THE CASE OF THE DISAPPEARING LAKES

Overview:

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

Objectives:

The student will:
- discuss the potential impact of drying lakes on both subsistence hunting and wildlife habitat;
- use aerial photography and satellite imagery to identify areas of lake expansion and shrinkage; and
- measure and compare the past and present surface area of a pond that is draining.

Targeted Alaska Grade Level Expectations:

Science

[9] 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.

[10] SA1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, analyzing data, developing models, inferring, and communicating.

[10] SE1.1 The student demonstrates an understanding of how to integrate scientific knowledge and technology to address problems by identifying that progress in science and invention is highly interrelated to what else is happening in society.

[10] SE2.1 The student demonstrates an understanding that solving problems involves different ways of thinking by questioning, researching, modeling, simulating, and testing multiple solutions to a problem.

[9] SG3.1 The student demonstrates an understanding that scientific knowledge is ongoing and subject to change by describing the role of serendipity in scientific discoveries.

[9] 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.

[10] SD1.2 The student demonstrates an understanding of geochemical cycles by describing their interrelationships (i.e., water cycle, carbon cycle, oxygen cycle).

[9-11] SD2.1 The student demonstrates an understanding of the forces that shape Earth by recognizing the dynamic interaction of erosion and deposition including human causes.

Vocabulary:

beaded stream – a stream characterized by narrow reaches linking pools or small lakes

ecology – the scientific study of the relationship between living things and their environments; a system of such relationship

habitat – the area or natural environment in which a living thing resides, such as a desert, coral reef, or freshwater lake

hydrology – the scientific study of the properties, distribution, and effects of water on Earth's surface, in the soil and underlying rocks, and in the atmosphere

permafrost – a thick subsurface layer of ground (soil or rock, and including ice and organic material) that remains below freezing point (0˚C or 32˚F) for at least two consecutive years

thermokarst lake – a lake occupying a closed depression formed by settlement of the ground following thawing of ice-rich permafrost or the melting of massive ice

THE CASE OF THE DISAPPEARING LAKES

Language Links:

Alaska Native people have always been careful observers of the environment. Their languages are rich in words that describe their environment. Ask a local Native language speaker to provide the words in the local dialect for the vocabulary listed in the chart below. The local dialect for these words may differ from the examples provided. Share the words with students to build fluency in local terms. Include local words in songs, stories and games when possible.

Bilingual Vocabulary

English	Gwich'in	Denaakk'e	Lower Tanana	Deg Xinag	Your Language
Water	Chuu	Too	Tu	Te	
Melt/ It's melting	Naaghwan/ neeyahkhwaii	Ghaan	Ghan	Ntidlighanh	
Ice	Łuu	Ten	Tenh	Tinh	
Lake	Van	Benh	Ben	Vinq'it	
Pond	Teełtin	Todaatltonh	Todatltonh		

Whole Picture:

The Athabascan people in Interior Alaska have noticed for many decades that lakes are shrinking and drying up. This has reduced the population of animals like the muskrat and the beaver because they cannot live in lakes that freeze to the bottom in winter. The meat of the beaver and the muskrat are important subsistence food, and the fur is a valuable resource, too. Some lake fish populations have dropped, as well, because of low water level. Fish, too, are an important subsistence food.

Much of the change seen by the people of the Interior is seen as climate change. The average temperature of Alaska has risen approximately 4 degrees Fahrenheit over the last five decades. Warming contributes to a cycle of change. Increasing air temperature contributes to thawing permafrost. When permafrost thaws, the hydrology of the region changes.

Permafrost stores water in its frozen state and keeps it from moving through the water cycle. Like bedrock, permafrost also acts as a barrier, preventing water from percolating very far through the ground. Water kept close to the surface can form lakes and ponds, be taken up by plants and released through transpiration, or evaporate directly into the atmosphere.

A significant indicator of permafrost thaw can be seen on Earth's surface by looking at changes in lakes and ponds. One indicator of thaw is when a body of water shows growth. As thaw close to the ground surface occurs, the bank of the pond (or lake) erodes and the surface area of the water becomes larger. The pond remains until deeper permafrost thaws, then the pond will very likely begin to shrink. As frozen soil thaws, it allows water to percolate further through the now-permeable soil, draining lakes and ponds similar to the way a bathtub empties when the drain is unplugged. Water normally harbored above the frozen layer begins to percolate down through the now-permeable soil.

Glaciers also harbor water in its frozen state and keep it from cycling through the water cycle. Glaciers are large rivers of ice formed over many years from packed snow in areas where snow accumulates faster than it melts. A glacier is always moving, but when its forward edge melts faster than the ice behind it advances, the glacier as a whole shrinks backwards.

The consequences of shrinking and disappearing lakes is hard to quantify, but scientists speculate that drying ground will lead to dramatic changes in the ecosystem. Wetlands are critical habitat for millions of migratory waterfowl as well as for moose and beaver. Critters like muskrat depend on water year-round; even in winter they rely on water under the ice for survival. Shallow lakes may freeze to the bottom, impacting muskrat populations.

Materials:

- VIDEO (Audio): "Arctic Lakes Shrink, Disappear"

THE CASE OF THE DISAPPEARING LAKES

- Transparency sheet with grid marks four lines per inch* (one per student)
- Black, fine-point, wet-erase, Vis-à-vis transparency marker (one per student)
- Red, fine-point permanent marker (one per student)
- VISUAL AID: "Alaska…Land of Millions of Lakes!"
- STUDENT INFORMATION SHEET: "Cache 'Menhti'"
- STUDENT INFORMATION SHEET: "Thaw Lakes"
- STUDENT WORKSHEET: "Growing, Growing…Gone!"
- STUDENT WORKSHEET: "No-Name Pond"
- STUDENT INFORMATION SHEET: "Arctic Lakes Shrink, Disappear" Radio Script from Arctic Science Journeys

*NOTE: A template has been provided so you can make your own transparencies. 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 Preparation:

Using the graph paper template provided, make one grid transparencies per student.

Activity Procedure:

1. Hand out STUDENT INFORMATION SHEET: "Cache Menhti." Explain "Menhti" means "among the lakes." Read through the sheet and discuss. Elders in Minto have noticed lakes and ponds around Minto Flats are changing. What could this mean for the people of Minto and their way of life? What would happen if the water disappeared?
2. Hand out STUDENT INFORMATION SHEET: "Arctic Lakes Shrink, Disappear" Radio Script from Arctic Science Journeys. Ask students to follow along as they listen to the audio version found linked along with this lesson PDF. For visual effect, display page one of VISUAL AID: "Alaska…Land of Millions of Lakes!" while students listen. When the audio file is finished, discuss. Use the following questions as discussion starters, if needed:
    a. What seems to be the trend for lakes in Alaska?
    b. What do scientists think might be causing lakes to shrink?
    c. What lies beneath many of the lakes in the north?
    d. What are some of the impacts of drying lakes?
    e. How do you think this might impact the hydrology of the Arctic, including the water cycle?
3. Hand out STUDENT INFORMATION SHEET: "Thaw Lakes" and STUDENT WORKSHEET: "Growing, Growing… Gone!" Ask students to read through the information sheets. While students are reading, display VISUAL AID: "Alaska…Land of Millions of Lakes!" page two. Ask students to examine both the 1951 and 2006 aerial photo of an area on the Seward Peninsula. Ask students what they notice. Students should indicate that the lakes are getting bigger. Ask students why the lakes are growing. Discuss. Point out the visual aid, which corresponds to the article, "The Orderly Orientation of Lakes." Discuss. Allow students time to complete STUDENT WORKSHEET: "Growing, Growing…Gone!" Circulate as students work to help point out expanding lakes, shrinking lakes and the old lakebed.
4. Hand out STUDENT WORKSHEET: "No-Name Pond," transparency sheets with grid marks, and black Vis-à-vis transparency marker. Explain the directions. When students are filling in grid squares fully inside the pond boundary, they may question squares that are almost full. Tell students these can be counted as full. When students are counting partial grid squares, they may question squares that are barely touched by the pen. Students should not count those squares. The answer key shows the approximate numbers of full and partial squares students should note and acts as a guide. Allow students time to complete the work.

Ideas for Filming:

NOTE: Students will complete a short film about permafrost for the final project associated with this UNITE US unit. Each lesson leading to the final project contains ideas about what students might film as they compile clips. Students are not limited to the list and are encouraged to use their imagination and creativity when filming.

THE CASE OF THE DISAPPEARING LAKES

If there is a thaw lake nearby, students could film the lake and narrate by explaining what kind of animals live nearby and rely on the lake, the importance of the lake to community members, and what would happen if the lake was to dry up. If there are no thaw lakes nearby, students can insert a still picture of a thaw lake and narrate over it.

Students could also put water in a sink (with a plug) then allow it to drain while talking about what happens to area lakes when the permafrost underneath thaws.

Answers:

STUDENT WORKSHEET: Growing, Growing…Gone!

1. Answers will vary, but students should circle areas where there has been obvious expansion. Teacher's discretion is required.
2. Lake growth occurs in the earlier stages of lake degradation. When a lake forms, the permafrost begins to thaw and extends the lake basin, sometimes merging with other nearby lakes.
3. Check photos for appropriate placement of red star.
4. Check photos for appropriate placement of red check marks.
5. 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.
6. Answers will vary, but should indicate that Carson was curious about a pattern he saw in the thaw lakes and wanted to find out what caused it.
7. Any two of the following: glaciers, the sun melted the south-facing bank causing erosion (peat to fall in), melt water filled in cracks in the ground, ice bashing into the shoreline
8. Wind currents stir the surface of the lakes and created eddies that produced larger waves on the sides of the lake at right angles to the wind.
9. The wind patterns further south are different.

STUDENT WORKSHEET: No-Name Pond

NOTE: This answer key is a guide. It only corresponds to grid paper with four squares per inch (see attached PDF). Student answers may vary according to their placement of the grid and the number of full and partial squares they count. Answers should be very close, however.

1. a. Assuming students counted 54 full squares, 10 x 10 x 54 = 5,400 square meters
   b. Assuming students counted 3 full squares, 10 x 10 x 3 = 300 square meters
2. a. ± 27; b. ± 4
   c. Assuming students counted 27, 10 x 10 x 27 = 2,700 square meters
   d. Assuming students counted 4, 10 x 10 x 4 = 400 square meters
3. a. A = 5,400 + 2,700/2 = 6,750 square meters; b. A = 300 + 400/2 = 500 square meters
4. a. 6,750 x 10.76 = 72,630 square feet; b. 500 x 10.76 = 5,380 square feet
5. a. 6,750 – 500 = 6,250 square meters; b. 72,630 – 5,380 = 67,250 square feet
6. 93% change/decrease

Additional Sources:

Science for Alaska Public Lecture Series, "Warmer Climate, Thawing Permafrost: What Will Happen to Alaska's Water?" by Larry Hinzman, UAF Water and Environmental Research Center

Climate Change – Boon or Bust for Northern Waters? http://www.climatechangenorth.ca/section-LP/LP_22_H_M_Jamie.html

ALASKA…LAND OF MILLIONS OF LAKES!

A photograph taken from the air reveals patterned ground surrounding thaw lakes in Alaska's Arctic National Wildlife Refuge. Photo courtesy U.S. Fish and Wildlife Service.

ALASKA…LAND OF MILLIONS OF LAKES!

Satellite imagery reveals lake orientation on Alaska's North Slope. Photo courtesy NASA.

CACHE "MENHTI"

The area known as Cache is an historic food gathering site for the people of Minto Village. The area has always had an abundance of fresh-water fish and waterfowl.

"Menhti" means "Among the Lakes."

Cache in the 1950s.
Photo courtesy of Chief Robert Charlie.

Cache as it is today.
Photo courtesy of the Alaska Native Knowledge Network and the Old Minto Mapping Project, Minto School

Cache

Chief Robert Charlie remembers staying at Cache as a kid in the 1930s when it was time for food gathering. "During these times of food gathering there was much laughter and many stories," he said.

By that time people were staying in wall tents, he said, but no matter the material, setting up camp was a way of life.

"For thousands of years the Minto Flats People used this site for a subsistence food gathering camp," Charlie said.

> "It was popular because it is at the confluence of two streams. The first is Minto Lakes Slough, which runs from two smaller sloughs fed with drainage from Murphy Dome and the big Minto Lake. The second is the Little Gold Stream Creek that runs from the Fox area. Both run into the Chatanika River.
>
> This food gathering happened twice a year. In the spring it was time for fresh-water fish and waterfowl. It was also prime time for muskrat hunting. In June it was time to start salmon fishing.
>
> In the fall the food-gathering activities focused on big game and small fresh-water fish like whitefish, pike, sucker fish, and grayling. More waterfowl was hunted, too. There would be up to 12 wall tents all along the bank, each with a small smoke cache in front. In the smoke cache would be fish, waterfowl, moose caribou, bear and many other dried foods. All kinds of berries would be stored in the many high caches.
>
> When the lakes and streams froze, that is when they would haul all the foodto the village."

Charlie noted to this day the area is still used for hunting and fishing.

THAW LAKES

Thaw lakes are the most common thermokarst feature. Such lakes usually begin when water pools in slight ground surface depressions, such as low-centered polygons. The underlying permafrost acts as a barrier similar to bedrock and prevents the water from percolating down, so the water is trapped.

That water retains heat so the permafrost beneath immediately begins to thaw. As thaw continues the lake basin extends and often merges with other adjacent lakes. Some thaw lakes are connected by stream channels and may form beaded streams.

As the thawing process continues, the lake can become compromised in a couple of ways. The banks may eventually give away completely, causing the lake to drain. The permafrost underneath may thaw, removing the barrier and allowing the water to drain throught the soil.

When the lake drains it leaves behind a scar of the former basin surrounded by the higher topography of the original tundra surface. Repeated formation and drainage of thaw lakes often creates an overlapping series of drained basins with only isolated ridges or platforms of the original surface remaining.

Thaw lakes are numerous in the Yukon Flats, Kanuti Flats, Koyukuk Flats, Yukon Delta, and north of the Tanana River near Minto.

The Orderly Orientation of Arctic Lakes

Alaska Science Forum Article #1353, September 4, 1997,
by Ned Rozell

Satellite imagery reveals lake orientation on Alaska's North Slope. Photo courtesy NASA.

This column is provided as a public service by the Geophysical Institute, University of Alaska Fairbanks, in cooperation with the UAF research community. Ned Rozell is a science writer at the institute.

My girlfriend stopped me last spring as we walked through a hallway in the Geophysical Institute's Elvey Building. She pointed to an aerial photograph of the North Slope near Prudhoe Bay. "Look at those lakes," she said. "They all point the same way."

I looked at the photograph, taken from a U2 surveillance plane. Sure enough, every lake in the photo was long, narrow, and pointed in the same general direction. Like dozens of salmon returning to their spawning stream, all of the blue and black lakes lined up northwest and southeast, parallel to each other.

Since the natural world doesn't often appear with such symmetry, I thought someone must have a hypothesis for the shared shape and orientation of the lakes. Someone did. The mystery intrigued Charles Carson so much that he earned his Ph.D. from Iowa State University in 1962 by exploring the orientation of the lakes.

Carson traveled to Barrow in the late 1950s and early 1960s and spent many hours on the treeless tundra examining the cigar-shaped lakes. He armed himself with speculations of other researchers who had also pondered the northwest-pointing lakes. One researcher said the sun was the driving factor; direct sunlight might soften up the frozen peat in the south-facing banks in the north end of the lakes, and the lakes might grow northward as the peat fell in. Another scientist said the lakes were the result of meltwater filling in cracks in the ground's surface that happened to occur in the pattern the lakes are oriented. Yet another theory was that strong winds elongate the lakes by bashing lake ice into the northwest or southeast shorelines.

Before making his own educated guess, Carson got to know the character of the lakes. From the soil sediments around the lake, he deduced they weren't formed by glaciers. He discovered the lakes are actually thaw basins, low areas in the tundra where water from melting snow and ice collect. Carson hypothesized how thaw basins grow: after snow melts and a puddle forms, the relatively warm water thaws the frozen ground below. In the fall, the water freezes and expands, shredding the vegetation beneath it. In following summers, the shredded tundra is moved around by winds, allowing the ground to thaw even further, and the lake to grow bigger. All of the lakes Carson studied were very shallow; even though the lakes could be several thousand feet long, most were no deeper than 10 feet.

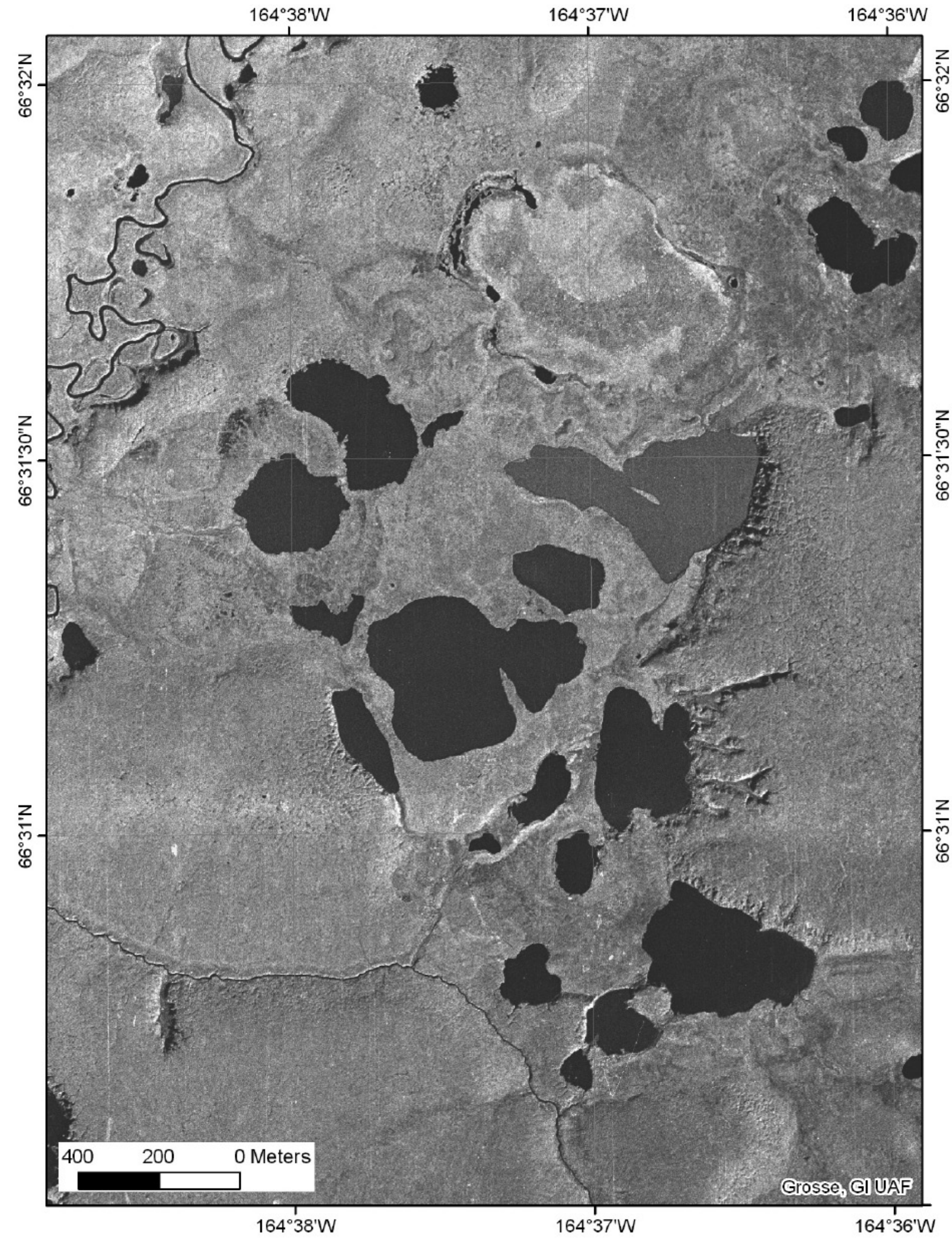
After the lakes formed, did the sun create their orderly appearance? Carson thought it was quite plausible that the south-facing banks at each lake's northern end could become mushy in the summer and dissolve into the lake, thereby extending the lake in a northward direction. To study the effects of the sun, Carson rigged up a set of copper plates that faced the sun in July and August, the only months when Carson figured it was warm enough in the Arctic for the lakes to grow. The copper plates absorbed a lot of heat on clear days, but it was almost always foggy during the thaw season. The clouds blocked enough solar radiation that Carson concluded direct sunlight has little to do with the way the lakes are oriented.

With the sun out of the lake-formation picture, Carson focused on a force he couldn't ignore-arctic winds. He measured winds that averaged 30 miles-per-hour at Ikroavik Lake near Barrow, with frequent gusts to 60 miles-per-hour. Oddly, the prevailing direction of the winds was northeast, perpendicular to the long lakes. Carson found a possible key to the crosswind mystery by measuring the currents the wind produced in the shallow lakes. When the wind stirred the surface of the lakes, it created eddies that produced larger waves on the sides of the lake at right angles to the wind. With that discovery, Carson came up with a hypothesis that the wind was indeed the shaper of the lakes: the waves caused by crosswinds struck the northwest and southeast shores, perhaps eating away at the peat more aggressively there and creating a pattern of elongation that all arctic lakes share.

NAME: ______________________________

GROWING, GROWING…GONE!

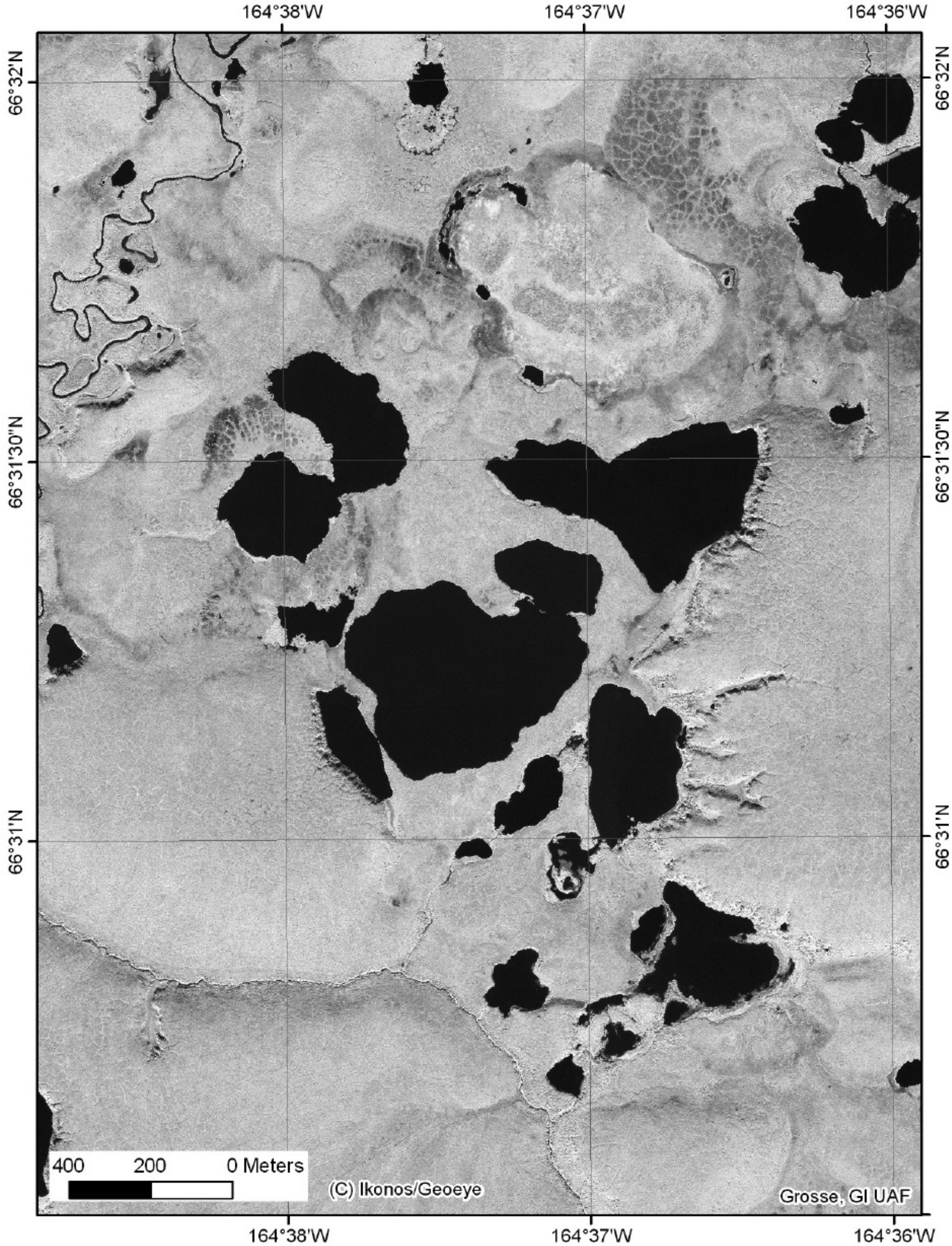
This 1951 aerial photograph shows a series of lakes located on the Seward Peninsula.



NAME: ______________________________

GROWING, GROWING…GONE!

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



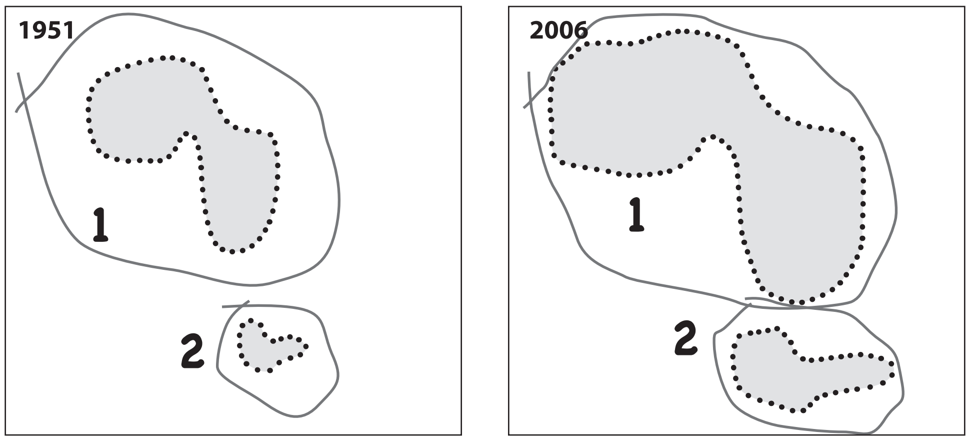
NAME: ____________________________

GROWING, GROWING…GONE!

Directions: Read STUDENT INFORMATION SHEET: Thaw Lakes. Compare the photo on page one of this worksheet with the photo on page two and complete the questions.

1. Examine the two photos side by side. Using a red pen, circle five areas that seem to have expanded between 1951 and 2006. Label each spot with a corresponding number on both photos.

EXAMPLE



2. Several of the lakes in the two aerial photographs appear to be growing. Would this represent the early stages or the later stages of lake degradation? Why?

____

____

____

3. Examine the two photos again. There appears to be an old lakebed in the upper half of the images. Place a red star by the drained lake (on both photos). ★

4. Comparing 1951 and 2006, there are two lakes in the lower half of the images that appear to be draining. Place a red check mark on each (on both photos). √

5. From what you have learned, would you assume a drained lakebed to be older or younger than lakes that have shallow water? Why?

____

____

____

6. Charles Carson earned his Ph.D. from Iowa State University researching the parallel orientation of thaw lakes on Alaska's North Slope. What do you think led him to pick this particular topic?

____

____

____

NAME: ______________________________

GROWING, GROWING…GONE!

7. Other scientists had speculated on the reason for the orientation of the thaw lakes. List two of the theories Carson DISPROVED about the cause of the parallel orientation.

   a. ____

   ____

   ____

   b. ____

   ____

   ____

8. What did Carson's research find CAUSES the parallel orientation of the thaw lakes?

   ____

   ____

   ____

   ____

9. Why do you think lakes further south do not take on the same orientation? ____________________

   ____

   ____

   ____

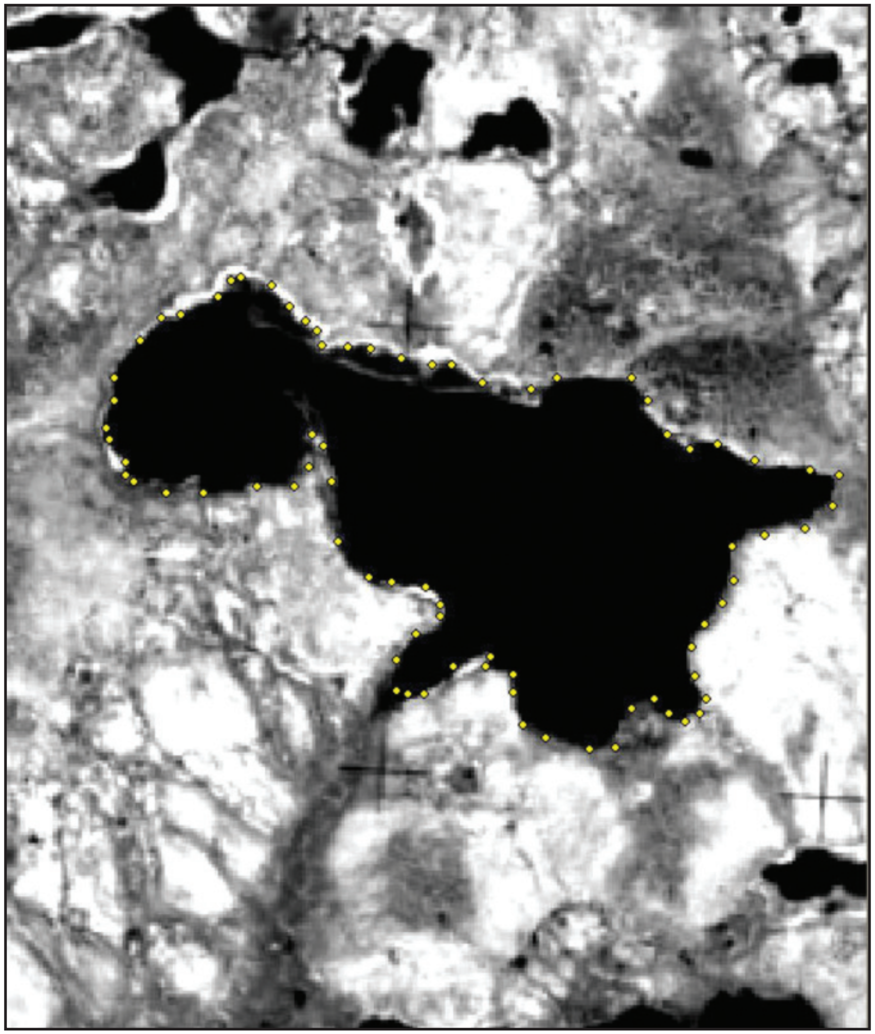
   ____

NAME: ____________________________

NO-NAME POND

This unnamed pond, located in Kobuk Valley National Park in northwest Alaska, is representative of tens of thousands of lakes and pond throughout the Arctic that are rapidly draining as the permafrost underneath thaws.

No-Name Pond 1980



No-Name Pond 2009

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

NAME: ______________________________

NO-NAME POND

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. Using a transparency grid overlay and a permanent 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.

Each grid square represents 10 meters by 10 meters.

i = interior area

p = perimeter area

m – meter

m²– square meter

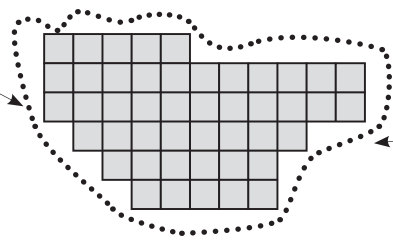
ft – feet

ft²– square feet

Finding i: It is easiest to find the area of an irregular shape by first dividing it into measurable units.

1. 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:

EXAMPLE



   a. What is the surface area of shaded squares for No-Name Pond – 1980? ____________ m^2

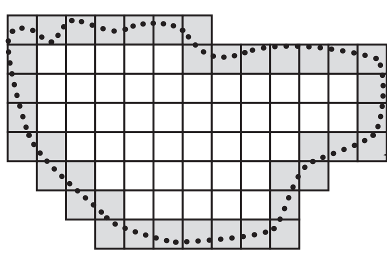
   b. What is the surface area of shaded squares for No-Name Pond – 2009? ____________ m^2

These quantities represent i, needed in Step 4.

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 $\frac{1}{2}p$.

2. 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: ________________ **m²**   d. 2009: ________________ **m²**

These quantities represent p, needed in Step 4.

NAME: ______________________________
NO-NAME POND

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

$$A = i + \tfrac{1}{2}\, p$$

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

4. Convert square meters to square feet. Use the following conversion and formula:

1 meter = 3.28 feet

$1\ m^2 = (3.28\ feet)^2 = 10.76\ ft^2$

   a. Estimated surface area 1980: _____________ ft^2
   b. Estimated surface area 2009: _____________ ft^2.

5. Find the difference in surface area between 1980 and 2009.

   Difference in area between 1980 and 2009:

   a. _____________ m^2 b. _____________ ft^2

6. Find the percentage change in surface area between 1980 and 2009. Round to the nearest whole number.

   Percentage change between 1980 and 2009: _________________

NAME: ______________________________

GRAPH PAPER

ARCTIC LAKES SHRINK, DISAPPEAR

ARCTIC Science Journeys Radio Script, 2005
Transcript from a NOAA Alaska Sea Grant College Program

Arctic Science Journeys is a radio service highlighting science, culture, and the environment of the circumpolar north. Produced by the Alaska Sea Grant College Program and the University of Alaska Fairbanks. The shortcut to our ASJ news home page is www.asjradio.org.

INTRO: Lakes and ponds across the Arctic are beginning to shrink, and some have disappeared altogether, as a warmer global climate dries out the northern landscape. Scientists say the loss of surface freshwater across the Arctic portends a dramatic ecological shift that could have long-term impacts on everything from subsistence to weather to ocean circulation.

STORY: Geography professor Laurence Smith from the University of California Los Angeles knew something strange was happening across the Arctic when he noticed Siberian rivers were carrying far more freshwater than usual.

All that freshwater had to be coming from somewhere. To solve the mystery, Smith compared satellite images of nearly 11,000 Siberian lakes in the early 1970s with images taken between 1997 and 2004.

In all, Smith says 1,170 lakes became smaller, shrinking a total of 359 square miles. And in just 30 years, 125 lakes had completely disappeared, and the lake beds are now covered by vegetation.

SMITH: “In the earth sciences world, this is a very rapid, dynamic change.”

Smith, together with scientists from the State University of New York and the University of Alaska Fairbanks, published their research in a recent issue of the journal Science. They say the lakes drained away after the frozen ground beneath them, called permafrost, thawed. UAF researcher Larry Hinzman.

HINZMAN: “Lakes in the southern region of permafrost are relatively thin. They are just lakes perched atop the permafrost, and if the permafrost thaws completely through, then they start to drain.”

Interestingly, lakes in northern Siberia actually gained in size. Smith says that’s because the permafrost beneath them is thicker and slower to thaw. In time, he says those lakes will shrink as well.

Lakes in Alaska also are shrinking as the underlying permafrost thaws. Researchers have documented lake declines in the Yukon Flats, the Seward Peninsula, and the Copper River region. And studies done two years ago by Canadian scientists found lakes there also have disappeared. Laurence Smith of UCLA says if the trend continues, the arctic landscape will look very different in coming decades.

SMITH: “With the river discharges that we have spoken of and now this study, the long-term impact is a shift from above-ground storage of water to below-ground storage of water.”

That shift would likely have cascading impacts on wildlife, the environment, the weather, and even Arctic Ocean circulation. Migratory birds, fish, and other wildlife important to Alaska’s Native subsistence users likely will be the first to feel the pinch as marshy habitat dries up. And with drier soils, Hinzman says the danger of forest fires will increase.

HINZMAN: “We get around Fairbanks something like 3,000 lightning strikes a day in the summer, but most don’t amount to anything. But if we have a lot drier soils, then we are going to see a lot more forest fires and more severe forest fires.”

And there may be other impacts—so much freshwater running off the land into the Arctic Ocean could alter the ocean food web, as well as change ocean circulation patterns that drive weather.

Thanks to the following individuals for help preparing this script:

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