



Resource Bulletin

Global Warming and Melting Glaciers

Global Warming

Global warming is one of the most pressing environmental issues of the 21st century. For many years, scientists have been studying this phenomenon and the evidence is now clear. Earth's climate is warming and mountain ecosystems like those found in Glacier National Park are seeing some of the most dramatic changes.

In the 20th century, global average temperature increased by about 1 degree Fahrenheit with accelerated warming over the last two decades. The 10 warmest years of the last century all occurred since 1985, with 1998 being the warmest year on record. Climate models predict a warming trend over the next 100 years of 5-7 degrees. While this may not seem like much, it could bring major changes in mountain ecosystems.

While Earth's climate is known to have changed in the past due to natural causes, the warming trend over the last few decades is primarily the result of human activities. Of major concern is the build up of carbon dioxide and other greenhouse gases in the atmosphere.

Greenhouse gases hold heat in the atmosphere that would otherwise radiate back out into space. While the greenhouse effect is what has made life on Earth possible, these gases are now increasing at an alarming rate. Since the beginning of the industrial revolution, the carbon dioxide concentration in the atmosphere has increased by 30%. Human activities that release carbon dioxide are burning of fossil



Grinnell Glacier, shown in the foreground, has retreated dramatically in recent years. Today, one can still see the smaller Gem Glacier on the upper left the Salamander Glacier, on the upper right, the latter of which was once apart of Grinnell.

fuels, harvesting and burning of trees, and land conversion to cities and for agriculture.

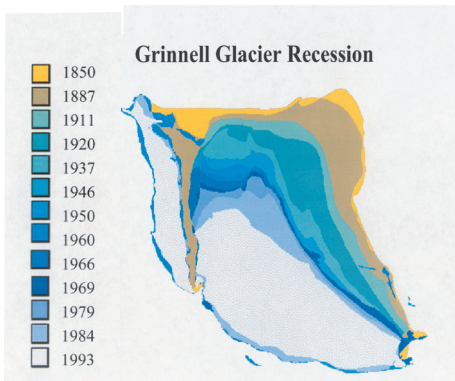
Melting Mountain Glaciers

In Glacier National Park, a dramatic result of a warming climate is the retreat of mountain glaciers. Glaciers are formed when snow that falls in winter doesn't completely melt in summer. As snow accumulates over many seasons it becomes ice. The weight from snow and ice causes the bottom layers to move, fashioning a frozen river of snow and ice that slowly flows across the landscape, eroding and shaping it into unique landforms. When more snow and ice melt in summer than can be replaced in winter, the

edge of the glaciers retreat back up the mountain and, eventually, the glaciers disappear.

The amazing mountains and valleys of Glacier National Park were sculpted by the action of glaciers over hundreds of thousands of years of glacial advance and retreat. In 1850, at the end of the Little Ice Age, there were an estimated 150 glaciers in the park. By 1968, these had been reduced to around 50, 37 of which had been named. Today the number of glaciers in the park is 27, many of which are mere remnants of what they once were.

Rapid retreat of mountain glaciers is not just happening in Glacier National Park, but is occur



The size of Grinnell Glacier has receded dramatically over the last hundred and forty years. The white area shows the extent of the glacier in 1993; the colored areas show the glacier's extent for years prior to that.

ing worldwide. While Earth's climate has undergone cooling and warming cycles in the past, the rate and magnitude of change we are witnessing today has not occurred since human civilization began. If the current rate of warming persists, scientists predict the glaciers in Glacier National Park will be completely gone by the year 2030.

The total loss of glaciers will certainly be a major change for Glacier National Park. For many people, the glaciers are one of the reasons the park holds special significance and are a feature they expect to see when they visit. Glaciers are also an important natural resource, providing vital functions for the ecosystem.

Glacier's Management Strategy

Now that the impacts of global warming are beginning to be understood, managers are taking the issue very seriously. Ultimately, greenhouse gas emissions, especially carbon dioxide, must be reduced. The National Park Service, in partnership with the Environmental Protection Agency, held a workshop for park personnel in December 2003 to discuss the issues relating to climate change in the park and what steps the park can take to respond to this threat.

Climate Friendly Parks: Moving From Knowledge to Action, a 2-day workshop held in Whitefish, MT, was aimed at park staff, concessioners, and park partners. An assessment of greenhouse gas emissions from Glacier was conducted prior to the workshop to provide background on what the primary activities are that can be targeted for emissions reduction. The single greatest contributor to carbon dioxide emissions in the park is transportation. Other significant sources are energy use in buildings and solid waste disposal.

The primary outcome of the workshop was an Action Plan for the park, which includes steps that can be taken to reduce greenhouse gas emissions and raise awareness of the issues. Some of these steps include energy efficiency in buildings, carpooling, recycling, alternative transportation for employees and visitors, and other sustainable actions.

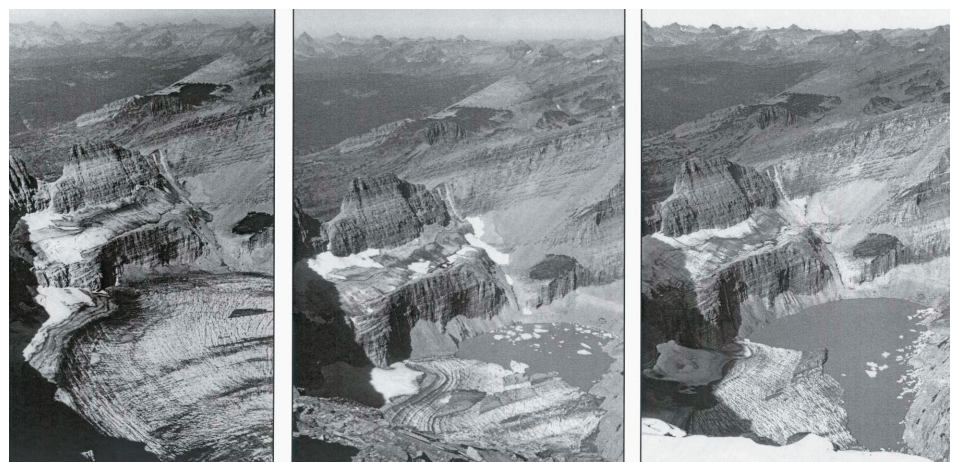
Another outcome of the workshop was organization of the Glacier Park Green Team, which holds monthly meetings to discuss issues relating to sustainable environmental practices in the park. The Climate Friendly Park Action Plan is also being integrated into Glacier's Environmental Management System, which will be completed summer 2005.



Resources for More Information

Glacier National Park staff:
Leigh Welling, Director, Crown of the Continent Research Center
Dan Fagre, Ecologist, USGS Glacier Field Station

Documents and web sites:
Glacier National Park Global Climate Change webpage: <http://www.nps.gov/glac/resources/bio7.htm#Global>
USGS website: Ecological Significance of Long-term Climate Changes in Montane Ecosystems, and Global Climate Change: http://nrmcs.usgs.gov/research/climate_changes.htm
Green Nature website: Glacier National Park Losing Glaciers: <http://greennature.com/article979.html>
Glacier National Park Green Team: <http://www.glac.nps.gov/glac/office/greenteam.cfm>



Repeat photographs of Grinnell Glacier taken from Mt. Gould show the rapid retreat of the glacier and the formation of a glacial lake; dates from left to right are 1938, 1981, 1998.