Title- **Population Ecology-Graphing Populations and Carrying Capacity**

Summary: Population Ecology. Students will discover how populations grow and maintain their populations (carrying capacity) and how environmental factors (limiting factors) influence their populations.

Subject and Grade Level: **Biology, Ecology 9-12**
Student Learning Objectives:

State Standard(s): HS. 7.2.A Use mathematical and or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.

ISTE Standard(s): 5c Students break problems into components parts, extract key information, and develop descriptive models to understand complex systems or facilitate problem-solving.

Step by Step Procedures:

HOOK/ATTENTION GETTER: Instructor captures student interest and connects with prior knowledge and experience.

Teacher Instructions:
Play the fish game on a chromebook. Send link to Google Classroom.

http://fishgame.cloudinstitute.org/games/fish_game.html
 "You have 10 days to catch as many fish as you can. The money you make from these fish will need to support your family for the next month. Each fish nets $2."
Ready to play? Remember: the object of the game is to have as many fish as possible at the end of the game.

Student Instructions:
Choose the digital tool or non tech activity for this step: chromebook or computer with internet
Get a chromebook, go to Google Classroom, click on

http://fishgame.cloudinstitute.org/games/fish_game.html
 "You have 10 days to catch as many fish as you can. The money you make from these fish will need to support your family for the next month. Each fish nets $2."

Did you ever make it through 10 days of fishing without depleting the fish stock in the lake?
Did you win?
What affected the population of fish? What factors influenced the number of fish? Were there several factors to consider and multiple outcomes?

Student Instructions:

Read news article- Answer or predict- Why did wolves disappear from the park? How did this affect the ecosystem (consider populations of animals and plants)? What might have happened when the wolves were reintroduced? What is a wolf pack's primary source of food? Can the Yellowstone ecosystem adapt to the reintroduction of wolves (consider populations and animals) and how? What changes will be noticed in populations- carrying capacity, limiting factors

https://docs.google.com/document/d/1UFLEf-7eOoufoxZbBL1RqgqjM69ccndqEyGQBCCdTzE/edit?usp=sharing

Will the population of the wolves be limited, or will they grow unchecked?

Article from Reintroduction of Wolves

DIRECT INSTRUCTION: Instructor shares knowledge, concepts, theories, and vocabulary with students.

What factors influence populations in ecosystems? How are these factors interrelated?

What is carrying capacity?

What is a limiting factor?
- Are concepts and processes clearly outlined and modeled?
  Does it provide concrete examples of the desired outcome(s)?

Describe your teaching methods, strategies, and activities here. You may optionally provide separate instructions for your students on how to use these tools.:

Students will be given a set of data to use in Google Sheets, they will create a spreadsheet of the data of elk and wolf populations over the last several decades. Students will create a graph using the data in a spreadsheet to identify the growth of a wolf population and the change in elk population when wolves are reintroduced.

Carrying capacity and limiting factors can be identified on the graph. Students may also be able to make predictions based on the data for the future populations of elk and wolves.

Teacher Instructions:

Students are given the data sets and instructed to make a two column spreadsheet on Microsoft Excel. Once data (with headings is entered, students graph the data together and determine carrying capacity and limiting factors for wolves.

Student Instructions:

With your partner, download the Microsoft Excel file and open it. On the file you will find two data sets for elk and wolf populations in Yellowstone National Park over the last 30-40 years. Your task is to make a graph of the data showing each population. Then estimate the carrying capacity for each population and name several limiting factors for each population. Instructions for making a two axes chart in Excel are also available on the link in Google classroom.
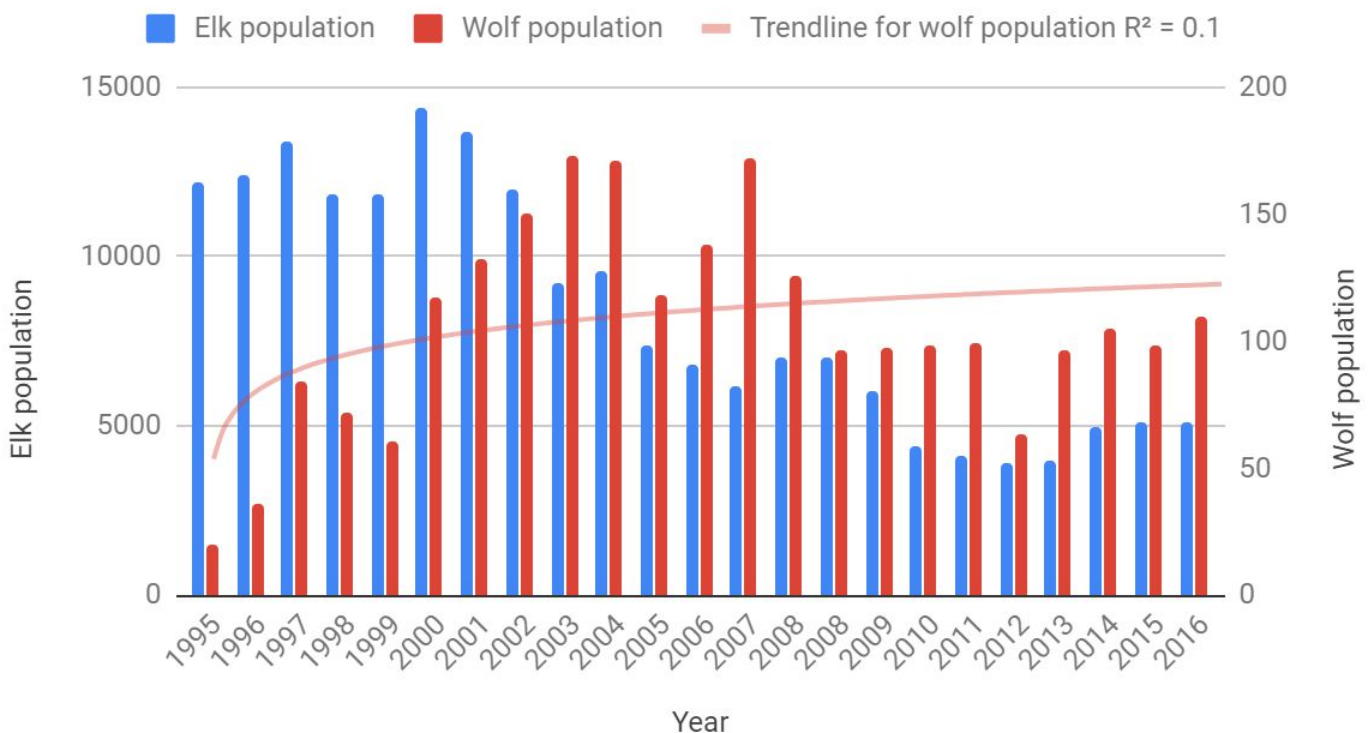
Choose the digital tool for this step:

Microsoft Excel

GUIDED and INDEPENDENT PRACTICE: Students work collaboratively to apply and work with knowledge, concepts, and theories.

Students work with a partner to make a graph of the data given. Teacher can show the Google Sheets example of the data and graphs and ask students to combine the graphs.

https://docs.google.com/spreadsheets/d/1oi0v2OL8UTqZ6dC1-SBF8z0ug-yO49K82tsIsPG6A4o/edit#gid=8388 50643**,**
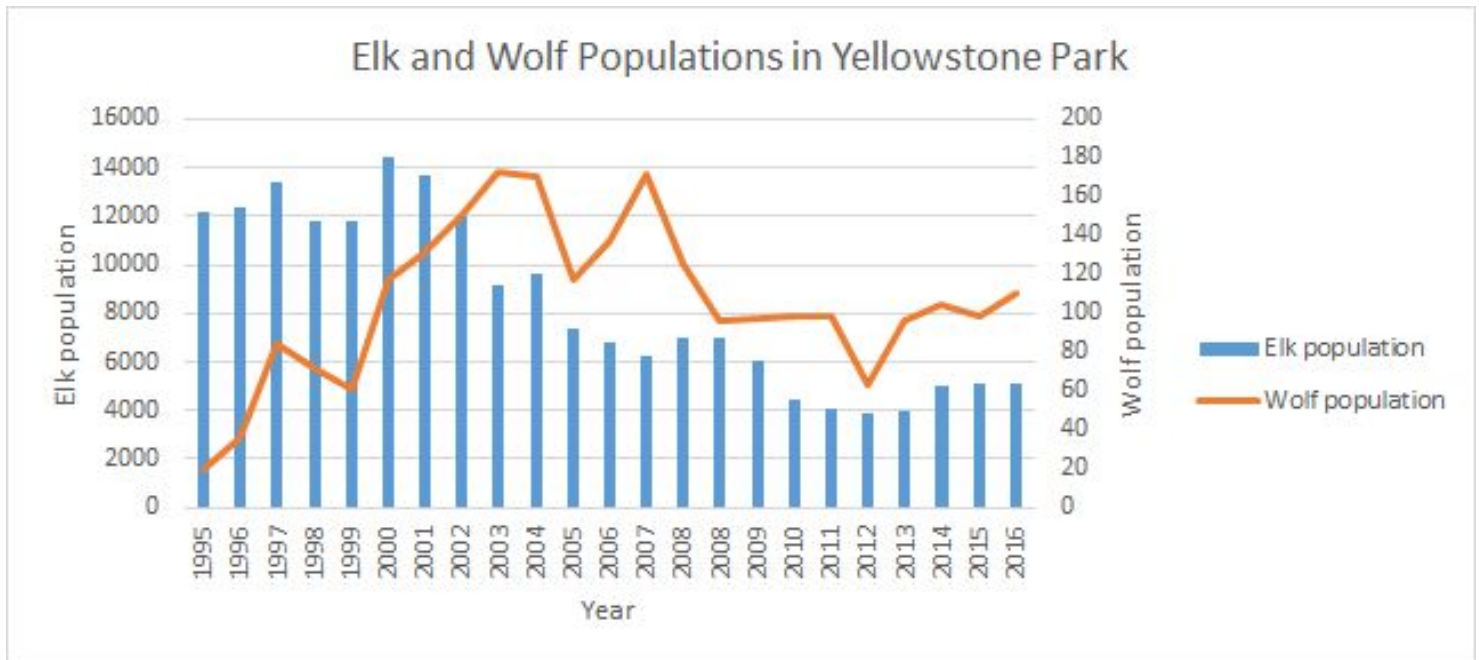

Elk and Wolf populations in Yellowstone Park

On Excel, students can make both axes and estimate a line of best fit for carrying capacity for both populations. They both list limiting factors that could affect both populations.

ASSESSMENT of LEARNING:

Students can print graphs of their data and draw (or have the computer make) a line of best fit for carrying capacity for both elk and wolf populations.
Students should have a combination graph with elk and wolf populations and a trend line of best fit.

Elk and Wolf Populations in Yellowstone Park

They should have a list of limiting factors that limit both populations- examples- but not limited to

Elk population limiting factors	Wolf population limiting factors
rainfall	Snow depth for hunting
grass/foliage growth	Elk population
Wolf population	Number of litters born in spring
Wildfires in Yellowstone	Hunting permits
Hunting permits	