









Legend

This map presents in a single image a set of conditions and dynamic events spanning thousands of years. It does not represent a specific single moment in time.

-  **The Cordilleran Ice Sheet** is shown at approximately its maximum extent, around 21,000 years ago. The repeated advances and retreats of its Purcell Trench lobe in what is now northwestern Idaho led to the repeated filling of glacial Lake Missoula.
-  **Mountain Glaciers** are shown in detail only for Oregon, at their maximum extent (see pages 134–135 for detailed maps). Mountain glaciation is shown only in a generalized way for Washington, and not at all for Idaho.
-  **Glacial Lake Missoula** is shown here at its maximum stand, just under 4,200 feet above sea level. The lake appeared, grew and emptied repeatedly between 18,000 and 12,000 years ago, in widely varying extents.
-  **Spillway** of the Lake Missoula Floods.
-  **The Missoula Floods** occurred as many as 100 times between 18,000 and 12,000 years ago and are shown here at their maximum extent covering much of eastern Washington and most of the Willamette Valley.
-  **Narrows**, natural choke points behind which flood waters backed up into low-lying surrounding areas.
-  **Pleistocene Lakes of the Great Basin** are shown at their maximum extent, about 18,000 years ago.
-  **Lake Bonneville Flood** occurred about 14,500 years ago and involved about 20 times the normal flow of the Columbia River.

The Missoula Floods

The most far-reaching and catastrophic events of the Pleistocene Ice Age in the Pacific Northwest were the Missoula Floods. These cataclysmic deluges occurred repeatedly when a lobe of the Canadian Cordilleran Ice Sheet advanced across the Clark Fork River in what is today northwestern Montana and northern Idaho. As the river valley filled with ice and glacial debris, the Clark Fork backed up, filling neighboring valleys to a distance of up to 200 miles to the southeast. Glacial Lake Missoula at its greatest extent held over 360 cubic miles of water, roughly the volume of today's Lake Ontario in the Great Lakes system. When the ice dam failed, the entire lake emptied in a matter of days, sending a wall of water across the Idaho Panhandle into Washington's Columbia Basin, and then through the Columbia Gorge and out to the Pacific. The cycle of damming, lake filling and catastrophic flooding may have occurred as many as 50 or even 100 times at the end of the Pleistocene epoch, between 18,000 and 12,000 years ago. In volume, each of these floods contained several times the combined flow of all the rivers on the globe. The Missoula Floods may have been the largest discharges of water in the history of the earth.

As the floodwaters roared southwestward across eastern Washington, they scoured the surface topography down to bedrock to create the rugged landscape today called the Channeled Scablands. At several choke points or narrows, the floodwaters briefly backed up to create large ephemeral lakes, one of which (Lake Allison) flooded nearly all of the Willamette Valley.

Floodwaters transported slabs of floating glacial ice, which carried embedded sedimentary debris, including boulders, from the mountains of Montana. As flood lakes receded, ice rafts stranded and melted, leaving behind transported sediments and large "erratic" boulders. In the Willamette Valley these erratics number in the hundreds and bear witness to the presence of standing water at least as far south as Harrisburg, just north of Eugene. The Willamette Formation represents fine sediments that settled out of the turbid waters onto the lakebed before the valley drained out to the north.

Ice Age Lakes

During a period of substantially increased rain and snowfall approximately 50,000 years ago, natural depressions in the Basin and Range region began to fill, creating large "pluvial lakes." The largest, Lake Bonneville, filled to the point of overtopping a divide nearly 800 feet above the present level of the Great Salt Lake, sending floodwaters north into the Snake River and down Hells Canyon into the Columbia. Outflow from Lake Modoc on the California–Oregon border deepened the Klamath Gorge. The rest of these lakes expanded and shrank within closed basins. Lush wetland vegetation brought sizable populations of fish, birds and mammals, including Pleistocene elephants, horses, bison and sheep. Reduced precipitation after about 11,000 years ago has shrunk these pluvial lakes to the much smaller but still fluctuating lakes of the present.