



Title:	Glaciers: Then and Now
Summary:	Students compare photographs of glaciers to observe how Alaskan glaciers have changed over the last century.
Source:	<i>Activity developed by Teri Eastburn at UCAR Education and Outreach and adapted for Windows to the Universe by Lisa Gardiner</i>
Grade level:	Grades 4-8
Time:	15 minutes prep time, 25 minutes for activity followed by 20-25 minutes for class discussion
Student Learning Outcomes:	<ul style="list-style-type: none">• Students will understand how alpine glaciers have changed rapidly over the past century.• Students will understand possible reasons for glacier retreat over long and short periods of time.• Students will learn about possible impacts of global glacier retreat.
Lesson format:	Matching activity and class discussion
National Standards Addressed:	<ul style="list-style-type: none">• K-4: Content Standard A: Science as Inquiry• 5-8: Content Standard A: Science as Inquiry• K-4: Content Standard D: Earth Science: Properties on Earth Materials• K-4: Content Standard D: Earth Science: Changes in the Earth and Sky• 5-8: Content Standard D: Earth Science: Structure of the Earth System• K-4: Content Standard F: Science in Personal and Social Perspectives: Changes in Environments• 5-8: Content Standard F: Science in Personal and Social Perspectives: Populations Resources and Environments

- [5-8: Content Standard F: Science in Personal and Social Perspectives: Risks and Benefits](#)

MATERIALS AND WORKSHEETS:

- For each student: A [Glacier: Then and Now Worksheet](#) (http://www.windows2universe.org/teacher_resources/glacier_worksheet.pdf)
- For each group of 2-4 students: An envelope containing the 16 glacier photos printed from the [Glacier: Then and Now - Image Pairs](#) pdf file (http://www.windows2universe.org/teacher_resources/glacier_then_now.pdf)

DIRECTIONS:

Preparation

1. Print enough copies of [Glaciers Then and Now Image Pairs](#) (pdf) to have one for each student group.
2. Cut each sheet of paper in half to separate the glacier photos.
3. Optional: Laminate all photos to make the sets more durable for repeated use.
4. Note: Do not share the first page with students until they have matched the pairs of photographs.

Introduction

Explain what glaciers are, how glaciers grow and retreat, and the two types of glaciers: continental and valley (or alpine) glaciers. Discuss the climate conditions that are necessary for a glacier to grow (snowy winters and cool summers). Discuss the climate conditions that are necessary for a glacier to shrink (warmer).

Activity

1. In groups of three or four, have students try to match the glacier images from the past and present. Give them approximately 10 minutes to accomplish the task. (Note: Do not share the key with students until they have matched pairs.)
2. Give students 5 minutes to compare their matches to those made by the other groups.
3. Discuss the images and reveal the correct matches.

4. Have students fill in the [worksheet](#) to record their observations. (If time permits, you may wish to have students write more about each image pair.)

Summary discussion questions

- What stayed the same? What changed?
- Do all the glaciers in this sample follow the same pattern? Are they growing, retreating, or staying the same?
- What climate conditions encourage glacier growth and glacier retreat?
- What might account for glacier retreat today?
- As glaciers get smaller, how might this affect the Earth?
- Are humans affected by melting glaciers? What are the risks and benefits to human populations?

BACKGROUND INFORMATION:

Glaciers are either one of two types: a continental glacier, also called an [ice sheet](#), such as those that occur on [Antarctica](#), or an alpine or valley glacier found in mountain valleys. The photographs in this activity are all alpine glaciers from Alaska, US. [Alpine glaciers](#) occur all over the world, yet require specific climate conditions to survive. This usually includes a location that has high snowfall in the winter and cool temperatures in the summer to prevent snow from melting.

If a glacier is to form in a given location, snow must accumulate over time, turn to ice, and begin to flow under the pressure caused by its own weight and gravity. As more and more [snow](#) accumulates over years, decades, centuries and longer periods of time, the glacier continues to move. In areas with little snowfall or low slope conditions, the glacier will flow downward and outward very slowly. If the ice is on a steep slope, if basal conditions are smooth and soft, and if there is high snowfall, then the glacier will flow faster. Often this rapid motion creates crevasses on the glacier's surface.

Glacier retreat occurs as a result of sublimation (transition of ice to vapor), snow evaporation (evaporation of liquid water in the snow), strong scouring winds, and ice melt. The process of a glacier getting

smaller is called *ablation*. Over the past 60 to 100 years, almost all glaciers worldwide have been getting smaller and in most cases there is strong evidence that current glacier retreat is due to Earth's warming climate. This is most evident for alpine glaciers in the [Arctic](#), which is warming quickly compared with other regions, and for alpine glaciers at high elevations in tropical latitudes.

RELATED SECTIONS OF THE WINDOWS TO THE UNIVERSE WEBSITE:

- [Earth's Polar Regions](#)
- [The Cryosphere](#)
- [Glaciers and Ice Sheets](#)
- [The Cryosphere and Climate Change](#)
- [Climate Change in the Polar Regions](#)

OTHER RESOURCES:

- [National Snow and Ice Data Center Glacier Photos](#)
- [Glacier National Park Repeat Photo Project](#)
- [Glaciers Online Ice Retreat Photos](#)

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Image Pairs for the Glaciers Then and Now Classroom Activity

Print the following pages, cut apart the glacier images, and laminate for classroom use. For your reference, the information about each photo pair is below.

Please refer to activity directions on *Windows to the Universe* for more information about classroom implementation of this activity. The web page that describes this activity is: http://www.windows.ucar.edu/tour/link=/teacher_resources/teach_glacier.html

Pair	Year	Photographer	Source	Page
1 Muir Glacier Lat: 59.0783 Long: -136.3606	1941	William O. Field	American Geographical Society	2 top
	2004	Bruce F. Molina	USGS	2 bottom
2 Carroll Glacier Lat: 59.0842 Long: -136.6449	1906	Charles Will Wright	USGS	3 top
	2003	Bruce F. Molina	USGS	3 bottom
3 Holgate Glacier Lat: 59.8711 Long: -149.9186	1909	Ulysses S. Grant	USGS	4 top
	2004	Bruce F. Molina	USGS	4 bottom
4 McCarty Glacier Lat: 59.7700 Long: -150.2208	1909	Ulysses S. Grant	USGS	5 top
	2004	Bruce F. Molina	USGS	5 bottom
5 Muir Glacier Lat: 59.0783 Long: -136.3606	1899	Grove Karl Gilbert	USGS	6 top
	2003	Ron Karpilo	National Park Service	6 bottom
6 Toboggan Glacier Lat: 61.0217 Long: -148.2769	1909	Sidney Paige	USGS	7 top
	2000	Bruce F. Molina	USGS	7 bottom
7 Muir Glacier Lat: 59.0783 Long: -136.3606	1976	Bruce F. Molina	USGS	8 top
	2003	Bruce F. Molina	USGS	8 bottom
8 Penderson Glacier Lat: 59.8928 Long: -149.7805	1909	Ulysses S. Grant	USGS	9 top
	2004	Bruce F. Molina	USGS	9 bottom

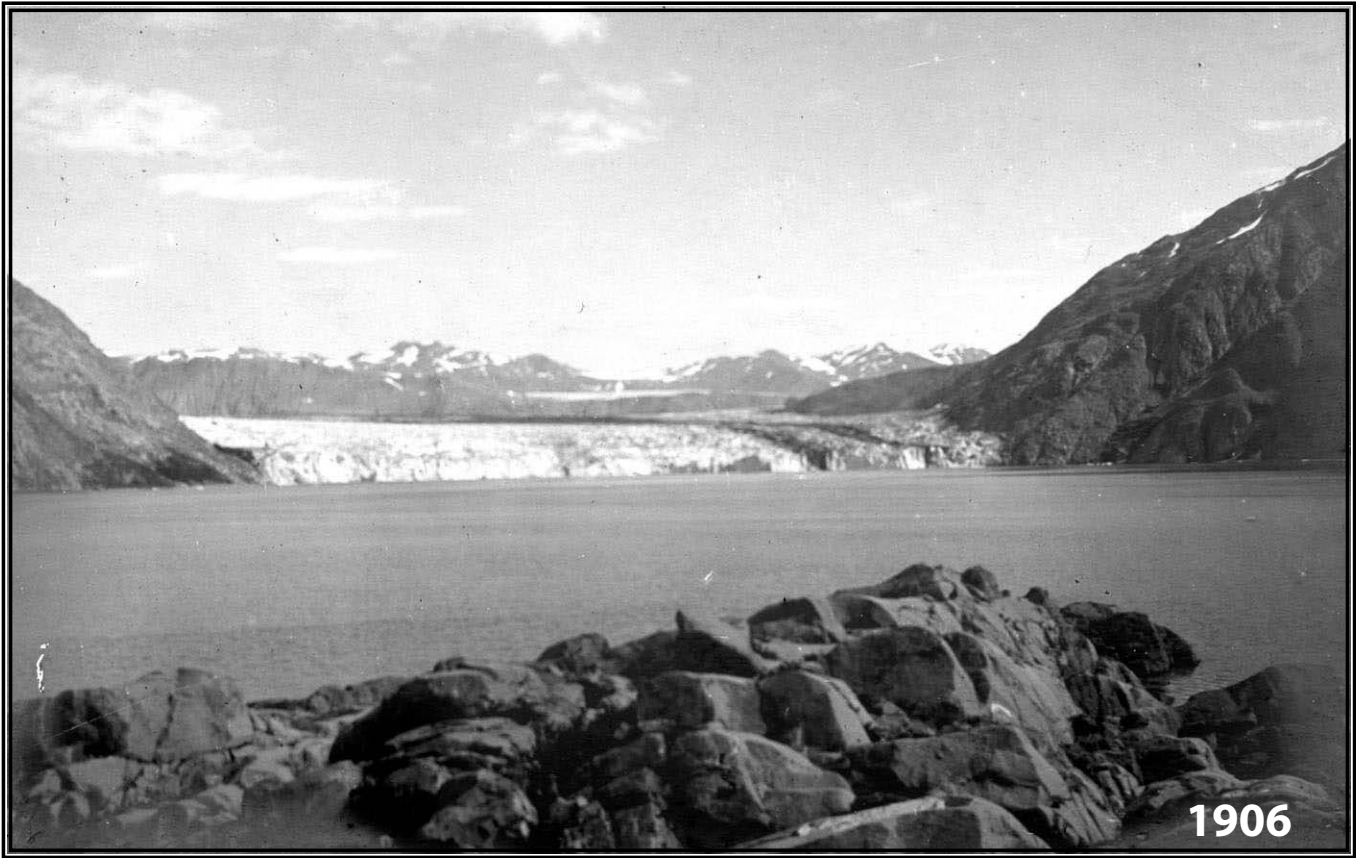
All glacier images are all from Alaska, U.S. and were published by the National Snow and Ice Data Center - World Data Center for Glaciology (www.nsidc.org)

Page numbers listed above correspond to the numbers on the following pages.

Muir Glacier



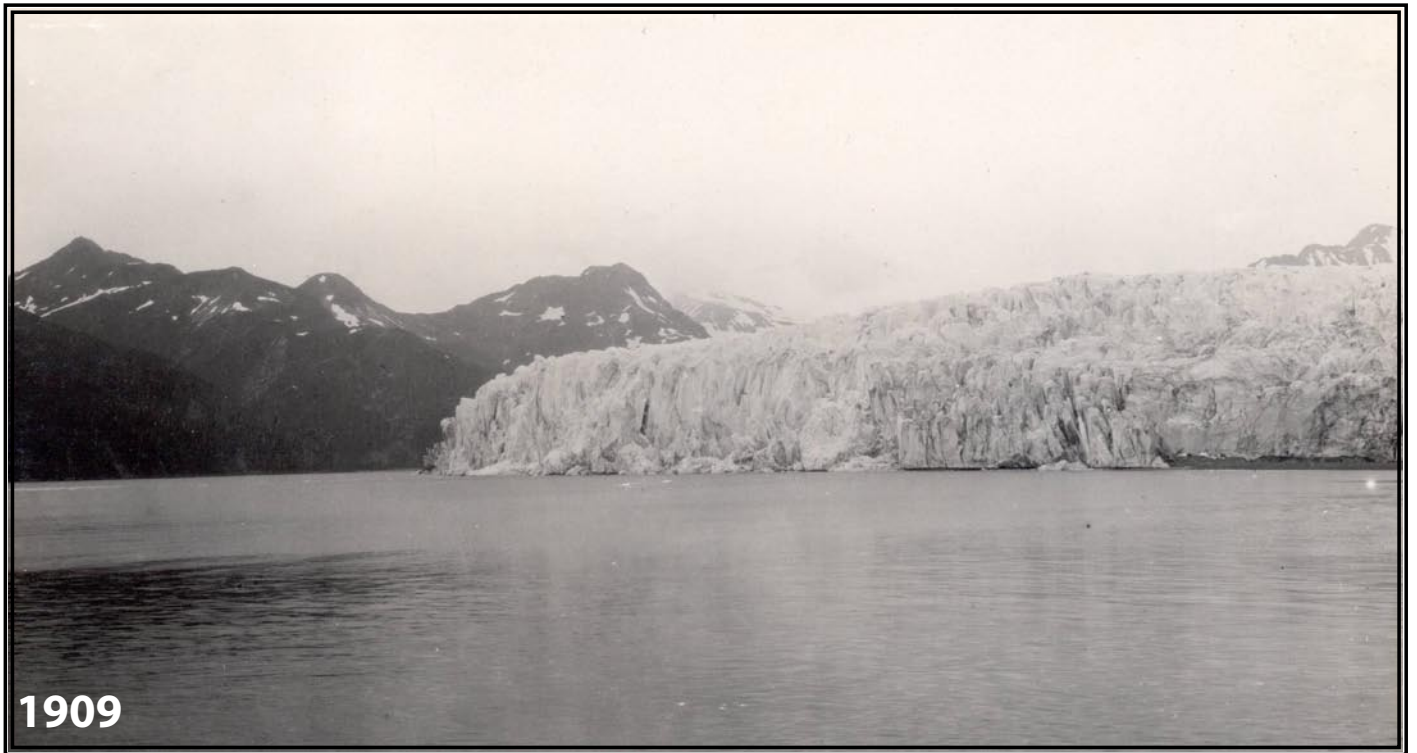
Carroll Glacier



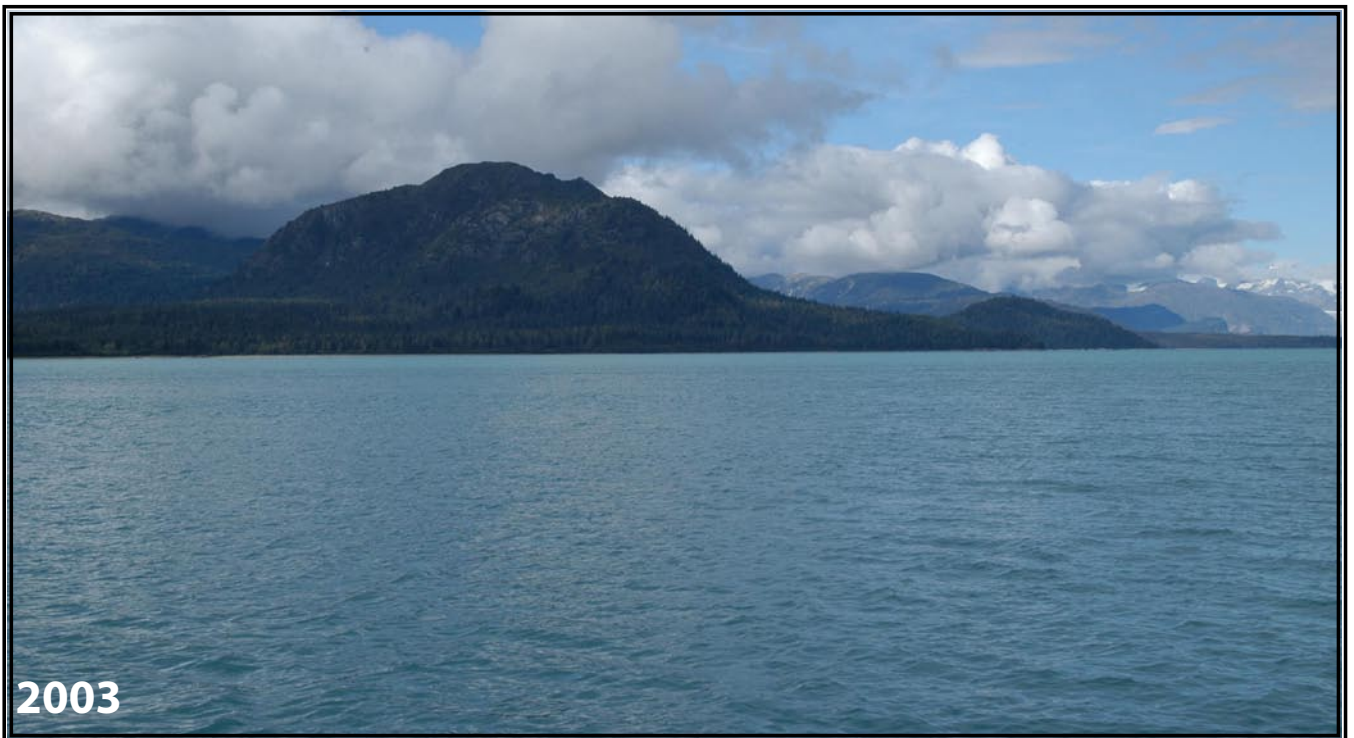
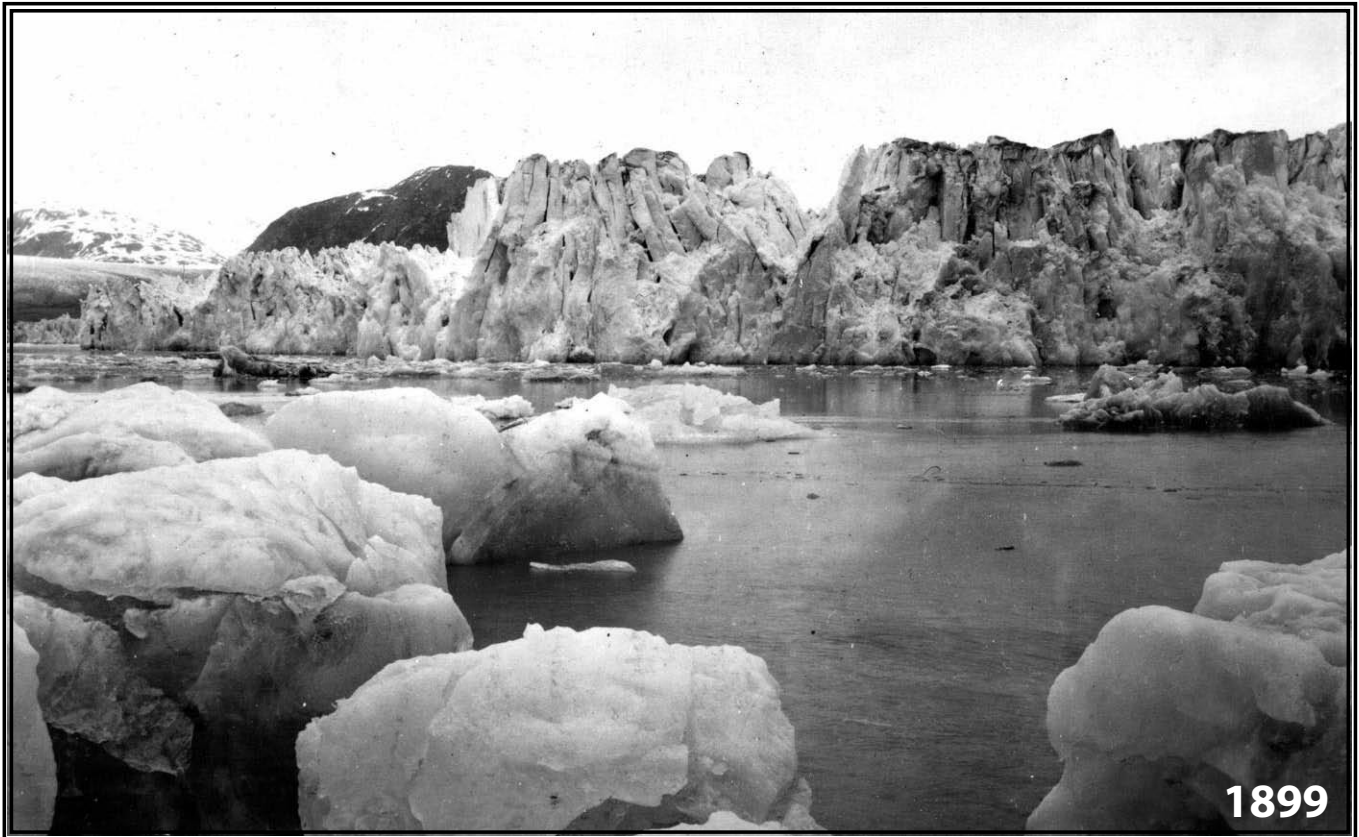
Holgate Glacier



McCarty Glacier



Muir Glacier



Toboggan Glacier



Muir Glacier



Penderson Glacier



Glaciers: Then and Now

NAME _____

Directions: After you have matched the old and recent glacier pictures, take a close look at the pairs. *What's the same in both pictures? What's different? How much time did it take for the changes to happen?* Use the table below to record what you notice.

DATE _____



Glacier Name	Solve: Year of recent photo - <u>Year of older photo</u>	Things in the two photographs that are the same ...	Things in the two photographs that are different ...