explain. _____

2. A different jar has 100 black marbles. (The total number of marbles is unknown.) If you pull 4 marbles out and 1 is black, what is your guess for the total number of marbles? _____

Explain. _____

Gizmo Warm-up

In the *Estimating Population Size* Gizmo, you will estimate the total number of fish in a pond. You will do this by tagging and releasing a certain number of fish, and then “recapturing” some.



To change the number of fish to tag or catch, drag the slider, or click on the number in the text field next to a slider, type a new value, and hit **Enter**.


1. Suppose a scientist tags 100 fish, and releases them. (Set the **Tagged fish in pond** to 100 to show this.) Later, a fisherman catches 50 fish from the same pond. (Set **Fish to catch** to 50 to show this.) The fisherman’s catch is a **sample** of all fish in the pond.

A. Click **Catch and check**. Look at the **Results** table. How many tagged fish did the fisherman catch? _____

B. What percent of the fish in his sample were tagged? _____

2. At the bottom of the Gizmo, select **Show total fish in pond**. How many fish are in this pond? _____ This number is the **population** of fish in this pond.



Activity A: Capture/recapture method	<u>Get the Gizmo ready:</u> <ul style="list-style-type: none"> Be sure Show total fish in pond is selected on the POND tab. 	
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The “capture/recapture” method lets you estimate the size of a population. To apply this to a fish pond, first catch and tag some fish. (This is the “capture” part.) Then release the tagged fish into the pond and wait. Later, catch a second group of fish. (This is the “recapture” part.) Count the tagged fish in the second group and use a proportion to estimate the pond’s fish population.

1. Set the **Tagged fish in pond** to 50. Click **New pond**.

A. How many fish are in this pond? _____

B. If you catch one fish out of this pond, what is the probability that your fish is tagged?

Fraction: $\frac{\quad}{\quad}$ Decimal (to nearest hundredth): _____

C. Suppose you catch 100 fish out of this pond. About how many of these fish would you expect to be tagged? _____ Explain. _____

D. Set the **Fish to catch** to 100. Click **Catch and check**. How does the number of tagged fish shown in the Gizmo table compare to your estimate above?

E. If you don’t know how many fish are in the pond, you can use the results from the catch to write a proportion to estimate the fish population. Fill in the blanks below with words to write this proportion.

$\frac{\quad}{\quad} = \frac{\quad}{\quad}$

F. Now, in the space to the right, use the catch above to write the proportion to estimate the fish population with numbers. Then, solve the proportion. Select the **CALCULATE** tab to check your work.

G. How close is your estimate to the actual fish population? _____

(Activity A continued on next page)



Activity A (continued from previous page)

2. On the **POND** tab, turn off **Show total fish in pond**. Click **New pond**. Set the **Tagged fish in pond** and the **Fish to catch** to the same number of your choice under 75.

A. How many fish were tagged and released? _____

B. Now click **Catch and check**. Fill in the blanks below to describe the number of tagged fish (and total fish) in your sample.

_____ out of _____ fish in the sample are tagged.

C. In the space to the right, write a proportion that you can use to estimate the fish population. Solve the proportion. Check your answer on the **CALCULATE** tab.

D. Turn on **Show total fish in pond**. What is the actual fish population? _____

E. How far off was your estimated population from the actual value? _____

F. Do you think your estimate would be more accurate if you increased the number of fish to catch? _____ Explain. _____

Use the Gizmo to check your prediction.

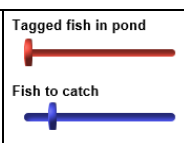
3. Suppose you use the “capture/recapture” method to come up with an estimate of 200 fish living in a pond. Assume that this result is accurate to within 20% of the estimate.

A. If p is the actual number of fish, write an inequality to describe the minimum number of fish in the pond. _____

B. Write an inequality to describe the maximum number of fish in the pond. _____

C. Combine your answers above into a compound inequality. _____



Activity B: Sample size	<u>Get the Gizmo ready:</u> <ul style="list-style-type: none"> • Select the POND tab. • Turn off Show total fish in pond. 	
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The “capture/recapture” method lets you estimate the size of a population. To apply this to a fish pond, first catch and tag some fish. (This is the “capture” part.) Then release the tagged fish into the pond and wait. Later, catch a second group of fish. (This is the “recapture” part.) Count the tagged fish in the second group and use a proportion to estimate the pond’s fish population.

1. Set **Tagged fish in pond** to 75 and **Fish to catch** to 10. Click **New pond**.
 - A. Click **Catch and check**. In the space to the right, write and solve a proportion to estimate the total fish in the pond. Select the **CALCULATE** tab to check.
 - B. Turn on **Show total fish in pond**. What is the actual fish population? _____
 - C. In the space to the right, find the difference between your estimate and the actual fish population. Then express this as a percent of the actual population.

This is known as the **percent error** and is given by the formula below:

$$\text{percent error} = \frac{\text{estimated value} - \text{actual value}}{\text{actual value}} \cdot 100$$

Note: If your estimate is less than the actual value, then the percent error is negative.

- D. Fill in the first row of the table for the catch above. Then, change the **Number of fish to catch** to the numbers shown in the first column and fill in the rest of the table.

Number of fish caught	Number of tagged fish in catch	Estimate of fish population	Actual fish population	Percent error
10				
30				
80				

(Activity B continued on next page)



Activity B (continued from previous page)

2. On the **POND** tab, click **New pond**. Be sure **Tagged fish in pond** is still set to 75.

A. Fill in the following table for the new pond.

Number of fish caught	Number of tagged fish in catch	Estimate of fish population	Actual fish population	Percent error
10				
30				
80				

B. On the **POND** tab, click **New pond** again. Fill in the following table for this pond.

Number of fish caught	Number of tagged fish in catch	Estimate of fish population	Actual fish population	Percent error
10				
30				
80				

C. Compare the last three tables you filled in. What tends to happen to the percent error as the number of fish caught (the sample size) increases? _____

D. Why do you think larger sample sizes usually lead to better estimates? _____

3. On the **POND** tab, click **New pond**. Be sure the **Tagged fish in pond** is still 75.

A. Select the **CALCULATE** tab. For each of the following sample sizes, click **Catch and check** 5 times. Record all 5 estimates below, and then fill in the rest of the table.

Number of fish caught	Five estimates of fish population					Mean of estimates	Actual fish population	Percent error
10								
30								
80								

B. Compare the percent errors for this 5-sample method to the percent errors for the 1-sample method above. Does the 5-sample method seem more reliable? _____

Explain. _____

