

Lesson 2: How does the changing climate impact the penguins around Antarctica?

Setting the Stage

Of the 17 species of penguins, 8 of them make their home in and around Antarctica. Students will investigate the life history characteristics of 2-4 of these species, then observe the changes that these populations have experienced. Students will relate the changes in population sizes to the penguins' requirements as well as changes that are taking place in their Antarctic habitats.



Photo Credit: Anna Ruth Halberstadt

Lesson Overview

- *Part 1 – (25 minutes) Penguin Behavior and Habitat Requirements*
Students will collect and share information on the natural history of several species of penguins found in and around Antarctica. Emphasis will be on the physical traits and behaviors that allow them to survive in extreme conditions.
- *Part 2 – (20 minutes) Penguin Population Dynamics*
Students will analyze data on penguin population sizes in different regions of Antarctica to understand changes that have occurred in different parts of Antarctica.
- *Part 3 – (15 minutes) Connecting the Data*
Students will connect what they have learned about penguin natural history and the impacts that climate change has had on regions of Antarctica with what they observed in the penguin population data.



These materials were developed by Meghan Mosher, Penny Rodrick-Williams, Allen Pope, Anna Ruth Halberstadt, Luke Trusel, and Mahsa Moussavi in collaboration with CIRES Education & Outreach at CU Boulder. Funded by NSF OPP Award #1643715.



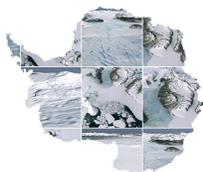


Instructional Overview	
Grade Level	High School
Instructional Time	60 minutes
Standards Alignment	<p>NGSS:</p> <ul style="list-style-type: none"> ● LS4.C: Adaptation: Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline—and sometimes the extinction—of some species. ● Analyzing and Interpreting Data ● Stability and Change
Driving Questions	<ul style="list-style-type: none"> ● What are the behaviors and habitat requirements of penguins in Antarctica? ● What are the population dynamics of the penguins? ● How are these connected to climate change in Antarctica?
Anchoring Phenomenon	<ul style="list-style-type: none"> ● Climate change and environmental feedback loops are causing Antarctic ice to melt, which is causing dramatic local and global impacts.
Learning Goals	<ul style="list-style-type: none"> ● Students will be able to: <ul style="list-style-type: none"> ● Describe general behaviors and habitat requirements of penguins necessary to survive in the harsh Antarctic environment. ● Interpret and summarize population trends. ● Connect the natural history of the species with their population changes in light of climate changes occurring in Antarctica.
Materials	<ul style="list-style-type: none"> <input type="checkbox"/> Laptops with access to internet <input type="checkbox"/> Student handouts <input type="checkbox"/> Large paper to create posters or access to Google slides or documents <input type="checkbox"/> Map of Antarctica
Material Preparation	<ul style="list-style-type: none"> <input type="checkbox"/> Print out student handouts (1 per student)
Instructional Strategies	<ul style="list-style-type: none"> ● 5E, cooperative learning, utilizing real scientific data



These materials were developed by Meghan Mosher, Penny Rodrick-Williams, Allen Pope, Anna Ruth Halberstadt, Luke Trusel, and Mahsa Moussavi in collaboration with CIRES Education & Outreach at CU Boulder. Funded by NSF OPP Award #1643715.





	Web Links for Lesson Resources
Part 1	<ul style="list-style-type: none">Become familiar with the 4 Antarctic penguin species that the students will be researching. http://www.penguinmap.com/Species/
Part 2	<ul style="list-style-type: none">MAPPPD http://www.penguinmap.com/mapppdThe most recent State of Antarctic Penguin reports can be found here: https://oceanites.org/future-of-antarctica/penguin-conservation/state-of-antarctic-penguins-reports/
Part 3	<ul style="list-style-type: none">The most recent State of Antarctic Penguin reports can be found here: https://oceanites.org/future-of-antarctica/penguin-conservation/state-of-antarctic-penguins-reports/

Part 1

Penguin Behavior and Habitat Requirements (25 minutes)

Driving Question - What are the requirements of penguins on Antarctica? How have they physically and behaviorally adapted to be able to survive?

1. Divide the class into groups to research the natural history of 2 - 4 penguin species (Emperor, Adelie, Gentoo, Chinstrap) found on Antarctica. If students have access to Google docs or slides and/or if they are learning remotely, they can share their research with the class on a shared document. Otherwise, they can share the information on large poster paper. Students should research the following:

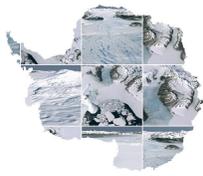
- Basic physical description
- Breeding behaviors
- Feeding behaviors
- Habitat requirements
- Current distribution
- Unique/notable facts

** If class time is limited, this research may also be assigned to be completed as homework and can be shared out at the beginning of class.*



These materials were developed by Meghan Mosher, Penny Rodrick-Williams, Allen Pope, Anna Ruth Halberstadt, Luke Trusel, and Mahsa Moussavi in collaboration with CIRES Education & Outreach at CU Boulder. Funded by NSF OPP Award #1643715.





Part 2

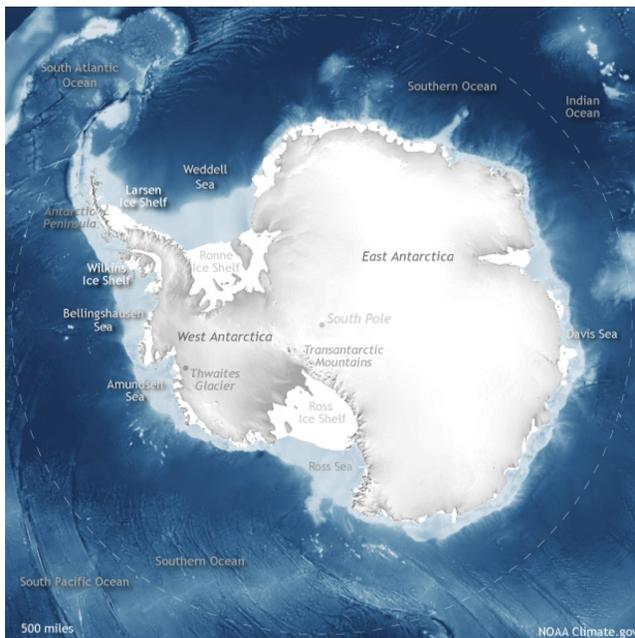
Penguin Population Dynamics (20 minutes)

Driving Question - How are penguin populations changing as the climate changes in Antarctica?

1. Instruct students to use the Mapping Application for Penguin Populations and Projected Dynamics website (<http://www.penguinmap.com/mapppd>) to research their species and learn about how the penguin populations have changed in various regions of Antarctica. For more information about how the data is collected and the population models are generated, read here: <http://www.penguinmap.com/about/>

The data is varied for each species and each region of Antarctica. If students are struggling to find information for a species in a specific region, they may look here for some additional information: <http://www.penguinmap.com/Dashboard/>

2. Use the map of Antarctica to remind students of the three main regions in Antarctica, and discuss how each region has not experienced the same changes in climate:



West Antarctica temperatures have increased by 4.3 °F. East Antarctica has experienced less change, increasing by 0.11°F. The Antarctic Peninsula, with its lower elevations and southernmost location, has experienced the largest increase in temperatures - between 5 °F in the summer and 9 °F in the winter.

These different changes in climate can have different impacts on the habitats and species, including the penguins.

Students can save their population trends graphs and insert them into their presentations from Part 1. Or students can summarize their population graphs or sketch

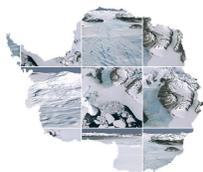
them onto their posters from Part 1.

Summary of Penguin Trends (based on the 2019 State of Antarctic Penguin report).



These materials were developed by Meghan Mosher, Penny Rodrick-Williams, Allen Pope, Anna Ruth Halberstadt, Luke Trusel, and Mahsa Moussavi in collaboration with CIRES Education & Outreach at CU Boulder. Funded by NSF OPP Award #1643715.





Look here for more recent updates:

<https://oceanites.org/future-of-antarctica/penguin-conservation/state-of-antarctic-penguins-reports/>

	Penguin Trends
East Antarctica	Adelie populations appear to have increased. New Emperor penguin colonies may be discovered here. No Chinstrap or Gentoo penguins appear to be breeding here.
West Antarctica	Gentoo populations appear to be increasing. Chinstrap populations appear to be declining. Although data is limited on the Chinstrap and Gentoo penguins. Adelie populations appear to be increasing around Ross Sea. Data is limited on Emperor Penguins.
Antarctic Peninsula	Gentoo populations have increased significantly. Chinstrap populations have declined on many islands, but are persisting on some other islands. Adelie populations have been declining. Emperor penguins appear to have been extirpated from the area.

Part 3

Connecting the Data (15 minutes)

Driving Question - How are penguin populations changing as the climate changes in Antarctica?

1. Instruct students to look at their penguin population data and see how both penguin behavior and climate change is impacting the population trends.

Students will uncover many connections based on their research in Part 1 and their population trends in Part 2. Some general trends are listed below:



These materials were developed by Meghan Mosher, Penny Rodrick-Williams, Allen Pope, Anna Ruth Halberstadt, Luke Trusel, and Mahsa Moussavi in collaboration with CIRES Education & Outreach at CU Boulder. Funded by NSF OPP Award #1643715.





	General Observations
East Antarctica	<p>In East Antarctica, it's colder and there has not been a similar warming trend. Scientists believe ocean and wind currents have largely shielded those regions from the warming trend. Adelie populations have increased.</p> <p>Not enough long-term data exists about the other species to predict their trends.</p>
West Antarctica	
Antarctic Peninsula	<p>Warming in the Antarctic Peninsula is also causing sea ice to melt rapidly and form more slowly, threatening the penguins' food source. Penguins feed off krill, and krill feed off the algae that grow under sea ice.</p> <p>Less ice means less algae for krill larvae to feed on.</p> <p>Gentoo's have adapted and switched to feeding on fish. This change could be helping their populations to increase despite the increase in temperatures.</p>



These materials were developed by Meghan Mosher, Penny Rodrick-Williams, Allen Pope, Anna Ruth Halberstadt, Luke Trusel, and Mahsa Moussavi in collaboration with CIRES Education & Outreach at CU Boulder. Funded by NSF OPP Award #1643715.

