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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 shrub expansion and related ecological changes from Alaska Native cultural, physical and earth science perspectives. This supplemental unit addresses the place-based question: How is the vegetation changing in our area and why are these changes important to our community?

The REACH Up Shrub Expansion unit consists of three activities. Each activity will require a 45-minute class period; 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 Vegetation Changes video or having your students practice the vocabulary card games multiple times. If you are utilizing the entire shrub Expansion 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 on a separate sheet of paper, or create copies of the corresponding worksheets that are included in this teacher's guide.

Whole Picture

Through millennia of living off the land, Alaska Native people have developed an intimate understanding of their surroundings. From generation to generation, people learned to read details about the environment from their relatives, elders, and other community members. People innately knew when particular animals would arrive on the landscape and when certain plants would be right for harvesting. This deep knowledge of the landscape was vastly important for survival, and in many communities was woven into the language. Activities that happened at certain times of the year were reflected in the meaning of month names. We see this still in Native communities like Golovin where the Native words for April, May, June, and July have meanings that reflect subsistence activities: "the month when people go out with the umiaq" (April), "the month when caribou lay their fawns" (May), "the month of small fish" (June), and "the month when birds molt" (July) (Wood and Bautnuq, part 1).

Understanding seasonal timing is an important scientific skill that enables people to understand the life cycles of the "rich array of vegetation, including numerous edible greens and berries" upon which they depend (Fienup-Riordan and Rearden, 2012, p. 13). Plant identification — both

their names and how they are used — is a crucial aspect of learning this skill. Plants provide people with much needed nutrients to balance out their diets, medicinal properties to heal the ailing, and resources to use in tool and craft making.

Traditionally, plant identification skills and uses were passed from generation to generation through long hours of observation and hands-on learning. Young people would go out on the land with their elders and family members to pick berries, harvest plants, observe the world around them, and then spend many hours learning to prepare the food for immediate eating or for storage to be eaten at a later time (Fienup-Riordan and Rearden, 2012; Kawagley, 2006; Krupnik and Jolly, 2002; Matthews, 1968). Today, harvesting plants and putting food up for winter is no less important, but young people spend less time out on the land with the people who can teach them proper identification and harvesting techniques. Nevertheless, elders and culture bearers identify these skills as essential for young people to learn.

Still, "the world is faster now" (Krupnik and Jolly, 2002) — scientists and culture bearers alike have noted alarming changes happening to plants as the result of climate change — changes that are making it difficult to know the land. Jeanette L. Aya, from Savoonga, has noticed that plants are growing faster than normal now. In the past, she says it was "as though time stood still" — people had time to gather and prepare food for winter storage. Now, the plants are nearly useless by the time they are first noticed (Aya, 2011), and people are finding it more and more difficult to get everything done. In the past, berry season followed the fishing season. Now, though, people often find themselves trying to gather berries at the same time as they need to be cutting and drying fish — this makes for challenging work and some are finding it difficult to put up enough food for winter.

As climate continues to change, people will witness more and more change, making traditional practices more and more difficult. It is therefore ever more important for young people to spend more time getting to know the plants and animals, not only so that the changes can be understood, but so that people can learn how to adapt to the changes and continue to survive.

References

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Alaska Native Knowledge Network. Accessed from: http://ankn.uaf.edu/ANCR/Inupiaq/plantsofmypeople/index.html.

Unit Vocabulary

Science Terms to Define	
shrub	a woody plant smaller than a tree, usually having multiple permanent stems brancing from or near the ground
shrub expansion	the northward and upslope encroachment of trees and shrubs into tundra-dominated areas
tundra[1]	a cold and dry biome that is characterized by short vegetation such as grasses, mosses, and lichens

Terms for Incorporating Local Indigenous				
English	**Iñupiaq**	**Yup'ik**	**Siberian Yupik**	**Local Translation**
shrub	uqpik	cuyaqsak	uqfilleqgaq	
willow	uqpik	uqvik	uqvigaq	
tundra	nuna	nunapik	nunivak	
treeline	napaaqtut	apat ngeliit	uqfiget	

[1]2009 Pearson/Prentice Hall Life Science Textbook definition: **tundra** = an extremely cold, dry biome

2009 Pearson/Prentice Hall Earth Science Textbook definition: **tundra** = a polar climate region, found across northern Alaska, Canada, and Russia, with short, cool summers and bitterly cold winters

These are also accurate definitions and teachers may want to use their textbook's terminology for consistency. We have provided an alternative definition to emphasize the vegetation of tundra.

Activity HS.5.1: Ask an Expert

Overview

In this activity, students will interview an Elder or cultural knowledge bearer.

Objectives

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

- demonstrate effective interviewing techniques
- interpret qualitative data from interviews
- describe how vegetation in the local ecosystem is changing
- explain how changes in vegetation impact wildlife populations

Alaska Standards

Alaska Science Standards / Grade Level Expectations

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

[9] SA1.2 hypothesizing, designing a controlled experiment, making qualitative and quantitative observations, interpreting data, and using this information to communicate conclusions.

[10] SA1.2 reviewing pertinent literature, hypothesizing, making qualitative and quantitative observations, controlling experimental variables, analyzing data statistically (i.e., mean, median, mode), and using this information to draw conclusions, compare results to others, suggest further experimentation, and apply student's conclusions to other problems.

[11] SA1.2 recognizing and analyzing multiple explanations and models, using this information to revise students' own explanation or model if necessary.

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:

[9] SC3.3 identifying dynamic factors (e.g. carrying capacity, limiting factors, biodiversity, and productivity) that affect population size.

[10] SC3.2 exploring ecological relationships. (e.g., competition, niche, feeding relationships, symbiosis)

[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:

[B2] 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:

[D.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:

[E.2] understand the ecology and geography of the bioregion they inhabit.

Bering Strait School District Scope & Sequence

9.5D. Predict how a change in an environmental factor can affect the number and diversity of species in an ecosystem.

9.7C Understand the relationship between animal adaptations and survival in their environment

9.9B. Identify the needs that must be met by an organisms surroundings

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

Materials

- Shrub Expansion High School Student Guide
- Student Worksheet: Ask an Expert about Shrub Expansion
- Internet access and projector

Activity Preparations

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 vegetation in the area has changed, 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.

Activity Procedure

1. Distribute the Shrub Expansion student guide and ask students to work with a partner to read pages 1-5.
2. Show the video *Vegetation Changes*, available at 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 local vegetation changes. Separate students into small groups according to how many knowledge bearers are available to share lake information with your class. Explain 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 Shrub Expansion 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. How has the local vegetation changed? What impacts might the changes have on local lifestyles? If your students learned local indigenous words for the vocabulary terms, compare their translations with the translations found on page 6.

Student Worksheet: Ask an Expert about Shrub Expansion

Names of Group Members:_____

Interview a long-term community member to learn more about vegetation in your area. Take notes about what you learn.

Who did you interview? _____

Ask:

How has the vegetation changed in this area in your lifetime? Are there more willows and shrubs than there used to be? Are the willows growing taller than the used to? (If there are spruce trees in your area, where there spruce trees here when you were younger?)

Have changes in vegetation affected hunting, berry picking, and/or transportation?

Have you noticed changes in the bird and animal populations? For example, are there moose in the area? Were there moose in the area when your were younger?

Other notes:

For Alaska Native Language Speakers:

What language(s) do you speak? _____

What dialect(s)?_____

Could you translate the following words?

Shrub: _____

Willow: _____

Tundra: _____

Moose: _____

Activity MS.5.2: Shrub Expansion Vocabulary

What terminology do we need to know to discuss shrub expansion?

Overview

In this activity, students will learn key shrub expansion 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, landscape and ecosystems
- illustrate and define terms related to shrub expansion and landscape changes in their region

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:

[B.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:

[E.2] understand the ecology and geography of the bioregion they inhabit.

Bering Strait School District Scope & Sequence

6.9G: Understand how ecosystems change over time.

Materials

- Vocabulary card sets (1 per group of 4-6 students)
- Word Games Instruction Sheet (1 per group of students)
- Shrub Expansion Vocabulary worksheet
- REACH Up High School Student Guide: *Shrub Expansion*
- Dry Erase Markers (1 per group)
- Timers (optional)

Additional Resources

2009 Pearson / Prentice Hall

- Earth Science Textbook Chapter 18
- Life Science Textbook Chapter 22

Activity Preparations

1. If your students completed Activity HS.5.1 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 6 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
			Diomede	Little Diomede
				Shishmaref
			Wales (Kinikmiu)	Wales
		Qawariaq	Teller	Teller
				Unalakleet
				Shaktoolik
			Fish River	Golovin*
				White Mountain
	Northern Alaskan Iñupiaq	Malimiut		Koyuk
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/.

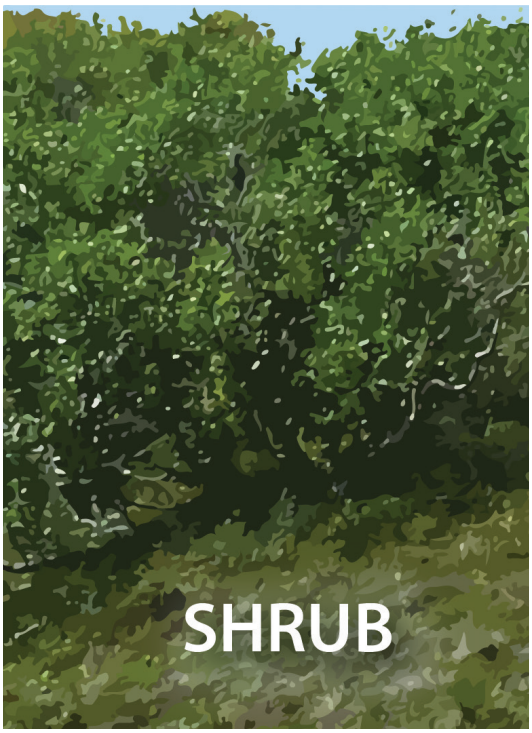
3. Keep in mind that different individuals may translate certain terms differently. For example, some languages may not have a separate term for "shrub" and "willow". Or, distinct terms may exist, but the individual speaker does not know the term for "willow", and uses the term for "shrub" in both instances. 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.
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 Word Games Instruction Sheet (one per group) and the Shrub Expansion Vocabulary worksheet (one per student).

Activity Procedure

1. Distribute the Shrub Expansion Student Guide and review pages 1-6.
2. Show students the vocabulary cards. Hold up each card. Discuss what each card depicts. How do these terms relate to vegetation in their region?
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 Shrub Expansion unit. If possible, schedule 10-15 minutes twice per week to practice the vocabulary terms.
9. Write the following terms on the board: shrub, shrub expansion, tundra. Ask students to share definitions for these terms. Refer back to the Shrub Expansion Student Guide as necessary.
10. Distribute the Shrub Expansion Vocabulary Worksheet and ask students to complete it.

Vocabulary Cards



Vocabulary Cards

_____ Local indigenous word	_____ Local indigenous word
_____ Local indigenous word	_____ Local indigenous word

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.

Student Worksheet: Shrub Expansion Vocabulary

Name:_____

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

shrub	a cold and dry biome that is characterized by short vegetation such as grasses, mosses, and lichens
shrub expansion	the northward and upslope encroachment of trees and shrubs into tundra-dominated areas
tundra	a woody plant smaller than a tree, usually having multiple permanent stems branching from or near the ground

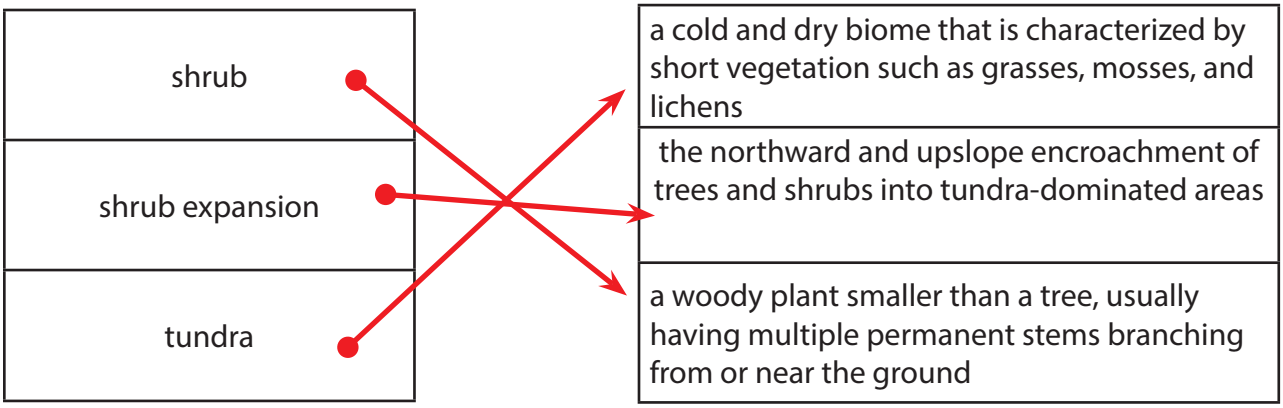
2) Complete the chart by writing the local Alaska Native Language terminology and illustrating the missing terms.

My Community: _____

English Word	Local Alaska Native Language Word	Illustration
shrub		
willow		
tundra		
moose		

Answer Key: Shrub Expansion Vocabulary

1)



2)

My Community: _____

English Word	Local Alaska Native Language Word	Illustration
shrub	Answers will vary depending on language and dialect spoken in this community.	Sketch should illustrate word at left.
willow	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.
moose	Answers will vary depending on language and dialect spoken in this community.	Sketch should illustrate word at left.

Activity HS.5.3: Estimating Shrub Height

Overview

In this lesson students will use a formula to estimate shrub height, and consider the impact of shrub height on animal habitat.

Objectives

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

- describe the role of climate change in vegetation shifts
- describe quantitative and qualitative changes to the landscape and ecosystem in their region
- collect quantitative and qualitative data
- consider the implications of climate-driven landscape and ecosystem changes in their region from scientific, cultural and personal perspectives

Alaska State Science Standards and Grade Level Expectations

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

[9] SA1.2 hypothesizing, designing a controlled experiment, making qualitative and quantitative observations, interpreting data, and using this information to communicate conclusions.

[10] SA1.2 reviewing pertinent literature, hypothesizing, making qualitative and quantitative observations, controlling experimental variables, analyzing data statistically (i.e., mean, median, mode), and using this information to draw conclusions, compare results to others, suggest further experimentation, and apply student's conclusions to other problems.

[11] SA1.2 recognizing and analyzing multiple explanations and models, using this information to revise students' own explanation or model if necessary.

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:

[9] SC3.3 identifying dynamic factors (e.g. carrying capacity, limiting factors, biodiversity, and productivity) that affect population size.

[10] SC3.2 exploring ecological relationships. (e.g., competition, niche, feeding relationships, symbiosis)

[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

N-Q.2 Define appropriate quantities for the purpose of descriptive modeling.

A-REI.4 Solve quadratic equations in one variable.

BSSD Scope and Sequence

9.5D Predict how a change in an environmental factor can affect the number and diversity of species in an ecosystem.

9.7C Understand the relationship between animal adaptations and survival in their environment

9.9B Identify the needs that must be met by an organisms surroundings

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

Materials

- *Shrub Expansion* REACH Up High School Student Guide
- Student Worksheet: *Estimating Shrub Height*
- Calculators
- Colored Pencils

Activity Preparations

1. Make copies of the Student Worksheet: *Estimating Shrub Height*.

Activity Procedure

1. Review pages 1-6 in the REACH Up Shrub Expansion High School Student Guide.
2. Next, read and discuss pages 7-9 together as a class. If students are having difficulty understanding Thaw Degree Days, it may help to think of 100 days of 10°C weather; that would be a TDD of 1,000. 10°C = 50°F, a typical summer day in Western Alaska. Of course, the weather doesn't go directly from below freezing to summer weather; 10x100=1,000 provides a ballpark estimate.
3. Distribute Estimating Shrub Height worksheets, colored pencils, and calculators. Go over the directions, then circulate and assist students with the worksheet.
4. For the formula, review the Order of Operations for solving an equation: Parenthesis, Exponents, Multiply and Divide, Add and Subtract. (A helpful pneumonic device is Please Excuse My Dear Aunt Sally.)

5. Discuss your findings, emphasizing the conclusion questions. If necessary, help students to visualize the shrub heights by using a meter stick or comparing to building heights. Focus on the calculation for 1920 and how that shrub height compares to snow depths. If students ask, scientists have found that while snow depth varies somewhat year to year, there is not a noticeable trend in the data. It is safe to assume that the snow depth in 1920 was similar to 2010.

Extension Activities

- Have students read and discuss news articles related to shrub expansion and its impact on animal habitat, such as the article below. http://www.scientificamerican.com/article/will-moose-thrive-or-die-because-of-climate-change/
  This Scientific American article is available on Newsela. Newsela is an education website that presents articles at different reading levels, and includes corresponding quizzes. A basic account is free. The original article is at a 12th grade reading level; Newsela staff have modified it for lower Lexile levels (8th, 6th, 4th, and 3rd grade reading levels). https://newsela.com/articles/moose-climatechange/id/17295/
- Take students outside to measure nearby shrubs. If you do not have tall shrubs in your community, you could measure other objects such as the flagpole. Measuring trees is a great example of STEM career skills and a real life application of a trigonometry. Foresters use a clinometer to calculate the height of a tree. You can make your own simple clinometer from a protractor. Or, use a smartphone as described in the website below. https://gabrielhemery.com/2011/05/15/how-to-calculate-tree-height-using-a-smartphone/

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Student Worksheet: Estimating Shrub Height

Name: _____

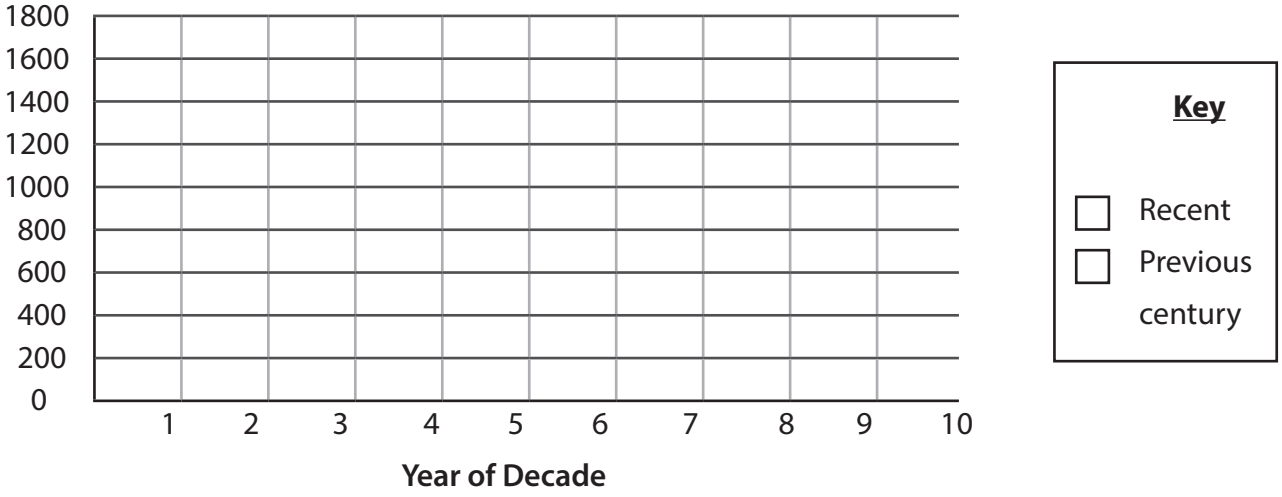
Directions: Use the temperature data for Nome, AK to estimate the approximate height of the shrubs in that area for both 2010 and 1920.

1. Find the average TDD for the 10-year period preceding 2010 and 1920.

Decade leading up to 1920		
Data Point	Year	TDD Value
1	1910	929
2	1911	1203
3	1912	1348
4	1913	1241
5	1914	1173
6	1915	1104
7	1916	1155
8	1917	1174
9	1918	1001
10	1919	973
	Total	
	Average TDD	

Decade leading up to 1920		
Data Point	Year	TDD Value
1	2000	1078
2	2001	1012
3	2002	1332
4	2003	1296
5	2004	1573
6	2005	1459
7	2006	1173
8	2007	1519
9	2008	1160
10	2009	1248
	Total	
	Average TDD	

2. Create a line graph to show the trends in data points from the above charts. Use two different colored pencils, one color for each decade.



3a. Estimate the average shrub height for 2010. Plug in your 2010 Average TDD value for the "n" in the shrub height formula.

n = _____

shrub height (cm) = 0.000341(n2) – 0.195(n) + 27.7

n2 = _____

0.000341 * n2 = _____ and 0.195 * n = _____

(1) (2)

(1) – (2) + 27.7 = _____

shrub height (cm)

3b. Does your answer seem reasonable? Explain.

4a. Next, estimate the average shrub height for 1920. Plug in your 1920 Average TDD value for the "n" in the shrub height formula.

n = _____

shrub height (cm) = 0.000341(n2) – 0.195(n) + 27.7

n2 = _____

0.000341 * n2 = _____ and 0.195 * n = _____

(1) (2)

(1) – (2) + 27.7 = _____

shrub height (cm)

4b. Based on your results, do you think there was good moose habitat near Nome in 1920? Explain.

Answer Key: Estimating Shrub Height

Name: _____

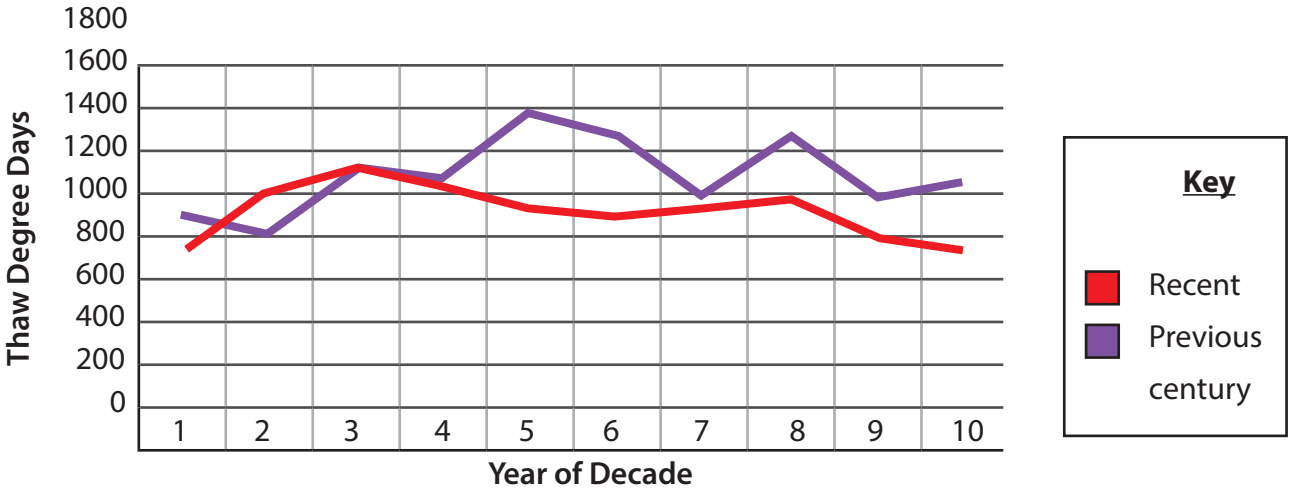
Directions: Use the temperature data for Nome, AK to estimate the approximate height of the shrubs in that area for both 2010 and 1920.

1. Find the average TDD for the 10-year period preceding 2010 and 1920.

Decade leading up to 1920		
Data Point	Year	TDD Value
1	1910	929
2	1911	1203
3	1912	1348
4	1913	1241
5	1914	1173
6	1915	1104
7	1916	1155
8	1917	1174
9	1918	1001
10	1919	973
	Total	11301
	Average TDD	1130

Decade leading up to 1920		
Data Point	Year	TDD Value
1	2000	1078
2	2001	1012
3	2002	1332
4	2003	1296
5	2004	1573
6	2005	1459
7	2006	1173
8	2007	1519
9	2008	1160
10	2009	1248
	Total	12850
	Average TDD	1285

2. Create a line graph to show the trends in data points from the above charts. Use two different colored pencils, one color for each decade. Sample Answers provided



3a. Estimate the average shrub height for 2010. Plug in your 2010 Average TDD value for the "n" in the shrub height formula.

n = 1285

shrub height (cm) = 0.000341(n2) – 0.195(n) + 27.7

n2 = 1,651,225

0.000341 * n2 = 563.06775 (1) and 0.195 * n = 250.575 (2)

(1) – (2) + 27.7 = 340.19275 shrub height (cm)

3b. Does your answer seem reasonable? Explain.

Answers will vary. 340cm is 3.4 meters. I know a meter is close to a yard, and I can picture willows that are 3½ yards tall. Yes, my calculation is reasonable.

4a. Next, estimate the average shrub height for 1920. Plug in your 1920 Average TDD value for the "n" in the shrub height formula.

n = 1130

shrub height (cm) = 0.000341(n2) – 0.195(n) + 27.7

n2 = 1,276,900

0.000341 * n2 = 435.4229 (1) and 0.195 * n = 220.35 (2)

(1) – (2) + 27.7 = 140.841981 shrub height (cm)

4b. Based on your results, do you think there was good moose habitat near Nome in 1920? Explain.

Answers will vary. 141 cm is 1.4 meters. We read that moose prefer shrubs that are 2 meters tall. So, the shrubs in Nome in 1920 were not tall enough to support a moose population.