Estimating Fish Populations

Objectives

Students will develop an understanding of types of activities PFBC biologists engage, and demonstrate that knowledge during group presentation of data. They will estimate a 'population of fish' using at least two mathematical models and compare the results of each. Students will also determine accuracy of estimate by comparing to actual population census/count.

Method

Students will use a mark and recapture model to estimate the population of fish (beans) in a waterway.

Background

How many fish are in that lake? That's a question often asked by anglers and biologists alike. The most accurate way would be to count every single fish. But to accomplish that, its likely that the lake would need to be drained, and all the fish collected and then counted. Course by then, the fish would likely be dead! Since this method at isn't practical, biologists come up with an estimate of the population.

An estimate is an approximation of the total population. Estimates are used when it's not practical to count all the individuals in a population. Estimates are made using representative samples of the fish being studied. That is, the sample collected is typical or representative of the entire water, and the entire population being studied. The data collected in each sample is then entered into a formula and an estimate of the population can be made. PFBC biologists use several different ways to collect population samples (see toolbox fact sheets for more information on each):

Electrofishing-by boat at night for lake & river fishes, towboat or backpack for stream fishes

Trapnetting--takes advantage of fish movement, either seasonally (like to spawning areas) or throughout the day.

Detailed records are kept on when, where and how long it took to collect the samples. In addition, information is gathered on the fish collected such as the weight, length of each fish (of certain species) and total number of species and number of each species. *Note: the catch can be further subdivided into fish of certain size, like legal size and greater, or trophy or young of the year.*

In addition, information about the size of the water is also considered. The entire lake can't be sampled; likewise it's not practical to sample the entire length of stream. The sampling area is representative of the entire waterway. In some cases, several sampling stations are identified.

Mark-recapture population estimate

The most commonly used method used by Fish and Boat Commission biologists is the mark and recapture estimate. During sampling, biologists mark the species they want to estimate the population. Fish may be marked by attaching tags or fins may simply be clipped. Marked fish are then returned to the stream. Then another sampling run is made on that same stretch of water, where the first sample was collected.

Grade Level: 7-12

Subject Areas: Environmental Science, Math, Biology Life Science

Standards:

Duration: at least 45 minutes

Group Size: any

Setting: classroom

Key Terms: inference, population, estimate, sample, percent error

On this sampling run, the number of marked fish collected is noted, along with the total number of fish collected on each run. Multiple sampling runs are made to increase the accuracy of the estimate.

When using this method, several conditions must be true (or the accuracy of the estimate is in question):

1. the marks can't be lost, or make the fish more vulnerable to predators, or die due to the handling.
2. fish are not moving into or out of the study area during the sampling process.
3. marked fish will mix randomly with the rest of the fish in the study area.
4. sampling is consistent for each sampling attempt; that includes the gear used, the area sampled, and the time spent sampling.

If any of these conditions is not met, then the method is not as accurate, and shouldn't be applied.

Mark-Recapture Activity

Materials/Equipment:

- 1/2 pound bag of dried beans
- Lunch sized paper bags, coffee can, small plastic grocery bags or other container to hold the "population" of fish.
- Stopwatches or watches with second hand
- Clip boards
- Population estimate worksheet
- Markers
- Small disposable cup, or measuring cup, container doesn't matter, as long as each group has similar size and the same size is used on each run
- Optional--calculator

Procedure

Before class

1. Divide the beans into enough bags for each group of 3. It won't matter if you evenly distribute or count the beans per bag.

2. Divide the group into pairs or three. Each group should get one worksheet, marker, and collection cup. Explain that the bag or container of beans represents a body of water, and each bean is a species of fish. Their job is to estimate the

population of fish found in that lake.

3. Each group should take a 'sample of the fish in the water ' using the small cup. Take the sample by scooping it through the beans or any other means--as long as the note the method used. Record the time spent 'collecting', by using either the stopwatch or a watch with second hand. Record the time as fractions of a minute. (the number of seconds/60)
4. Count and mark each bean in the cup. *(Note: there may be other marks on the beans from previous classes--the group will have to make sure their mark can be distinguished from the others)* Record the number marked on the data sheet. This is the Marking run. The number marked in this run should be entered in every row in that column on the data sheet.
5. Using the same sample collection method, repeat the sampling five more times (the number of runs can be reduced to save time, but do no fewer than three repeats). Enter the data on recaptures (R) on the data sheet for each run.
6. Use the worksheet to calculate the Peterson estimate for each run. Then calculate the average value.
7. Use the worksheet to calculate the Schnable population estimate.
8. Count the actual number of beans in the 'lake'. Compare to the population estimate by calculating percent error. Percent error is an indication of the accuracy of the estimate, compared to the actual count. Biologists don't and can't use this method. They use other statistics to measure the accuracy of the estimate.

Assessment

Catch/Harvest Rate

While this isn't a population estimate method per se, it is one means that biologists can track population trends. The idea is that the number of fish collected is divided by the amount of time it took to catch/collect them.

For example, in 1 hour of eletrofishing, 10 trout were collected. So the catch per unit effort (CPU) is 10/1=10. This rate can be compared to the rate observed when sampling this water before. If the CPU last sampling (2 years ago) was 5, did the population increase or decrease?
CPU=catch/time
Catch=number of species collected during sampling time
Time=the amount of time spent sampling

Zippin's removal method

$N=n_1^2/n_1-n_2$

N=population estimate
n_1=number removed on first run
n_2=number removed on second run

In this estimate, individuals are temporarily removed from the population. In this case, don't return the beans collected on the first run back to the 'lake'.

Evaluation

Have each group present their data, including population estimates, actual counts and percent error.

Fish Population Estimate Data sheet

Group name:_____ Date:_____

Mark and recapture data

Sampling run number	Sampling time	M Number marked	C total number caught	R number recaptured	M x C	Peterson Estimate N=M xC/R
0--marking run	Start: Stop: Total time:					
1	Start: Stop: Total time:					
2	Start: Stop: Total time:					
3	Start: Stop: Total time:					
4	Start: Stop: Total time:					
5	Start: Stop: Total time:					
	Start: Stop: Total time					
			Sum of column			

Actual Count of 'fish'

Schnable Estimate: Sum of M x C / Sum of R	Peterson Estimate: sum of N / 5 (or number of runs)

Percent error=(actual amount/estimate) x 100