

## GRINNELL GLACIER - USA

48.75°N 113.73°W

The Grinnell Glacier sits just to the east of the continental divide in the Rocky Mountains of northern Montana State. It is in the middle of the United States of America's famous Glacier National Park. In 1850, Grinnell covered 2.33 square kilometres, by 1993 its remnants totalled only 1.11 square kilometre. From 1850 to 1920, Grinnell retreat averaged six metres annually. Between 1920 and 1946, retreat averaged 15 metres per year and it had lost 51% of its 1850 area. Between 1946 and 1979, the retreat slowed to four metres per year but the glacier reduced in area another 41% from the 1946 total. Its volume has decreased at even faster rates during this same time span.

The National Park was established in 1910 because of the many glaciers and the rough beauty of its glacially carved mountains and valleys. Less than 100 years later, the many scientists who have analysed the research agree that warming temperatures will eliminate all glaciers from Glacier National Park within four decades. Grinnell's response to the changing climate is currently investigated by Carl Key and Dan Fagre of the US Geological Survey.

Grinnell glacier forms to the south of 2698 metre Mount Grinnell. To the west, the glaciers drain through the Clark Fork, the Bitterroot, and the Kootenay valleys (featured in the movie "A River Runs Through It") to the Columbia River and the Pacific Ocean. A few kilometres to the southeast the glaciers drain through the Marias and Missouri Rivers to the Mississippi and the Gulf of Mexico. But the Grinnell drains to the St Mary's and South Saskatchewan Rivers out through Canada to Hudson's Bay.

Since the 1930s, Going-to-the-Sun Road has brought countless visitors into Glacier National Park who expect to find ecosystem treasures in the high mountain "wilderness". Sadly, those treasures are as doomed as the glaciers that nurture them. According to the 2002 US National Communication to the UN Framework Convention on Climate Change, alpine meadows in the Rocky Mountains are particularly threatened and will disappear entirely in many places. These alpine meadows host plants adapted to cold conditions too harsh for other species. The range of trees that thrive in high, cool environments will shift northward. In the Rockies, alpine and sub-alpine spruce-fir forests will shrink and, in the long term, disappear as their mountain habitats warm. These are the ecosystems that include grizzly bears, mountain lions, wolves, bighorn sheep, mountain goats, and cutthroat trout.

The hydrological cycle familiar to the inhabitants of the American West is changing rapidly. Climate models suggest that precipitation will increase on the western slopes of the Rockies and that it will fall more as rain and less as snow. Snow will fall later in the autumn and will melt earlier in the spring. On the eastern slope the predictions are gloomier. Precipitation is expected to decrease but what falls will come fast and wet. This means less water stored as snow and ice for slow release and percolation through thawed soils as the season warms. Less snowfall and



1914

Marble, Glacier National Park archives



1997

Fagre, Glacier National Park archives

earlier snowmelt increase the probability of flooding early in the year and reduce the runoff of water during late spring and summer. Basins in the western United States are particularly vulnerable to such these shifts in timing of water delivery.

Less moisture in late spring and summer means greater risk of wildfire in forests, scrub, and grasslands. It also means less supply for agriculture, hydroelectric capacity, industrial processes, and domestic consumption. Ecosystems under stress from drought invite pest infestation. Whole forests and ecosystems will not survive. They are being destroyed right now by fire and predators. Only marginal populations will survive and adapt to the changing climate.

US citizens know that their climate is changing and many attribute it to fossil fuel addiction. According the the US National Assessment on Water, "Global-average and U.S.-average surface temperatures will continue to increase above recent historical levels unless there are substantial changes in both U.S. and international energy and land-use patterns. As greenhouse-gas emissions continue into the future, the size of these temperature increases will become larger over time."

In the meantime, America's beloved western wilderness withers and burns. And soon, Glacier National Park's rugged beauty will look ordinary and tame because it will have no glaciers at all.

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