

**Middle 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 questions: 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 Break Up on Two Alaskan Rivers. An optional extension, called The Hunger Cranes, is included with the lesson Break Up on Two Alaskan Rivers. The Hunger Cranes is a game that can be used to explore and reinforce the impact of changing phenology on Alaskan wildlife.

Each activity, including the extension, 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 is a key component of life on Earth. As Alaska's seasons shift, the subsequent changes in



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## Seasonal Shifts

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.

Trophic mismatch is one such example that is being widely studied in Alaska. 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 may emerge earlier. If migratory birds do not adjust and also 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 of 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. These include: Global Learning and Observations to Benefit the Environment (GLOBE) ([www.globe.gov](http://www.globe.gov)), and Local Environmental Observers (LEO) Network ([www.leonetnetwork.org](http://www.leonetnetwork.org)). LEO was founded in 2009 by the Center for Climate and Health at the Alaska Native Tribal Health Consortium. It includes reporting apps and an interactive website that allows users to pan around a map and explore reports from throughout Alaska, and around their own village. Together with scientists and elders, 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/>

Global Learning and Observations to Benefit the Environment (GLOBE)  
<https://www.globe.gov/>

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>

Iditarod Race Information  
<http://iditarod.com/about/champions-records/>

**Unit Vocabulary**

<b>Science Terms to Define</b>	
<b>long-term data set</b>	observations collected over many decades
<b>phenology</b>	the study of timing in nature -- "nature's calendar"
<b>qualitative data</b>	an observation that deals with characteristics that cannot be expressed in numbers
<b>quantitative data</b>	an observation that deals numbers or amounts
<b>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>	upangaqraq	upnerkaq	upenghaq	
<b>summer</b>	upangaaq	kiak	kiik	
<b>tundra</b>	nuna	nunapik	nunivak	
<b>winter</b>	ukiuq	uksuq	uksuq	

### Activity MS.3.1: Ask an Expert

#### 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

**SA3:** The student demonstrates an understanding that the interactions with the environment provide an opportunity for understanding scientific concepts by

[6]SA3.1 gathering data to build a knowledge base that contributes to the development of questions about the local environment (e.g. moose browsing, trail usage, river erosion)

[7]SA3.1 designing and conducting a simple investigation about the local environment

[8]SA3.1 conducting research to learn how the local environment is used by a variety of competing interests (e.g. competition for habitat/resources, tourism, oil and mining companies, hunting groups)

**SC1:** The student demonstrates an understanding of how science explains changes in life forms over time, including genetics, heredity, the process of natural selection, and biological evolution by:

[6]SC1.2 recognizing that species survive by adapting to changes in their environment.

#### 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:

1: acquire insights from other cultures without diminishing the integrity of their own;

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### Activity MS.3.1

#### TEACHER GUIDE



- 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:
- 1: acquire in-depth cultural knowledge through active participation and meaningful interaction with Elders;
  - 3: interact with Elders in a loving and respectful way that demonstrates an appreciation of their role as culture-bearers and educators in the community;
  - 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:
- 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.

### Materials

- REACH Up Middle School Student Guide: *Seasonal Shifts*
- 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 MS.3.1

#### TEACHER GUIDE



### Activity Procedure

1. Distribute the REACH Up Middle School Student Guide: *Seasonal Shifts* and ask students to work with a partner to read page 1-4.
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 5.





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## Seasonal Shifts

### Activity MS.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 MS.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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### Activity MS.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

- 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:
- 1: acquire insights from other cultures without diminishing the integrity of their own;
  - 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:
- 1: acquire in-depth cultural knowledge through active participation and meaningful interaction with Elders;
  - 3: interact with Elders in a loving and respectful way that demonstrates an appreciation of their role as culture-bearers and educators in the community;



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## Seasonal Shifts

### Activity MS.3.2

#### TEACHER GUIDE



- 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:
- 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.

### Materials

- REACH Up Middle 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 MS.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 5 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. 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.
- 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.
- Make copies of the Student Information Sheet: *Word Games Instructions* (one per group) and the Student Worksheet: *Seasonal Shifts Vocabulary* (one per student).



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## Seasonal Shifts

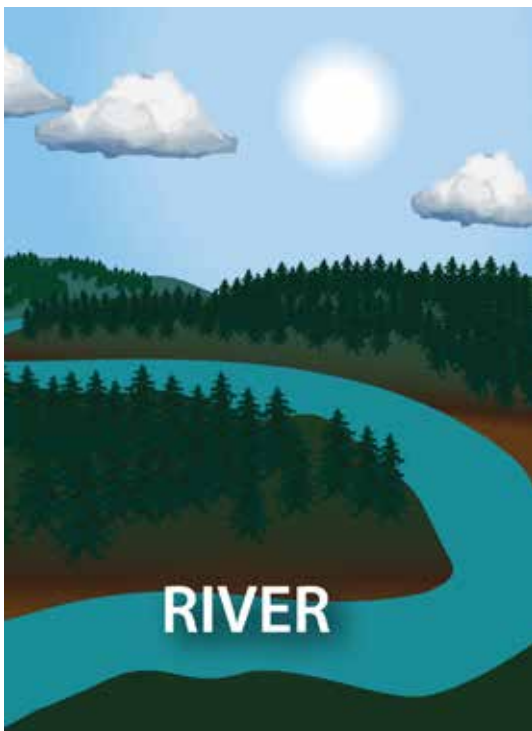
### Activity Procedure

1. Distribute the REACH Up Middle School Student Guide: *Seasonal Shifts* and review pages 1-5.
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 Student Information Sheet: *Word Games Instructions*, 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 Student Information Sheet: *Word Games Instructions*. 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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## Seasonal Shifts

### Vocabulary Cards



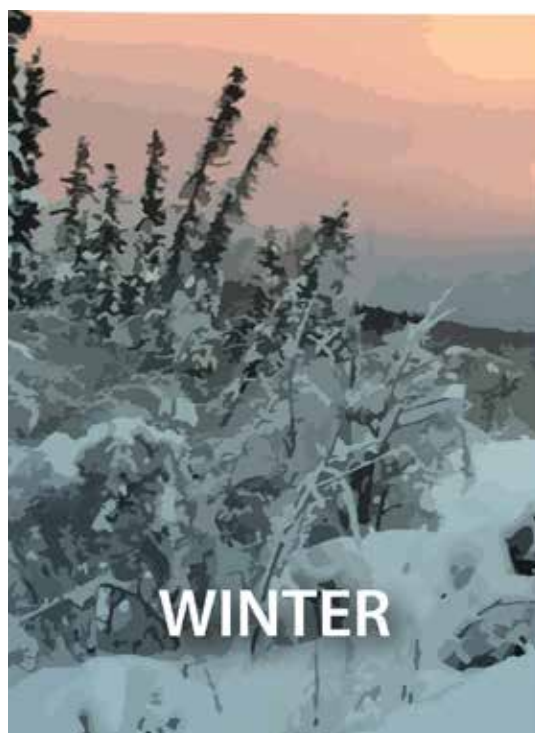
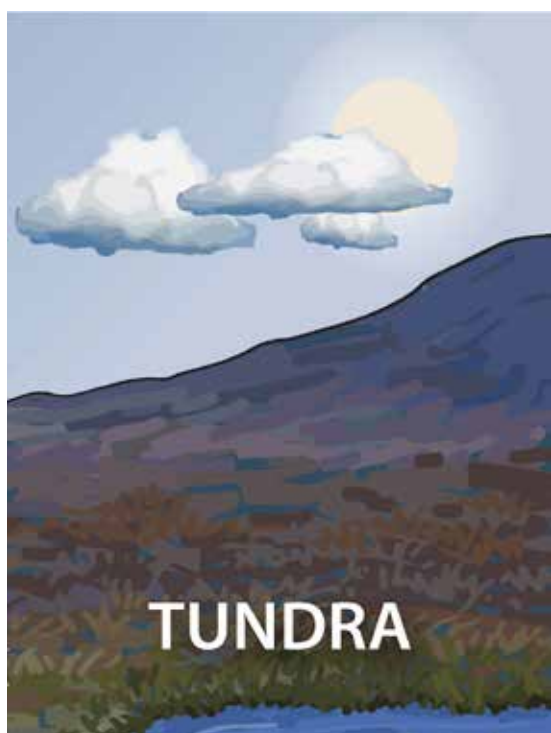
# CHANGING CLIMATE

## Seasonal Shifts

Activity MS.3.2  
TEMPLATE



### Vocabulary Cards





# CHANGING CLIMATE

## Seasonal Shifts

### Vocabulary Cards

\_\_\_\_\_

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 terms 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.
5. Repeat until all cards are gone. The team with the most points wins.



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### STUDENT WORKSHEET: *Seasonal Shifts Vocabulary*

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

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

<b>long-term data set</b>	an observation that deals with characteristics that cannot be expressed in numbers
<b>phenology</b>	an observation that deals numbers or amounts
<b>qualitative data</b>	observations collected over many decades
<b>quantitative data</b>	a line that illustrates the direction that a graph is changing
<b>trendline</b>	the study of timing in nature -- "nature's calendar"

# CHANGING CLIMATE

## Seasonal Shifts

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		

# CHANGING CLIMATE

## Seasonal Shifts

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

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

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

long-term data set	an observation that deals with characteristics that cannot be expressed in numbers
phenology	an observation that deals with numbers or amounts
qualitative data	observations collected over many decades
quantitative data	a line that illustrates the direction that a graph is changing
trendline	the study of timing in nature -- "nature's calendar"

# CHANGING CLIMATE

## Seasonal Shifts

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.

### Activity MS.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.

#### Next Generation Science Standards

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

**Standards by Topic:** Matter and Energy in Organisms and Ecosystems

#### Performance Expectations

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

MS-LS2-1: Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

#### Dimension:

##### *Science & Engineering Practices*

Analyzing and Interpreting Data

##### *Crosscutting Concepts*

Cause and Effect

Stability and Change

#### Alaska Standards

#### Alaska Science Standards and Grade Level Expectations

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

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

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## Seasonal Shifts

### Activity MS.3.3

#### TEACHER GUIDE



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

[8]SD3.1 recognizing the relationship between the seasons and Earth's tilt relative to the sun and describing the day/night cycle as caused by the rotation of Earth every 24 hours.

### 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

**7.6A:** Understand cycles influenced by energy from the sun and by Earth's position and motion in our solar system: including daylight cycles, moon phases and eclipses, tidal action, relationships between seasons and Earth's tilt relative to the sun.

### Materials

- REACH Up Middle 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 Middle School Student Guide: *Seasonal Shifts*. Ask students to work individually or in groups to re-read Pages 2-3.
2. Next, read and discuss Page 6 together as a class.
3. Then, instruct students to open to Pages 7 and 8, Activity: What is Phenology? and read the instructions together.





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## Seasonal Shifts

### Activity MS.3.3

#### TEACHER GUIDE



4. Distribute the marker chips to each student or group.
5. Designate one color for examples of phenology, and one color for examples that are not phenology. Explain this to students.
6. 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.
7. Review the discussion questions together.



# CHANGING CLIMATE

## Seasonal Shifts

### 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.*



### Activity MS.3.4: *Break Up on Two Alaskan Rivers*

#### Overview

This lesson includes two parts. In Part 1, students will use a sample graph of Iditarod race times to learn to draw a trendline (also called a line of best fit). In Part 2 they will work in teams to analyze two long-term phenology data sets (break up on the Tanana and Yukon Rivers), and in Part 3, extrapolate future conditions.

#### Objectives

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

- explain why scientists and Elders collect long-term data sets,
- draw and analyze a trendline (line of best fit) on a graph ,
- 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:** Earth and Human Activity

**Standards by Topic:** Weather and Climate

#### Performance Expectations

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

MS-ESS3-5: Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

#### Dimension:

##### *Science & Engineering Practices*

Asking Questions and Defining Problems

##### *Disciplinary Core Ideas*

##### *ESS3.D: Global Climate Change*

- Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth’s mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities. (MS-ESS3-5)

# 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

[6-8]**SA1.1** asking questions, predicting, observing, describing, measuring, classifying, making generalizations, inferring and communicating

[6]**SA1.2** collaborating to design and conduct simple repeatable investigations

[7]**SA1.2** collaborating to design and conduct simple repeatable investigations, in order to record, analyze (i.e., range, mean, median, mode), interpret data, and present findings.

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

[8]**SD3.1** recognizing the relationship between the seasons and Earth's tilt relative to the sun and describing the day/night cycle as caused by the rotation of Earth every 24 hours.

## Alaska Math Standards

**6.SP** Develop understanding of statistical variability

**6.SP.1:** Recognize a statistical question as one that anticipates variability in the data related to the question and accounts for it in the answers.

**6.SP.2:** Understand that a set of data has a distribution that can be described by its center (mean, median, mode), or spread (range), and overall shape and can be used to answer a statistical question.

**8.SP** Investigate patterns and association in bivariate data.

**8.SP.3:** Use the equation of a linear model to solve problems in the context of bivariate measurement data, interpreting the slope and y-intercept.

## 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:

- 1: acquire insights from other cultures without diminishing the integrity of their own;
- 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;

# CHANGING CLIMATE

## Seasonal Shifts

- 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

**7.6A:** Understand cycles influenced by energy from the sun and by Earth's position and motion in our solar system: including daylight cycles, moon phases and eclipses, tidal action, relationships between seasons and Earth's tilt relative to the sun.

### Materials

- REACH Up Middle School Student Guide: *Seasonal Shifts*
- Student Worksheet: *Looking at the Trend*
- Student Worksheet: *Break Up on Tanana River 1967-2017 ("Team Tanana")*
- Student Worksheet: *Break Up on Yukon River 1967-2017 ("Team Yukon")*
- Scissors
- Tape
- Pencil
- Ruler

### Activity Preparation

1. Gather supplies and make copies of Student Worksheets: *Looking at the Trend*, *Break Up on Tanana River 1967-2017 ("Team Tanana")*, and *Break Up on Yukon River 1967-2017 ("Team Yukon")*. You could have students use the graphs featured in the Student Guide instead of the Team Yukon and Team Tanana worksheets. If using the Student Guide, make sure students do not write in the guide. If desired, you can make your own copies of graph paper using a website such as <https://incompetech.com/graphpaper/>. You will have to set the size to .8cm / 8mm, to match the river graphs. When printing, make sure your settings are set to "actual size," and not "shrink to fit."

### Activity Procedure

1. Distribute the REACH Up Middle School Student Guide: *Seasonal Shifts*. Work individually or in groups to read page 9-10.
2. Divide the class into groups of up to 4 students each. Assign each group to either Team Tanana or Team Yukon.
3. Distribute Student Worksheet: *Looking at the Trend*.
4. Instruct students to open the REACH Up Middle School Student Guide: *Seasonal Shifts* to pages 11-14, Activity: Break Up on Two Alaskan Rivers.



# CHANGING CLIMATE

## Seasonal Shifts

### Activity MS.3.4

#### TEACHER GUIDE



5. Instruct student groups to complete Part 1 of their student worksheet. Review the answers together as a class. If you would like more information on changing Iditarod race times (including a video), visit: <http://www.ktuu.com/content/news/Iditarod-Why-race-times-improved-dramatically-since-its-start-475864733.html>.
6. Explain that students will be graphing real, long-term phenology data sets next. Instruct students to read and complete Part 2 of their student worksheet. Distribute Team Tanana and Team Yukon worksheets to the appropriate groups. Assist students as needed.
7. Review the directions for Part 3 as a group and assist students as needed.
8. Review the answers to the student worksheets.
9. Wrap up with additional discussion as time and interest allow.

### Extension Activity

*The Hunger Cranes*, a lesson plan by the Madison Audobon Society, is an interactive game that can be used to teach about phenological mismatch in migratory birds. Available at: [http://216.243.143.200/assets/documents/Climate\\_Initiative\\_Lesson\\_8\\_Activity\\_Hunger\\_Cranes.pdf](http://216.243.143.200/assets/documents/Climate_Initiative_Lesson_8_Activity_Hunger_Cranes.pdf).



# CHANGING CLIMATE

## Seasonal Shifts

### STUDENT WORKSHEET: *Looking at the Trend*

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

#### Part 1: Studying a Sample Graph

Study the sample graph below to learn to find patterns in quantitative data. The title describes what the graph shows, Winning Iditarod Finishing Times 1973-2017. The labels on each axis describe the data being compared (**year** on the x-axis to **winning time in hours** on the y-axis).

**Draw a trendline.** Place your ruler on the graph. Draw a line that is as close to as many points as possible. A trendline is also called the “line of best fit.” Since this sample graph has ten data points, try to put five of the points on each side of your line of best fit.



**Circle the sentence that best describes your trendline:**

- It is sloping down, showing a trend toward shorter race times.
- It is sloping up, showing a trend toward longer race times.
- It is level, showing no change in winning times over the years.

**Discuss:** Mitch Seavey, the 2017 Iditarod champion, set a new record for finishing the race in just under 196 hours. This is more than twice as fast as Dick Wilmarth, the first winner in 1973. Dick finished the race in just under 481 hours. What factors do you think have contributed to this trend?

# CHANGING CLIMATE

## Seasonal Shifts

### Activity MS.3.4

#### WORKSHEET



### Part 2: Looking at the Trend

Your teacher will give you a separate page with a graph that shows the break up dates for either the Yukon River or the Tanana River. Like the Iditarod sample graph, the x-axis shows the year. The y-axis shows the date break up was recorded that year. The trendline, also called the line of best fit, has been drawn for you.

Study the graph carefully. Look for a pattern, and answer the questions below. You may need to estimate the years and break up dates in between the ones that are labeled.

1. In what year was the latest break up recorded?
2. In what year (or years) was the earliest break up recorded?
3. The trendline shows the pattern of change in break up on the Yukon River over the last 50 years. Circle the sentence that best describes the trendline.
  - It is sloping up, showing a trend toward a later breakup.
  - It is sloping down, showing a trend toward an earlier break up.
  - It is level showing, no change in the phenology of breakup over time.

### Discuss:

As you look at the graph, you can see that break up varies a lot from year to year. Some years it is very early. Other years it is in very late and happens in May. This is why both elders and scientists build long-term data sets with repeated observations over many years. Even though there is a lot of variability, when we look at the overall direction of the graph (the trend), we can see that spring break up is getting earlier.

Scientists say spring temperature is the most important factor for the timing of ice break-up, especially the timing of warm or cold spells. Other important factors include winter temperatures, how much snow falls, and overall ice thickness.

4. What could happen if break up continues to get earlier and earlier?

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5. Name at least one animal that uses the river closest to your school. \_\_\_\_\_

How could earlier river break up impact them? \_\_\_\_\_

6. What river is closest to your community? \_\_\_\_\_

7. Early break up on rivers can lead to ice jams, floods, and damage to roads and homes. How can your community adapt to earlier break up?







### Part 3: Forecasting Break Up

If this trend continues, what will break up on rivers in Alaska look like when you are an elder?

1. The following page has blank graph paper. Detach it from your worksheet and place it to the right of your river graph. Use scissors to carefully cut off the margin. Carefully align the graph paper so it extends the lines of the graph. Make sure the bottom line of the blank graph lines up with the x-axis. Gently tape the graphs together.
2. Extend the x-axis by 50 years, using the same scale as the existing graph. Label the even years, starting with 2020 and ending with 2068.
3. Next, use your ruler and pencil to extend the trendline onto the graph paper to 2068.
4. Plot a data point where the trendline intersects with the line for 2068.
5. Use your finger to trace a line back to the y-axis; read the date for the forecasted break up in 2068. Remember, your data point may fall between the labeled dates. What is the new break up date for your river?
6. Share your results with the rest of the class.
7. Describe one way that this could change life in the communities along this river.



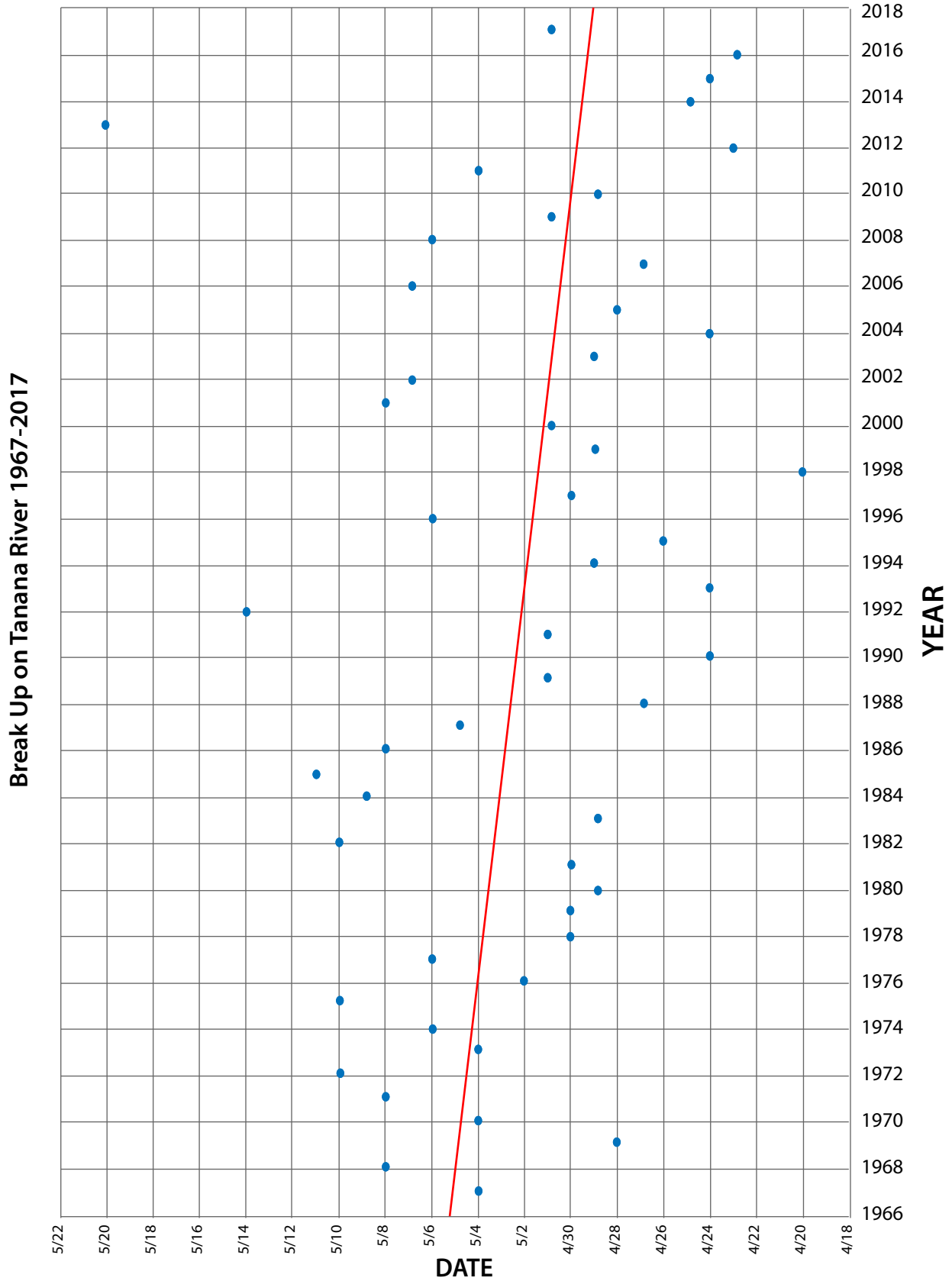


# CHANGING CLIMATE

## Seasonal Shifts

### Activity MS.3.4

### WORKSHEET

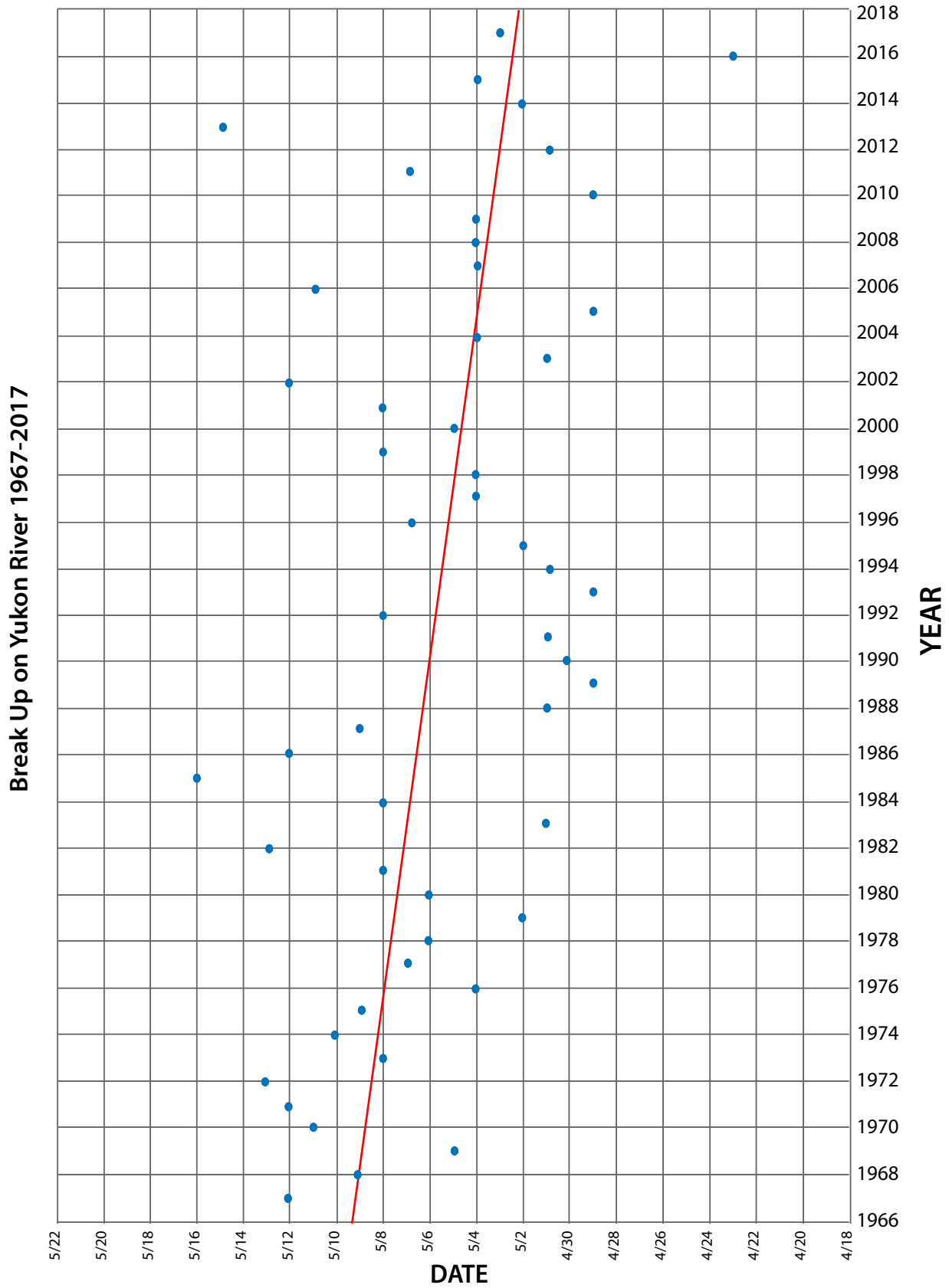


# CHANGING CLIMATE

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### Activity MS.3.4

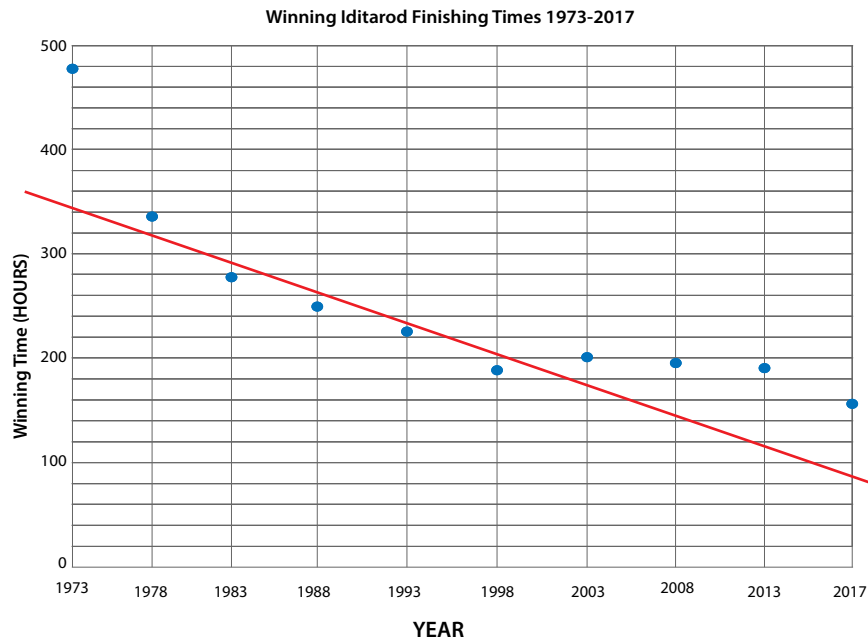
### WORKSHEET





### STUDENT WORKSHEET: Looking at the Trend, Part 1

#### Answers key



Answers will vary. It is ok if there is variability in the trend lines on student graphs. The line should be as close to as many points as possible, and show a slope that is visually similar to the one shown above.

Circle the sentence that best describes your trendline.

It is sloping down, showing a trend toward shorter race times.

It is sloping up, showing a trend toward longer race times.

It is level, showing no change in winning times over the years.

**Discuss:** Answers will vary. It is important that students do not assume that faster Iditarod race times are related to the seasonal shifts they are studying in this unit. Most mushers agree that there are three main factors in the dramatic decrease in race times:

- Stronger Dogs—Modern dogs have been selectively bred to be stronger, smaller and faster.
- Improved Gear—Technological developments have led to improved sled design, lighter gear, and other advancements that have made teams lighter and faster and able to travel longer stretches of trail without stopping.
- Changes in Race Conditions—In the early days of the race, mushers were breaking trails, setting camp, and traveling through unknown conditions. It was more of a camping/endurance race. Today, mushers travel a groomed trail that is maintained by race officials, with seated sleds and iPods. Some stop only at checkpoints staffed with volunteers. It is now a race about speed and strategy.

Note also that the race switched between northern and southern routes and that it has started in Fairbanks in some years (e.g., 2017). The overall distance, however, is roughly the same.



# CHANGING CLIMATE

## Seasonal Shifts

### Activity MS.3.4

#### ANSWER KEY



### STUDENT WORKSHEET: *Looking at a Trend, Parts 2: Team Tanana*

#### Answer key

1. 2013
2. 1998
3. Circle the sentence that best describes the trend line.  
It is sloping up, showing a trend toward a later breakup.  
It is sloping down, showing a trend toward an earlier break up.  
It is level showing, no change in the phenology of breakup over time.
4. Answers will vary, but should reflect an understanding that eventually rivers may not freeze at all.
5. Answers will vary.
6. Answers will vary.
7. Answers will vary.

### STUDENT WORKSHEET: *Looking at a Trend, Parts 3: Team Tanana*

#### Answer key

Answers should be around April 23.



# CHANGING CLIMATE

## Seasonal Shifts

### Activity MS.3.4

#### ANSWER KEY



### STUDENT WORKSHEET: *Looking at a Trend, Parts 2: Team Yukon*

#### Answer key

1. 1985
2. 2016
3. Circle the sentence that best describes the trend line.  
It is sloping up, showing a trend toward a later breakup.  
It is sloping down, showing a trend toward an earlier break up.  
It is level showing, no change in the phenology of breakup over time.
4. Answers will vary, but should reflect an understanding that eventually rivers may not freeze at all.
5. Answers will vary.
6. Answers will vary.
7. Answers will vary.

### STUDENT WORKSHEET: *Looking at a Trend, Parts 3: Team Yukon*

#### Answer key

Answers should be around April 25.

