Strand: 8.4.4 Part II - Effects

**Emphasis:** Earth’s changing climate affects species (including humans), but we have the ability to make changes to mitigate climate change and reduce these effects.

**Anticipated Time Required:**
- LE 1 - 45 minutes
- LE 2 - 30 minutes
- LE 3 - 30 minutes
- LE 4 - 30-45 minutes
- LE 5 - 30 minutes
- LE 6 - 15-20 minutes to explain/discuss; time needed for students to complete the assessment varies

**Dominant CCC:** Cause and effect
**Dominant SEP:** Analyzing and interpreting data; engaging in argument from evidence

**Management Strategies** to support equitable access to content:
Student choice for final assessment

**Shopping list:** none
### 8.4.4 - Effects of climate change Storyline Overview

**Anchor Phenomenon:** Temperatures in Utah have increased 2 times the global average.

**Student Performance Expectation:**

- **8.4.4** Analyze and interpret data on the factors that change global temperatures and their effects on regional climates. Examples of factors could include agricultural activity, changes in solar radiation, fossil fuel use, and volcanic activity. Examples of data could include graphs of the atmospheric levels of gases, seawater levels, ice cap coverage, human activities, and maps of global and regional temperatures.


<table>
<thead>
<tr>
<th>Dominant DCI</th>
<th>Dominant CCC</th>
<th>Dominant SEP</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESS3.D: Global Climate Change</td>
<td>Cause and effect; stability and change; energy and matter</td>
<td>Analyzing and interpreting data; evaluating and communicating information</td>
</tr>
</tbody>
</table>

### Science Experiences

<table>
<thead>
<tr>
<th>CCC/SEP</th>
<th>What are students doing? <em>(This should match your SEP!)</em></th>
<th>What Disciplinary Core Idea understandings should students get from this experience?</th>
<th>New questions students have to lead to the next science experience</th>
<th>Assessment</th>
</tr>
</thead>
</table>
| 1: Effects in Utah: snowpack and ecosystems | **Gather:** Students research the difference between rain and snow (how do different forms of precipitation affect ecosystems?) and then analyze data on Utah’s snowpack.  
**Reason:** Students determine why different data sets show different trends, and evaluate which data sets are more reliable.  
**Communicate:** Students record understanding of the implications of lost/reduced snowpack. | Snowpack in Utah and the West is decreasing.  
Although snow and rain are both water, snow allows the water to be stored and released over a longer period of time | What happens to the plants and animals if the snowpack disappears? | Formative: Responses to questions on exit ticket should be used to assess how well students understand the trends in snowpack in the Western US, and the effect of these trends. |
| 2: Changes in plant/animal ranges | **Gather:** Students gather information from data on ranges of birds and marine life.  
**Reason:** Students create a diagram to tell the story of the data they analyzed, and then use what they’ve learned to predict how species in Utah will be affected by increased climate and decreased snowpack. | Plants and animals are adapted to live in particular climates and if the climate changes, they respond by moving to a different location, if possible, or perhaps dying out. | How do these changes affect other factors? For example, why does it matter if fish or birds are found in different areas? | Formative: Student diagrams should be used to assess their ability to analyze and interpret data.  
Student predictions about species in Utah should be used to assess their |
| 3: resource mismatch and phenology | **Gather:** Students use news article to learn about effects of animal cycles and climate change on the animal species.  
**Reason:** Students are given cards with information about various species and predict how climate change will interact with the species’ natural cycle to affect the species.  
**Communicate:** Students record their predictions and reasoning and summarize their understanding of the interaction between climate change and natural cycles and how this interaction can affect the species. | Not all species respond to climate change the same. This can result in one species not having adequate food or other resources. | How can changing patterns (time and range) of migration directly affect humans? | Formative: Students ability to predict the effects on species should be used to assess their understanding that the behavior cycles with the seasons, and as climate change affects when seasons start and stop, these cycles can result in resource mismatches. |
| --- | --- | --- | --- | --- |
| 4: species range change/infectious disease | **Gather:** Students analyze data/newspaper articles about the spread of west nile (maybe zika?) (need to include information about how these diseases spread)  
**Reason:** Students use what they learned in previous lessons to construct an explanation for why these diseases are spreading to places like Utah.  
**Communicate:** Increasing range of mosquitoes and other vectors could increase the spread of disease.  
Less severe cold seasons can allow mosquito and other vector populations to increase, resulting in the greater spread of disease | | | |
| 5: Climate change and wildfires | **Gather:** Students review two documents (an article and an infographic) to gather information about the relationship between climate change and wildfires.  
**Reason:** With a partner, students evaluate the way information about climate change and wildfires was communicated in each document and identify different communication strategies.  
**Communicate:** Students support a claim about how to effectively communicate information about climate change. | Climate change can increase the frequency and severity of wildfires by increasing temperatures and decreasing precipitation/moisture in an ecosystem.  
There are different ways to effectively communicate the impacts of climate change; the intended audience should be taken into consideration. | What do we do about this? | Formative: Student exit tickets should be used to assess how well they understand the connections between climate change and wildfires, as well as their ability to evaluate the effectiveness of different communication methods. |
<table>
<thead>
<tr>
<th>Gather: Students return to LE 5 from the previous storyline to revisit the causes of climate change; students identify which of the factors that cause climate change can be influenced by humans.</th>
</tr>
</thead>
<tbody>
<tr>
<td>There are factors causing climate change that humans have the power to influence.</td>
</tr>
<tr>
<td>Summative: Student action plans should be used to assess their understanding of the effects of climate change, and our ability to affect climate change.</td>
</tr>
</tbody>
</table>

5: Increased awareness of human impact on ecosystems

CCC: Stability and change; cause and effect

SEP: Designing solutions; communicating information

Reason: Students select one factor that humans can influence and identify a plan of action concerning that factor.

Communicate: Students implement and share their action plan.
8.4.4 Effects Learning Episode 1

Student Science Performance

<table>
<thead>
<tr>
<th>Topic: Climate Change</th>
<th>Title: Snowpack and its effects</th>
</tr>
</thead>
</table>

**Overarching Performance Expectations (Standard) from State Standards or NGSS:**
8.4.4 Analyze and interpret data on the factors that change global temperatures and their effects on regional climates. Examples of factors could include agricultural activity, changes in solar radiation, fossil fuel use, and volcanic activity. Examples of data could include graphs of the atmospheric levels of gases, seawater levels, ice cap coverage, human activities and maps of global and regional temperatures.

**Lesson Performance Expectations:**
Students will analyze, interpret, and evaluate data regarding the snowpack in Utah and the western US, and explain how changing snowpack could affect ecosystems and humans.

**CCC:** Patterns, cause and effect, stability and change  
**SEP:** Analyze and interpret data, evaluate information

**Students Will . . . To Construct Meaning**

Engage with a Phenomenon: Temperatures in Utah have increased about twice the global average.

**Teacher Will . . . To Support Students**

**Management Strategy:** During this unit, students will be working to understand the effects of this phenomenon. You may want to have students set aside a page in their lab books or provide them with a graphic organizer so that after each lesson, they can summarize the effects of this warming in Utah.

Tell students that temperatures in Utah have increased 2x the global average, and/or show them this video to illustrate that Utah is not immune to climate change:
https://vimeo.com/album/4245985/video/190912659

Ask students what observations we could make to evaluate the climate (besides reading the temperature on a thermometer). Record students’ ideas, and keep them in a place where you can refer to them throughout the unit. Consider allowing students time to record 2-3 ideas before starting the class discussion to allow time for them to think. If students are having a hard time getting started, provide them with one example. When you finish, your class list might include:
- Amount of ice/snow  
- When and where there is snow  
- Type of plants  
- When the flowers bloom in the spring  
- When we see migratory birds (robins = spring?)  
- When and where we observe different animals (deer might come down from the mountains when there is too much snow in the winter, etc.)

Tell students that today they will be investigating some of these things to see how they might be affected by a changing climate. Today we will
**Gather**: Watch the video/read the information about the difference between snowpack and rain. Record how these two types of precipitation affect the ecosystem differently.

Share your ideas about how snow and rain affect ecosystems differently with your partner. When it is not your turn to share, listen to what your partner says. If she says something that you missed, you can add it to your notes. If she says something that you don’t understand, ask a question to help your partner clarify her idea.

As a class, summarize the importance of snowpack. Also predict what could happen to plants, animals and humans if the snowpack is reduced or disappears.

Analyze the two sets of data about snowpack in Utah and the Western United States. What patterns do you see in the data from the EPA? After you record the patterns you find in the data, pick up the snowpack data collected at Utah ski resorts. What patterns are there in the data from the ski resorts?

**Reason**: With your partner, summarize the patterns you found in each set of data, and then come up with an explanation for the differences. Be prepared to share your explanation with the class.

<table>
<thead>
<tr>
<th>Focus on snowpack.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instruct students to record how snowpack and rainfall affect ecosystems differently (you may want to allow them to make a few predictions as a class first). Depending on the class and how much time you have, allow them to get information about snowpack from:</td>
</tr>
<tr>
<td>- a short reading (included in the lesson materials)</td>
</tr>
<tr>
<td>- video: <a href="https://www.youtube.com/watch?v=csH-VpQshNQ">https://www.youtube.com/watch?v=csH-VpQshNQ</a></td>
</tr>
<tr>
<td>As students work with their partners, circulate through the room and listen for ideas that you would like students to share during the class discussion.</td>
</tr>
</tbody>
</table>

Facilitate a class discussion to allow students to summarize reasons that snowpack is important. Then ask them to predict how plants and animals (including humans) would be affected if the snowpack disappeared. Act as a recorder to document their predictions; if any predictions seem outlandish, allow the class to discuss them and determine if they should be included on this list or not.

Distribute the data sets from the EPA with the instructions to identify patterns in the snowpack. After students have recorded the patterns, they can pick up the data collected at the ski resorts in Utah and again look for patterns in the data.

As students discuss their ideas with their partners, circulate through the room and listen to their ideas. Make note of students that you want to call on to share their ideas during the class discussion. Facilitate a class discussion to acknowledge that the two data sets seem to tell different stories. Allow the class to discuss which data is more reliable and why. Students can be reminded of time scales; one data set includes information gathered over 60 years while the other contains information from eight years. You may also want to discuss which data students would be more likely to be exposed to. The EPA data is on their website;
Communicate: On your exit ticket:
- One major difference in the way snow and rain affect the ecosystem
- Description of how the snowpack is changing (or not) with evidence to support it
- One concern that humans should have about reduced snowpack

Have students complete an exit ticket to summarize their understanding of what they learned during this lesson.

Assessment of Student Learning

Student discussions as they work to reconcile differences in the data set should be used to formatively assess their ability to analyze and interpret data. Exit tickets should also be used as formative assessments.

Example responses for exit ticket:
- Differences in snow/rain:
  - “The snow makes it so water can stay in the mountains longer. The plants and animals can use the water all summer. If it rains, the water just runs down the mountains and the plants and animals can’t use it.”
  - “If it only rained, the water leave the ecosystem faster and the plants and animals can’t use it.”
- Description of how snowpack is changing:
  - “The data set with the most data shows that in most places in the Western US, the snowpack is declining.”
  - “One data set showed the snowpack is stable and one said it was changing. The one that said it was stable only had data from 8 years, so it is probably not as reliable.”
- Concerns we should have:
  - “If it only rains, we won’t have anywhere to store the water, so it will leave in rivers and we won’t have anything to drink.”
  - “I like to ski and if there is no snow, I won’t be able to ski. And all the people who work at the ski resort won’t have jobs.”
  - “If it doesn’t snow, the trees in the mountains might die. Then there might be more forest fires or other problems.”
Temperature and precipitation are key factors affecting snowpack, which is the amount or thickness of snow that accumulates on the ground. In a warming climate, more precipitation will be expected to fall as rain rather than snow in most areas—reducing the extent and depth of snowpack. Higher temperatures in the spring can cause snow to melt earlier.

Mountain snowpack plays a key role in the water cycle in western North America, storing water in the winter when the snow falls and releasing it as runoff in spring and summer when the snow melts. Millions of people in the West depend on the melting of mountain snowpack for power, irrigation, and drinking water. In most western river basins, snowpack is a larger component of water storage than human-constructed reservoirs.1 Changes in mountain snowpack can affect agriculture, winter recreation, and tourism in some areas, as well as plants and wildlife. For example, certain types of trees rely on snow for insulation from freezing temperatures, as do some animal species. In addition, fish spawning could be disrupted if changes in snowpack or snowmelt alter the timing and abundance of streamflows.
Trends in April Snowpack in the Western United States, 1955–2016


For more information, visit U.S. EPA's "Climate Change Indicators in the United States" at www.epa.gov/climate-indicators.
Trends in April snowpack, 1955–2013. Snowpack has declined at most monitoring sites in Utah and the Upper Colorado River Basin. Source: EPA.
### Total yearly snowfall at Utah resorts

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<thead>
<tr>
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<tr>
<td>Brian Head</td>
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<td>341</td>
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<td>178</td>
<td>209</td>
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<td>Beaver Mountain Lodge</td>
<td>174</td>
<td>139</td>
<td>110</td>
<td>117</td>
<td>73</td>
<td>227</td>
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<td>222</td>
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<tr>
<td>Eagle Point</td>
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<td>180</td>
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<td>155</td>
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<td>Sundance</td>
<td>233</td>
<td>126</td>
<td>92</td>
<td>227</td>
<td>126</td>
<td>176</td>
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<td>154</td>
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<tr>
<td>Snowbird</td>
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<td>437</td>
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<td>436</td>
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<td>249</td>
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<td>Brighton</td>
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<td>358</td>
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<td>Solitude Mountain</td>
<td>439</td>
<td>559</td>
<td>320</td>
<td>280</td>
<td>262</td>
<td>453</td>
<td>230</td>
<td>289</td>
</tr>
<tr>
<td>Park City Mountain</td>
<td>348</td>
<td>408</td>
<td>280</td>
<td>143</td>
<td>347</td>
<td>263</td>
<td>205</td>
<td>268</td>
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<tr>
<td>Deer Valley</td>
<td>268</td>
<td>317</td>
<td>240</td>
<td>226</td>
<td>156</td>
<td>234</td>
<td>165</td>
<td>223</td>
</tr>
<tr>
<td>Snowbasin</td>
<td>273</td>
<td>274</td>
<td>224</td>
<td>191</td>
<td>197</td>
<td>225</td>
<td>181</td>
<td>243</td>
</tr>
<tr>
<td>Nordic Valley</td>
<td>188</td>
<td>131</td>
<td>97</td>
<td>94</td>
<td>108</td>
<td>73</td>
<td>45</td>
<td>110</td>
</tr>
<tr>
<td>Powder Mountain</td>
<td>299</td>
<td>219</td>
<td>222</td>
<td>249</td>
<td>151</td>
<td>219</td>
<td>146</td>
<td>279</td>
</tr>
</tbody>
</table>

All measurements in inches. Data from onthesnow.com.

This table documents the past 8 years of snowfall in inches, according to onthesnow.com. Scientists predict the “Greatest Snow on Earth” could disappear by the end of the century. (Chuck Dearden)
Snowpack Exit Ticket
You can use your notes to answer these questions

What is one major difference in the way snow and rain affect ecosystems?

Describe how the snowpack in Utah and the western US is changing (or not). Use evidence to support your answer.

What is one reason we should be concerned about reduced snowpack in the mountains?
### 8.4.4 Effects Learning Episode 2

<table>
<thead>
<tr>
<th>Student Science Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topic:</strong> Climate Change</td>
</tr>
<tr>
<td><strong>Title:</strong> Changes in plant/animal range</td>
</tr>
</tbody>
</table>

**Overarching Performance Expectations (Standard) from State Standards or NGSS:**

8.4.4 Analyze and interpret data on the factors that change global temperatures and their effects on regional climates. Examples of factors could include agricultural activity, changes in solar radiation, fossil fuel use, and volcanic activity. Examples of data could include graphs of the atmospheric levels of gases, seawater levels, ice cap coverage, human activities and maps of global and regional temperatures.

**Lesson Performance Expectations:**

Students analyze and interpret data to determine the relationship between a species’ range and climate; they use what they’ve learned from the data analysis to make predictions about how species in Utah may be affected by climate change.

- **CCC:** Stability and change, cause and effect
- **SEP:** Analyze and interpret data, construct explanations

**Students Will. . . To Construct Meaning**

**Engage with a Phenomenon:** The location of animals and blossoming of trees is changing.

**Gather:** Select one of the data sets to analyze. As you analyze the data:

- Identify what each axis represents
- Determine if there is a relationship between the variables
- Identify patterns
- Look for peaks and troughs; are the high points and low points changing?

**Reason:** With your partner, create a diagram (words and pictures) that captures the main point of the data.

**Communicate:** Share your diagram with your group.

**Teacher Will. . . To Support Students**

Remind students of the indicators of climate that they generated during the last lesson, and tell them that they will be investigating how climate change affects some more of these indicators (specifically, where species live). Start by asking the question, “We have evidence that snowpack in the West is being reduced and that temperatures are increasing; how do you think this will affect the plants and animals in the area?” If needed, allow students to share a few predictions with the class.

Distribute the data sets, or let students pick which one they would like to analyze. Instruct students to analyze the data, and provide some guiding questions they can use. If you have students who are still struggling with analyzing data, consider assigning them the bird data (it is a bit more straightforward) and/or providing written background information and/or key points to help the students make sense of the data. Key points and background information can be found by following the link with each data set, scrolling down, and clicking on the “key point” or “background” tab.

As students work, circulate through the room and use questions to help guide students.

Pair students with someone who looked at the same data set and have them create a diagram together. This allows them to discuss what they got from the data, and also think about the best way to communicate the story from the data in words and pictures.

Ideally, each group of students will have a pair who looked at fish data and a pair who looked at bird data. Instruct students on how you would like them to share their data.
As a group, predict how the following populations will be affected by the changing snowpack in Utah:

- Aspen and pine trees (currently found in the mountains, below the timberline)
- Picas (small mammals currently found in the rocky area above the timberline)
- Trout (currently found in various cold water lakes)

Label each sticky note with the name of the species (trees, picas, trout). After determining if you think each species will remain stable where it is, move to a different location, or go extinct, write your explanation for each prediction on a separate sticky note. Post your sticky notes in the correct places on the board.

In your lab book, summarize how climate affects the range of plants and animals.

<table>
<thead>
<tr>
<th>Species</th>
<th>Possible Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspen and pine trees</td>
<td>Remain stable, move, go extinct</td>
</tr>
<tr>
<td>Picas</td>
<td>Remain stable, move, go extinct</td>
</tr>
<tr>
<td>Trout</td>
<td>Remain stable, move, go extinct</td>
</tr>
</tbody>
</table>

Go over each species and its current location with the class; consider showing pictures of each species. Many students may not know what timberline means or what picas are. Instruct students to predict what will happen to these species as the temperature increases and the snowpack decreases. Give each group three sticky notes. On the board, make a grid that has the names of the species across the top (aspen/pine trees, picas, trout) and the three possibilities for their populations down the side (remain stable, move to a different location, go extinct). Students should post their sticky notes in the correct boxes on the grid, providing a nice starting place for a class discussion. Use the placement of the sticky notes to facilitate a class discussion:

- “What patterns do you notice in the predictions people made?”
- “Why do you think people ended up making the same prediction about trout but not about picas?”
- “How many different explanations are there for (these sticky notes in the same box)?”

After the class discussion, allow students to summarize what they understand about climate and a species range in their notebooks. You could also do this as an exit ticket.

**Assessment of Student Learning**

*Student diagrams should be used to assess their ability to analyze and interpret the data in the graphs; predictions should be used as a formative assessment of how well they understand the relationship between climate and where species are able to live, as well as how species are being affected by climate change.*
Data from [https://www.epa.gov/climate-indicators/climate-change-indicators-bird-wintering-ranges](https://www.epa.gov/climate-indicators/climate-change-indicators-bird-wintering-ranges)

Change in Latitude of Bird Center of Abundance, 1966–2013


For more information, visit U.S. EPA's "Climate Change Indicators in the United States" at www.epa.gov/climate-indicators.
Data from https://www.epa.gov/climate-indicators/climate-change-indicators-marine-species-distribution

Change in Latitude and Depth of Marine Species, 1982–2015


For more information, visit U.S. EPA's "Climate Change Indicators in the United States" at www.epa.gov/climate-indicators.
# 8.4.4 Effects Learning Episode 3

## Student Science Performance

<table>
<thead>
<tr>
<th>Topic: Climate Change</th>
<th>Title: Phenology</th>
</tr>
</thead>
</table>

### Overarching Performance Expectations (Standard) from State Standards or NGSS:

**8.4.4** Analyze and interpret data on the factors that change global temperatures and their effects on regional climates. Examples of factors could include agricultural activity, changes in solar radiation, fossil fuel use, and volcanic activity. Examples of data could include graphs of the atmospheric levels of gases, seawater levels, ice cap coverage, human activities and maps of global and regional temperatures.

### Lesson Performance Expectations:

Students gather information about plant and animal behaviors/cycles that allow them to access to resources, and use this information to predict how other species may be affected by climate change.

- **CCC:** Stability and change; cause and effect
- **SEP:** Obtaining and evaluating information; arguing from evidence (using evidence to support a prediction)

## Students Will. . . To Construct Meaning

**Engage with a Phenomenon:**

Snowshoe hares are not always matched to their environment.

**Gather:** Listen to/read the story about snowshoe hares. In your lab book, create a flowchart that shows the cause and effect relationships that lead to more of the snowshoe hares being eaten by predators because they are mismatched.

Phenology is the study of cyclic and seasonal phenomena. For example, the hares change color with the seasons. As snowpack and the seasons are affected by climate change, these cycles in plants and animals will be affected.

**Reason:** With your partner, use the information about different organisms to predict how they may be affected by climate change and

## Teacher Will. . . To Support Students

Distribute transcripts of the news story so students can follow along (and make notes, if needed) as they listen to it: [http://www.npr.org/2013/09/08/220188619/climate-change-leaves-hares-wearing-the-wrong-colors](http://www.npr.org/2013/09/08/220188619/climate-change-leaves-hares-wearing-the-wrong-colors) (there is a “transcript” link below the play button). After listening to the story, instruct students to make a flowchart showing the cause and effect relationships that have led to more hares being mismatched and easier targets for predators (for example: cold air in fall → hares turn from brown to white; late snowfall → white hares on brown ground → hares are easier to see → eaten by predators). If students need help getting started, allow the class to come up with one cause and effect relationship and then let the students work individually from there.

Explain what phenology is and that students will be working to understand how climate change and the natural cycles of plants/animals may have a negative effect on different species, like the hare. It is not important for students to know the word “phenology,” but they should understand the concept. Ask students for other examples of cycles that species go through (trees flower in the spring, drop leaves in the fall, etc.).

Provide each partnership with the information cards, and instruct them to predict how the species will be affected by their own cycles and changes in the climate. If needed, help students construct a graphic organiser to record their information, or distribute organizers for them to use.

E. Harward
why. Record your predictions and reasoning in your lab book.

<table>
<thead>
<tr>
<th>Communicate: Complete your exit ticket:</th>
</tr>
</thead>
<tbody>
<tr>
<td>How might the natural cycles of a species be affected by climate change?</td>
</tr>
</tbody>
</table>

Depending on time, you may want to have students only look at two of the cards instead of all three. As students work, circulate through the room and listen to student conversations. Use questions to help students clarify their ideas.

Information on the cards was taken from the following sources:


Provide paper for students to do their exit ticket.

<table>
<thead>
<tr>
<th>Assessment of Student Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Snowshoe hare flowcharts should be used to assess students’ abilities to identify cause and effect relationships. Their discussions/written work with their partners should be used to formatively assess their understanding of how climate change may interact with plant/animal behaviors/cycles in way that is negative for the species.</strong></td>
</tr>
</tbody>
</table>

E. Harward
Birds and caterpillars

Many migratory birds’ cycles have not shifted as quickly as plants and insects. One example is a bird named the great tit. These birds rely on a species of caterpillar to feed their young. The caterpillars are emerging earlier in the spring, but the bird’s egg-laying date has not changed as quickly. If the caterpillars continue to emerge earlier, but the birds lay their eggs at the same time, how will the bird species be affected?

Monarch Butterflies

When the daylight gets shorter, it signals the monarch butterflies to start their migration south. In the fall, the butterflies migrate from the Northern and Central United States to Mexico. The monarchs can’t live through the colder winters in the United States; however, the plants that young monarchs need to eat don’t grow in Mexico. This means that in the spring, the monarchs must fly back to the United States. It was recently discovered that cold temperatures trigger the monarchs to fly back north. Researchers captured some monarchs. They kept the monarchs in different temperatures and then observed where the monarch flew. Monarchs that were kept in warmer temperatures continued to fly south. Monarchs that were kept in colder temperatures flew north. If temperatures continue to increase, what will happen to the monarchs that are supposed to migrate north, where their food source is?

Pollinators

A plant in Asia (called Cordyalis ambigua) depends on honeybees for pollination. When the bees visit the flowers, they move pollen from one plant to another, which results in the plant being able to produce seeds. As spring comes earlier, the plants produce flowers earlier in the year, but the bees aren’t coming out of hibernations earlier. By the time the bees emerge, there are only a few flowers left on the plants. If the plants continue to flower before the bees emerge, how will their species be affected?
Cycles and Climate Change

How do you think each species might be affected by their natural cycles and climate change? Record your predictions below. Include your reasoning!

<table>
<thead>
<tr>
<th>Species</th>
<th>Prediction: what do you think will happen to this species?</th>
<th>Reasoning: explain your prediction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Great tit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caterpillars that the great tit eats</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monarch butterflies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asian plant <em>Cordyalis ambigua</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bees that pollinate the Asian plant <em>Cordyalis ambigua</em></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Why Does the Sun Cause Sunburns?

Whether at beaches, barbecues, hanging out in the park or at the pool, most people catch more sun rays this season than other times of the year. In the process, some will get a suntan while others, unfortunately, will experience sunburns.
# 8.4.4 Effects Learning Episode 5

## Student Science Performance

<table>
<thead>
<tr>
<th>Topic: Climate Change</th>
<th>Title: Wildfires and climate change</th>
</tr>
</thead>
</table>

### Overarching Performance Expectations (Standard) from State Standards or NGSS:

**8.4.4** Analyze and interpret data on the factors that change global temperatures and their effects on regional climates. Examples of factors could include agricultural activity, changes in solar radiation, fossil fuel use, and volcanic activity. Examples of data could include graphs of the atmospheric levels of gases, seawater levels, ice cap coverage, human activities and maps of global and regional temperatures.

### Lesson Performance Expectations:

Students evaluate information about wildfires and climate change from two sources, and determine how to effectively communicate information about climate change.

- **CCC:** Cause and effect
- **SEP:** Obtaining and evaluating information

### Students Will . . . To Construct Meaning

**Engage with a Phenomenon:** The severity of wildfires has increased in the past 30 years.

**Gather:** Use the reading and the infographic to learn how wildfires have changed, and how climate change and wildfires are related. Record the main points of each document in your lab book.

**Reason:** Evaluate each document and the information in each document. To do this, look for the following:

### Teacher Will . . . To Support Students

Use a graph and/or newspaper article to introduce the phenomenon:

- **Graph:**
  - https://www.epa.gov/climate-indicators/climate-change-indicators-wildfires
  - Article:

Direct students to the article and the infographic, with instructions to use both resources to learn how climate change and wildfires are related. If needed, provide a graphic organizer for them to record the main points of each document. For ELL students, consider creating a shortened version of the article.

- **Article link:**
  - Infographic link:

As students work, circulate through the class and check what they are recording in their lab books; use questions to help guide students who may need help.

Provide questions to help students evaluate each document. They are looking for effective communication strategies. Most students will find the infographic more user-friendly, but the article contains a lot more information and supporting evidence. Both documents were produced by

---

E. Harward
Communicate: With your group, discuss your ideas about which document is more effective in communicating important information about wildfires and climate change. Be ready to use evidence to support your answer.

Exit ticket
Address the following questions:
- What are two ways that climate change affects the number and severity of wildfires?
- What are two things that lead to effective communication about the impacts of climate change?

Group partnerships together to create groups of four, and allow the groups to discuss their ideas about which document was more effective at communicating important information about wildfires and climate change.

Facilitate a short class discussion so that students can share their ideas about characteristics of effective communication. Student should recognize that a large part of effective communication deals with the audience. Some audiences may want more evidence, some may respond better to pictures, etc. Students should understand that there are different ways to effectively communicate the same message.

Allow students time to complete their exit tickets.

Assessment of Student Learning
Student notes and discussions should be used to formatively assess their ability to understand and evaluate information. Exit tickets should be used to assess how well they understand the connection between wildfires and climate change, as well as different methods for effective communication.
Exit ticket sample responses:

- Climate change and wildfires:
  “Climate change can cause there to be less snowpack, or for the snow to melt earlier in the year. This makes the forest dry for a longer time, causing it to burn more easily. Climate change could also lead to fewer fires in some places, because all of the vegetation might die so there will be nothing to burn.”
  “As the climate gets hotter and drier, it will be easier for fires to burn. Also, with less snow, there is more time throughout the year that wildfires can burn.”

Communication:

- “Using evidence can help people understand and accept what you are saying. Pictures and diagrams can also make it easier for people to understand what you are saying.”
- “Pictures and graphs are effective ways to communicate because then you can get the information without having to read it. Also, telling people how much fires might cost can be effective because if they know it will cost them money, they might want to know how to stop the fires.”
Wildfires and Climate Change

Read each document and summarize the main points about the relationship between wildfires and climate change.

<table>
<thead>
<tr>
<th>Article</th>
<th>Infographic</th>
</tr>
</thead>
</table>

With your partner, evaluate each document. Which document is better for communicating the relationship between wildfires and climate change? Use the following questions to guide your discussion:

- Which document included evidence to support and explain what may be causing the increase in wildfires?

- Which document contains links to additional information that you could use to understand the issue better?

- Which document was easier to learn information from?

- Which document includes reasons for wanting to stop the increase in wildfires?

- Which document is more appealing to you? Why?

- Who produced each document?
Wildfires and Climate Change
Exit Ticket

What are two ways that climate change affects the number and severity of wildfires?

What are two things that lead to effective communication about impacts of climate change? In other words, if you needed to produce a document to educate someone of the impacts of climate change, what would you include?

Name _______________________________________________________________ period ________
# 8.4.4 Effects Learning Episode 6

## Student Science Performance

<table>
<thead>
<tr>
<th><strong>Topic:</strong> Climate Change</th>
<th><strong>Title:</strong> Action</th>
</tr>
</thead>
</table>

### Overarching Performance Expectations (Standard) from State Standards or NGSS:

**8.4.4** Analyze and interpret data on the factors that change global temperatures and their effects on regional climates. Examples of factors could include agricultural activity, changes in solar radiation, fossil fuel use, and volcanic activity. Examples of data could include graphs of the atmospheric levels of gases, seawater levels, ice cap coverage, human activities and maps of global and regional temperatures.

### Lesson Performance Expectations:

Students plan ways to address climate change issues, either by implementing a plan that can cause change or my educating others about climate change.

- **CCC:** Cause and effect, stability and change
- **SEP:** Designing solutions, communicating information

<table>
<thead>
<tr>
<th><strong>Students Will. . . To Construct Meaning</strong></th>
<th><strong>Teacher Will. . . To Support Students</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Engage with a Phenomenon: Some factors causing climate change can be influenced by humans.</td>
<td>Show students the page from the previous lesson so they know what they are looking for. Give them a few minutes to review the factors on their sheet and determine which can be affected by humans. Depending on the class, you may want to make additional data sets available for students who would like more choices for this project.</td>
</tr>
<tr>
<td>Gather: Find your “factors affecting climate change” notes from the last unit. Look through the factors on your paper, and put a star next to the factors that humans can control, or at least influence.</td>
<td>Help students understand that even though climate change can have some very scary effects (like those they’ve been learning about in class), it is a human-caused problem. This means that humans have power in slowing down or stopping it. For this lesson, students will be doing something to either change their own behavior, or communicate the facts of climate change and what we can do to slow down climate change.</td>
</tr>
<tr>
<td>Reason: You will be developing an action plan regarding one of the factors that humans can control or influence. Select one of the factors that you put a star next to.</td>
<td>Review each type of action plan with students so they can choose something that is right for them.</td>
</tr>
<tr>
<td>Next, choose the type of action plan you would like to work on. You could:</td>
<td>- Write a letter: this could be to a policy-maker (a congressman or state legislator, a school administrator, governor, etc.) or a letter to the editor. The student will need to consider the topic of their letter and their audience (for example, a letter about creating a no-idle zone in front of the school might be good to send to the principal; a letter asking for higher fuel-efficiency standards for cars would be better addressed to a congressman). Students will need to do some research on a topic, write a rough draft, get feedback on it, and</td>
</tr>
<tr>
<td>● Write a letter about the issue and what we could do about it</td>
<td>- Create a plan to change your own behaviors to address the issue</td>
</tr>
<tr>
<td>● Create a plan to change your own behaviors to address the issue</td>
<td>- Create an infographic or piece of teacher will support students</td>
</tr>
<tr>
<td>● Create an infographic or piece of teacher will support students</td>
<td></td>
</tr>
</tbody>
</table>
artwork to help educate others about the issue

- Design your own action plan; it will need to be approved by your teacher :)

You will be creating a first draft of your plan and then revising it; your teacher will provide deadlines and instructions for implementing your plan.

Communicate: Your final revision will be shared with the intended audience:

- If you wrote a letter, your teacher will mail it to the intended recipient(s)
- If you created a plan to change your behaviors, you will report to the class about the changes you made and why you made them, as well as how easy or hard it was to implement the changes
- If you created an infographic or piece of artwork, it will be displayed in the school or other location
- If you designed your own action plan, your method for sharing with an audience depends on the plan

- Make at least one more revision before mailing it.
- Change your own behaviors: Students will need to research how some of their current behaviors affect greenhouse gases or other factors related to climate change. They will need to be intentional about the changes they want to make, and document what they will change and why. After implementing the changes, they will keep a record of how their life has been impacted. Was it hard to make the changes? Is it hard to not change back? The student will document and share his experience with the class.
- Infographic or artwork: Students will research a factor that affects climate change in order to produce an infographic or piece of artwork that includes evidence. Infographics could be made with an online program (google “infographic creator”) or something like google draw. Artwork should include an artist statement, where the student can explain what the art means and why he created it. One idea for artwork is to allow students to create an illustrated graph; lesson and information can be found at: https://www.sciencefriday.com/educational-resources/illustrated-graphs-using-art-enliven-scientific-data/
- Own plan: if students have their own idea of how they can affect climate change through their own actions or by educating others, let them do it! All plans should be approved by you before students begin, and should include a mechanism for students to communicate what they are doing.

Make expectations regarding deadlines, use of class time, etc. clear. Provide resources for students doing research and scaffolding for ESL students.

Allow time in class for students to share their artwork, infographics, experiences, or other projects.

Assessment of Student Learning

*The product the student creates should be used as a summative assessment. Before beginning, students should be provided with a rubric so they know what information their products should contain. A generic rubric is included below; you may choose to make rubrics that are more specific to each type of plan.*

Sample rubric:

<table>
<thead>
<tr>
<th>Surpasses proficiency</th>
<th>Product meets requirements for proficiency, and the student used additional communication techniques or found unique ways to share their plan. For example:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• A student writing a letter to her congressman may have researched his opinion on climate change and tailored her letter to address his bias</td>
</tr>
<tr>
<td></td>
<td>• A student producing a piece of artwork arranges to have to artwork displayed at</td>
</tr>
</tbody>
</table>
the public library (or even school library?), or may use the artwork to teach younger students about climate change and our ability to affect climate change

- A student who made a plan for changing behaviors presented his plan to his scout troop and all of the scouts in his troop to committed to making similar changes

<table>
<thead>
<tr>
<th>Proficiency</th>
<th>Product demonstrates:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Understanding that some factors that cause climate change can be controlled/influenced by human choices</td>
</tr>
<tr>
<td></td>
<td>Understanding that we have the power to reduce the impacts of climate change by changing policies and behaviors</td>
</tr>
<tr>
<td></td>
<td>Evidence that climate change is happening (can include scientific uncertainties)</td>
</tr>
<tr>
<td></td>
<td>Effective communication of the reasons for needing to reduce/minimize climate change</td>
</tr>
</tbody>
</table>

| Approaching proficiency       | Product includes requirements to meet proficiency, but some items may be incomplete    |
| Below proficiency             | Product does not include requirements to meet proficiency, items that are included may be incomplete |