Changing Landscapes

Thawing Permafrost

Middle School Guide

REACH Up

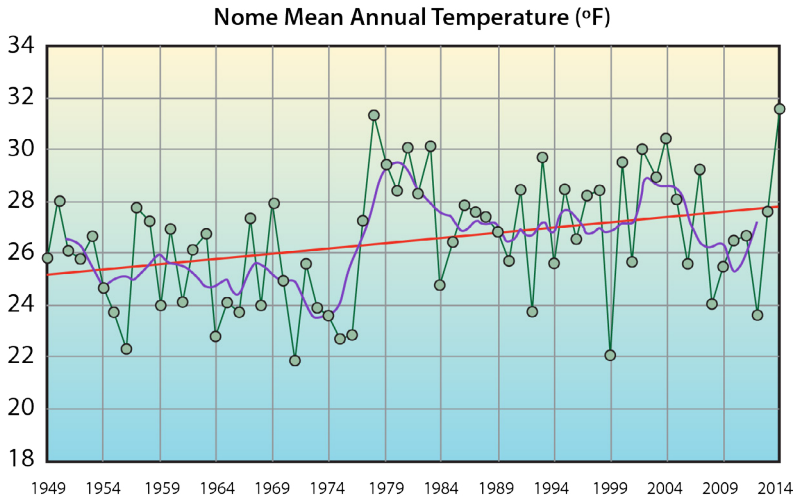
Raising Educational Achievement through Cultural Heritage Up

Changing Landscapes

How does climate change impact the landscape?

The climate in the Bering Strait region of western Alaska is warming. Increasing temperatures change the landscape in a variety of ways. Landscape changes impact local ecosystems and ways of life for local residents. What are these changes? What processes cause them? How do these changes impact Bering Strait communities?

Bering Strait, Alaska

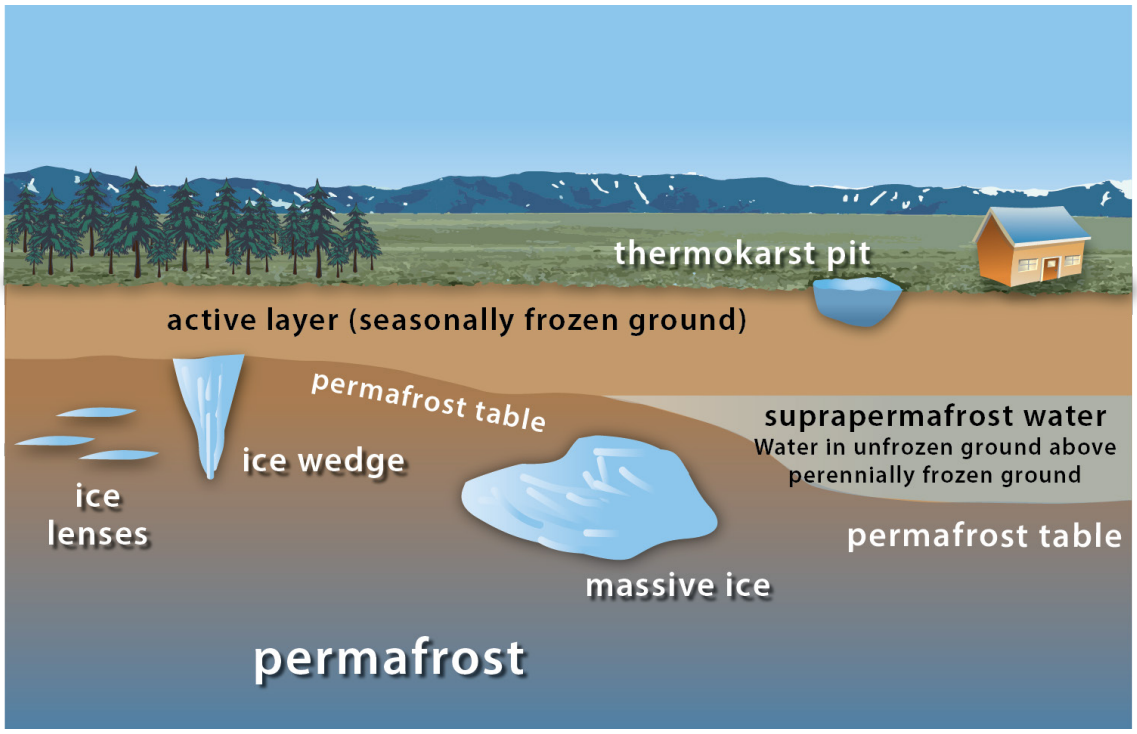


What is permafrost?

Permafrost is ground that has remained frozen for at least two years. As the climate warms, permafrost begins to thaw. This can cause changes to the landscape. Sinkholes form, lakes drain, and ground subsides.

Sinkhole filling with water from spring runoff. Photo courtesy of Vladimir Romanovsky

What will I find if I dig down to permafrost?



The ground surface that we walk on is not permafrost. This soil is known as the active layer. The active layer freezes during the winter and thaws during the summer. The thickness of the active layer depends on climate and ground cover. It can be a few inches or a few meters thick. Permafrost lies beneath this insulating active layer. If you were to extract a sample of permafrost, it would most likely look like dirt with tiny ice crystals in it. Some parts of your sample might be more ice than dirt.

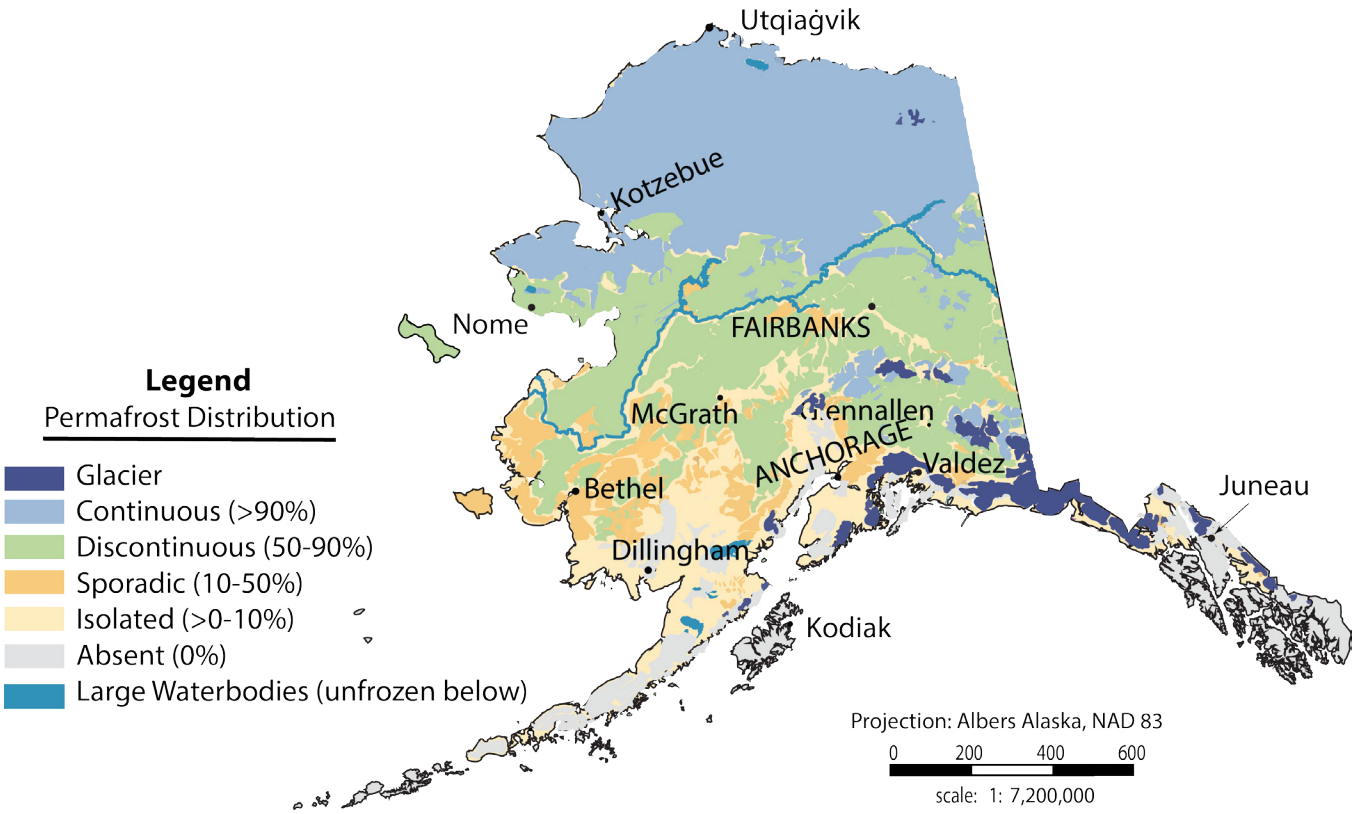
Sample of permafrost from Interior Alaska

Where is Alaska's permafrost?

Most of Alaska is underlain by permafrost that formed during the last ice age. Continuous permafrost stretches from the northern half of the Seward Peninsula to the North Slope of Alaska. This means that more than 90% of the ground surface in this area has permafrost beneath it. Discontinuous permafrost underlies St. Lawrence Island, most of the Norton Sound shoreline and a broad swath of Interior Alaska. Discontinuous describes regions where 50-90% of the ground surface has permafrost beneath.

Alaska's permafrost has begun to thaw in recent years. Warmer temperatures across the state mean that the active layer is no longer adequate insulation for the permafrost. Study the map below. What is the permafrost distribution in your community? What changes might occur if the permafrost around you thaws?

Permafrost Characteristics of Alaska



Based on Permafrost Characteristics of Alaska map. Jorgenson, et al.
http://permafrost.gi.alaska.edu/content/data-and-maps

Ask an Expert

1. Watch the video *Permafrost Thaw* available at www.k12reach.org/videos.php
2. Conduct your own interview with an elder or cultural knowledge bearer.

   Explain that you are learning about permafrost and how the landscape is changing as result of thawing permafrost. These changes can include lakes and ponds that are draining or expanding. Some questions you may want to ask:

   - How are lakes used for local subsistence or recreation?
   - What changes have you observed? Do you know of any lakes nearby that have dramatically shrunk or disappeared in your lifetime? Do you know of any lakes that have dramatically increased in size?
   - How have the changes in lakes affected traditional uses?

3. If the person you interview speaks an Alaska Native language, ask them what language and dialect(s) they are familiar with. Ask them to please translate the following words:
   - Permafrost
   - Ice
   - Lake
   - Ground

Compare your words with other translations found on the following page.

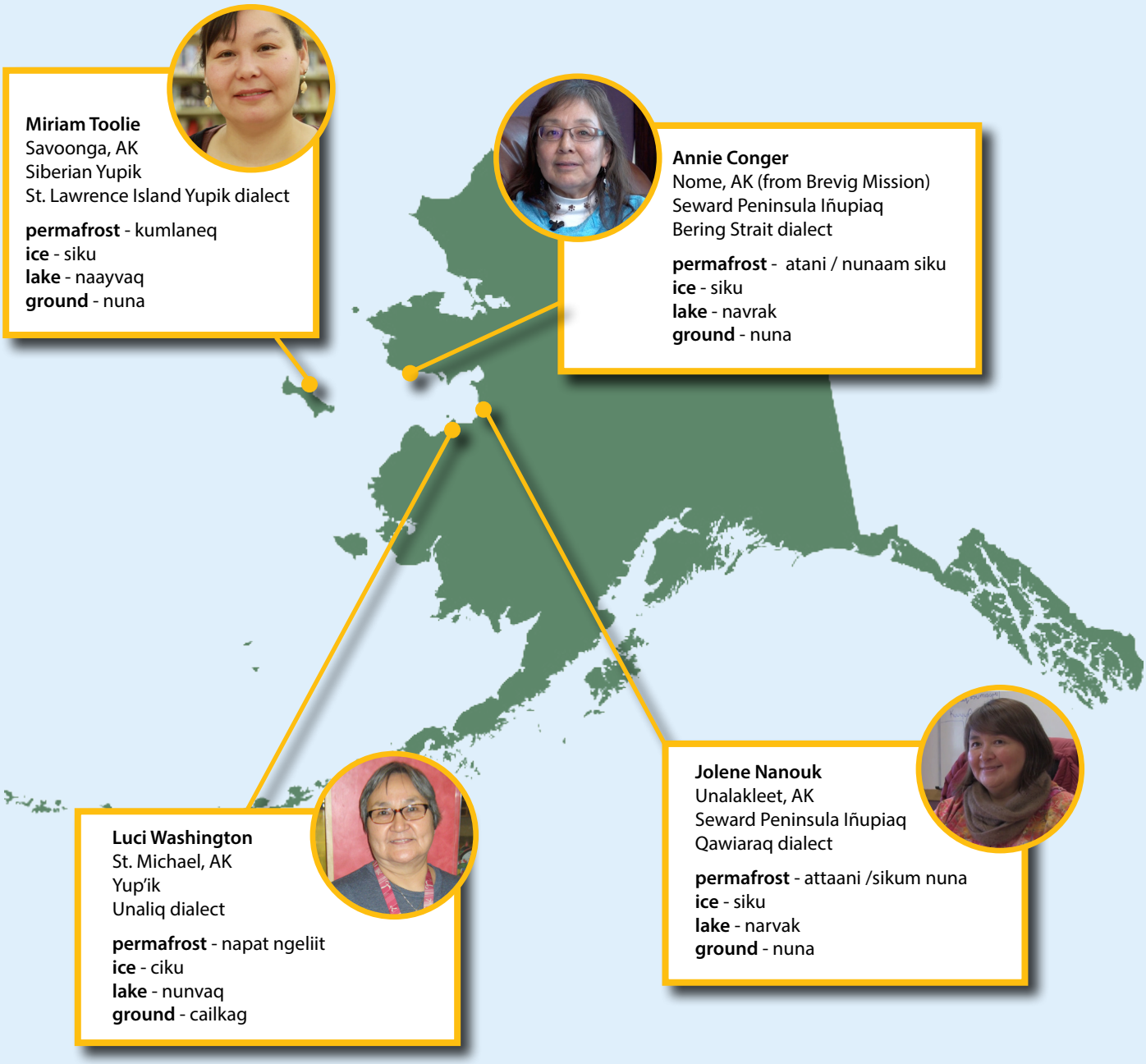
Are the terms the same or similar?

Marie Otten-Pete, Stebbins, AK

Permafrost Vocabulary

Would you like to know Alaska Native language terms related to climate change?

Work with your classmates to practice permafrost vocabulary words in English and the indigenous language of your community. Your teacher will give you vocabulary cards with the English word and an illustration on one side. Write the corresponding indigenous term on the blank line on the back of each card. Use the words that you learned from a local elder or cultural knowledge bearer, or choose the translation below that is closest to your community.



Miriam Toolie
Savoonga, AK
Siberian Yupik
St. Lawrence Island Yupik dialect

permafrost - kumlaneq
ice - siku
lake - naayvaq
ground - nuna

Annie Conger
Nome, AK (from Brevig Mission)
Seward Peninsula Iñupiaq
Bering Strait dialect

permafrost - atani / nunaam siku
ice - siku
lake - navrak
ground - nuna

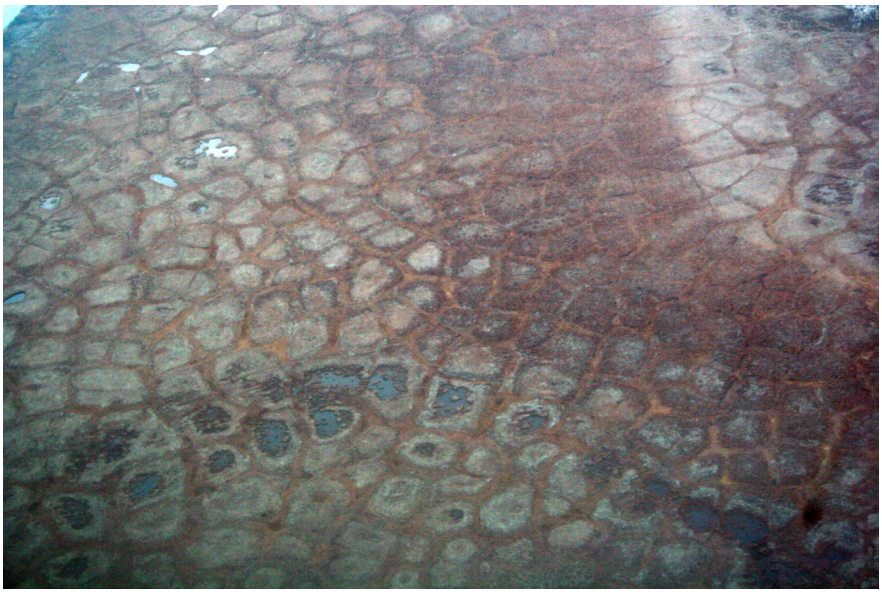
Luci Washington
St. Michael, AK
Yup'ik
Unaliq dialect

permafrost - napat ngeliit
ice - ciku
lake - nunvaq
ground - cailkag

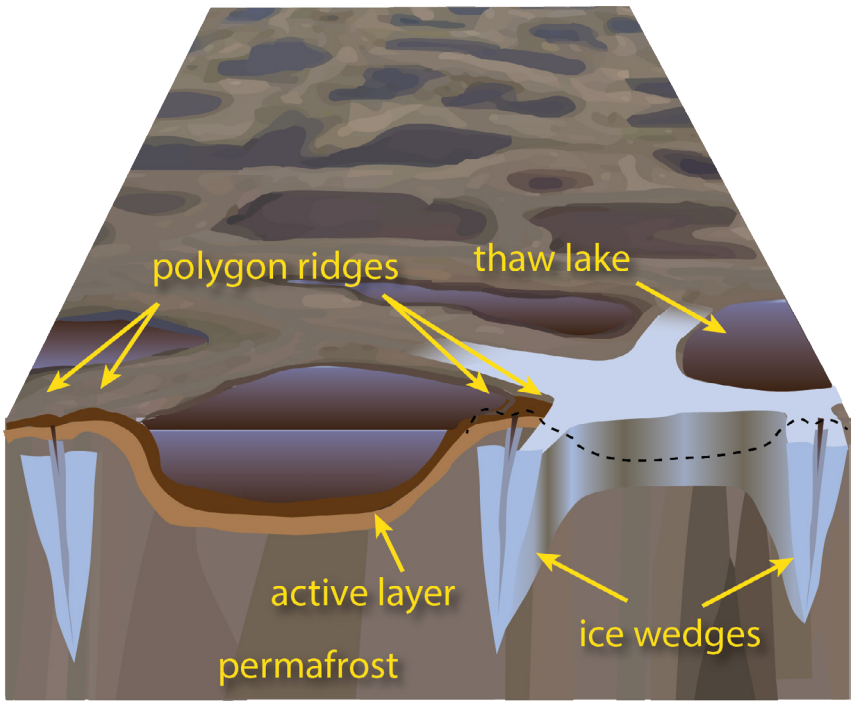
Jolene Nanouk
Unalakleet, AK
Seward Peninsula Iñupiaq
Qawiaraq dialect

permafrost - attaani /sikum nuna
ice - siku
lake - narvak
ground - nuna

Polygonal Ground



Polygonal ground, and the thaw lakes that are associated with it, are common features on the tundra. Permafrost plays a role in the development of these features. When the ground cools in the winter, it shrinks and cracks form. Water seeps down into the cracks in the spring, then freezes the following winter. Ice wedges form from the repeated cracking and freezing. The ice wedges push the soil above them upward, forming tussocks and ridges. These ridges make up the borders of the shapes (called polygons) on the ground.



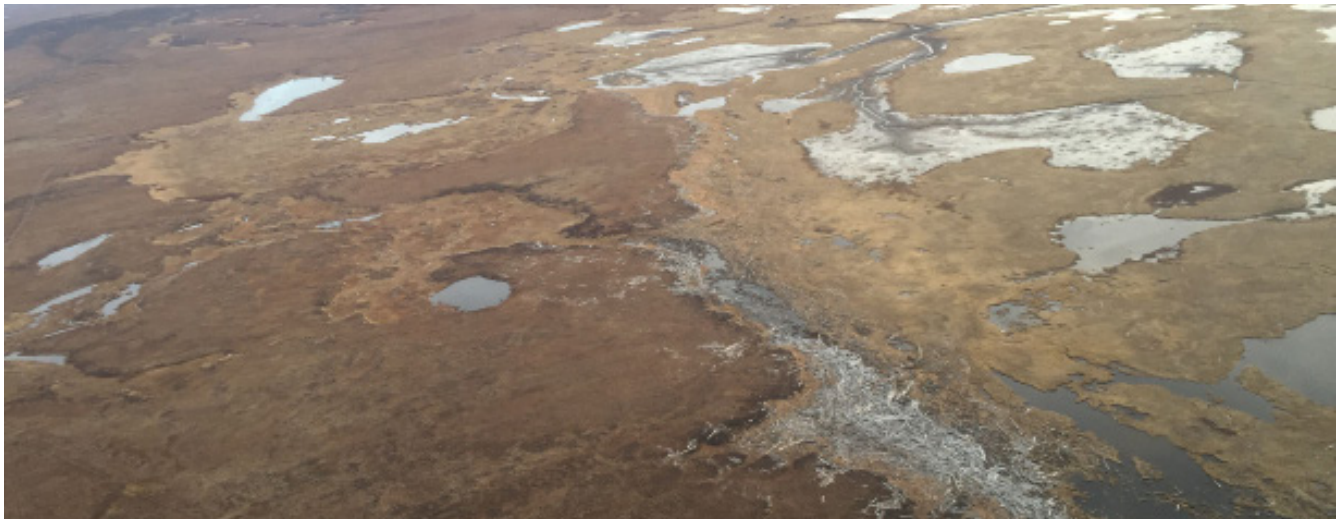
A thaw lake forms when water pools in the low area between the ridges of a polygon. The permafrost beneath the lake acts as a barrier and prevents the water from percolating down. The water absorbs heat from the sun and retains it, contributing to permafrost thaw around and underneath the lake.

If the banks of the lake thaw first, the lake will expand. The lake may even merge with adjacent lakes as the banks wear away.

Changing Lakes

As the thawing process continues, the lake can change in a couple of ways. The banks of the lake may give way completely, and the water will drain out onto the tundra surface. Or, the permafrost underneath may thaw, removing the barrier and allowing the water to drain through the soil. When lakes drain this way it can happen quickly, like someone pulling the plug out of the bottom of a bathtub!

Have lakes and ponds near your community been affected by thawing permafrost? How might changes to nearby lakes impact people in your community? How can we measure changes to lakes?



Lake systems near Stebbins and St. Michael

Lakes near Wales

Measure Lake Loss

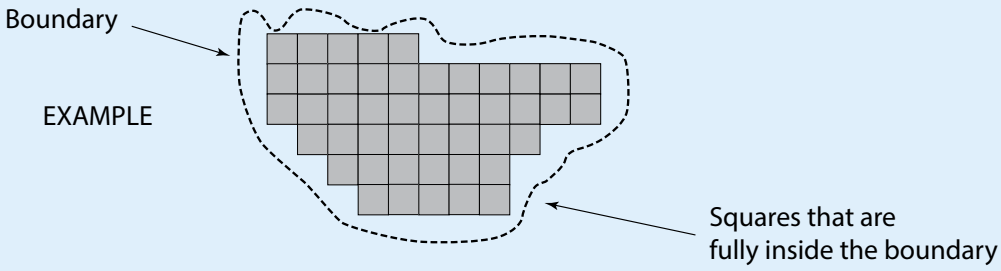
On the following pages, there are two aerial photographs of the same lake. The first one was taken in 1980 and the second in 2009. The lake has decreased in size, but by how much exactly? Quantify the change by calculating the surface area of both lakes.

You will need:

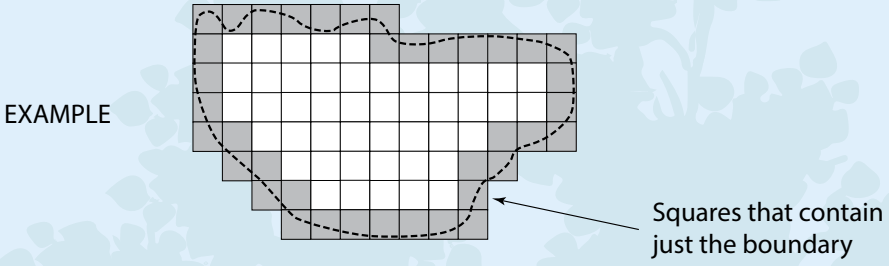
- Transparency grid
- Markers for transparencies in two colors

Step 1: Carefully trace *No Name Pond 1980* onto the grid. On the bottom half, do the same for *No Name Pond 2009*. Each square represents 100 m^2.

Step 2: Find i (i=interior grid area). Shade and count all the squares that are entirely within the boundaries of the lake in 1980 and again in 2009. Record these numbers. Multiply each number by 100 m^2.

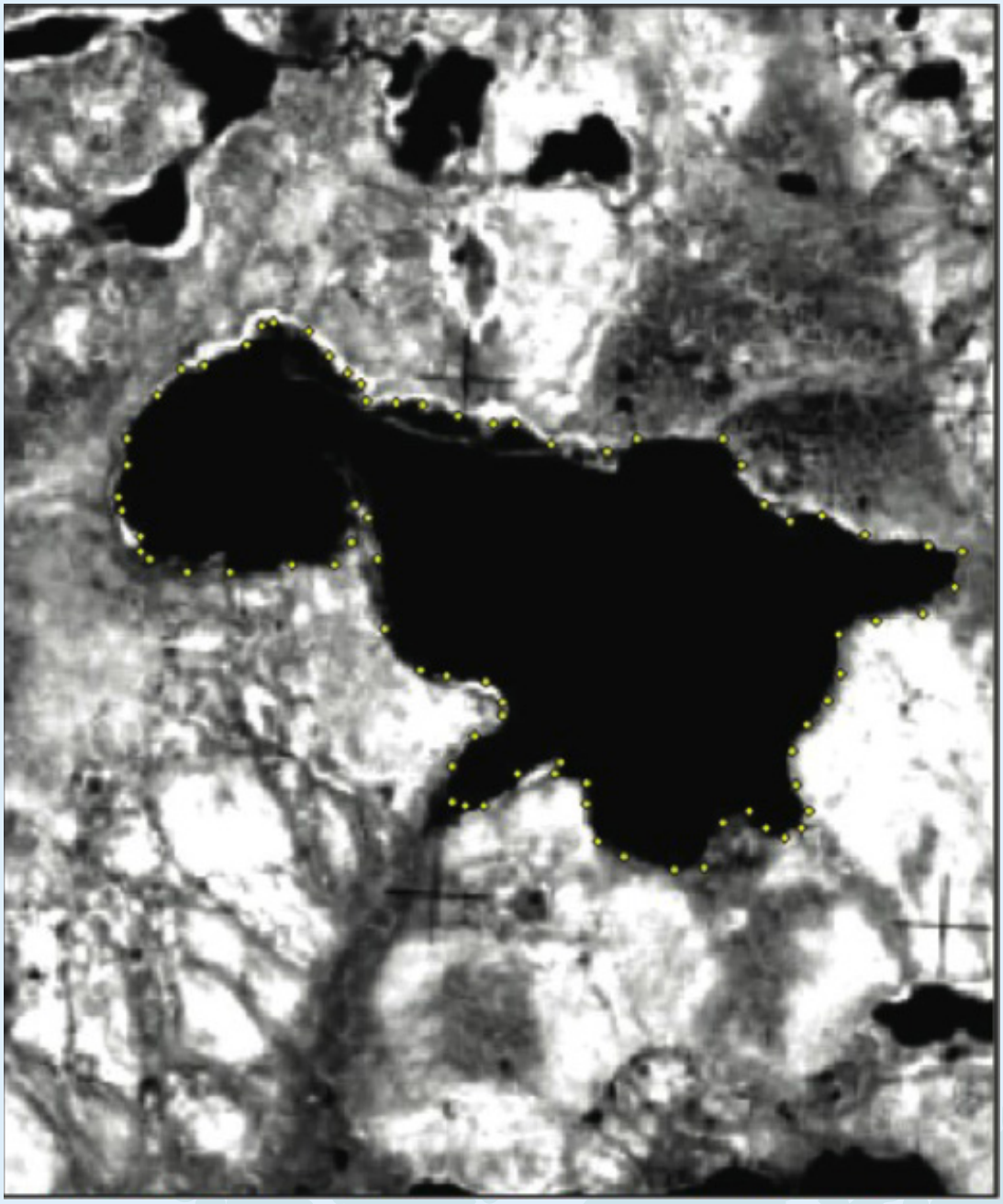


Step 3: Find p (p=perimeter grid area). Using a different colored marker, shade and count all the squares that are partially inside the lake in 1980 and again in 2009. Record these numbers. Multiply each number by 100 m^2.



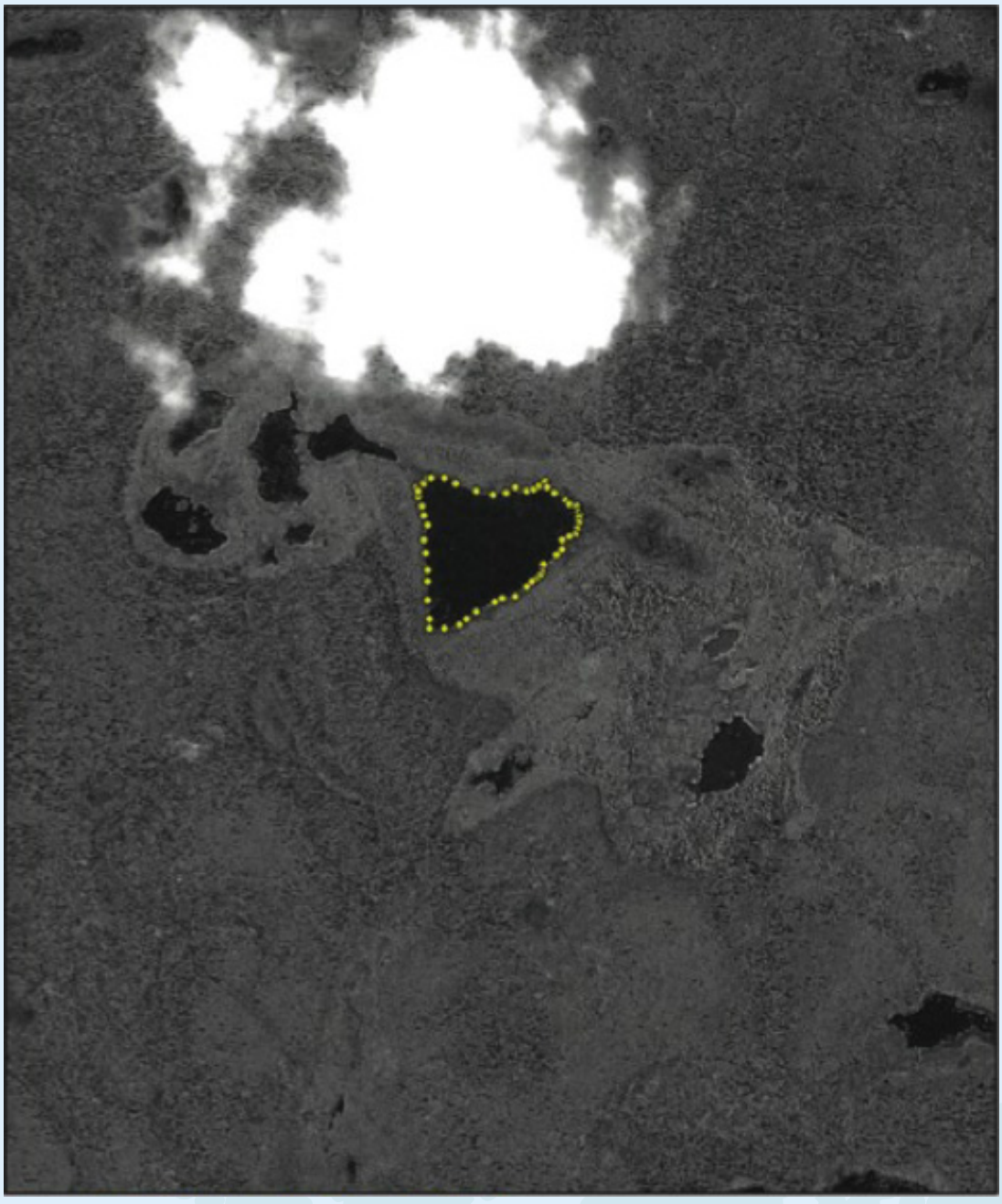
Step 4: Since some of the perimeter grid squares are almost full of lake, while others are half full and some almost empty—the approximate average is half. To find the total area (A) of the lake each year, use the following formula: $A=i+1/2p$

No-Name Pond 1980



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

No-Name Pond 2009



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?

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