FOLLOWING THE GREAT FLOODS

When Glacial Lake Missoula exploded through an ice age dam, the deluge flooded much of the Pacific Northwest. Evidence of that cataclysmic event is still visible in parts of western Montana. BY BECKY LOMAX

HALF-MILE TALL During the last ice age, a glacial lobe crept down from Canada into the Idaho Panhandle and blocked the Clark Fork River's westward flow. The 2,500-foot-high dam created a massive lake covering much of what is today western Montana.

ILLUSTRATION BY STEVE H. OMINSKI

THE GREAT WALL OF WATER When the ice dam broke, 500 cubic miles of water was forced between tall cliffs, causing the torrent to gush as if sprayed from a nozzle.

STEV H. OMINSKI

Fifteen thousand years ago, a torrent of water—ten times the flow of all the world's current rivers combined—rampaged across the Pacific Northwest. The source, Glacial Lake Missoula, disgorged a tumultuous flood from today's western Montana when a glacial dam gave way.

A volume of water equal to Lakes Erie and Ontario combined tore its way west at 65 miles per hour, gouging out canyons, dropping house-sized boulders, piling up mile-long sandbars, and eventually spewing debris for miles into the Pacific Ocean.

That catastrophic ice age flood and others afterward left remnants and signs of their existence across the Northwest. In western Montana, visitors can see massive boulders stranded on open plains, hillsides scarred from floodwater debris, ripple marks so big they're visible from space, and gaping potholes gouged by the swirling torrents.

In 2009, Congress recognized the unique effect of the great floods on the four-state landscape by establishing the Ice Age Floods National Geologic Trail. The geologic trail, the nation's first, is not a hiking path but rather a route along existing highways across the four-state region where visitors can see evidence of the great flood.

Becky Lomax, a writer in Whitefish, is a frequent contributor to Montana Outdoors.

LIKE WATER FROM A NOZZLE

From 15,000 to 20,000 years ago, fingers of the Cordilleran ice sheet that covered Canada crept southward across the 49th parallel. One massive glacial lobe inched south into the Idaho Panhandle through the Purcell Trench and eventually blocked the westward path of the Clark Fork River. The 2,500-foot-tall ice dam forced water back up into northwestern Montana valleys, producing a massive lake of long fjord-like inlets.

As water deepened behind the dam, pressure built until eventually the ice formation burst. During the next several days, 500 cubic miles of water was forced between tall cliffs 1.5 miles apart, shooting out of the narrow opening as if sprayed from a nozzle. The cataclysmic flood—estimated to be 60 times the flow of the Amazon River—spewed glacial debris and torrential waters more than 400 miles westward to the Pacific Ocean. Floodwaters tore across eastern Washington, chewing black basalt bedrock into a tangle of channels, canyons, and gorges found today in the Palouse River and Grand Coulee Canyon. Thundering water laden with ice, boulders, and topsoil sheared walls of the Columbia Gorge into vertical cliffs. As floodwaters drained from Washington and Oregon, they deposited boulders weighing up to 40 tons in the Willamette Valley. Mile-long bars of coarse gravel piled up around Portland.

This geologic devastation happened more than once. As new glacial fingers spread south and blocked the Clark Fork, Glacial Lake Missoula reformed then flooded again at least twice, according to Marc Hendrix, a University of Montana (UM) geology professor. "But exactly how many more times, we don't know," he says.

That's not the only mystery geologists are trying to solve. Evidence along the Flathead River indicates that Glacial Lake Missoula existed for roughly 3,700 years but doesn't reveal the date. "We don't know exactly when Glacial Lake Missoula existed because very little organic carbon was preserved in the lake," says Hendrix. "Without this information, it's difficult to reconstruct its history through geologic time." Another puzzle is the ice dam. "No one has been able to demonstrate whether it failed from wholesale collapse or from a slower, tunneling-based release of water," says Hendrix. "It really depends on how fast the glacier advanced and the balance between the erosive effects of summer river water flowing under the glacier versus the ability of the glacier to self-heal by surging forward and closing off sub-glacial tunnels."

Despite uncertainties over some aspects of the ice age lake and dam, geologists agree that Glacial Lake Missoula gave birth to some of the world's biggest floods. Its discovery allowed geologists to recognize the "signatures" of great flood sites elsewhere. Research from the Montana-based events has even provided geologists with evidence to help determine that catastrophic floods created the giant ripple marks and outwash fans on Mars, says Jim Shelden, president of the Glacial Lake Missoula Chapter of the Ice Age Floods Institute.

As stipulated in last year's Ice Age Floods Bill, the National Park Service oversees the trail from its Seattle offices, but communities in Washington, Oregon, Idaho, and Montana will operate individual interpretive stops. "The trail concept was sold all the way to Congress as being largely under local control, so that small communities would benefit," says Shelden. "The idea was that the trail adds something that would make a tourist buy a steak in town or stay a night." The Washington-based Ice Age Floods Institute, which has been guiding public field trips over the last decade, has jumpstarted the process by establishing interpretive exhibits at roadsides, visitor centers, and museums along the route.

Because the trail begins in western Montana, Shelden and others see Missoula as a natural starting point. The institute helps maintain a display in the Montana Natural History Center there, but Shelden and others hope a full-blown Ice Age Floods Trail visitor center can be built someday. According to the UM's Small Business Institute, a center would generate between $733,000 and $3.9 million each year for Missoula from tourism. Other Montana communities such as Polson—as well as Lewiston (Idaho); Ellensburg, Yakima, and Spokane (Washington); and Eugene and Astoria (Oregon)—will benefit economically from trail tourism. Though Congress has yet to appropriate funds for interpretive kiosks, signage, education programs, or other floods trail management, visitors today can see many remnants of the landaltering events on their own.

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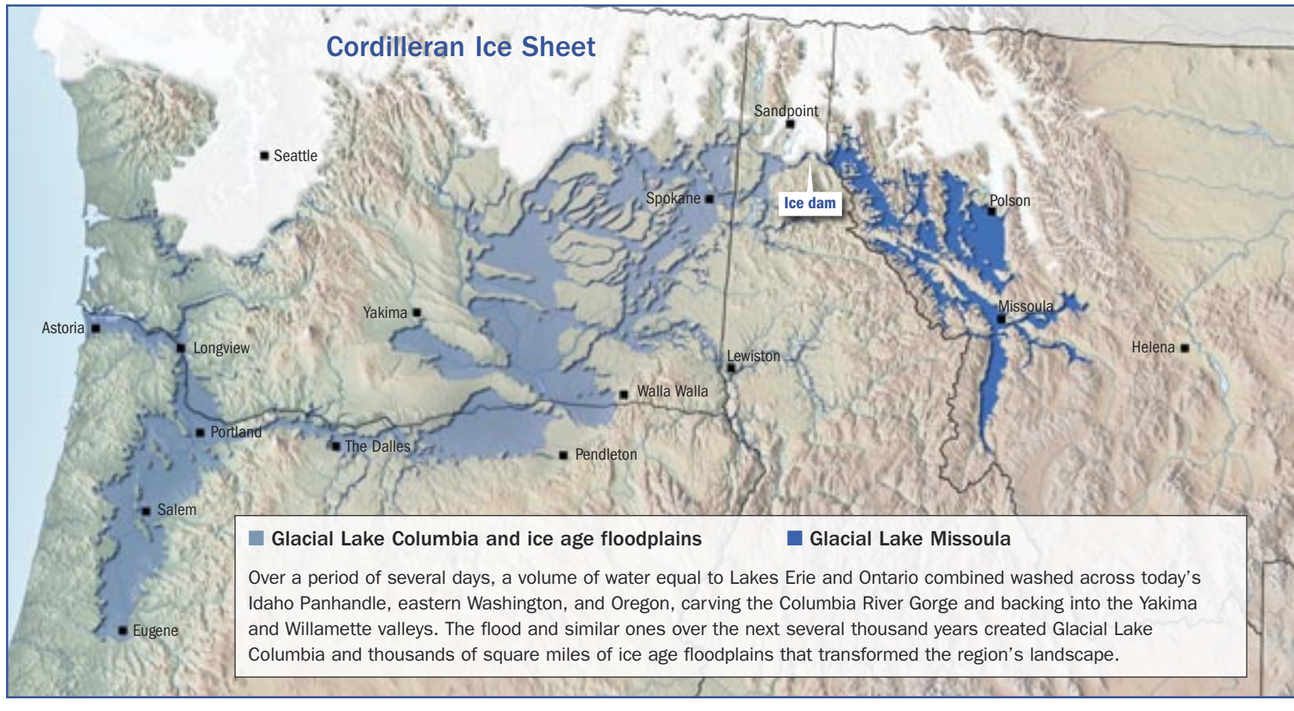

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LITTERED WITH EVIDENCE

Signs of the ice age lake and floods are scattered across northwestern Montana. "We're lucky to have all these sites right here in our backyard," says Hendrix. Like rings in a bathtub, Glacial Lake Missoula left proof of its existence in strandlines—horizontal terraces created by varying lake levels. These are most evident on the grassy slopes of mountains around Missoula, particularly Mount Jumbo and Mount Sentinel. The strandlines also appear along the U.S. Highway 93 corridor north to St. Ignatius. While hard to distinguish during some seasons, they become pronounced when highlighted by fresh or melting snow.

The torrents also pried boulders loose and plopped them in places where they now sit alien amid surrounding native geology. Angular boulders—some weighing several tons—are strewn across the UM campus. One boulder plucked from the walls of Hellgate Canyon, 1 mile east of the university, protrudes 5 feet above the grass in the campus area known as The Oval.

Floodwaters also left ripple marks—huge undulating, wavelike patterns in the ground. South of Hot Springs, giant grass-covered ripples of silt crest up to 35 feet high. The earthen waves also run perpendicular to State Route 382 through Camas Prairie. The massive ripples, big enough to be visible on Google Earth, formed the primary evidence in 1942 for geologist J.T. Pardee to infer that Glacial Lake Missoula emptied rapidly.

Montana also holds evidence of a kolk—a titanic whirlpool that can grind a lake bed out of bedrock. When the floodwaters collided, they created a violent vortex that dug up rock chunks and flung them into the torrent. Southwest of Hot Springs on Montana Highway 28, a kolk augured the 1.5-mile-long Rainbow Lake from bedrock. Also known as Dog Lake, the basin sits in a depression with no inlet or outlet. Rocks chewed from the basin landed several miles away along the road toward Plains.

Much of Glacial Lake Missoula drained through the Clark Fork River channel. Like those in smaller rivers, the floodwaters amassed stones into gravel bars and sheared rock to form steep-walled canyons. West of Missoula at Tarkio, look for a 1.5-mile-long gravel bar several hundred feet high, full of rounded rocks the size of softballs and footballs. Farther downstream, between Plains and Thompson Falls, the Clark Fork squeezes through the rugged vertical-walled canyon of Eddy Narrows. The sheer rock cliffs, scraped free of topsoil by gushing torrents, are witness to the floodwaters' enormous power.


NORMAN & MAURINE JACOBSON


JIM STREETER


BECKY LOMAX

MOUNTAINS OF EVIDENCE When the ice dam broke, some floodwaters tore through Hellgate Canyon (above), a mile east of Missoula. The canyon is flanked by Mount Jumbo and Mount Sentinel, both of which show terracing caused by varying floodwater levels. Right: Dark and light layers of clay silt deposited by the glacial lake are today visible near Ninemile. Below: Earthen ripple marks resembling large waves were left by racing floodwaters in Camas Prairie south of Hot Springs.

Humans did not reach the Pacific Northwest from Alaska and Canada for several thousand years after the great floods swept across the region. As a result, no pictographs, legends, or other cultural evidence of the geologic events exist. But the floods themselves left ample evidence of their passing. Over a single weekend (see sidebar below), Montanans and visitors can see stark reminders of what nature can do when the right climatic conditions combine.

Learn more at the Ice Age Floods Institute's website, iafi.org, or at the Montana Natural History Center's Glacial Lake Missoula website, glaciallakemissoula.org. Or pick up a copy of Glacial Lake Missoula and Its Humongous Floods*, a lively history of the geologic event by UM geology professor David Alt (Mountain Press Publishing Co., 2001).*


BECKY LOMAX

Interpretive panels tell the ice dam story at the Cabinet Gorge Dam Viewing Area.

A self-guided weekend tour of the ice age floods

By Becky Lomax

To see some of the most dramatic flood features, take this weekend driving tour—complete with camping at three state parks:

1 Salmon Lake to Big Arm

Both Salmon Lake and Big Arm state parks sat under hundreds of feet of ice when Glacial Lake Missoula existed. A tour between them leads through the ancient lake bed. From Salmon Lake (about 25 miles east of Missoula), follow Montana Highway 200 toward Bonner and then take I-90 to Missoula. One mile before the freeway reaches the city, you'll drive through the tight bottleneck of Hellgate Canyon—the narrowest point in the floodwaters' route to the Pacific Ocean. Raging waters scoured the south wall of the canyon, ripping out boulders and flinging them into the Missoula Valley up to a half mile from the canyon's mouth.

In Missoula, visit the Montana Natural History Center for an overview—including maps, photos, and a 14-minute video—of the Ice Age Floods National Geologic Trail. Then head to The University of Montana to see boulders embedded in The Oval. Ambitious visitors can climb the 17 switchbacks through the glacial lake's strandline terraces on Mount Sentinel to the iconic "M."

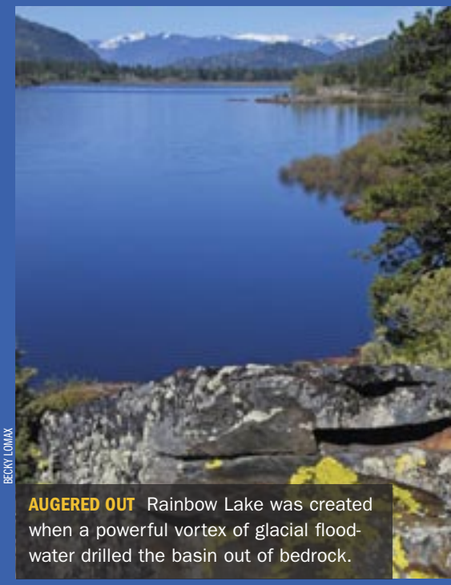
From Missoula, consider an optional 80-mile round-trip that takes you toward Idaho on I-90. One-half mile west of exit 82, look along either side of the freeway to see exposed bands of fine dark clays alternating with light-colored silt—evidence of Glacial Lake Missoula's existence. Between mileposts 61 and 62, the enormous Tarkio gravel bar is revealed, though only a portion is visible along the freeway. Take exit 61 and drive halfway down to the Tarkio Fishing Access Site. Look back to grasp the full scale of the forest-covered geologic residue.

As you head north to Flathead Lake's Big Arm State Park from Missoula on U.S. Highway 93, take a brief detour to the National Bison Range. After reaching the summit of the 19-mile Red Sleep Mountain Drive, look for the Glacial Lake Missoula Interpretive Site on the road's north side. The site sits 150 feet above the lake's highest level. The 30-mile-long expanse of the Mission Valley below is just one finger of the massive glacial lake.

2 Big Arm to Thompson Falls

From Elmo, head south toward Rainbow Lake, 7 miles southwest of Hot Springs on Montana Highway 28. Turn right onto a dirt road swinging west. Park, then climb the dark rocks to view the lake, which was drilled out by a floodwater vortex. Retrace your route along the highway back toward Hot Springs, turning south onto State Route 382 to see giant ripple marks across the Camas Prairie.

From Perma or Plains, head northwest on Montana Highway 200 toward Thompson Falls. Between mileposts 59 and 60, stop at the KooKooSint Sheep Viewing Interpretive Site in the Eddy Narrows to see where the ice age floods swept away topsoil and created the vertical canyon walls.


BECKY LOMAX

AUGERED OUT Rainbow Lake was created when a powerful vortex of glacial floodwater drilled the basin out of bedrock.

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3 Thompson Falls to Idaho border

After camping at Thompson Falls State Park, which would have been buried by 2,000 feet of water from Glacial Lake Missoula, visit the site of the ice dam. Turn off Montana Highway 200 at milepost 62.9 to reach the Cabinet Gorge Dam Viewing Area, which is just over the border in Idaho. Interpretive panels point out the height of the ice

Montana State Parks
(406) 752-5501, fwp.mt.gov

Montana Natural History Center
(406) 327-0405

National Bison Range
(406) 644-2211
fws.gov/bisonrange/nbr/