ON TO SPAWN Spawning Yellowstone cutthroat trout swim up a tributary of the Yellowstone River. When historical migrations like these are blocked, fish populations suffer.

CINDY GOEDDEL

Open or Close?

Why connectivity is essential for native fish populations—except when it isn't.

By Tom Dickson

When you catch a trout, sauger, or other species from a river or stream, it's natural to assume the fish spent most, if not all, of its life in that one spot.

Yet that fish probably didn't stay put. It likely moved upstream and downstream many times throughout the year, perhaps traveling 100 miles or more. "There's a whole world of fish movement down there, like an underwater freeway that people don't see," says Emma Cayer, Montana Fish, Wildlife & Parks Arctic grayling habitat biologist in Dillon.

Because fish often must travel great distances to complete their annual life cycle, barriers to movement threaten their existence. That's why fisheries biologists spend a great deal of time identifying things that thwart movement, such as dams or degraded stream habitat, and working to help fish swim past those barriers.

But a century of human landscape alterations and new fish introductions have made fish connectivity a complicated matter. As unlikely as it might sound, occasionally a barrier that blocks fish migration is the only thing keeping a population from disappearing altogether.

On the go

Whether it's a redband trout in northwestern Montana or a blue sucker in the lower Yellowstone River, each fish has a wide range of habitat needs during its lifetime and throughout the year.

For instance, river-dwelling westslope cutthroat trout need to lay their eggs in the clean gravel in shallow, clear water found in high mountain streams. Each spring cutthroat make their way up from mainstem rivers, like salmon moving up from the Pacific Ocean, in search of ideal spawning habitat. After spawning, the fish move back downstream to slow-current mainstem pools, where they rest and recover from the stress of spawning. If river water becomes too warm in midsummer, trout move once again, seeking cooler stretches fed by underground springs or mountain streams. In fall, when fish need to bulk up for winter, the trout move to shallower stretches where they can find food more easily. When cold weather arrives and their metabolism slows, the trout hunker down in deep pools to conserve energy in the slow current.

To reach seasonal habitats, fish need the ability to travel. Distances vary widely. Some minnow species like dace, shiners, and chubs that live in small streams can meet their seasonal habitat needs in a stretch no longer than a football field. Larger big-river fish like channel catfish, bull trout, and shovelnose sturgeon might need to swim many miles during the year to find the right conditions. "Over time, most fish have adapted to use as much habitat in the watershed as they need," says David Schmetterling, coordinator of the FWP Fisheries Research Program in Missoula. "By migrating, a species is hedging its bets, so to speak, so that if something goes wrong in one portion, the population still survives because it's using others."

Tracking fish movement

For years, fisheries biologists had little idea how far fish traveled. The heroic migrations of Pacific salmon were widely known. But who knew that burbot, channel catfish, and cutthroat trout swimming in inland waters also needed to migrate?

> "Some sauger that we captured would swim 150 miles downstream, spawn, then move 150 miles back upstream."

During the past 20 years, new technology has allowed scientists to track the movement of these and other species. Fisheries biologists can now surgically implant tiny radio transmitters the size of an AA battery into the belly of fish (an amazing 85 to 100 percent of which typically survive the procedure, depending on the species). Biologists then follow the fish by using handheld receivers or periodically monitoring stations set up 20 to 30 miles apart along a river that record when tagged fish pass.

In recent years, biologists have learned that resident trout (those that stay in tributaries their whole lives) might move just a few hundred yards during the year, while migratory trout (which spawn in tributaries but live most of their lives in the mainstem river or connected lakes) can cover over 100 miles. Some highly migratory Arctic grayling travel 60 to 80 miles. One FWP study found that almost all of the sauger in the Missouri upstream from Fort Peck Reservoir spawn in a single reach near the Fred Robinson Bridge. "Some that we captured and radiotagged as far away as below Great Falls would swim 150 miles downstream, spawn, then move 150 miles back upstream," says Anne Tews, FWP fisheries biologist in Lewistown.

The farthest-ranging specimen that FWP biologists have tracked so far is a paddlefish originally tagged in the Wolf Point area of the Missouri River. In a single year, the nomadic fish traveled at least 670 river miles: up and down the Milk River, down the Missouri to North Dakota, and finally back to where biologists first captured it.

Tom Dickson is editor of Montana Outdoors.

UNIVERSAL NECESSITY High-profile species such as trout and sauger aren't the only ones that must migrate to complete their annual life cycle. Minnows like the redside shiner (above) and prehistoric relics like the shovelnose sturgeon (right) also require water free of barriers.

CLOCKWISE FROM TOP LEFT: TODD PEARSONS/ENGBRETSON UNDERWATER PHOTOGRAPHY; MONTANA FWP; LARRY DEARS; LARRY DEARS

Stopping the flow

"That tells you just how far some of these big-river species need to migrate," says Steve Dalbey, FWP fisheries manager in Glasgow. He points out that, historically, fish evolved with intact stream and river systems that had full connectivity. An occasional mudslide, avalanche, or drought impeded fish movement, but for the most part fish could swim where they needed to go. Then people started to develop the land, altering streams and rivers.

For instance, for the 100 years before it was removed in 2008, Milltown Dam at the confluence of the Blackfoot and Clark Fork Rivers east of Missoula blocked upstream migration. One FWP study found that 200,000 fish of 11 different species stacked up below the structure each year. "Those fish didn't just turn around and find somewhere else to spawn," says Schmetterling. "They would stay at the dam and try to move past it for days or even months."

In addition to blocking movement with their presence, large dams like the one below Fort Peck Reservoir can create movement barriers by turning the river upstream into a lake and changing historic downstream flow patterns and water temperatures. "Big dams can completely disrupt how a river functions," says Tews.

FISH FOLLOWERS Left: FWP biologists surgically implant transmitters in rainbow trout to track fish migration up the Clark Fork after removal of Milltown Dam in 2008. Right: Biologists tag paddlefish with colored, numbered bands—later reported by recreational snaggers—as well as with radio transmitters. One Missouri River paddlefish traveled nearly 700 miles in one year.

BLOCKED OUT? Trout usually can make their way through natural barriers like beaver dams (left). But large impoundments such as Diversion Dam (above) on the Sun River create impassable barriers that block fish from reaching seasonal habitats.

CLOCKWISE FROM TOP LEFT: ALLEN WIEDERRICH; CRAIG & LIZ LARCOM; ADAM SIGLER

Hundreds of diversion dams on streams and rivers across Montana that redirect water into irrigation canals for watering crops also block upstream fish movement. Thousands of "perched" culverts running under mountain forest roads create miniature waterfalls that many species can't ascend. In some cases, stock dams in eastern Montana disrupt the movement of plains killifish, Iowa darters, brook sticklebacks, and other little-known prairie species.

In addition to these physical barriers, habitat barriers make some stream stretches impassable. Low flows, muddy water, and chemicals leaching from acid mine drainage can block fish movement as effectively as any concrete dam. So can wide, shallow areas of warm water created when cattle trample stream banks. "In the heat of summer, if a sensitive fish like a grayling can't get past that habitat barrier and instead gets stranded in pools that have low water and little oxygen, it will die," says Cayer.

Velocity barriers are those in which water speed is far too fast for fish to move past. "When you have a 6-foot-wide stream flowing into a 2-foot-wide culvert, the water during spring runoff shoots out the other side like a fire hose," says Ladd Knotek, FWP fisheries biologist in Missoula. "Even strong swimmers like bull trout can't get through undersized pipes at high flows."

Barrier problems

So *what* if bull trout can't get through a culvert? Can't they simply turn around and spawn elsewhere?

Probably not. "Bull trout will return to the stream where they were was born and make every effort to spawn there," says Schmetterling. "They rarely just peel off and go to another stream to spawn, like rainbows and browns. They've evolved in a way that 'site fidelity' is critical to their survival."

One problem with barriers is they prevent fish from reaching the very best seasonal habitats they need to survive. For instance, newly hatched pallid sturgeon larvae must drift downstream for hundreds of miles in a river to develop sufficiently for survival. But because spawning pallids can't get upstream from Fort Peck Dam on the Missouri or Intake Dam on the Yellowstone, their larvae float into North Dakota's Lake Sakakawea, an impoundment of the Missouri created with completion of Garrison Dam in 1954. There the underdeveloped fish sink into an oxygen-deprived "dead zone" and suffocate.

DRINK HERE, PLEASE To prevent bank trampling that makes water too shallow and warm for trout migrations, cattle are confined to watering areas as part of a Montana State University study near Belgrade.

Barriers also isolate fish populations, making them more susceptible, in the long term, to catastrophic events such as a forest fire that boils all the fish in a stretch of mountain stream. "Without full connectivity, that tributary could never be recolonized with fish coming up from the mainstem," says Knotek. Isolation also limits genetic exchange, leading to inbreeding and the loss of genetic variability.

Restoring movement

Restoring fish connectivity can be as easy as removing an obsolete diversion dam. And as hard as convincing federal agencies to alter their operations.

Installed in 2007, the Muggli Fish Passage in southwestern Montana allows channel catfish, sauger, and other prairie fish passage up an additional 50 miles of the Tongue River blocked since the late 1800s. In the Upper Big Hole watershed, Cayer and others have helped grayling swim past 42 diversion dams by installing small fish ladders that open up 60 miles of habitat on the mainstem Big Hole and tributaries.

Bull trout can now bypass Thompson Falls Dam on the lower Clark Fork thanks to

RUINING REPRODUCTION Fort Peck Dam (spillway, top left) blocks pallid sturgeon migration and disrupts natural flow regimes. As a result, FWP must raise sturgeon larvae (above right) in its Miles City Fish Hatchery for release into the Missouri and Yellowstone Rivers.

a $10 million fish ladder. Farther downstream, biologists with Avista Corporation transport bull trout by truck around Cabinet Gorge Dam to upstream tributaries during spawning season as part of an agreement between the company and state and federal fisheries management agencies.

On several tributaries of the Blackfoot River, westslope cutthroat are returning to reaches blocked for decades by low water in midsummer. When landowners changed their irrigation regimes, minimum stream flows were restored so fish could pass.

In national forests throughout western Montana, FWP biologists are working with U.S. Forest Service crews and Trout Unlimited volunteers to replace small culverts with larger ones built with a rough rather than smooth bottom. "If you're a fish moving upstream, you shouldn't even notice the difference between that and the natural stream," says Knotek.

Unfortunately, helping pallid sturgeon is not so simple. At Fort Peck Dam, all biologists can do is continue to urge the U.S. Army Corps of Engineers to adjust water releases below the dam at key times to mimic natural flows. "We are recommending a brief pulse in spring to trigger adult pallid spawning movement closer to the dam, and then lower flows later in early summer to slow larval drift," says Dalbey. At Intake Dam on the Yellowstone, the Corps of Engineers is working on an Environmental Impact Statement that evaluates fish passage options.

Beneficial barriers?

Despite all the harm to fish populations, sometimes migration barriers such as culverts, degraded habitat, and even dams can benefit fish populations. Barriers slow the spread of viruses and other fish diseases. They keep invasive species such as carp and northern pike from degrading existing fisheries. Barriers also prevent rainbow trout from moving upstream and mixing with pure-strain westslope cutthroat, and they stop aggressive non-native brook trout and brown trout from crowding out native species.

Take Hungry Horse Dam, for example. Since it was built in 1953 to impound the lower South Fork of the Flathead River, the structure has protected bull trout, westslope cutthroat, sculpins, and other native species in the nearly 9,000-square-mile watershed from incursions by non-native fish. "Before widespread human settlement, a barrier would have only caused problems for fish populations," says Don Skaar, a senior FWP fisheries official. "But with the spread of fish disease and growing threats from introduced fish, the issue is more complicated."

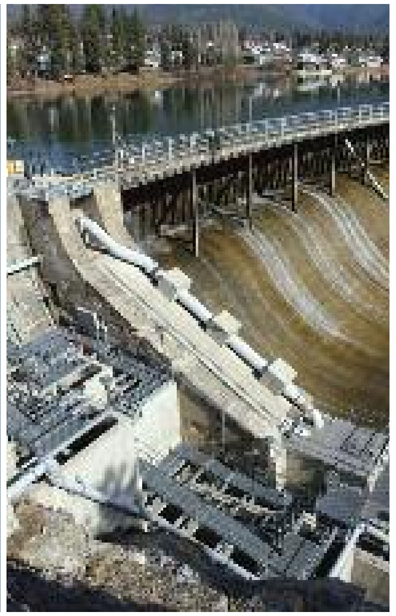
Hybridization by and competition from non-native trout is the biggest threat facing westslope cutthroat east of the Continental Divide, where the native species occupies a small fraction of its historic range. FWP rates the risk of westslope cutthroat extinction for many local populations as "high to extreme." To protect high-mountain populations from threats by non-native trout downstream, the agency occasionally builds fish barriers and has reintroduced westslope cutthroat above natural waterfalls.

The problem, of course, is that the same structures blocking rainbow trout from headwaters prevent the "protected" cutthroat trout up there from fully using the stream systems. By isolating small cutthroat populations, barriers make them vulnerable to inbreeding and catastrophic floods, drought, or wildfire. "Any time we consider building a barrier, we have to weigh the pros and cons," says Dave Moser, FWP fisheries biologist in Bozeman. "Installing a barrier is only a last resort for extremely low populations where the danger of extirpation [local extinction] from hybridization or competition outweighs the loss of connectivity."

According to Bruce Rich, head of the FWP Fisheries Division, biologists make that same analysis before removing or helping fish bypass a barrier anywhere in Montana. "Whenever we consider restoring connectivity, we have to consider all the possible consequences, like unwanted fish moving upstream or the high cost of building and maintaining a barrier," he says. "Sometimes, even with potential benefits, it's just not worth doing. There's no one-size-fits-all approach to connectivity. All we can do is go case by case and figure out what each fish population needs most and how we can best meet those needs.

"For some fish populations," adds Rich, "the only thing worse than a barrier might be no barrier at all."

> "By migrating, a species is hedging its bets, so to speak, so that if something goes wrong in one portion of a stream, the population survives because it's still able to use other portions."



CLIMB, FISH, CLIMB Left: In 2015, a small fish ladder was installed to help spawning brown trout from Ennis Lake migrate into Smith Lake. Anglers reported seeing brown trout upstream of the ladder just a few months after installation. Right: Built in 2009, the $10 million Thompson Falls fish ladder is the first full-height fish passage in the United States constructed specifically for bull trout. After 95 years, the fish once again migrate upriver past Thompson Falls Dam into hundreds of miles of native spawning waters in the upper Clark Fork drainage.

CLOCKWISE FROM TOP LEFT: MONTANA FWP; U.S. ARMY CORPS OF ENGINEERS; DEBRA KRANTZ; JOSHUA BERGAN

REMOVING SOME BARRIERS WHILE CREATING OTHERS Top left: A typical "perched" culvert on a tributary of the Blackfoot River blocked upstream bull trout and westslope cutthroat trout migration by creating a waterfall during low water and a high-velocity torrent during spring runoff. As in many forested watersheds across western Montana, the culvert was replaced by a free-span bridge (above right) that allows for natural fish movement. Below left: A natural waterfall on Ruby Creek near Ennis protects a reintroduced westslope cutthroat trout population upstream from hybridization by non-native rainbow trout below. Below right: FWP built this concrete box culvert on White Creek, a tributary to Canyon Ferry Reservoir, to safeguard pure-strain westslope cutthroat trout above the structure from non-native fish downstream.

ALL PHOTOS THIS PAGE: MONTANA FWP