HEADWATERS SCIENCE INSTITUTE

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Student Investigation

In this lesson, students will investigate how competition for nesting sites affects penguin populations on Ardley Island, focusing on Gentoo and Adélie penguins. Using historical data, students will analyze and compare nesting site counts for each species over time to identify trends and shifts in population dynamics.

As they explore the data, students will consider how competition for limited nesting space may influence which species thrives or declines in a shared habitat. They will graph and interpret their findings to better understand the relationship between species interactions and population change. Through this analysis, students will build skills in data interpretation while gaining insight into how ecological competition shapes wildlife populations in Antarctic ecosystems.

NGSS STANDARDS

HS-LS2-6. Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

HS-LS4-2. Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.

SUNSHINE STATE STANDARDS

SC.912.L.17.4 Describe changes in ecosystems resulting from seasonal variations, climate change and succession.

SC.912.L.17.6 Compare and contrast the relationships among organisms, including predation, parasitism, competition, commensalism, and mutualism.

SC.7.L.17.3 Describe and investigate various limiting factors in the local ecosystem and their impact on native populations, including food, shelter, water, space, disease, parasitism, predation, and nesting sites.

The Penguins of Ardley Island

Located in the South Shetland Islands, Ardley Island is a small, rocky island that stretches about one mile in length. It serves as an important habitat for both Adélie and Gentoo penguins. Each year, penguin breeding season begins in September, when environmental conditions are most favorable for successful hatching. However, as the climate changes, scientists have begun to observe shifts in penguin breeding patterns and behavior.

ADÉLIE PENGUINS

Adélie penguins are considered specialists, meaning they are adapted to thrive in narrow ecological niches and require specific habitats, limited diets, and precise environmental conditions to survive. They rely heavily on abundant krill populations for both survival and successful breeding seasons. Male Adélie penguins build nests and compete to create the largest and most attractive structures to attract females. They are also considered “sea ice obligate” species, depending on sea ice for resting, avoiding predators, and accessing food sources such as krill.

GENTOO PENGUINS

Gentoo penguins are considered generalists, meaning they can thrive in a wide range of environmental conditions and make use of diverse resources, including varied diets and habitats. They feed on a mix of fish species and krill. Gentoo penguins build their nests using stones arranged in a circular shape, and competition over these stones can become quite intense. In fact, males often present stones to females as part of their courtship behavior. Unlike some other penguin species, Gentoo penguins are not dependent on sea ice and will only breed in areas that are free of snow and ice.

COMPETITION IN ARDLEY ISLAND

As the climate shifts, the timing of the nesting season is also changing. Adélie penguins typically return to their breeding sites first, followed by Gentoo penguins. However, because Gentoos often winter closer to these sites, they can sometimes arrive earlier. When this happens, Adélie penguins may drive Gentoos away using loud calls or physical behaviors such as flipper slaps. Gentoo penguins have a varied diet that includes both fish and krill, while the more specialized Adélie depend on krill. Scientists are concerned that increased competition for food could give Gentoo penguins an advantage, particularly in years when krill populations are low.

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Student Investigation

In this investigation, you will examine real, open-source penguin population data provided by Oceanites. You will focus on Adélie and Gentoo penguins on Ardley Island, analyzing nest counts collected over the past 10 years. Using this data, you will look for trends in nesting patterns, compare the two species, and explore how competition for nesting sites and changes in food availability may be affecting their populations.

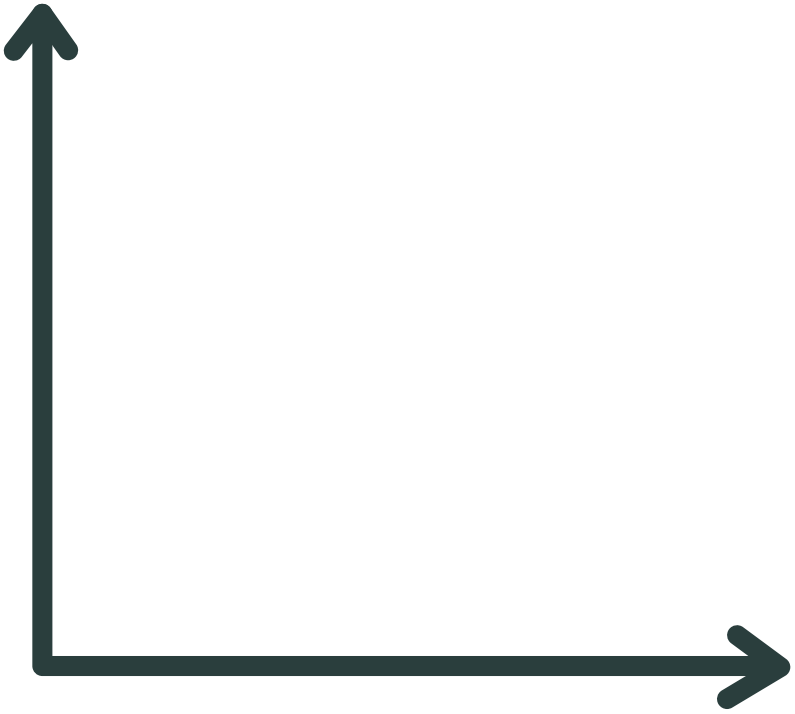
How does competition between Adélie and Gentoo penguins influence the number of nest sites each species occupies?

Hypothesis:

_____
_____
_____

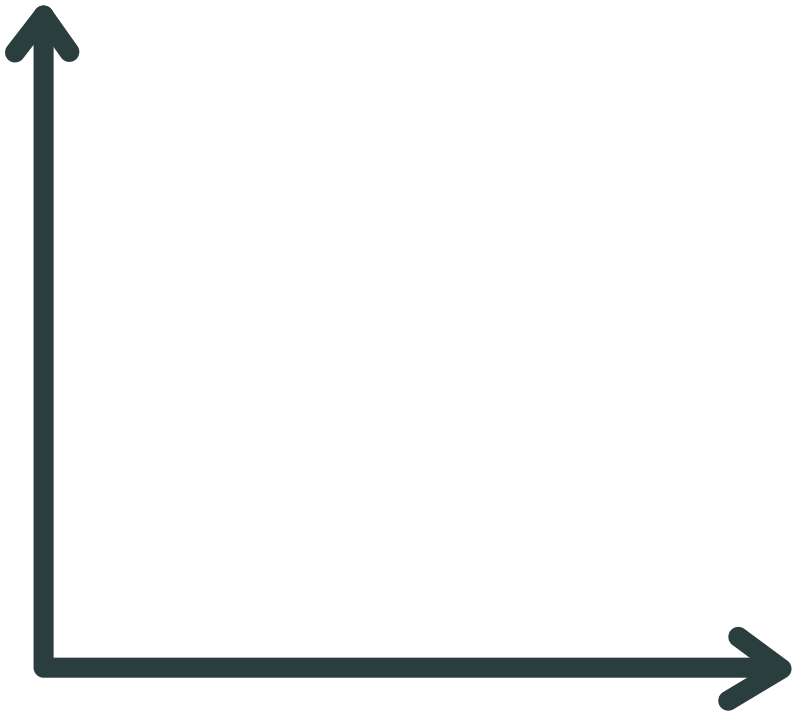
Create a graph for each of the data sets provided.

Species	Year	Nest Site Count
Gentoo	2011	5761
Gentoo	2012	6417
Gentoo	2013	6188
Gentoo	2014	6464
Gentoo	2015	5726
Gentoo	2016	7227
Gentoo	2017	6242
Gentoo	2018	6428
Gentoo	2019	6695
Gentoo	2021	7121



Student Investigation

Species	Year	Nest Site Count
Adélie	2011	592
Adélie	2012	384
Adélie	2013	429
Adélie	2014	260
Adélie	2015	307
Adélie	2016	448
Adélie	2017	338
Adélie	2018	339
Adélie	2019	300
Adélie	2021	200



Use your graphs and hypothesis to write a conclusion. What patterns do you see, and how do they support or challenge your hypothesis?

How have Adélie and Gentoo penguin nest counts on Ardley Island changed over the past 10 years? How does the timing of arrival at breeding sites affect competition and nesting success between Adélie and Gentoo penguins?

How might changes in food availability, such as krill abundance, interact with competition to influence penguin population trends?

In what ways might climate change alter competition and population dynamics between Adélie and Gentoo penguins?

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