Fisheries Management: Sampling Activity / Population Estimates

How do fisheries managers determine how many fish are in a lake? For that matter, how do conservationists know how many fishing licenses to issue throughout the year? Or how many doe tags to issue during deer hunting season? This activity will introduce several basic concepts on how to estimate the number of organisms that exist in a particular habitat.



Fishing regulations and rules are set up so that the various fish species are not over-fished. If too many individual fish are removed from a population by commercial means or through sport fishing, the population will not be able to maintain adequate numbers of catchable-sized fish.

This activity uses the simple method of “capture, marking and recapture” to estimate the number of fish in a given population. You will use equal sized pieces of paper kept in a coffee can for this random sampling exercise. You will use TWO sampling methods: (1) **the Peterson Estimate** (simpler, less accurate) and (2) the **Schnabel estimate**.

**Peterson Estimate**: (# of fish marked) X (total # of fish caught)

number of recaptures

**Schnabel Estimate**: sum of (# of fish marked) X (total # of fish caught)

sum of the number recaptured

**Materials** Coffee Can (or container) ~400 – 500 paper pieces

**Procedures**

1. Record all your results in the Calculation and Data section (*page 3*).

2. Obtain a coffee can or container which holds an unknown # of paper pieces.

a. *Use 5 sheets of 8.5 x 11” paper and cut the paper into approximately 1-inch squares.*

*b. You should have about 400 paper pieces, but DO NOT COUNT them.*

*c. Have ANOTHER person put the paper pieces into the coffee can or container WITHOUT counting them.*

3. Cover and shake the coffee can to thoroughly mix the paper pieces.

Rules: 1) Do not look into the coffee can to pick and choose papers.

2) You may use ONLY your thumb and index finger to grab papers.

3) Do not use the sides of the coffee can to help remove papers.

4. Reach in and grab some paper pieces and place the papers on the table in front of you.

5. Count the number of papers you have “captured” and record this under **“Sample 1 … Column II … Number “Captured**” in the data table (*page 3*).

1. Using a dark pen or marker, place a large “X” on both sides of each of the “**captured**” paper pieces. Return all the paper pieces to the coffee can.
2. Record the “Number of Marked Papers” on the data sheet under **“Sample 2 … Total # of Marked Papers in Can**.” (*Determine this number by adding the previous sample’s “Number of Marked Papers in Can” to the “Number Captured*” of column II)

8. Cover and shake the coffee can to thoroughly mix the paper pieces.

Rules: 1) Do not look into the coffee can to pick and choose papers.

2) You may use ONLY your thumb and index finger to grab papers.

3) Do not use the sides of the coffee can to help remove papers.

9. Reach in and grab some paper pieces and place the papers on the table in front of you.

10. Count the total number of paper pieces that were grabbed out. Record this number in the data table under “**Sample 2 … Number Captured**.”

11. Count the number of paper pieces in this group that have the “**X**” you previously marked on them as already “captured.” Record this number in the data table under “**Sample 2 … Number of Recaptures**.”

12. Place an “X” on both sides of all the paper pieces that do not already have the marks. Return all the papers to the coffee can.

13. Record the “Total # of Marked Papers” in the data table under **“Sample 3 … Total # of Marked Papers in Can**.” (*Determine this number by adding the previous sample’s “Number of Marked Papers in Can” to the “Number Captured” (II) – “Number of Recaptures” (III)*)

14. Continue the same process until you have completed all six samples. Calculate the answers for **Column IV** by multiplying Column I by Column II.

15. Calculate the SUM for each column and record that SUM in the calculations and data section where indicated.

16. Use the equations on the data sheet to calculate the **Peterson Estimate** and **Schnabel Estimate** for all the samples shown.

17. Count the actual number of paper pieces that were in the coffee can when you started. If your estimates were valid, the number of actual paper pieces should be close to the estimates you calculated.

*18. If possible, either do the entire experiment twice or have other people do the experiment so you can compare results. Possibly share information with classmates?*

**Calculations & Data**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | I | II | III | IV |
| **Sample #** | **Total # of Marked Papers in the Coffee Can** | **Number “Captured”** | **Number of “Recaptures”** | **Column I times Column II** |
| 1 | 0 |  | no answer | no answer |
| 2 |  |  |  |  |
| 3 |  |  |  |  |
| 4 |  |  |  |  |
| 5 |  |  |  |  |
| 6 |  |  |  |  |
| SUM |  |  | \* | \* |

Peterson Estimate:

**Sample #2**: column I X column II = \_\_\_\_\_ X \_\_\_\_\_ = \_\_\_\_\_ (*the answer*)

column III

**Sample #3**: column I X column II = \_\_\_\_\_ X \_\_\_\_\_ = \_\_\_\_\_ (*the answer*)

column III

**Sample #4**: column I X column II = \_\_\_\_\_ X \_\_\_\_\_ = \_\_\_\_\_ (*the answer*)

column III

**Sample #5**: column I X column II = \_\_\_\_\_ X \_\_\_\_\_ = \_\_\_\_\_ (*the answer*)

column III

**Sample #6**: column I X column II = \_\_\_\_\_ X \_\_\_\_\_ = \_\_\_\_\_ (*the answer*)

column III

**AVERAGE of Peterson Estimate** = Add the 5 estimate answers = \_\_\_\_\_

5 (**AVERAGE**)

Schnabel Estimate: Use the “SUM” numbers at the bottom of the data *table (see the items with the* \*)

SUM from column IV = \_\_\_\_\_ = \_\_\_\_\_ (*the answer*)

SUM from column III

**ACTUAL NUMBER** of paper pieces in the coffee can (Procedure #17): \_\_\_\_\_

**Group Tally Fill in the results for other groups (Optional)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Group 1** | **Group 2** | **Group 3** | **Group 4** |
| **Actual #** |  |  |  |  |
| **Peterson Estimate AVERAGE** |  |  |  |  |
| **Schnabel Estimate** |  |  |  |  |

**CONCLUSIONS AND QUESTIONS**:

1. Based on your results, the sample results (page 5), and other groups results (optional), were the sampling estimates accurate? In other words, were the estimates close to the actual number of paper pieces in the coffee can?

2. Which sampling method was more accurate: Peterson or Schnabel?

3. If sampling is based on estimates rather than actual numbers that have been counted, how can we trust their accuracy?

4. Give two factors that may account for the estimate NOT being close to the actual number of paper pieces?

5. Assumptions need to be made in order to produce reliable sampling estimates. Below is a list of such assumptions used by fisheries managers.

**ASSUMPTIONS**:

1. Marked “fish” randomly mix with the rest of the fish in the lake.
2. Sampling equipment is able to catch all sizes of fish in the same abundance as they are found in the lake.
3. Tags or marks on the fish do not get lost.
4. Handling and marking fish do NOT make them susceptible to disease or predation.
5. Fish do not move into or out of the study area (*migrate*) during the sampling.

Which of the assumptions are least likely to be kept in real life?

Which of the assumptions are most likely to be kept in real life?

**Calculations & Data SAMPLE DATA**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | I | II | III | IV |
| **Sample #** | **Total # of Marked Papers in the Coffee Can** | **Number “Captured”** | **Number of “Recaptures”** | **Column I times Column II** |
| 1 | **0** | **11** | no answer | no answer |
| 2 | **11** | **23** | **4** | **253** |
| 3 | **30** | **17** | **3** | **510** |
| 4 | **44** | **32** | **7** | **1408** |
| 5 | **69** | **13** | **3** | **897** |
| 6 | **79** | **27** | **5** | **4833** |
| SUM | **101** | **---** | **22\*** | **7901\*** |

Peterson Estimate:

**Sample #2**: column I X column II = \_\_11\_ X \_23\_\_ = \_\_63\_ (*the answer*)

column III 4

**Sample #3**: column I X column II = \_\_30\_\_ X 17\_\_\_ = \_170\_ (*the answer*)

column III 3

**Sample #4**: column I X column II = \_\_44\_ X \_32\_\_ = \_201\_ (*the answer*)

column III 7

**Sample #5**: column I X column II = \_\_69\_ X \_13\_\_ = \_299\_ (*the answer*)

column III 3

**Sample #6**: column I X column II = \_\_79\_ X \_27\_\_ = \_966\_ (*the answer*)

column III 5

**AVERAGE of Peterson Estimate** = Add the 5 estimate answers = **340**

5 (**AVERAGE**)

Schnabel Estimate: Use the “SUM” numbers at the bottom of the data *table (see the items with the* \*)

SUM from column IV = 7901 = **360** (*the answer*)

SUM from column III 22

**ACTUAL NUMBER** of paper pieces in the coffee can (Procedure #17): **371**

**CONCLUSIONS AND QUESTIONS**:

1. Based on your results, the sample results (page 5), and other groups results (optional), were the sampling estimates accurate? In other words, were the estimates close to the actual number of paper pieces in the coffee can?

**The estimates (sample data) were relatively close.**

2. Which sampling method was more accurate: Peterson or Schnabel?

**The Schnabel index when compared with the Peterson index gives a better actual population estimate. This is because there is more given data in the Schnabel data. Thus, making the estimate closer to the true population size and value.**

3. If sampling is based on estimates rather than actual numbers that have been counted, how can we trust their accuracy?

**Mark-recapture studies are commonly used by wildlife biologists to estimate population size and to estimate survival probabilities for individuals. Models used to analyze mark-recapture data are categorized into those dealing with “open” populations and those dealing with “closed” populations. The difference is that closed population models assume that there is no change in the population size during the period of sampling (i.e., no births or deaths, no immigration or emigration). If the sampling is conducted over a short enough period of time, changes in population size from any of these factors may be deemed negligible.**

4. Give two factors that may account for the estimate NOT being close to the actual number of paper pieces?

**See the assumptions in question 5 … Also, in an open ecosystem, organisms can leave and do leave and do not return.**

5. Assumptions need to be made in order to produce reliable sampling estimates. Below is a list of such assumptions used by fisheries managers.

**ASSUMPTIONS**:

1. Marked “fish” randomly mix with the rest of the fish in the lake.
2. Sampling equipment is able to catch all sizes of fish in the same abundance as they are found in the lake.
3. Tags or marks on the fish do not get lost.
4. Handling and marking fish do NOT make them susceptible to disease or predation.
5. Fish do not move into or out of the study area (*migrate*) during the sampling.

Which of the assumptions are least likely to be kept in real life?

**#5, 2**

Which of the assumptions are most likely to be kept in real life?

**#1, 3**