# 4 POPULATION DYNAMICS AND CARRYING CAPACITY

**ESTIMATED TOTAL TIME**
**50 minutes**

- **Grades 9–Adult**
- **Life Sciences, General to Advanced**
- **Data Literacy, Social Studies, and Art Connections**

This activity builds on the historical human impacts on panther populations in Activity 3, focusing on population dynamics and carrying capacity. After graphing the data, students estimate the carrying capacity of the Florida panther population and compare it to Yellowstone's gray wolf carrying capacity. Students determine the stage of panther population growth and use evidence and reasoning to defend or refute a claim as to whether or not the Florida panther is likely to reach carrying capacity in the future.

**For younger audiences**, students can use the table provided to graph the panther population from 1900. Additionally, students should watch the introductory video for logistic and exponential growth models.

**For advanced high school and adult audiences**, participants can complete Activity 3 before doing this activity, to gather and graph the data. Additionally, participants can choose to watch the introductory or advanced video for logistic and exponential growth functions in population ecology.

**KEY TERMS**

- **carrying capacity**
- **exponential growth**
- **logistic growth**

## BACKGROUND

The Florida panther population has changed dramatically in the last 500 years. Once a healthy population of at least 3,000 individuals, the population plummeted due to habitat loss, hunting, and other human activities during the 19th and 20th centuries. Efforts to save the Florida panther from extinction have resulted in an increase from a critically low population of 20-30 individuals in the 1970s to approximately 200 today.

Because Florida panthers play critical ecological roles as apex predators and keystone species, biologists' work involves monitoring how increases or decreases in the panther population would influence the ecosystems within

the Florida Wildlife Corridor. Researchers monitor **carrying capacity** to assess factors such as food availability, water sources, shelter, and other resources, in order to estimate how many animals an area can support without degrading the environment or leading to population crashes. If a population were to exceed the carrying capacity of its habitat, this could lead to resource depletion, increased competition, and heightened human-wildlife conflicts. Conversely, if a population falls below the carrying capacity, it may indicate habitat degradation or limited resources, necessitating habitat restoration or other management actions. Populations experiencing **exponential growth** will eventually deplete resources. Populations experiencing **logistic growth** increase more slowly until the population reaches its carrying capacity, influenced by limiting factors in the ecosystem. As a population grows, it can eventually overshoot the carrying capacity, leading to a die-off, and fluctuate back and forth around the carrying capacity in an unstable or stable equilibrium.

Monitoring the panther population to determine its stage of growth (logistic or exponential) in relation to carrying capacity helps conservationists implement strategies to maintain a sustainable balance. These strategies might include habitat preservation, wildlife corridor connectivity enhancement, and measures to reduce human impacts like road mortality and habitat fragmentation. By managing the population within the carrying capacity of the habitat, scientists aim to ensure the long-term survival of Florida panthers while maintaining the health of the entire ecosystem within the wildlife corridor.

Florida panther conservationists may look to the reintroduction of the gray wolf within the Greater Yellowstone Ecosystem as a model of population growth for an apex predator that was previously absent from its ecosystem.

## STANDARDS

This activity addresses the following:

**NGSS: HS-LS2-1:** Use mathematical/computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.

**Florida NGSS: SC.912.L.17.5:** Analyze how population size is determined by births, deaths, immigration, emigration, and limiting factors (biotic and abiotic) that determine carrying capacity.

**AP Env. Sci: ERT-3.E.** Describe the impact of carrying capacity on ecosystems.

## OBJECTIVES

**Students will:**

- identify and describe factors that affect population size;
- analyze data to construct population graphs and determine the population's stage of growth; and
- use evidence and reasoning to defend or refute a claim regarding whether or not a population has reached carrying capacity.

## PREPARATION

**Gather and/or print materials:**

- Video: "Threats to the Panther" (2:19) (optional)
- Slides: Population Dynamics and Carrying Capacity
- Handout: Florida Panther Population Analysis (1 per student or small group)

**Set up technology:**

- Determine if students will be using graphs from Activity 3 or the table provided to graph the population.

## 5 MIN RECONNECT WITH THE FLORIDA PANTHER'S STRUGGLE FOR SURVIVAL

1. Ask students to brainstorm some of the ecological challenges that the Florida panther population has experienced from human impacts.
2. If students have not previously viewed the "Threats to the Panther" video clip, watch it now and add ideas to the brainstorming list.

## 15 MIN GRAPH THE FLORIDA PANTHER POPULATION

3. Have students create a population graph for the Florida panther population from 1900-present day, by completing Part 1 in the Florida Panther Population Analysis handout. A model has been provided in the slides. Note that unconnected data points represent incomplete census data.
4. As a class or group, watch one of these videos that illustrates carrying capacity, logistic growth, and exponential growth of a population:
   a. For younger audiences or introductory biology students, watch this video, "Exponential and Logistic Growth in Populations" (7:32).
   b. For advanced high school and adult audiences, consider watching this video, "Logistic Growth Versus Exponential Growth" (10:02) if students are using functions and ecological equations in their coursework.
5. Have students use their data to answer Part 1, questions 1 and 2 in the handout, and use the terms from the video to consider which type of growth the Florida panther population is experiencing. Students should conclude that the Florida panther is in the logistic growth stage of carrying capacity, and that habitat destruction from human development and hunting has led to the panther population's near extinction.

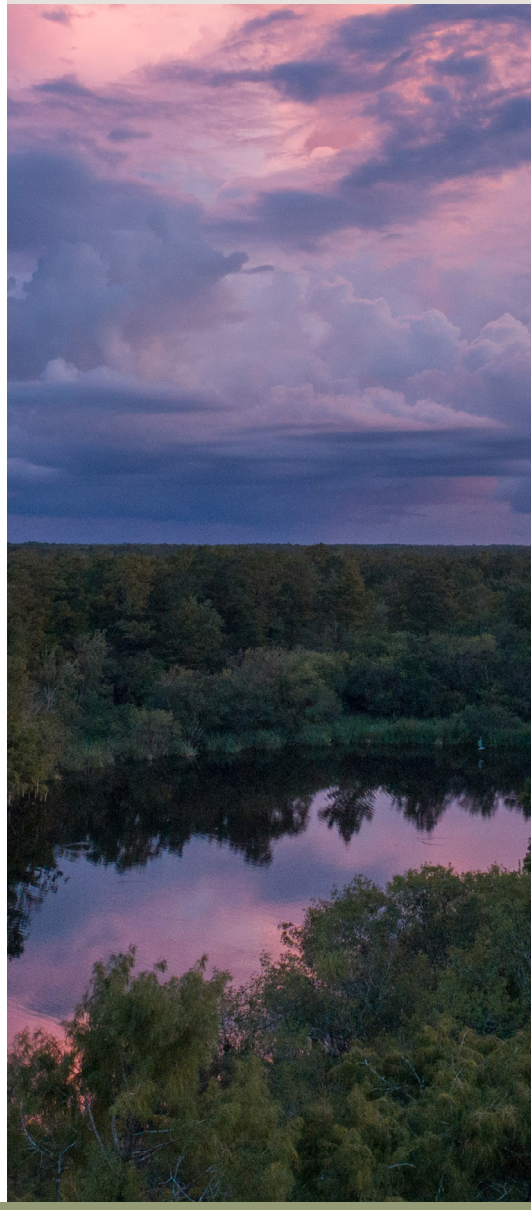
## 15 MIN INVESTIGATE THE GRAY WOLF POPULATION'S CARRYING CAPACITY

6. Use the slides to have students compare the history of the Florida panther population to the history of the Yellowstone gray wolf population. First, show students a historic image illustrating the excessive extermination of wolves and explain to them that wolves were hunted to extinction in the Greater Yellowstone Area.
7. Then show students the *History of the Wolf Population in Yellowstone National Park* graph. Explain that the population extends across the Greater Yellowstone Ecosystem, but the Yellowstone National Park wolf packs have been carefully monitored, with population size measured annually, so the regional population is larger. Have students answer Part 2, question 1 in the handout to identify the stage where the wolf population is according to the graph.
8. Explain to students that the gray wolf population has been fluctuating between about 90 and 120 individuals since 2009, as can be seen in the blue oval on the next graph in the slides, which suggests that the gray wolf population fluctuations in Yellowstone National Park may be due to reaching carrying capacity. Additional considerations include prey populations, migration, and changes to federal and state protections which have led to increased trophy hunting in recent years. Continued careful monitoring of this population over time will help researchers understand the population dynamics of these wolf packs. Ask students to use evidence from the gray wolf population graph to **support** or **refute** the claim: *The gray wolf in Yellowstone National Park has successfully recovered*, Part 2, question 2 in the handout. Have students share out with the whole class. Help students recognize that scientists may differ in their assessments of the health and growth of the wolf populations. (Note: According to these data for gray wolves in Yellowstone National Park, shown in the graph for this activity, the wolves are not experiencing exponential growth after unstable equilibrium.)
9. Show the two population graphs: Florida panther and Yellowstone gray wolf, also on the handout. Have students discuss the two graphs with a partner and then as a class. Have them build on their analysis for the final question in Part 2, question 3 on the handout: *Do you think the Florida panther population will reach carrying capacity? If yes, how? If no, why not?*

## MORE TO EXPLORE

**POPULATION DYNAMICS EXPLORATION**

Identify local species students are interested in that are endangered, threatened, introduced, or invasive. Have students choose a species and research the population changes, limiting factors, growth, carrying capacity, and mortality/natality. Discuss, using the following prompt: In what ways might changes in populations of these species directly affect other populations?



**15 MIN** **WHOLE CLASS DISCUSSION**

**10.** If time allows, have an active whole-class discussion using "concentric circles." Organize students who say "yes" to the question above in an inner circle, with students who say "no" in an outer circle. Each student pair shares their evidence for whether or not they think the panther population will reach carrying capacity. (Students in the inner circle do not move, while the students in the outer circle rotate when a 90 second timer is up.) Students share evidence from the graphs to support their positions as the outer circle rotates around the inner circle. Complete three or more rounds of concentric circles to ensure students have ample opportunity to share and listen to opposing viewpoints.

## MORE TO EXPLORE

**COMPARE RESEARCH EFFORTS FOR THE WOLF AND PANTHER**
Have students explore in-depth the population research strategies for these two keystone species. Find out more about Yellowstone's wolf population research and management with this 2022 report from the National Park Service. A number of Florida Fish and Wildlife Conservation Commission Panther Program resources are included here.