POLAR TREC
Learning Resources

Details

Completion Time: About a week
Permission: Download and Share

Squirrely Numbers: Exploring Arctic Ground Squirrel Data

Overview
In this set of lessons, students have the opportunity to think like scientists as they examine actual data related to Arctic ground squirrels, organize it in logical ways, and make inferences based on the data.

Objectives
• Students will develop an understanding of some of the ways scientists use and organize data.
• Students will organize data from a given data set in a logical manner
• Students will analyze data in multiple formats and draw logical conclusions, supported by the data.
• Students will recognize hibernation as a process that enables animals to conserve energy.
• Students will develop a general understanding of the pattern of rising/falling Arctic ground squirrel body temperatures during hibernation and during the active period.

Lesson Preparation
Required Background Knowledge:
• Students should have experience viewing and analyzing data in numerous formats (variety of charts, graphs, tables, etc.)
• The video introduction included in the first lesson will provide enough background knowledge about the scientific work of Team Squirrel for students to complete these lessons. However, some students might appreciate additional insight into the work of Team Squirrel. This can be accomplished by giving students the opportunity to peruse the blog of Team Squirrel's work (http://www.polartrec.com/expeditions/arctic-ground-squirrel-studies) or by beginning the lesson with this additional short introductory video: (http://www.youtube.com/watch?v=CR6B_z3AF60).

Additional Consideration:

Materials

- For each group of 3-5 students:
- Computer or tablet with Internet access
- Data Set #1 (electronic copy)
- Data Set #1 Graph (printed copy)
- Data Set #2-A (printed copy)
- Data Set #2-B (printed copy)
- Data Set #3 (printed copy)
- Paper/Pencil
- Graph paper
- For teacher:
- Data Set #2-A Example Graph
- Data Set #3 Example Graph
- Projector/Computer with Internet access (YouTube access required)
- Squirrely Numbers PowerPoint

Learning Resources

This lesson requires the teacher to actively circulate and confer with groups to help direct their thinking, but the teacher should be careful to let students problem solve to the best of their ability.

Preparation
• Divide students into groups of 3-5
• Make needed copies (see "Materials" section)
• Arrange for students to have electronic access to Data Set #1 (see "Materials" section)
• Prepare the technology needed to show the videos/PowerPoint (projector and computer with Internet access)

Procedure
Day 1: Recognizing the value of representing data graphically/Interpreting data
• Divide students into cooperative groups of 3-5 (keep same groups for all 4 lessons)
• Show introductory video: http://www.youtube.com/watch?v=kYkWzEF_u6E&feature=youtu.be
• Teacher shows PowerPoint Slide #3 and says, "One trait of Arctic Ground Squirrels that scientists find fascinating is the way they control their body temperature during hibernation. Who can tell me what "hibernation" means? (Accept student responses).
• "Why might some Arctic animals, like the Arctic ground squirrel, hibernate during the winter?" (Lead students to consider the lack of energy sources (food) available in winter during the extremely cold/snowy Arctic winter. Reducing heat production/activity saves energy.)
• "Let's look at a sample of data that scientists gathered about one Arctic Ground Squirrel."
• Provide small groups of students with a digital copy of Data set #1 on a laptop/tablet.
• Teacher asks, "What do you notice about this spreadsheet?"
o Guide students to notice things like: title, labels, and types of data included in the spreadsheet, the units of measurement, the increments of measurement, the vast amount of data, etc.
• When it comes up in the conversation while discussing the data, share with students:
o Show PowerPoint Slide #4. "Scientists gather data about squirrel body temperature through small body temperature loggers called iButtons. These loggers are surgically implanted in the squirrel's abdomen. The logger records the squirrel's body temperature at regular intervals and stores it until the squirrel is recaptured and the scientists surgically remove the body temperature logger."
o Show PowerPoint Slides #5 and #6. "Scientists have special soil temperature loggers located near many of the Arctic Ground Squirrel burrows. These loggers gather data about the soil temperature and scientists download it periodically using a special program on a laptop computer, as you can see in these pictures".
• Teacher says, "It can be challenging to see patterns and trends in the data in this format, especially when there is so much data. It is easier to see what story the data is telling when we organize it graphically. Let's look at the same data set arranged as a graph".
• Share printed copy of Data Set #1 Graph with each small group of students. The graph is also included on PowerPoint slide # 7.

• Guide students as they examine the graph in small groups. Possible questions include:
• What do you notice?
• How is graph organized?
• What do you wonder?
• What do you notice about the data in the spreadsheet vs. the data in the graph?
• Teacher says, "With your group, study the graph and think like a scientist. What inferences could you make? What evidence supports your inferences?"
• Give students time to discuss. Have each group share with the class. Discuss.
• Some possible conclusions/observations (will be explored more in depth in later lessons):
o The soil temperature drops as winter approaches and begins to rise again in the spring. The soil temperature affects squirrel body temperature.
o The data in August/September shows the squirrel when it is active (not hibernating). The body temperature remains fairly high (close to 40° C with slight variations (related to the squirrel's circadian rhythms) during this time.
o The data from late September through May shows the squirrel's body temperature changes during hibernation. The squirrel's body temperature drops very low and remains that way for a few weeks before rising for a short time.
• Reflection question possibilities for class discussion or individual exit slips:
• How does the work you did today relate to the work of scientists?
• Discuss your experiences analyzing data in the spreadsheet and analyzing data in the graph. How were they the same? How were they different?
• What does the data make you wonder about Arctic ground squirrels?

Day 2: Graphing and Organizing Torpor Data
• Teacher says, "Yesterday, we saw that Team Squirrel is interested in squirrel body temperatures during hibernation. When we looked at the graph of data from one squirrel yesterday, many of you noticed that the squirrel's body temperature seemed to be very low during hibernation for a few weeks, then jumped to a much higher temperature for a short time before returning to very low temperatures". (Refer back to Data Set #1 Graph or PowerPoint Slide #7) "Today, we will explore data to learn more about that pattern".
• Distribute Data Set #2-A: Torpid body temperatures at a variety of hibernacula temperatures to each group of 3-5 students. Ask students what they notice/observe about the data sheet (consider titles, column headings, measurement methods, etc.)
• Teacher says, "You probably see some words on your new data sheets that you might not be familiar with: hibernacula and torpor. What do you infer 'hibernacula' means?" (Accept a few student responses). "During hibernation, Arctic ground squirrels stay in special underground burrows called hibernacula. After you explore the data today, I bet you will have a pretty good idea what 'torpor' means".

Creating the Graph:
(Students will likely need guidance setting up the graph today. Adjust the amount of support given based on the needs of the students. The description below includes lots of guidance).
• Ask students, "What type of question might a scientist try to answer by looking at this

data?" (Possibility: How does the temperature of the hibernacula impact the body temperature of Arctic Ground Squirrels during torpor?) Record the question on the board.
• Say, "Yesterday, we saw that graphing makes it much easier to identify trends and patterns in data. Today, we will organize this data sample in a graph to help answer the question we wrote on the board. Looking at the question we wrote, what are the two variables we are measuring here?" (hibernacula temperature and body temperature). Record the variables on the board.
• Ask, "Which is the independent variable (stands alone) and which is the dependent variable (impacted by independent variable)?" (Independent: Hibernacula temp and Dependent: Body temp) Label both variables on the board as independent or dependent.
• Say, "Remember, we always graph the independent variable on the x axis and the dependent variable on the y axis" Write x and y next to the appropriate terms on the board. (X: Hibernacula temp, Y: Body temp)
• One way to help students remember which variable goes on which axis is to hold up your left hand in an "L" shape (fingers together, thumb extended at a right angle). Your thumb can work on its own. It is independent. Your fingers work together; they are dependent on each other. Your independent thumb represents the x axis and your dependent fingers represent the y axis
• Guide students to look at the data and identify/record the minimum and maximum values for the data that will be plotted on each axis. This will help them determine the increments they use when creating their graph to ensure their graph makes the best use of the allotted space.
• X: minimum -16.2, maximum 3.4
• Y: minimum -1.7, maximum 4.3
• Distribute graph paper to each group. Looking at the identified minimums and maximums, and the size of the graph paper, help students determine what increments they should use when creating their graph.
• Ask students what logical titles/labels should be included on the graph.
• Using a quick, rough sketch of the graph developed with students, demonstrate how to plot the data in Data Set #2-A (see Data Set #2-A Example Graph for assistance)
• Small groups of students create a graph of Data Set #2-A on graph paper.
• Teacher circulates and assists small groups as needed.
• Small groups discuss what they notice when studying their graphs. What claim could they make about Arctic Ground Squirrels, based on the data? How might they answer the original question developed by the class?
• Each group shares their graph and explains their claim/evidence.
• For a sample of what student graphs might look like, see Data Set #2-A Example Graph.
• Logical conclusions that students can make from this data set: During torpor, as the hibernacula temperature drops, the squirrel's body temperature drops. The difference between body temperature and hibernacula temperature remains fairly constant until the hibernacula temperature drops below 0 degrees Celsius. At this point, the difference between body temperature and hibernacula temperature widens. When the body temperature drops to about -2 degrees Celsius, it remains at -2 degrees, regardless of hibernacula temperature.

So, squirrels are setting their internal thermostat to a really low body temperature (almost -2 degrees C [colder than an ice cube]).
• Share with students as it makes sense during class discussion: The salts in our blood and tissues cause them to freeze at temperatures lower than 0° C. As this data set shows, the Arctic ground squirrel's body temperature gets colder than this during hibernation. This is called super-cooling. The squirrel's body temperature actually drops slightly below the freezing point of the tissue.
• Reflection question possibilities for class discussion or individual exit slips:
• Based on the data you examined today, how would you define "torpor"? (will discuss more in depth in next lesson)
• How does the work you did today relate to the daily work of scientists?
• What does the data make you wonder about Arctic ground squirrels?

Day 3: Graphing and Analyzing Arousal Data
• Ask a student to summarize what the class learned/observed yesterday.
• Distribute a copy of Data Set #2-B: Arctic Ground Squirrel Body Temperatures During Arousal vs. Hibernacula Temperatures to each group of 3-5 students.
• Ask students what they notice/observe about the data sheet (consider titles, column headings, measurement methods, etc.)
• Teacher says, "You see the word 'hibernacula' on your new data sheet. Remind me what that means." (Accept a few student responses). "Yesterday, you examined data from an Arctic ground squirrel during torpor. Today, you will see data from the same hibernating squirrel, but in periods of arousal. After studying the data, you will be able to explain the difference between topor and arousal".
• Ask students what type of question a scientist might try to answer by looking at this data. (Possibility: How does the temperature of the hibernacula impact the body temperature of Arctic ground squirrels during arousal?) Record the question on the board.
• Direct students to look at Data Set #1 Graph. The data from Data Set #2-B is already plotted on this graph (along with other data). Have students use Data Set #2-B to label body temperatures and hibernacula temperature during arousal directly on Data Set #1 Graph. (Students should look for high body temperatures that correspond with the dates noted on Data Set #2-B)
• Teacher circulates and assists small groups as needed.
• Small groups discuss what they notice about body temperatures and soil temperatures during periods of arousal when studying the graph. What claim could they make about Arctic ground squirrels, based on the data? Each group explains their claim/evidence.
• Logical conclusions that students can make from this data set: During arousal periods, body temperature remains at about 38 degrees Celsius, regardless of soil temperature. The maximum body temperature during each arousal is very high and nearly constant (it does increase with decreasing hibernacula temperature - this is probably because squirrels might be active or shivering at those low temperatures). So, the squirrels have reset their internal thermostat.
• Guide students in comparing/analyzing Data Set #1 Graph or PowerPoint Slide #7 and the

graph they created yesterday.
• What do they notice?
• What do they wonder?
• How might they define "torpor" and "arousal", based on the data they have examined? Torpor- drastic reduction in body temperature setpoint. Arousal- brief, less than 1 day return to "normal" body temperature.
• Ask, "What general statement could they make about Arctic Ground squirrel hibernation/ body temperature, based on the graphs?" (may allude to the cyclical nature of body temperature changes during hibernation)
• To further illustrate the body temperature changes that occur in Arctic ground squirrels during arousal, share this four-minute video created by a graduate student at the University of Alaska: http://www.youtube.com/watch?v=jtWntEftFuk
• Possible discussion after watching the video: Ask students how they warm themselves up when they get cold (shivering). At really low body temperatures mammals can't shiver so they have a special organ (brown fat) that generates heat. Once their body temperatures get to about 20 deg C (68 F) they start to shiver as well to warm themselves. Human babies also have a fair bit of brown fat so they can warm themselves without shivering.
• Reflection question for individual exit slip:
• Describe the most important thing you have learned during the past three days or list one question that you still have from your work during the past three days.

Day 4: Graphing and Analyzing Active period data
• Teacher says, "The past two days, we have focused on a squirrel's body temperatures during hibernation. Today, we are going to look at data from a few days of squirrel's active period, when it is not hibernating.
• Distribute Data Set #3: Arctic Ground Squirrel Body Temperature During 6 days of the Active Season to each group of students.
• Ask students what they notice/observe about the data sheet (consider titles, column headings, measurement methods, etc.)
• Ask students what type of question a scientist might be trying to answer by looking at this data. (Possibility: How does the body temperature of an Arctic ground squirrel change over the course of the day?) Record the question on the board.
• Ask students how they might organize the data to make it easier to understand/more visual (most likely a graph). Working in small groups, students create a graph of the data. One option is for students to use the free website http://nces.ed.gov/nceskids/createagraph/ for graphing. Graphing by hand is also an option.
• Teacher circulates and assists small groups as needed.
• Small groups discuss what they notice when studying their graphs. What claim could they make about Arctic Ground Squirrels, based on the data?
• Each group shares their graph and explains their claim/evidence.
• For a sample of what student graphs might look like, see Data Set #3 Example Graph.
• Logical conclusions that students can make from this data set: During the active season, squirrel body temperature is high, but has a daily rhythm (may wish to introduce the term

"circadian rhythm"). So, squirrels have an internal thermostat, set to a daily rhythm so body temperature is warmer during the day, compared to at night.
• Guide students in comparing/analyzing Data Set #1 Graph and the two graphs they created. Possible questions include:
• What do you notice?
• What do you wonder?
• If you were part of Team Squirrel, what other data might you gather?
• If you were part of Team Squirrel, what other questions might you research?
• Teacher says, "Looking at the data from the past four days, how could you summarize what you learned about Arctic ground squirrel body temperature?" Give groups time to discuss and share. (Possibility: Arctic ground squirrels have a high body temperature during the active season that drops slightly at night, then rises again during the day. During hibernation, Arctic ground squirrels' body temperature drops very low for a few weeks during torpor, getting even colder than an ice cube. Every few weeks, the squirrel raises its body temperature during arousal for about a day before its temperature drops very low again. This cycle continues during hibernation.)
• Reflection question possibilities for individual exit slips:
• How does the work you have done this week relate to the daily work of scientists?
• How do scientists use data?
• Describe your challenges/success working with data the past few days.

Extension
Students can conduct further research on a question that they developed while studying the data.

Alicia Gillean's PolarTREC blog about her work with scientists studying Arctic ground squirrels. Created summer 2013. (http://www.polartrec.com/expeditions/arctic-ground-squirrel-studies)

Scientific American article related to the Arctic ground squirrel's super-cool hibernating body temperatures. (http://www.scientificamerican.com/article.cfm?id=arctic-ground-squirrel-brain)

Overview of Arctic ground squirrel biology, habitat, and behavior. (http://animaldiversity.ummz.umich.edu/accounts/Spermophilus_parryii/)

Overview of Arctic ground squirrel biology, habitat, and behavior. Includes videos and photos. (http://www.arkive.org/arctic-ground-squirrel/spermophilus-parryii/)

The video mentions Toolik Field Station. This is the website for the field station. (http://toolik.alaska.edu/)

Assessment

Learning Resources

Describe how student understanding, learning, and achievement are evaluated for this lesson. List any related documents (e.g. surveys, rubrics) when submitting the lesson and send them separately.

The objectives of this lesson are assessed informally through class discussion and through teacher discussion with small groups.

More formal assessments can be made by analyzing student graphs/ presentations and written student responses to exit slip questions mentioned on each day's lesson.

Credits

This lesson was created by PolarTREC teacher Alicia Gillean with the assistance of Dr. Cory Williams from the University of Alaska. Alicia can be contacted at alicia.gillean@jenksps.org.

Learning Resources

National Science Education Standards (NSES):

Content Standards, Grades K-4

Content Standard A: Science As Inquiry
a. Abilities necessary to do scientific inquiry
b. Understandings about scientific inquiry

Content Standard C: Life Science
a. Characteristics of organisms
b. Life cycles of organisms
c. Organisms and environments

Content Standards, Grades 5-8

Content Standard A: Science As Inquiry
a. Abilities necessary to do scientific inquiry
b. Understandings about scientific inquiry

Content Standard C: Life Science
a. Structure and function in living systems
c. Regulation and behavior
d. Populations and ecosystems
e. Diversity and adaptations of organisms

Content Standard G: History and Nature of Science
a. Science as a human endeavor
b. Nature of science

Content Standards, Grades 9-12

Content Standard A: Science As Inquiry
a. Abilities necessary to do scientific inquiry
b. Understandings about scientific inquiry

Content Standard C: Life Science
e. Matter, energy, and organization in living systems
f. Behavior of organisms

Content Standard G: History and Nature of Science
a. Science as a human endeavor
b. Nature of scientific knowledge