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

The REACH Up Thawing Permafrost 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 Permafrost Thaw video or having your students practice the vocabulary card games multiple times. If you are utilizing the entire Thawing Permafrost 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

In Alaska Native oral tradition, it is said that Raven made Earth's landforms and brought light and life to the world — including that of humans (Fienup-Riordan, 1994; Kawagley, 2006). This worldview provides an important clarification for understanding human roles and responsibilities in the world. Yup'ik creation stories, for example, tell how "the creative force [Ella] took the form of the Raven to make the world so that the Yupiaq will never think that they are above the creatures of the earth" (Kawagley, 2006, p. 17-18). According to this philosophy, people are on equal ground with the natural world, and in fact, have a responsibility to maintain ecosystem balances by demonstrating respect for all parts of the environment. This emphasis on the interconnectedness of all parts of the ecosystem, including the role and impact of humans within it, is echoed by climate scientists studying the impacts and driving forces behind climate change the Arctic (Richter-Menge, Overland & Mathis, 2016).

Nevertheless, the ecosystem balance has been disturbed, as is demonstrated by the unprecedented changes happening in the Arctic, including flooding, permafrost thaw, severe coastal erosion, thin and melting sea ice, ferocious wildfires, and changes to seasonal timing and range of plants and animals. Scientists and Alaska Native cultural knowledge bearers agree that many of the climate changes are the result of human activities, though the reasons cited for these changes sometimes differ between the two groups.

Scientists explain that "human activities—especially the burning of fossil fuels since the start of the Industrial Revolution—have increased atmospheric CO2 concentrations by about 40%, with more than half the increase occurring since 1970" (Royal Society and USNAS, 2014, p. 2). Carbon dioxide (CO2) is one of the greenhouse gasses that traps and absorbs heat high in the atmosphere. In turn, this contributes to the overall global temperature rise. By comparing observations with models, and "fingerprinting the detailed patterns of climate change caused by different human and natural influences," in connection with a deep understanding of physics, scientists know that the dramatic recent changes we have seen in the climate are human-caused (Royal Society and USNAS, 2014, p. 5).

Alaska Native people also link the changes currently happening in the climate to human action and interaction. This understanding is based in a worldview which links the human world with the natural and spiritual worlds. In Yup'ik tradition, Ellam Yua, the person of the universe, is always watching, and will reprimand people who do not follow strict rules for maintaining balance in the world (Fienup-Riordan and Rearden, 2012).

Culture bearers point to the fact that people aren't following the rules about how to act appropriately with the natural world as evidence of why the climate is changing so dramatically. For some, like Jeanette Aya from Savoonga, this translates directly into a respect (or disrespect) for Mother Nature: "Respect Mother Nature. We respect all the abundance that she gives to us. Just like if you don't respect your mother, she slaps you on the side of the head or something! Well it's the same thing with Mother Nature. If you don't respect what she gives to you, the signs that she gives to you, like the weather, the water currents, or whatever, something bad's gonna happen" (Aya, 2011). George Noongwook of Savoonga puts it this way: "We cannot change nature, our past, and other people for that matter, but we can control our own thoughts and actions and participate in global efforts to cope with these global climate changes. That I think is the most empowering thing we can do as individuals" (Krupnik and Jolly, 2002, p. 189).

Whether one agrees strictly with scientists who blame human use of fossil fuels, or Alaska Native oral tradition that cites inappropriate behaviors between people and the natural world, or some combination of the two, one thing is clear: "Climate change is already here … Everything that is impacted from another outside source it impacts us too. It's just like if somebody threw a rock into a pond, the ripples expand and expand, and it hits everybody" (Aya, 2011).

References

Aya, Jeanette L. (2011). *2011: Message to the World. Stories About Adaptation and Subsistence: Native Voices from the Frontlines of Climate Change.* Aksik. Accessed from: http://aksik.org/village/savoonga.

Fienup-Riordan, Ann. (1994). *Boundaries and Passages: Rule and Ritual in Yup'ik Eskimo Oral Tradition*. Norman and London, University of Oklahoma Press.

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Kawagley, Angayuqaq Oscar. (2006). *A Yupiaq Worldview: A Pathway to Ecology and Spirit*. Long Grove: Waveland Press.

Krupnik, Igor, and Daynna Jolly. (2002). *The Earth is Faster Now: Indigenous Observations of Arctic Environmental Change*. Arctic Research Consortium of the United States and Smithsonian Institution Presses.

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Unit Vocabulary

Science Terms to Define	
permafrost	Soil that has remained frozen year-round for at least two years
active layer	The layer of soil that freezes and thaws annually -- In cold regions, this layer lies on top of permafrost
polygonal ground	A honeycomb pattern that forms on the surface of the tundra as connected ice wedges push the soil above them upward
ice wedge	An inverted triangular prism (wedge) of ice that forms when water seeps into a crack in the ground and freezes

Terms for Incorporating Local Indigenous Language				
English	**Iñupiaq**	**Yup'ik**	**Siberian Yupik**	**Local Translation**
permafrost	attani	napat ngeliit	kumlaneq	
ice	siku	ciku	siku	
lake	narvak	nunvaq	naayvaq	
ground	nuna	cailkag	nuna	

Activity MS.4.1: 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 thawing permafrost is changing the local landscape

Alaska Standards

Alaska Science Standards / Grade Level Expectations

[6-8] SA1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, inferring, and communicating.

[6] SA3.1 The student demonstrates an understanding that interactions with the environment provide an opportunity for understanding scientific concepts by 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]SD1.2 The student demonstrates an understanding of geochemical cycles by explaining the water cycle's connection to changes in the Earth's surface.

[8]SD1.2 The student demonstrates an understanding of geochemical cycles by applying knowledge of the water cycle to explain changes in the Earth's surface.

Alaska Cultural Standards

[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

6.9G: Understand how ecosystems change over time. (SF)

7.3B: Understand that wind, water (in different states) and gravity change the surface of the earth. (SD1.2, SD2.3)

7.9B: Apply knowledge of the water cycle to explain changes on the earth's surface. (SD1.2)

Materials

- *Thawing Permafrost* Middle School Student Guide
- Student Worksheet: *Ask an Expert about Permafrost Thaw*
- 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 nearby lakes and ponds are used by themselves or the community, as well as any changes they have noticed to the lakes or ponds. 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 *Thawing Permafrost* student guide and ask students to work with a partner to read pages 1-5.
2. Show the video, *Permafrost Thaw*, 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. Ask students how the community uses nearby lakes (subsistence, recreation and transportation themes may arise). Explain that students will interview a few community members about this topic.

4. 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.
5. Review expectations for student behavior while conducting the interview, including introductions and thanking the interviewee at the end of the interview. assigned interviewees Discuss suggestions for effective interviewing techniques, such as allowing ample time for the interviewee to answer, and asking follow-up questions.
6. Distribute one Student Worksheet: Ask an Expert about Permafrost Thaw 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.
7. Reconvene in the classroom and ask groups to share their findings. How are local lakes used? How are they changing? What impacts might current or future changes have on local lifestyles?

Student Worksheet: Ask an Expert about Permafrost Thaw

Names of Group Members _____

_____

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

Who did you interview? _____

Ask:

How do people in our community use nearby lakes and ponds?

Are nearby lakes and ponds changing? If so, how?

How are current changes to lakes and ponds impacting our community? If the lakes and ponds have not changed, how might future loss of lakes due to permafrost thaw impact our community?

For Alaska Native Language Speakers

What language(s) do you speak? _____

What dialect(s)?_____

Could you please translate the following words?

Permafrost _____

Ice _____

Lake _____

Ground _____

Activity MS.4.2: Permafrost Vocabulary

What terminology do we need to know to discuss permafrost-related lake loss?

Overview

In this activity, students will learn key permafrost 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 permafrost and lake loss in their region

Alaska Standards

Alaska Science Standards/Grade Level Expectations:

[7]SD1.2 The student demonstrates an understanding of geochemical cycles by explaining the water cycle's connection to changes in the Earth's surface.

[8]SD1.2 The student demonstrates an understanding of geochemical cycles by applying knowledge of the water cycle to explain changes in the Earth's surface.

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.

[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:

[E2] understand the ecology and geography of the bioregion they inhabit.

Bering Strait School District Scope & Sequence

7.3B: Understand that wind, water (in different states) and gravity change the surface of the earth. (SD1.2, SD2.3)

7.9B: Apply knowledge of the water cycle to explain changes on the earth's surface. (SD1.2)

Materials

- *Thawing Permafrost* Middle School Student Guide
- Vocabulary card sets (1 set per group of 4-6 students)
- Dry erase markers (1 per group)
- Student Information Sheet: *Word Games Instructions* (1 per group)
- Student Worksheet: *Permafrost Thaw Vocabulary* (1 per student)
- Timers (optional)

Additional Resources

- 2012 Glencoe / McGraw Hill Earth Science textbook, Chapter 14

Activity Preparations

1. If your students completed Activity MS.4.1 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
			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/.

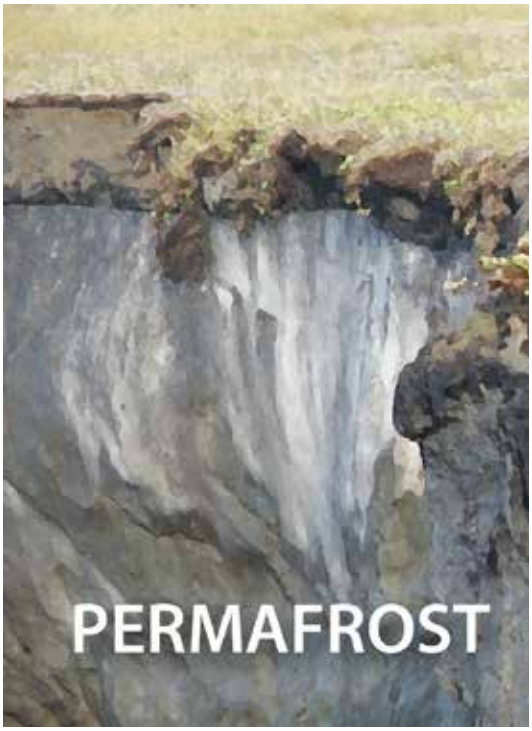
3. Keep in mind that different individuals may translate certain terms differently. For example, "frozen ground" and "ground that is frozen" will both work when communicating about "permafrost". It's fine to have different student groups working with various translations, or you can choose a set list 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.

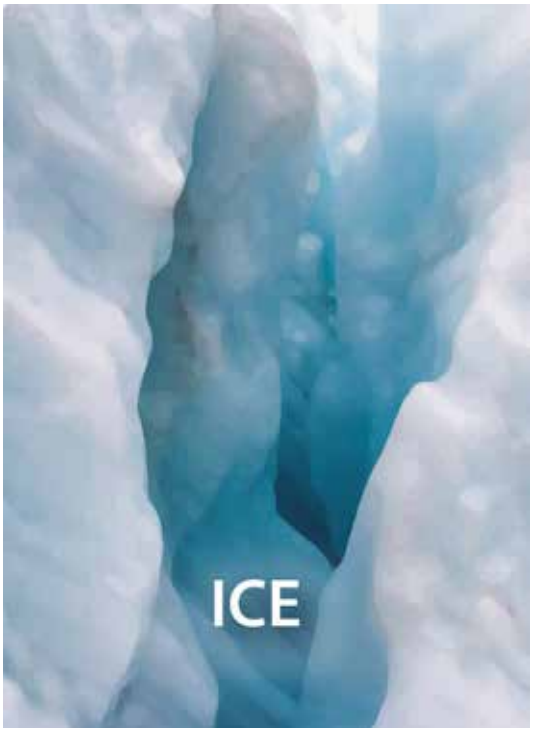
5. Make copies of the Word Games Instruction Sheet (one per group) and the Permafrost Vocabulary worksheet (one per student).

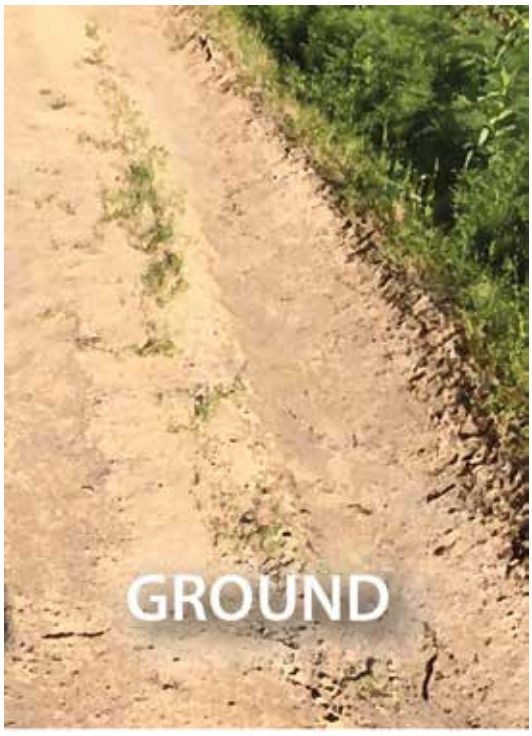
Activity Procedure

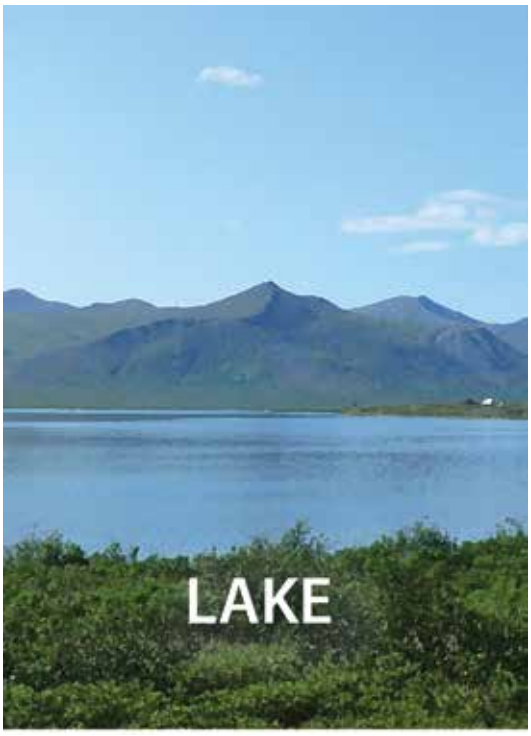
1. Distribute the *Permafrost Thaw* Student Guide and review pages 1-5.
2. Show students the vocabulary cards. Hold up each card. Discuss what each card depicts. How do these terms relate to soil in their region?
3. Say the English and local Alaska Native Language word for the illustration depicted on 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 Permafrost Thaw unit. If possible, schedule 10-15 minutes twice per week to practice the vocabulary terms.
9. Write the following terms on the board: permafrost, active layer, polygonal ground, and ice wedge. Ask students to share definitions for these terms. Refer back to the Thawing Permafrost Student Guide as necessary.
10. Distribute the Permafrost Thaw Vocabulary Worksheet and ask students to complete it. Provide review as needed.

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 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 each correct Alaska Native Language word.
5. Repeat until all cards are gone. The team with the most points wins.

Student Worksheet: Permafrost Thaw Vocabulary

Name _____

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

Active layer	An inverted triangular prism (wedge) of ice that forms when water seeps into a crack in the ground and freezes.
Ice wedge	Soil that has remained frozen year-round for at least two years
Polygonal ground	A honeycomb pattern that forms on the surface of the tundra as connected ice wedges push the soil above them upward.
Permafrost	The layer of soil that freezes and thaws annually. In cold regions, this layer lies on top of permafrost.

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

My Community:_____

English Word	*Local Alaska Native Lanuage Word*	*Illustration*
Ground		
Ice		
Lake		
Permafrost		

Answer Key: Permafrost Thaw Vocabulary

1)

Active layer	An inverted triangular prism (wedge) of ice that forms when water seeps into a crack in the ground and freezes.
Ice wedge	Soil that has remained frozen year-round for at least two years
Polygonal ground	A honeycomb pattern that forms on the surface of the tundra as connected ice wedges push the soil above them upward.
Permafrost	The layer of soil that freezes and thaws annually. In cold regions, this layer lies on top of permafrost.

2)

My Community:_____

English Word	*Local Alaska Native Lanuage Word*	*Illustration*
Ground	Answers will vary depending on language and dialect spoken in this community	Sketch should illustrate word at left
Ice	Answers will vary depending on language and dialect spoken in this community	Sketch should illustrate word at left
Lake	Answers will vary depending on language and dialect spoken in this community	Sketch should illustrate word at left
Permafrost	Answers will vary depending on language and dialect spoken in this community	Sketch should illustrate word at left

Activity MS.4.3: Measure Lake Loss

Overview

In this lesson, students will explore how thawing permafrost affects northern landscapes by examining Alaska lakes.

Objectives

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

- describe the changes in thaw lakes when the permafrost around and underneath them thaws
- measure and compare the surface area of a pond that is draining

Next Generation Science Standards

Standards by Disciplinary Core Ideas: Earth's Systems

Standards by Topic:

Earth's Systems

History of Earth

Performance Expectations

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

MS-ESS2-2: Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and special scales.

Dimention:

Science & Engineering Practices

Constructing Explanations and Designing Solutions

Disciplinary Core Ideas

ESS2.A: Earth Materials and Systems

- The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future. (MS-ESS2-2)

ESS2.C: The Roles of Water in Earth's Surface Processes

- Water's movements—both on the land and underground—cause weathering and erosion, which change the land's surface features and create underground formations. (MS-ESS2-2)

- Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land. (MS-ESS2-4)

Crosscutting Concepts

Cause and Effect
Energy and Matter

Alaska Standards

Alaska Science Standards / Grade Level Expectations

[6-8] SA1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, inferring, and communicating.

[6] SA3.1 The student demonstrates an understanding that interactions with the environment provide an opportunity for understanding scientific concepts by 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]SD1.2 The student demonstrates an understanding of geochemical cycles by explaining the water cycle's connection to changes in the Earth's surface

[8]SD1.2 The student demonstrates an understanding of geochemical cycles by applying knowledge of the water cycle to explain changes in the Earth's surface

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:

[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. (SF)

7.3B Understand that wind, water (in different states) and gravity change the surface of the earth. (SD1.2, SD2.3)

7.9B Apply knowledge of the water cycle to explain changes on the earth's surface. (SD1.2)

Materials

- *Thawing Permafrost* Middle School Student Guide
- Visual Aid #1 and #2

- Student Worksheet: *No-Name Pond*
- Transparency sheet with grid marks (one per student)
- Markers for transparencies (Vis-a-Vis) (two per student)
- Internet access and projector
- Meter stick (optional)

Activity Preparations

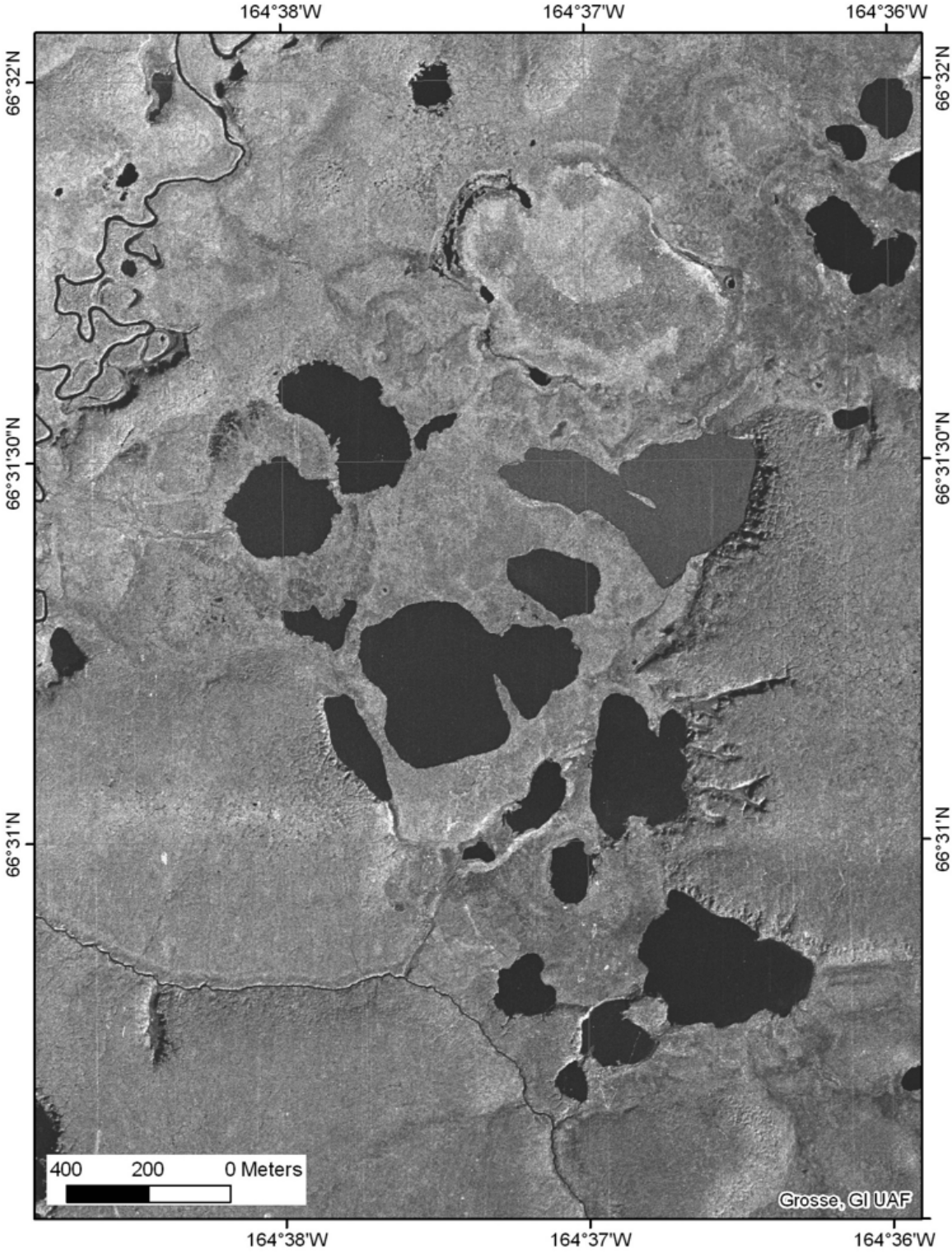
1. Make transparency sheets of the grid. A template is provided. The answer key is based on a grid of three lines per inch. You can generate your own grid paper at http://incompetech.com/graphpaper/, however if the scale is changed, the answer key will no longer be accurate and calculations will need to be redone.

Activity Procedure

1. Distribute the *Thawing Permafrost* student guide. Review the information on pages 1-5. Then ask students to work with a partner to read pages 6-7. Discuss the information on pages 6-7 as a class.
2. Show the overheads: an aerial photo from 1951 and an aerial image of the same area from 2006.
3. Ask students to point out five areas that seem to have expanded between 1951 and 2006. Do expanding lakes represent the early, or late stages of permafrost thaw? Why? *(Lake growth occurs in the earlier stages. When a lake forms, the permafrost begins to thaw and extends the lake basin, sometimes merging with other nearby lakes.)*
4. Point out the two lakes in the lower half of the image that appear to be draining. Is a drained lakebed older or younger than lakes with shallow water? *(Students can assume a drained lakebed is older than a lake that still has water. The shallow lake will likely drain too, but is not as far along as the dry bed.)*
5. Distribute the Student Worksheet: No-Name Pond. To get a sense of the scale used on the grid, have students measure the area of the classroom, then ask them to imagine an area 10 meters x 10 meters.
6. Hand out transparency grids and markers. Introduce the activity and explain how to use the transparency to find the surface area of the ponds.
7. When students are finished with the worksheet, ask if they think this lake disappeared slowly or quickly. Point out that the change occurred over the span of only 29 years. Discuss the impact rapidly thawing permafrost and draining lakes have on the ecosystem. Why is permafrost thawing more rapidly?

Visual Aid #1

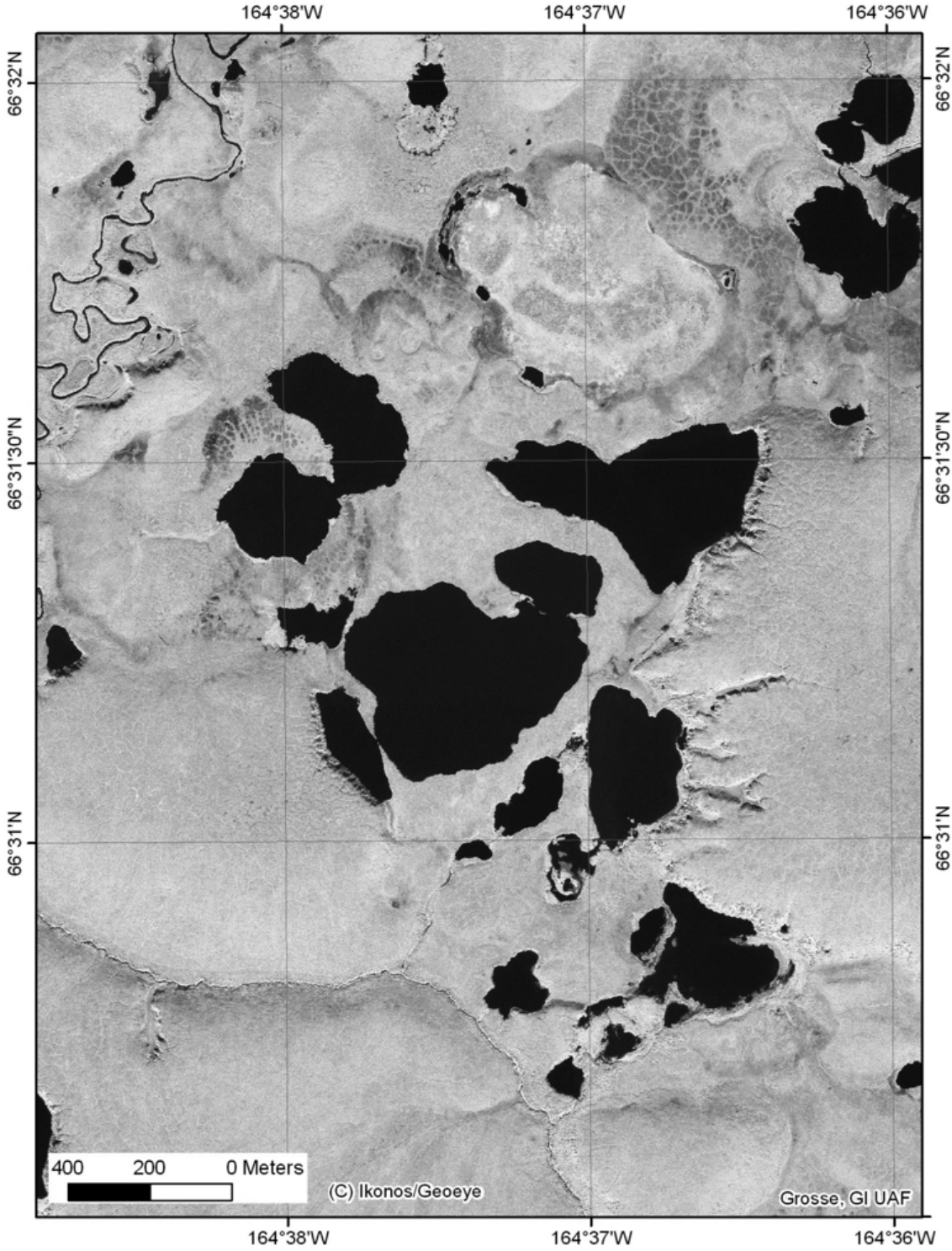
This 1951 aerial photograph shows a series of lakes located on the Seward Peninsula.



Photos courtesy of Dave Verbyla, Professor of GIS/Remote Sensing, Department of Forest Sciences, School of Natural Resources, University of Alaska Fairbanks.

Visual Aid #2

This 2006 aerial photograph shows the same series of lakes, located on the Seward Peninsula, shown on page one.



Photos courtesy of Dave Verbyla, Professor of GIS/Remote Sensing, Department of Forest Sciences, School of Natural Resources, University of Alaska Fairbanks.

Student Worksheet — No Name Pond

Name _____

Directions

Find the approximate surface area of No-Name Pond in 1980 and in 2009, then calculate the difference. Note the key to the right, then follow the steps below to find the answer. Always include the unit of measure in your calculations.

1. **Using a transparency grid overlay** and a marker, carefully trace No-Name Pond – 1980, onto the top half of the grid. On the bottom half, do the same for No- Name Pond – 2009.
2. **Finding *i*:** It is easiest to find the area of an irregular shape by first dividing it into measurable units.

   On your transparency, locate all the squares that are fully within the boundaries of each pond's outline and fill them in, as shown in this example:

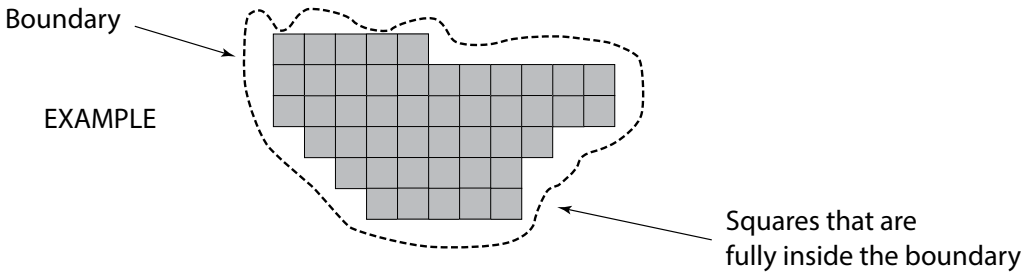
Each grid square represents 10 meters by 10 meters.

i = interior area

p = perimeter area

m - meter

m^2 - square meter



How many interior squares are there?

a. 1980: _____ squares b. 2009: _____ squares

The interior area for No-Name Pond would be:

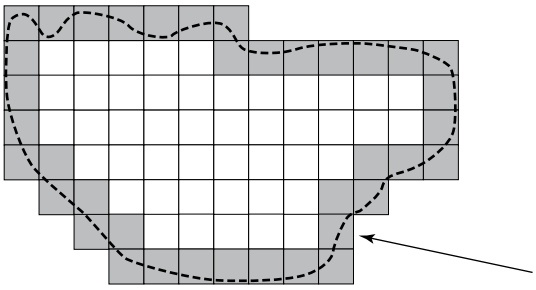
c. 1980: _____ m^2 d. 2009: _____ m^2

These quantities represent *i*, needed in Step 4.

3. **Finding *p*:** In order to find the area of the remaining irregular pieces, mathematicians assume that some grid units are almost full, some half full, and some mostly empty—the average being half. In the formula to find the area (Step 3) you will calculate ½ *p*.

   Mark each perimeter square that contains a portion of the pond boundary, as in the example below:

EXAMPLE



How many perimeter squares are there?

a. 1980: _____ squares b. 2009: _____ squares

The additional surface area for No-Name Pond would be:

c. 1980: _____ m^2 d. 2009: _____ m^2

These quantities represent *p*, needed in Step 4.

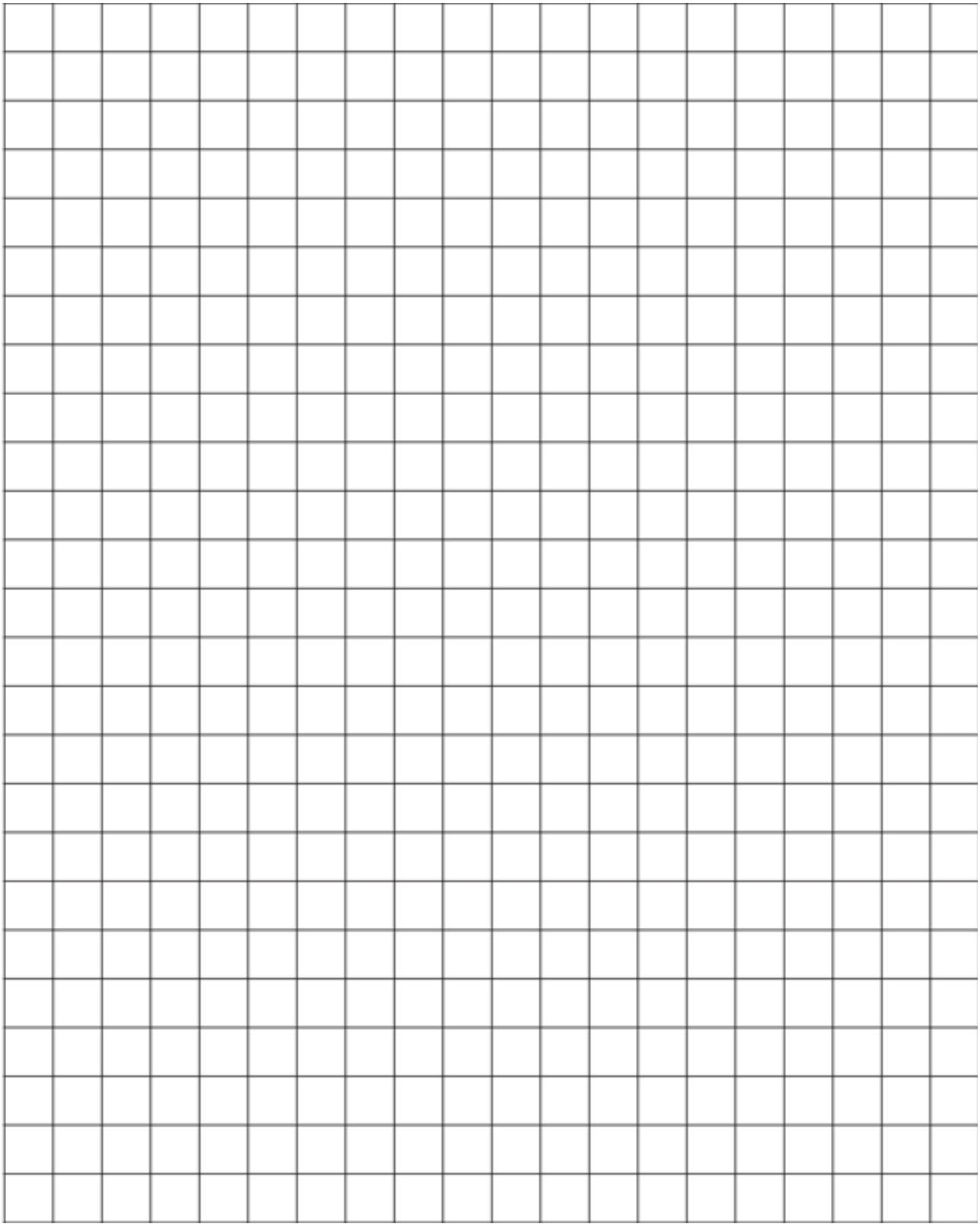
4. Calculate the total estimated surface area for the pond in 1980 and in 2009. To do so, use the following formula:

$$A=i+1/2p$$

   a. Estimated surface area 1980: _____ m^2
   b. Estimated surface area 2009: _____ m^2

Discuss:

Find the difference in surface area between 1980 and 2009. How much did the lake shrink? How might this have affected the surrounding ecosystem? How might this have affected nearby communities?



Answer Key: No-Name Pond

NOTE: This answer key is a guide. It is based on the template grid, with three squares per inch. Student answers may vary according to the placement of the grid and the number of full and partial squares counted.

1. **Using a transparency grid overlay** and a marker, carefully trace No-Name Pond – 1980, onto the top half of the grid. On the bottom half, do the same for No- Name Pond – 2009.
2. **Finding *i*:** It is easiest to find the area of an irregular shape by first dividing it into measurable units. On your transparency, locate all the squares that are fully within the boundaries of each pond's outline and fill them in, as shown in this example.

How many interior squares are there?

a. 1980: 54 squares b. 3 squares

The interior area for No-Name Pond would be:

c. 1980 4,500 m^2 d. 2009: 300 m^2

These quantities represent i, needed in Step 4.

3. **Finding *p*:** In order to find the area of the remaining irregular pieces, mathematicians assume that some grid units are almost full, some half full, and some mostly empty—the average being half. In the formula to find the area (Step 4) you will calculate ½ *p*. Mark each perimeter square that contains a portion of the pond boundary, as in the example below:

How many perimeter squares are there?

a. 1980: 27 squares b. 2009: 4 squares

The additional surface area for No-Name Pond would be:

c. 1980: 2,700 m^2 d. 2009: 400 m^2

These quantities represent p, needed in Step 4.

4. Calculate the total estimated surface area for the pond in 1980 and in 2009. To do so, use the following formula:

$$A = i + 1/2p$$

a. Estimated surface area 1980: 6,750 m^2

5,400 + 2,700/2 = 6,750

b. Estimated surface area 2009: 500 m^2

300 + 400/2 = 500

Discuss:

Find the difference in surface area between 1980 and 2009. How much did the lake shrink? How might this have affected the surrounding ecosystem? How might this have affected nearby communities? (community?)

Sample Answer: 6,750 – 500 = 6,250 m^2. The lake shrank by 6,250 m^2. Back in 1980, migrating birds may have stopped at No-Name Pond, and used it as their breeding grounds. Now the lake is so small, the migrating birds have probably found a different lake. Now the people in the nearby community have to travel farther to hunt birds.