Student Pages: Group Activity

Grizzly Bear Science Team 1

For this activity, your group is the "Grizzly Bear Science Team #1". Your team is responsible for scientifically evaluating whether or not the GYE grizzly bear population has met **Demographic Recovery Criterion #1**.

To do this, we should take another look at **Demographic Recovery Criterion #1**:

"Because **48** adult females with cubs of the year is equivalent to a population of approximately **500** total individuals, we are establishing a target number of 48 adult females of the year. This target number shall not go below **48** for any **two** consecutive years. For genetic reasons, it is desirable that the total population of grizzly bears in the GYA be maintained above 400 bears. To assure that this goal is met and in order to adopt a conservative approach, the total population will be maintained at or above **500** grizzly bears."

Your team needs to scientifically evaluate this Demographic Recovery Criterion. So, you need to use the scientific process, which includes at least the following steps:

1. Develop Hypotheses
2. Use hypotheses to develop predictions
3. Design a scientific study to rigorously evaluate predictions
4. Collect data
5. Analyze and evaluate data
6. Use results from data evaluation to draw conclusions, and to inform new hypotheses
7. Share findings with peers and the public

Unfortunately, we don't have time to design field studies, determine statistical estimators, and tromp around in the mountains following grizzly bears to collect data. The IGBST gets to do all that fun stuff! Lucky for us, the IGBST has shared their data, so your team CAN participate in Steps 1, 2, 5, 6, and 7.

Let's get started with hypotheses:

Hyp 1: The grizzly bear population has met Demographic Recovery Criterion #1

There's a competing alternative hypothesis, what is it?

Hyp 2:

_____

Great! Okay, let's go back to Hypothesis 1. If Hypothesis 1 is correct, what predictions would you make about the data you evaluated in Datasets 1-3?

Example of one prediction:

Prediction 1A: This population maintains 48 females with cubs of the year, and the number of females with cubs of the year does not go below 48 during two consecutive years

What would prediction 1B be (hint: it has something to do with the number 500)?

Prediction 1B:

_____

_____

If Hypothesis 2 is correct, what predictions would you make about the data you evaluated in Datasets 1-3?

Prediction 2A:

_____

_____

Prediction 2B:

_____

_____

Okay, it's time for Step 5 of the Scientific Process (i.e., Analyze and Evaluate Data).

Hmmmmmmm.....some of the data in Datasets 1-3 are a little confusing, and this might make it difficult to evaluate your predictions. In the following paragraphs, you will find some information that should help:

What does "Minimum Population Estimate" mean exactly?

In Dataset 1, you were asked to graph the "Minimum Population Estimate" for years 1991-2014, and then calculate lambda (λ) for each consecutive 2-year period. What exactly does "Minimum Population Estimate" mean?

It means that the size of the population of grizzly bears during $year_X$ was AT LEAST as big as the "Minimum Population Estimate" for $year_X$.

To calculate the "Minimum Population Estimate" for years 1991-2006, the IGBST used an equation that included information about ONLY the number of females with cubs of the year (COY). Therefore, the "Minimum Population Estimate" is **biased LOW** and provides a **conservative estimate** for total annual population size.

Importantly, the IGBST regularly updates its methods as new science evolves to better calculate and estimate numbers.

For example, beginning in 2007, the IGBST began to calculate "**Estimated Total Population Size**" by using an improved equation that includes information about MORE than just the number of females with COY (we won't be getting into the nitty gritty of this equation!).

Specifically, the IGBST began estimating annual size for each **population segment** of the grizzly bear population. What are the population segments? Independent females (females that are 2+ years old), dependent young (individuals that are < 2 years old) and independent males (males that are 2+ years old).

Dataset 2 looks different from Dataset 1 because in 2007, the IGBST began collecting data on these 3 segments of the population. They then used an improved equation to estimate annual **total population size** that combined all of this information about the 3 population segments, along with information about reproductive success.

"Estimated Total Population Size" and "Minimum Population Estimate" are not the same thing.

So....the graph that you created from Dataset 1 that shows the "Minimum Population Estimate" by year **actually shows** the "Minimum Population Estimate" for years 1991-2006 and "Estimated Total Population Size" for years 2007-2014. It's a little confusing, but it's the best we can do with the data we have. Just know that the "Minimum Population Estimate" is biased low. The "Estimated Total Population Size" is more accurate.

95% Confidence Intervals

"Estimated Total Population Size" values in Dataset 2 include 95 confidence intervals (CI). Every time a scientist estimates a value, there is some uncertainty involved. CIs are one way to include these measures of uncertainty.

Why did the IGBST pick the number 500?

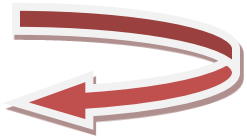
Because the GYE grizzly bear population is currently geographically isolated from other grizzly bear populations, it is subject to the possible effects of genetic drift and inbreeding depression. To adequately mitigate the potential effects of genetic drift and inbreeding depression, Miller and Waits (2003) recommended that the total population size for the GYE grizzly bear population be at least 400 bears. To assure that this goal is

met and in order to adopt a conservative approach, the IGBST recommends that the total population size should be maintained at or above 500 grizzly bears in the GYE.

What is lambda?

You have probably learned a bit about lambda already. If not, no worries. Lambda is the "per capita geometric rate of increase of the population". What? In a nutshell, lambda provides information about the total population trend during time 0 to time 1. Did the population grow during that time period? Did the population decrease during that time period? How can you tell? Lambda provides insight into these questions.

How do you calculate lambda?



$$\text{Lambda} = N_1/N_0$$

Where:
N_0 = estimated population size at time 0
N_1 = estimated population size at time 1

If lambda < 1, then the population decreased during the time period of interest
If lambda " > 1, then the population increased during the time period of interest
If lambda = 1, then the population remained stable during the time period of interest

What is NChao2?

In Dataset 3, you had to calculate the number of females with cubs annually using the NChao2 estimator. **This estimator accounts for individual sighting heterogeneity.**

Here's the equation:

$$N_{Chao2} = m + \frac{f_1^2 - f_1}{2(f_2+1)}$$

Where:
N is the estimated size of the females with cubs
m is the number of females sighted randomly (without the aid of telemetry)
f_1 is the number of families sighted once
f_2 is the number of families sighted twice

As a team, make sure you know what "individual sighting heterogeneity" means and why the IGBST thinks it's important to account for individual sighting heterogeneity when estimating the number of females with cubs (hint: the answer is NOT found in these Student Pages.....).

Okay, you should have enough information now to complete Step 5 of the Scientific Process (i.e., Analyze and evaluate the data) and complete Step 6 (i.e., Use results from data evaluation to draw conclusions). Which predictions did the data from Datasets 1-3 refute?

Based on the scientific data you have, has Demographic Recovery Criterion #1 been met or has Demographic Criterion #1 NOT been met?

Time to work on Step 7 of the Scientific Process (i.e., share findings with your peers).

Your team will now prepare a presentation about Demographic Criterion #1 and your findings related to this criterion. Your team will give this presentation to the rest of the class (i.e., Grizzly Bear Science Team 2 and Grizzly Bear Science Team 3).

In this presentation, make sure to include AT LEAST the following:

1. What is Demographic Recovery Criterion #1?
2. What are your hypotheses and predictions?
3. What does minimum population estimate mean?
4. Why did the IGBST change the way they estimated population size beginning in 2007?
5. Show the graph you made for Minimum Population Estimate for years 1991-2014 (from Dataset 1). Let your classmates know that the point estimates for years 2007-2014 are more accurate than those for years 1991-2006.
6. Why did the IGBST use 500 as the minimum number of individuals to maintain in this grizzly bear population?
7. What is lambda? Show the graph you made for estimated lambda for each consecutive 2-year time period for years 1991-2014 (from Dataset 1). What can you say about the population trend? During the last 5 years or so, lambda has remained around 1. What does this indicate about the population?
8. Show the graph you made for "Annual Size Estimate" for independent females with 95% CIs for years 2007-2014 (from Dataset 2). Why is it important to include 95% CIs?
9. Show the graph you made for the number of unduplicated females with COY (using the NChao2 estimator) for years 1983-2014 (from Dataset 3). Why did the IGBST use the NChao2 estimator?
10. Which predictions did your data support?
11. What are your conclusions regarding the grizzly bear population in GYE with respect to Demographic Criterion #1?