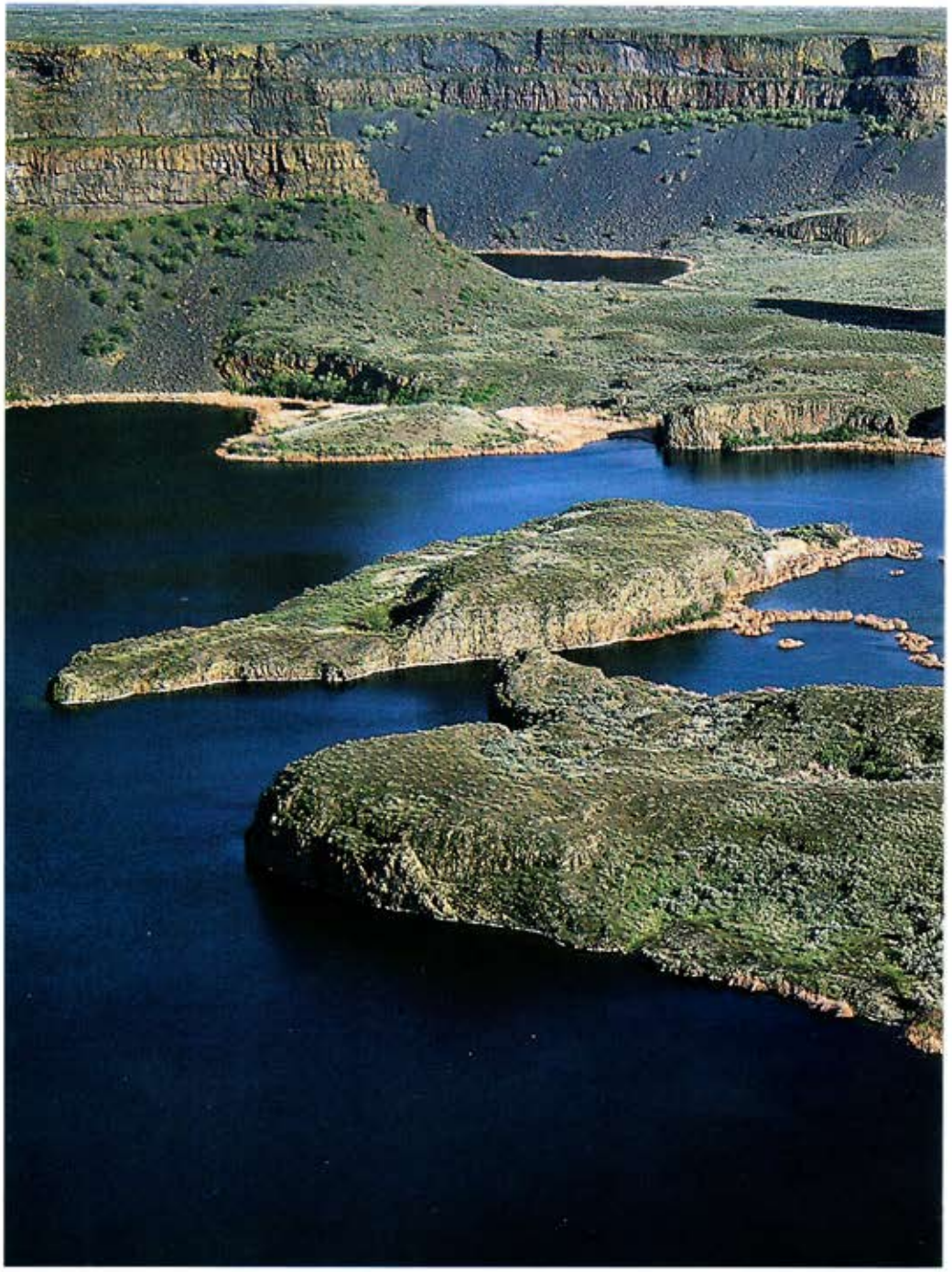
Missoula's MONSTER FLOODS

by RHONDA & GEORGE OSTERTAG
photographs by GEORGE OSTERTAG



WITH NO APPARENT cause in sight, a thunder crescendos, the ground trembles, and an icy wind blows stronger and stronger until it reaches hurricane force. Then it appears—a cataract of water 1,000 feet high rushing forward with ten times the combined flow of all the rivers in the world today. Multi-ton chunks of basalt, house-sized boulders, uprooted trees, and gravel and sediment from across the Pacific Northwest churn in the unstoppable torrent. Rivers run backwards and hilltops are swamped.

This Ice-Age flood and dozens that followed it have shaped land and life in this corner of the United States for thousands of years. Their legacy stretches across the landscape from western Montana to eastern Washington and the Columbia Basin.

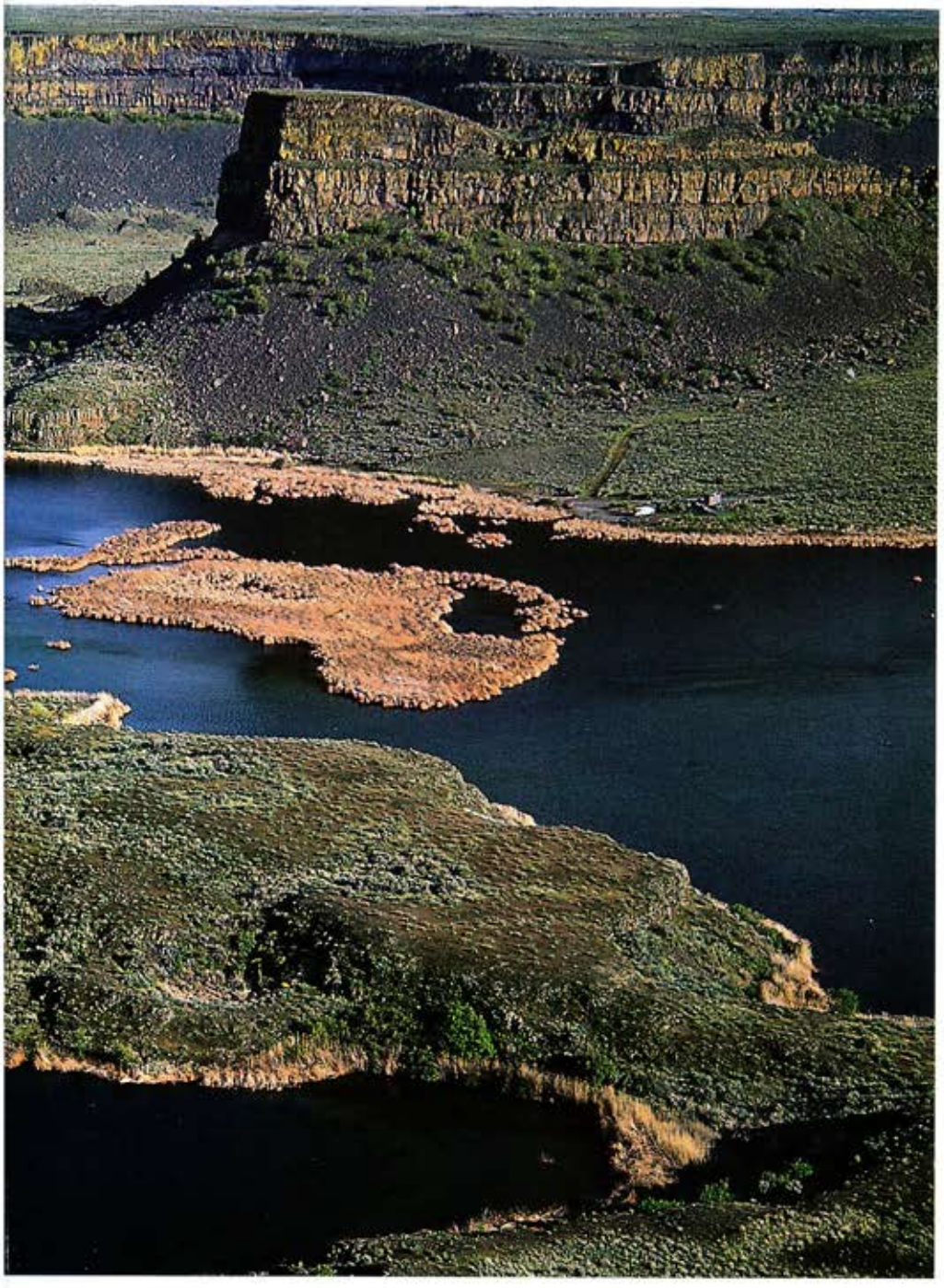
The floodwaters originated in southwestern Montana, near what is now the town of Missoula, about 17,000 years ago. British Columbia and the northernmost valleys of Washington, Idaho, and western Montana lay buried beneath a sheet of ice thousands of feet thick. The frozen fingers of the Cordilleran Ice Sheet inched into the Idaho Panhandle, eventually blocking the waters of the Clark Fork River.

The waters behind the ice dam gradually rose until a 3,000-square-mile lake drowned much of western Montana. Known as glacial Lake Missoula, it contained as much fresh water as present-day Lake Erie and Lake Ontario combined.

The weight of the rising lake waters put increasing pressure on the dam. When the water was nearly 2,000 feet deep—the height of the ice wall—small tunnels appeared in the seal between the ice and the underlying rock. Seeping water melted wider and wider holes in the rock-hard ice. The channels eventually broke through the leading edge of the ice dam, until ultimately the entire wall collapsed. Five hundred cubic miles of water exploded out of the dam at more than 65 miles per hour. At that speed, the lake may well have emptied within 48 hours.

The unbridled waters tore across Idaho, eastern Washington, and northern Oregon at up to 75 miles per hour before spilling into the Pacific Ocean.

JHARLEN BRETZ, A GEOLOGIST with the University of Chicago, was the first to propose the existence of the Missoula Floods. His fieldwork took him into the "scablands," part of the Columbia Basin in eastern Washington stripped clean to the bedrock, gouged with channels, and dotted by pothole pools. After



During successive floods from glacial Lake Missoula, a wall of water three-and-a-half-miles wide and a thousand feet high thundered over this 400 foot drop, now known as Dry Falls. The pool carved out by the torrents is today a tranquil lake mirroring dry rock walls.

studying the landforms, Bretz concluded in 1923 that a catastrophic flood alone could explain the topography.

Bretz presented his theory at a 1927 meeting in Washington, D.C. For a man prone to understatement, his assertion seemed wildly out of character. The very idea of a flood scandalized his colleagues. Uniformitarianism, the prevailing belief of the day, held that ordinary natural forces acting over a long period of time could account for virtually all geological phenomena. By contrast, catastrophic explanations such as sudden floods were heresy, or sophomoric at best. After the presentation, Bretz reportedly said, "They were all loaded for me and after letting me talk for two hours they opened fire." In a 1928 paper, Bretz wrote, "Ideas without precedent are generally looked on with disfavor and men are shocked if their conceptions of an orderly world are challenged."

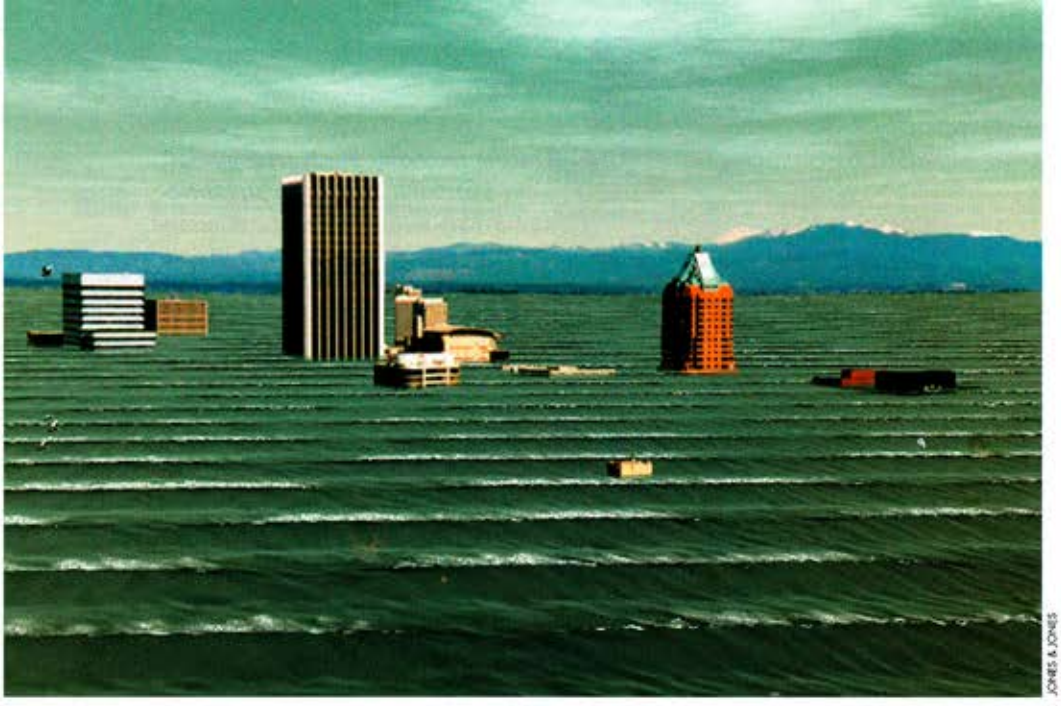
It didn't help that Bretz had no clue as to the source of the water, and he would spend nearly 15 years in doubt about his findings. He was finally redeemed in 1942 by United States Geological Survey researcher Joseph T. Pardee, who connected the floods with glacial Lake Missoula. The existence of the lake had been known since 1872. Pardee himself described it in detail in 1910, when he attributed its formation to a lobe of the Cordilleran Ice Sheet.

But it was the giant ripples of gravel found in Camas Prairie, 50 miles northwest of Missoula, that made Pardee into a believer. These ripples look exactly like the impressions left behind by the currents on a beach, but on a far greater scale. They tower 50 feet high, stretch a mile long, and stand 100 to 250 feet apart. His calculations showed that the ripples must have been made by floodwaters 800 feet deep, traveling at roughly 55 miles per hour. Technology developed during World War II made aerial photography possible, and pictures of the ripples which Bretz published in 1956 put an end to the argument. All the images spelled flood.

WITHIN THE 16,000-SQUARE-mile footprint of the floods lay many more clues to the magnitude of the fast moving water. The water's force had piled gravel bars 30 stories high, carved the broad valleys known as coulees, rerouted rivers, and gouged rounded punchbowls and potholes deep into the rock. It transported granite boulders weighing more than 200 tons and abandoned them hundreds of miles from their place of origin. The torrent cut Washington's Grand Coulee, and steepened the sides of the Columbia River Gorge.

But the formation that has become the icon of the Ice Age floods is central Washington's Dry Falls. Erosion from the rush of hundreds of feet of water ate backwards up the canyon for 17 miles and left behind a sheer precipice. Drained of cascading water today, the horseshoe-shaped cliffs loom nearly 400 feet high and are more than 3.5 miles wide. The perilous surge would make 175-foot tall Niagara Falls look toylike in comparison.

Altogether, the Missoula Floods excavated some 50 cubic miles of earth



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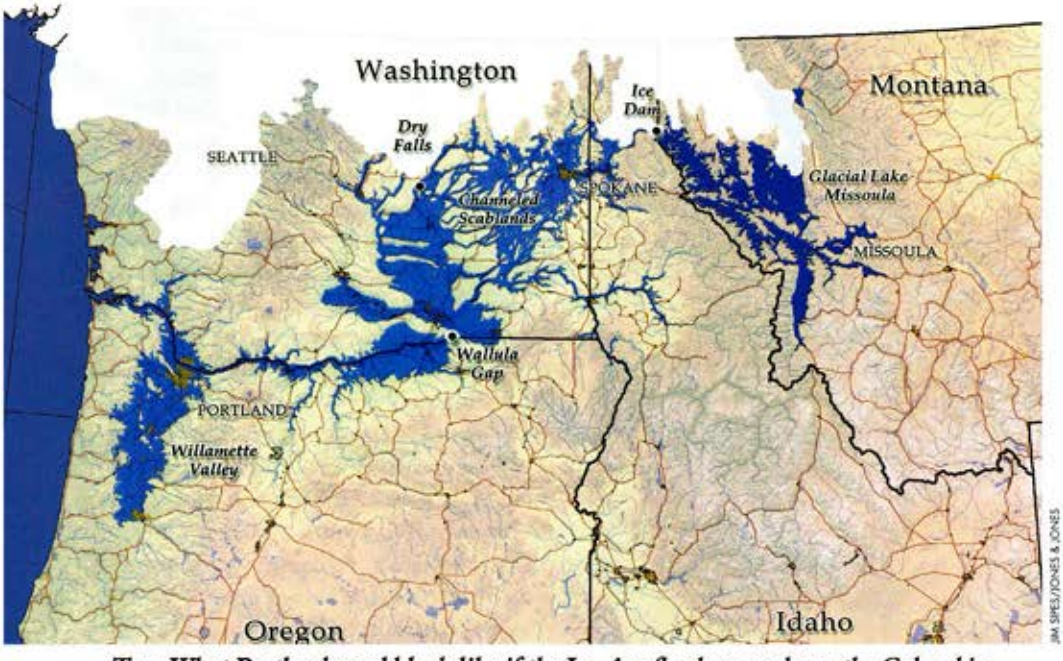

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Top: What Portland would look like if the Ice-Age floods came down the Columbia Valley today. Above: Each time the ice melted and the dam burst, 3,000-square-mile glacial Lake Missoula, impounded by a lobe of the Cordilleran Ice Sheet, probably drained within 48 hours. In the process, it shaped the landforms of Montana, Idaho, Oregon, and Washington and strongly influenced modern land use.

and shuffled the deck, transporting glacial silts from Idaho and Washington to Oregon's Willamette Valley and out to the Pacific Ocean. Geologists estimate that more than 90 percent of the silt ended up on the sea floor.

During the 1970s, geologist R.B. Waitt of the USGS set out to determine the number and frequency of the floods. He studied sedimentary patterns in southwest Washington's Walla Walla Valley. There, the Burlingame ravine exposed layer after layer of sediments stacked in beds one to four feet thick. Rhythmites, Waitt called them. These layers serve as a record of the deposits over time. The composition of each layer supplies clues to its origin and time of deposit. The sheer number of rhythmites suggested dozens of floods had blasted through the region. Waitt's findings confirmed at least 40 flood cycles, but more recent studies elsewhere in the region now put the flood count at closer to 100.

Sandwiched between the beds of rhythmites are layers of volcanic ash that erupted from Mount St. Helens. By correlating the ash layers with known eruption dates, scientists have pinned down the era of the dam bursts to between 17,000 and 15,000 years ago. The evidence shows that during this 2,000-year period, the glacier repeatedly advanced enough to stop the river, each time rebuilding the lake, each time ending in flood.

Given that several Ice Ages have come and gone, "It'd be naive to think the Missoula Floods were an isolated event in geologic history," says Jim O'Connor, research hydrologist with the USGS. "Likely floods occurred previously. The problem is, more recent floods would have erased the evidence."

O'Connor's recent studies have highlighted the brute power of the Missoula Floods. Together with Gerardo Benito of the Center of Environmental Sciences in Madrid, Spain, he calculates that at least 15 of the floods that charged through the Columbia River Gorge moved water at a rate more than five times faster than the Amazon River empties into the Atlantic.

Comparable catastrophic floods have occurred in other glaciated areas on Earth. Significant single-episode floods in North America include the draining of glacial Lake Agassiz, located in what is now Manitoba, Canada, as well as glacial Lake Bonneville, the gigantic forerunner to Utah's Great Salt Lake. But even the transformation of the landscape caused by the breaching of Lake Agassiz, which measured four times the size of Lake Superior and whose 12,000 cubic miles of water probably caused the world's oceans to rise half a foot, cannot rival the Ice Age torrents of the West. For now, the Missoula Floods remain the greatest documented freshwater floods on Earth.

Comparisons even stretch to Mars. The channel-riddled landscape of the planet's Ares Vallis ("Mars' Valley") so resembles the scablands of eastern Washington that NASA scientists studied them in preparation for the Mars Pathfinder mission.

BY RESHAPING THE TERRAIN, redistributing the sediment, and changing aquifers and waterways, the

floods prescribed where wildlife and humans would settle and live today.

Keith Dunbar, a planner with the National Park Service, says the potholes and flood-scoured depressions left behind by the floods in eastern Washington have since become productive freshwater marshes. The wetlands draw hundreds of thousands of migrating waterfowl each year as part of the Pacific Flyway.

The floods later determined travel routes through the region. The coulees and river valleys became highways into and around the area, first for wildlife and Native Americans, and later for the pioneers, the railroad, and modern freeways.

The Oregon Trail owed both its reason for being and part of its route to the floodwaters. The promise of the Willamette Valley was its abundant fertile soil, delivered by the floods. Near present-day Hermiston, Oregon, sand left behind by a lake formed by the floods swallowed the metal-rimmed wagon wheels of the first Oregon Trail pioneers. Later emigrants chose a route farther south, which delayed their arrival at the Columbia River.

In eastern Washington and Oregon, raw scablands sit side-by-side with islands of farmland bypassed by the flood's onslaught. On these islands, the fertile loess soil supports wheatfields. In the valley bottoms of the Walla Walla, Yakima, and Willamette, farmers grow grasses, vegetables, fruits, and nuts in the rich flood silts. Farther up the valleys a thin layer of silt favors vineyards.

Though the Missoula Floods rolled across the Pacific Northwest 17,000 years ago, their impact still tumbles on.

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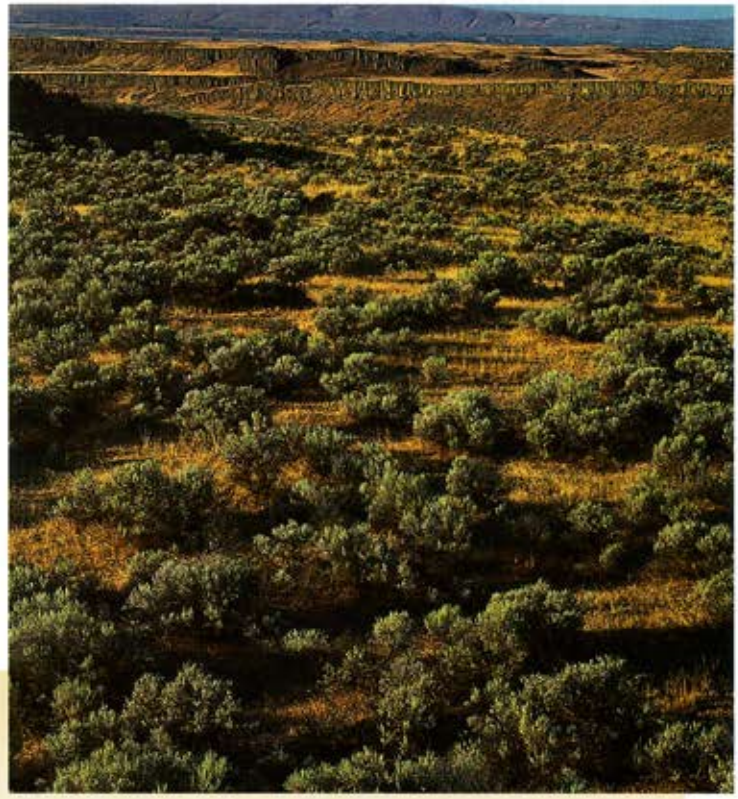
Above: Glacial Lake Missoula's Floods rerouted the Palouse River some 15,000 years ago, gouging out the Palouse Falls.



Right: The floods scoured the earth clear down to bedrock. Today, scant pockets of thin soils on these scablands can only support sagebrush and hardscrabble grasses.

Ice Age Floods National Geologic Trail

AN ICE AGE FLOODS NATIONAL GEOLOGIC TRAIL retracing the route of the floods has been proposed. According to planner Keith Dunbar of the National Park Service, the trail would allow visitors to follow the 600-mile path of the flood by reading informational plaques posted along existing highways. The route would begin in present-day Missoula, site of glacial Lake Missoula, and stretch across western Montana, northern Idaho and eastern Washington, through the Columbia River Gorge, into the Willamette Valley, and out to Astoria, Oregon, where the floods emptied into the Pacific. The Park Service report was passed to Congress in 2001, where legislation to designate the trail and begin development has yet to be introduced. The full report is available at http://www.nps.gov/iceagefloods/