With measuring tools ranging from old-fashioned yardsticks to high-tech Doppler radar, streamgagers watch the state's potentially dangerous rivers.

MONITORING MONTANA'S MOVING WATER

BY BECKY LOMAX

Greg Trunkle perches 20 feet above the muddy North Fork of the Flathead River in a metal-framed cable car attached to an inch-thick galvanized cable. The river churns with late May runoff at Glacier Rim, about 4 miles upstream from where the river meets the Middle Fork of the Flathead at the southwest corner of Glacier National Park. Trunkle, a streamgager for the U.S. Geological Survey (USGS), hand pulls the cable car across the 200-foot-wide channel, stopping every 5 feet to measure the river's depth and speed. As the car bounces from his movements, he winches a 100-pound torpedo-shaped lead weight down into the torrent. All the while, he eyes the water upstream to make sure no floating trees or other debris will snag the weight and tear it—and the cable car—into the swollen river. As the weight touches the riverbed, an attached meter in Trunkle's hand displays the water depth.

He cranks the weight a few feet off the bottom. Above the weight, six tiny cone-shaped cups spin on a horizontal wheel, producing audible clicks. The rate of the clicks tells Trunkle the river's velocity. He jots the data in a notebook dangling from a cord around his neck, slides the car another 5 feet, and repeats the process.

For more than 100 years, streamgagers have been wading streams and dangling from cables above rivers to gather information critical for flood forecasting, bridge construction, water quality monitoring, and various uses of streams. Gaging (spelled without a "u" in this discipline) also provides vital information to anglers and rafters as they plan trips, adjust angling strategies, and determine whether rivers are safe enough to float.

In the Middle Fork of the Flathead River lurks a massive boulder known as the Can Opener. When the river runs high, at 5 or 6 feet, rafters splash safely over the rock. But as flows drop in summer, the rock emerges, snagging boats and knocking riders into the river. "As soon as the river drops to 4 feet, our guides know to watch out," explains Randy Gaynor, owner of Montana Raft Company in West Glacier. Gaynor and his guides also track streamflow to learn when snowpack runoff has peaked and they can begin scheduling fishing trips. "When the river maintains a consistent drop, that's a good indication it will clear up soon and the fishing will be good," says Gaynor.

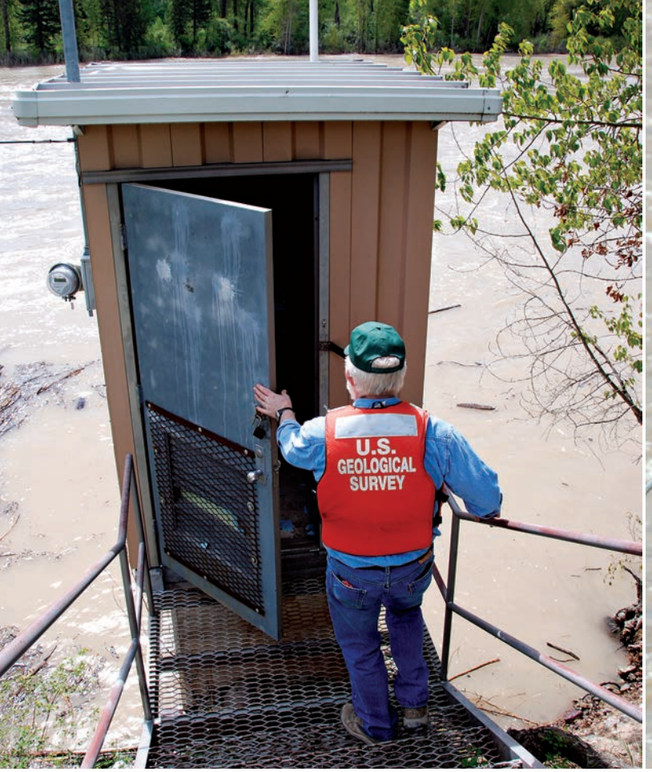
ESSENTIAL INFORMATION

Because rivers can be dangerous, they require constant surveillance. When engorged with high water they can destroy property, drown boaters, and blow out bridges. When river levels drop too low, fish die and water needed for drinking, irrigation, and industry slows to a trickle. To keep a close watch on rivers, the federal government maintains a little-known but essential service called streamgaging.

Streamgagers measure "flow," or discharge—the total volume of water moving past a point on a river in a given time. Measured in cubic feet per second (cfs), flow is determined by multiplying a river's width by its depth by its velocity. That calculation would be easy if a river were all one depth and its velocity the same top to bottom, mid-stream to shore. But current speed varies widely, and stream channels are irregular. Streamgagers, therefore, measure the water depth and current speed at several

BOMBS AWAY Greg Trunkle, a federal streamgager, lowers a 100-pound device into the swollen waters of the North Fork of the Flathead River to record water velocity and depth.

ALL PHOTOS BY BECKY LOMAX EXCEPT WHERE NOTED.



CRAIG & LIZ LARDOM

CURRENT AFFAIRS Clockwise from above left: "Lucky" Sultz, a retired streamgager, enters a gagehouse on the Flathead River at Columbia Falls where river stage is automatically recorded every 15 seconds and transmitted by satellite to U.S. Geological Survey offices. Streamgager Phil Karper pulls his cable car across the Missouri River near Great Falls while testing current velocity. Greg Trunkle lowers a small tri-hulled boat outfitted with Doppler radar into the Flathead River. The high-tech electronics are used where rivers allow bridge access. Without bridges, streamgagers use cable cars and lower a torpedo-shaped weight fitted with a device (white arrow) that measures current velocity as it spins.

points across the riverbed to obtain an accurate picture of the river's discharge. They also record "stage," the height of the river above some given point. And at some locations, streamgagers measure water temperature and occasionally water quality.

Streamgagers update their work on average once a month and sometimes as often as biweekly, says Wayne Berkas, chief of the USGS Montana Water Science Center's Data Section. Flooding, bank erosion, and other natural processes constantly alter the shape of a channel. "The geometry of a river changes every time the river surges," says Berkas. Streams with stable channels do not need to be measured as often as those with fast-changing sandy bottoms, such as the Powder River. Also requiring more frequent monitoring is the Bighorn River downstream from Yellowtail Dam, where algae grows so thick it can alter river flow.

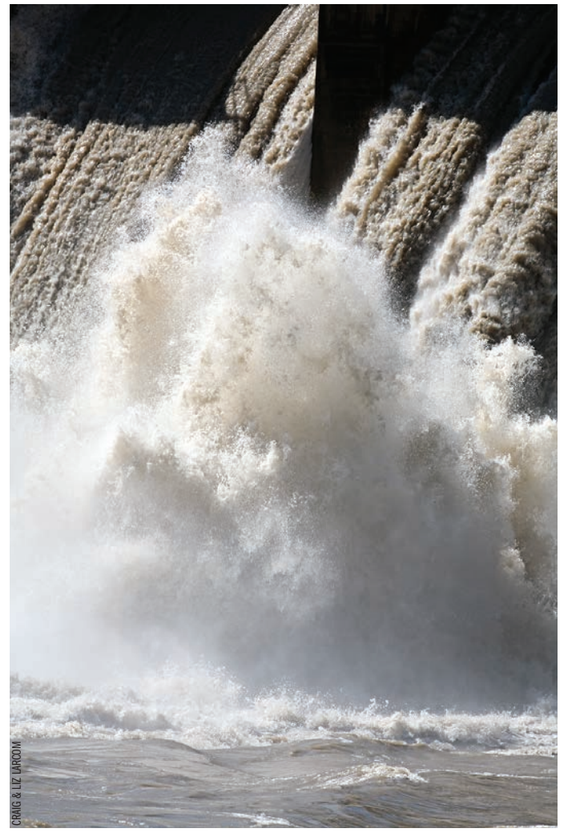
Montana's oldest gaging station still in operation is at Fort Benton on the Missouri River. Records there date to 1890, when flow and stage readings were telegraphed downstream to steamship captains so they could determine if the Missouri was navigable. Later, the USGS dispatched streamgagers from Denver and Spokane to Montana, where they rented horses to reach remote rivers. Streamgagers waded into streams and small rivers to take measurements with yardsticks, a method still used today. On rivers with bridges, they lowered a weight from the trestle. On large rivers that lacked bridges, they built cable spans like the one still used on the North Fork of the Flathead and many other large rivers across Montana. "It's technology designed in the 1930s," explains "Lucky" Sultz, a retired 27-year veteran streamgager, "but they haven't found anything more accurate."

They have found a method that's faster, however. Where bridges cross rivers, modern streamgagers use Doppler radar to measure the channel. Over the side of a bridge spanning the Flathead River in Columbia Falls, Trunkle lowers an orange trimaran equipped with a $25,000 radar device that reads the water depth and flow. While holding a line to the small boat, he pushes a baby jogger rigged with a computer and a transmitter across the bridge. In 14 minutes, he walks two round trips over and back. Doppler beams bounce off particles in the water to read the speed and off the riverbed to determine depth. "It may take longer to set up and test this than to do it by hand, but the computer shows me a whole picture of the river as I go across," says Trunkle, adding that this site would require two hours to measure the old way.

Back at his Kalispell office, Trunkle types the data into his computer. Sultz, the retired streamgager who accompanied Trunkle today, says that when he began measuring river flow and stage data in 1979, the information was hand written in ledgers and published only once each year. "The Internet was a radical change that really sped up the pace of our work," says Sultz, noting that Montana was the first state to put real-time river data on-line. "Now there's more pressure than ever to make sure the data is correct."

In addition to the information gathered by 15 field streamgagers, the USGS uses automated gaging stations at 220 sites on roughly 100 streams and rivers. These small shacks located on riverbanks contain pipes that extend into the river and monitor stage to within one-eighth of an inch every 15 minutes. The information is then transferred by satellite to a publicly accessible USGS website (see sidebar on page 40).

Becky Lomax is a writer in Whitefish.



CRAIG & LIZ LARDOM

NO WADING TODAY Water gushing from the Morony Dam near Great Falls demonstrates the Missouri River's enormous power. The flow this day was 12,400 cfs, just one-sixth that of the record of 72,000 cfs set in June 1964. Left: Trunkle jots down flow and depth readings recorded by a Doppler radar device.

DRY FLIES OR STREAMERS?

Recreation, livelihoods, and even lives depend on the data's accuracy. Just downstream from the Camp Baker Fishing Access Site, the put-in spot for popular float trips down the Smith River in central Montana, a gage tells Montana Fish Wildlife & Parks staff when the water has dropped too low for outfitters or individuals to run drift boats or rafts. The gage also indicates when the river is too high and dangerous to float. A gage on West Rosebud Creek monitors flow from the small Mystic Lake power plant, a popular kayaking spot in the Beartooth Mountains

about 75 miles southwest of Billings. Tim Tollett, owner of the Frontier Anglers fly shop in Dillon, says he and his staff regularly check the USGS website for streamflow conditions. "If the Beaverhead is at 300 cfs in mid-July, we can expect some incredible PMD (Pale Morning Dun) hatches," he says. "But if it's at, let's say, 700 cfs, then there will be way too much surface turbulence for good dry fly fishing."

"For fisheries management, streamgaging data is critical," says Andy Brummond, FWP streamflow specialist. He explains that biologists track present and historical stream flow and stage as well as stream temperature so they can make informed management decisions. Gages on the Big Hole River, for example, tell biologists when midsummer water levels drop so low they threaten arctic grayling. When trout stream temperatures soar above 73 degrees F for three days running, fisheries managers close waters to angling to prevent further stress to trout. "Without the gaging data, we would know far less about what's going on in a river that could be affecting fish," Brummond says.

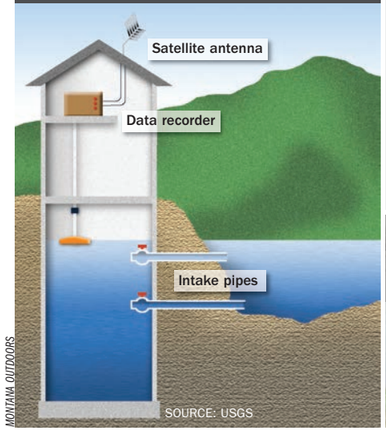
Other stream flow data users include the National Weather Service, for predicting floods, and agricultural producers such as those along the Musselshell and Milk rivers, for regulating irrigation water. Public agencies and private utilities use flow reports to determine the timing and amount of water released from dams for generating hydroelectric power. On contaminated rivers such as the upper Clark Fork, a Superfund site, streamgagers regularly test water quality. On the North Fork of the Flathead, they have begun gathering baseline information to monitor possible pollution from a proposed mining operation just across the border in British Columbia.

A SAFER THRILL Rivers like the Middle Fork of the Flathead offer a wild ride but can drown rafters at high flows. River outfitters regularly monitor USGS streamgaging data to avoid dangerous conditions.

The most frequent users of streamgaging reports are ordinary anglers and recreational boaters. Nonresident trout anglers study historical hydrographs on-line to ensure their next visit to Montana coincides with the best water flows for fishing. Local anglers keep daily tabs to see if their favorite stream is wadeable, or to help determine if certain hatches have begun. Kayakers floating the Gallatin and other whitewater rivers monitor flow reports like day traders tracking the Dow Jones industrial average.

One reason Trunkle doesn't mind pulling himself out over raging rivers or wading ice-cold streams is knowing that kayakers, anglers, biologists, and industries constantly use his information. "I'm an outdoors person, and I wanted a job where I worked with rivers, so this is really a great fit for me," he says. "But we also provide an important service to the public, so that's definitely a another good thing about this job."

Typical gaging station components

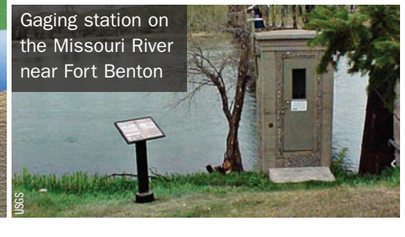


MONTANA OUTDOORS

Follow most Montana streams minute by minute

Hydrologists use gaging stations to automatically monitor river stage, flow, temperature, and water chemistry. There are 220 stations on roughly 100 rivers and streams across Montana. Real-time stream data transmitted to the USGS via satellite is available to the public at mt.water.usgs.gov. The site also shows long-term median flow and lets visitors compare current flows to the flood history of four peak years for each river.

Gaging station on the Missouri River near Fort Benton



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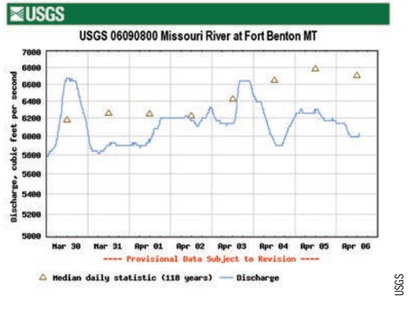

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