Pika Models + Climate Change

Overview

Students explore the life of pikas, small mammals that live in alpine areas, and how they are being impacted by climate change. A brief introduction includes a reading, short video, and story, which includes a mathematical model. Then students engage in a kinesthetic simulation to gain first-hand experience of life as a pika, and how the animals can be impacted by shrinking habitat. Students then create line graphs with data from the simulation and analyze it.

Part II of the lesson allows students to create their own model to teach others about pikas and their connections to their ecosystem. Students can also include how the pika or another organism is impacted by human activities. Students then give oral presentations about their models to demonstrate their learning. The Extend / Enrich section lists a variety of other ways to engage all learners. **Please note:** This lesson is adaptable for grades 3–8. BAESI has another version of the lesson targeted for grades 9–12: baesi.org/pika-models-climate-change-lesson-plan.

Subjects: Science, Math, Writing, Speaking & Listening, Physical Education, Environmental Education, Art

Grades: Targeted to grade 4; Adaptable for grades 3–8

Duration: Two 50-minute periods or one long block of 90 minutes; additional time to complete projects and present them to the class

Vocabulary

- biodiversity
- ecosystem
- ecological community
- model
- pika
- species
- talus

Guiding Questions

- How are organisms affected by the environment?
- How do adaptations allow organisms to survive in their environment?
- How might climate change impact alpine habitats and pika populations over time?
- How might other species of wildlife be impacted if their habitat changes?

An American pika forages in its alpine habitat
Bernd Thaller, Flickr, CC-BY-2.0

Objectives

- Students will participate in a kinesthetic pika population simulation, graph the data, and analyze it.
- Students will create a model to teach others about pikas and their connections to their ecosystem.
- Students will create written explanations of their models and oral presentations about them to demonstrate their learning.
- Students will discuss how pika populations have been changing and how human activities may play an increasing role in population changes over time.

Next Generation Science Standards + Common Core State Standards		
NEXT GENERATION SCIENCE STANDARDS	**Performance Expectations**	**3-LS4-4.** Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change. **MS-LS2-4.** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
	Crosscutting Concepts	• Stability and Change • Systems and System Models
	Science & Engineering Practices	• Asking Questions and Defining Problems • Analyzing and Interpreting Data • Developing and Using Models • Using Mathematics and Computational Thinking • Constructing Explanations and Designing Solutions • Engaging in Argument from Evidence • Obtaining, Evaluating, and Communicating Information
	Disciplinary Core Ideas	**LS1: From Molecules to Organisms: Structures and Processes** LS1.A: Structure and Function LS1.B: Growth and Development of Organisms **LS2: Ecosystems: Interactions, Energy, and Dynamics** LS2.A: Interdependent Relationships in Ecosystems LS2.C: Ecosystem Dynamics, Functioning, and Resilience "By end of Grade 5: When the environment changes in ways that affect a place's physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die" (*A Framework for K-12 Science Education* nap.edu/read/13165/chapter/10#155). **LS4: Biological Evolution: Unity and Diversity** LS4.C: Adaptation **ESS3.C: Human Impacts on Earth Systems**
COMMON CORE STATE STANDARDS INITIATIVE **ELA**	**Writing**	4, 10
	Speaking & Listening	1, 2, 4, 6
	Language Standards	1, 2, 3, 6
	Writing Standards Science & Technical Subjects	4, 7, 10
California's Environmental Principles and Concepts	**Principle II—People Influence Natural Systems** The long-term functioning and health of terrestrial, freshwater, coastal and marine ecosystems are Influenced by their relationships with human society. **Concept A.** Direct and indirect changes to natural systems due to the growth of human populations and their consumption rates influence the geographic extent, composition, biological diversity, and viability of natural systems.	

Teacher Background

This lesson is designed to help you teach and reinforce a variety of concepts and skills and is adaptable for a wide-range of grades and connections across the curriculum. For example, several different kinds of models are used, including diagrams, a kinesthetic model, and graphical representations of data, to help students understand the content presented. Simultaneously, the activity helps them understand how to use models to find deeper meaning in the science and better convey information to others. Your focus could be on pikas and how they are impacted by rising temperatures as a poignant example of how **anthropomorphic** (human-caused) climate change is affecting organisms' ability to survive. Or you might choose to focus on a concept such as adaptation, the importance of biodiversity in ecosystems, or all of the above.

A citizen scientist searches for pikas on a talus slope.
National Park Service

Adaptations

One way to approach the lesson is to explain how different kinds of organisms (living things) have different needs. Some plants grow well only in full sun, for example, while others do better in shade. The traits that help organisms survive are their **adaptations**, which developed over millions of years through the process of **evolution**. Individuals that were better adapted to survive in an area were able to pass on their genes. These are **physical** traits, such as fur in mammals, and **behavioral** adaptations, such as being nocturnal.

Thick fur is an example of a physical adaption. Making hay piles to survive the winter is an example of a pika behavioral adaptation.
Public Domain

Ecosystems

An **ecosystem** is any group of living and nonliving things that interact with one another. Some ecosystems are relatively small, like the **talus** slopes (areas of accumulated rock debris) on mountainsides where pikas thrive. Others are large **biomes**, like rainforests or grasslands. Average temperatures and rainfall are the two most important factors that make up an area's **climate** and determine what ecosystems will be found there. As our planet warms, with some areas such as the intermountain West warming more than other places, ecosystems are changing and forcing the organisms found in them to adapt or find new homes. Pikas, which are well-adapted for cold weather and already inhabit colder areas such as mountaintops, have limited options for places where they can move.

Biodiversity

Biodiversity is a measure of the number of different species of organisms in a specific area, and it is also used as a general description of species richness, ecosystem complexity, and genetic variation. In general, the more biodiversity, the more stable the ecosystem and the less it is impacted by changes in the environment. The organisms that interact with each other in their ecosystem are called **ecological communities**.

Keystone Species

Some members of a community, such as pikas, are particularly important for ecosystems. For example, pikas recycle nutrients in the generally nutrient-poor alpine soils through the hay piles they create to survive the winter, as well as with their dung and urine. They are also an important food source for predators in their sparsely inhabited alpine environments. Their hay piles can provide nourishment for other organisms, as well, plus they disperse and fertilize seeds for plants. Because of all these important roles, pikas can be considered a **keystone species** for their ecosystem; just like the keystone at the top of an arch which helps hold the whole structure together, a keystone species is vital to the stability of an ecosystem. If it is in trouble, the whole ecosystem can be negatively impacted.

Foxes depend on pikas for food, like many other predators.
Sergio Cerrato, Pixabay

In some cases, whole ecosystems can even collapse due to the loss of one species, as was the case when fur traders killed nearly all sea otters. Sea otters were one of the main predators of spiny sea urchins, which quickly became overpopulated and ate through the holdfasts that secure kelp to the ocean floor. Kelp forests—and all the fish and other marine life that depend on them—were drastically depleted. But with the recovery of sea otters to help control the urchin population, kelp forests, too, are recovering. Hopefully pika populations can be stabilized and continue for many years to come through efforts to mitigate the effects of climate change and to help protect their fragile alpine ecosystems.

Materials + Preparation

- Make copies of the handouts at the end of the lesson for each student or pairs of students:
  - "Pikas! Fact Sheet" reading
  - "Pika Data: Population Over Time"
  - "Pika Math!"
  - "Model / Presentation Rubric"
- Gather about 360 natural sticks, craft sticks, or popsicle sticks, or enough so that each student in your class can have 12 of them.
- An area with space for the class to run around, such as a ballfield.
- Prepare to show a short video about pikas, such as:
  - Two-minute trailer for "Adventures of the American Pika" or just the clip from (0:41–1:35): vimeo.com/163557729
  - This fun 3-minute clip from the BBC Life Collection with Sir David Attenborough: youtu.be/0aP4WZEy9GI
- Science notebooks or paper for students; pencils
- *Optional:* Computer(s) and data projector
- *Optional:* Large sheets of paper to create visual models and/or computers for students to use
- *Optional:* Colored pencils, markers, and/or crayons for students to share

Screenshot from "Adventures of the American Pika"

- *Optional:* Read additional sources such as those listed at the end of the lesson for additional background information, and/or make copies of them for students to read and discuss.

Teaching Suggestions in the 5E Model

Part I: Modeling Pika Population Changes

Engage

1. Ask students an essential question to engage them and prime them for learning, such as "How might animals be impacted if their habitat becomes warmer or cooler, or wetter or drier?" Suggest they discuss the question with a neighbor and write down their ideas while you circulate to answer questions. After a couple of minutes, ask for a group to share their thoughts. Explain that you will explore that question in class today as it relates to animals called the pikas.
2. Ask the students to again turn to their neighbor and discuss what they know about animals called pikas, including what they think they look like, where they live, and how they survive. After a minute, ask for a group to share what they already know about the little rabbit relatives.

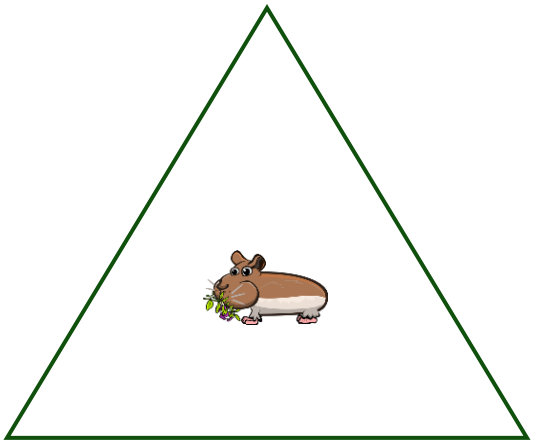
Explore

1. Show (or ask the pairs to watch) one or more short video clips of pikas in the wild. Good choices include:
   - A fun 3-minute clip from the BBC Life Collection narrated by Sir David Attenborough that shows their alpine habitat and how they create hay piles to last through the winter: youtube.com/watch?v=0aP4WZEy9GI.
   - "The Adventures of the American Pika" trailer (2:00): vimeo.com/234885043
   - "Pikas" by Mitch Chapman (4:33): vimeo.com/17925621
2. Pass out the "Pikas! Fact Sheet" handout found at the end of the lesson and ask the student pairs to read it together and discuss it. You could provide them with a discussion question or two, such as:
   - What do pikas need to survive in the wild?
   - How would you know if pikas are present in a habitat?

   You also might direct the students to good online resources to learn more about pikas, such as those listed on the handout.

Explain

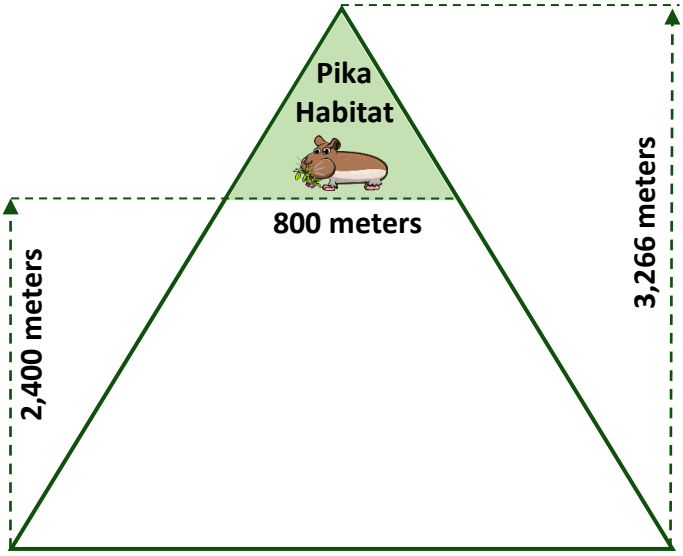
3. Tell students they will be playing a game to simulate the pika's life in their mountain habitat. But first they need to do a little problem solving to plan the simulation game space:
   - Ask students to draw a large equilateral triangle in their science notebooks or on a sheet of paper while you draw one on the board. Explain that it represents a mountain where scientists have found pikas. However, the pikas have been disappearing from the lower part and south



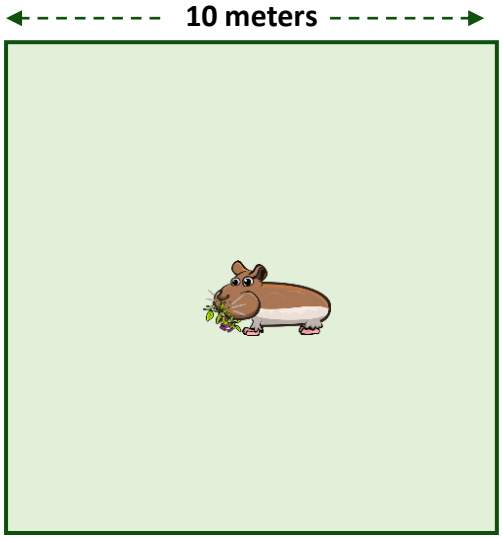
An equilateral triangle: a simple model of a mountaintop

side of the mountain. Ask students to share their ideas about why that might be the case and discuss. (As explained in the "Pikas! Fact Sheet" reading, scientists suspect this may be linked to rising temperatures, because pikas are very sensitive to heat. Pikas are usually only found where summer temperatures rarely exceed 75˚F (24˚C). In fact, they can die within only an hour of being exposed to temperatures of 78˚F (26˚C) or more.)

- Explain that a research project is being done to study the pikas that can still be found on the north side of the mountain in an area of talus (pile of rock debris) on a steep slope at the top of the mountain. Tell them that the scientists have observed signs of pikas and discuss student ideas about what evidence that might include (hay piles, dung, and their distinctive calls). Explain that the signs start at about 2,400 meters (7,900 feet) of elevation, where it is cooler than lower elevations, up to the top of the mountain at 3,266 meters (10,715 feet). Draw a line about half-way up the "mountain" that stretches horizontally across it and write 2,400 meters next to it. Write 3,266 meters at the top and label the triangular area above the 2,400 m line "Pika Habitat." Ask the students to recreate the model in their science notebooks.



- Explain that scientists have measured that the talus slope and nearby meadow areas where the pikas live and gather food is about 800 meters (3,300 feet) long at the 2,400-meter mark. Label the line 800 meters, then tell the students that the scientists have already determined that there is an average of 1 pika for every 100 square meters of habitat area. Now the scientists want to calculate the AREA of the habitat where the pikas live so they can determine the total approximate population of pikas. Draw a square on the board and label one of the sides 10 meters. Inside the square you could draw a quick pika or pika face, or attach a picture of a pika).



1 pika per 100 m^2

- If the majority of your students have already learned how to calculate the area of triangles, ask them to work with a neighbor to calculate the size of the habitat. If they succeed with that, they can attempt to calculate the approximate number of pikas on the mountain. You can circulate through the room and answer questions, as needed. If students are struggling, ask them how to calculate the area of triangles, or if necessary, they can

research it on the Internet or in a math book. They can then use the formula below to find the answer based on the known information. If most students have not yet learned how to calculate the area triangles, teach them the formula below and work with them to find the answer.

Area = ½ (base) (height)

base = length of one side of the triangle

height = length of a perpendicular line drawn from the base to the angle across from it on the triangle

- The students should then be able to calculate the area and approximate number of pikas:

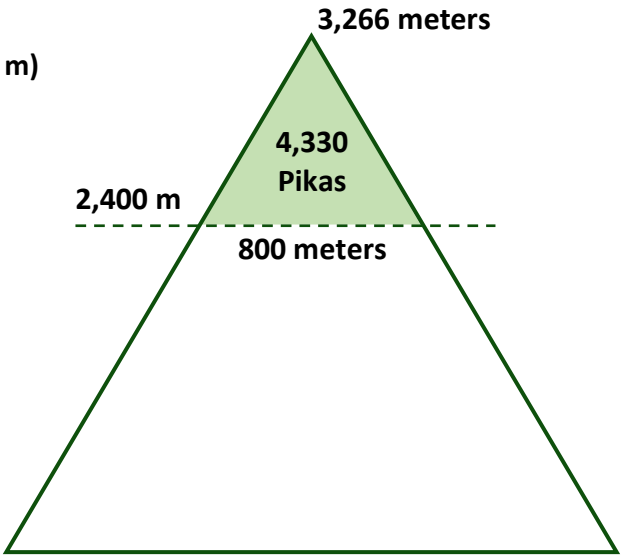
Area of the habitat = ½ (800 m) (3,266 m - 2,400 m)

½ (800 m) (866 m) = **346,400 m^2**

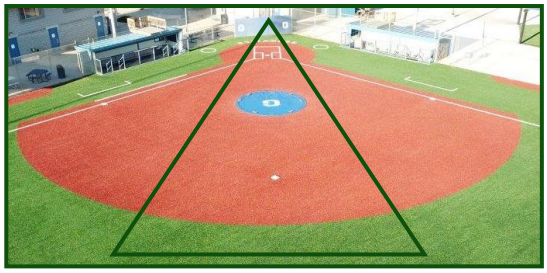
(The habitat is between 3,266 m and 2,400 m, so the height is 866 m).

Approximate number of pikas

433,000 m^2 / 100 m^2 = 3,464 pikas
(Since the scientists determined there was an average of 1 pika per 100 m^2.)



4. Tell students that they will now create a kinesthetic model—a model in which they will get to move around—of the pikas in their habitat.
   - Pass out paper cups, one per student, and ask them to write their names on the cups—or what they would like their name to be if they were a pika.
   - Ask the class to bring their cups with them as you move to an area with lots of room to move around, preferably a field or other outdoor space.
   - Create a large triangular game area that is a minimum of 12 meters long on each side, but ideally at least 30 meters long on each side. You could use a tape measure or simply mark approximate meters with long strides. The area should be large enough for your whole class to move around in without running into each other. You could mark the area with orange cones and a rope, safety flagging, etc. Tell students that it is a model of the alpine habitat (mountain region with rocks and plants). They will need to gather enough plant material inside the triangle, representing the top of them mountain, to eat for the whole winter.



A field works well for the simulation. Create an equilateral triangle to represent the pika mountain habitat, or you could start with a baseball diamond and adjust one side of the game area for different rounds.
Glenville State University, CC-BY-2.0

Round 1:

- Ask the class to help you distribute the sticks—either natural or craft/popsicle/pickup sticks, about 12 per class member—evenly throughout the area, with a few beyond the boundary of one side of the triangle. Explain that these sticks beyond the boundary represent plants in an area at a lower elevation that is too hot for pikas; if they go in that area they will overheat and die. The other two sides of the triangle represent the air above their mountain home where there is no food for them.
- Direct students to put their cups, representing their nests, in the play area. Explain that when you (or a student who is physically unable to play) says "SPRING!" the "pikas" will dash from their nests to gather new plants (sticks), being careful not to run into each other. Tell them they will have 30 seconds to gather sticks and return them to their "nests" (cups) ONE AT A TIME, since pikas are small and cannot carry much. They will continue this process to form hay piles until you (or the student assistant) shouts "WINTER!" Then they will return to their "nests" and count the number of sticks they gathered.
  Notes: You could choose to have only 10 or 15 volunteers participate in each round to reduce the risk of collisions. And you play the role of an eagle; if a "pika" pushes another one, you will see it and "eat" it. (It will have to leave the game.)
- Tell students that they will need to gather at least 10 sticks to survive the winter, but if they gather 12 or more sticks they will have enough energy to be able to reproduce.
- Shout out "SPRING!" and time the players for 30 seconds. Then shout "WINTER!" and ask the players to count their sticks. If they do not have 10 of them, they did not survive and they must exit the game; they should take their cups but leave their sticks behind on the "mountain." You and the class can count those students who did not survive and record the data on a chart like the one below.

Any kind of sticks can simulate grass and wildflowers that pikas gather to make hay piles.
Rupert Kittinger-Sereinig, Pixabay

Pika Survival 	**"Year" 1**	**"Year" 2**	**"Year" 3**	**"Year" 4**	**"Year" 5**	**"Year" 6**	**"Year" 7**
Did not survive							
Survived only							
Survived and reproduced							

- Ask students who collected 10 or 11 sticks to raise their hands and record that number of survivors on the chart under "survived only." Finally, count the hands of the students with 12 sticks and record the number under "survived and reproduced."
- Ask students to return all sticks they collected to the game space after each round.

Round 2:

- Tell students that due to warming temperatures you need to move the game boundary line which represents the lowest part of the mountain on which the pikas can survive so that their habitat is about 1 meter smaller. As you do so, explain to students that all of the food on that part of the mountain is now in an area that is too hot for them, so any players remaining in that area will have to move their nests and find food in the smaller area. As they do so, they should be sure to be at least 1 arm length away from the next nearest pika nest, since pikas are very territorial.
- For every student who was able to reproduce in the first round, one student who did not survive can return to the game as a young pika.
- For round 2, one student can be a predator, such as a coyote or another predator found in your state. When the round starts, the predator runs after the pikas and tries to tag them. Tagged students have become the predator's lunch and must leave the game.
- You might want to ask a few questions about pikas and their habitat to determine who gets to be the predator, as well as who gets to return to the game as young pikas.

  Optional questions you might ask at this time and/or later for review:

  - In what habitats are pikas found? (North American species are only found in rocky areas at higher elevations, although you might mention that some Asian species construct burrows)
  - What do pikas eat? (A large variety of herbaceous (green) plants: grasses, wildflowers (forbs), sedges, thistles, etc.; will eat mosses if more nutritious plants not available; they sometimes also eat their dung or store it for later to get more nutrition from their plant foods)
  - What physical adaptations do pikas have that allow them to survive? (Thick fur coats and short, thick bodies to conserve heat; camouflage; high metabolism and body temperature; large, round ears to hear predators and other pikas, although to conserve heat their ears are shorter than those of other animals in the rabbit family)

Prime pika habitat
Syed Muneeb Ur Rahman, Pixabay

- What do pikas do that helps them survive the winter? (Create hay piles to store food; find shelter in rocky areas)
- How might snow help pikas survive the winter? (Insulates their nests to help keep them warm; source of water)
- Do some pikas hibernate like bears? (No, they must eat all winter to survive)
- Do pikas share nests with large groups? (No, but they live in colonies and alert each other to danger)
- What animals eats pikas? (Predators include hawks, foxes, coyotes, weasels, martins, prairie falcons, bobcats, and ravens)
- What is a U.S. state or Canadian province where pikas are found? (Range includes mountainous areas of California, Nevada, Oregon, Washington, Idaho, Colorado, Utah, Montana, New Mexico, Alaska, British Columbia, and Alberta.)
- How many species of pika are found in North America? (Two: American pika *(Ochotona princeps)* and collared pika *(Ochotona collaris)*, found only in Alaska, Yukon territory, and British Columbia); there are 36 known subspecies of pika found in North America, 7 of which are listed as vulnerable)
- What factors might limit the pika population (total number of them)? (Available food, water, and space; predators; shrinking habitat)
- How do pikas communicate? (Loud calls to mark their territory and announce predators; scent markings; males also use song during the breeding season to attract mates, with mated pairs of males and females sometimes singing duets; both males and females have been found to use song in fall)
- What important roles might pikas play in their ecosystem? (Their hay piles and dung recycle nutrients and fertilize soil; spreading seeds; important food source for many species of predators)

Pika range in North America

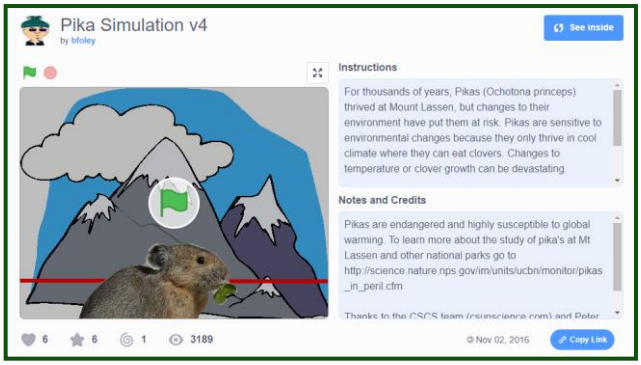
Adapted from "COSEWIC Assessment and Status Report on the Collared Pika Ochotona Collaris in Canada – 2011": sararegistry.gc.ca/default.asp?lang=En&n=2C5BA237

- Repeat the stick collection activity explained above (this time with predators like coyotes) and record the data on the chart.

Round 3:

- Move the boundary layer so that the triangular game space is about 2 meters smaller than the original space. Complete the round with the remaining players, including any "young pikas" who were able to join the round of the game due to reproduction from the last round.
- Record the data on the chart and congratulate the "pikas" who were able to survive and/or reproduce. If time allows, you could play more rounds in which the habitat is about 2 meters smaller each round, and record the data on the chart.

5. Return to the classroom and present the data to the class, either with a document camera and/or data projector or on the board. Ask the class to plot the data and create line graphs to show population changes over time; you might offer them a choice of using the "Pika Population Over Time" handout that follows the lesson, graph paper, or a computer spreadsheet, such as Microsoft Excel or Google Sheets.
6. While students complete the activity, circulate through the room to answer questions and help students.
7. Tell students that after they finish their graphs, they can run this computer simulation about pika populations and effects of temperature change: scratch.mit.edu/projects/128765571. Students can adjust the temperature and watch how the size of the pika habitat shrinks and grows. They track the data and then analyze it.
8. After all students have completed their graphs of the class data, discuss them with the class and/or have them reflect on the questions below in writing in science notebooks. Use a data projector and/or document camera (if available) to more easily share a couple examples of student graphs.



The "Pika Simulation" created with Scratch is another great way for students to model population changes over time.

   - How can students describe the data changes over time?
   - Was there anything surprising about the results of the model?
   - How might the pika population change in the future if the habitat continued to shrink in size at the same rate?
   - How can models be helpful in predicting changes in populations and ecosystems?
   - Do students have any ideas about how the model might be improved to make it more reflective of pika biology and their alpine ecosystems?
9. Have a brief discussion with the class about how pika populations will likely be impacted by human activities over time. You might also want to discuss student feelings about how climate change might affect pikas, other wildlife, and humans.

Part II: Student Research + Models (for another class period or one long block)

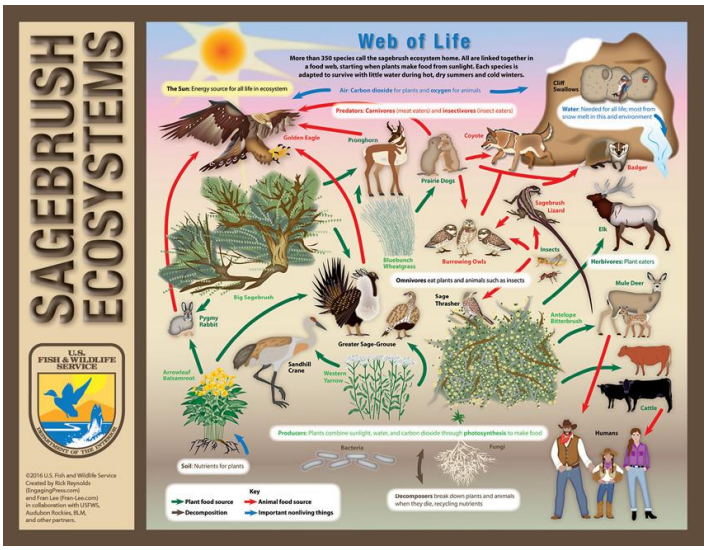
Engage

10. Invite students to work with a partner or small groups to each choose an animal that lives in alpine areas to research.

- Some examples of animals they might chose are shown in "A Short Guide to Sierra Nevada Predators & Prey" by Hands on the Land, which you can share with students: handsontheland.org/teachers/data/Sierra_Nevada_Predators_and_Their_Prey.pdf.
- Students can write about what they learn and/or make short presentations to the class, including details about specific habitats where the animal lives, what it eats, what eats it, and how it can be impacted by climate change and other human impacts.

Explore

11. Tell students that they will be able to create their own model to teach others about pikas and their connections to their alpine ecosystem. For example, they might create a visual diagram of an alpine ecosystem similar to the sagebrush ecosystem shown to the right and here: fws.gov/library/collections/sagebrush-ecosystem-curriculum.



Concept map about sagebrush ecosystems
Created by Rick Reynolds and Fran Lee in collaboration with the U.S. Fish & Wildlife Service

- Students could create a visual model on paper (larger sheets are better) or using a computer.
  - For example, they could add illustrations of the organism they are focusing on, other organisms in the ecosystem, and important nonliving components of it, such as sunlight, rainfall/snow, soil, and rocks.
  - Examples of plants found in alpine ecosystems that they could include: nps.gov/subjects/mountains/plants.htm
  - Alpine wildflower choices: www.pc.gc.ca/en/pn-np/bc/glacier/nature/faune-flore-fauna-flora/fleurs-flowers
- Students could also cut out images printed from websites or magazines, and/or simply use words and/or other symbols to represent the concepts. Then they can add arrows pointing from the animals to the other living and nonliving parts of the ecosystem (e.g. organisms they eat, etc., as shown in the example above) to show relationships. Or they can use arrows and other symbols to help model another important scientific

phenomenon, such as how the pika is being impacted by climate change and/or other human activities.

- There are many software tools to create diagrams, too, such as those listed on Kathy Schrock's "Concept Mapping in the Classroom" page: schrockguide.net/concept-mapping.html
- More examples of types of models students could choose to create:
  - A short video showing how changes in temperature and/or moisture over time might impact an organism's survival
  - 3D models or dioramas with labels and/or annotations on the important living and nonliving components of the ecosystem
  - A "web of life" that has each student representing an organism from the alpine ecosystem linked together by yarn that shows a relationship between them. Students could create a set of cards to represent the organisms that could be distributed to the whole class in a circle—preferably outside. See Project Learning Tree for one way to do the activity: plt.org/family-activity/web-of-life.
  - A computer simulation like the one listed above.

12. Pass out the rubric at the end of the lesson, which explains how they will be assessed. Ask the students to complete their portion of the rubric and turn it in to you with the project on or before the due date.
13. Explain that students can reference the "Pikas! Fact Sheet" handout and/or conduct additional research and take notes on their topic. As the students do that and begin planning their project, circulate through the room answering questions. Point students to additional sources of information, as necessary, such as those listed at the end of the lesson. Tell students that they will also be preparing a written description of the model and making a brief 1–2-minute presentation to the class about it.
14. Allow students to work on their projects for the rest of the period, then allow additional time to complete the project during or outside of class, if needed.
15. On the day the assignment is due, ask students to share their models with the class as part of short oral presentations. Close with a pair-share in which students discuss what they learned about wildlife, ecosystems, and models from the presentations, and how might they use different kinds of models in the future.

Explain

16. Ask student volunteers to share their projects with the class. Facilitate a class discussion about the important concepts the simulations model: impacts of climate change, habitat loss, adaptations, and ecosystem models. See the Teacher Background section for more information.

17. Discuss how the student projects help to show how the more **biodiversity** (different types of organisms) there is in an ecosystem, the more stable it is and the less it is impacted by changes in the environment. Relate the concept of biodiversity to human diversity and how a wide variety of physical and emotional traits can be beneficial for long-term **sustainability** in all types of communities.)

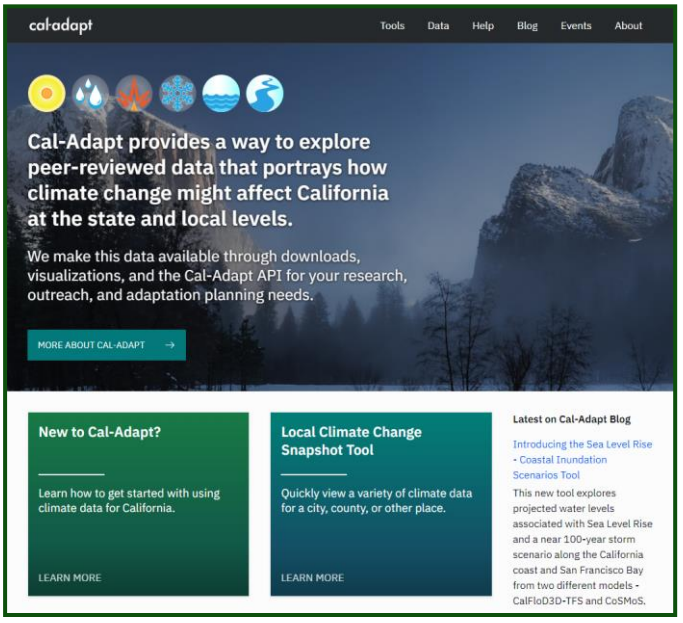
18. Ask students to complete the "Pika Math!" handout found at the end of the lesson. It could be completed for homework. Then discuss their answers and ideas as a class.

19. Completed student models can be displayed in your school and in your local community to educate others about pikas, other alpine organisms, and their fragile ecosystems

Extend / Enrich

- Students can play the free "Life of Pika" game by EarthGames: earthgames.org/2018/12/08/life-of-pika-is-now-available. Players "collect food as they dodge predators and avoid overheating. In addition to a full single-player campaign with a compelling story . . . there is a split-screen two player mode." A teacher's guide is available at earthgamesdotorg.files.wordpress.com/2020/06/life-of-pika-teachers-guide-2.pdf

- Take students on a field trip to explore an area of talus slope pika habitat (or a more accessible natural area) first hand. Have students engage in an activity such as creating a nature journal or field guide of the organisms they observe. A lesson plan entitled "Field Journaling" can be found on the Idaho Rangeland Resource Commission education website: idrange.org/_literature_156764/Field_Journaling. More information on creating nature journals can also be found on the BirdSleuth website: birdsleuth.org/nature-journaling.



- Students can visit the California Energy Commission's Cal-Adapt website at cal-adapt.org and find specific temperature forecasts for pika habitat in the Eastern Sierras. For example, they could see that the average temperature in August is expected to rise by 10°F between 2000 and 2100 under one scenario, but only 3°F if humans emit less carbon dioxide from their use of fossil fuels. Students can enter temperature changes into the simulator to explore the impact on the pika. Through this activity, students should recognize that pikas do much better under the low-emission scenario than the high-emission scenario. They can analyze the problem and write about what humans can do to help pikas and their ecosystem.

- Explore the effects of climate change on pikas more fully. Resources are listed at the end of the lesson, including this video from *Smithsonian* which discusses how loss of snow pack, for instance, is a problem: smithsonianmag.com/videos/category/science/pikas-and-climate-change
- Explore the link between population growth and extinction with your students. Learn more from the Center for Biological Diversity: biologicaldiversity.org/programs/population_and_sustainability/extinction Population Education resources are found here: populationeducation.org

Evaluate

20. Lead a discussion about the guiding questions of the lesson. Or, ask students to reflect on these questions in writing.

- How might climate change impact alpine habitats and pika populations over time?
- How do adaptations allow organisms to survive in their environment? Ask students to give examples of pika adaptations that relate to their ecosystem.
- How might other species of wildlife be impacted if their habitat becomes warmer or cooler, or wetter or drier?
- What steps can we take to reduce and/or reverse our adverse impacts on natural ecosystems, as well as on human populations?

21. Ask students to explain in writing what they thought was good about the simulation and what they think could be done to improve it. They should suggest at least two changes that could improve the model, as well as additional information or data that could be included in the simulation

22. Review student models, written reflections, completed handouts, and graphs. Provide feedback.

Expand Knowledge + Skills

Pika Background / News / Research

- "Pika Research" video of ecologist discussing pikas and her research: youtu.be/f6c2cZf0ULI
- Another ecologist discusses the "Perilous Plight of the Pikas": youtu.be/US_Hy_eGPtg
- Stone, K. "Climate Change Threatens California Pikas." GotScience Magazine. June 13, 2022: magazine.scienceconnected.org/2022/06/climate-change-threatens-california-pikas
- "Pikas Disappearing from Parts of the West Due to Climate Change." USGS. 25 Aug. 2016: usgs.gov/news/pikas-disappearing-parts-west-due-climate-change-0
- Stephens, T. (2015, Feb. 6). Shrinking range of pikas in California mountains linked to climate change. University of California Santa Cruz: news.ucsc.edu/2015/02/pika-study.html

Lessons / Units

- "Effect of Snow Pack and Connectivity on Pika" lesson plan. Biological Sciences Initiative: docs.wixstatic.com/ugd/f6b310_6c8648f749834da3a5c71d397d0f190a.pdf
- Sagebrush ecosystem posters, curriculum, and more from the U.S. Fish and Wildlife Service and other partners: fws.gov/library/collections/sagebrush-ecosystem-curriculum
- Video explaining how to calculate the area of triangles from Khan Academy: khanacademy.org/math/geometry-home/geometry-area-perimeter/advanced-area-with-triangles/v/area-of-an-equilateral-triangle

Standards

- This lesson was inspired by the "High School Three-Course Model Living Earth Snapshot 7.6: Shrinking Pika Habitat" vignette described in the *2016 Science Framework for California Public Schools (pp. 839-841)*. More examples of what NGSS looks like for high school students can be found in Chapter 7 of the *document:* cde.ca.gov/ci/sc/cf/documents/scifwchapter7.pdf.
- More information about the Next Generation Science Standards, including a link to *A Framework for K-12 Science Education* to which this lesson was aligned, can be found at nextgenscience.org/framework-k%E2%80%9312-science-education.
- More information about the Common Core State Standards and links to the complete documents: corestandards.org

Appreciation + Thanks

Thank you for using BAESI resources and helping to inspire the next generation of thinkers and scientists! We welcome your questions or comments.

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Pikas! Fact Sheet

American Pika (*Ochotona princeps)* and collared pika (*Ochotona collaris)* in North America, plus 35 species in Asia

Although they look a lot like hamsters and other rodents, pikas are in the same group as rabbits. They have short limbs and big, round ears. These small mammals are well-adapted to survive on cold mountains.

Size: Adult American pikas are about the size of hamsters, usually 18–20 centimeters (7–8 inches) long.

Diet: Pikas are **herbivores** (plant eaters). They prefer grasses and wildflowers. They save up food by collecting piles of wildflowers and grasses. They lay them in the sun to dry out so they do not get moldy. Then the hay is stored in their dens to help them survive the winter. They only need to go out to forage when the weather permits.

An American pika in its mountain habitat
Bernd Thaller, Flickr, CC-BY-2.0

Habitat

Sometimes called "rock rabbits," pikas are found in alpine (mountain) areas, above the tree line. They usually make their dens and nests in areas of large rocks near meadows with grass and wildflowers.

Pikas gather hay piles to survive the winter.
Public domain

Protection from Predators + Cold

Many animals prey on pikas, such as weasels, hawks, foxes, and coyotes. Their rocky habitat provides good protection from predators, especially larger ones. They also protect themselves by living in **colonies** near other pikas. They will alert the group to predators by sending out a warning call.

Pika fur is brown and black, good camouflage in mountain rocks. Their tails aren't visible under their thick fur, which keeps them warm in winter. Their fur is less thick in summer, but pikas can still overheat in temperatures above 77˚F.

Communication

American pikas are often heard before they are seen—"EEP!" They make loud calls to alert other pikas to danger, define and protect their territory, and attract mates. They also use smells from urine (pee), feces (poop), and rubbing rocks with their cheeks to tell other pikas where they live. They are very territorial and protect the area around their dens.

"EEP!" Hear a pika's high-pitched call at youtu.be/DM-ZXUdYYvY?t=17.
David Kingham, Fickr, CC BY-NC-ND 2.0

Range

American pikas (*Ochotona princeps)* live on mountains in the western United States and Canada. They can be found in Montana, Wyoming, Colorado, Idaho, Washington, Oregon, California, Nevada, Utah, New Mexico, British Columbia, and Alberta. Their close relatives collared pikas (*Ochotona collaris)* live in parts of northern Canada and eastern Alaska. Thirty-five other species live in Asia.

Pika range in North America

Adapted from "COSEWIC Assessment and Status Report on the Collared Pika Ochotona Collaris in Canada – 2011": sararegistry.gc.ca/default.asp?lang=En&n=2C5BA237

Reproduction

American pikas begin to breed in early to mid-spring. Many pikas breed twice—once in the spring and again in the summer. Females are pregnant for about 30 days before giving birth to a litter of 2–6 young. Pika babies are born blind and mostly hairless. They depend on their mother for milk. It takes about a month for the young to be weaned off milk and 3 months to reach adult size. They breed the next year.

Lifespan

American pikas can live up to 7 years, but their average lifespan in the wild is 3 years.

Sensitivity to Climate Change

Pikas are very sensitive to heat. They are usually only found where summer temperatures rarely exceed 75˚F (24˚C). In fact, they can die within only an hour of being exposed to temperatures of 78˚F (26˚C) or more. Pikas have been disappearing from some of their historical ranges at lower elevations. Scientists think that this is linked to rising temperatures due to human-caused climate change.

A pika hay pile drying in the sun to help them survive the winter. How can we help pikas survive summers in the years ahead?

J.N. Stuart, Flickr CC BY-NC-ND 2.0

Learn More

- Adapted with permission from "American Pika." National Wildlife Federation: nwf.org/Educational-Resources/Wildlife-Guide/Mammals/American-Pika
- "American Pika." BioKIDS: biokids.umich.edu/critters/Ochotona_princeps
- "American Pika." U.S. Fish and Wildlife Service: fws.gov/mountain-prairie/es/species/mammals/americanpika
- "American Pika." Colorado Parks & Wildlife: cpw.state.co.us/learn/Lists/Wildlife%20Species/DispForm.aspx?ID=1
- "Collared Pika." Alaska Department of Fish and Game: adfg.alaska.gov/index.cfm?adfg=collaredpika.main
- "Collared Pika." Wikipedia: wikipedia.org/wiki/Collared_pika
- "Pika." Wikipedia, plus references at end of article: en.wikipedia.org/wiki/Pika

Name(s): _____ Period: _____ Date: _____

Pika Data: Population Over Time

1. **Add data points from the table** using 3 different colors.
2. **Label the colors** in the legend.
3. **Connect the points** in the 3 sets of data with straight lines of the same colors. This will create **line graphs** which show the changes over time.

Number of Pika After Each Round

0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32

0 1 2 3 4 5 6 7

Round (each round models pika survival after one year)

Legend ◯ **Did Not Survive** ◯ **Survived Only** ◯ **Survived and reproduced**

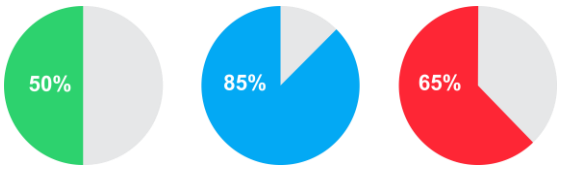
Name: _____ Period: _____ Date: _____

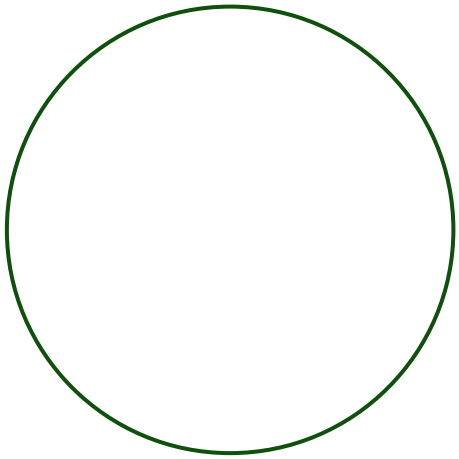
Pika Math!

Graph Title:_____

1. Pikas are **herbivores** (plant eaters). A pika might eat 52% grasses, 40% wildflowers, and 8% other plants. Create a **pie graph** (pie chart) to show this pikas' diet visually. Then **label** and **color** the important parts of the graph.

   Pie graph examples:





2. If the pika described above ate 100 grams (0.22 pounds) of food in one week, what would the mass of the food types eaten be in grams and pounds?

grasses: _____ grams _____ pounds

wildflowers: _____ grams _____ pounds

other plants: _____ grams _____ pounds

3. Imagine that the pika described above lived in an area that is becoming drier. There are fewer plants, so they only consumed 50 grams (0.11 pounds) of food in a week. What would the mass of the food types consumed be in grams and pounds?

grasses: _____ grams _____ pounds

wildflowers: _____ grams _____ pounds

other plants: _____ grams _____ pounds

4. Imagine that the pika described above lived in a thriving alpine ecosystem. If they consumed 147 grams (0.37 pounds) of food in a week, what would the mass of the food types consumed be in grams and pounds?

grasses: _____ grams _____ pounds

wildflowers: _____ grams _____ pounds

other plants: _____ grams _____ pounds

5. The predators and scavengers shown below are observed in an area with pikas. Scientists believe that they are hunting and scavenging pikas for meals.

Mammals


weasels


foxes


coyotes


cats


unleashed dogs

Birds


owls


eagles


ravens


vultures

Reptiles


Snakes

a. What **fraction** of the total number of animals thought to be eating pikas are:

____ mammals ____ birds ____ reptiles ____ cats and dogs

Can the fractions be reduced? If so, write the reduced fractions below.
For example, 25/50 could be reduced to 1/2.

____ mammals ____ birds ____ reptiles ____ cats and dogs

b. What **percent** of the total number of animals thought to be eating pikas are:

____ mammals ____ birds ____ reptiles ____ ravens and vultures (scavengers of dead pikas)

c. **Predators** can improve ecosystem health by keeping pika populations stable. Plant communities are not over-harvested, so **herbivores** have enough food and **soil** is protected by roots and leaves. However, **invasive** predators that aren't **native** (naturally found) in an area, like cats, can kill too many native species.

Imagine that populations of the native species listed below **increase** by 10% over 10 years in an area. Scientists believe this happened because humans controlled invasive predators and habitat loss due to climate change and development. What would the populations be after 10 years?

- 1,000 pikas would increase to _____ pikas
- 1,240 song birds would increase to _____ birds

  If humans take no action to help native species and their populations **decrease** by 50% over 10 years, what would their populations become?

- 1,000 pikas would decrease to _____ pikas
- 1,240 song birds would decrease to _____ birds

Name(s): _____ Per: _____ Date: _____

Model / Presentation Rubric

Title: _____

Presentation Component	Maximum Points Possible	Self-Score (fill out before presentation)	Teacher Score
Part 1: Content			
Subject and purpose of model clearly introduced	10		
Key concepts identified on model and clearly explained in well-organized way; interactions with other organisms including humans shown	10		
Ideas supported by examples, data, graphs, etc.; All information accurate and obtained from reliable sources	10		
Conclusion summarizes key points in persuasive way; Questions answered thoroughly and accurately	10		
Part 2: Delivery / Audience Engagement			
Speech delivered clearly at appropriate volume and speed (not too fast, slow, loud, or soft)	5		
Speed, volume, and voice inflection are varied to engage audience and emphasize key points	5		
Speaker connects with audience through eye contact and does not spend too much time looking at notes or screen	5		
Speaker demonstrates enthusiasm for topic throughout presentation; audience is persuaded by speaker	5		
Part 3: Visuals			
Visuals help to clearly explain concepts	10		
Model contains clear labels, as necessary	10		
Part 4: Written Explanation / Writing Conventions			
Written explanation of model is well written, organized, and easy to understand	10		
Grammatical and spelling conventions followed in written materials and in model	10		
TOTALS:	**100**		

Teacher comments: