FINDING A PULSE FOR PALLIDS

Why a brief surge from Fort Peck Dam mimicking natural spring runoff could help restore life to Montana's rarest fish species. BY ANDREW McKEAN

An artist's rendition of pallid sturgeon spawning below Fort Peck Dam following a pulse of water that replicates historical spring flows.
Illustration by Liz Bradford

When built in the 1930s, Fort Peck was the world's largest earthen dam. After the 4-mile-long structure impounded the Missouri River, it blocked upstream movement of native fish. If water conditions allow, a proposed 2022 test would send flows over the spillway (shown here during low water) to trigger spawning activity downstream that would aid young pallid sturgeon development.

Hulking Fort Peck Dam, built with muscle and steam shovels during the 1930s, has been called a marvel of modern engineering, a Depression-buster, and the engine of a recreational economy that has sustained eastern Montana for three generations.

The 4-mile-long earthen dam that created Fort Peck Reservoir could also be called a fish killer for blocking the spawning runs of a dozen native species that moved hundreds of miles up and down the Missouri River for millennia. Now, decades after Fort Peck Dam's construction, the dam is set to play an outsized role in the recovery of at least one of those species.

This time next year, if water levels are high enough, the U.S. Army Corps of Engineers—which operates the dam—will release a brief surge of water from the reservoir into the Missouri River. The proposed 2022 test would be the first of many to be conducted in coming years. The aim of these experiments is to mimic natural spring runoff conditions that pallid sturgeon and other native fish require for what fisheries biologists call "recruitment": the advancement from eggs into young fish into older fish that "recruit" to the population to produce young of their own. If this flow test succeeds in provoking what scientists call a "spawning event," it could signal a new approach for recovering one of the most imperiled fish species in the United States. It could also help native game species like channel catfish, sauger, and paddlefish, as well as blue suckers, sicklefin chubs, and other seldom-seen fish that evolved in the once-free-flowing Big Muddy.

Long as a broom handle, pallid sturgeon are prehistoric fish that evolved over millions of years in free-flowing prairie rivers like the Missouri and lower Yellowstone. They were listed as federally endangered in 1990 because of plummeting populations and little ability to reproduce naturally in the dammed river. If the Missouri's remaining wild pallids respond to Fort Peck's proposed 2022 spring spill and manage to spawn and develop, then fisheries managers may see a path to recovering the species and a new way to manage the river's flows for a few days every several years. "The potential is huge," says Eileen Ryce, Montana Fish, Wildlife & Parks fisheries chief. "If this works, it would be the most important development to help pallids that we've ever seen."

If pallids don't respond, the game isn't over; scientists will keep searching for ways to enhance wild pallid sturgeon recruitment.

In the meantime, the population will continue to rely on what amounts to fisheries CPR: stocking young pallids grown in hatcheries to sustain remnants of the ancient species. Hatchery fish are better than nothing, but for the pallid sturgeon to ever be considered recovered under the Endangered Species Act, fish must be able to reproduce on their own. "It's not enough to just stock pallids and use the river as an aquarium," says Tyler Haddix, FWP pallid sturgeon biologist. "We are using hatchery fish only to make up the void in recruitment over the past half century. If we get the hydrology and the habitat right, we're hoping the wild fish will be able to do that on their own."

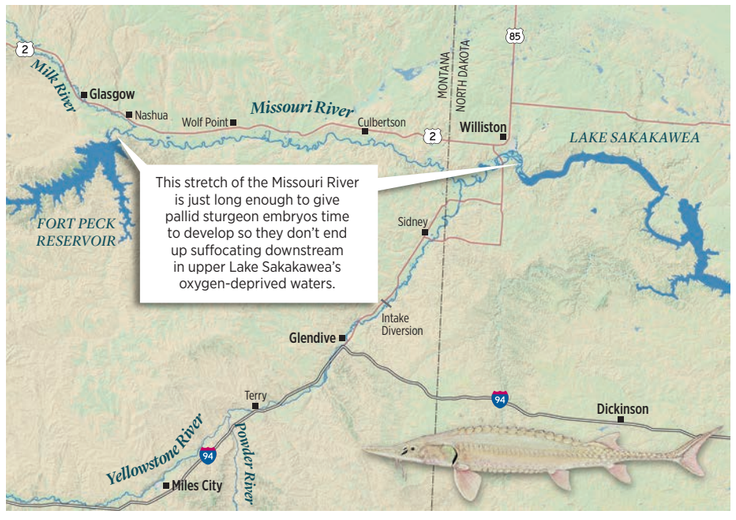

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PHOTO: USACE, OMAHA DISTRICT; MAP ILLUSTRATION: LUKE DURAN/*MONTANA OUTDOORS*

ILLUSTRATIONS BY LIZ BRADFORD

DUST-COUNTRY HYDROLOGY

Understanding the pallid's plight requires a quick course in how the big rivers of the northern Great Plains guided the species' evolution. Like their cartilaginous cousins the shovelnose sturgeon and the paddlefish, pallids need muddy, slow, free-flowing rivers with plenty of nutrients like larval insects and small fish. They also require high water in June to cue upstream movement. In fact, their torpedo-shaped bodies evolved to navigate heavy springtime flows and reach upstream spawning sites, generally underwater sand dunes next to slower-moving channels.

Construction of Fort Peck Dam as well as Garrison Dam in North Dakota put a roadblock on those long spawning runs. At the same time, hydropower management replaced heavy spring pulses of turbid, warm runoff with steady flows of cold, clear water from the reservoir bottom. While that prevented downstream farms and towns from flooding, it removed the pallids' seasonal spawning cues. The relatively few wild pallid sturgeon in the Yellowstone and Missouri rivers above Lake Sakakawea in western North Dakota have not successfully recruited young to the population since the mid-1950s.

That reproductive drought is due mainly to the threat the reservoir poses to newly developing baby sturgeon. When sturgeon spawn, the fertilized eggs hatch into free-floating embryos that drift downstream hundreds of miles, feeding off their attached yolk sac. After one to two weeks, the quarter-inch embryos, which resemble tiny tadpoles, grow into 1-inch, free-swimming larvae that look much like miniature versions of adult sturgeon. At this point the tiny fish have used up their yolk sac and can now feed on tiny aquatic insects with their newly developed mouth. Even more important, they have developed pectoral fins and a stronger tail, enabling them to swim.

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But for more than half a century, the tiny fish haven't had enough time—or, more to the point, enough river miles—to reach this stage.

A CRITICAL TRANSFORMATION

That's because, following construction of Garrison Dam in 1953, Lake Sakakawea backed water upstream nearly to Montana. Sediment and organic material accumulated where the river enters the reservoir. Recent studies have shown the sediments in this area lack enough oxygen to support sturgeon larva development.

Historically, pallid embryos had plenty of time to develop as they floated down the Missouri and Yellowstone. But with Sakakawea now looming downstream, the embryonic fish have been in a race against time to develop fast enough to swim up and out of the stagnant upper reaches of the reservoir before they sink to the bottom and suffocate.

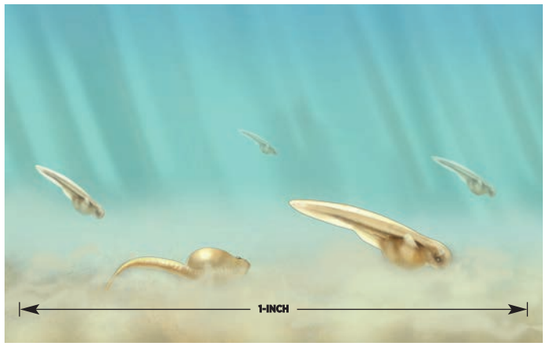
"If we didn't have Fort Peck Dam, the adults could spawn farther upstream and give the larvae enough time to develop," says Haddix. "Or if we didn't have Sakakawea, they would have more downstream miles to develop. But having both means the larvae are boxed in and have just the bare minimum number of river miles, and only if conditions are just right."

The 2022 pulse experiment aims, in part, to draw adult sturgeon closer to Fort Peck Dam to spawn, giving embryos an extra couple of days to develop.

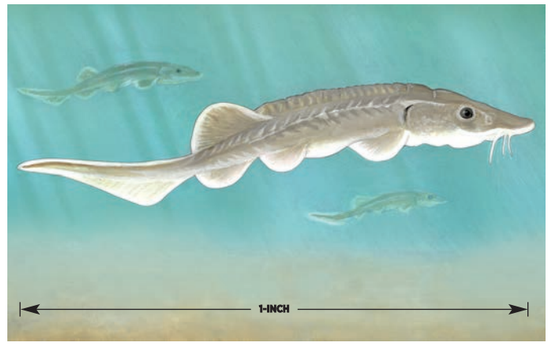
Biologists don't have much time to help the roughly 100 wild pallid sturgeon remaining in the Missouri and Yellowstone system reproduce. These big fish—4 to 5 feet long and weighing up to 60 pounds—were all juveniles in the 1950s when Garrison Dam was built. They are now nearing 70 years old and slowly dying off. Though some hatchery pallids, first stocked as youngsters in 1998, are now old enough to spawn, the clock is ticking as biologists try ways to get the wild old-timers to reproduce before they disappear for good.

PROOF IT COULD WORK

Scientists learned a lot about pallids over the past two decades. FWP crews netted the big



WITHOUT enough time to develop, embryos floating downstream in the current sink to the bottom of upper Lake Sakakawea and suffocate in the oxygen-deprived environment.



WITH enough time to develop, embryos grow into larvae with pectoral fins and a stronger tail, enabling the miniature sturgeon to swim up and out of Sakakawea's anoxic danger zone.

fish in the lower Missouri and Yellowstone, surgically implanted radio transmitters in their bellies, then released them. Biologists then began to track movements and understand habitat preferences. Years of following the few remaining wild pallids and the new generations of hatchery-reared fish revealed that the species will move upstream only during preferred water conditions and to specific spawning sites.

In 2007, crews documented adult female pallids dropping their eggs near males close to Fairview, along the Montana–North Dakota border. That same year, they released days-old hatchery embryos about 75 miles below Fort Peck Dam and monitored their drift. That's when they learned that the Missouri from Fort Peck Dam downstream to Lake Sakakawea is just long enough to give embryos drifting downstream time to develop their pectoral fins and strengthen their tiny tails so they can kick out of the current, thus avoiding the downstream death sentence at upper Sakakawea.

> **"This proved it was possible for pallids to pull off a successful spawn if they just had enough springtime flows to trigger it."**

"Over the past 20 years, we've collected enough solid scientific data to indicate that, with the right conditions, there can be some pallid recruitment on the Missouri," Haddix says. "That work also determined that a flow test—releasing enough water that combines water from Fort Peck's turbines and spillway combined with warm, muddy Milk River water—could create conditions that pallids would respond to."

In spring 2011, nature confirmed what scientists suspected. When massive snows from the previous winter melted, the Milk River—which runs along the Hi-Line and meets the Missouri 10 miles below Fort Peck Dam—turned into a raging torrent that hydrologists labeled a "1,000-year flood event." Muddy water gushing from the Milk into the Missouri mimicked the historical high flows of the larger river from before Fort Peck Dam construction. Sturgeon downstream got the spawning signal and, for the first time in decades, started moving up both rivers. "We observed pallids spawning in 2011 near the mouth of the Milk," Haddix says. "Then we captured our first ever wild-produced, genetically confirmed pallid sturgeon free embryo in the Missouri River. This proved it was possible for pallids to pull off a successful spawn below Fort Peck if they just had enough springtime flows to trigger it."

In 2018, after several years of high water in Fort Peck, the Corps released warm water from the top of the reservoir over the spillway. Once again, pallids paid attention, and biologists recorded fish moving up the Missouri. Both high-water events convinced the U.S. Fish & Wildlife Service, the agency responsible for endangered-species management, to renew its interest in the Missouri and set the table for next year's historical flow test.

THAR SHE BLOWS! Massive snowmelt and heavy rains in spring 2011 forced the U.S. Army Corps of Engineers to release a record 90,000 cubic feet of water per second through the Fort Peck spillway in mid-June. Shown here: 50,000 cfs on June 11.

The Corps, convinced by the growing body of scientific data, agreed to the experiment, signaling a more focused approach by the agency to endangered species recovery. "Sturgeon are the most critically endangered group of fish in the world," says Steve Dalbey, FWP regional fisheries manager in Glasgow. "The Corps' proposed action is a step toward recognizing this dire fact and taking action to rectify some of the harm that dams have caused to pallid survival."

A SPIKE, THEN A PULSE

While federal and state agencies, downstream irrigators, and dam managers are still negotiating final details, the 2022 flow experiment is proceeding as planned. One major prerequisite is that the reservoir holds enough water next spring from rain and runoff to send sufficient flows over the spillway. "Otherwise the experiment won't work," says Joe Bonneau, manager of the Corps' Missouri River Recovery Program. If conditions allow, warmer surface water from Fort Peck will be released in April. This "spike" release will be a flow of 14,000 to 16,000 cubic feet per second, compared with normal spring flows of about 8,000 to 12,000 cfs. It's designed to reproduce early prairie runoff in a pre-dam system and alert downstream fish that it's time to move upstream to spawning sites. The release will also test downstream bank stability and irrigators' pumps, which can get blown out if flows are too strong.

The main event—high flows from the spillway timed to coincide with muddy June runoff from the Milk—is designed to actually trigger spawning. This June "pulse" would, for a day or two, send as much as 28,000 cfs down the Missouri. (Flows downstream at Wolf Point and Culbertson, after additional water from the Milk River and other tributaries come in, would not exceed 35,000 cfs.) Then flows from the dam would be cut to around 8,000 cfs to give embryos time to drift and develop.

Though the pulse flow will be higher than normal, it is only one-third what the river sent downstream during the 2011 flood, which peaked at 90,000 cfs, and would resemble the flows seen in 2018 (see graphic, page 40). "Hydrology modeling indicates no noticeable change in downstream operations, so people along the lower Missouri should not

BACKUP PLAN Pallid sturgeon at a federal fish hatchery show the species' wedge-shaped head, which evolved to help the fish stay close to the river bottom during heavy flows. Sturgeon hatched from eggs taken from Montana pallids and reared in hatcheries have been regularly stocked in the Missouri and Yellowstone rivers since 1998. They provide a backup for biologists working to find ways for the handful of remaining wild sturgeon to "recruit" new generations of pallids into the population, one of the nation's most endangered.

TOP TO BOTTOM: U.S. ARMY PHOTO / DIANA FREDLUND; JOEL SARTORE

expect to see anything different from usual as a result of the test," says Bonneau.

Fisheries crews will monitor movement of pallids to spawning sites and later evaluate whether the fish laid eggs that developed into free-floating embryos. "If this works, helping with pallid reproduction may only require doing something like this periodically," Dalbey says. "Historically, pallids had successful recruitment only every several years, when hydrological conditions were optimal."

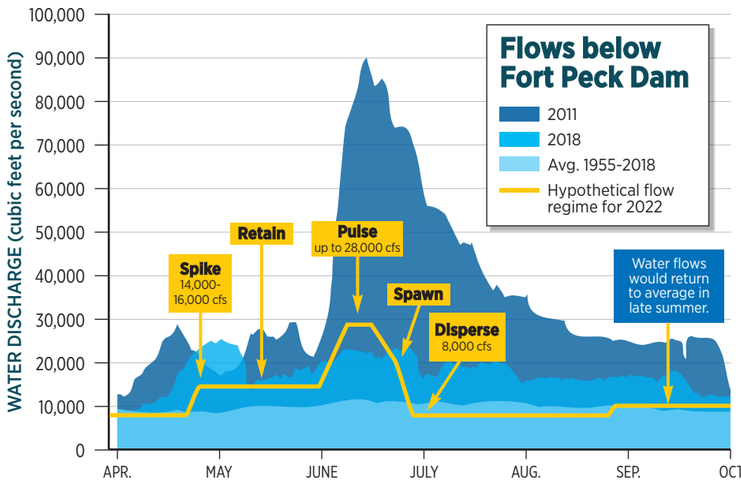
As might be expected, a plan involving one of the nation's largest rivers has raised some concerns. Irrigators on the Missouri downstream from Fort Peck Dam, especially, worry how their pumps will function in flows likely to be three times higher than Fort Peck's normal June releases. "Every irrigator lives and dies by river flows," says Dick Iverson, who grows wheat and hay near Culbertson. "During irrigation season, I'll wake up at night and make sure the gauge numbers don't move even a couple of inches, because even little bumps [in flow] can affect our pumps."

Iverson and other irrigators fear they could lose equipment to the heavy current of the test's highest flows, and that the post-pulse low flows would then strand pumps and attached debris screens in exposed mud. "If a floating pump drops down into the silt, you could lose a $3,000 screen in a matter of seconds," he says.

Over the past few years, FWP and Corps officials have regularly met with county conservation districts, irrigators, and other water users to determine how proposed flows might affect pumps and irrigation. A field review of more than 150 pump sites led to a request by FWP to raise the low flow during the 2022 test from 4,000 cfs to 8,000 cfs so irrigation pumps won't be left high and dry at critical periods of the growing season. "We need to work locally if recovery actions for this fish are going to be effective in the long term," Dalbey says. "That means using the best available science on proposed flows to balance irrigation, power generation, and pallid recovery."

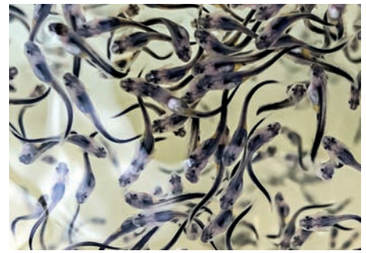
Zach Shattuck, FWP native fish species coordinator, says that despite all the excitement over the proposed 2022 test, it's important to view it as a learning opportunity, not a silver bullet. If native fish respond favorably, agencies have another management tool that not only helps recover the endangered sturgeon but also improves populations of other native big-river fish species. "But that one flow test won't save the pallids," Shattuck says. "We're hoping it gives us a better understanding of how we can help rivers function more naturally. As part of that, maybe we can find ways of managing the river that allow pallid sturgeon to reproduce."

Editor's Note: Opportunity for public comment on the draft Environmental Impact Statement for the Fort Peck pulse test is open until May 25, 2021. To view the EIS and comment, type "Draft EIS for Fort Peck Dam test" into an online search engine.



POSSIBLE FLOWS If water conditions allow, the U.S. Army Corps of Engineers will release a "spike" of roughly 15,000 cfs from Fort Peck Dam in late April 2022. That will signal adult sturgeon downstream to move up to the dam. Flows will remain at that level to retain the fish at spawning sites. Then in mid-June, a "pulse" of up to 28,000 cfs will be released for several days, triggering spawning activity. Flows will then drop so developing embryos can disperse downstream.

MIMICKING NATURE Above: FWP pallid sturgeon biologist Tyler Haddix with a hatchery-reared fish that spawned in 2018. If all goes according to plan, the pulse experiment next spring will encourage wild sturgeon to move up the Missouri River close enough to Fort Peck Dam to spawn. That way embryos (below left) that develop from eggs will have enough river miles to develop into larvae as they drift downstream, then into juvenile sturgeon (below right) that "recruit" into the population and become adults that begin reproducing.



CLOCKWISE FROM TOP: MONTANA FWP; ANDREW MCKEAN; ZACH SHATTUCK/MONTANA FWP

Meanwhile, on the Yellowstone...

During years of high water, pallid sturgeon also spawn on the Yellowstone River. Unlike the Missouri below Fort Peck Dam, the free-flowing Yellowstone still runs high and muddy with springtime snowmelt. But for more than a century, pallids' access to hundreds of miles of river has been blocked by a 10-foot-tall rock structure built in 1909 near Intake, just downstream of Glendive. Known as Intake Diversion Dam, it delivers water through a series of canals to sugar beet farmers and hay growers along the lower Yellowstone.

During the past several years of negotiations on the 2022 Missouri flow experiment, a concurrent project has involved rehabilitating Intake Diversion Dam so that pallids and other fish can swim past. Funded by the U.S. Army Corps of Engineers, the retrofit should also reduce "entrainment"—fish drawn into and then trapped in irrigation canals. The re-engineered structure, which includes a 2-mile-long channel that fish can use to bypass the dam, is the result of successful lawsuits demanding that the structure better accommodate pallids and other native fish.

"The fact that the Yellowstone and Missouri projects are happening at the same time is a recognition that, to pallids, it's all one big river system," says Mike Backes, FWP's fisheries manager in Miles City. "Anything we can do to improve fish passage, spawning habitat, and then larval drift distances is good for these fish, no matter which river they use."

Tyler Haddix, FWP pallid sturgeon biologist, points out that the work at Intake and on Fort Peck's flows will increase the pallids' odds of reproducing successfully. "Both projects have uncertainties regarding how well sturgeon will respond, so by doing both we have a better chance of getting fish to recruit," he says. ■

ROADBLOCK For more than a century, Intake Diversion Dam has prevented pallid sturgeon from reaching hundreds of miles of spawning water upstream on the Yellowstone River.

U.S. ARMY CORPS OF ENGINEERS

Following Number 36

So few adult pallid sturgeon remain in the lower Missouri and Yellowstone rivers that the fisheries biologists and technicians who study them are familiar with each individual fish. These 100 or so wild adults carry radio transmitters that allow crews to follow them for years.

That's how biologists know so much about Number 36, a female pallid that may have hatched before Garrison Dam was built nearly 70 years ago. Her movements, relayed to fish biologists over the years through her coded transmissions, show how interconnected the Yellowstone and Missouri systems are, and how selective pallids can be about seeking spawning habitat.

"In spring 2014, she went up the Yellowstone, up the side channel of Intake [Diversion Dam], and then upriver to the mouth of the Powder River," says Mike Backes, FWP's southeastern region fisheries manager. That's about 240 river miles above the confluence of the Yellowstone and Missouri rivers. "We assumed she spawned a few miles up the Powder because, when we netted her, she had lost the sort of weight we see in post-spawn females," Backes says.

In spring 2018, Number 36 took a different route, up the Missouri, navigating 180 miles of river to spend two weeks in the spillway channel below Fort Peck Dam. "We're not sure why, but she didn't spawn there," Backes says. Instead, she turned around and swam downriver and spawned near the confluence of the Yellowstone. "She demonstrated that, when conditions are right, pallids will use both systems to the extent possible," Backes says.

In 2020, biologists moved the sturgeon up and over Intake Diversion Dam to see how far the fish would travel and if she would spawn. Number 36 headed upstream and, based on body weight loss, spawned around Miles City and again about 20 miles downstream.

How this mobile pallid will respond to next year's proposed Fort Peck flow test is anybody's guess. "These adult wild fish are geriatrics," says Backes. "On the one hand, that's a problem because they're old and, historically, most spawn only every other year. On the other hand, it's a good thing, because if they weren't so long-lived they'd all be gone by now." ■

MONTANA FWP