



Mark and Recapture: Pennsylvania Black Bear Lesson Plan

Teacher Sheet

Summary:

Students will learn about the biology and management of Pennsylvania black bears. Students will also simulate processing a black bear through similar steps taken by State Game Wardens and use ratios to estimate a bear population for a given year.

Subjects: Math, Science

Suggested Grades: Middle School

Duration: 1 –2 40-minute class periods

Objectives:

- Students will be able to answer several questions related to black bear biology and management.
- Students will learn how State Game Wardens and Bear Biologists catch and process black bears as part of black bear management in Pennsylvania.
- Students will be able to calculate an estimated bear population using the Lincoln-Peterson method and a variation of the method—Correction for Continuity.

Materials:

Links:

- Black Bear Wildlife Note: <https://www.pgc.pa.gov/Education/Pages/Virtual%20Learning.aspx>
- Bear Management PowerPoint: <https://www.pgc.pa.gov/Education/Pages/Virtual%20Learning.aspx>

Included:

- Bear head & ear-tags PDF download
- Student worksheets PDF download

Other necessary materials needed per student (not included)

- Paper clips
- Ruler
- String - cut to varying lengths between 1-12 (whole numbers).
- Ruler
- Scissors
- Disposable gloves (optional)

Bear Management PowerPoint Slides & Notes



Background Information:

Part 1: Black Bear Management /*Bear Management PowerPoint Notes

Slide 1



The Pennsylvania Game Commission manages all of Pennsylvania's wild birds and mammals, for current and future generations.

Slide 5



Once a bear is caught, a tranquilizing drug is loaded into a jab stick. Small holes on the top of the trap allow for easy access. Care is taken to be sure that the needle is injected correctly.

Slide 2



Pennsylvania is home to a population of approximately 20,000 black bears. Bears can be found in large forested areas statewide although, they are not as common in large urban or agricultural areas.

Slide 6



The tranquilizing drugs prevent the bear from blinking. Eye drops and a blindfold are used to protect the eyes and keep the bear calm while being processed.

Slide 3



Bears are trapped for research or in areas where they have become a nuisance. In PA, we currently trap and tag about 700 bears each year. Typically nuisance bears are moved after capture, while research bears are released on site.

Slide 7



The weight of the bear is estimated by using a chest tape.

Slide 4



Bears are captured in a "culvert" trap. Inside the trap, there is a basket that is filled with bait. Often, traps are baited with donuts. When a bear pulls on the basket, a trigger releases the door and the trap closes.

Slide 8



Metal tags with unique numbers are placed in both of the bear's ears using special pliers that close the tags.

Bear Management PowerPoint

Slides & Notes



Slide 9



Tags allow the bear to be identified in the event it is re-captured or harvested. This information allows us to study their range and distribution.

Slide 14



Occasionally the bear is given a reversal drug to help it recover faster or it may be allowed to recover on its own.

Slide 10



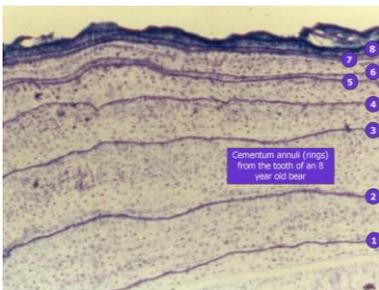
To determine the age of the bear, a small premolar tooth located directly behind the large canine tooth is removed. They are located on both sides of the top and bottom jaws and are not necessary for the bear to eat or survive.

Slide 15



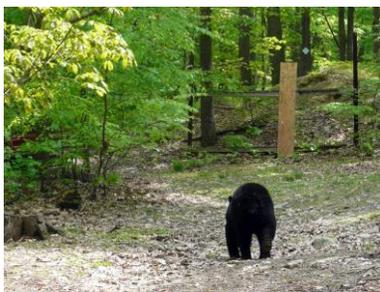
Regardless of the method used, when the bear wakes up it is a little groggy and a bit shaky on its feet.

Slide 11



In a lab, a thin cross section is cut from the root of the tooth and placed under a microscope. Growth rings (called cementum annuli) are counted to determine the age, much like aging trees by counting their growth rings.

Slide 16



In a very short time, the bear is able to walk normally and heads for the bushes to take a nap and sleep off the remaining effects of the tranquilizing drug.

Slide 12



All of the data taken from the bear is recorded. Data includes tag numbers, weight, sex and location of where the bear was trapped. This information goes into a computer data base for future reference and research.

Slide 17



The entire experience has no lasting effect on the bear.

Slide 13



Even after the bear is processed, it is closely monitored until it "wakes up." The blindfold is removed and the bear is placed in a position to aid respiration and recovery.

Slide 18





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Background Information continued:

Part 2: Pennsylvania Black Bear Population Estimates:

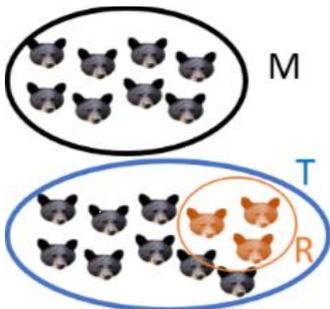
Like most animals, direct counts of black bear populations are impossible because of their secretive nature and inaccessibility. The Game Commission uses a technique called the Mark and Recapture Method to estimate the Pennsylvania black bear population. This method involves the Game Commission to capture individual black bears in a natural population (using a culvert trap), mark them (with ear-tags), release them back into the population (nuisance bears are released at the nearest State Game Land and research bears are released on site), and recapture a smaller population sample (using the statewide firearms season).

This method assumes that animals (black bears in this case) in the population are equally likely to be marked and recaptured and that the marked animals (black bears) are randomly distributed in the population during recapture. This method also assumes the population is closed during the mark and recapture period—meaning there is no immigration, emigration, births or deaths in the bear population.

Tag loss, immigration, emigration, and undetected mortality of tagged animals (equal catchability) can be problems for a mark-recapture estimate. To minimize these effects, the Game Commission wipes the slate clean each year and only counts an animal as ‘marked’ if it was handled in the current year. In other words, if a bear with old ear tags is harvested, but it wasn’t handled that year, it is considered an ‘unmarked’ bear for the purpose of a simple mark-recapture estimator.

The Mark and Recapture method can be expressed mathematically using ratios:

$$\frac{R \text{ (Marked Re-captures)}}{T \text{ (Total in Second Sample)}} = \frac{M \text{ (Marked Initially)}}{N \text{ (Total Population)}}$$



M = Number of bears ear-tagged that year/ first capture

T = Total number of bears recaptured (total bear harvest/statewide firearms season)

R = Number of ear-tagged bears in harvest/recaptured

We can rearrange the equation to estimate the Pennsylvania black bear population, N , to be:

$$N = \frac{M \cdot T}{R}$$

This formula is typically referred to as the **Lincoln-Petersen Formula**.



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Background Information continued:

Part 2: Pennsylvania Black Bear Population Estimates:

Real-life Example:

The data below is actual data used to estimate the Pennsylvania black bear population for 2018.

The 2018 capture period began the day after the 2017 statewide firearms season and ended the day before the 2018 statewide firearms season. A total of 733 bears were ear-tagged during that period. Twenty-two of the tagged bears died during the same capture period (mostly by vehicle), one tagged bear was harvested in the Early Season, and twenty tagged bears were harvested in the Archery Season. Leaving 690 tagged bears still alive going into the statewide firearms season (733-22-1-20=690). Of these 690 tagged bears, 73 were harvested in the general season. The total harvest in the general season was 2,017.

Using the above information we would have an equation that would look like this:

$$\frac{R (73)}{T (2017)} = \frac{M (690)}{N}$$

$$\text{or } N = (690 \times 2,017) / 73 \quad N = 19,064$$

There are several variations of the Lincoln-Peterson formula that have been developed based on statistical sampling theory. The variation of the Lincoln-Peterson formula that the Game Commission uses is called the **Correction for Continuity**. This method uses +1 and -1 adjustments. These adjustments are there to prevent biased estimates when sample sizes are small. Using the Correction for Continuity method our equation now looks like this:

$$\frac{R (\text{Marked Recaptures}) + 1}{T (\text{Total in Second Sample}) + 1} = \frac{M (\text{Marked Initially}) + 1}{N (\text{Total Population})} - 1$$

$$\text{Or } N = (690 + 1) \times (2,017 + 1) - 1 / (73 + 1)$$

$$N = 18,843$$

The black bear population for 2018 was estimated to be 18,843 black bears.



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Procedure:

Part one:

Discuss Pennsylvania black bear management with students using the background information in Part one - the "Bear Management " PowerPoint. Provide each student with "Part One" of the student worksheets, the Black Bear PowerPoint slides & notes, and the Black Bear Wildlife note. Instruct students to read the Black Bear Wildlife note and use what they learned about black bear management to answer the questions on the worksheet.

Part Two:

Tell students now that they have learned all about black bears and their management, they are honorary State Game Wardens (SGWs) and they are going to work through a simulation of "processing" a black bear for research similarly to how a SGW would process a black bear in the field. Give each student the following materials: "Part Two" of the student worksheets, black bear head and ear-tags student sheet, 1 piece of string, a ruler, and 2 paperclips or they can use a stapler. Explain the bear head represents a bear they caught in a culvert trap. To "process" the bear they will need to follow the instructions on their student worksheet and fill out the field data sheet.

Part Three

Tell students they will now play the role of a black bear biologist and they are tasked with estimating the black bear population for a given year. Explain that the black bear population in Pennsylvania is estimated using a method called the Mark and Recapture method. Using the background information (part two), explain what a Mark and Recapture method is and how it works, specifically for the Pennsylvania Black bear population. Be sure to explain that this method involves the Game Commission to capture individual black bears in a natural population (using a culvert trap), mark them (with ear-tags), release them back into the population [nuisance bears are released at the nearest State Game Land and research bears are released on site], and recapture a smaller population sample (using the statewide firearms season). Express that this method assumes the population is **closed** and explain what a closed population is. Explain to students that the Mark and Recapture method can be expressed mathematically using ratios. Use the examples in the background information to show students how to estimate the black bear populations using both the Lincoln—Peterson Method and the variation of that method the Game Commission uses -the Correction for Continuity method.

Tell students it's now their turn to estimate a pseudo black bear population using both the Lincoln-Peterson method and the Correction for Continuity method. Have the students complete "Part Three" on their student worksheets.

After the students complete all the worksheets, go over the correct answers with them.