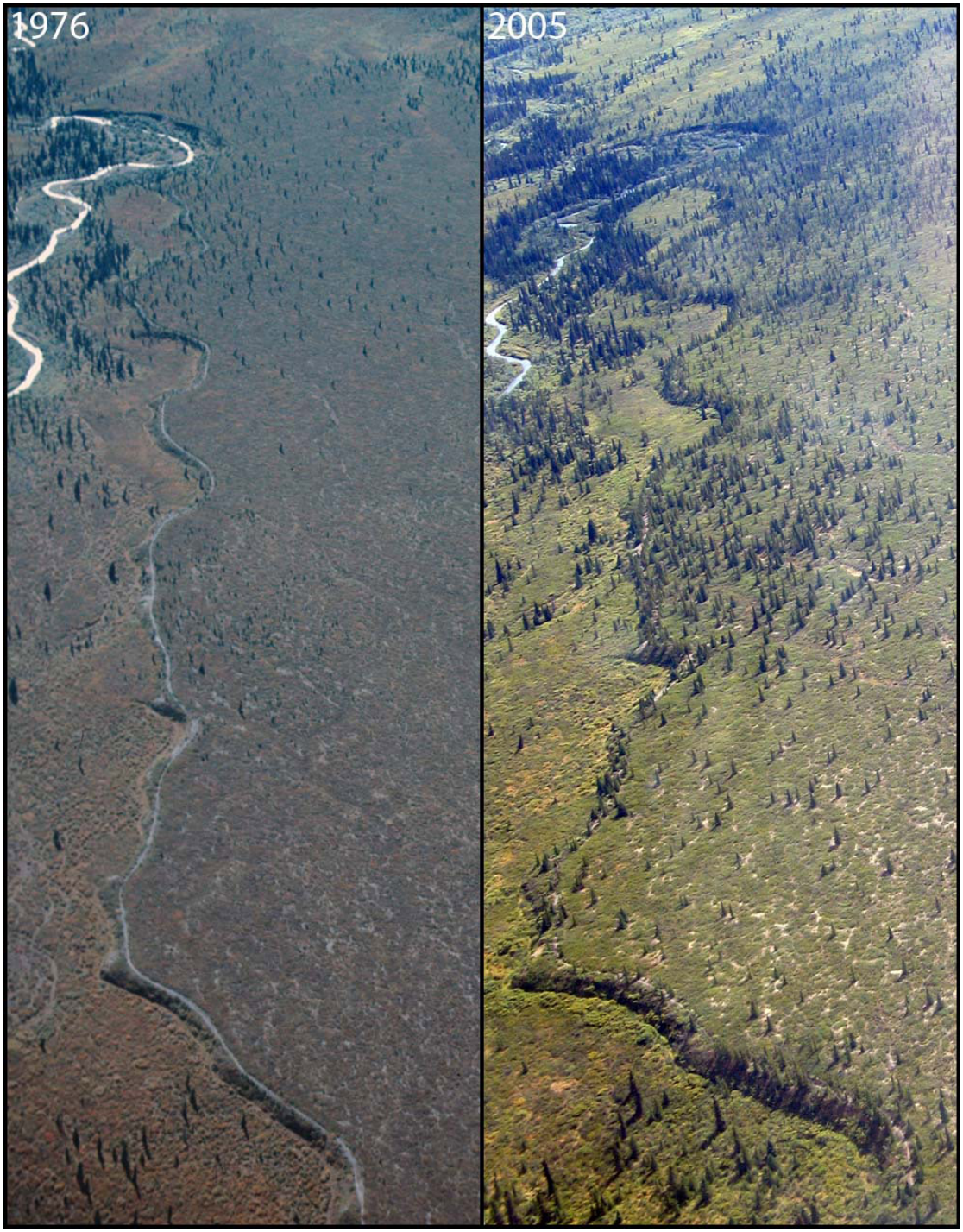
It's All About Repetition!
An Introduction to Repeat Photography

(lesson prepared by Julia West, Communicating Climate Change 2013)

Take a look at the following two pairs of photos. Do you see things that are the same in the photos of each pair? Do you see differences? Describe what you see in each pair.

Top: Stephen R. Capps , Bottom: R.D. Karpilo



Left: Fred Dean, right: Carl Roland

These photos are examples of *repeat photography.* In this lesson, we will learn what repeat photography is, and discuss how it can be used in scientific analysis.

What *is* repeat photography? It is the taking of photographs from the same location, over time, to document changes. This tool has become extremely useful in science, as a qualitative way to document the effects of humans on an area, succession in vegetative communities, seasonal changes, and much more.

Why do landscapes change over time?

- Human activity (deforestation, development, agriculture, pollution)
- Animal activity (beaver dams, overgrazing, insect or fungal infestation)
- Fire
- Natural events (floods, hurricanes, volcanoes, etc)
- Climate change

What can we look for when observing change using repeat photography?

- Landform changes
  - rivers changing course
  - lakes or ponds changing size
  - beaches eroding
  - landscaping and development (such as roadbuilding)
  - glacial retreat or advancement
  - effects of landslides or avalanches

- Vegetation changes
  - presence of vegetation
  - size of vegetation
  - types of vegetation
  - location of vegetation types

Some of these factors will be discussed as we take a look at some repeat photography. As you look at these photo pairs, consider the questions that follow them, and jot down notes.

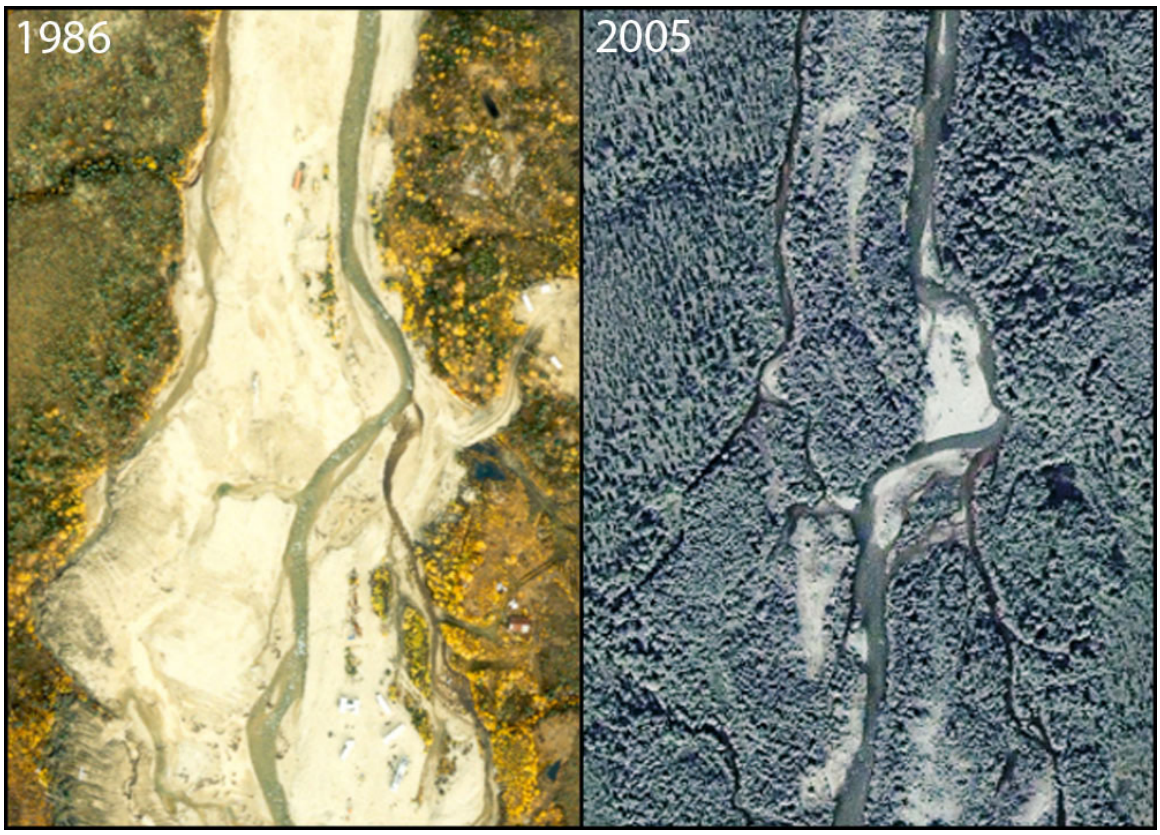
You will get a chance to analyze some photos yourself and answer a few questions, and then experiment with creating your own repeat images.

Here are some examples of repeat photography, showing human-caused changes:

(Photos by Fred Dean and Carl Roland)

You can use repeat photography to show human development in an area. This simple photo pair shows development in McKinley Village, AK.

Can you think of any vantage points in your area where you could document increased development over time?



Technical aerial photos.

These photos show restoration of a riverbed in the Kantishna Hills area of Denali National Park, Alaska. In the first photo, the area was showing the effects of years of placer (gold) mining in the years before 1986. The Park Service has since reclaimed the site, and it has been almost completely revegetated. Repeat photography can be used to show positive human impact!

Are there any new parks in your area, reclaimed mines or industrial sites, or other places where nature has been restored?

This next pair shows vegetative changes in a desert area, which was well adapted to frequent fire, as a result of human-caused changes in the role of fire. Fire suppression started with grazing in the 1800s, which caused less fuel in the form of dried grasses to form. After this, people started to actively suppress fires, which caused more woody vegetation (and hotter-burning fuel) to grow.

Photo by William Henry Jackson, 1899

Enchanted Mesa near Albuquerque, NM. In this 1899 photo, you can see the lack of shrubs and woody vegetation. Grasses and non-woody flowering plants dominate the landscape.

Photo by H.E. Malde, 1977

This same site in 1977 shows how fire suppression has caused the increase in shrubs and woody plants.

Are there any areas near where you live where the vegetation has changed because of animal grazing, farming, or fire suppression?

Here is example of repeat photography used to document glacial retreat. Accelerated glacial retreat has been documented on a global scale using repeat photography, and is evidence of a warming global climate.

Glacier National Park archives

These photos are of the Grinnell glacier in Glacier National Park, Montana. The top one is from 1940, and the one below is from 2006. You can see how the glacier has retreated and the glacial lake has formed at the terminus of the glacier.

Photo by Karen Holzer, USGS

Have you ever seen glaciers? If you live where there is snow, can you think of opportunities to document changes in snow depth or drifting through images?

OK, you get the idea of what this is all about! Now, here is some more background information, and then you can get started analyzing a few photos yourself:

When examining repeat photography, it is extremely important to not make assumptions, especially when you are exploring landscapes that are naturally changeable (for example, changing riverbeds or areas that flood frequently). There are usually several microclimates depending on local topography, and one area might show change while another nearby area doesn't. This tool is useful for making generalizations and documenting large-scale changes. Using these, we then design more detailed studies and specific site analysis.

It is also important to recognize that the photos are not telling us *why* the change is happening, nor the *effects* of the changes. This is what additional quantitative investigation is for.

Assignment: Examine the following photo pairs and answer the following questions for each one.

1- Describe changes that you see, considering the factors on page 3.
2- Consider any known factors that might have contributed to the change, and write these down as hypotheses for further study.
3- Using your knowledge of food webs in ecosystems, along with background information that is given to you with each photo pair, state some possible effects on animal and plant communities that might result from the change.
4- Consider any possible effects this change might have on the physical environment or the microclimate of the area (wind, snow accumulation, frequency of fire, etc)

Photo pair #1: Go back to page 1, and take another look at the photos there. These are the Polychrome Glaciers in the Alaska Range, Denali National Park.

Photo pair #2: Revisit the photos on page 2. These are along the Savage River in Denali National Park. Notice the time span of only 29 years between these photos, compared to nearly 100 years in the first pair. Can it be assumed that change is happening faster in pair #2? (It might seem so at first, but you need to see a photo of the Polychrome Glacier scene from 29 years ago to make a conclusion about that!)

Photo pair #3:

TJ Hileman, Glacier NP archives

Hidden Lake, Glacier National Park, circa 1930

Lisa McKeon, USGS

Hidden Lake, Glacier National Park, 2009

Photo pair #4

George Ruhl, GNP archives Lisa McKeon, USGS

Piegan Glacier, Glacier National Park, circa 1930 and 1998

The trees in the left photo are whitebark pine, the seeds of which are a very important food source for grizzly bears. What change do you see on the right? What changes *don't* you see in the photos that you might have expected?

Note: As you consider the effects of the changes in the next photo pair, think about the animals that live in Denali National Park in Alaska. Caribou is an important species that feeds mostly on lichens and small tundra plants. Moose are also very common, and are usually found in low-lying areas where there are plenty of shrubs and small trees to feed on. Snowshoe hares' habitat is mainly brushy areas with abundant shrubs for protection and food. Wolves prey on caribou, moose, hares, or any other small mammal or bird. Lynx eat almost exclusively snowshoe hares, but will prey on other small animals when the hares are at the low point of their 8-11 year population cycles. Some birds need open tundra to nest, and others thrive in shrubby or forested areas.

In general, also remember that fire is a natural part of many western U.S. landscapes. Consider the increase in woody vegetation combined with either drier weather or, in the north, drier ground as a result of thawing (and draining) permafrost. What might be the effects on wildfires?

Photo pair #5

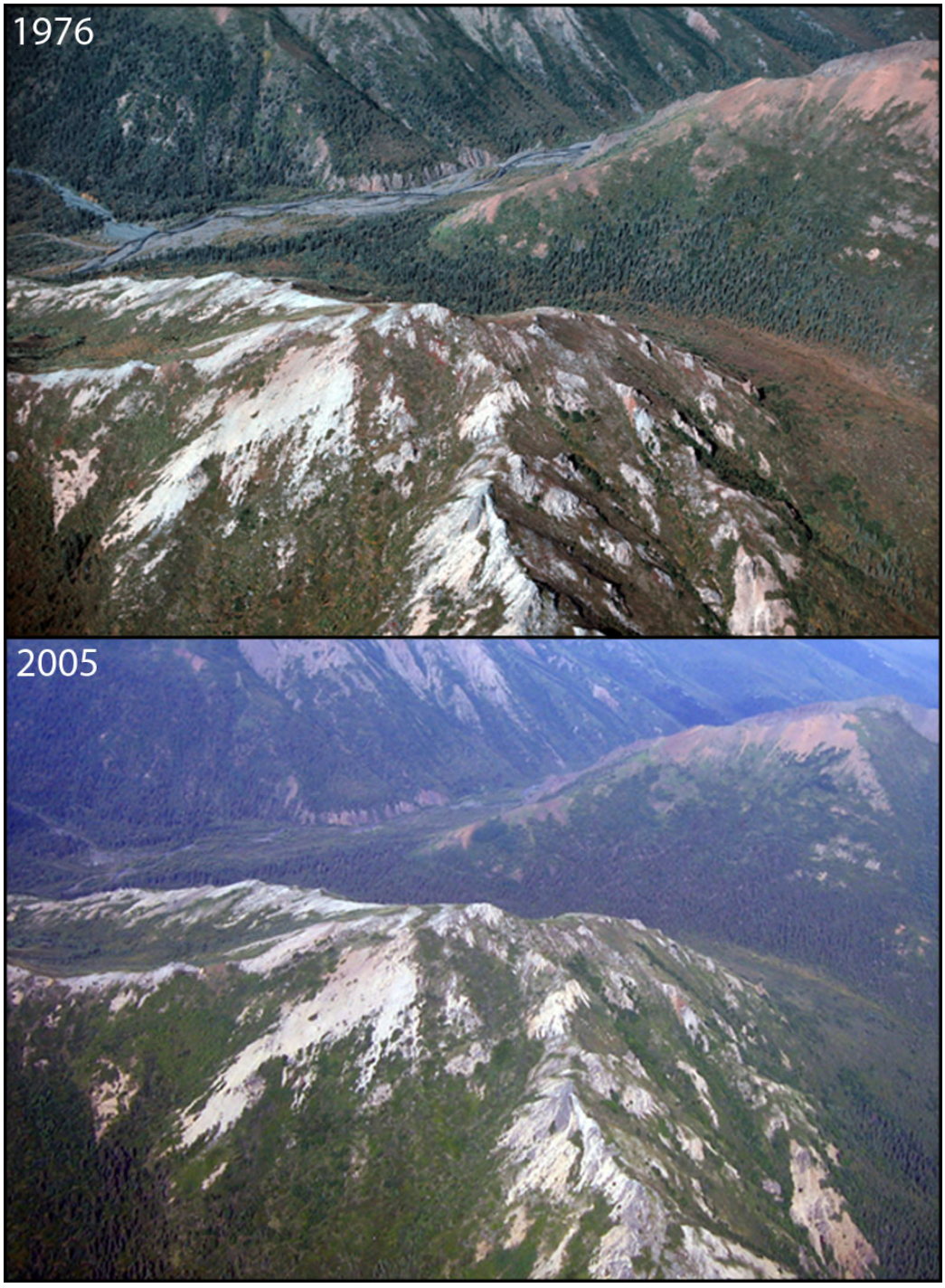


Photo by Fred Dean

Photo by Carl Roland

Big Creek near Teklanika, Denali National Park

Look closely, as the change in shrubs is sometimes trickier to see than tree growth. You will see change all over these photos. The darkest green is trees, then shrubs, and the lightest green is tundra.

Extension Ideas:

- Create your own repeat photography project to explore the change of seasons. Over a period of as many months as possible, take photos of a landscape every week, and describe what you see. Since this is a short term project, you will need to get closer to your subject area, unlike many of the large scale photos presented above. You will want to capture the growth of herbaceous vegetation.
- Predict the future! Find a good vantage point in your area, and take a photo, draw, or paint what you see. Imagine a future, 10, 20, or 50 years down the road, and create an image that shows what you think the area will look like at that point. Do you live where there are forest fires? Will there be increased development – suburbs, road building, towns? Is a cleared area growing back to forest? Is there a dam and reservoir affecting the area? You can either choose by researching current and past trends in human activity, or create a scenario that you would like to see happen there. Add a description of your project and intentions.
- Choose an area close to home, where you can compare old photos (from many years ago) to current photos. You don't need to find repeat photography examples. Create your own! Find old photos and see if you can determine where they were taken from. Try to capture the scene as it exists now, and create your own photo pairs. Include descriptions.
- Research another area of the world where repeat photography has been done, and create a presentation about it, explaining the changes.
- Consider the applications of repeat photography in park management. Very often, small incremental changes go unnoticed, and over time result in a large change from the original. Examples could be the number of signs along a road, increased erosion from foot traffic on a trail, etc. Choose either a national or state park that you have visited, or a local natural area. Make a list of human impacts on the area, and the possible applications of repeat photography to capture incremental changes over time. Describe the implications each could have in management decisions.

Teacher notes:

- This lesson is intended either to stand alone for independent student work, or used in a class situation with a discussion.

- For this lesson, it is assumed that the students have covered some environmental science topics, including biomes, succession, human impact on natural environments, ecosystems and food webs, and microclimate.

- See the resource list for better resolution on some of these photos. These websites have excellent descriptions of the changes, along with explanations. In this lesson, the photos are isolated so students can come up with their own conclusions.

Partial discussion of photos:

Photo pair #1: The glaciers are clearly thinning and shrinking. It is more difficult to see, but with careful observation, students might notice an increase in vegetation on the river bar draining the middle glacier. This could be due to a lower water flow from the glacier. Further investigation would reveal the type of vegetation moving in, and the extent and speed of glacial retreat.

Photo pair #2: There is an obvious and marked increase in spruce tree density. With closer investigation, the type of spruce can be determined. Black spruce tends to grow on wetter soil, indicating there might be permafrost, and white spruce will grow on better drained areas.

Photo pair #3: There is a great increase in vegetation, especially at the base of the mountain (Bearhat Mountain), center left. Students will likely presume that the increase in vegetation is due to a warming climate, less year-round snowpack, and a longer growing season. Climate data could be collected (for all the photo pairs), long term vegetation plot studies could be initiated or continued.

Photo pair #4: There are two interesting things about these photos. There is no visible change in the glacier. Reasons? Students might consider the aspect (which direction it is facing), which could affect the microclimate. The second point of interest is that not only has the vegetation in the meadow in the foreground increased, but also the *type* of trees has changed. The rounded crowned whitebark pines have been replaced by the spiky subalpine firs. Encourage creative thinking about this one. Whitebark pine has primarily succumbed to blister rust. (http://nrmsc.usgs.gov/research/whitebar.htm). Is climate change involved here? It certainly isn't apparent from these photos! Perhaps it does have a role in the increased blister rust in the area?

Photo pair #5: It takes some close examination, but the shrubs have filled in many areas that were previously tundra. Several of the "holes" have closed in. The treeline in the background has moved up the slope, and students might suggest that the river bottom has filled in with vegetation. Given all the background information on the animals, students may suggest that caribou might be harmed by the loss of tundra vegetation, while moose might increase. Snowshoe hares may increase, which could increase food for wolves, reducing the pressure on the larger mammals. Tundra bird species will decrease, while those that prefer brushy and treed areas will increase. There are many possible suggestions for further study, including vegetation analysis (composition, size, density), mammal population studies, mammal diet studies, etc.

For all of the areas with increased vegetation, there might be increased snow accumulation in the form of drifts, as well as reduced wind. This could increase local moisture. However, the thawing of the permafrost that causes some of these changes is likely to cause areas that were previously quite wet in the summer to drain, which would dry the soil out and change the vegetation. It should be emphasized to students that cause and effect changes are not clearcut; there are many factors involved!

NSES Science Standards:

- Content Standard A: abilities necessary to do scientific inquiry, and understanding scientific inquiry. Analyzing evidence, providing alternative explanations
- Content Standard C: interdependence of organisms
- Content Standard E: science and technology
- Content Standard F: population; natural resources; natural and human-induced hazards; science and technology in local, national, and global challenges

References

http://denalirepeatphotos.uaf.edu:8080/
http://www.nps.gov/features/dena/003/landchange/virtual_tour.html
Allen, Betencourt, Swetnam, 1997. Southwestern US LUHNA pilot project (http://cpluhna.nau.edu/Research/grasslands1.htm)
USGS Repeat Photography Project (http://nrmsc.usgs.gov/repeatphoto)
http://www.adfg.alaska.gov/index.cfm?adfg=animals.main

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