Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date \_\_\_\_\_\_\_\_\_\_

AP Biology Mr. Collea

***Estimating Population Sizes***



 The best way to measure the size of a population is to count all the individuals in that popula­tion. When determining the population sizes of trees or other relatively immobile organisms, this method is practical. If the organism is mobile, however, such as a fish, counting every individual would be difficult. Some individuals might be counted twice or not at all, since the experimenter would not know which fish had been counted and which had not.

Knowing the size of a population of plants and animals is important in making environmental decisions that would affect the population. However, as previously stated, accurately estimating the size of wild populations can be extremely diffi­cult. In the case of ocean dwellers, such as whales, the task is especially challenging. Estimates of the number of Minke whales, for example, have differed by as much as a factor of 10.

Decid­ing whether to allow hunting of Minke whales, based on population estimates that are too high, could lead to extinction of the species. On the other hand, basing a decision on an estimate that is too low could unnecessarily ban hunting of Minkes by people that depend on whales for food. One method for estimating population size, the "line-transect survey", involves observing every animal seen while traveling in a straight line. Although traditionally used for counting land animals, the line-transect survey method has recently been applied to whales, providing more reliable data.

Another method often used to estimate population size is the **"mark and recapture"** technique, in which scientists capture some animals from the population, mark them, and release them. At a later time, the scientists again capture animals from the same population and observe how many of them are marked. *The method assumes that the ratio of the actual population to the sample size is the same as the ratio of the number of marked animals to the number marked in the recap­ture sample.* Knowing three of the four values: **number originally marked**, **total number recaptured** and **number marked in the recapture**, scientists can calculate an estimate of the actual population size. This method of estimation is called the Lincoln Index and utilizes the following formula:

 Estimated Population Size Total Number Recaptured x Number Marked

 Number Recaptured with mark

The Lincoln Index makes several assumptions that must be met if the estimate is to be accurate. These assumptions are:

- The population of organisms must be closed, with no immigration or emigration.

- The time between samples must be very small compared to the life span of the organism being sampled.

- The marked organisms must mix completely with the rest of the population during the time between the

 two samples.

**Objective:** Estimate population size of goldfish in Peach Lake using the mark & recapture technique.

**Materials:** (per group)

Bag of Goldfish Crackers plastic cup marker (any color)

**Methods**:

**1.** Obtain a population of goldfish in a Peach Lake.

**2.** Capture **20** gold fish by removing a “handful” from the bag.

**3.** Place a mark on each gold fish using a marker.

**4.** Return the **20** marked gold fish back to the lake without injury.

**5.** With your eyes closed, grab a “handful” of the population. This is the recapture step. Record the number of goldfish recaptured in total and the number that have a mark on them in **Table 1**.

**6.** Return the goldfish to the back to the lake without injury and repeat. Do **10** recaptures.

**7.** When the ten recaptures are completed, enter the totals in the **Table 1** and average your results.

**Table 1. Estimating the Number of Goldfish in Peach Lake**

|  |  |  |  |
| --- | --- | --- | --- |
| **Trial** | **Number Marked** | **Total Number Recaptured** | **Number Recaptured with Mark** |
| **1** |  |   |   |
| **2** |   |   |   |
| **3** |   |   |   |
| **4** |   |   |   |
| **5** |   |   |   |
| **6** |   |   |   |
| **7** |   |   |   |
| **8** |   |   |   |
| **9** |   |   |   |
| **10** |   |   |   |
| **Avg.** |   |   |  |

**8.** Estimate the size of the Goldfish population in Peach Lake using the formula below:

 Estimated Population Size Total Number Recaptured x Number Marked

 Number Recaptured with mark

**9.** Estimated Size = \_\_\_\_\_\_\_\_\_\_\_\_\_\_ Actual Size = \_\_\_\_\_\_\_\_\_\_\_\_\_

**10.** Perform a chi-square (X2) test to compare your INDIVIDUAL results with the expected results. *Remember, this statistical tool will tell you whether the two sets of data are statistically different. In particular, it will tell you whether the difference is due to chance or whether some other factor is responsible.*

**Table 2. Estimating the Number of Goldfish in Peach Lake - INDIVIDUAL RESULTS**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | observed*(estimated)* | expected*(actual)* | obs - exp | (obs - exp)2 | (obs - exp)2 exp |
|  |   |   |   |   |   |
|  |  |  |   |  X2 Total |   |
|  |  |  |  Degrees of Freedom (n – 1) |   |

**11.** Perform a chi-square (X2) test to compare the CLASS results with the expected results.

**Table 2. Estimating the Number of Goldfish in Peach Lake - CLASS RESULTS**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | observed*(estimated)* | expected*(actual)* | obs - exp | (obs - exp)2 | (obs - exp)2 exp |
| **1** |   |   |   |   |   |
| **2** |   |   |   |   |   |
| **3** |   |   |   |   |   |
| **4** |  |  |  |  |  |
| **5** |  |  |  |  |  |
|  |  |  |   |  X2 Total |   |
|  |  |  |  Degrees of Freedom (n – 1) |   |

**Table 3: The Chi-Square Distribution Table.**

|  |
| --- |
| **CHI-SQUARE TABLE** |
|  | **Degrees of Freedom** |
| **p** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** |
| **0.05** | 3.85 | 5.99 | 7.82 | 9.49 | 11.07 | 12.59 | 14.07 | 15.51 |
| **0.01** | 6.64 | 9.32 | 11.34 | 13.28 | 15.09 | 16.81 | 18.48 | 20.09 |

**12.** Should you ACCEPT or REJECT the Null Hypothesis that your INDIVIDUAL results are NOT statistically different from the expected values? *(Check lab for proper wording of this response.)*

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**13.** Should we ACCEPT or REJECT the Null Hypothesis that the CLASS results are NOT statistically different from the expected values? *(Check lab for proper wording of this response.)*

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**Post-Lab Questions**

**1.** How do your estimates compare to the actual population size? (*Calculate your Percent Error*)

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**2.** If your estimated values differ from the actual value, why do you think this might have occurred?

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**3.** What could you do to get more accurate results?

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**Sample Problems**

**1.** After random sampling, 500 sunfish are captured, tagged (marked) and released from Peach Lake.

 A month later, 10 sunfish are recaptured of which 2 are tagged. Based on the Lincoln-Peterson index, estimate the number of sunfish in Peach Lake.

**2.** A biologist nets 45 largemouth bass from a farm pond, tags their fins, and releases them unharmed.

 A week later, she nets 58 bass from the pond, including 26 with tags. Based on the Lincoln-Peterson index, estimate the number of bass in the pond.

 **3.** A biologists originally marked captured and tagged 40 butterflies in Collea Park. Over a month long period, butterfly traps recaptured 200 butterflies. Of the 200, 80 were found to have tags. Based on the Lincoln-Peterson index, estimate the number of bass in the pond.