OVER ITS BANKS Ordinarily a sleepy prairie river, the Musselshell burst out across thousands of acres of farmland near Two Dot during peak flooding in May 2011. Though tragic for homeowners, businesses, and ranchers, the high water rejuvenated the floodplain, recharged the aquifer, and brought new life to the central Montana river.

CHRISTOPHER BOYER

THE FLIP SIDE OF FLOODS

Though a curse to river towns and nearby farms, high water like that in 2011 can be a blessing for fish populations and aquatic ecosystems.

BY JEFF ERICKSON

It was a sunny June day in Livingston, the snowcapped Absaroka Range towering above town. Standing on the bank with a group of onlookers gaping at the rampaging Yellowstone River below, I overheard someone lament that the river's fabled trout "were being washed downstream to North Dakota."

The Yellowstone at that time was certainly a dangerous torrent of muddy water. In some places the river was spilling over its banks, and uprooted trees raced past in the powerful current. The same was true of rivers across the state. Record snowpack and heavy spring rains had combined to create river flows, water levels, and flooding destruction unseen in Montana for decades.

Yet despite all that hydrological muscle, the high water and flooding did not harm Montana's fish. In fact, the floods actually benefitted many species.

What to us seems like a destructive force above the water surface improves trout habitat below—cleaning spawning gravel, scouring holes, and flushing clogged channels. The same is true for the habitat of other Montana river species such as sauger, paddlefish, and

pallid sturgeon, which have evolved over eons in response to the vagaries of naturally flowing rivers.

For people in their pathway, floods are rarely good news. For fish, even those in the roiling Yellowstone River I watched flow past, periodic high water is essential.

INUNDATION ABOVE, SCOURING BELOW Plants and fish living in river environments have evolved over eons to require periodic flooding. Surging water carves out new river channels, washes fertile silt far onto the floodplain, and carries nutrients into the river. Underwater, the powerful currents scour sediment from rocks and gravel where aquatic insects live and fish spawn.

The heaviest floods of 2011 were east of the Continental Divide, as a combination of above-normal snowpack and drenching spring rains pushed many waterways over their banks. The normally mellow Milk River crested at 26,500 cubic feet per second (cfs), the second highest flow ever recorded. The Musselshell peaked at 20 times its usual flow for late May. The Yellowstone broke a 102-year-old record at Glendive with a torrent of 125,000 cfs. High water flooded several towns—including Roundup, Glasgow, and Crow Agency—forcing the temporary evacuation of hundreds of residents.

In western Montana, flows not seen in a decade or more were reported on the Big Hole, Bitterroot, and Clark Fork, the latter flooding neighborhoods in Missoula.

While causing tens of millions of dollars in road, home, and crop damage, the high water flushed out silt-laden rivers and streams while bathing floodplains in restorative water and nutrients. "Floods reshape the condition of the river. They freshen it up," says Steve Dalbey, Montana Fish, Wildlife & Parks regional fisheries manager in Glasgow. He compares a stream or river to a respiratory system, periodically expanding and contracting in floodplains like healthy lungs so the aquatic system can "breathe."

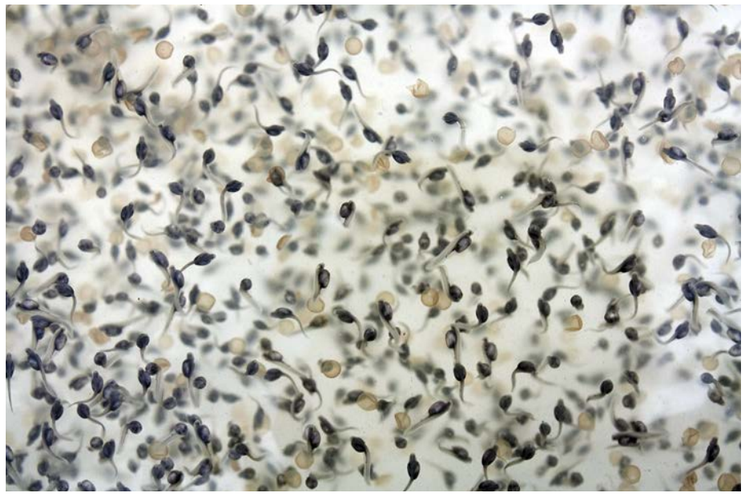
"Floods re-sort and clean out the gravel, creating better conditions for trout spawning redds [grounds]," says Jim Vashro, FWP regional fisheries manager in Kalispell. Vashro explains that trout eggs do best in clean gravel, where flowing water carries oxygen to developing fish embryos. Without cleansing flows, silt washing in from the surrounding watershed fills in spaces between gravel, preventing oxygenation and smothering eggs. Vashro says the spawning success of native bull trout, for instance, decreases during low-flow years, when silt and other fine material can comprise 30 to 40 percent of the stream bottom.

Heavy flows also trigger spawning runs of several species, including the federally endangered pallid sturgeon, one of the rarest fish in the United States. According to George Liknes, FWP fisheries manager in Great Falls, pallid sturgeon numbers have plummeted over the past half-century primarily because of dams. The structures block access to upstream reaches, reduce turbid water the pallid prefers, and hold back strong flows that trigger spawning movement and behavior.

Montana's pallid sturgeon respond to high water in the same way salmon do, says Liknes. The fish don't make spawning runs until heavy flows let them know they can move far upstream, over barriers that block migration when flows are low. Liknes says high flows in the Missouri River above Fort Peck Reservoir in 2011 triggered a surge of spawning pallid sturgeon and enabled them to move farther upstream from the reservoir than ever recorded.

Below Fort Peck Dam, Dalbey says fisheries crews used radiotelemetry to track five pallids well up the Milk River from its confluence with the Missouri. One fish traveled 36 miles, the farthest ever recorded. Large numbers of sturgeon also moved up the Missouri River from below the confluence with the Yellowstone River. "Usually these fish head up the Yellowstone, because it has heavier and warmer springtime flows," Dalbey says. "But last year, 40 percent came up the Missouri due to Milk River flows combined with record releases over Fort Peck Dam." Dalbey explains that water from the top of the reservoir was warmer than water released from the base of the dam, as is usually the case. "Pallids respond to warmer water, because they evolved here long before there were any dams," he says.

WHAT DAM? High water swamps diversion dams like this one at Intake on the Yellowstone River. Fish ordinarily blocked from upstream movement to spawning waters were able to swim over the submerged concrete obstructions. In summer 2011, FWP biologists found spawning pallid sturgeon below Fort Peck Dam for the first time in decades. Below: Newly hatched sturgeon fry.



CLOCKWISE FROM TOP LEFT: NELSON KENTER; BRENT HANSON/USGS; STEVEN H. RANNEY; MICHAEL READY

Another first: Fisheries crews found spawning pallid sturgeon congregating below the mouth of the Milk River. Several weeks later, crews sampling the river discovered a recently hatched baby sturgeon, smaller than a pencil eraser. It was the first documentation of pallid sturgeon spawning in the Missouri River below Fort Peck Dam. "All this is unprecedented, a huge change," says Dalbey. "For pallid conservation, it doesn't get much bigger than this."

"All this is unprecedented, a huge change. For pallid conservation, it doesn't get much bigger than this."

Heavy river flows also help fish by restoring connectivity. Flooding allows fish to go over or around low-water obstacles and reach new habitat. High water blows out log jams and beaver dams on tributaries. This lets trout and other species travel farther upstream to prime spawning habitat and then move back later in the year to deeper pools in the mainstem river.

The record high water in 2011 gave spawning paddlefish the opportunity to migrate much farther up the Yellowstone and its tributaries than normal, says Mike Backes, FWP regional fisheries manager at Miles City. "Paddlefish are only able to get over Intake Diversion Dam [near Glendive] or around via a side channel about once every ten years," he says. "After they get upstream of Intake, they can go a long way."

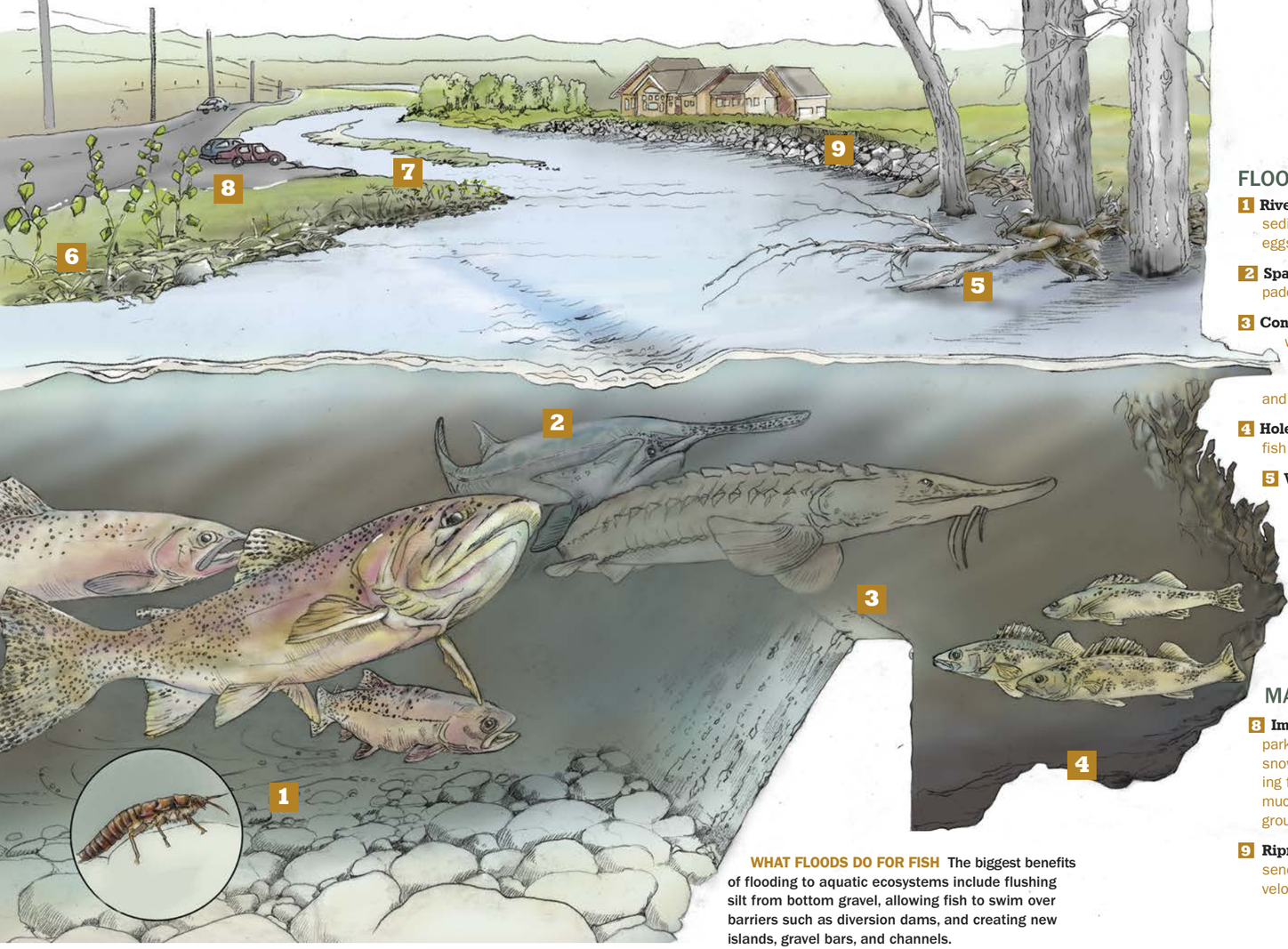
Flathead chubs and lake chubs were found 60 miles from the Yellowstone up tiny Sunday Creek. "Landowners who've been there for 70 years have never seen the creek with so much water," says Backes. "It was a recurring theme on many tributaries in the region."

Floods create new habitat for coldwater, coolwater, and warmwater species including trout, arctic grayling, sauger, burbot, and channel catfish. Heavy flows carve out new side channels, pull boulders in from riverbanks, build new sand and gravel bars, and deposits logs that fish use as habitat. "We should see phenomenal sauger production on the lower Yellowstone as a result of last year's high water," says Backes. "Native species just thrive in these conditions."

Another benefit of high water comes from the sediment it carries into floodplains. Cottonwood seeds take root only in the fine-grained silt left by receding floodwaters. Cottonwoods shade streams, keeping them cooler in summer. When the trees eventually die of old age, they tumble into rivers, adding nutrients and creating hiding areas for fish. "Without the recruitment of cottonwoods and shrubs through periodic flooding, streambanks would be far less vegetated," says Vashro.

On reservoirs and lakes, high water inundates shorelines and draws nutrients into the aquatic system. Plants along flooded shorelines decompose, feeding microorganisms that in turn provide food for insects and fish fry. Many fish species spawn in flooded vegetation, which also provides cover for young fish. "Everything benefits" from shoreline flooding, says Dalbey, who notes that Fort Peck rose to record levels in 2011. At the end of the year, his crews were already noticing "an increasing plumpness in the walleye," he says.

Even with all this good news for Montana fish, flooding does cause some harm to aquatic life. Retreating floods can leave fish



WHAT FLOODS DO FOR FISH The biggest benefits of flooding to aquatic ecosystems include flushing silt from bottom gravel, allowing fish to swim over barriers such as diversion dams, and creating new islands, gravel bars, and channels.

FLOODING BENEFITS

1 **River bottoms** are flushed of sediment that can smother fish eggs and aquatic insects.

2 **Spawning runs** by pallid sturgeon and paddlefish are triggered by heavy flows.

3 **Connectivity** increases when high water allows fish to go over diversion dams and other obstacles that typically block spawning runs and other movement.

4 **Holes and undercut banks** used by fish as hiding cover are scoured out.

5 **Woody debris** is washed into the river, adding nutrients and cover for insects and fish.

6 **Young cottonwoods** grow in the fine-grained silt left by water in floodplains.

7 **New channels** and islands are created by heavy flows.

MAKING THINGS WORSE

8 **Impervious surfaces** such as roads, parking lots, and lawns send rain and snowmelt directly into rivers, increasing flows. Natural vegetation allows much of that water to seep into the ground and aquifers.

9 **Riprap** "corsets" a river's energy, sending it downstream with increased velocity and power.

stranded in fields and road ditches. In some cases, high water velocity causes fish to use too much energy, making them susceptible to disease or predation, or it pushes them to places with less available food. Sustained muddy water can harm the gills of trout and other species unaccustomed to turbidity. And high water can wash eggs out of spawning redds and blow newly hatched fry far downstream.

Cataclysmic floods even destroy fish habitat. If great enough, flows erode banks in ways that make channels too wide and shallow, fill side channels with silt, and suck out submerged logs and other important fish cover. Vashro says some northwestern trout streams ravaged by a massive flood in 1964 still haven't fully recovered.

While some floods blow out beaver dams and other obstacles blocking fish movement, others produce barriers. Vashro says last year's flooding in the South Fork of the Flathead drainage deposited tons of rock and woody debris that prevented fish movement in some areas. "People don't realize how much material a stream moves until they've heard boulders clattering along the bottom," he says.

In some cases human development in a watershed can worsen a flood's environmental effects. One problem is riprap—large boulders, concrete, and other material installed along river shorelines to keep rising water from eroding banks and flooding homes and property. "After a big flood, with the perception that Mother Nature has gone wild, there is a tendency to mess with the river and try to make it leave you alone," says Chuck Dalby, a surface water hydrologist with the Montana Department of Natural Resources and Conservation in Helena. Unfortunately, riprap and dikes cause harm by constricting the river's energy and pushing the water downstream, "where it will eventually find a place to spill out with far greater force," he says. "Riprap essentially moves flooding to your downstream neighbors."

> **"After a big flood, with the perception that Mother Nature has gone wild, there is a tendency to mess with the river."**

"Impervious surfaces" such as parking lots and roads pose another problem. When heavy rains fall on natural vegetation, water is slowly absorbed into the ground, recharging the aquifer. When rain and snowmelt hit pavement or a fairway-like lawn, water quickly cascades downstream, rapidly increasing flows. Streamside residents also worsen a flood's damaging effects when they remove shrubs and trees and replace them with lawn. Without the native vegetation's deep roots to anchor them, banks are eroded by high water and sediment washs into the river.

Floods are able to reshape river channels, carry away cars, and even push buildings off their foundation. Amazingly, those surging waters do little damage to the fish themselves. Contrary to the predictions I'd heard that trout in Livingston were being washed downstream to North Dakota, fish have found ways to survive even the most severe flooding.

One look at the graceful, streamlined form of a trout, sturgeon, or other river fish and it's obvious the creature has evolved to negotiate fast-flowing water. And when flows get too strong, says Backes, fish simply move from the main channel to banks or side channels where velocity is slower.

In a few cases fish wash downstream, such as when newly hatched fry and even adult walleye washed over Holter Dam into the Missouri last spring. But Backes says such cases are uncommon, and that in free-flowing rivers, fry swept downstream eventually move back as they grow larger and flows drop.

LET THE WATER IN Riprap that is used to keep water from flooding homes and eroding banks—shown here on the Yellowstone River near Livingston—acts like a hardening of the arteries, increasing water pressure downstream. When high water is allowed to flow over banks and onto floodplains, cottonwood seeds take root in the silt. Below: seedlings along the Musselshell River in October 2011, sprouting from sediment deposited by floodwaters several months earlier.

Eventually, all floodwaters recede, as I saw for myself a few months later after returning to the Yellowstone downstream from Livingston. It was a river transformed, with massive scour areas on inside bends and islands festooned with enormous tangles of logs and root wads. As I reached the water's edge, I could see early autumn leaves on century-old cottonwoods beginning to turn yellow. In the silty soil below, young seeds were germinating and taking root in the fertile ground created by the flood. I began casting into a run that was low and clear—typical September conditions. Thinking back to the raging torrent I'd seen in June, I recalled an observation by the ancient Greek philosopher Heraclitus: "You cannot step twice into the same river."

It was prime 'hopper season, with both rainbows and browns eagerly taking my foam imitations. Another flood had come and gone, adding new life to this great river. Its streambed was freshly scoured and sparkling clean, and I knew that nymphs were scrambling in the rocks and gravel below the water surface. A trout took my fly and, after a few minutes, I brought it to hand. It was another fat, healthy Yellowstone River rainbow, no worse for the wear.

Jeff Erickson is a writer in Helena.

CLOCKWISE FROM TOP LEFT: ILLUSTRATION BY EMILY HARRINGTON; CRAIG & LIZ LARCOM; USDA/NCRS