

High School Unit 3: Seasonal Shifts

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# CHANGING CLIMATE

## Seasonal Shifts

### Introduction

Thank you for using this Raising Educational Achievement through Cultural Heritage Up (REACH Up) unit in your classroom! The lessons are designed to address the Alaska Science Standards and Grade Level Expectations, Alaska Cultural Standards and the Bering Strait School District Scope and Sequence goals. All of the activities focus on seasonal shifts and related changes from Alaska Native cultural, physical and earth science perspectives. This supplemental unit addresses the place-based question: How is climate change affecting the timing of our seasons? How do seasonal shifts affect our community?

The REACH Up Seasonal Shifts unit consists of a total of four activities: Ask an Expert, Seasonal Shifts Vocabulary, What is Phenology?, and Long-term Data Sets. The optional extension, LEO: The Local Environmental Observation Network, includes resources for collecting qualitative phenology data around your village, and reporting these observations to a web-based network.

Each activity will require its own class period (approximately 45 minutes) and discussion could easily be extended into multiple class periods. You may also want to repeat sections of an activity during subsequent class meetings, such as reviewing the Seasonal Shifts video, having your students practice the vocabulary card games, or quizzing students with events from What is Phenology? If you are utilizing the entire Seasonal Shifts unit, you should introduce the activities in the order they are presented. However, if time is short, any of the activities could be presented independently.

The accompanying student guide is intended for use with multiple groups of students and you should not allow students to write in them. You can either have students record their work in a science notebook or create copies of the corresponding worksheets that are included in this teacher's guide.

### Whole Picture

Climate change is affecting the seasons in Alaska in a myriad of inter-related ways. Changes in temperature, precipitation, and other climatic parameters lead to seasonal shifts. Throughout Alaska, snow is melting earlier, spring is arriving earlier, fall is extending, and sea ice forms later in the season, to name a few.

Phenology is the study of cyclic or seasonal phenomenon, such as the green up of plants, the emergence of insects, and the timing of animal migration. It is often called "nature's calendar," and it is a key component of life on Earth. As Alaska's seasons shift, the subsequent changes in phenology can have ripple effects throughout the ecosystem. These changes are complex. Not everything is changing at the same rate, or in the same direction. Some things are not changing at all. The result can be a loss of synchrony, a mismatch in important life events for living things that depend on each other.

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## Seasonal Shifts

Trophic mismatch is one such example that is being widely studied in Alaska. For example, over millennia, bird migration and nesting has evolved to coincide with the greatest abundance of food. Likewise, insect emergence is timed with the growth of leaves and flowers. If spring conditions arrive earlier, the tundra will green up, and insects will emerge earlier. If migratory birds do not also adjust and arrive earlier, they risk missing the big pulses of food that allow their chicks to grow in the short arctic summer. Current research shows that some species may be capable this change, and others may not. Thus changing phenology is likely to have different impacts on different species, in essence producing climate change “winners” and “losers.”

Changes in phenology can also have significant impacts on human communities. Farmers rely on the phenology of plants and insects to time planting, fertilizing, harvesting and managing pests. Scientists predict phenology to manage invasive species. Health professionals rely on phenology to predict human health concerns such as allergies and diseases.

In Alaska, changes to phenology can profoundly impact the safety of travel and the availability of traditional subsistence foods. Rivers and sea ice are freezing later and breaking up earlier, restricting safe travel and changing the availability of fish, seals and other marine resources. Changes in the timing of snowfall and thaw are impacting when and where caribou, moose, and other wildlife are present on traditional hunting grounds. Shorter winters can also restrict the availability of safe food storage in traditional ice cellars.

There is still so much to learn about the impacts of changing phenology on Alaska’s natural and human communities, and we can all help. There are a variety of programs where teachers and students can contribute phenological observations from their communities. The Local Environmental Observers (LEO) Network is an example, which is described in the Long-term Data Sets activity as an optional extension. Together, we can study how Alaskan ecosystems respond to shifting seasons and better plan for climate change impacts to our habitats, wildlife, subsistence and safety.

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## Seasonal Shifts

### References

National Phenology Network (NPN)  
<https://www.usanpn.org/>

Local Environmental Observers (LEO) Network  
<https://www.leonetwork.org/en/docs/about/about>

National Park Service: State of the Park Report (Historical and Projected Changes in Climate)  
Bering Land Bridge National Preserve  
<https://www.nps.gov/stateoftheparks/bela/naturalresources/climate.cfm>

EPA Community Connection: Break up on two Alaskan rivers  
<https://www.epa.gov/climate-indicators/alaskan-rivers>

Fischer, J.B., and R.A. Stehn. 2013. Nest population size and potential production of geese and spectacled eiders on the Yukon-Kuskokwim Delta, Alaska, 1985-2012. Unpub. Report. U.S. Fish and Wildlife Service. Anchorage, AK. Retrieved from [www.fws.gov/alaska/mbsp/mbm/waterfowl/surveys/pdf/ykd\\_nest\\_plot\\_report\\_2012.pdf](http://www.fws.gov/alaska/mbsp/mbm/waterfowl/surveys/pdf/ykd_nest_plot_report_2012.pdf)



**Unit Vocabulary**

| <b>Science Terms to Define</b>         |                                                                                                          |
|----------------------------------------|----------------------------------------------------------------------------------------------------------|
| <b>phenology</b>                       | The study of timing in nature--“nature’s calendar”                                                       |
| <b>quantitative data</b>               | Information that is recorded using numbers to describe what is observed, such as measurements and counts |
| <b>qualitative data</b>                | Information that is recorded using words to describe what is observed                                    |
| <b>long-term data set</b>              | Observations collected over many decades                                                                 |
| <b>Line of best fit/<br/>trendline</b> | a line that illustrates the direction that a graph is changing                                           |

| <b>Terms for Incorporating Local Indigenous Language</b> |                |               |                       |                          |
|----------------------------------------------------------|----------------|---------------|-----------------------|--------------------------|
| <b>English</b>                                           | <b>Iñupiaq</b> | <b>Yup’ik</b> | <b>Siberian Yupik</b> | <b>Local Translation</b> |
| <b>fall</b>                                              | ukiaq          | uksuaq        | uksaaq                |                          |
| <b>rain</b>                                              | ivganiq        | ivsuk         | eslalluk              |                          |
| <b>river</b>                                             | kuuk           | kuik          | kiik                  |                          |
| <b>snow</b>                                              | qannik         | qanikcaq      | anigu                 |                          |
| <b>spring</b>                                            | upangaqsraq    | upnerkaq      | upenghaq              |                          |
| <b>summer</b>                                            | upangaaq       | kiak          | kiik                  |                          |
| <b>tundra</b>                                            | nuna           | nunapik       | nunivak               |                          |
| <b>winter</b>                                            | ukiuq          | uksuq         | uksuq                 |                          |

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## Seasonal Shifts

### Overview

In this activity, students will interview an elder or cultural knowledge bearer about seasonal change they have observed over their lifetime.

### Objectives

On successful completion of the lesson, students will be able to:

- demonstrate effective interviewing techniques,
- interpret qualitative data from interviews,
- explain how climate change is affecting seasons in their community, and
- describe how seasonal events and subsistence resources in the community were in the past compared to today.

### Alaska Standards

#### Alaska Science Standards/Grade Level Expectations

**SA1:** The student demonstrates an understanding of the processes of science by:

- [9] **SA1.1** asking questions, predicting, observing, describing, measuring, classifying, making generalizations, inferring and communicating
- [10] **SA1.1** asking questions, predicting, observing, describing, measuring, classifying, making generalizations, analyzing data, developing models, inferring and communicating
- [11] **SA1.1** asking questions, predicting, observing, describing, measuring, classifying, making generalizations, analyzing data, developing models, inferring and communicating

**SC3:** The student demonstrates an understanding that all organisms are linked to each other and their physical environments through the transfer and transformation of matter and energy by:

- [11] **SC3.2** analyzing the potential impacts of changes (e.g., climate change, habitat loss/gain, cataclysms, human activities) within an ecosystem

### Alaska Cultural Standards

**B)** Culturally-knowledgeable students are able to build on the knowledge and skills of the local cultural community as a foundation from which to achieve personal and academic success throughout life. Students who meet this cultural standard are able to:

- 2:** make effective use of the knowledge, skills, and ways of knowing from their own cultural traditions to learn about the larger world in which they live.

**D)** Culturally-knowledgeable students are able to engage effectively in learning activities that are based on traditional ways of knowing and learning. Students who meet this cultural standard are able to:

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## Seasonal Shifts

- 4: gather oral and written history information from the local community and provide an appropriate interpretation of its cultural meaning and significance.
- E) Culturally-knowledgeable students demonstrate an awareness and appreciation of the relationships and processes of interaction of all elements in the world around them. Students who meet this cultural standard are able to:
- 4: determine how ideas and concepts from one knowledge system relate to those derived from other knowledge systems.

### Bering Strait School District Scope & Sequence

9.9A. Understand the interaction of living and nonliving parts of an ecosystem. (SC3.2, SC3.3, SF)

9.9H. Analyze the potential impacts of changes (climate change, habitat loss/gain, cataclysms, human activities) within an ecosystem. (SC3.2)

10.5D. Describe causes, effects, preventions, and mitigations of human impact on climate. (SD 3.1). Global warming/climate change.

11.7E. Students develop an understanding of the dynamic relationships among scientific, cultural, social and personal perspectives. (SF)

### Materials

- REACH Up High School Student Guide: *Shifting Seasons*
- Student Worksheet: *Ask an Expert about Shifting Seasons*

### Activity Preparation

1. Identify adults within your school who have lived year-round in the community for many years. This might include teachers, administrators, secretaries, teacher aides, lunchroom/kitchen staff, recess duties, maintenance and custodial staff, etc. Ask these local knowledge bearers if they would be willing to speak with a group of your students about how seasons have shifted over their lifetimes, and how those changes have affected the community. Make sure that the volunteers you have identified will be available during the time that your class will be completing this activity.
2. Ask the volunteers if they speak an Alaska Native Language, and if so, which language(s) and dialect(s) they are familiar with. If applicable, have them translate the written words on the student worksheet, so you have an answer key. Also, ask them to teach you the pronunciation of the terms.

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## Seasonal Shifts



### Activity Procedure

1. Distribute the REACH Up High School Student Guide: *Seasonal Shifts* and ask students to work with a partner to read Pages 1-3.
2. Show the video, *Seasonal Shifts*, available at [www.k12reach.org/videos.php](http://www.k12reach.org/videos.php). Videos are located under the Multimedia tab. Allow time for students to share comments and ask questions.
3. Explain that students will interview a few community members about seasonal changes they have observed over their lifetimes. Separate students into small groups according to how many cultural knowledge bearers are available to share information with your class. Be sure to tell your students if the appointed interviewees speak an Alaska Native Language, so students know whether or not they should pursue that portion of the interview.
4. Review expectations for student behavior while conducting the interview, including introductions and thanking the interviewee at the end of the interview. Discuss suggestions for effective interviewing techniques, such as allowing ample time for the interviewee to answer, and asking follow-up questions.
5. Distribute one Student Worksheet: *Ask an Expert about Seasonal Shifts* to each group and assign each group one local knowledge bearer to interview. Provide 15-20 minutes for students to locate and interview the knowledge bearer.
6. Reconvene in the classroom and ask groups to share their findings. What kinds of seasonal shifts have people in their community observed? What impacts might these seasonal changes have on wildlife and subsistence lifestyles? If your students learned local indigenous words for the vocabulary terms, compare their translations with the translations found on Page 4.





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## Seasonal Shifts

### Activity HS.3.1

### WORKSHEET



#### **STUDENT WORKSHEET: *Ask an Expert about Seasonal Shifts***

Names of Group Members:

---

---

Interview a long-term community member to learn about the seasonal changes they have observed over their lifetime. Take notes about what you learn.

Who did you interview? \_\_\_\_\_

#### **Ask:**

Have you noticed any changes in the seasons over your lifetime? If so, how have the seasons changed?

Have you noticed any changes in when plants green up, flower, or when berries ripen each year?

Have you noticed any changes in when and where animals move or have their young?

Has the timing of break up or freeze up changed? If so, has this changed safety and travel?

Have people in our community made any changes to subsistence activities to adjust to shifting seasons?

Other notes:



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## Seasonal Shifts

### Activity HS.3.1

### WORKSHEET



#### For Alaska Native Language Speakers:

What language(s) do you speak? \_\_\_\_\_

What dialect(s)? \_\_\_\_\_

Could you please translate the following words?

fall: \_\_\_\_\_

rain: \_\_\_\_\_

river: \_\_\_\_\_

snow: \_\_\_\_\_

spring: \_\_\_\_\_

summer: \_\_\_\_\_

tundra: \_\_\_\_\_

winter: \_\_\_\_\_

Do you know any other words for seasons that are not listed here?

Record the words and translations here:



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## Seasonal Shifts

### Activity HS.3.2: Seasonal Shifts Vocabulary

What terminology do we need to know to discuss seasonal shifts?

#### Overview

In this activity, students will learn terminology in English and their local Alaska Native language by playing vocabulary games with peers.

#### Background Information

Based on the Visual Iñupiaq Vocabulary Acquisition (VIVA) Program of the North Slope Borough School District, the vocabulary cards provided for this activity have Alaska Native Language and English terms and an associated image. The games suggested are meant to promote fluency through repeated practice. Other vocabulary cards can be easily integrated into the games. This will extend potential length of the games and add a greater challenge. By working with the words through different games, students can develop greater fluency with the vocabulary.

#### Objectives

On successful completion of this lesson, students will be able to:

- read and speak indigenous terms related to climate and seasons, and
- illustrate and define terms related to seasons.

#### Alaska Standards

##### Alaska Cultural Standards:

- A) Culturally-knowledgeable students are well grounded in the cultural heritage and traditions of their community. Students who meet this cultural standard are able to:
- 1: assume responsibilities for their role in relation to the well-being of the cultural community and their lifelong obligations as a community member.
- B) Culturally-knowledgeable students are able to build on the knowledge and skills of the local cultural community as a foundation from which to achieve personal and academic success throughout life. Students who meet this cultural standard are able to:
- 2: make effective use of the knowledge, skills, and ways of knowing from their own cultural traditions to learn about the larger world in which they live.
- D) Culturally-knowledgeable students are able to engage effectively in learning activities that are based on traditional ways of knowing and learning. Students who meet this cultural standard are able to:
- 5: identify and utilize appropriate sources of cultural knowledge to find solutions to everyday problems.

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### Bering Strait School District Scope & Sequence:

**9.9A.** Understand the interaction of living and nonliving parts of an ecosystem.

**9.9H.** Analyze the potential impacts of changes (climate change, habitat loss/gain, cataclysms, human activities) within an ecosystem.

**10.5D.** Describe causes, effects, preventions, and mitigations of human impact on climate.

**11.7E.** Students develop an understanding of the dynamic relationships among scientific, cultural, social and personal perspectives.

### Materials

- REACH Up High School Student Guide: *Seasonal Shifts*
- Vocabulary card sets (1 per group of 4-5 students)
- Student Information Sheet: *Word Games Instructions* (1 per group)
- Student Worksheet: *Seasonal Shifts Vocabulary*
- Dry Erase Markers (1 per group)
- Timers (optional)

### Activity Preparation

1. If your students completed *Activity HS.3.1 Ask an Expert*, refer to their completed worksheets for the terms you will have them use for the vocabulary word card games.
2. If your students did not conduct interviews with Native language speakers, consult with a local knowledge bearer or language expert to determine which language/dialect translation provided on page 4 of the Student Guide would be most appropriate for your students to practice. The following chart is provided for reference.





| Alaska Native Languages in the Bering Strait Region |                          |                                |                            |                  |
|-----------------------------------------------------|--------------------------|--------------------------------|----------------------------|------------------|
| Language                                            | Dialect Group            | Dialect                        | Subdialect                 | Community        |
| Iñupiaq                                             | Seward Peninsula Inupiaq | Bering Strait                  |                            | Brevig Mission   |
|                                                     |                          |                                | Diomedede                  | Little Diomedede |
|                                                     |                          |                                |                            | Shishmaref       |
|                                                     |                          | Wales (Kinikmiu)               | Wales                      |                  |
|                                                     |                          | Teller                         | Teller                     |                  |
|                                                     |                          |                                | Unalakleet                 |                  |
|                                                     |                          |                                | Shaktoolik                 |                  |
|                                                     | Fish River               | Golovin*                       |                            |                  |
|                                                     |                          | White Mountain                 |                            |                  |
|                                                     |                          | Northern Alaskan Iñupiaq       | Malimiut                   |                  |
| Siberian Yupik                                      |                          | St. Lawrence Island Yupik      |                            | Gambell          |
|                                                     |                          |                                | Savoonga                   |                  |
| Yup'ik                                              |                          | Norton Sound (Unaliq-Pastuliq) | Unaliq                     | Elim             |
|                                                     |                          |                                |                            | Golovin*         |
|                                                     |                          |                                |                            | St. Michael      |
|                                                     |                          | General Central Yup'ik         | Nelson Island and Stebbins | Stebbins         |

\* It is very common for more than one language / dialect, or a combination of dialects, to be spoken in a community. It should also be noted that Inupiaq-Yup'ik bilingualism was common throughout the 1900s in the Norton Sound villages of White Mountain, Golovin, Elim, and Unalakleet. Golovin is listed twice on our chart because specific subdialects were cited in the research found on the Alaska Native Language Center website: <http://www.uaf.edu/anlc/languages/>.

- Keep in mind that different individuals may translate certain terms differently. For example, some languages may not have a general term for "salmon" but may have specific terms for different salmon species. Alternatively, terms may exist, but the individual speaker may not know the term. It's fine to have different student groups working with various translations, or you can choose a set list of words for your whole class to practice. Highlight the diversity and do not attempt to offer an authoritative translation; the goal is to practice an Alaska Native language while discussing climate change topics.

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## Seasonal Shifts

4. If using the Vocabulary Cards provided by REACH Up, label a sample set of cards with local indigenous words using a dry erase marker. If needed, create your own sets of the vocabulary cards from the template provided.
5. Make copies of the Student Information Sheet: *Word Games Instructions* (one per group) and the Student Worksheet: *Seasonal Shifts Vocabulary* (one per student).

### Activity Procedure

1. Distribute the REACH Up High School Student Guide: *Seasonal Shifts* and review Page 4.
2. Show students the vocabulary cards. Hold up each card. Discuss what each card depicts.
3. Say the English and local Alaska Native Language word for the illustration depicted on the card. Ask students to repeat the words. Repeat this once or twice, then ask students to call out the correct words as you hold up each card.
4. Divide the class into four groups.
5. Provide each group with the Word Games Instruction sheet, a set of Vocabulary Cards, dry erase marker, and a timer (optional).
6. Instruct students to label their cards with the local indigenous words. Groups can select one student from the group for this task, or take turns.
7. Direct students' attention to the Word Games Instruction sheet. Students can commit to one game for a period of time or mix and match.
8. Encourage students to play the vocabulary games and practice the vocabulary words during free time throughout the duration of the Seasonal Shifts unit. If possible, schedule 10-15 minutes twice per week to practice the vocabulary terms.
9. Distribute the Student Worksheet: *Seasonal Shifts Vocabulary* and ask students to complete it. Provide review as needed.

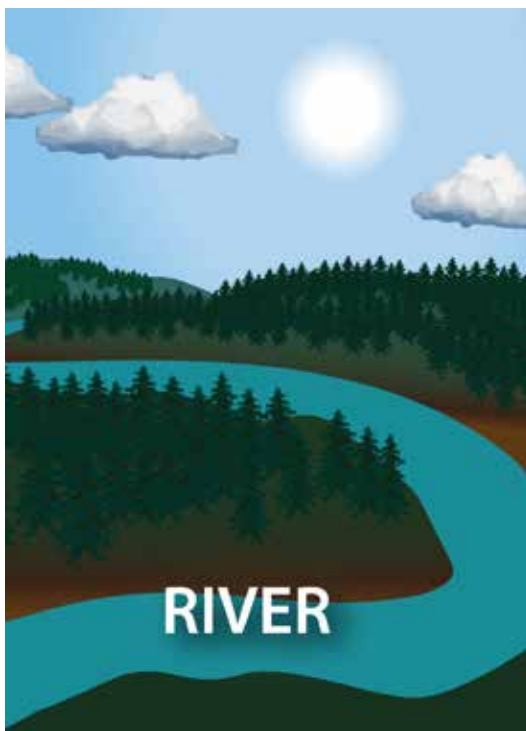
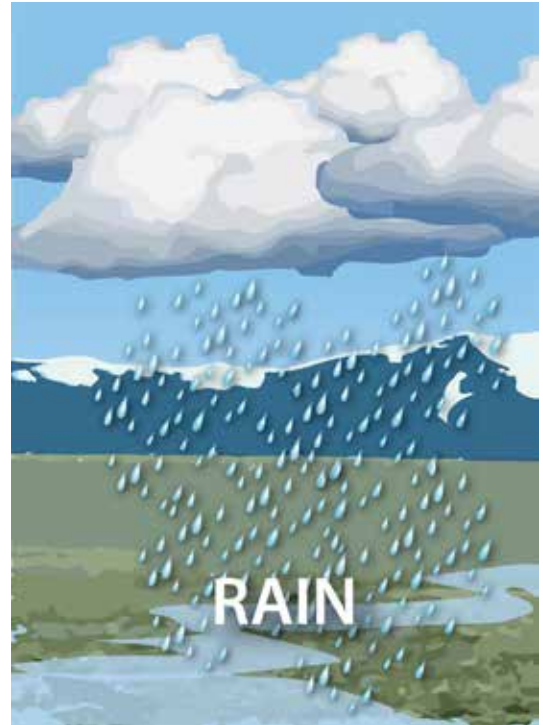
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Activity HS.3.2  
TEMPLATE



### Vocabulary Cards





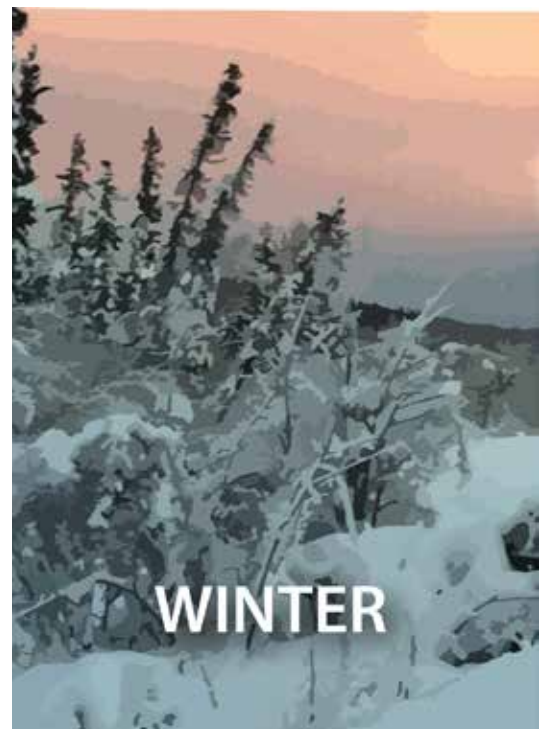
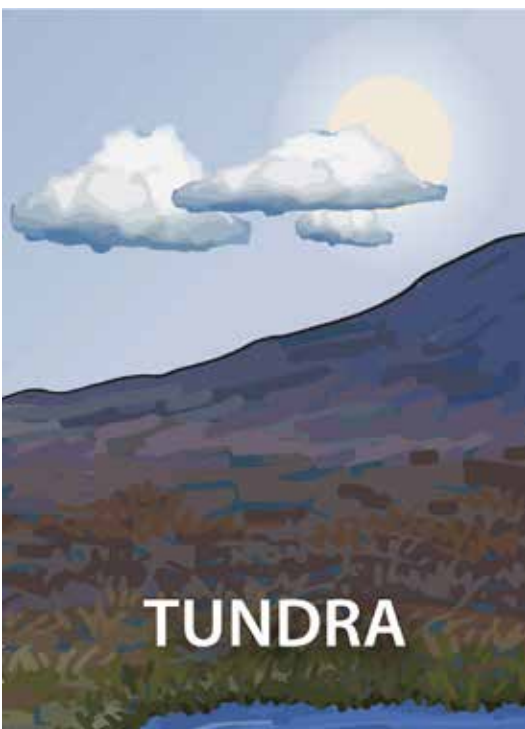
# CHANGING CLIMATE

## Seasonal Shifts

Activity HS.3.2  
TEMPLATE



### Vocabulary Cards





# CHANGING CLIMATE

## Seasonal Shifts

Activity HS.3.2  
TEMPLATE



**Answer Key: *Subsistence Vocabulary***

\_\_\_\_\_

Local Indigenous Word

\_\_\_\_\_

Local Indigenous Word

\_\_\_\_\_

Local Indigenous Word

\_\_\_\_\_

Local Indigenous Word



# CHANGING CLIMATE

## Seasonal Shifts



### Student Information Sheet: *Word Games Instructions*

#### VOCABULARY SWAP:

1. Distribute one card to each person.
2. Practice the word on your card, then find a classmate. Teach them the word on your card and learn the word on their card. Trade cards.
3. Find another classmate and repeat.

#### FIND THE CARD:

1. Divide into small groups. Each group will need a set of vocabulary cards. Spread the cards in front of you so that everyone in your group can see the pictures.
2. Listen as your teacher says a word aloud from one of the cards.
3. Work with your group to find and hold up the correct card.

#### VOCABULARY SLAP:

1. Select one student to serve as the “caller” for this game. That student should make a list of the vocabulary words on a separate sheet of paper. The words can be found on the back of the cards.
2. Place the cards in a circle, picture-side-up, in the middle of the playing area.
3. The caller should call out a word from their list. Everyone else should quickly place their hand on the picture that they believe represents that word.
4. Turn over the card or cards that students selected to see who chose correctly. Each student who placed his or her hand on the correct card earns a point.
5. Put the card(s) back in the circle and play again.
6. Play for a designated period of time. At the end of the time, the person with the most points wins.

#### TEAMWORK:

1. Divide your group into two teams. Each team will need a pencil and paper.
2. Shuffle the vocabulary cards and stack them picture-side up in the middle of the table.
3. Work with your team to write down the local Alaska Native Language term and English words for the picture on the card.
4. After both teams have written answers for the top card, turn the card over to check. Teams get 1 point for the correct Alaska Native Language word and 1 point for the correct English word.
5. Repeat until all cards are gone. The team with the most points wins.



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## Seasonal Shifts

### Activity HS.3.2

### WORKSHEET



### STUDENT WORKSHEET: *Seasonal Shifts Vocabulary*

Name: \_\_\_\_\_

1. Draw a line connecting each definition to the term that it represents.

|                           |                                                                                                          |
|---------------------------|----------------------------------------------------------------------------------------------------------|
| <b>phenology</b>          | Information that is recorded using numbers to describe what is observed, such as measurements and counts |
| <b>quantitative data</b>  | Information that is recorded using words to describe what is observed                                    |
| <b>qualitative data</b>   | a line that illustrates the direction that a graph is changing                                           |
| <b>long-term data set</b> | the study of timing in nature -- "nature's calendar"                                                     |
| <b>fit/trendline</b>      | observations collected over many decades                                                                 |



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## Seasonal Shifts

### Activity HS.3.2

### WORKSHEET



2. Complete the chart by writing the local Alaska Native Language terminology and illustrating the missing terms.

| My Community: _____ |                                   |              |
|---------------------|-----------------------------------|--------------|
| English Word        | Local Alaska Native Language Word | Illustration |
| fall                |                                   |              |
| rain                |                                   |              |
| river               |                                   |              |
| snow                |                                   |              |
| spring              |                                   |              |
| summer              |                                   |              |
| tundra              |                                   |              |
| winter              |                                   |              |



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## Seasonal Shifts



### STUDENT WORKSHEET: *Seasonal Shifts Vocabulary* Answer Key

Name: \_\_\_\_\_

1. Draw a line connecting each definition to the term that it represents.

|                           |                                                                                                          |
|---------------------------|----------------------------------------------------------------------------------------------------------|
| <b>phenology</b>          | Information that is recorded using numbers to describe what is observed, such as measurements and counts |
| <b>quantitative data</b>  | Information that is recorded using words to describe what is observed                                    |
| <b>qualitative data</b>   | a line that illustrates the direction that a graph is changing                                           |
| <b>long-term data set</b> | the study of timing in nature -- "nature's calendar"                                                     |
| <b>fit/trendline</b>      | observations collected over many decades                                                                 |

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2. Complete the chart by writing the local Alaska Native Language terminology and illustrating the missing terms.

| My Community: _____ |                                                                               |                                        |
|---------------------|-------------------------------------------------------------------------------|----------------------------------------|
| English Word        | Local Alaska Native Language Word                                             | Illustration                           |
| fall                | Answers will vary depending on language and dialect spoken in this community. | Sketch should illustrate word at left. |
| rain                | Answers will vary depending on language and dialect spoken in this community. | Sketch should illustrate word at left. |
| river               | Answers will vary depending on language and dialect spoken in this community. | Sketch should illustrate word at left. |
| snow                | Answers will vary depending on language and dialect spoken in this community. | Sketch should illustrate word at left. |
| spring              | Answers will vary depending on language and dialect spoken in this community. | Sketch should illustrate word at left. |
| summer              | Answers will vary depending on language and dialect spoken in this community. | Sketch should illustrate word at left. |
| tundra              | Answers will vary depending on language and dialect spoken in this community. | Sketch should illustrate word at left. |
| winter              | Answers will vary depending on language and dialect spoken in this community. | Sketch should illustrate word at left. |

# CHANGING CLIMATE

## Seasonal Shifts

### Activity HS.3.3: What is Phenology?

#### Overview

In this lesson students will learn to differentiate between seasonal events in their community that are phenology and those that are not.

#### Objectives

On successful completion of this lesson, students will be able to:

- define phenology,
- explain how climate change is shifting seasons,
- differentiate between seasonal events in their communities that are examples of phenology and those that are not, and
- identify new examples of phenological events that are significant to their own lives.

#### Alaska Standards

##### Alaska Science Standards and Grade Level Expectations

**SA1:** The student demonstrates an understanding of the processes of science by

[9] **SA1.1** asking questions, predicting, observing, describing, measuring, classifying, making generalizations, inferring and communicating

[10] **SA1.1** asking questions, predicting, observing, describing, measuring, classifying, making generalizations, analyzing data, developing models, inferring and communicating

[11] **SA1.1** asking questions, predicting, observing, describing, measuring, classifying, making generalizations, analyzing data, developing models, inferring and communicating

**SC3:** The student demonstrates an understanding that all organisms are linked to each other and their physical environments through the transfer and transformation of matter and energy by

[11] **SC3.2** analyzing the potential impacts of changes (e.g., climate change, habitat loss/gain, cataclysms, human activities) within an ecosystem

**SD3:** The student demonstrates an understanding of the cycles influenced by energy from the sun and by Earth's position and motion in our solar system by

[10] **SD3.1** describing causes, effects, preventions, and mitigations of human impact on climate

[11] **SD3.1** describing causes, effects, preventions, and mitigations of human impact on climate

# CHANGING CLIMATE

## Seasonal Shifts

### Alaska Cultural Standards

- B) Culturally-knowledgeable students are able to build on the knowledge and skills of the local cultural community as a foundation from which to achieve personal and academic success throughout life. Students who meet this cultural standard are able to:
- 2: make effective use of the knowledge, skills, and ways of knowing from their own cultural traditions to learn about the larger world in which they live;
- E) Culturally-knowledgeable students demonstrate an awareness and appreciation of the relationships and processes of interaction of all elements in the world around them. Students who meet this cultural standard are able to:
- 2: understand the ecology and geography of the bioregion they inhabit;
  - 4: determine how ideas and concepts from one knowledge system relate to those derived from other knowledge systems.

### Bering Strait School District Scope and Sequence

- 9.9I. Develop an understanding of the dynamic relationships among scientific, cultural, social, and personal perspectives (hunting, fishing). (SF)
- 9.9H. Analyze the potential impacts of changes (climate change, habitat loss/gain, cataclysms, human activities) within an ecosystem. (SC3.2)
- 10.5D. Describe causes, effects, preventions, and mitigations of human impact on climate. (SD 3.1) Global warming/climate change.
- 10.6G. Understands that seasons are related to changes in Earth's position relative to the sun.
- 11.7E. Students develop an understanding of the dynamic relationships among scientific, cultural, social and personal perspectives. (SF)

### Materials

- REACH Up High School Student Guide: *Seasonal Shifts*
- Marker chips in two colors (at least 10 per color for each student). If chips are limited, students can work in groups. Each group will need at least 10 per color.

### Activity Preparation

1. Gather the supplies.
2. Decide if students will work in groups or individually. You will need at least 10 chips of each color per student or group. Count these out ahead of time if necessary.

### Activity Procedure

1. Distribute the REACH Up High School Student Guide: *Seasonal Shifts*. Ask students to work individually or in groups to re-read Page 2.



# CHANGING CLIMATE

## Seasonal Shifts

### Activity HS.3.3

#### TEACHER GUIDE



2. Instruct students to open the REACH Up High School Student Guide: *Seasonal Shifts* to Pages 5-6, *Activity: What is Phenology?* and read the instructions together.
3. Distribute the marker chips to each student or group.
4. Designate one color for examples of phenology, and one color for examples that are not phenology. Explain this to students.
5. Read each event description aloud, one at a time, or assign students to do so. After reading each event, allow time for students or groups to place the appropriate color on top of the icon.
6. Review the discussion questions together.



# CHANGING CLIMATE

## Seasonal Shifts

Activity HS.3.3

ANSWER KEY



### STUDENT WORKSHEET: *What is Phenology?*

#### Answer Key

The following are examples of phenology:

- When the first flower in the tundra blooms
- When the river breaks up
- First mosquito of the year
- When the caribou have their young
- Date of the first snowfall
- When bears wake up from hibernation
- Last group of swans spotted flying over the river in the fall
- First salmon swimming upstream
- Date the sea ice is safe to travel
- Date the berries are ripe in my traditional picking spot

The follow are NOT examples of phenology:

- When I travel for a basketball game
- How many birds I see fly over the school
- How many salmon are in the smokehouse at fish camp
- Date of the summer solstice (the longest day of the year)
- Date when school gets out for summer vacation
- Date of the winter solstice (shortest day of the year)
- The number of times it rains in the summer
- The number of caribou killed by hunters this year

#### Discuss

1. Share your results with your classmates.  
*Answers may vary.*
2. If there is a different opinion about the answers, discuss the ones you chose.  
*Answers should reflect the designations above. Ensure students understand that phenological events are natural, seasonal events. Phenology does not include quantities, human events (such as school schedules), or regular, annual events that occur at the same time every year (such as holidays).*
3. Can you think of more examples of phenology that are important in your community?  
*Answers will vary.*
4. What examples of phenology are most important to your life?  
*Answers will vary.*



# CHANGING CLIMATE

## Seasonal Shifts

### Activity HS.3.4: Long-term Data Sets

#### Overview

In this lesson students will work in teams to graph long-term data sets and look for trends in the changing phenology of river break up and bird migration.

#### Objectives

On successful completion of this lesson, students will be able to:

- differentiate between qualitative and quantitative data,
- explain why scientists and Elders collect long-term data sets,
- construct and read a graph using Microsoft Excel,
- describe a trendline and relate it to real world conditions, and
- extrapolate future conditions based on a trend.

#### Next Generation Science Standards

**Standards by Disciplinary Core Ideas:** Ecosystems: Interactions, Energy, and Dynamics

**Standards by Topic:** Interdependent Relationships in Ecosystems

#### Performance Expectations

The activity is just one step toward reaching the performance expectations listed below:

HS-LS2-2: Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

#### Dimension:

##### *Science & Engineering Practices*

Using Mathematics and Computational Thinking

##### *Disciplinary Core Ideas*

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (HS-LS2-2)

# CHANGING CLIMATE

## Seasonal Shifts

### *Crosscutting Concepts*

Stability and Change

### **Alaska Standards**

#### **Alaska Science Standards and Grade Level Expectations**

**SA1:** The student demonstrates an understanding of the processes of science by

[9] **SA1.1** asking questions, predicting, observing, describing, measuring, classifying, making generalizations, inferring and communicating

[10] **SA1.1** asking questions, predicting, observing, describing, measuring, classifying, making generalizations, analyzing data, developing models, inferring and communicating

[11] **SA1.1** asking questions, predicting, observing, describing, measuring, classifying, making generalizations, analyzing data, developing models, inferring and communicating

**SC3:** The student demonstrates an understanding that all organisms are linked to each other and their physical environments through the transfer and transformation of matter and energy by

[11] **SC3.2** analyzing the potential impacts of changes (e.g., climate change, habitat loss/gain, cataclysms, human activities) within an ecosystem

### **Alaska Math Standards**

Statistics and Probability Standards: Interpreting Categorical and Quantitative Data: Summarize, represent, and interpret data on two categorical and quantitative variables.

**S-ID.6.** Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.

### **Alaska Cultural Standards**

**E)** Culturally-knowledgeable students demonstrate an awareness and appreciation of the relationships and processes of interaction of all elements in the world around them. Students who meet this cultural standard are able to:

**2:** understand the ecology and geography of the bioregion they inhabit;

**4:** determine how ideas and concepts from one knowledge system relate to those derived from other knowledge systems.

### **Bering Strait School District Scope and Sequence**

**9.9A.** Understand the interaction of living and nonliving parts of an ecosystem. (SC3.2, SC3.3, SF)

**9.9H.** Analyze the potential impacts of changes (climate change, habitat loss/gain, cataclysms,

# CHANGING CLIMATE

## Seasonal Shifts

human activities) within an ecosystem. (SC3.2)

**10.5D.** Describe causes, effects, preventions, and mitigations of human impact on climate (SD 3.1) • Global warming/climate change

**11.7E.** Students develop an understanding of the dynamic relationships among scientific, cultural, social and personal perspectives. (SF)

### Materials

- REACH Up High School Student Guide: *Seasonal Shifts*
- Student Worksheet: *Alaskan River Break Up*
- Student Worksheet: *Alaskan Goose Hatch Dates*
- Computers with access to REACH Up, Microsoft Excel, and printer (optional), at least one per group

### Activity Preparation

1. Make copies of Student Worksheet: *Alaskan River Break Up* and Student Worksheet: *Alaskan Goose Hatch Dates*.
2. Ensure you are familiar with the location of the data sets on the Reach Up website (<http://k12reach.org/grade9-12theme1.php>).
3. Ensure your students will be able to access the REACH Up website. If not, download the four data sets for them prior to the lesson, and be sure they will be able to access them on the computer they are using.
4. Decide how you will divide your students into groups. You will need a minimum of four groups, one for each of the two rivers, and one for each of the two geese. A maximum of 3 or 4 students per group is recommended. If you have a large class, you may have more than one group work on the same data set.
5. If you plan to do the extension activity, visit <https://www.leonetwork.org/> and explore the LEO network. Watch the informational video at: <https://www.leonetwork.org/en/docs/about/about>. Pan around the map and click on sightings reported in your area. You may opt to have your class contribute sightings throughout the school year. If so, you will need to register as a LEO observer. To do this, click Sign In/Join from upper right hand corner of the menu bar. You will be prompted to create a log in and verify your email address. Be sure to use a log in that you are comfortable sharing with your students, or you will need to report all the sightings yourself. If you anticipate using the site often, students can also eventually make their own log ins.

### Activity Procedure

1. Distribute the REACH Up High School Student Guide: *Seasonal Shifts*. Ask students to work individually or in groups to read Pages 7-8.
2. Instruct students to open the REACH Up High School Student Guide: *Seasonal Shifts* to Page 12, Activity: *Long-term Data Sets*. Read the introductory information on Pages 9-11 carefully together first.

# CHANGING CLIMATE

## Seasonal Shifts

3. Divide students into at least 4 groups of 2-4 students each. Allow students time to break into their teams and ensure their computers are ready.
4. Explain that students will be graphing real, long-term phenology data sets. Assign each group a data set (Yukon River, Tanana River, White-fronted Goose, Cackling Goose). Ensure you have at least one group per data set. It is ok to have more than one group use the same data set.
5. Distribute Student Worksheet: *Alaskan River Break Up* to the groups working on the river data, and Student Worksheet: *Goose Hatch Dates* to the groups working on the goose data.
6. Continue reading the REACH Up High School Student Guide: *Seasonal Shifts Activity: Long-term Data Sets*. Read through all the graphing instructions carefully together.
7. Guide students to the REACH Up website (<http://k12reach.org/grade9-12theme1.php>) to download their data. These are Excel files, so should open Microsoft Excel when the students open them.
8. Instruct students to open their file, follow the instructions to create their graphs, and then work together to answer the questions on the student worksheet.
9. Instruct students that when the above (#8) activity is done, the "River" group should share their results with a "Goose" group and vice versa, and fill out the back of the student worksheet with the other group's information.
10. Assist students as needed.
11. Review the answers to the student worksheet.
12. Wrap up with additional discussion as time and interest allow.

### Optional Extension: The Local Environmental Observers (LEO) Network

1. Explain to students that we all can contribute to building long-term data sets to help study changing phenology in our communities.
2. Introduce LEO. LEO is a qualitative data set that is being built by people in communities all over Alaska. You may choose to have students watch the informational video at: <https://www.leonetwork.org/en/docs/about/about>.
3. Allow students time to explore the map and look at sightings in their area.
4. If you chose to become a LEO observer, you can continue to use and integrate this resource throughout your school year. This can be done in many ways. Be creative! One idea is to designate a time each week to discuss and report phenology observations as a class.

# CHANGING CLIMATE

## Seasonal Shifts



### STUDENT WORKSHEET: *Alaskan River Break Up*

My River: \_\_\_\_\_

Answer the following questions with your team, then share your results with your class.

1. Circle the sentence that best describes your trendline.

It is sloping down (showing a trend toward earlier breakup).

It is sloping up (showing a trend toward later breakup).

It is level (showing no change in phenology over time).

2. As you can see by looking at your graph, there is a lot of variation from year to year. Some years are early, some are late, and some are very extreme. Use your graph and your data chart to answer the following questions.

What is the date of the latest break up recorded? \_\_\_\_\_

What year or years was this recorded? \_\_\_\_\_

What is the date of the earliest break up recorded? \_\_\_\_\_

What year or years was this recorded? \_\_\_\_\_

3. Elders and scientists collect long-term data sets by making observations over many decades. Repeated observations over many years help us look past the variation in each year, and detect more gradual change. Making a graph with a trendline helps us see this change.

Using the direction of the trendline as a clue, predict the phenology of your river in 50 years when you are an Elder.

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# CHANGING CLIMATE

## Seasonal Shifts



**Compare:** Find a team working on geese hatch dates.

**Goose:** \_\_\_\_\_

4. What is the date of the latest hatch date recorded? \_\_\_\_\_

What year or years was this recorded? \_\_\_\_\_

What is the date of the earliest hatch date recorded? \_\_\_\_\_

What year or years was this recorded? \_\_\_\_\_

5. Are the years with the earliest hatch dates the same as the years with the earliest river break ups?

\_\_\_\_\_

6. Are the years with the latest hatch dates the same as the years with the latest river break ups?

\_\_\_\_\_

7. Why do you think it is hard to compare break up on the Yukon and Tanana Rivers with hatch dates of birds in the Yukon Delta National Wildlife Refuge? What can we learn from these long-term data sets?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_



# CHANGING CLIMATE

## Seasonal Shifts



### STUDENT WORKSHEET: *Alaskan Goose Hatch Dates*

Answer the following questions with your team, than share your results with your class.

My Goose: \_\_\_\_\_

1. Circle the sentence that best describes your trendline.

It is sloping down (showing a trend toward earlier hatch dates).

It is sloping up (showing a trend toward later hatch dates).

It is level (showing no change in phenology over time).

2. As you can see by looking at your graph, there is a lot of variation from year to year. Some years are early, some are late, and some are very extreme. Use your graph and your data chart to answer the following questions.

What is the date of the latest hatch date recorded? \_\_\_\_\_

What year or years was this recorded? \_\_\_\_\_

What is the date of the earliest hatch date recorded? \_\_\_\_\_

What year or years was this recorded? \_\_\_\_\_

3. Elders and scientists collect long-term data sets by making observations over many decades. Repeated observations over many years help us look past the variation in each year, and detect more gradual change. Making a graph with a trendline helps us see this change.

Using the direction of the trendline as a clue, predict the phenology geese hatch dates 50 years when you are an Elder.

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# CHANGING CLIMATE

## Seasonal Shifts

### Activity HS.3.4

### WORKSHEET



**Compare:** Find a team working on river break up.

**River:** \_\_\_\_\_

4. What is the date of the latest break up recorded? \_\_\_\_\_

What year or years was this recorded? \_\_\_\_\_

What is the date of the earliest break up recorded? \_\_\_\_\_

What year or years was this recorded? \_\_\_\_\_

5. Are the years with the earliest hatch dates the same as the years with the earliest river break ups?

\_\_\_\_\_

6. Are the years with the latest hatch dates the same as the years with the latest river break ups?

\_\_\_\_\_

7. Why do you think it is hard to compare break up on the Yukon and Tanana Rivers with hatch dates of birds in the Yukon Delta National Wildlife Refuge? What can we learn from these long-term data sets?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

# CHANGING CLIMATE

## Seasonal Shifts

### Activity HS.3.4

#### ANSWER KEY



### STUDENT WORKSHEET: *Alaskan River Break Up*

#### Answer Key

**My River:** Students should write either Yukon River or Tanana River depending on the data set they were assigned.

1. Circle the sentence that best describes your trendline.

It is sloping down (showing a trend toward earlier breakup).

It is sloping up (showing a trend toward later breakup).

It is level (showing no change in phenology over time).

2. What is the date of the latest break up recorded? 20 May (Tanana); 16 May (Yukon)

What year or years was this recorded? 2013 (Tanana); 1985 (Yukon)

What is the date of the earliest break up recorded? 20 April (Tanana); 23 April (Yukon)

What year or years was this recorded? 1998 (Tanana); 2016 (Yukon)

3. Answers will vary but should reflect an understanding that since the trend lines show both rivers are breaking up earlier, students should predict that the rivers will break up even earlier in 50 years when they are Elders. It is also correct for students to note that there might be a day in the future when the rivers do not freeze at all.

**Compare:** Find a team working on geese hatch dates.

**Goose:** Students should write either Cackling Goose or White-fronted Goose depending on the data set of the group they shared with.

4. What is the date of the latest hatch date recorded? 4 July (Cackling); 4 July (White-fronted Goose)

What year or years was this recorded? 1982 for both species

What is the date of the earliest hatch date recorded? 14 June (Cackling); 16 June (White-fronted Goose)

What year or years was this recorded? 2004 for both species



## CHANGING CLIMATE

### Seasonal Shifts

## Activity HS.3.4

### ANSWER KEY



5. No
6. No
7. Answers will vary but should reflect an understanding that the rivers and the Yukon Delta National Wildlife Refuge are all in different parts of Alaska. Although conditions vary in all these different areas, phenology is changing in the same way all over. Break up is getting earlier in both rivers, and both species of geese are responding by nesting earlier.



# CHANGING CLIMATE

## Seasonal Shifts

Activity HS.3.4  
ANSWER KEY



### STUDENT WORKSHEET: *Alaskan Goose Hatch Dates* Answer Key

**My Goose:** Students should write either Cackling Goose or White-fronted Goose depending on the data set they were assigned.

1. Circle the sentence that best describes your trendline.

It is sloping down (showing a trend toward earlier hatch dates).

It is sloping up (showing a trend toward later hatch dates).

It is level (showing no change in phenology over time).

2. What is the date of the latest hatch date recorded? 4 July (Cackling); 4 July (White-fronted Goose)

What year or years was this recorded? 1982 for both species

What is the date of the earliest hatch date recorded? 14 June (Cackling); 16 June (White-fronted Goose)

What year or years was this recorded? 2004 for both species

3. Answers will vary but should reflect an understanding that since the trend lines show both bird species are hatching earlier, students should predict that the birds will hatch even earlier in 50 years when they are Elders. It is also correct for students to note that there might be a day in the future when those species may not be present any more.

**Compare:** Find a team working on river break up.

**River:** Students should write either Yukon River or Tanana River depending on the data set of the group they shared with.

4. What is the date of the latest break up recorded? 20 May (Tanana); 16 May (Yukon)

What year or years was this recorded? 2013 (Tanana); 1985 (Yukon)

What is the date of the earliest break ups recorded? 20 April (Tanana); 23 April (Yukon)

What year or years was this recorded? 1998 (Tanana); 2016 (Yukon)



## CHANGING CLIMATE

### Seasonal Shifts

## Activity HS.3.4

### ANSWER KEY



5. No
6. No
7. Answers will vary but should reflect an understanding that the rivers and the Yukon Delta National Wildlife Refuge are all in different parts of Alaska. Although conditions vary in all these different areas, phenology is changing in the same way all over. Break up is getting earlier in both rivers, and both species of geese are responding by nesting earlier.

