

Volume I

2024

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Sustainable Water Solutions

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Any errors are the author's.

The City of Milwaukee identifies seven principles that make a Water Centric City:

Applied Water Research

Arts, Talent, Culture & Education

Fishable, Swimmable Water

Green Infrastructure

Sustainable Healthy Water Supply

Water Leadership

Water Technology

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Cover image and this page:

Milwaukee artist John Kowalczyk paints a sturgeon-inspired artwork at the 2023 Harbor Fest, sponsored by the nonprofit Harbor District, Inc.

Author's Note



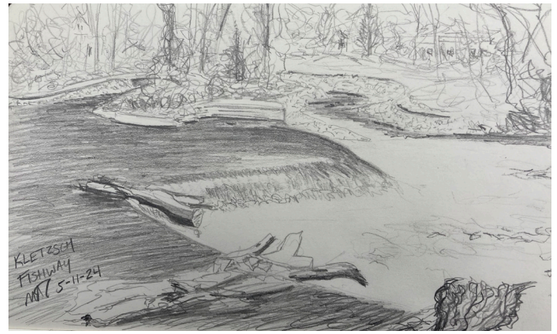
If you are curious about real stories exploring the evolving relationship between humans and our planet in 21st-century America, then this volume is for you.

Milwaukee — the city where we call a bubbler a *bubbler* — is the setting. 2024 was the year. Water is the unifying theme. Inspired by *National Geographic*, in these pages we reveal rich slices of the Milwaukee water world — worthy of attention across our nation.

Inside you will find fifteen feature stories originally published as a series of articles in *Urban Milwaukee*. It was my honor to write these as Milwaukee Water Storyteller for the nonprofit Reflo, with support from a Great Lakes Education grant from Wisconsin Coastal Management Program. Dozens of Milwaukeeans freely suggested story ideas, generously shared their time and expertise, and then persisted in doing the good work that too often goes unnoticed or underreported.

The stories stand alone. They also stand together as a visually rich testament to Milwaukee's water leadership expressed at local, regional, and national scales. Informed by a series of virtual roundtable discussions and seeking to balance a diversity of perspectives, the stories cut across domains of science, geography, history, governance, business, technology, engineering, culture, art, community, economics, policy, planning, justice, education, and more. You will meet Indigenous leaders, fisheries biologists, stormwater engineers, classroom teachers, beaver believers, justice advocates, high-school artists, freshwater scientists, nonprofit organizers, tech entrepreneurs, avid boaters, and urban anglers. You will encounter conflict as decades-old patterns of behavior run up against various reckonings of spirit, resource, and biosphere. You will gain insight learning the ways that ingenious, industrious, and good-willed people are fighting to create a resilient future for us all — and those relatives yet to come.





author's sketch of Kletzsch Dam Fishway on May 11, 2024

"Nature is a living whole."
—Alexander von Humboldt



a scavenger hunt creates intergenerational connection between shoreline anglers and Millennial tourists

For

Mom & Dad

A FISH STORY

PART I: HOW THE KLETZSCH FISHWAY WAS CREATED

IT WAS THIS *BIG. SO BEGINS, WITH ARMS SPREAD WIDE, EVERY GREAT FISH TALE.*

One such story threads through the Milwaukee River in Kletzsch Park, where the work to add a "fishway" bypassing the Kletzsch Dam is part of a larger strategic effort to renegotiate our relationship with water. Considering the past 200 years, these projects intend a reversal of our relationship to the river: from cinching its flow with dams to redesigning watercourses with a watershed view of the whole led by respect for species other than our own. This includes lake sturgeon, a species locally wiped out but now the focus of a decades-long collaborative effort to restore naturally producing populations in a river system their ancestors once called home.

The picturesque scene on any given day at Kletzsch Park in the leafy suburb of Glendale belies this intergenerational drama. Water pours over the sinuous Kletzsch Dam—often mistaken for a natural falls but actually a Depression-era Civilian Conservation Corps project built for recreation when Dust Bowl droughts squeezed continental America dry—enveloping the west bank in a soft cloud of sound.

Visitors, perched at picnic tables beneath the dappled shade of mature oaks that tower above eroded slopes, gaze at the dam or just downstream where sun-speckled riffles reveal dark cobble protruding from the shallows.

A sexual urge draws fish here, season after season, to push upriver to spawn. This primal drive in turn attracts human anglers, who wade knee-deep into the river with hook and line to pursue the mystery of what lies beneath.

Some fish—introduced species like salmon or steelhead—launch muscular silver bodies into the air in attempt to overcome barriers.

Imagine Giannis Antetokounmpo, all six foot eleven inches of the Milwaukee Bucks superstar, vaulting over a 10-foot basketball hoop and you have some idea of what it means to be a fish facing turbulence at the dam.

Aaron Schiller, fisheries biologist with Wisconsin Department of Natural Resources, points across the Kletzsch Dam in August 2023 toward the excavation of the Kletzsch fishway. It's a bypass designed to unlock access to critical spawning habitat for fish like northern pike and lake sturgeon, a species once extirpated from the Milwaukee River but now being reintroduced in hopes to reestablish a naturally reproducing population.

Native fish like northern pike or lake sturgeon cannot make this jump. At Kletzsch, 11 miles upstream from where river meets their wintering waters of Lake Michigan beneath the Hoan Bridge, their path to progeny is blocked. Until now.

Excavation and construction began in summer 2023 on a "nature-like fishway" to circumvent this hurdle to fish passage.

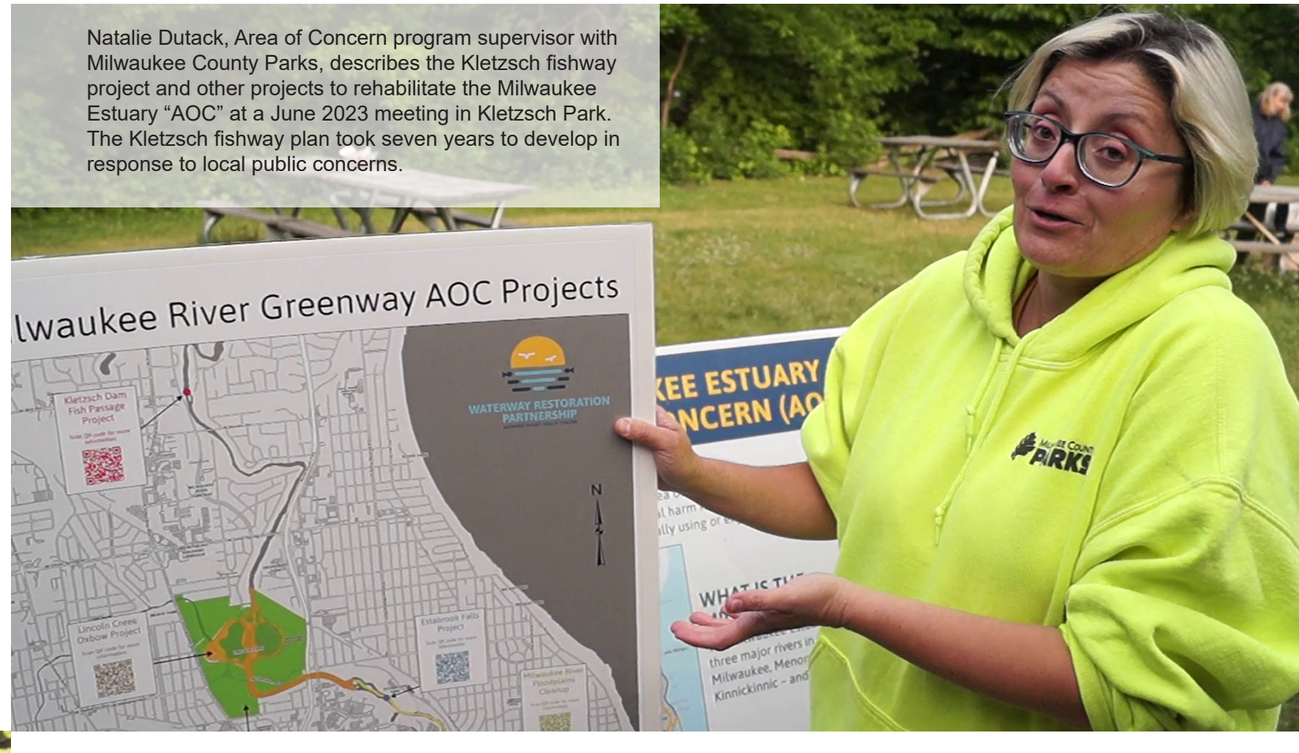
"It took about seven years for us to come up with a design and a solution that made everyone happy. Essentially we designed a stream that will take the fish up and around the dam and bring them to happier, higher quality habitat up north," explained Natalie Dutack, Area of Concern program supervisor with Milwaukee County Parks, which is partnered with Milwaukee Metropolitan Sewerage District (MMSD) and Wisconsin Department of Natural Resources (WDNR) on this approximately $3.3 million project including needed repairs to the dam itself.

After its December 2023 completion, the Kletzsch fishway promises to reconnect fish in Lake Michigan and the lower Milwaukee River with 25 miles of river upstream, an additional 29 miles of tributary streams, and 2,400 acres of wetlands, according to a fact sheet from the Waterway Restoration Partnership (WRP).

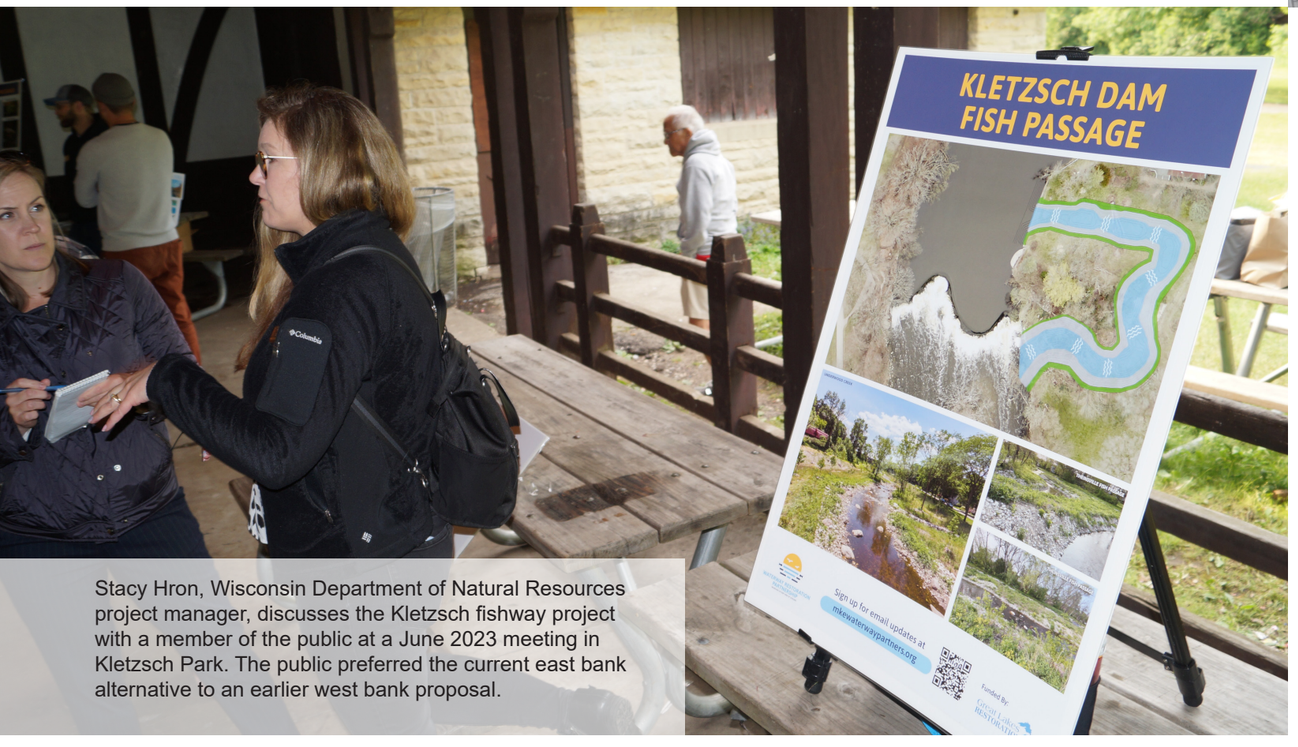
The WRP is a super-group of entities including Parks, MMSD, and WDNR. The partners united to accomplish projects informed by decades of monitoring and science identifying how and where to undo critical impairments to the Milwaukee Estuary "Area of Concern (AOC)"—the lower reaches of Milwaukee's three rivers, their confluence, several tributaries, and the harbor.

It's proved a powerful partnership so far.

In fall 2023 the federal government announced a historic $275 million award to remove and sequester contaminated river sediment—matched against some $170 million in non-federal funding. That estimated $450 million sediment project constitutes the largest cleanup effort ever under the U.S. Environmental



Natalie Dutack, Area of Concern program supervisor with Milwaukee County Parks, describes the Kletzsch fishway project and other projects to rehabilitate the Milwaukee Estuary "AOC" at a June 2023 meeting in Kletzsch Park. The Kletzsch fishway plan took seven years to develop in response to local public concerns.



Stacy Hron, Wisconsin Department of Natural Resources project manager, discusses the Kletzsch fishway project with a member of the public at a June 2023 meeting in Kletzsch Park. The public preferred the current east bank alternative to an earlier west bank proposal.

Protection Agency's Great Lakes Restoration Initiative (GLRI) and the Great Lakes Legacy Act.

But removing habitat impairments is equally important, and GLRI previously awarded approximately $2.8 million to support the Kletzsch project.

Think of the fishway like a wheelchair ramp circumventing a steep stairwell.

The Kletzsch Dam itself remains, but native fish can navigate upstream via a series of resting pools connected through a gentler gradient in a new channel cut into the Milwaukee River's east bank.

If the fishway performs as designed, it will reunite thousands of maturing native fish with the beneficial waters they need to spawn their next generation.

"Connectivity in this system has been broken for so long," explained Jeff Houghton, fisheries biologist with the UW-Milwaukee School of Freshwater Sciences. One end goal of the Kletzsch fishway is to restore that connectivity and reestablish a naturally reproducing population of lake sturgeon in the Milwaukee River.

Lake sturgeon are a slow-maturing native species once locally extirpated (completely wiped out). But now sturgeon are beneficiaries of almost two decades of state and partner efforts to reintroduce this iconic fish with Native American significance.

Houghton points to lake sturgeon as an indicator of overall water quality.

"This work is good not just for sturgeon but for other species like pike and bass," Houghton said. "If the sturgeon are doing well, other species will as well."

Preparing for the opening of the historic passage, Houghton has surveyed, mapped, and analyzed the Milwaukee River up to the Ozaukee County line to identify suitable sturgeon spawning habitat.

Dr. John Janssen with the UW-Milwaukee School of Freshwater Sciences maneuvers the boat in the Milwaukee River during 2023 fieldwork.

Houghton's team used an Acoustic Doppler Current Profiler attached to a dingy tow to collect detailed stream velocity data at a number of river transects.

The field observations are needed to calibrate the HEC-RAS model.

photo by Jeff Houghton

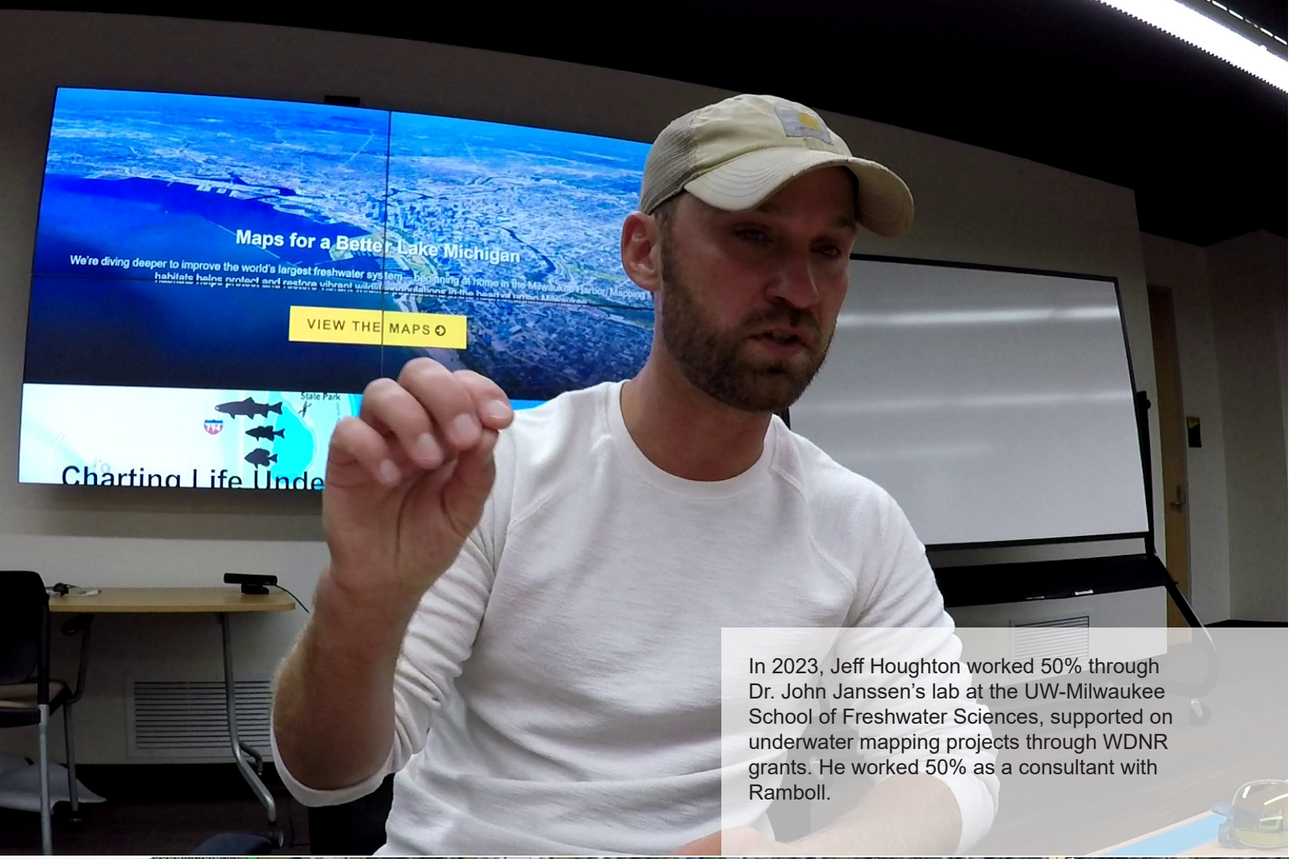
The 2023 ADCP transects followed up on 2022 bathymetric and side-scan sonar surveys of the Milwaukee River bottom up to the Milwaukee/Ozaukee County line that measured depth and identified bottom substrate.

In 2023, in-stream ADCP measurements corresponded well with USGS stream gage data, though the team had to pause data collection at times due to low flows.

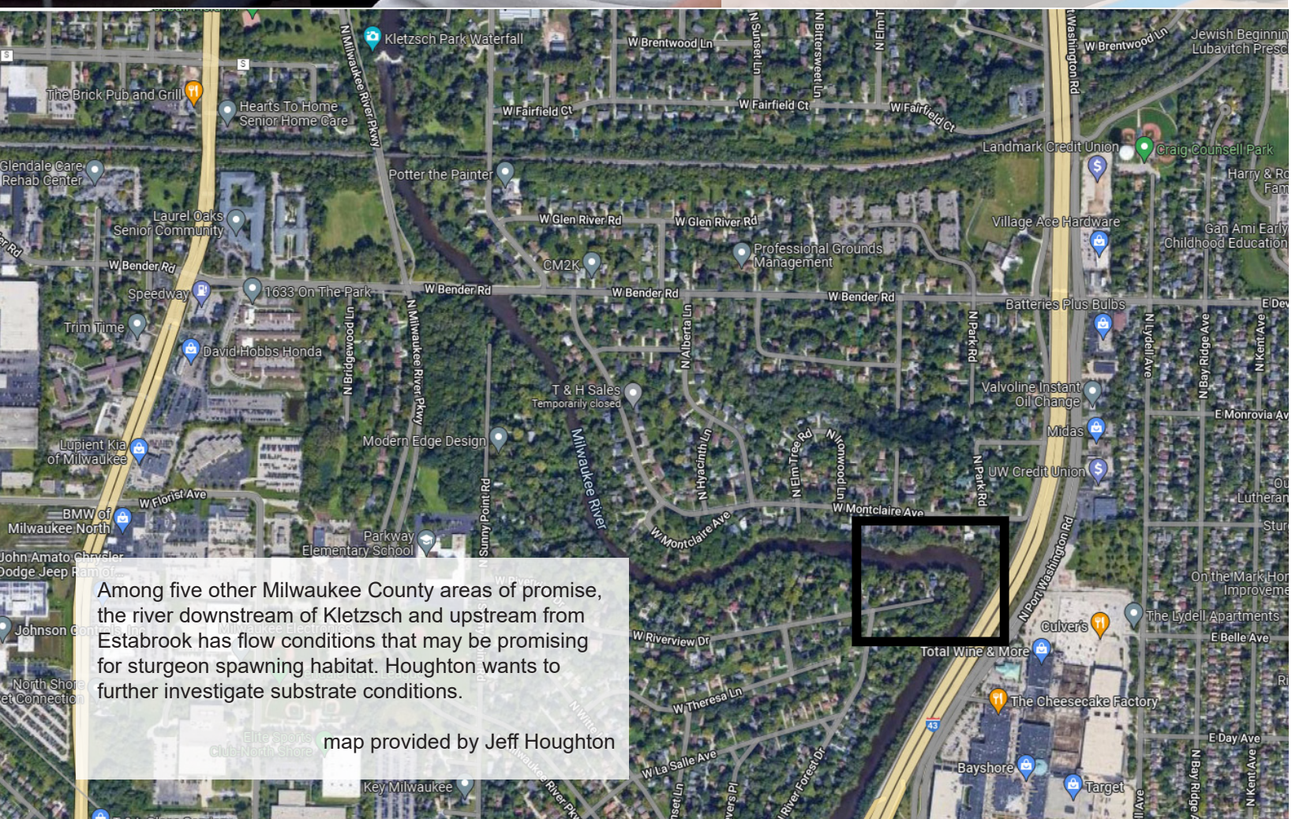
photo by Jeff Houghton

The work so far has identified six promising sites, including a stretch between Kletzsch and Estabrook Parks. "We need to dig in a little further to know whether substrate already exists or if it could be improved," Houghton said.

North of the Milwaukee/Ozaukee County line, the domain of Ryan Miller, fisheries biologist with Ozaukee County, the picture is even more promising. Over the past years, Miller paddled a canoe with a portable sonar unit to map a cumulative 14 stream miles. At a 2023 public outreach event, Miller noted that over 40% of the Ozaukee County reach contains substrate (bottom material) identified as cobble—high value for potential sturgeon spawning habitat.

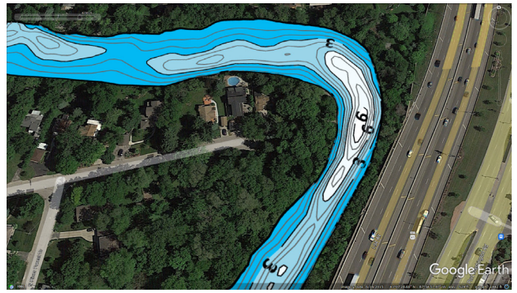


In 2023, Jeff Houghton worked 50% through Dr. John Janssen's lab at the UW-Milwaukee School of Freshwater Sciences, supported on underwater mapping projects through WDNR grants. He worked 50% as a consultant with Ramboll.



Among five other Milwaukee County areas of promise, the river downstream of Kletzsch and upstream from Estabrook has flow conditions that may be promising for sturgeon spawning habitat. Houghton wants to further investigate substrate conditions.

map provided by Jeff Houghton



Milwaukee River bathymetry (water depth contours).



Side-scan sonar false-color imagery of river bottom.

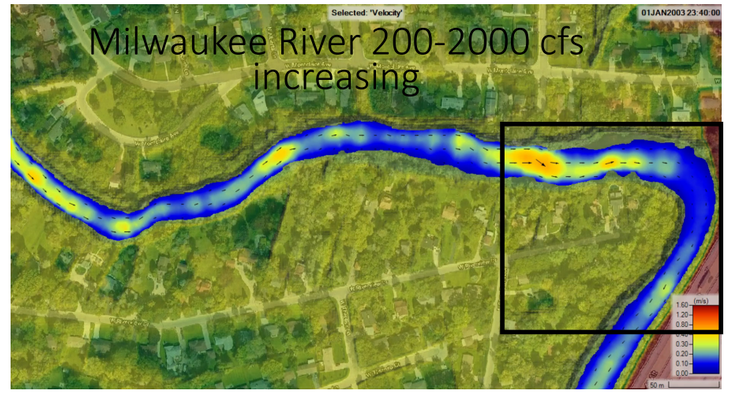
MAPPING & CHARACTERIZING THE MILWAUKEE RIVER TO EVALUATE FOR STURGEON SPAWNING HABITAT

Spawning lake sturgeon are very picky about water velocities.

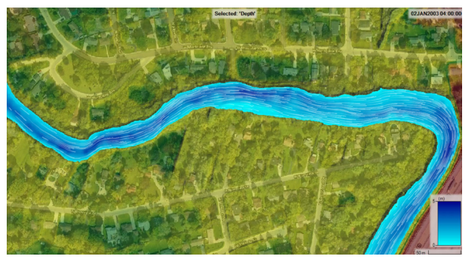
The ancient fish prefer velocities between 0.5 and 1.5 meters per second. That's a range of about 1.1 to 3.4 miles per hour.

If the water is too fast or too slow, they are simply not in the mood for love.

Houghton's work measured and modeled stream velocities under different flow conditions to identify reaches of river that could be promising for sturgeon spawning habitat.







Q = VA is hydrological shorthand for the fundamental relationship that holds between volumetric flow (Q), velocity (V), and channel cross-sectional area (A). The relation is dynamic. As flow increases or decreases, the cross-sectional area also changes. As does velocity. Houghton inputs detailed bathymetric data and the HEC-RAS model outputs in-stream velocities for expected spring flows ranging from 200 cfs (left) (cubic feet per second) up to 2,000 cfs (right).

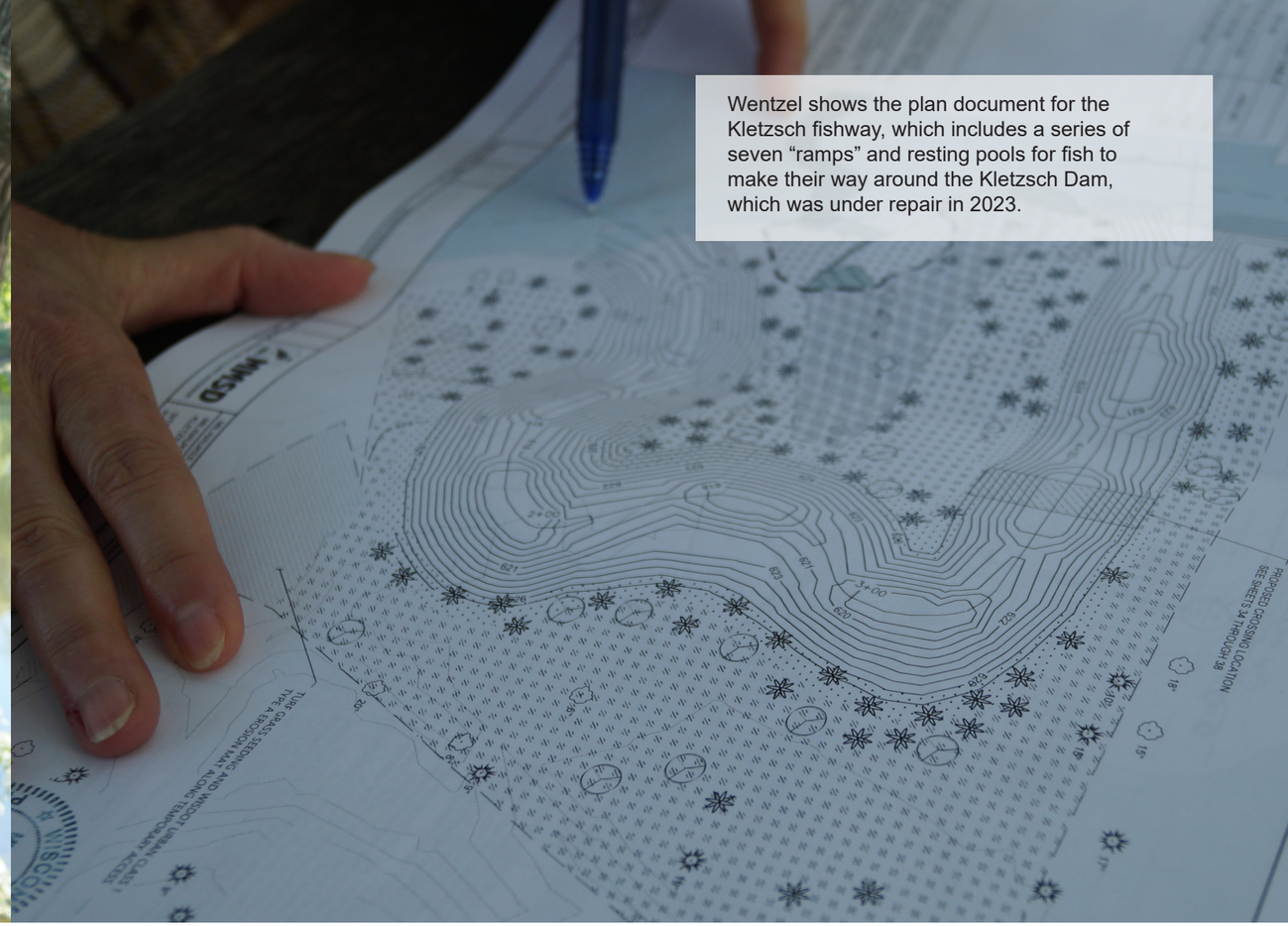
“CONNECTIVITY IN THIS SYSTEM HAS BEEN BROKEN FOR SO LONG. THIS WORK IS GOOD NOT JUST FOR STURGEON BUT FOR OTHER SPECIES LIKE PIKE AND BASS. IF THE STURGEON ARE DOING WELL, OTHER SPECIES WILL AS WELL.”

—JEFF HOUGHTON

A juvenile lake sturgeon swimming.
photo by Jeff Houghton



Beth Wentzel, senior project manager with the Milwaukee Metropolitan Sewerage District, oversees the engineering of the Kletzsch fishway. Through the Waterway Restoration Partnership, MMSD is also working on fish passage solutions for Estabrook Falls and the former North Avenue Dam.



Wentzel shows the plan document for the Kletzsch fishway, which includes a series of seven “ramps” and resting pools for fish to make their way around the Kletzsch Dam, which was under repair in 2023.

With the completion of the Kletzsch fishway, fish will be able to access these promised waters to take advantage of upstream spawning habitat, said Aaron Schiller, WDNR fisheries biologist. Mapping work by Houghton and Miller so far suggests at least about 20 sites in all, Schiller said.

“As you go upstream, especially Grafton down through Lime-Kiln [former dam], that’s all great gradient, big drop, good rock, there’s deep holes available for the adults to sit in, and there’s good stretches of that faster water because it’s actually steeper there,” Schiller said. “That flow keeps the rock clean. There’s not sediment in the rock. So when the eggs stick to the rock they’re not getting silted in. So they stay oxygenated. ’Cause they’re real sticky. And once they hatch they have a long stretch to drift of good, clean habitat.”

The Kletzsch fishway is designed for lake sturgeon and northern pike, Schiller said, two native fish with differing swimming styles. “Right now those are the target species because if we improve fish passage for them, everything else can get through.”

Kletzsch presented an engineering challenge. The final design prepared by MMSD’s consultant Interfluve called for seven resting pools curving through about 450 feet of new channel cut on the east bank.

“We realized we needed all of that in order to have the space because ultimately what’s going to be an important variable is what the total length of your fishway is, because you have these series of ramps and pools and they can’t be too steep and they can’t be too long,” said Beth Wentzel, senior project manager who joined MMSD in 2020. Wentzel brought her engineering experience from Interfluve and also redesigning the Mequon-Thiensville fish passage for Ozaukee County in 2021-’22.

The east-bank design emerged after years of public objections to an earlier west bank design which would have removed mature oak trees. MMSD acquired a key floodplain parcel to make an east bank alternative feasible. The $20,000 real estate purchase was covered with part of a Fund for Lake Michigan grant and a donation from Milwaukee Audubon, according to Stacy Hron, WDNR project manager.

“The real estate was a little bit complex because there was a mix of [Milwaukee] County-owned properties, Glendale-owned properties, and a small sliver of privately owned property when we started,” said Wentzel.

The design was based conservatively on lab observations of fish swimming, Schiller noted. “In the lab they don’t have that ambition to really get up and go for spawning drive. Here, we’ll know: water temperature, time of year, and their drive. It’s real-

MMSD ACQUIRED A KEY FLOODPLAIN PARCEL TO MAKE AN EAST BANK ALTERNATIVE FEASIBLE.

world application. So that's different than what's available information right now."

How will we know if the fishway works?

Part of the answer: an innovative tracking system to count fish as they pass between underwater antennas.

Supported by a $70,000 grant from Fund for Lake Michigan as part of the project, the array will allow WDNR to track fish with PIT tags.

PIT stands for *passive integrated transponder*. Each tag, slightly longer than a grain of rice, contains a microchip bearing a unique ID code. The tag is injected into a fish's muscle. When the tag passes near an antenna, it registers the fish, adding to a database Schiller manages.

One antenna monitors each end of the fishway.

"We'll know how long [tagged fish are] in there, how many made it through successfully, and then if any made it halfway and turned around and came back out, we'll have that detection as well," Schiller said.

Combined with another antenna array miles downstream near Urban Ecology Center Riverside and another upstream at the Mequon-Thiensville fishway, the PIT arrays will provide a feast of field data that should improve managers' understanding of local fish population movements.

Annually reintroduced lake sturgeon are the main PIT tag recipients, but Schiller envisions one day tagging suckers, redhorse, smallmouth bass, steelhead, brown trout, and other species of interest.

The area around the dam will be managed as habitat, and WDNR is working through the process to designate the fishway as a fish refuge, WDNR's Hron said in an email. No angling will be allowed in the fishway.

"Kletzsch is the biggest barrier in the lower 30 miles," Wentzel said. "But the next one that is significant is at Estabrook Falls [also manmade]. So we're currently working on a design of a fish passage solution there, and we have a consultant developing designs for that. It's going to be different than this. We're not cutting into the bank for that one, but rather, modifying the falls to create places where fish can get through directly in the river. So, we're hoping to have funding to do construction on that maybe as soon as late in 2024."
Another AOC fish passage project considers how to moderate the velocity in the Milwaukee River just upstream of the former North Avenue Dam.

That dam was removed in 1997, ushering in a new era of enhanced water quality, followed by removal of Grafton's Chair Factory Dam in 2000, Lime-Kiln Dam removal and Mequon-Thiensville Dam fish passage in 2010, and Estabrook Dam removal in 2018. With the opening of the Kletzsch fishway, the last major barrier to fish passage on the lower Milwaukee River is the Bridge Street Dam in Grafton.

Those 30 miles of connected river bode well for the return of lake sturgeon.

"A lot of people [who] hook into a sturgeon—in Milwaukee at least—have never seen or heard of a sturgeon before," said Schiller.

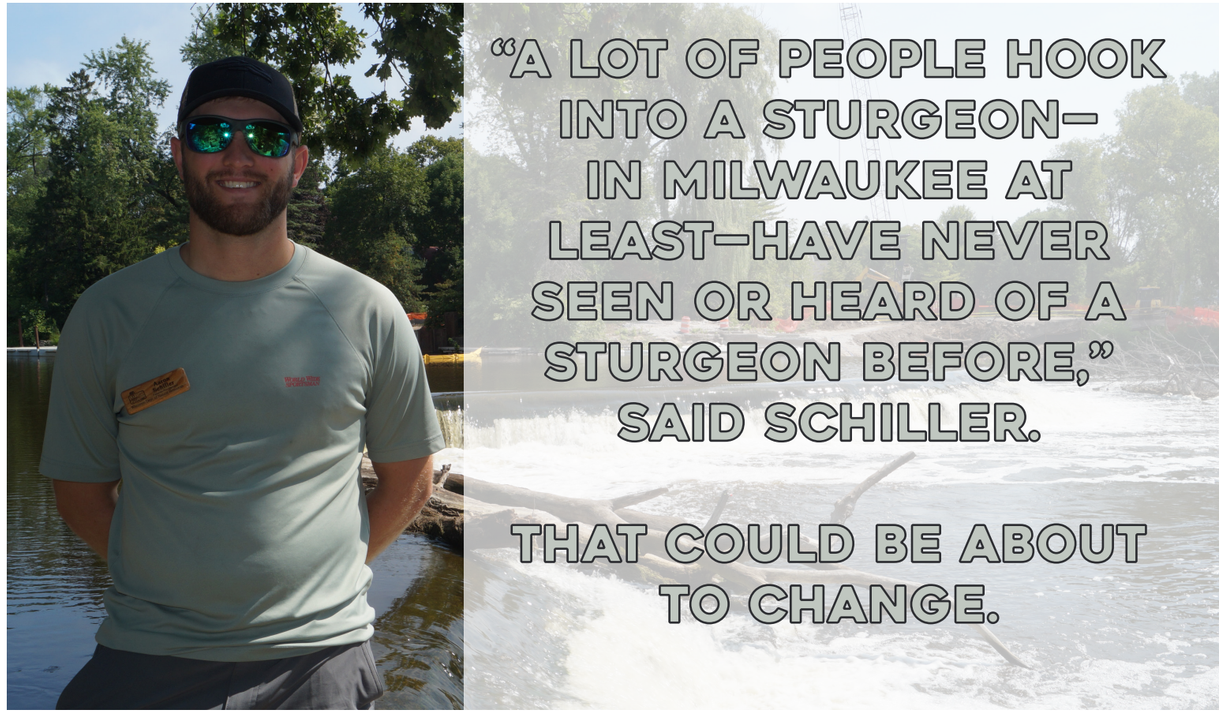
That could be about to change.

In late summer two boys stood ankle deep in the river beside Kletzsch Dam, their rods glinting in the mid-morning sun and ambient spray.

To make their way down to the water, they passed an unobtrusive metal WDNR sign posted about sturgeon. The Milwaukee 11-year-olds, who said they come two or three times a week to Kletzsch to fish, were casting for bass.

What did the boys know about sturgeon?

"Not much," one said. "I've never seen one pass through here. I know they can get really big. Like 12 feet long. Which is pretty cool. I don't really know much else except for that."



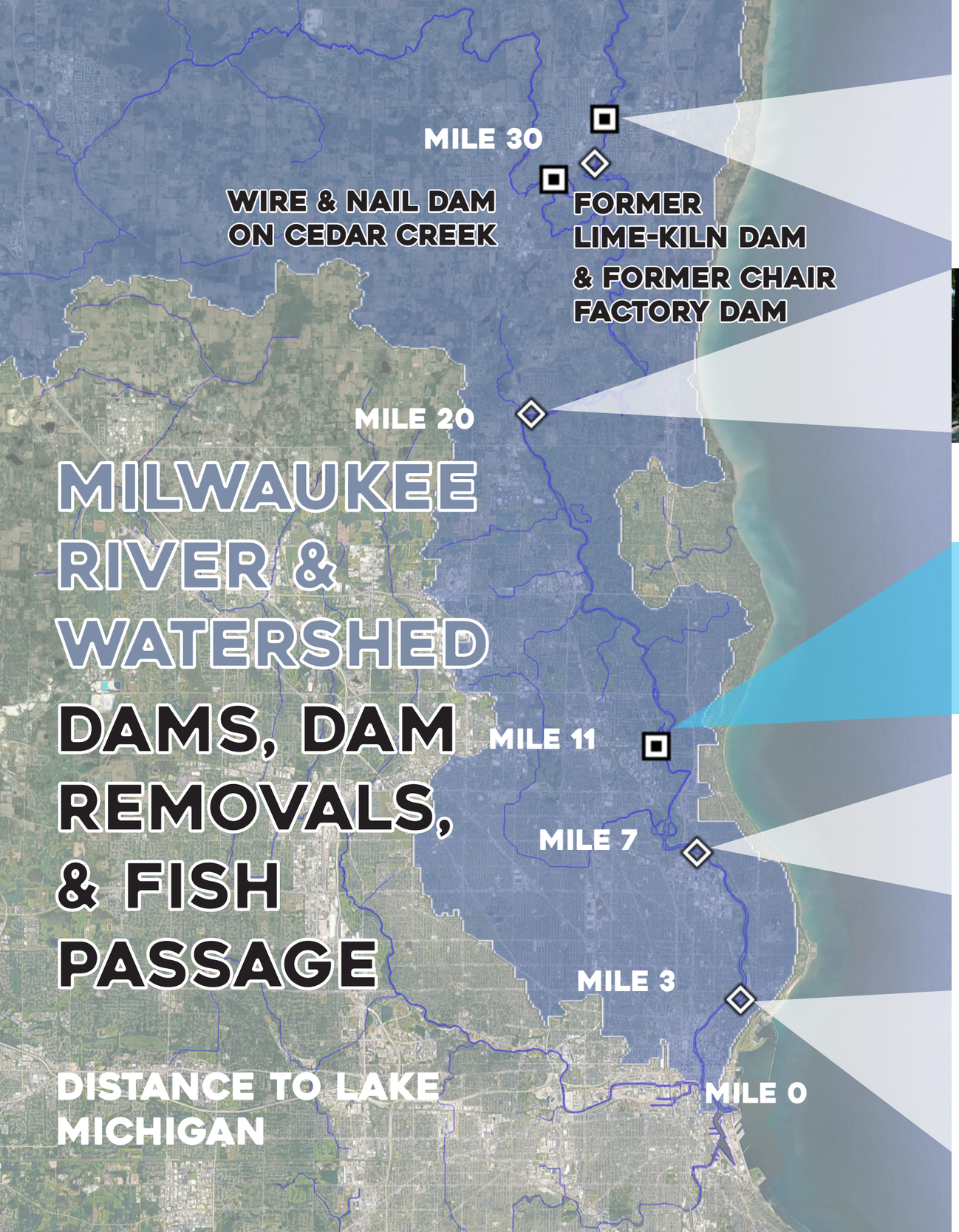


Will Gee, 11 (left) and Max Joyce, 11 (right) go fishing in the Milwaukee River near Kletzsch Dam two or three days a week during the summer. They typically fish for largemouth or smallmouth bass.

Anglers cast their lines downstream of the Kletzsch Dam in September 2023 as the fishway is constructed on the east bank beyond.



An aerial image of the Kletzsch Dam and fishway on December 12, 2023 when it opened to Milwaukee River waters.
courtesy Waterway Restoration Partnership





BRIDGE STREET DAM IN GRAFTON

Some 30 river miles from Lake Michigan, the Bridge Street Dam in Grafton is the end of the line for native fish swimming upstream in the Milwaukee River after the opening of the Kletzsch fishway in late 2023.

Within about a mile downstream, Grafton's Chair Factory Dam was removed in 2000 and the Lime-Kiln Dam removed in 2010.







MEQUON-THIENSVILLE DAM & FISHWAY

About 20 river miles from Lake Michigan, a fishway was installed around the Mequon-Thiensville Dam in 2010 and upgraded in 2021-'22. An underwater camera is installed in the fishway culvert along with two PIT tag antennas.

KLETZSCH DAM & FISHWAY IN GLENDALE

Eleven river miles from Lake Michigan, a fishway was built around the Kletzsch Dam in 2023. PIT tag antennas track the movements of tagged fish.





ESTABROOK FALLS IN MILWAUKEE

At 7 river miles from Lake Michigan, the manmade Estabrook Falls is the focus of in-channel fish passage engineering work as early as 2024.

Just upstream, the Estabrook Dam was removed in 2018.



FORMER NORTH AVENUE DAM IN MILWAUKEE

About 3 river miles from Lake Michigan, the North Avenue Dam was removed in 1997. A pedestrian bridge crosses the river at the site.

The Waterway Restoration Partnership is considering fish passage options here to help fish swim upriver here during high flows.

A FISH STORY

PART II: THE RETURN OF THE STURGEON

Cheryl Masterson, WDNR fisheries supervisor with the Lake Michigan-South team, holds an adult lake sturgeon captured during a dip net survey in the Milwaukee River.

photo courtesy Aaron Schiller from his “Lake Sturgeon Rehabilitation | Milwaukee River, WI” 2023 presentation

LONG BEFORE THERE WERE GREAT LAKES, THERE WERE LAKE STURGEON.

With bodies like torpedoes, sturgeon entered the Great Lakes as drainage basins flexed following the recession of the continental ice sheet some 14,000 years ago.

The species has endured for over 100 million years.

Growing as large as seven feet long, several hundred pounds, and over 150 years old, these gentle giants once marauded the bottoms of the Great Lakes to feed, swimming upriver to spawn in spring. Sturgeon swim belly close to benthic (bottom) surfaces, using their barbels (fish whiskers) and sensitivity to electric fields to find prey below, which they vacuum up through protruding tubular mouths. That direct connection to organisms low on the food chain makes the sturgeon a great indicator for water and sediment quality.

“They’re like a barometer for how our Great Lakes are doing,” said Mary Holleback, educator and science manager for the nonprofit Riveredge, who has assisted Wisconsin Department of Natural Resources (WDNR) in a unique program rearing lake sturgeon for the past 17 years. “In other words, they need clean, livable water with high oxygen, not much pollution. They tell us how the overall environment is doing, just by their presence or their absence.”

In the 20th century, absence characterized the sturgeon’s story more than presence.

Once revered and consumed by Wisconsin's Native peoples, lake sturgeon almost did not survive European Americans in the 19th century—suffering a trifecta of abuse: overfishing, pollution, and habitat loss tied with the construction of dams that blocked their passage to spawning waters.

But that was not the end of their story.

Thirty-eight miles upstream from the Kletzsch fishway, an unassuming pump draws Milwaukee River water through a buried hose like a kid sucking on a soda straw.

Every May through September, the three-inch hose delivers its liquid payload 350 yards up a wooded hill, through two 600-pound filters, and into a trailer—one of six "streamside rearing facilities" surrounding Lake Michigan.

Inside, aerated with oxygen injected from from cylindrical gas canisters, the river water circulates through four periwinkle-blue basins mounted to the trailer walls, two per side.

In late summer 2023, about 500 fingerling lake sturgeon prowled these open-air "raceways" like miniature sharks. Each fish was about the length of a cell phone and half as wide. Most had dark backs, a few albino. Looking down, the effect suggested an undulating M.C. Escher print.

If these sturgeon had looked up, they might have seen a giant careworn face beyond the periodic rain of chopped krill and carefully apportioned bloodworms, the larvae of midges. Mary Holleback has doted on generations of baby sturgeon here like a concerned nursemaid, a role she fell into in 2006.

"It was really the Little River Band of Ottawa Indians up in Michigan that actually figured out how to do this in a streamside rearing facility and they passed it on to Michigan DNR who passed it on to Wisconsin DNR," Holleback said. "All of us have been doing this for about the same length of time. All of us have the same quota somewhere between 1,000 and 1,500 fish per year. Not more than that because they don't want any of these fish to swamp the gene pool out in Lake Michigan."

The 25-year project, planned through 2031, aims to undo over a century of abuse: reintroducing lake sturgeon to Lake Michigan waters and helping them once again call the Milwaukee River home.

"THEY'RE LIKE A BAROMETER FOR HOW OUR GREAT LAKES ARE DOING. IN OTHER WORDS, THEY NEED CLEAN, LIVABLE WATER WITH HIGH OXYGEN, NOT MUCH POLLUTION. THEY TELL US HOW THE OVERALL ENVIRONMENT IS DOING, JUST BY THEIR PRESENCE OR THEIR ABSENCE."

–MARY HOLLEBACK

A pump draws Milwaukee River water up to the trailer at Riveredge.



The Streamside Rearing Facility at Riveredge in Newburg, Wisconsin consists of a trailer connected to constantly circulating water pumped up from the Milwaukee River.



Mary Holleback, educator and science manager for the nonprofit Riveredge, has assisted Wisconsin Department of Natural Resources (WDNR) in a unique program rearing lake sturgeon for the past 17 years.

FROM UBIQUITY TO SCARCITY



At first commercial fisherman did not like that the giant sturgeon got tangled in their nets, so they killed sturgeon en masse. These “trash fish” were sometimes bludgeoned or burned, not sold or consumed.

By the late 1800s, attitudes shifted as people discovered that sturgeon eggs were highly marketable as caviar. Then the problem became overfishing.

Consulting the Great Lakes Fisheries Commission Database reveals the striking population crash. From the late 1800s to early 1900s, based on pounds of commercial sturgeon catch reported, the lake sturgeon population curve flatlined.

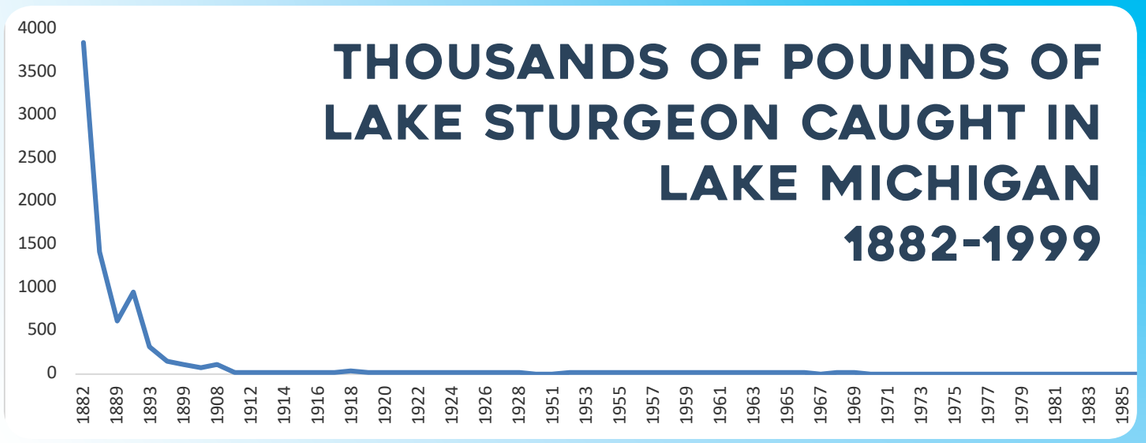
In 1882, 3.8 million pounds of lake sturgeon were caught on Lake Michigan, the highest catch ever recorded, and about the same weight as 20 adult blue whales—our planet’s largest animal.

“It was considered a disgrace for any fisherman to take in a sturgeon less than 200 pounds each and these large fish sold for around 50 cents apiece,” said Oliver Smith, president of Smith Bros. Fisheries, in a 1958 interview on the history of Great Lakes commercial fishing, recalling the late 1800s.

Catch rapidly decreased after that. By 1900 fishermen reported pulling less than half-a-blue-whale’s worth of sturgeon from the whole lake.

By 1928, the amount of sturgeon caught would not even weigh as much as one blue whale’s heart.

In less than a century, a fish once so ubiquitous that Port Washington, Wis.-based Smith Brothers used a fisherman hauling a sturgeon on his back as their commercial fishing company logo, had been extirpated in the Milwaukee River and pushed to the brink of extinction on the Great Lakes.



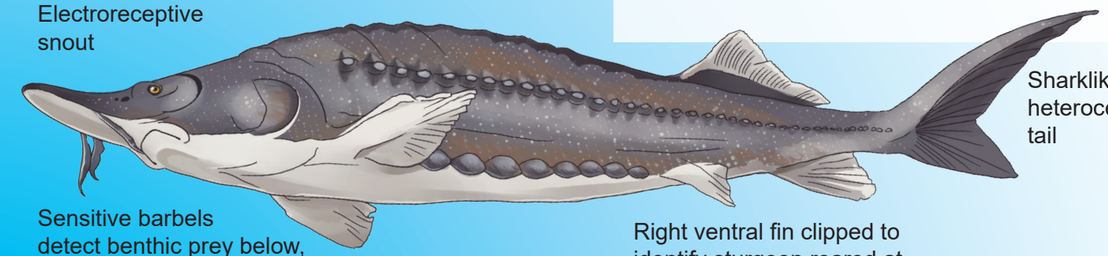
Data source: Great Lakes Fisheries Commission Database: Baldwin, N.A., R.W. Saalfeld, M.R. Dochoda, H.J. Buettner, and R.L. Eshenroder. 2009. Commercial Fish Production in the Great Lakes 1867-2006 [online]. Accessed April 2017. Available from: http://www.glfc.org/databases/commercial/commerc.php.

illustrations by Sydney Hoffman

Acipenser fulvescens

Females reach sexual maturity when about 55 inches long, about age 24-26 years

Males reach sexual maturity when about 45 inches long, about age 15 years



LAKE STURGEON

Lake sturgeon are one of 27 species of sturgeon globally, eight native to North America, three to Wisconsin, one of which is no longer found. (The shovelnose sturgeon is found in the Mississippi River system but not the Great Lakes.) Lake sturgeon spawning on Wisconsin’s Wolf River provide eggs and milt used in a collaborative effort to reintroduce naturally reproducing populations to the Milwaukee and Kewaunee Rivers.

“IT WAS CONSIDERED A DISGRACE FOR ANY FISHERMAN TO TAKE IN A STURGEON LESS THAN 200 POUNDS EACH AND THESE LARGE FISH SOLD FOR AROUND 50 CENTS APIECE.”

–COMMERCIAL FISHERMAN OLIVER SMITH RECALLING THE 1800S

Smith, Oliver. “History of Commercial Fishing on the Great Lakes.” recorded May 15, 1958. Retrieved from Port Washington Historical Society archives, April 2017.

The fish imprint on the water they are raised in, Holleback explained. “The fish actually smell the chemistry of this water, the Milwaukee River water.” Decades later, when these slow-maturing fish are ready to reproduce, the sturgeon rely on that scent memory to home in on spawning waters.

There is evidence this approach is working in the Milwaukee River.

“For the first 10 or 15 years of this project we did it all based on faith,” Holleback said. “They told us that they would imprint on Milwaukee River water and come back to the Milwaukee River to spawn, but there was no proof of that from this project till some of the males from this project starting coming back two years ago [2021].”

Because each sturgeon released is fin-clipped and PIT-tagged, managers are gaining a better understanding of their movements.

“Once they get to be about three years old, then they get kind of wanderlust and head out into the big lake and are found all over,” Holleback said. In 2011 one of their fish released in 2008 turned up in Whiting, Indiana and another a few weeks later in Big Bay De Noc in Upper Michigan. “So they get out all over the lake and only find their way back when it’s time to spawn. That’s pretty exciting.”

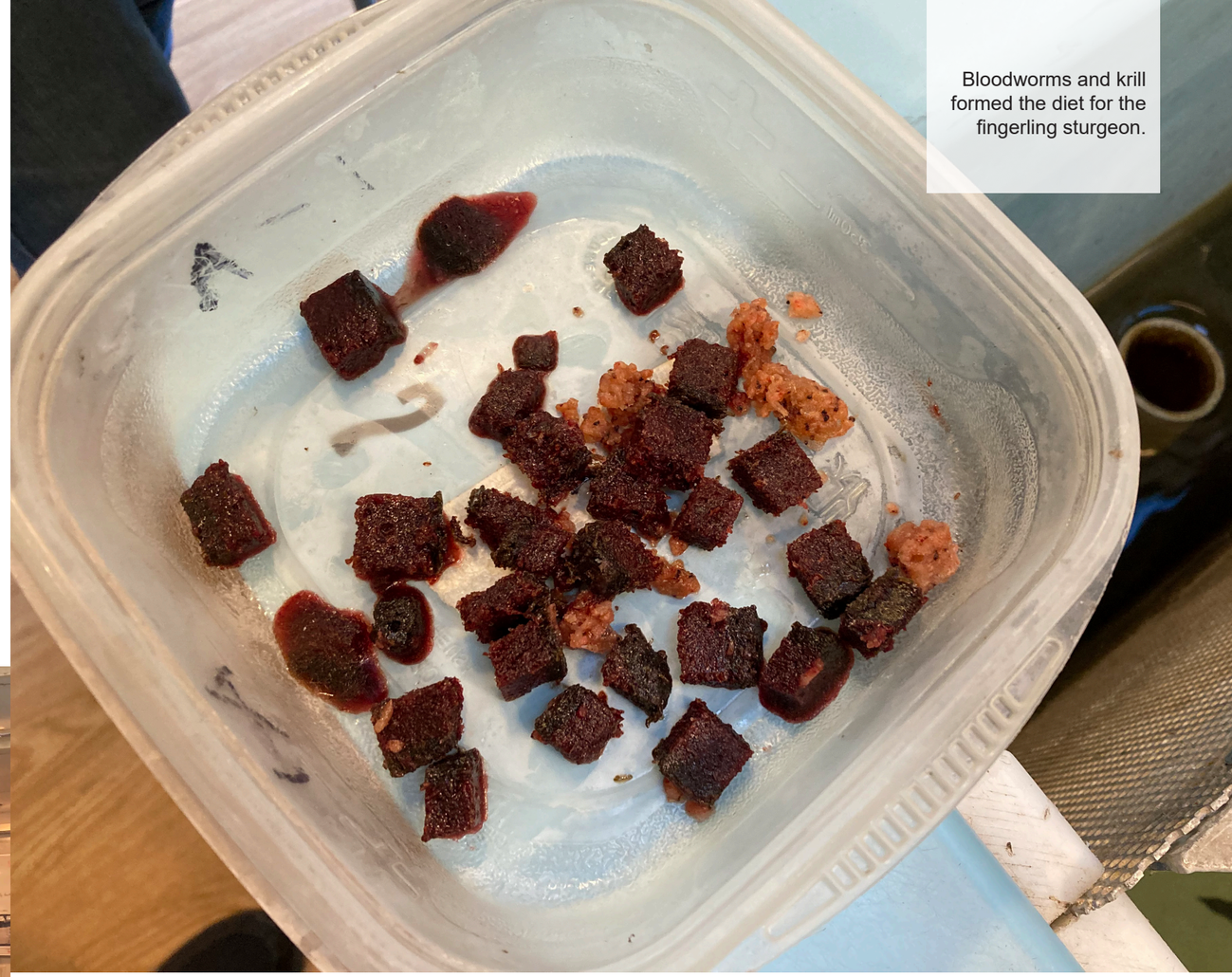
Raising broods of young fish is a labor of love.

Inside the Riveredge trailer, volunteers take shifts feeding the sturgeon on little conveyor belts that dole out protein diced from frozen blocks of food. “It’s all based on how many fish and their weight, so that we know we’re not overfeeding them,” Holleback said, “and we try to make the pieces small enough to get in their mouth.”

Sometimes the fish get sick. Illness killed about half the fish in 2023. A WDNR veterinary report identified no viruses of concern but did find a columnaris bacterial infection, skin disease, gill damage, and water mold infection. Holleback compared the sturgeon’s crowded circumstances to the spread of COVID-19 among humans packed in public spaces.



The trailer is familiar territory to Holleback and a network of volunteers who feed the fish, clean the tanks, and make sure pumps and filters are running.



Bloodworms and krill formed the diet for the fingerling sturgeon.

There are good years and bad years for sturgeon hardiness. In 2023, all the fish reared at Riveredge descended from the genetic mingling of eight females and five males.

Each year’s fingerlings grow from eggs and milt (sperm) collected every spring from naturally spawning fish in the Wolf River near Shawano. Spawning fish the size of logs in shallow waters is a spectacle. As females release eggs, males sidle up alongside, vibrate their tails, and release sperm. “They [WDNR fisheries managers] actually strip the eggs, and get the milt, and mix the eggs and milt together up there so they come here [Riveredge streamside rearing facility] fertilized the same day,” Holleback said.

Until completion of the Kletzsch fishway, the annual sexual drama unfolding in the Wolf River had scant stage on which to play in the Milwaukee River. But after 17 years of downstream releases the first actors are in the wings.

And eager.

Based on gut contents of sturgeon that have washed up on Lake Michigan beaches, it’s now known that sturgeon are feasting on round gobies, an invasive fish



Fingerling lake sturgeon swim in one of the four open-air basins filled with circulating Milwaukee River water in August 2023.

photo Kareem Benson-White

In a typical year, about 1,000 fingerling sturgeon are reared here from fertilized eggs over the course of May to September. In 2023, illness caused about half the fish to die.



Mary Holleback pulls out a giant foam sturgeon used for educational programming.

Riveredge has spread the sturgeon gospel to thousands of students, visitors, volunteers, families, and members of the public over the years of their partnership with WDNR.

species increasingly integrated into Great Lakes food webs, said Aaron Schiller, WDNR fisheries biologist.

"They're readily available for the sturgeon," Schiller said. "Their [gobies'] defense is kind of camouflage and sit still on the bottom. As the sturgeon swims over—those barbels—they know they're there. They just suck 'em right up."

The ample availability of round gobies as food may have increased the growth rate of the Lake Michigan sturgeon population, meaning they could be reaching sexual maturity years earlier than previously projected.

If so, more Riveredge sturgeon alumni should soon be pushing upstream in pursuit of their reproductive dream—making efforts to expand the sturgeon's portfolio of spawning habitat options more vital.

"We're not in control of the flow of the water," said Schiller. "They're very picky on the velocity they need for spawning. [But] We can work on substrate. So if they need a certain size rock and the velocity and the depth is there, I can put in rock there."

Schiller also hopes to provide advice to riverfront property owners who may be on an outside bend—preferred by spawning sturgeon—who are looking at landscaping. "And say, 'If you ever want to re-landscape here, we suggest this type and this size of rock. If you're interested, we may be able to get some grant funding to help out with that,'" Schiller said. "Working with partners is essential in all this stuff."

Jay Wesley, Lake Michigan Basin Coordinator for Michigan DNR, works with interstate partners and tribal nations to manage sturgeon reintroductions to Lake Michigan.

"The reintroduction efforts have been going on for over 20 years, and we are now starting to see mature adults coming back to the rivers that they were released in," Wesley wrote. "This is a great sign that the efforts put in over the [years are] working. It will be another 20 years to determine if adult populations increase in our river systems to become self-sustaining. That is the goal of the current stocking and habitat improvement programs."

The work raising tiny fish in a tiny trailer in tiny Newburg, Wis. has already attracted global attention. Like in 2006—when a tour bus of Azerbaijanis showed up at Riveredge unannounced.

"I was at the end of the driveway and was about to pull out and this bus—I mean a big fancy bus—pulls up," Holleback recalled. "You never see that out here, maybe a school bus. The guys got out in tuxedos and I was like, What in the—? Two people in the group spoke English. The rest all spoke Russian. I was on the phone with Brad [Eggold with WDNR Fisheries], like, What is this?"

The Azerbaijanis had just come from Lake Tahoe in California, Eggold told her, and he would be there soon to give them a tour. They had been touring fish hatcheries across the United States to inform their own efforts to restore native beluga sturgeon—whose caviar goes for a thousand dollars an ounce, Holleback said. "They were trying to see how this was done."

One lesson for the Azerbaijanis: It takes a village to raise these fish.

Holleback credits the dedication of volunteers, some who have invested over a decade of their lives to take care of these fish. "The volunteers treat these like they were their children," she said. "They have names for them. There's one that has two noses. Who would notice that? I wouldn't. There's 500 fish in here but they know: 'Yep, it's up there.'"

Holleback and a short list of WDNR fisheries staff are literally on call May through September. Someone has to respond whenever there is an alarm at the trailer from a power outage, clogged filter, or pump failure. Sometimes that's meant responding in the middle of the night—if the aeration tanks go down, an entire year-class of fish could suffocate for lack of oxygen.

In the early years, frequent power failures meant WDNR fisheries personnel would have to drive up from Greenfield Avenue in Milwaukee, an hour away, to rescue the fish. "So we'd be running to the river with buckets of water and running back up with buckets of water to keep them going," Holleback recalled. "We'd operate things off of our car batteries. It was just a mess."

A backup generator was installed but the need for

vigilance remains. When heavy rains flush sediment into the turbid river, it can compromise the filters.

Holleback recalled a recent alarm that kept repeating. “Every two hours you had to be down here. I got the daytime shift. Brad got the one from six to midnight, and poor Keith, who lives here, got the midnight to six in the morning,” she said. “His wife was ready to divorce him!”

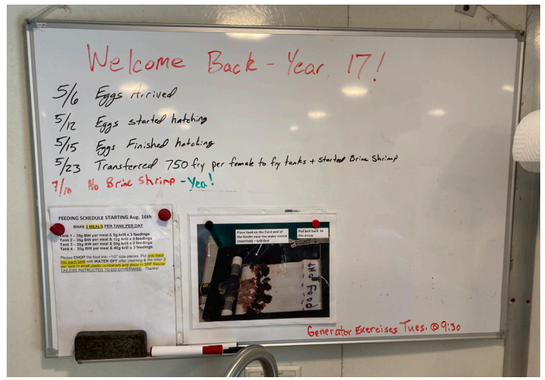
The cause demands an uncommon devotion of sturgeon caretakers. But the reward could mean bringing back a species that historic human activity pushed to the brink of extinction.

With ongoing rearing-and-release efforts plus the removal of stream impediments, the goal of a naturally reproducing lake sturgeon population in the Milwaukee River seems within reach.

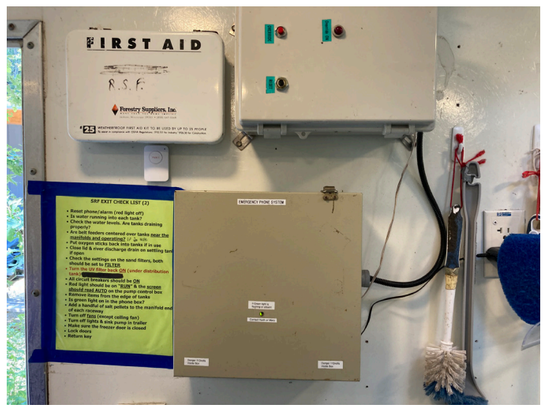
“By the time we’re done we will have have released about 30,000 lake sturgeon from this facility alone,” Holleback said. “And this is one of only six on Lake Michigan… So there’s a really good chance that lake sturgeon by that time [2031] will be well established in Lake Michigan and coming back to all these various rivers. It’s all very promising.”



A trailer similar to this one is used to rear sturgeon on the Kewaunee River as well. That is staffed by WDNR.



“Welcome Back - Year 17!” reads a whiteboard inside the trailer. A per-tank feeding procedure is posted. The fish get three square meals of bloodworms and krill per day.



The trailer alarm system auto-calls a phone tree of sturgeon caretakers who must respond in case of power outage or other emergency.



Holleback stands on Riveredge’s accessible pier on the Milwaukee River in August 2023. This is the river water that generations of young sturgeon have imprinted on inside the trailer before being released every fall into downstream waters connected to Lake Michigan.

From here the Milwaukee River flows 19 miles east and south to Grafton, where it flows over the Bridge Street Dam, then another 19 miles downstream to Kletzsch Dam and fishway, then another 11 miles to Lake Michigan.

Fifteen to 25 years after their release, the smell of these waters will call those fish that survive upstream to spawn.

COLLECTING EGGS & MILT





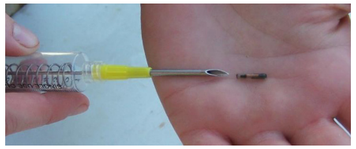
Eggs and milt are stripped from spawning sturgeon on the Wolf River, then the fertilized eggs transported to the Streamside Rearing Facility at Riveredge each May.

MONITORING

July 2021 installation of a PIT tag antennas in the Milwaukee River near the Riverside Urban Ecology Center. This array and those at Kletzsch fishway, Mequon-Thiensville fish passage, and others around Lake Michigan help managers track how sturgeon and other species move as they mature.



All fingerling sturgeon large enough are injected with a PIT tag prior to release.



For 2006-2011, sturgeon were released below Thiensville Dam in Mequon; in 2012, into Milwaukee's inner harbor at the School of Freshwater Sciences (SFS) slip; for 2013-2019, at Lakeshore State Park in Milwaukee; and for 2021-2023 into Milwaukee's inner harbor at SFS with Sturgeon Fest incorporated into the annual Harbor Fest.

The streamside rearing facility paused operations in 2020 due to the COVID-19 pandemic but 3 yearling fish were released.

Data & photos:
Aaron Schiller's "Lake Sturgeon Rehabilitation | Milwaukee River, WI" 2023 presentation, with 2023 figure from WDNR website

RELEASES

YR	FISH
2006	27
2007	158
2008	767
2009	2,038
2010	1,192
2011	1,616
2012	1,609
2013	1,679
2014	1,649
2015	1,497
2016	1,605
2017	1,650
2018	1,003
2019	1,261
2020	3
2021	1,494
2022	1,158
2023	590





Yearling sturgeon cruise in Riveredge Nature Center’s aquarium in August 2023. Each year, a few fingerlings are kept in the aquarium and released in a subsequent year.

A FISH STORY

PART III: WHY DO WE CARE ABOUT THE STURGEON?

PLUSH STURGEON TOYS. FOAM STURGEON PUPPETS. VIBRANT STURGEON MURALS AT STURGEON FEST. FOR A GROWING NUMBER OF MILWAUKEEANS, THE LAKE STURGEON HAS BECOME A POTENT SYMBOL OF A NEW RELATIONSHIP WITH WATER: HOPE ON FINS.



PhD student Nick Miller listens to Sturgeon Protector volunteer Anne Steinberg at Harbor Fest 2023.

Sturgeon Protectors at the Milwaukee Riverkeeper table at Harbor Fest 2023.

Milwaukee artist John Kowalczyk paints a sturgeon mural board for Harbor District, Inc. at Harbor Fest 2023.

From curious children petting them in a touch tank at Discovery World to annually hand-releasing hundreds of bony-backed fish from ice cream buckets into Milwaukee waters, sturgeon have recaptured the public imagination.

Why?

"Why do we care?" asked Nicholas Miller, pursuing his PhD in Multispecies History and Anthropology at UW-Milwaukee in fall 2023. "Why are we putting so much energy into restoring these? They were here before and we're trying to repopulate them and this idea of bringing them back: Why is that important to people?"

Miller (no relation to Ozaukee County's Ryan Miller, who mapped prospective sturgeon spawning habitat), attended Harbor Fest on Sept. 24, 2023 to find out.

Since 2021, the annual street festival on E. Greenfield Avenue, run by the nonprofit Harbor District, Inc., has also incorporated Sturgeon Fest, an annual celebration supported by the nonprofit Riveredge and Wisconsin Department of Natural Resources (WDNR). The partners rear young sturgeon that the public are invited to release into the water in support of a 25-year effort to reintroduce a self-sustaining population.

It's a fitting location. The WDNR Lake Michigan southern fisheries division is headquartered in the adjacent Great Lakes Research Facility managed by the UW-Milwaukee School of Freshwater Sciences. The harbor slip and homeport of the EPA Lake Guardian and R/V Neeskay research vessels offers a protected sturgeon release point connected to Milwaukee's Inner Harbor. And Harbor Fest offers a family-friendly destination welcoming nearby Latinx neighborhoods to the water's edge at Harbor View Plaza.

Among the pungent aromas effused from food trucks, colorful performances of public artists, and tabling displays of water-related organizations, Miller circulated among the crowd, speaking to sturgeon advocates to inform his research.

"It's just another sign the river is becoming more healthy," Anne Steinberg told him of the sturgeon returning. "It helps people feel connected to our watersheds."

"IT'S JUST ANOTHER SIGN THE RIVER IS BECOMING MORE HEALTHY," ANNE STEINBERG TOLD HIM OF THE STURGEON RETURNING. "IT HELPS PEOPLE FEEL CONNECTED TO OUR WATERSHEDS."

Steinberg is part of a volunteer group inspired by the efforts of the "Sturgeon Guard" who station themselves along the banks of the Wolf River during spring spawning runs to protect these giant fish from poaching.

In Milwaukee, their effort is coalescing under the name "Sturgeon Protectors" and aims to focus on public education rather than adopt a stance that could be perceived as militaristic. In late 2023 they had devised a logo, launched a website with educational materials, and were pursuing a Wisconsin Coastal Management Program grant. The Native American-led citizen's group shared a table with Milwaukee Riverkeeper at Harbor Fest.

"After 20 years of reintroduction efforts, lake sturgeon are finally making a comeback to the Milwaukee River, which is so exciting," said Cheryl Nenn, riverkeeper with Milwaukee Riverkeeper, who is helping organize the Sturgeon Protectors. "In the last few years, there have been several documented and rumored poaching incidents of these prehistoric fish—which is concerning given the extraordinary efforts of so many—and also because it can take sturgeon 20 years to reach reproductive maturity! So, to have them poached, either knowingly or unknowingly, as they return to our river to spawn, is heartbreaking."

Mark Denning is the heart of the Milwaukee Sturgeon Protectors.

Denning, a member of Sturgeon Clan enrolled in the Oneida Tribe of Wisconsin, with ancestry including Menominee, Mille Lacs Ojibwe, Stockbridge-Munsee, French, and English, places the story of sturgeon and our relationship to them in a moral context.

"When Sturgeon return home, we should be thinking about what kind of home that place will be," Denning wrote. "Like us, as Native people, sturgeon had been removed from their original homelands. We, as they, have seen in this place displacement, destruction, and disease. Barriers kept us, and them, from returning home. Whatever vestiges remained from the devastation, our ancestors survived—quietly, waiting, watching mostly invisible living on the edges of what we once called home. We, as Natives, have returned, in some cases never left... So now our relatives are able to return—but return to what?"

Denning's words contemplate the historic near genocide of an entire species and the mutual healing offered by work to create a new communion with life flowing through our waters.

"As Sturgeon struggle to get home after over a century and decades of banishment, we should be working and create inside of each of us a work ethic that whatever we can do to ease that return, we must do," Denning wrote. "Is this not what we do for the victims of war?"

Denning invites a reorientation between humans and the natural world.



Riveredge staff Matt Smith and Anna Jean Hallmann hold a plush sturgeon toy at Harbor Fest 2023.



Sturgeon in an ice cream bucket before release in 2016.

photo courtesy Emily Tyner

HARBOR FEST 2023



Milwaukee artist John Kowalczyk



Ryan Miller with Ozaukee County fish passage



The line to release one of 590 sturgeon



WDNR and Riveredge dole out sturgeon in nets



Volunteer Rich Harter has been feeding sturgeon since 2008.



Sturgeon Fest banner



WDNR fisheries biologist Aaron Schiller shows a baby sturgeon. Lake Michigan Fisheries division manager Cheryl Masterson looks on lower right.

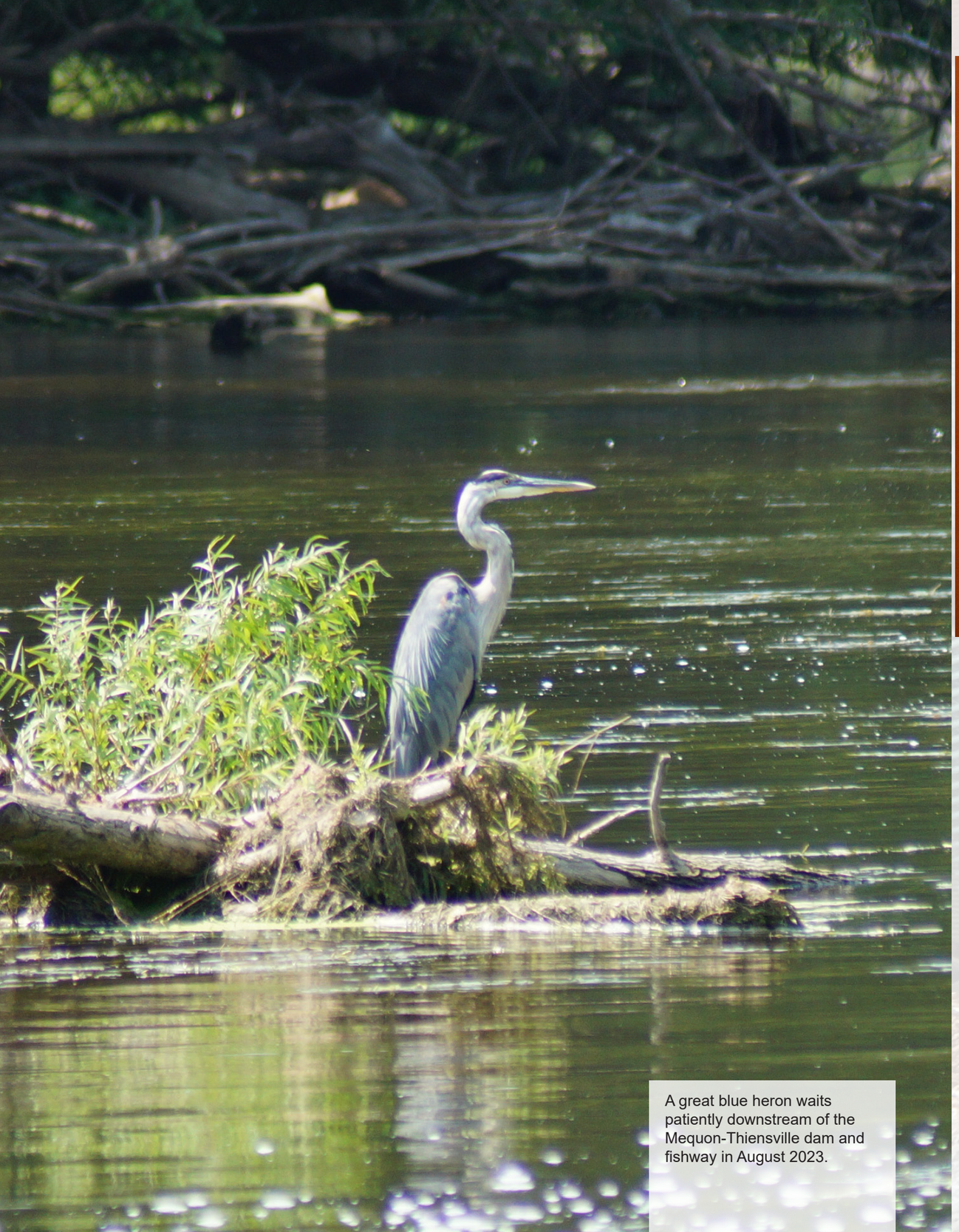


The largest sponsorship credit for Harbor View Plaza is denoted with a sturgeon.



Jeff Mercer with his son Lucas

photo courtesy Jamie Mercer

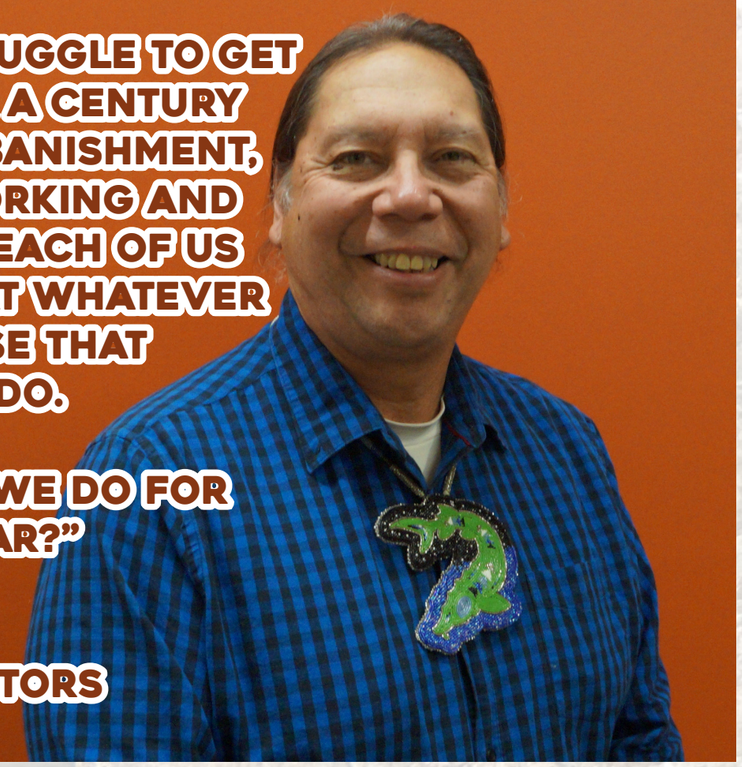


A great blue heron waits patiently downstream of the Mequon-Thiensville dam and fishway in August 2023.

"AS STURGEON STRUGGLE TO GET HOME AFTER OVER A CENTURY AND DECADES OF BANISHMENT, WE SHOULD BE WORKING AND CREATE INSIDE OF EACH OF US A WORK ETHIC THAT WHATEVER WE CAN DO TO EASE THAT RETURN, WE MUST DO.

IS THIS NOT WHAT WE DO FOR THE VICTIMS OF WAR?"

–MARK DENNING
STURGEON PROTECTORS



"We, as Native people, stand as relatives to Sturgeon and in our bond we both understand blood memory, an ancestral and genetic call that transcends time. Land and Water share this memory too. Imagine what it must be like when each meets in healthy, grounded places of abundance. That is what must continue to happen," Denning wrote. "As they live, we live."

Denning's words have become the slogan of the Milwaukee Sturgeon Protectors and help to answer PhD student Miller's fundamental question.

Consulting historic maps of the Milwaukee River, along with its former tributaries and wetlands, drawn from the public land surveys of 1835-1837, reveal how much the geography of our land and waters have changed over the past 200 years after the 1833 Treaty of Chicago pushed many Native Americans from ancestral lands and paved the way for widespread white settlement.

As we've lived more intensively—damming rivers, removing trees, concentrating wastes, paving our surroundings—various they's haven't always prospered.

About 20 years ago, the Milwaukee Metropolitan Sewerage District (MMSD) added a great blue heron to its logo. The addition was both aspirational and prophetic—a visible symbol standing for invisible water quality.

Once unthinkable for some river reaches, if you travel the length of the Milwaukee River in the 2020s, an increasing diversity of bird life is evident as you head upstream.



A bobber and tangled fishing line hang from a dead branch just downstream of the Mequon-Thiensville dam and fishway in August 2023. Angling is prohibitied in the fishway itself but allowed in the river.

Scissoring swallows roost beneath the bascule bridges of downtown Milwaukee, redwing blackbirds dive-bomb the banks at the River Revitalization Foundation's Turtle Park by the former North Avenue Dam, hawks circle among myriad species spotted along the riverbank trails at Riverside Urban Ecology Center, great blue herons squawk in the rocky shallows at Estabrook Falls, egrets flash their wings in sunlit circles by the Mequon-Thiensville fishway, while kingfishers and green herons wing their ways above the sarsaparilla waters of the Milwaukee River at Riveredge Nature Center.

We share the same river.

Birds eat fish. Healthy birds mean healthy fish. Healthy fish mean healthy water.

While the aquatic food web is not quite that simple, the general equation holds.

And the lesson is being learned.



At Kletzsch Park, as seventh grader Elijah "Eli" Pacada put it, "We're seeing if our waters are clean or not by looking at which animals are in there."

In fall 2023, Pacada was at Kletzsch Park with his seventh grade class from Glen Hills Middle School. The seventh graders left their shoes on shore, pulling on hip waders to venture into the river itself. They measured



Members of the Sturgeon Protectors group meets at the UW-Milwaukee School of Freshwater Sciences on Feb. 1, 2024. From left to right: Anne Steinberg, Eric Hansen, Mark Denning, Shirley Aspinall, Don Behm, David Wenstrup, Clare Eigenbrode, and Cheryl Nenn.

"OUR VISION IS TO WORK TOGETHER TO ENSURE A THRIVING AND SELF-SUSTAINING STURGEON COMMUNITY IN THE MILWAUKEE RIVER BASIN. WE HOPE TO EDUCATE THE COMMUNITY ABOUT THESE AMAZING FISH, WHICH ARE HIGHLY SIGNIFICANT TO THE NATIVE AMERICAN COMMUNITY, TO PROTECT THEM FROM HARM AS THEY COME BACK TO OUR RIVERS, AND TO INSPIRE VOLUNTEERS TO HELP US ENSURE THAT BABY STURGEON STOCKED TODAY CAN REACH THEIR POTENTIAL TO LIVE WELL OVER 100 YEARS!"

—CHERYL NENN
MILWAUKEE STURGEON PROTECTORS



the water's temperature, speed, and pH. They turned over rocks to uncover invertebrates. Among their finds: damselfly larvae, stonefly nymphs, dragonfly larvae, crayfish, and water pennies.

Pacada had never seen a sturgeon, but said he would like to. His main question about the water: "If it's safe for living things?"

Lalitha Murali, Pacada's teacher, said many kids in her class come to Kletzsch Park to fish but others know little about the fishway, the dam, or the river itself.

"We want to teach them because it's in our backyard," Murali said. "Many kids, they don't understand that it's such a precious natural resource in their backyard, and how they need to understand and appreciate and take action. So that's the main purpose, and the kids are loving it."

Seventh grader Ruby Gruen described one of the stations her class rotated through. "We looked through those bins over there to find insects and stuff," Gruen said. "And I think it's important so we know what we're drinking."

Beneath the mature oak trees shedding an autumnal veil of leaves, Murali's colleague Jen Clark was busy

"SOME FISH AREN'T STRONG ENOUGH TO GO THROUGH THE CURRENT AND CAN'T JUMP."



Caleb Olander, Mason Homa, and Joshua Reid



Eli Pacada

"WE'RE SEEING IF OUR WATERS ARE CLEAN OR NOT BY LOOKING AT WHICH ANIMALS ARE IN THERE."

"I THINK IT'S IMPORTANT SO WE KNOW WHAT WE'RE DRINKING."

Seventh graders from Glen Hills Middle School work with a team from Milwaukee County Parks to survey the Milwaukee River downstream of Kletzsch Dam in September 2023.



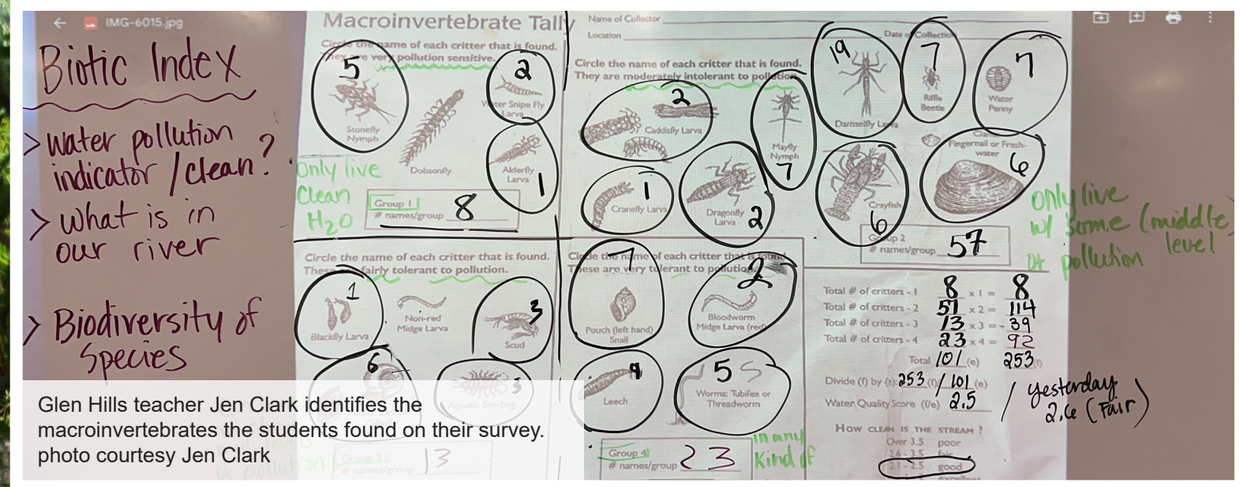
Ruby Gruen and Evynn Davis

Seventh graders sampled the water's turbidity and tested for pH, dissolved oxygen, nitrate, and phosphate. They also measured the river speed, temperature, and assessed an Index of Biological Integrity based on what organisms they observed.

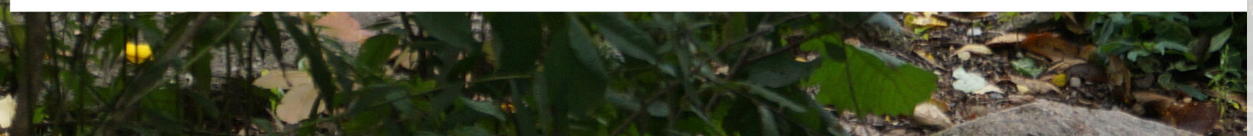


“WE WANT TO TEACH THEM BECAUSE IT’S IN OUR BACKYARD,” MURALI SAID. “MANY KIDS, THEY DON’T UNDERSTAND THAT IT’S SUCH A PRECIOUS NATURAL RESOURCE IN THEIR BACKYARD, AND HOW THEY NEED TO UNDERSTAND AND APPRECIATE AND TAKE ACTION. SO THAT’S THE MAIN PURPOSE, AND THE KIDS ARE LOVING IT.”

Glen Hills teacher Lalitha Murali joins her students in waders for the Kletzsch field experience.



Glen Hills teacher Jen Clark identifies the macroinvertebrates the students found on their survey. photo courtesy Jen Clark



teaching her students the history of the Kletzsch Dam and the importance of the fishway being built on the far shore.

Explained her seventh grader Mason Homa: “They are building an area for a fish to go through ‘cause some fish aren’t strong enough to go through the current and can’t jump. Most fish have to jump and migrate to the waters to lay their eggs.”

Educating the next generation of humans is important, said Aaron Schiller, WDNR’s fish biologist, because the return of sturgeon will ultimately depend on all of us.

“Spawning habitat, protecting those adults, and water quality are three big things for getting this population rehabilitated,” Schiller said. “Awareness is going to be big.”

Riveredge’s Mary Holleback, instrumental in the annual rearing of young sturgeon since 2006, is optimistic Milwaukee sturgeon advocates will make a difference.

“We will have people who will at least be aware and go to the boat landings and wherever and educate people about that this is in fact an unusual fish,” she said. “They are very unique. They are very ancient. They have not been in the Milwaukee River for so many years. And this is a process of trying to reintroduce them. We hope people will be respectful of them and leave them be!”

Decades of Native American leadership and the work of teams of science-based fisheries managers have led to the point where, every September at Sturgeon Fest, parents wait in long lines to donate money for the chance for their kids to release a baby sturgeon at the water’s edge.

In 2023, one family was Jeff and Jamie Mercer and their son Lucas. First grader Lucas opted to send his sturgeon down the PVC-halfpipe slide into the harbor.

“We love going to Sturgeon Fest,” said Jamie Mercer. “Lucas attends Riveredge Outdoor Learning Elementary School where some of the sturgeon are raised. Students have the opportunity to visit the sturgeon at school and learn about them as they grow into fingerlings. It’s really exciting for him to come to Sturgeon Fest to release the sturgeon and be an active part of the process he’s learning about in school.”



Carly Hintz with Milwaukee County Parks Wehr Nature Center identified a distinctive “water penny” beetle larvae the students uncovered in the river.

Jeff Mercer helps his son Lucas release a sturgeon down the halfpipe and into the Milwaukee harbor slip on Sept. 24, 2023.

photo courtesy Jamie Mercer

Each fish that plops in is a down payment on the future: pennies plinking into the Lake Michigan piggy bank.

And a reminder that we are all part of the sturgeon story.

With almost a half-billion dollars expected to flow into Milwaukee Estuary Area of Concern cleanup projects over the coming years, it's a leveraged investment.

The work to bring back sturgeon—through fish passage, habitat improvement, and sediment cleanup projects—ultimately benefits much more than one species, said Milwaukee County Parks' Natalie Dutack, including our own.

"We're talking about enhanced populations of native fish," said Dutack. "Fish that people love to fish for. Fish that people rely on for food—subsistence fishermen. We're also talking about pure recreational enjoyment. And obviously, I say all that, and I always like to say we're also talking about better lives for the fish themselves."

If they survive, sturgeon released today—the size of first-grader Lucas' hand—could grow to seven feet and endure into the 22nd century.

"There's nothing bigger out there. They're bigger than you or I," Holleback said. "Believe it or not, some fish from the '40s are still coming back [in the Wolf/Winnebago system]. These things live till they're 150 years old. The females can go to 180 years."

What will the story of the Milwaukee River look like for those sturgeon in 50 years—in the 2070s—when today's seventh graders will be in their early 60s?

"I feel like it's going to be cleaner," said one of the Glen Hills seventh graders exploring the Milwaukee River at Kletzsch Park, "maybe."



WDNR staff supports urban fishing opportunities including this August 9, 2023 outing at Harbor View Plaza. The young angler had just caught a round goby, an invasive species that lake sturgeon have been found to eat.

TOO SALTY

EVERY WINTER WE DOSE OUR LAND WITH OVER A MILLION TONS OF A POLLUTANT THAT IS BUILDING UP IN OUR WATER WITH HARMFUL EFFECTS FOR LIFE.

SALT: SODIUM CHLORIDE. THE SAME MINERAL WE EAT, POUR FROM SHAKERS, AND INGEST IN PROCESSED FOODS – IS USED ACROSS THE STATE TO DE-ICE ROADS AND WALKS, IN ORDER TO KEEP SOCIETY SAFELY MOVING.

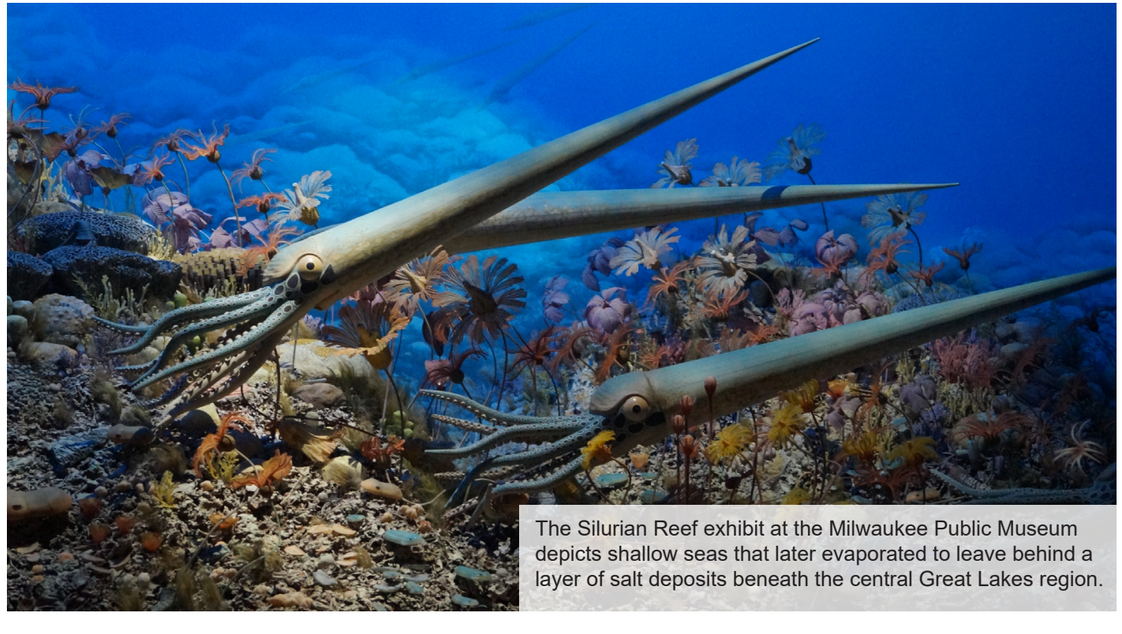
BUT SALT COMES WITH HIDDEN COSTS.

THE IMMENSE QUANTITIES APPLIED OVER THE YEARS WASH OFF IMPERVIOUS SURFACES INTO OUR SOIL AND WATER.

SO MUCH SO THAT THE SALINITY OF LAKE MICHIGAN IS ACTUALLY INCREASING.

Port Milwaukee leases space used by three vendors who stockpile mountains of road salt like this one seen in August 2023.

photo by Kareem Benson-White



The Silurian Reef exhibit at the Milwaukee Public Museum depicts shallow seas that later evaporated to leave behind a layer of salt deposits beneath the central Great Lakes region.

PART I: WISCONSIN USES MILLIONS OF TONS OF SALT

The story of salt begins with tropical seas some 400 million years ago—when the tectonic plates of planetary crust that became our Great Lakes region floated atop the superhot mantle near Earth's equator.

Depicted at the Milwaukee Public Museum's popular Silurian Reef exhibit, featuring squid-like cephalopods hovering underwater above hand-sized trilobites, after 20 million years of climatic warming, these reef-sequestered shallows evaporated and left behind a layer of salt.

Geologically part of the Salina Formation, these salt deposits are buried hundreds of feet beneath Michigan, Ohio, Pennsylvania, New York, and the Canadian province of Ontario.

Deep below the rims of Lakes Erie and Huron, miners excavate salt in marvelous manmade caverns evoking the lair of a Bond villain.

Among other purposes, salt is mined as "rock salt" like that piled into black-shrouded mounds on Milwaukee's Jones Island where the "dry bulk" commodity is offloaded from self-unloading freighters, before being distributed by thousands of truckloads to communities across Wisconsin for de-icing winter roads.

Through various subsidiaries, three major salt vendors operate through the Port of Milwaukee: Cargill, Compass Minerals, and Morton. Milwaukee imports more salt than Green Bay or Chicago and is a major distribution node of road salt to communities in 16 Wisconsin counties as far west as Sauk County and as far north as Fond du Lac.

The slogan of one company—"Morton Salt is an American way of life"— is apt, for salt has become a key ingredient dissolving invisibly into the recipe of modern society. If we want to move freely about our business during icy winters, applying salt to human surfaces has become the default conditioned response. Just how much salt moves through Port Milwaukee, "an economic entity of the City of Milwaukee government" governed by a publicly appointed Board of Harbor Commissioners?

Madison Goldbeck, Port Milwaukee's marketing and communications officer, declined to provide exact figures, referring inquiries to Port tenants.

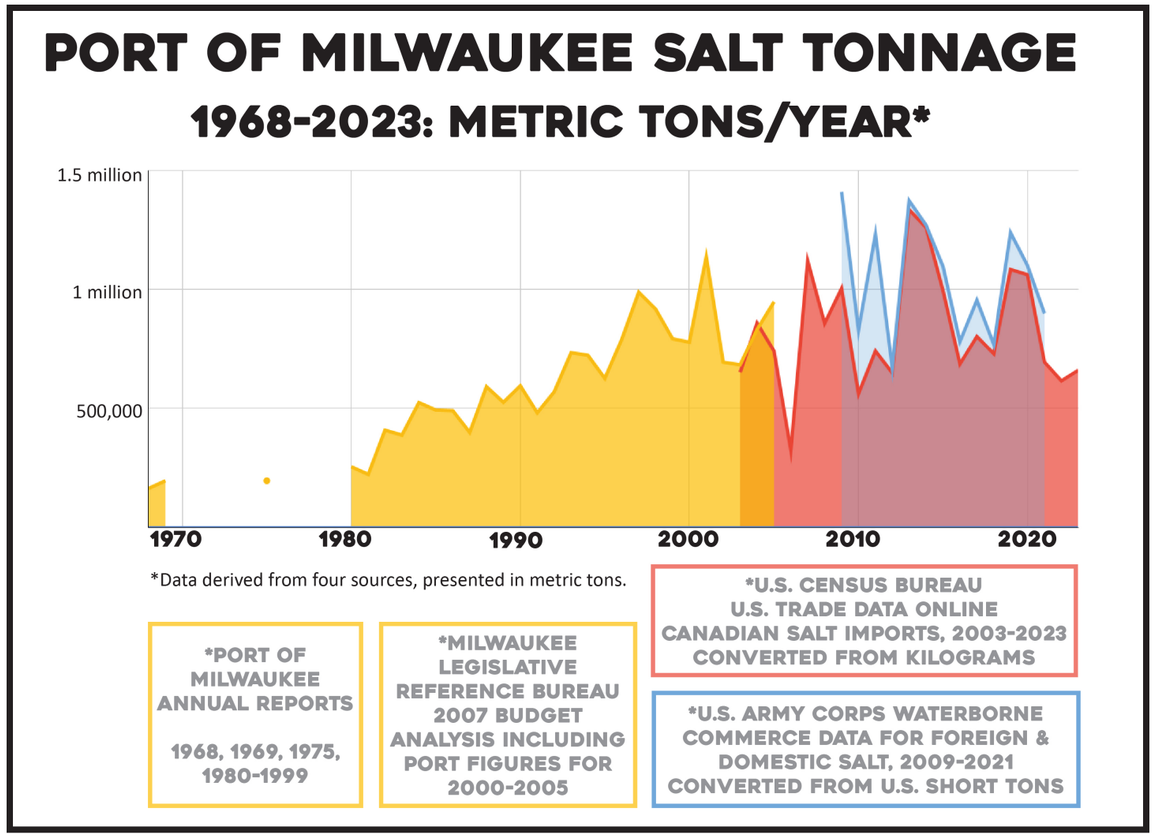
"Dry bulk commodities, which include salt, are the largest type of commodity handled at Port Milwaukee. During 2023 over 50% of dry bulk commodities handled at Port Milwaukee consisted of salt," Goldbeck said in an email. "I suggest reaching out to the tenants you mentioned, as we do not share tenant-specific information because they are private companies."

Through a company spokesperson, Kinder Morgan, which handles salt imported from Morton's Canadian counterpart K S Windsor Salt Ltd., declined to comment. Through a company spokesperson, Compass Minerals, which imports salt from what Compass's website describes as the world's largest underground salt mine beneath Goderich, Ontario on the eastern shore of Lake Huron, declined to comment, referring inquiries back to the Port. Cargill, which according to public accounts has operated a salt mine beneath Cleveland, Ohio that extends beneath Lake Erie, did not respond to a request for information.

But federal data sheds light on the question. The U.S. Census Bureau tracks commodity imports when ships unladen their cargoes at ports. A review of the past two decades of salt imports through Milwaukee provides a baseline for comparison. In 2023, Milwaukee imported 660,065 metric tons of salt (1 metric ton = 1,000



*The source of Cargill salt moving through Port Milwaukee could not be independently confirmed.
The source of Compass Minerals salt mined in Goderich, Ontario and Morton salt mined in Windsor, Ontario is based on a review of vessel calls recorded from bills of lading archived by ImportInfo and five years of WisDOT salt bid data. Illustrations by Sarah Gail Luther | basemap from Google Earth



kilograms). These figures likely undercount actual tonnage, as Army Corps of Engineers Waterborne Commerce data, available for 2009 through 2021 and including both domestic and foreign shipments, routinely tally slightly larger figures.

Salt supply and demand fluctuate year to year in response to winter severity, prior-year stockpiling, and other factors like labor disputes. The U.S. Census Bureau tracked 17.4 million metric tons of salt moving through Port Milwaukee over the past 21 years for which data were available, 2003 through 2023. The average size of the annual import was 829,598 metric tons. The high was 1.33 million metric tons in 2013 and the low 322,248 metric tons in 2006.

Other sources trace the journey of salt across our freshwater Great Lakes.

Vessels like the Algoma Innovator, a 650-foot-long self-discharging bulk carrier built in 2017, routinely transport salt from Goderich, Ontario, location of Compass Minerals' salt mine, to Milwaukee. From 2019 through 2023 the Algoma Innovator made 41 Milwaukee port calls—the most of any vessel—unlading 879,000 metric tons of salt. Over that time, it transported 2.8 million metric tons of salt from Goderich, meaning that Milwaukee comprised about a third of its salt duty. That's according to publicly available data reviewed from ImportInfo, which maintains a database derived from bills of lading, legal shipping documents which are provided to U.S. Customs officials on port calls but then filed away out of public view. These bills comprise the source for the public U.S. Census Bureau and U.S. Army Corps of Engineers Waterborne Commerce data, which aggregate individual shipment records into monthly and annual tallies.

A recent shipment logged for February 2024 included just shy of 27,000 metric tons of rock salt.

"DRY BULK COMMODITIES, WHICH INCLUDE SALT, ARE THE LARGEST TYPE OF COMMODITY HANDLED AT PORT MILWAUKEE. DURING 2023 OVER 50% OF DRY BULK COMMODITIES HANDLED AT PORT MILWAUKEE CONSISTED OF SALT," GOLDBECK SAID.

According to a 2014 Toronto Star report, one shipment of this scale is close to the daily output capacity of the Goderich mine-23,000 metric tons. The Star reported the minde produces 6.3 million metric tons of salt per year and was expected to remain viable for 120 years.

Other vessels in the Canadian-based Algoma Central Corporation fleet—Algoma Buffalo, Algoma Compass, Algoma Conveyor, Algoma Intrepid, Algoma Niagara, Algoma Sault, and Algoma Transport—have also made calls on Milwaukee from Goderich, all transporting salt.

Salt is a major part of Port Milwaukee business—comprising roughly one-third of annual tonnage. Salt operations use over 25 acres of land.

Compass Minerals leases just over 10 acres of Port property on eight parcels, near E. Lincoln Avenue and S. Bay Street in Bay View. The salt piles closest to the Lincoln Avenue Viaduct are here.

Kinder Morgan leases a number of Port parcels, including 7.68 acres designated for salt, closer to I-794. An energy infrastructure company, Kinder Morgan provides bulk materials handling. Based on a review of vessel calls, the salt piled here appears to originate from the Morton-affiliated salt mine in Windsor, Ontario, just across the Canadian border near Detroit.

Cargill, the current vendor supplying the City of Milwaukee with road salt, leases a 4.87-acre Port tract along the Inner Harbor, south of the new DeLong facility.

Over the past four decades, salt imports have clearly increased at Milwaukee. Salt has always been a major component of the Port's bulk tonnage, but has also grown as an increasingly dominant factor in annual tonnage overall. That's according to a review of Port of Milwaukee annual reports from 1980 through 1999, when the Port routinely published per-commodity annual tonnage. In 1980, the earliest year for which consistent figures were reported, the Port reported handling 254,725 metric tons of salt. Over the ensuing decades this figure climbed as high as 987,833 metric tons for 1997.

This increase is coupled with a regional increase in population, development, and impervious surfaces over same period.

VESSEL CALLS ON MILWAUKEE

COMPASS MINERALS SALT MINE
GODERICH, ONTARIO

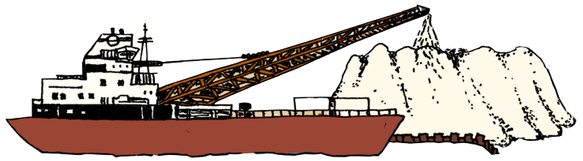
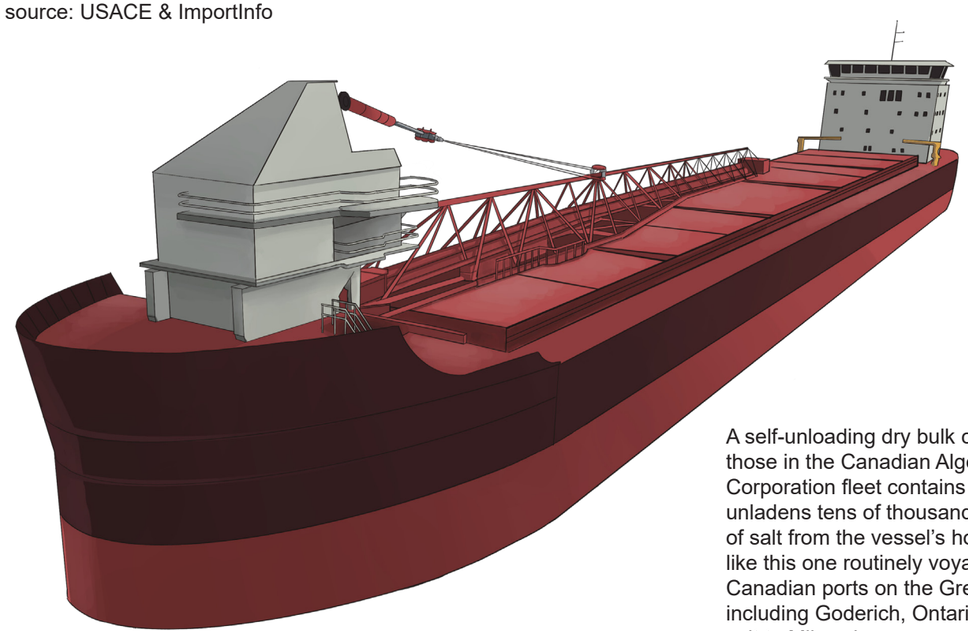


Illustration by Sarah Gail Luther



Data source: USACE & ImportInfo



A self-unloading dry bulk carrier like those in the Canadian Algoma Central Corporation fleet contains a boom that unladens tens of thousands of tons of salt from the vessel's hold. Ships like this one routinely voyage from Canadian ports on the Great Lakes, including Goderich, Ontario, carrying salt to Milwaukee.

Illustration by Sydney Hoffman



A freighter unloads salt in January 2017.

photo courtesy Henry Jorgenson

Salt is a multi-national, multi-billion-dollar business characterized by increasing mergers and acquisitions. Highway deicing accounted for about 41% of total salt consumed nationally in 2023, according to a U.S. Geological Survey mineral commodities report.

The Customs value of those 660,000 metric tons of salt (727,596 tons) delivered to Milwaukee in 2023 was about $21.1 million, according to the U.S. Census Bureau figures.

It is sold to local communities for over twice as much. Compass Minerals International, Inc., headquartered in Kansas City, Mo., is publicly traded on the New York Stock Exchange. Compass was formerly North American Salt Company, itself formed from the merger of various salt firms in 1990.

Morton Salt and its Canadian counterpart were sold for $3.2 billion in 2020 to Stone Canyon Industries, a holding company whose portfolio includes Kissner, Morton Salt, Detroit Salt. Co., NSC Minerals, Central Salt, Lyons Salt Company, Lobos, and Windsor. It is the world's largest salt producer, according to its website, claiming capacity to produce 29 million tons of salt per year.

Cargill is a privately held company that markets a variety of salt products for food and other uses.

Every year local Wisconsin communities spend millions of dollars purchasing salt to spread onto winter roads. (While the commodity is shipped in metric tons, the following costs are per U.S. tons. 1 ton = about 0.91 metric tons.)

The City of Milwaukee reported using 26,619 tons of salt in 2023 at a cost of $81.29 per ton, which includes delivery charges. That's over $2.1 million.

Per-ton costs appear to be rising far beyond inflation—even as municipalities like Milwaukee are starting to apply salt more efficiently. In 2019, just five years ago, the City of Milwaukee reported using 44,832 tons of salt at a cost of $47.78 per ton.

The City of Milwaukee has a standard three-year contract with Cargill for salt, according to Tiffany Shepherd, marketing & communications officer for Department of Public Works.

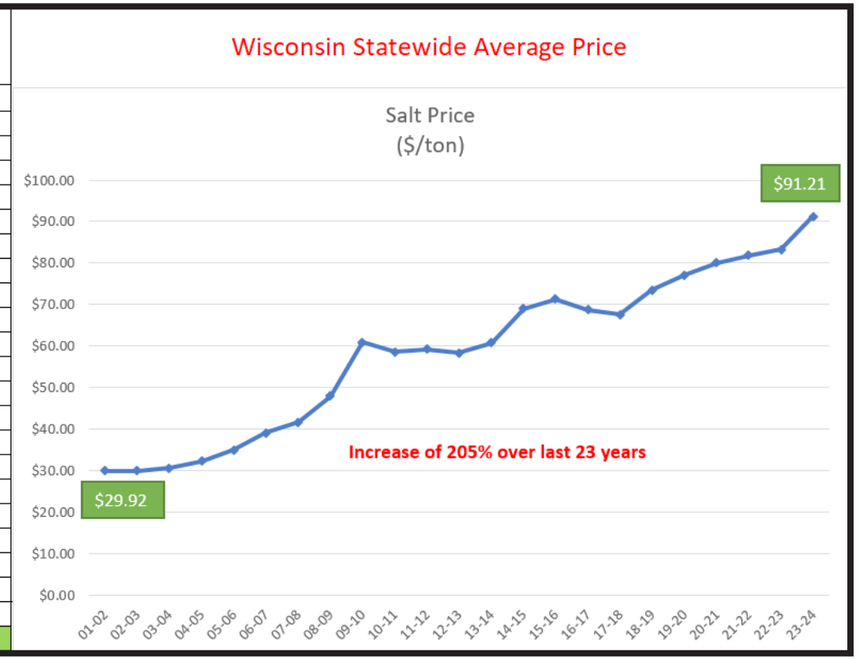
Other local communities and jurisdictions obtain salt through the Wisconsin Department of Transportation's shared salt bid, according to Cody Churchill, WisDOT winter maintenance engineer.

For the 2022-2023 season, 25 public entities in the county—including the State of Wisconsin, Milwaukee County, MMSD, and all municipalities (except the City of Milwaukee and West Milwaukee)—participated in the shared bid sourced from Compass Minerals salt imported to Port Milwaukee. For 2022-2023 the per-ton cost for Milwaukee County entities was $69.90, or just over $4.5 million.

In all, the State of Wisconsin DOT salt bid procured 681,059 tons of salt from Compass for over $55 million for the 2022-2023 season and 230,426 tons from Morton for $18.7 million. That supplied about 460 Wisconsin public entities statewide and includes salt shipped through the Great Lakes via Milwaukee, Green Bay, Marinette, and Duluth/Superior and also along the Mississippi River at Dubuque, La Crosse, Winona, St. Paul, and Prairie du Chien.

But that's just the beginning of what salt costs us.

Year	Statewide ($/ton)
01-02	$29.92
02-03	$29.96
03-04	$30.57
04-05	$32.21
05-06	$34.98
06-07	$39.03
07-08	$41.69
08-09	$47.91
09-10	$60.92
10-11	$58.55
11-12	$59.18
12-13	$58.34
13-14	$60.78
14-15	$69.01
15-16	$71.35
16-17	$68.74
17-18	$67.60
18-19	$73.51
19-20	$77.10
20-21	$80.09
21-22	**$81.80**
22-23	**$83.31**
23-24	**$91.21**



The cost of salt is rising. Sold by the (U.S.) ton (including trucking costs to local salt depots averaged across Wisconsin) to public entities through the shared Wisconsin Department of Transportation salt bid, this chart shows the average per-ton cost for road salt to Wisconsin communities based on 20 years of WisDOT data.

courtesy of Wisconsin Salt Wise



A view of salt piles on Port Milwaukee parcels leased by Compass Minerals looking north from the Lincoln Avenue Viaduct in January 2024.

PART II: HOW SALT IS POLLUTING STATE'S WATERS

When salt dissolves into water as ions of sodium and chloride it does not disappear. Dr. Hilary Dugan, a scientist at the University of Wisconsin Center for Limnology at Madison, is among a chorus raising the alarm about chloride pollution to Wisconsin waters.

Dugan's research estimates that about 1.2 million tons of chloride enter Lake Michigan via its tributaries every year—slowly but measurably raising the salinity of our freshwater lake.

Chloride concentrations in the Great Lakes have risen from 1-2 milligrams per liter in the 1800s to contemporary concentrations greater than 10, Dugan and her co-authors reported in a 2021 paper. From 1980 to 2020, Lake Michigan chloride concentrations rose from about 9 to 15 milligrams per liter.

They identified urbanized, highly impervious watersheds as closely correlated with salt loading.

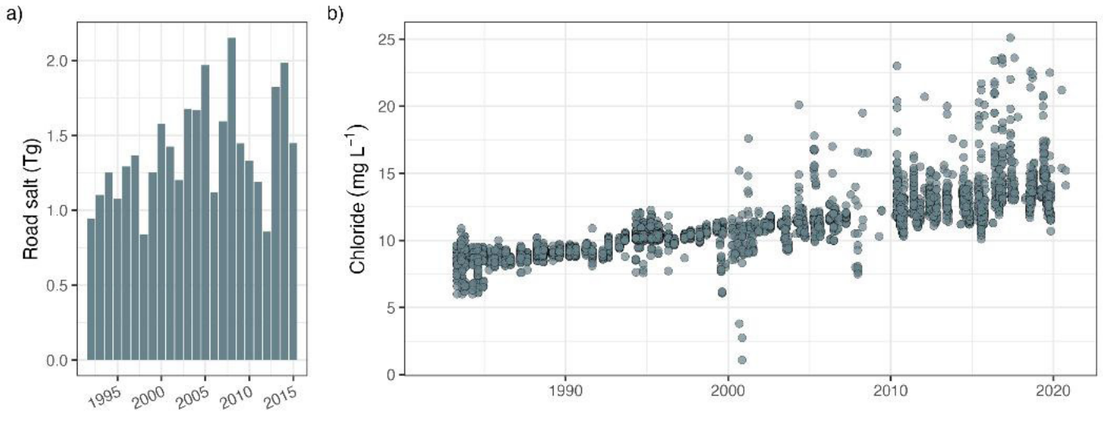
"The largest of these highly urbanized tributaries is the Milwaukee River, which accounts for approximately 8% of the total tributary load (5th largest contributor overall)," Dugan and her fellow authors wrote.

Our freshwater, the source of public drinking water supplies, is getting saltier due to human activity.



Dr. Hilary Dugan, a scientist at the University of Wisconsin Center for Limnology at Madison, stands by a salt pile in the Jefferson County Salt Barn in February 2019.

photo courtesy Wisconsin Salt Wise



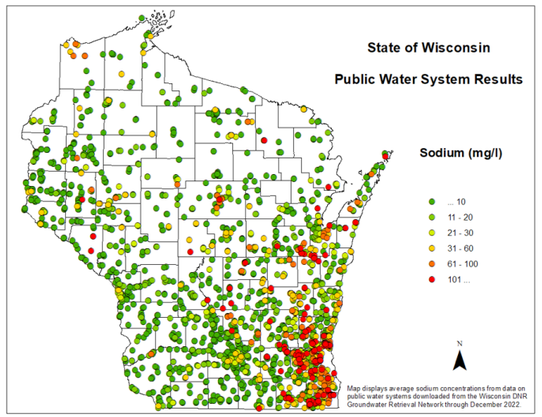
Lake Michigan is actually getting saltier from human contributions to rivers and streams in the watershed. The figure above includes concentration data from the 2021 *Limnology and Oceanography Letters* paper, “Tributary chloride loading into Lake Michigan” whose lead author was Dr. Hilary Dugan. Prior to the 1990s, chloride concentrations were routinely below 10 milligrams per liter. Recent concentrations are closer to 15 milligrams per liter. Estimated mass inputs of road salt in the Lake Michigan watershed are shown left per year. One teragram is 1 million metric tons. One metric ton is 1,000 kilograms.

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During a January 31, 2024 meeting of the Southeastern Wisconsin Regional Planning Commission’s Chloride Impact Study Technical Advisory Committee, SEWRPC’s principal planner Joe Boxhorn noted that the U.S. EPA recommends 20 milligrams per liter as the upper limit of sodium in drinking water for health purposes. “I would note that based on their consumer confidence reports, 34 municipal water utilities in the region report sodium concentrations higher than this,” Boxhorn said. “So, it is a problem.”

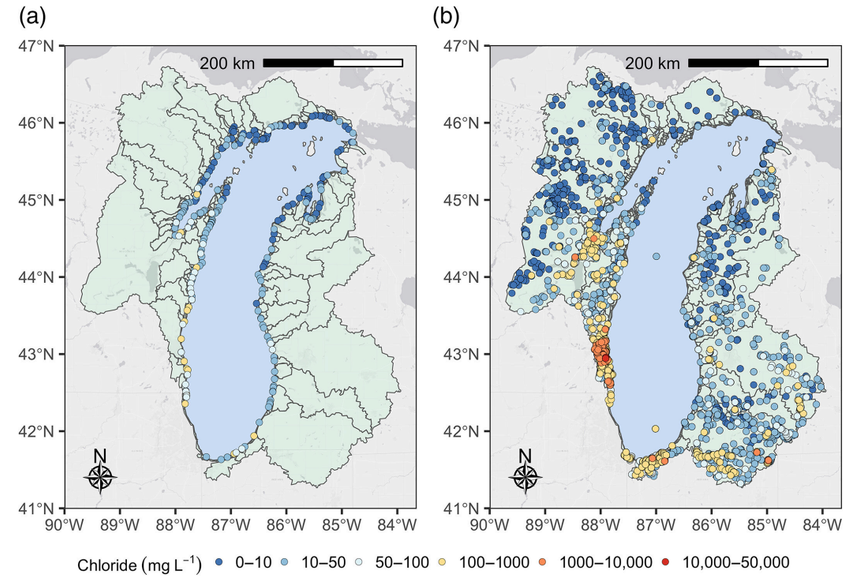
Milwaukee’s drinking water measures below that threshold for now. The 2022 Milwaukee Water Works consumer confidence report notes an average chloride concentration of 15.5 milligrams per liter and 9.95 milligrams per liter of sodium. The 2016 value for chloride was 14.5 milligrams per liter.

Increases in chloride concentration in drinking water can promote corrosion of plumbing, which



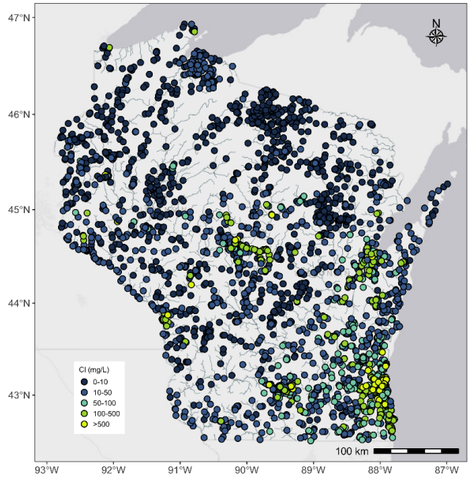
This map displays average sodium concentrations from data on public water systems downloaded from the Wisconsin DNR Groundwater Retrieval Network through December 2022.

courtesy of Wisconsin Salt Wise



The maps above include tributary chloride concentration data from the 2021 *Limnology and Oceanography Letters* paper, “Tributary chloride loading into Lake Michigan” whose lead author was Dr. Hilary Dugan. The left map shows values measured for one week in July 2018. The right map show values from many years and sources. The highest concentrations of chloride are clustered in the Milwaukee-area tributaries to Lake Michigan with other urban watersheds also contributing more chloride than less urban ones.

reproduced with the author’s permission



Mean chloride concentrations in Wisconsin lakes and rivers. Figure by Hilary Dugan, data from US Water Quality Portal.

courtesy of Wisconsin Salt Wise

can release metals such as lead, Boxhorn noted. As for sodium, elevated levels in drinking water can raise blood pressure risks. Even airborne micro-particulate de-icing salts can contribute to statistically subtle human health impacts for lung diseases.

More directly concerning are the toxicity of chloride to aquatic life and disruption to food webs.

The nonprofit organization Milwaukee Riverkeeper puts the case clearly on its website: “Road Salt is a threat to our waterways. Chloride, the key element in road salts, poses a threat to the health of our rivers and environment. When water runs over the landscape, it picks up pollutants along the way, including excess road salt and other deicing chemicals. These contaminants pollute our rivers, streams and lakes. If used correctly, road salt can be a helpful safety precaution. When we use too much, we damage our roads and environment, while not increasing safety.”

Under Section 303(d) of the U.S. Clean Water Act, states identify impaired waters to the U.S. Environmental Protection Agency. In Wisconsin, the current water quality criteria for chloride toxicity is 395 milligrams per liter (chronic) and 757 milligrams per liter (acute).

Since 2010 Milwaukee Riverkeeper has measured chloride concentrations in local waterways, launching its Winter Road Salt Monitoring program supported by volunteers in 2011. Their monitoring has helped provide the state with data showing when chloride levels exceed state criteria.

"Of the Milwaukee River Basin's 500 miles of perennial streams," Riverkeeper notes, "117 miles are listed as impaired for chloride pollution" on the Wisconsin Department of Natural Resources' Listed Impairments for 2022.

Chloride impacts are growing in recent years.

"More than half of the existing impaired waters listings for chloride were added in the 2016 and 2018 reporting cycles and are located in the Milwaukee area," according to a December 2022 Wisconsin chlorides workgroup report to the state's Water Initiatives Steering Committee.

Amid rising concerns, in 2017 SEWRPC embarked on a detailed review and analysis of chloride impacts consisting of two years of its own field data collection and a years-long process of releasing seven technical reports.

It can be hard to think of salt as a dangerous pollutant because we routinely consume it, but excessive chloride can harm organisms through a variety of ways—especially those with life cycles immersed in water. Too much salt can outright kill sensitive organisms, but even non-lethal concentrations can affect growth and development and reverberate through food webs.



The fish above was exposed to 25 days of 3,000 milligrams per liter of calcium chloride. The fish below was part of a control group not exposed to chloride. The experiment found similar growth reduction impacts for fishes also exposed to 3,000 milligrams per liter of sodium chloride. Calcium and sodium chloride are both used as road salt. The research, published by William Hintz and Rick Relyea in a 2017 issue of *Environmental Pollution*, considered different types and concentrations of chloride salts on the development of young rainbow trout.

photo by Bill Hintz

Boxhorn's Jan. 31, 2024 presentation summarizing the findings of his 175-page report read like a litany of abuses implicating excessive chloride.

In a striking example, Boxhorn showed a photo of two fishes from a University of Toledo experiment published in 2017 that compared rainbow trout exposed to 25 days of different concentrations of de-icing salts.

The fish grown in water exposed to the highest chloride concentrations was stunted compared to its control counterpart grown in salt-free water. The photo makes plain what can be hard to visualize about salt's impact on many other freshwater organisms and communities with a range of salt tolerances.

One way excessive chloride harms aquatic organisms is through "osmotic stress" where cells are forced to divert energy from other processes to pump out chloride ions. That's energy that would otherwise be used for growth, reproduction, feeding, or protection.

Essentially, organisms suffering from "osmotic stress" become impoverished.

Boxhorn's review of scientific literature also raised the question whether current water quality criteria designed to be protective of the environment account for subtler impacts on the structure of aquatic communities. Boxhorn identified at least nine studies that observed community-level changes at chloride concentrations below Wisconsin's water quality criteria.

One of those was conducted by Dr. William Hintz, whose University of Toledo lab did the earlier rainbow trout study.

"The vast majority of research contributing to our understanding of salt pollution has been conducted in laboratory settings under 'perfect' conditions with the 'lab rats' of science," Hintz said in an email. "However, when we use semi-natural mesocosm experiments that contain a greater diversity of species and species interactions, we find that the impacts of salt pollution can occur at lower concentrations than previously thought.

"Ultimately, science can be slow to catch up with environmental change or issues like salt pollution," Hintz said. "We certainly need to understand how salt pollution affects a greater diversity of freshwater species and ecosystem processes, but the available evidence suggests we should act sooner rather than later."

At least 34 river and stream reaches in southeastern Wisconsin were listed as impaired by chloride in 2022, according to SEWRPC. That includes over 24 miles of the Menomonee River, over 30 miles of the Root River, 13 miles of Oak Creek, the entire Kinnickinnic River, and many river miles of other urban waterways including the Honey, Indian, and Lincoln creeks. More waterways are likely impacted but go unmonitored.

Over a decade of Riverkeeper monitoring has revealed now-common spikes in chloride indicators following snowmelt or runoff events in winter or spring.

"We're seeing more spikes in the summer, which is concerning," observed Milwaukee Riverkeeper's Cheryl Nenn during the Jan. 31, 2024 TAC meeting. "And, I mean, not shockingly in a lot of the urban creeks that are draining the highway, but even in some of the other creeks, we've been seeing exceedences now in the summer."

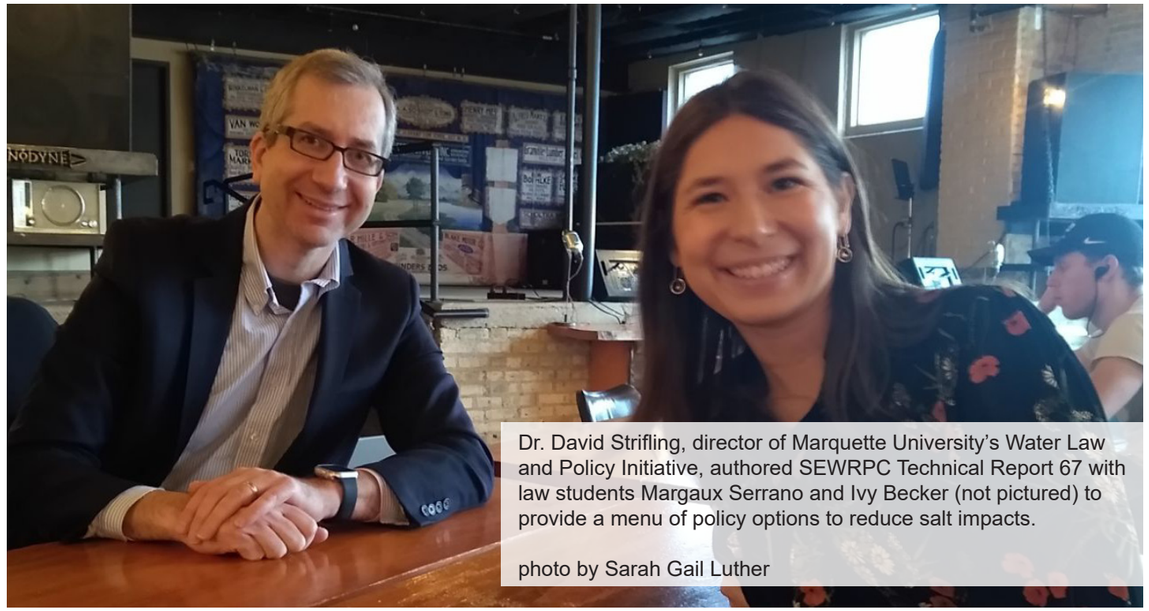
This appears to be due to salty groundwater, according to Dr. C.J. "Charlie" Paradis, UW-Milwaukee assistant professor of geosciences, who has proposed studying the Milwaukee River to better understand the fate and transport of salts in and out of freshwater streams.

"The annual persistence of salts is commonly attributed to groundwater and movement via baseflow to streams," Paradis wrote. "However, salts may also be stored above the groundwater table and moved via stormflow streams."

While scientists continue to study how the "The Freshwater Salinization Syndrome" impacts the web of life, the source of the problem is clear.

It's us.





Dr. David Strifling, director of Marquette University's Water Law and Policy Initiative, authored SEWRPC Technical Report 67 with law students Margaux Serrano and Ivy Becker (not pictured) to provide a menu of policy options to reduce salt impacts.

photo by Sarah Gail Luther

PART III: HOW CAN WE REDUCE SALT POLLUTION?

In Wisconsin, chloride enters our waters from water softener discharges, runoff from agricultural fertilizers like potash (potassium chloride), industrial sources—and would you guess even brine from cheesemaking?

But by far the largest contributor in the Milwaukee area is road salt. Can we reduce its use?

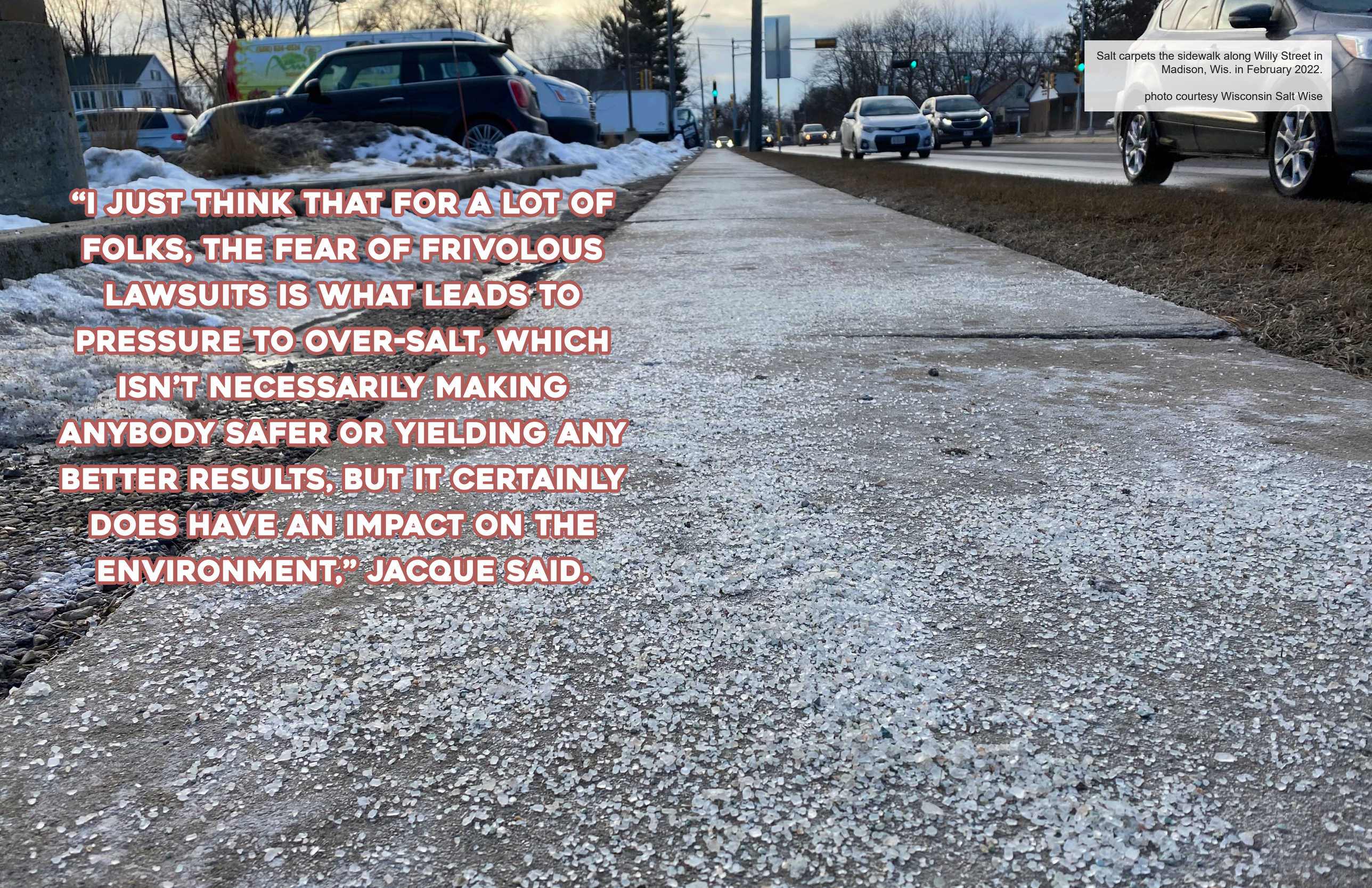
A report by the Southeastern Wisconsin Regional Planning Commission outlines a menu of policy options to help people, businesses, and communities reduce salt use and chloride impacts. Dr. David Strifling, director of Marquette University's Water Law and Policy Initiative, authored the SEWRPC report with law students Ivy Becker and Margaux Serrano.

Strifling, whose background is engineering, described his role as bridging the communication gap between scientists and policymakers. "We've known for a long, long time that chloride has these negative impacts in the environment," he said, "but it's been really difficult to come up with policies to address it."

One policy on the menu involves de-icing practices on private property, where their research identified that protection from slip-and-fall liability is a common motivation for applying too much salt.

Addressing this concern is a proposed policy modeled after New Hampshire's novel "Green Snow Pro" certification program which took effect in 2013. In the state whose motto is "Live Free or Die," an appropriately non-regulatory policy limits liability for de-icing contractors and private property owners certified through a training program to optimize and record salt application amounts. The intent is to remove the incentive for over-application for those wary of lawsuits should a tenant or guest slip and fall on ice.

"New Hampshire is the gold standard when we look at these kind of reform bills, and this all starts from the premise that the biggest driver of over-application of salt is fear of legal liability for slip-and-fall cases," Strifling said.



Salt carpets the sidewalk along Willy Street in Madison, Wis. in February 2022.

photo courtesy Wisconsin Salt Wise

“I JUST THINK THAT FOR A LOT OF FOLKS, THE FEAR OF FRIVOLOUS LAWSUITS IS WHAT LEADS TO PRESSURE TO OVER-SALT, WHICH ISN’T NECESSARILY MAKING ANYBODY SAFER OR YIELDING ANY BETTER RESULTS, BUT IT CERTAINLY DOES HAVE AN IMPACT ON THE ENVIRONMENT,” JACQUE SAID.



Allison Madison, program manager for Wisconsin Salt Wise, testifies in favor of 2023 Wisconsin Senate Bill 52 at the State Capitol in March 2023.

photo courtesy Wisconsin Salt Wise

Strifling pointed to Liberty Mutual Insurance marketing materials explaining the certification to insureds that advertises that "NH Law Changes the Game" as evidence the policy, which has also withstood legal challenges, is working in New Hampshire.

In Wisconsin, the effort to enact a bill modeled on New Hampshire produced a unique alignment between Republican state legislators and environmental advocates. Democratic legislators initially signed on, but withdrew support in January 2024 after what they characterized as unfriendly amendments.

State Senator Andre Jacque (R-DePere), who serves as chair of the Great Lakes St. Lawrence Legislative Caucus and is active with the National Caucus of Environmental Legislators, led the bill. "Anytime you're dealing with contaminants in our lakes and streams, things that get into our actual drinkable water—I mean, we really have freshwater as just a tremendous resource," Jacque said. "And to the extent to which that has steadily been, I guess, corrupted by chlorides, that's a major concern."

Senate Bill 52 would have established a voluntary certification program administered by Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP) to enroll de-icing contractors in training and reporting that would track the amount of salt spread and—barring gross negligence—protect them from slip-and-fall liability claims.

"I just think that for a lot of folks, the fear of frivolous lawsuits is what leads to pressure to over-salt, which isn't necessarily making anybody safer or yielding any better results, but it certainly does have an impact on the environment," Jacque said.

Senate Minority Leader Dianne Hesselbein (D-Middleton) was originally a co-sponsor of what seemed a uniquely bipartisan bill in an otherwise polarized legislature. Her communications manager explained Hesselbein's dissent after a January 2024 amendment tweaked the language. "Ultimately, SSA2 [the January 2024 amendment] makes the legislation less about salt reduction and the environment and instead enacts more unnecessary liability shields, which she could not support," said Chandra Munroe in an email, pointing to two minor language changes.

The amended bill, which passed the Senate narrowly in January 2024 with Republican-only support, removed the word "solely" to describe the kinds of hazards caused by snow and ice from which certified contractors would be protected from liability. It also reinforced the voluntary nature of the program by adding language that unregistered contractors cannot have that fact or evidence related to the program used against them.

The Wisconsin Association for Justice, the trial lawyers' lobby whose lobbyists include former Democratic Senate Majority Leader Joseph Strohl, registered 180 hours opposed to the bill in 2023, according to hours the group reported to the Wisconsin Ethics Commission. It recorded another 180 hours opposed to the companion bill in the Assembly, AB 61, meaning that almost a third of all the 2023 lobbying hours the group claimed were in opposition to the slip-and-fall liability limitation legislation.

For comparison, five other groups registered just 82 cumulative hours lobbying for the bill in 2023 (and 64 hours for its Assembly companion).

Allison Madison, program manager for the advocacy group Wisconsin Salt Wise, who registered herself as a lobbyist on behalf of the Capital Area Regional Planning Commission, was chief among the proponents, which also included the Lutheran Office for Public Policy in Wisconsin, Municipal Environmental Group – Wastewater Division, Wisconsin Civil Justice Council, Inc., and Wisconsin Insurance Alliance.

In February 2024, the Assembly tabled its own bill and advanced the version the Senate approved. On Good Friday, March 29, 2024, Democratic Governor Tony Evers vetoed the bill.

In his veto message, Evers objected to "creating such a broad immunity from liability" and "creating an unfunded mandate" for DATCP. The governor's objection also claimed that "Under this bill, an unregistered commercial applicator could falsely claim the immunity provision in this bill, and that claim could not be rebutted, due to the fact that the relevant evidence is suppressed."

"His veto message really misrepresents this bill and the way that it is functioning in New Hampshire," Madison said. "I'm really disappointed and frustrated that he has been so swayed by the trial lawyers."

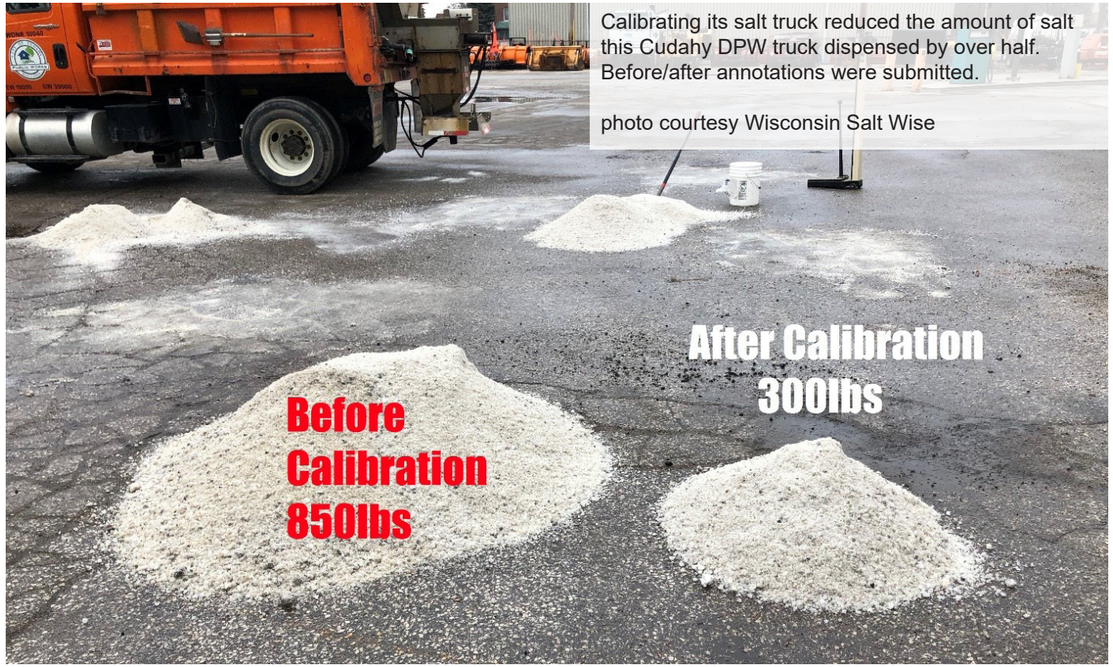
The veto does not change the need for action, which is widely recognized at the state, regional, and local levels.

In fact, a March 2023 letter on the initial bill from Wisconsin Department of Natural Resources Stormwater Section Manager Shannon Haydin relayed that 70% of respondents to an August 2022 WDNR survey of business owners and deicing applicators identified slip-and-fall liability as "a major concern leading to the overapplication of deicers."



Dr. Hilary Dugan testifies in favor of 2023 Wisconsin Senate Bill 52 at the State Capitol in March 2023.

photo courtesy Wisconsin Salt Wise



Calibrating its salt truck reduced the amount of salt this Cudahy DPW truck dispensed by over half. Before/after annotations were submitted.

photo courtesy Wisconsin Salt Wise

Despite the setback, Madison views the fact the bill even got heard in the Legislature as a major success. She invited a dozen de-icing contractors to circle the State Capitol honking their horns in a "snow plow rally" to support SB 52 on March 19, 2024. They came.

"I see this as a huge win for our freshwaters," Madison said. "We need to do something. But I'm just over the moon that salt was discussed on the Senate floor… People argued about this particular solution—this particular strategy for addressing it—but no one was saying that it's not a problem."

A former chemistry teacher, Madison appreciates that more research can better understand complex negative effects of chloride pollution, but maintains we already know enough to act now on practices that can make a big difference.

Her group Salt Wise, a coalition supported by $150,000 in grants from the Fund for Lake Michigan in 2020 and 2021, and founded from a collaboration in Madison, Wis., has taken a statewide approach to educating the public and training winter maintenance personnel.

There's currently no training required to spread salt, and too often salt is applied as though there are no implications to its use, Madison said. Training helps "just the basic understanding that while some salt is good, more salt isn't always better and if we're going to use this, we need to use it as efficiently as possible and not salt first. We need to shovel first or snowblow first or plow first and then you're just using salt if needed and as needed."

Calibrating equipment is also important to improve the efficiency of salt application and to quantify the amounts used, Madison said.

"The rates that communities are using now are like 200 pounds per lane-mile, sometimes a hundred pounds per lane-mile when it's pre-wetted with brine," Madison said. "It used to be 500, 600—City of Milwaukee put down 800 pounds per lane-mile. Probably some operators even more than that. I think they're trying to get people dialed down to 400 or below at this point. But the only way you really know what you're putting down is if you have calibrated your equipment."

And default equipment settings may be wrong. "You may think you're putting down 400 but you're putting down 800," Madison said, because equipment isn't dialed in for precision applications.

Madison pointed to the City of Cudahy, whose DPW in fall 2023 manually recalibrated a brand-new salt truck from factory settings that had been dumping out twice as much salt as the gauge indicated. Before and after photos shared are striking.

The fix cost nothing and saves tax dollars, but it required a DPW taking action to measure salt dispensed rather than trust the gauge.

These low-hanging-fruit solutions are critical now, Madison said, and untrained private contractors may not even be thinking about calibration when pouring salt into a hopper.

"They [Cudahy DPW] are working hard to be salt-wise," Madison said. "That is where we need people to be… People are reducing their salt use by 30% to 50%—sometimes even more than that—it's unreal. That 30-50% is sometimes just calibrating. And pre-wetting."

Municipal DPWs are starting to shift salt practices, including "pre-wetting" salt to help it stick to roads and brine spray before winter storms to help prevent ice from forming.

The City of Milwaukee is among municipalities adding salt brine to their de-icing portfolio. "All of our trucks are capable of pre-wetting the salt with brine," said DPW's Tiffany Shepherd in an email. "We have 25 salt trucks that also have anti-icing capabilities and five tankers for anti-icing."

Salt Wise is also leveraging Wisconsin policy leadership to build a broader conversation and coalition around smarter de-icing among regional partners. Madison is working with the national Snow Ice Management Association (SIMA).

"Because of the work with this bill, they're paying more attention to Wisconsin and we're looking at putting together the first Midwest Salt Symposium, similar to the program they do in New Hampshire," she said. "It's likely going to be in Waukesha in September [2024] and working to bring private contractors together and talk about best practices and talk about the business side of things. But they have pitched out the idea of bringing in the state



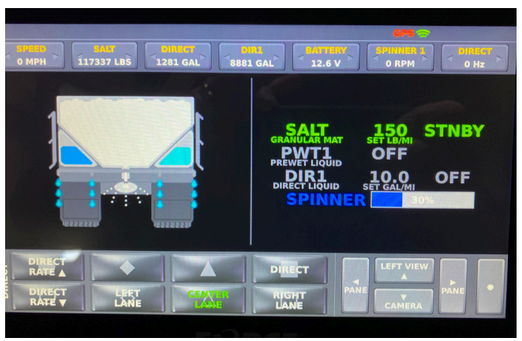


Above, pavement temperature salt application guidelines on a truck dashboard.

Right, calibrating a salt truck.

Below, computer control allows for precision pounds-per-lane-mile applications.

photos courtesy Wisconsin Salt Wise

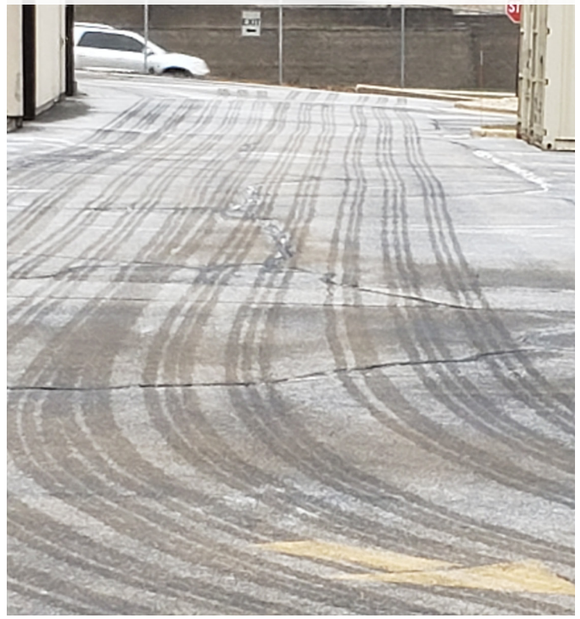


The Bruce Company in Middleton, Wis. loads brine from the tanker truck into the sidewalk units.

photo courtesy Wisconsin Salt Wise

The application of wet salt brine onto road surfaces reduces the salt needed to de-ice pavement and increases its effectiveness.

photo courtesy Wisconsin Salt Wise





Allison Madison sweeps salt from the curb before it can wash into the storm sewer.

photo courtesy Wisconsin Salt Wise

I DON'T WANT TO DRIVE ON ICY ROADS ANY MORE THAN THE NEXT PERSON DOES. BUT THERE'S A LIMIT... WHEN YOU'RE WALKING AROUND AND YOU'RE CRUNCHING [SALT] UNDER YOUR BOOTS, THAT'S TOO MUCH.

climatologists to talk about climate change and how that might be impacting their businesses."

How could warmer, wetter Wisconsin winters influence our relationship to salt?

The endurance of black and white trapezoidal pyramids rising from Port Milwaukee salt pads could represent one bellwether to watch over the next decade, as current Port leases for salt vendors contain renewal options extending into the 2030s and beyond.

A July 2023 Martin Associates report on the economic value of Great Lakes shipping based on 2022 data among 41 ports placed salt (9.7 million metric tons) sixth in terms of cargo types moved after iron ore/bulk (39.8 million metric tons), stone/aggregate (31.7 million metric tons), grain (16.5 million metric tons), coal (11.7 million metric tons), other liquid bulk (10.2 million metric tons).

But based on available data, for Port Milwaukee, salt figures first.

And Census Bureau Customs commodities tallies for salt consistently place Milwaukee among the top 10 importers of salt nationwide.

A recent Sea Grant report detailing the reduction of Great Lakes ice cover over the past two decades carries dual implications. Reduced ice cover makes for a longer shipping season, allowing for more vessel calls. But warmer winters on land could also correspond with more efficient de-icing practices to reduce the regional demand for road salt. That could alter the economic calculus when the Board of Harbor Commissioners and Milwaukee Common Council consider future Port lease terms.

Salt constitutes roughly a third of all cargoes by weight moving through Port Milwaukee, salt storage parcels occupy about 12% percent of current Port land, and salt transport via truck means employment and intensive use of local transportation infrastructure, so the implications of shifting our relationship could be significant.

If imagining alternatives to Port Milwaukee's salt piles seems too speculative, consider how far we've come in less than a century.

The SEWRPC report points out how changing policies and societal values after World War II led to our current relationship with salt. The "bare pavement" policy of road managers today emerged in the 1960s and was not always the public standard. Tire chains are now rarely used and Wisconsin restricted the use of snow tires in the 1970s.

"What we've seen over those decades is a shift in cultural expectations," Marquette's Strifling said.

"People now expect to be able to drive 65 miles an hour on the freeway an hour after a blizzard or in some cases even during a blizzard. And it's just not realistic, if we're going to do anything about this problem. You got to slow down, got to accept some inconvenience in some of these cases. And people just don't have that awareness, I don't think.

"And that's part of what makes Salt Wise and programs like that so important. Again, my driveway was a sheet of ice this [January 2024] morning and I'm certainly not suggesting that we should stop salting roads. I don't want to drive on icy roads any more than the next person does. But there's a limit… When you're walking around and you're crunching [salt] under your boots, that's too much."

Clarification: an earlier printed version of this book unintentionally contained an unedited version of Too Salty that was less up to date than the story published online and reproduced here.

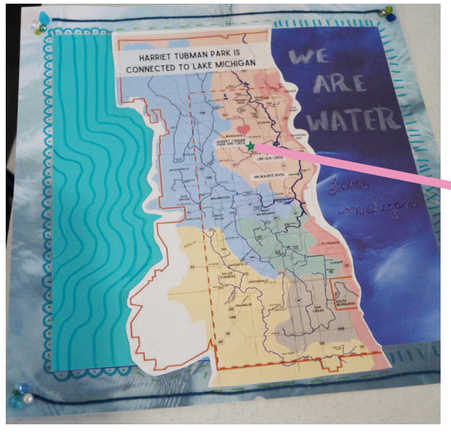
Special thanks: Milwaukee Public Library Humanities Department; City of Milwaukee Municipal Research Librarian Kathy Williams; USGS Research Hydrologist Steven Corsi; Tim Grundl, Professor Emeritus, Geosciences Department and School of Freshwater Sciences; USGS Commodities Specialist Wally Bolen.

CLIMATE JUSTICE IN THE LINCOLN CREEK GREENWAY

People gather on a bridge spanning Lincoln Creek near 47th and Congress streets in Milwaukee during a walk to celebrate Harriet Tubman Day on March 9, 2024 co-led by Nearby Nature and River Revitalization Foundation.

About 30 people, including Representatives Supreme Moore Omokunde (D), who represents the 17th Wisconsin Assembly District through which this reach of Lincoln Creek flows, and Darrin Madison, Jr. (D), who represents the 10th District, which encompasses the Milwaukee River as it flows through Glendale (including the Kletzsch Dam) and the western part of Lincoln Park downstream of the Milwaukee River oxbow into which Lincoln Creek flows.

The walk started in Harriet Tubman Park, renamed in 2021 in honor of the abolitionist, civil rights activist, suffragette, and Underground Railroad conductor, and followed the concrete-channel-lined Wahl Creek to where it flows into more naturalized channel of Lincoln Creek.





WHERE IS LINCOLN CREEK?

Climate justice was the topic for a day of programming in the neighborhoods surrounding Lincoln Creek, which flows south from Havenwoods State Forest, then east from 64th Street all the way across the city to Lincoln Park. There the urban tributary drains into the Milwaukee River adjacent to habitat improvement projects supported through the Waterway Restoration Partnership.

About 30 people gathered at Harriet Tubman Park, near 47th and Hampton, on a brisk but sunny Saturday on March 9, 2024 to celebrate the legacy of abolitionist Harriet Tubman. Speakers connected the current struggle for urban environmental justice with the story of the American freedom fighter. Tubman freed herself, then led scores of enslaved people to freedom along the Underground Railroad.

Detaya Johnson, program director at Nearby Nature, co-led the walk with Catie Petralia, volunteer coordinator at River Revitalization Foundation.

Nearby Nature is an environmental justice and equity initiative that in July 2023 became a 501(c)3 organization. “Recognizing a great need in neighborhoods stressed by high poverty and injustice, the group focuses its efforts in Milwaukee’s 30th Street Corridor and Lincoln Creek Greenway,” according to the group’s website. River Revitalization Foundation is an urban land trust known for stewarding the Milwaukee River Greenway. It is currently undergoing a merger with the Ozaukee-Washington County Land Trust.

Johnson and Petralia led walkers along the drainageway known as Wahl Creek, named for Christian Wahl, “grandfather” of Milwaukee’s parks system. Harriet Tubman Park was named Wahl Park prior to renaming in January 2021. The straight-and-narrow concrete-lined channel conducts flows south over City of Milwaukee property along the eastern edge of the Milwaukee County Park. The creek then flows behind private residential properties and empties into Lincoln Creek, which flows across properties owned by Milwaukee County and Milwaukee Metropolitan Sewerage District.

Where Wahl Creek’s waters enter Lincoln Creek it



Wahl Creek looking north from a Glendale Avenue bridge over the channelized waterway as it flows along the east edge of Harriet Tubman Park south toward Lincoln Creek.



Wahl Creek looking south toward Lincoln Creek from a pedestrian bridge near 47th and Congress.



Maria Chilbert photographs Wahl Creek from a walking bridge over the waterway as it flows into Lincoln Creek near 47th and Congress on March 9, 2024 during a walk co-led by Nearby Nature and River Revitalization Foundation to celebrate Harriet Tubman Day.



Kyle Hayes, Sally Callan, Jen Abel, and Erin Moore stand on the pedestrian bridge over Wahl Creek as it flows into Lincoln Creek.



Lincoln Park Greenway depicted on Google Earth basemap. The water's flow direction is shown by arrows. The circle notes the pedestrian bridge near 49th and Congress.



Catie Petralia listens to State Representative Supreme Moore Omokunde (D-17) along the banks of Lincoln Creek in the 17th Assembly District.

transitions from concrete-lined banks to rock and cobble.

"And so I want you to make that parallel as we're walking in this neighborhood," Johnson said. "When we think about that generational trauma that gets passed down, but then you make that connection to a lined channel [that] isn't free, that's hindered from its best potential from doing its best because of these things that have happened. But when you see the naturalized area, when it's allowed to be itself, when it's allowed to rage free and how beautiful that is."

Walkers turned south of Glendale Avenue, traversed broken glass on the N. 46th Street sidewalk, greeted curious neighbors, and stepped into the sunlight at Lincoln Creek and its "greenway," a contiguous stretch of public-owned land along the creek rehabilitated by multimillion-dollar MMSD flood management projects from the late 1990s into the 2000s.

Maria Chilbert attended the walk to learn more about the Milwaukee River and its tributaries.
"Learning the history with the concrete lining and how they're taking that away and how actually it's helping to prevent flooding. So that's interesting. And how they've got other projects in the city to help with preventing pollutants getting into the water with certain systems," Chilbert said. "I think it's beneficial to learn these things about our community and becoming better."

Concrete removal in Lincoln Creek was motivated by protecting homes and businesses from floods, but the new rock-lined channels also provided pools and riffles for fish passage. And fish are finding the creek.

Felice Green, director of programming with the nonprofit Milwaukee Water Commons, on her phone showed a November 2022 video of coho salmon swimming upstream in Lincoln Creek near Hopkins Hollow, the naturalized area a few blocks to the east



Water collage art at Harriet Tubman Park on March 9, 2024. photo by Melanie Ariens

where Lincoln Creek bends north after flowing beneath Hopkins Street near 35th and Congress. The salmon, splashing in the rocky shallows, are a species stocked annually by the Wisconsin Department of Natural Resources.

Back at Harriet Tubman Park, Melanie Ariens, Milwaukee Water Commons' creative arts manager, organized an art collage activity to help participants visualize the continuous interconnection between Wahl Creek, Lincoln Creek, the Milwaukee River, and Lake Michigan. Ariens prepared colorful paper maps highlighting the Milwaukee-area river watersheds, with a star showing Harriet Tubman Park.

This sense of connection is important, said Cheri Briscoe, a longtime parks advocate for whom the walk was her first time visiting Harriet Tubman Park.

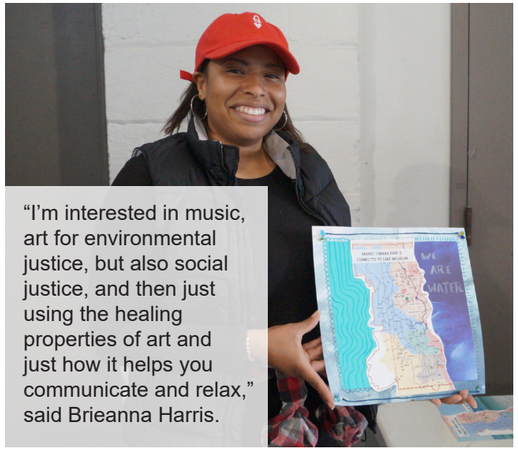
"I'm glad I'm here. And the interesting thing is this park is so much bigger than I've realized, and there are so many things that can be done with it. I am delighted that Nearby Nature has brought more focus into our—for lack of a better word—inner city, our more interior parks. Because you probably know, even the Oak Leaf Trail, it's considered a necklace around parks, and now we need to bring more focus into our more urban parks."

Tracing the path of waterways connecting to the Great Lakes echoes the journeys of escaped slaves seeking freedom in Canada, said Petralia, especially after the Fugitive Slave Act of 1850 made even Northern states like Wisconsin, where slavery was illegal, unsafe.

Two state representatives who joined the walk also



Melanie Ariens prepared an art map experience.



"I'm interested in music, art for environmental justice, but also social justice, and then just using the healing properties of art and just how it helps you communicate and relax," said Brieanna Harris.



Rep. Darrin Madison, Rep. Supreme Moore Omokunde, and Dr. Russel Cuhel on March 9, 2024.

participated in an afternoon panel discussion, "Climate Justice, Our Planet, Our Survival," held at the Villard Square Branch of the Milwaukee Public Library. Darrin Madison (D-10) and Supreme Moore Omokunde (D-17), whose current legislative districts both include parts of Lincoln Creek, joined Hanan Ali and Dr. Russel Cuhel on the panel.

Poet Shana Wilson, who performs with the name Blue Lotus, offered opening remarks after producing a meditative tone on her singing bowl named Sun.

"Mankind has abused free will to the point where it's a struggle to even be able to tell the seasons apart," said Wilson. "We unconsciously vandalize and violate God's art and come up to the very edges of Revelation. A revolution is long overdue… Why continue to disrespect God's masterpiece when we ourselves are part of it and we have the resources to support the planet in healing itself? 'Now' is what we have, and we can't just keep ignoring the signs."

Johnson was inspired to organize the climate panel after a planned snowshoe event for February 2024 fell through due to lack of snow. This winter was Wisconsin's warmest on record.

The panelists responded to a series of questions for almost two hours before an audience of 16.

Ali teaches environmental science at Bradley Tech High School and works as a land steward with Nearby Nature. She shared her research assistantship experience with Clean Wisconsin where she used maps to consider sustainable agriculture options for Wisconsin's changing climate. She mentioned Aronia berries, American hazelnut, and perennial grain Kernza, crops which could help farmers address chronic soil loss.

"This relates to food insecurity, also relates to food deserts very much as well. So even though I was looking at the whole of Wisconsin, this raises the question of our food prices. We are the common people. We get the biggest hit whenever crops go down. If climate change occurs the way it's going to occur," Ali said, "what kind of crops are we going to have in the future?"

Dr. Cuhel, a scientist at the UW-Milwaukee School of Freshwater Sciences, has been studying natural aquatic environments for 52 years, working on Lake Michigan for 29 years. "I have been around long enough to understand change," Cuhel said. "I want to get across this concept: To understand change you must know what was there before."

Working with Dr. Carmen Aguilar, Cuhel said much of their work is "research education" where students help generate long-term data for Lake Michigan. "Instead of going to a lot of places once, I went to the same place over and over and over again," Cuhel said.

From 1990 on, students have joined Aguilar and Cuhel on research cruises aboard the R/V Neeskay in the Milwaukee harbor and Lake Michigan, collecting

samples and taking measurements. Each student group recorded data points noted in their own color. "They would see what we saw as continuous cycles with change imposed, but they would see that some of the points were ones they made or their friends made," Cuhel said. "And to them that was huge."

Representative Moore Omokunde described his roots in Montessori education and pointed to his time as the county's representative on the City-County Task Force on Climate and Economic Equity, which led to Milwaukee's Climate & Equity Plan and its "10 Big Ideas" formally adopted by the city in 2023.

"We need to make sure that we're doing the type of jobs that are going to hit the communities that are most affected by climate change, like Black and brown communities," said Moore Omokunde. "We're figuring out what kind of jobs there are, what kind of transitional jobs we need to create, and who needs to be able to do that work and how are they going to be able to do that work?"

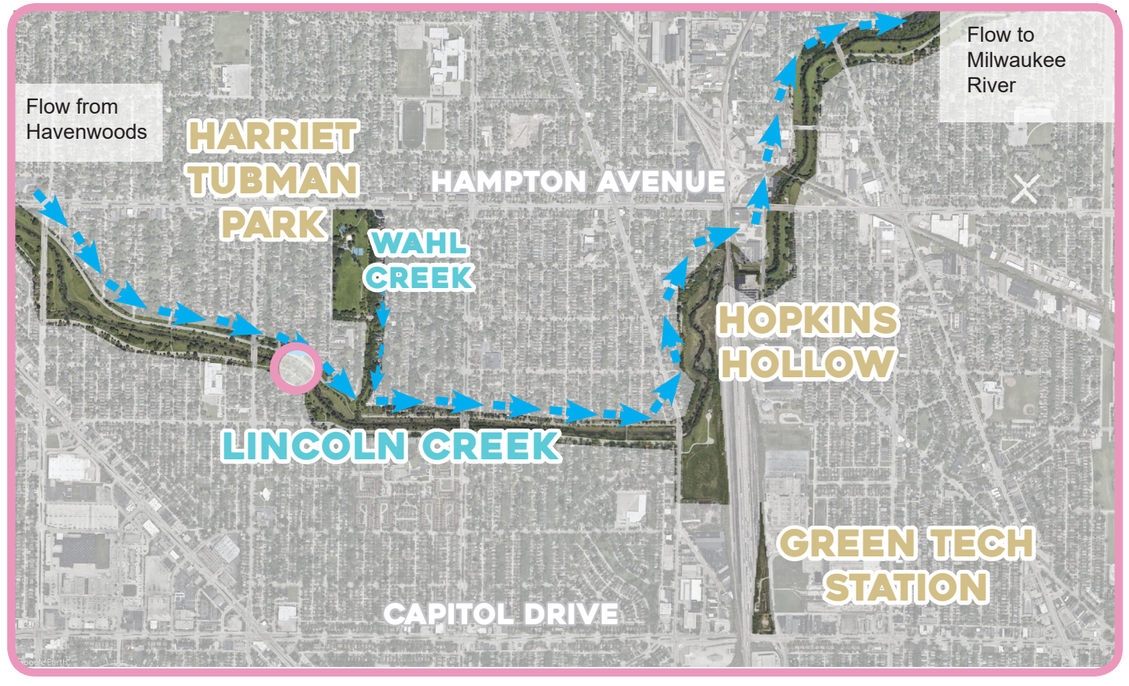
Moore Omokunde said he tells skeptical constituents that climate change worsens pocketbook, safety, and stability concerns ranging from potholes and crime to health issues like asthma and freeway congestion.

"All of these challenges that you think are more important are only exacerbated by climate change," Moore Omokunde said. He invited interested citizens to join Our Future Milwaukee, a coalition advocating for full plan implementation.

He also implicated capitalism as the problem, arguing systemic change is needed. "We can't recycle our way out of climate change…" Moore Omokunde said. "Large corporations have to reduce their greenhouse gas emissions. Also, we have to change the way we deal with transportation."

Rep. Darrin Madison (D-10), who described himself as an "open socialist in the Legislature," said environmentalism was baked into his path as an organizer to his first term serving in the State Assembly.

"It started at the Urban Ecology Center here in Milwaukee. And then I worked for the U.S. Forest Service for a period of time. Then went to Howard



Detaya Johnson and Catie Petralia, left, gather walkers on the Lincoln Creek pedestrian bridge on March 9, 2024.



University where I majored in biology and then came home, worked for the Urban Ecology Center again, then the City of Milwaukee's Environmental Collaboration Office, launching the Eco Neighborhoods Initiative, in which Lindsay Heights is our first Eco Neighborhood. And then started doing prison abolition work and then somehow ended up in this space," he said.

Madison said he plans to introduce a Wisconsin constitutional amendment to confer rights to natural lands, waters, and the environment likely on Earth Day 2024.

"We'd be the first to acknowledge climate justice in our constitutional amendment and have the ability for environmental lawyers or anyone to sue based off the auspices of climate change," Madison said.

The panel concluded with speakers invited to reflect on how Harriet Tubman's leadership and legacy connected with climate justice.

Ali said climate justice promotes equity and equality for all, especially the poor who are impacted most. "I saw [Harriet Tubman] as a pioneer, just like how we have environmental justice pioneers," Ali said. "She was a pioneer of equity and equality."

Tubman, known to have led at least 70 enslaved people to freedom, was said to threaten reluctant escapees with a gun if they considered turning back.

Madison said that same intensity of purpose is needed today.

"When we're talking about climate justice, we're talking about liberation," he said. "Harriet was someone who fought for true liberation, but what we're talking about right now is the liberation of the environment, the ability to thrive in a self-sustainable community. We can't do that if we do that halfheartedly. She's a representation of doing that wholeheartedly and understanding the risk of fighting for true justice. There is a risk in fighting for justice in all forms. And it requires sacrifice."

INDIGENOUS-LED WALK HONORS WATER

A firekeeper from Strong Native Minds tends the fire before sunrise in Lincoln Park on April 20, 2024.



Winona Grieger, Ron Grieger Jr., and Maryann Galicia of the Indigenous-led nonprofit organization Strong Native Minds.

FIRE SMOKE AND TOBACCO FILLED THE PREDAWN AIR. THE HONKING OF CANADA GEESE ECHOED ACROSS THE MILWAUKEE RIVER OXBOW NORTH OF HAMPTON AVENUE AS THE LIGHT OF SUNRISE SLICED THROUGH GRAY CLOUDS.

Dozens of people, many bundled in knit caps and some wrapped in blankets, gathered at the water's edge in Lincoln Park on Saturday, April 20, 2024 to participate in an 11-mile walk for the water.

Strong Native Minds, the Indigenous-led Milwaukee community group, sponsored the action with support of Wisconsin Native American leaders and local environmental partners.

This "Sturgeon Water Walk MKE" followed the traditional wisdom of the late Josephine Mandamin, "Grandmother Water Walker," who led and inspired a series of water protector walks around the Great Lakes from 2003 to 2017.

In Milwaukee, walkers sought to honor and defend the water and the native lake sturgeon, now returning after decades of reintroduction efforts.

Their route transected the city, following the Milwaukee River downstream through downtown to the confluence with the Menomonee River, then west to the Urban Ecology Center at 34th Street on the bluff overlooking Three Bridges Park. Two hundred years ago, this vista would have overlooked a wild rice wetland at the heart of the Menomonee Valley occupied by Potawatomi people. In the 21st century, walkers shared trails with runners of a half-marathon and volunteers picking up trash with the annual Milwaukee Riverkeeper spring cleanup.

Walkers rallied from across Milwaukee and woke early to drive in from as far as Keshena on the Menominee Reservation. At least one person had participated in the Native American camps protesting the Dakota Access Pipeline project at Standing Rock in 2016.

Some were grandmothers. Several women wore colorful handmade ribbon skirts extending almost to the feet. "The reason for the ribbon skirt is because it brings us back to our womanhood, like our strength," explained Maryann Galicia, board member with Strong Native Minds. "And it also connects us with Mother Earth. It's the link within Mother Earth and the Grandmother Moon."

The next generation took a leading role in the opening ceremony at Lincoln Park. Youth escorted a ceremonial copper water vessel for the first mile.

Young girls, who had earlier practiced the rite at Indian Community School, initiated the sunrise ceremony by carrying water in individual copper cups. They shared water and strawberries with those gathered.

"Water is life. It is also medicine," said Siobhan Marks, who guided the girls. "And it is even much more so after this ceremony."

The girls' voices filled the chilled air with sweet song in the Ojibwe language. Translated to English: "Water, I love you. Water, I thank you. Water, I respect you."

"So that's what that song is all about. And that's what we need to do," said Auntie Oralann Caldwell, of the Menominee Nation and Bear Clan, "to think about our lifeblood. And it's through this water that keeps that lifeblood flowing through our beautiful, beautiful vessels that the creator put that sound of life in our spirit, in our heart, in our minds, and in our body."



People gather for the Sturgon Water Walk MKE, warming around the fire.

Youth offered smudge blessings of aromatic smoke and circulated with wooden bowls of dried tobacco. Participants held the tobacco in the left palm, significant for its connection to the heart, offered a prayer, then placed the tobacco into the fire, proceeding clockwise as the sun overhead. Shining red strawberries signified the heart, blood, life's beating pulse.

The ceremony was an exercise in freedom of religion—something Native Americans were denied until the American Indian Religious Freedom Act of 1978, said Mark Denning, who helped organize the walk and led a tobacco ceremony.

Denning connected the sacred power of prayer with themes of intention, healing, family, and the environment. He shared the tragic loss of his children, and acknowledged that everyone may be facing pain, loss, or suffering.

"I'll be thinking of her and I'll be thinking about how she's everywhere now," Denning said of his daughter. "Everywhere I look, every tree that I see, that's where she'll be. That's where my sons are. For those of you who have lost, that's where your relatives are. On this walk today you'll see them everywhere. You'll hear them singing above your head. You'll see the earth glow in front of you before your feet. You're going to be touching the sacredness of our water that is so very special, and very much a part of our life."

After the sunrise ceremony, water was blessed and poured into a brightly polished copper vessel, glinting in the sun.

A woman wearing a skirt carried the water. To her left a man carried a staff adorned with an eagle's talon and topped with the wooden effigy of the lake sturgeon.

The pair led the procession side by side, the water never stopping once in forward motion. The woman's ceremonial role was to protect the water, source of life, and the man's role to protect the woman. Leaders handed off the honor of escorting the water with walkers following behind, saying, "We do this for the water."

Several hours and eleven miles later, the women who shared the honor of carrying the water poured it into the Menomonee River, completing the journey with another tobacco blessing.

Marks watched the ripples spread as water poured from the copper vessel became one with the river, flowing on its way to Lake Michigan.

"That's like that evident truth of that healing, right?" she said. "That beautiful water carried by all of us, starting with the beautiful fire lighting, our children singing, smudging, our tobacco ceremony, all of it, every step, every good intention, every conversation, all went to heal our water, and to protect all of our life that's here during that dredging project, because we know there'll be a disruption."

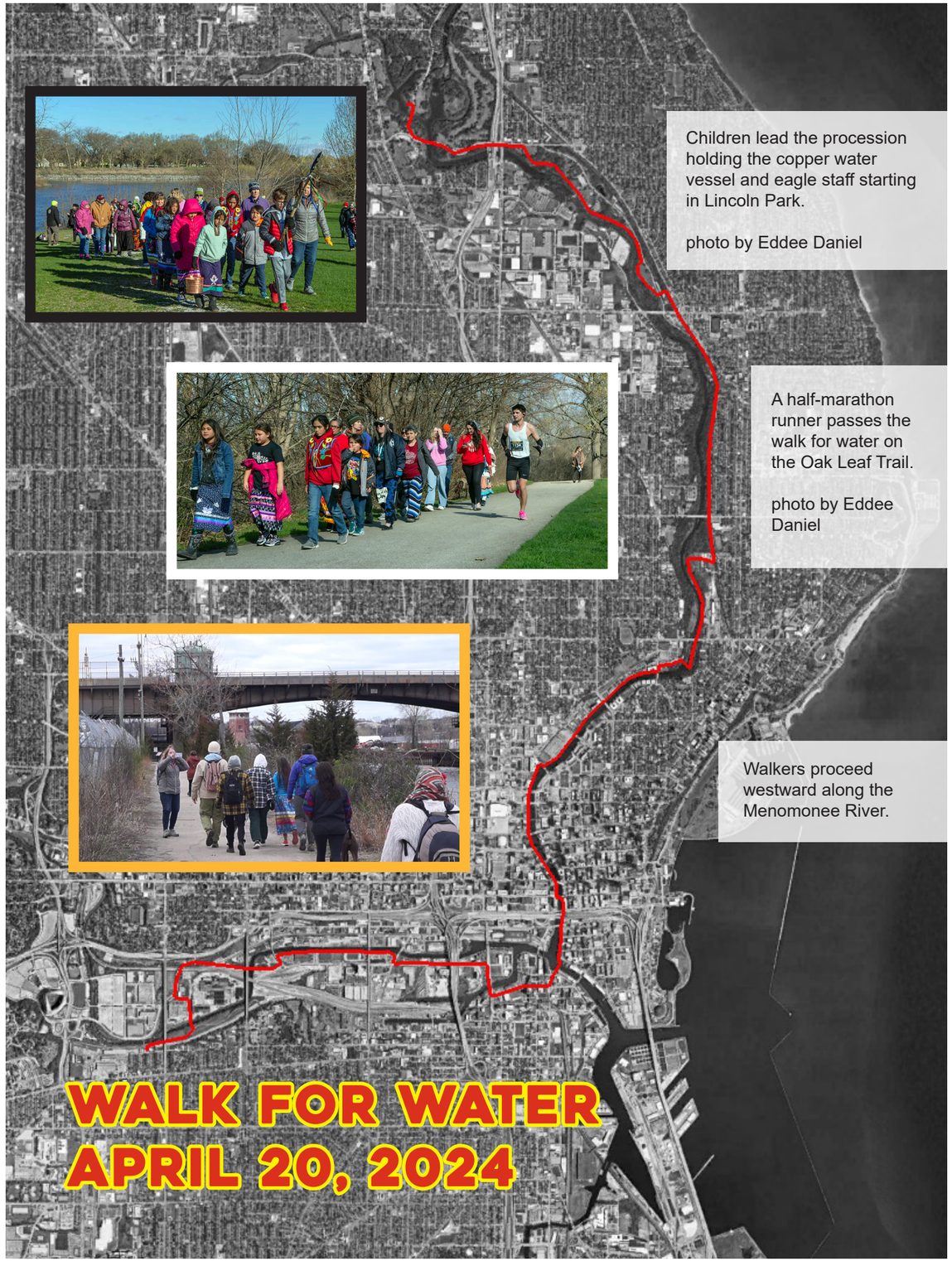
Outside the Menomonee Valley Urban Ecology Center, walkers reunited with the all-male firekeepers from Strong Native Minds. The firekeepers' role was to start the ceremonial fire in Lincoln Park, tend it, and safely transport it to the walk's endpoint without letting the fire falter. The day of ceremony closed with walkers offering another blessing of tobacco into the fire.

Strong Native Minds then hosted participants upstairs at the Urban Ecology Center with a community lunch of bread and soup, where Beth Wentzel of Milwaukee Metropolitan Sewerage District shared an overview of Waterway Restoration Partnership projects to improve the habitat of the Milwaukee Estuary Area of Concern.

Wentzel highlighted fish passage projects designed to benefit self-sustaining populations of lake sturgeon. This included the Kletzsch Dam fishway, previously reported by Urban Milwaukee, and plans to modify Estabrook Falls near the biergarten to make it easier for native fish to make it upstream. This project could start as early as summer 2025.

Native Americans have endured generations of forced removals, assimilation, cultural traumas, and freedoms denied, so Denning said projects like these to benefit native species have the potential to help restore a sense of Native identity.

Denning is a member of Sturgeon Clan, and the heart of the volunteer group Sturgeon Protectors, organized to educate the public about lake sturgeon. Eleven sturgeon have been detected so far this spring by an underwater array in the Milwaukee River near Urban



Children lead the procession holding the copper water vessel and eagle staff starting in Lincoln Park.

photo by Eddee Daniel

A half-marathon runner passes the walk for water on the Oak Leaf Trail.

photo by Eddee Daniel

Walkers proceed westward along the Menomonee River.

Walkers cross the Milwaukee River after its confluence with the Menomonee heading south on Water Street.

photo by Cheryl Nenn

The Sturgeon Water Walk MKE proceeded through downtown through the Third Ward along the Milwaukee Riverwalk.

photo by Cheryl Nenn

Siobhan Marks and Joe Fitzgerald lead the walkers over the 6th Street Viaduct.

photo by Cheryl Nenn

Ecology Center Riverside. As animal species return to Wisconsin waters—including otters, pelicans, beavers, sturgeon—Denning said those Anishinaabe Clans whose identities are rooted in these animal spirits are reinvigorated.

Their enduring presence is recognized as part of a larger whole.

Caldwell, whose Native name means "Yellow Thunder Cloud Woman," offered a lesson in water's central role as source of spiritual life force in an Indigenous creation story. The honored storyteller invited contemplation of "the beginning before the beginning."

Marks then described how anyone may assemble "water bundles" of natural items that can be offered seasonally to honor the water.

The walk was an opportunity to build new community bonds and strengthen a sense of common humanity, especially among Milwaukee's Indigenous community.

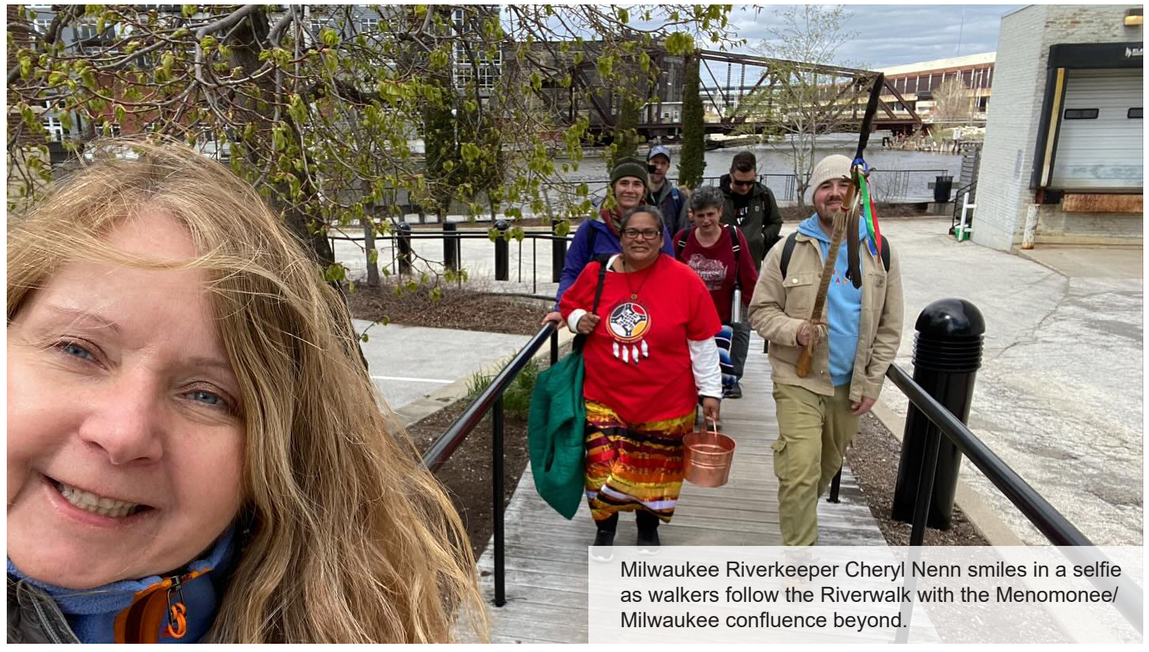
Ron Grieger, Jr. founded Strong Native Minds in 2021 with his wife Winona.

"I feel like we've lost a lot of our connection," he said. "We lost a lot of our insight in who we are as Native people, how we live and how we take care of each other. If we lose those stories or we lose those connections, we're going to lose everything about ourselves."

The group exists to counteract that cultural drift.

Welcoming all people, Strong Native Minds hosts men's talking circles and cultural arts where women learn how to bead, embroider, and make ribbon skirts together. They sponsored de-escalation training for Sturgeon Protectors volunteers and also connect youth with elders to cut lawns and clean attics.

"The more that we communicate amongst each other, that just enhances us and embraces us even more and makes us stronger," Grieger said. "And that's the whole purpose of this."



Milwaukee Riverkeeper Cheryl Nenn smiles in a selfie as walkers follow the Riverwalk with the Menomonee/ Milwaukee confluence beyond.



The core group poses at the Menomonee River after an 11-mile walk for the water starting along the Milwaukee River in Lincoln Park.

"THAT BEAUTIFUL WATER CARRIED BY ALL OF US, STARTING WITH THE BEAUTIFUL FIRE LIGHTING, OUR CHILDREN SINGING, SMUDGING, OUR TOBACCO CEREMONY, ALL OF IT, EVERY STEP, EVERY GOOD INTENTION, EVERY CONVERSATION, ALL WENT TO HEAL OUR WATER, AND TO PROTECT ALL OF OUR LIFE THAT'S HERE DURING THAT DREDGING PROJECT, BECAUSE WE KNOW THERE'LL BE A DISRUPTION."



Drone photo of Milwaukee's outer harbor showing the main (center right) and north (far left) harbor gaps.

The different color of the water reveals its different properties inside and outside the breakwater.

WCMP did not fund the drone photography, which is used with permission.

photo by Eric Halvie | @erichalvie

MILWAUKEE DREDGING PROJECT COULD HAVE EXTRA BENEFIT

ESTUARY CLEANUP EFFORT COULD RELEASE NUTRIENTS THAT BOOST LAKE MICHIGAN PERCH

IT STARTED WITH A MYSTERY: WHAT WERE THE GREEN HAIR-LIKE TUFTS CLOGGING NETS DRAWN UP FROM THE MILWAUKEE HARBOR?

Fisheries biologist Aaron Schiller wondered if what had glommed the small squares of Wisconsin Department of Natural Resources (WDNR) sampling nets in summer 2023 was Cladophora, algae known for washing up on beaches in foul-smelling mats from the warm waters of late summer and early fall.

Drs. Carmen Aguilar-Diaz and Russell Cuhel, senior scientists at the UW-Milwaukee School of Freshwater Sciences, doubted it was Cladophora.

But then, what were these algae?

"And so, they brought us a little slime from their nets and it turned out to be these really long, centimeter-long ribbons of diatoms, which are beautiful juicy steaks of the food web," Cuhel said. "They're loaded with lipids and protein and because they grow so long, they were actually clogging the gill nets of the DNR and the fish would come up and they would see 'em and swim around."

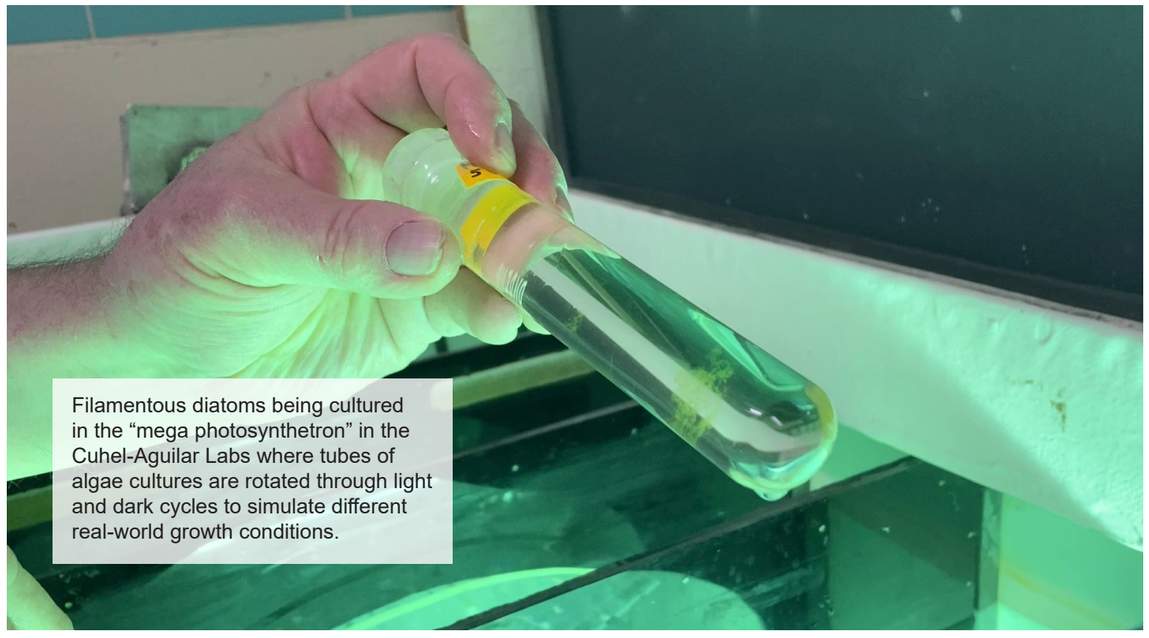
Clogged nets made it difficult for WDNR to sample fish, but the diatoms could be a boon for young fish that eat them.

And 2023's diatoms were exceptionally abundant—showing up at a concentration and location that surprised Aguilar-Diaz and Cuhel with their almost 30 years of studying Lake Michigan and the Milwaukee harbor.

What are diatoms?

One of many different types of algae, diatoms are microscopic organisms with "houses" made of silica, the same mineral composing sand or glass. Like most algae, diatoms photosynthesize just as terrestrial plants do, hence their green color.

Rich in fats and protein, diatoms make great food for larval and juvenile yellow perch—of Milwaukee fish fry fame. Beneficial blooms of these algae can give the aquatic food web an energy boost.



Filamentous diatoms being cultured in the "mega photosynthetron" in the Cuhel-Aguilar Labs where tubes of algae cultures are rotated through light and dark cycles to simulate different real-world growth conditions.



Dr. Russell Cuhel holds a diatom sample in the cold room of his lab at the UW-Milwaukee School of Freshwater Sciences in April 2024. Cuhel likes to call diatoms the "juicy steak of the food web." They are nutritious for young fish.

But since invasive mussels altered the food web, Lake Michigan diatom blooms declined. The scientists wondered: could those found in Milwaukee's harbor be responding to a new source of nutrients?

Finding the diatoms coincided with the first phase of dredging to remove contaminated river sediment from the Milwaukee Estuary Area of Concern, in 2023 mainly polycyclic aromatic hydrocarbons (PAHs) related to We Energies' historic coal gasification plant in the Third Ward.

The Waterway Restoration Partnership, which includes WDNR, We Energies, and others, banded together to clean up this river muck. Their goal is to remove legacy carcinogens that lead to fish tumors and consumption advisories, in short: to make our waters "fishable and swimmable."

The main dredging is not expected until at least 2026 when a facility to hold the removed solids is completed. Construction on this "Dredged Materials Management Facility," or DMMF, began in spring 2024. When completed, the 43-acre holding area is intended to sequester years of sediments dredged from Milwaukee's river bottoms.

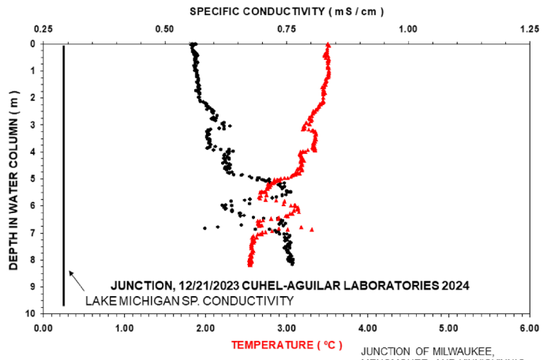
But the Third Ward sediments dredged in 2023 were deposited into the existing Confined Disposal Facility north of the Lake Express Ferry terminal.

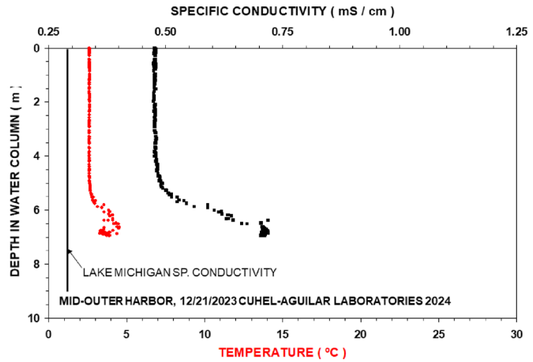
When a slurry of dredged sediments like these is deposited, it is "de-watered." That water is treated to remove regulated contaminants before being returned to Lake Michigan.

In the lab, Aguilar-Diaz and Cuhel's grad student simulated the dredging process and found that the simulated "leachate" water was rich in ammonia. The scientists wondered if this nutrient could be related to the unusual surge of diatoms observed.

To pursue the mystery, they conducted fieldwork

TEMPERATURE & SPECIFIC CONDUCTIVITY VERSUS HARBOR WATER DEPTH





JUNCTION OF MILWAUKEE, MENOMONEE, AND KINNICKINNIC RIVERS ABOVE HOAN BRIDGE, 12/21/2023, CUHEL-AGUILAR LABS

SITE: JUNCTION

SITE: MID OUTER HARBOR

MEASUREMENTS REVEAL WATER LAYERING & DIFFERING PHYSICAL DYNAMICS WITHIN PARTS OF THE HARBOR

PLOTS BY CUHEL-AGUILAR LABORATORIES 2024

SAMPLING DATA FROM 12/21/2023

aboard the R/V Neeskay, UW-Milwaukee's research vessel. Throughout 2023 and 2024 the scientists and their students made more observations and hypothesized connections.

They found compelling though not conclusive evidence of a connection.

"We found anomalous concentrations of ammonia and nitrite and phosphate near the disposal site where the sludge from the dredging was being de-watered, and that area was richer in nice, juicy-steak-of-the-food-web algae, and it continued to be that way all summer long, and now," Cuhel said. "So, the question is: Did the dredging stimulate them or was it something else?"

Whatever the cause, diatom blooms could constitute a movable feast for young native fish that anglers and society at large care a great deal about bringing back from the brink.

Diatoms are not to be confused with a "harmful algal

INTERPRETING THE FIELD DATA

Two data plots shared with permission of Cuhel-Aguilar Laboratories in April 2024 are shown on the facing page.

On the left, sampling from the junction of Milwaukee's three rivers.

On the right, sampling from the mid outer harbor between the Hoan Bridge span and the breakwater lighthouse as shown on the Google Earth basemap.

Both plots show data from the first day of winter 2023 to illustrate how layering of harbor water impacts water chemistry that in turn affects aquatic life, nutrient dynamics, and other processes important to water resource managers.

"You wouldn't normally see this, but we see it 'cause we're measuring this," Cuhel said.

"THE LAYERING IS REALLY IMPORTANT BECAUSE NOW THAT [WATER] HAS A DIFFERENT CHEMISTRY."

To understand both plots, it is easiest to orient to the Mid Outer Harbor plot (right) first.

Vertical lines of data points show little or no change in measured values, meaning water spanning that depth (from Mid Outer Harbor water surface down to about 5 meters) comprised a relatively stable, uniform layer.

Conductivity is a surrogate for water washed from rivers. Water in the lake stratifies by density, in Lake Michigan most often a function of temperature. Warmer surface waters will ride above deeper colder waters until mixing caused by the churn of storms or weakening of temperature gradients involved in "upwelling" events.

"In the summer the bottom had lake water," Cuhel said. "But in the winter, the bottom has river water."

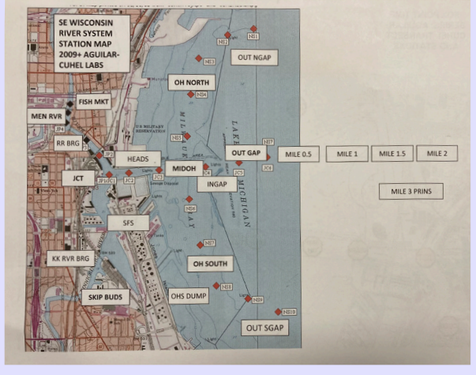
Water exhibits maximum density at 4 degrees Celsius, so in winter the colder layer of water actually sits above a slightly warmer, denser layer from 5 to 7 meters deep in a zone of mixing with water sequestered below. The increase in conductivity in this mixing zone shows this water has different chemical properties than above. The upper layer with lower conductivity shows the influence from open Lake Michigan water (the vertical black line shown for reference). Deeper, however, the conductivity measured in the harbor reveals the influence of water contributed from Milwaukee's rivers. "And so the layering is really important because now that has a different chemistry," Cuhel said.

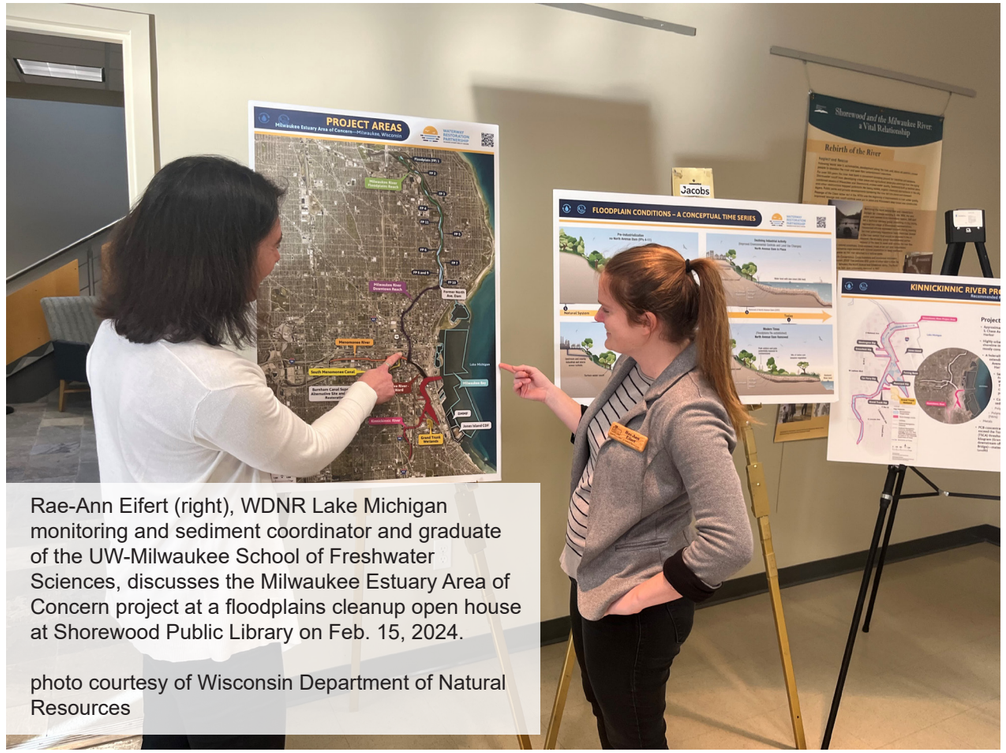
The data collected in Milwaukee's Inner Harbor at the junction of the rivers, before water flows out beneath the Hoan Bridge span, reveal a more complex story.

"There's at least six layers," Cuhel said. "And that's because the Kinnickinnic and the Menomonee and the Milwaukee, and the river, the harbor, and Lake Michigan are all meeting there. And they are all different and they're different enough to actually layer."

The layered structure of Milwaukee's harbor waters has implications for the transport of nutrients, preferred fish habitats, and the depths at which different algae, like diatoms, may proliferate under different conditions.

A map of routine field sampling stations where the Cuhel-Aguilar Lab plumbs the depths from aboard the R/V Neeskay. Because they have sampled the same sites over the decades, the long-term dataset allows the scientists to discern patterns and also detect variations. Sampling locations range from the Milwaukee River near the Milwaukee Public Market, throughout the Inner and Outer Harbors, and into the open waters of Lake Michigan eastward for over three nautical miles near the shipwreck of the Prins Willem V.





Rae-Ann Eifert (right), WDNR Lake Michigan monitoring and sediment coordinator and graduate of the UW-Milwaukee School of Freshwater Sciences, discusses the Milwaukee Estuary Area of Concern project at a floodplains cleanup open house at Shorewood Public Library on Feb. 15, 2024.

photo courtesy of Wisconsin Department of Natural Resources

bloom" of cyanobacteria, different toxic algae that capture headlines.

Cuhel said the shape of Milwaukee's harbor makes toxic blooms here unlikely. That's because cyanobacteria tend to dominate only when nutrient-rich waters are both warm and calm for an extended period. Lake Michigan and Milwaukee's harbor generally have too much wave action and current to favor cyanobacterial blooms—though the area near the proposed disposal facility is relatively protected and could grow stagnant under certain weather conditions.

This same area could be near where future dredge spoils are de-watered, so their observations led the UW-Milwaukee scientists to conversations with WDNR about potential harbor food web impacts.

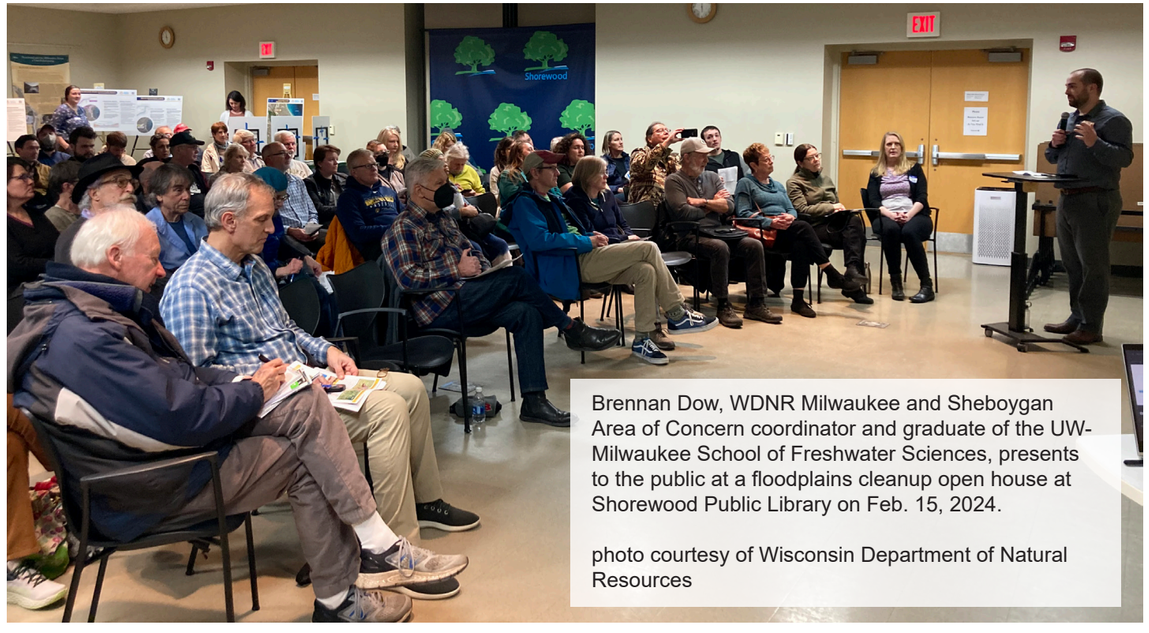
In spring 2024, Aguilar-Diaz and Cuhel connected with WDNR's Brennan Dow, Milwaukee and Sheboygan Area of Concern coordinator, and Rae-Ann Eifert, Lake Michigan monitoring and sediment coordinator. Both are graduates of UW-Milwaukee School of Freshwater Sciences.

The DMMF's water treatment plant will be designed to meet regulatory criteria, Eifert said, and discharges will need permits managed through WDNR. The U.S. Environmental Protection Agency and its contractor will ultimately be responsible for performing the cleanup and designing the DMMF treatment system, Dow said. Its final design is to be determined and could be informed by the work of the Milwaukee scientists and greater attention to nutrient impacts.

Understanding how dredging impacts Milwaukee could have implications for other harbors, Dow said.

"I mean, we've been dredging our harbors in Lake Michigan for a long, long time, and some of them haven't been dredged in a while. So, they might be similar to Milwaukee in the case where you have a lot of organic matter that hasn't been touched in a few decades," Dow said. "And if dredging that up can release more nutrients and cause a temporary effect or something, it's good to know so we can manage expectations with the public about what they may see in the environment."

"WE'VE BEEN DREDGING OUR HARBORS IN LAKE MICHIGAN FOR A LONG, LONG TIME, AND SOME OF THEM HAVEN'T BEEN DREDGED IN A WHILE. SO, THEY MIGHT BE SIMILAR TO MILWAUKEE IN THE CASE WHERE YOU HAVE A LOT OF ORGANIC MATTER THAT HASN'T BEEN TOUCHED IN A FEW DECADES," DOW SAID. "AND IF DREDGING THAT UP CAN RELEASE MORE NUTRIENTS AND CAUSE A TEMPORARY EFFECT OR SOMETHING, IT'S GOOD TO KNOW."



Brennan Dow, WDNR Milwaukee and Sheboygan Area of Concern coordinator and graduate of the UW-Milwaukee School of Freshwater Sciences, presents to the public at a floodplains cleanup open house at Shorewood Public Library on Feb. 15, 2024.

photo courtesy of Wisconsin Department of Natural Resources

He and Eifert agreed that more research is needed to tease out causes of the higher diatom densities.

Another mystery puzzle piece was Eifert's unrelated sampling cruise that confirmed Milwaukee's 2023 diatom surge—extending eastward miles into the lake from the harbor—was unique along western Lake Michigan.

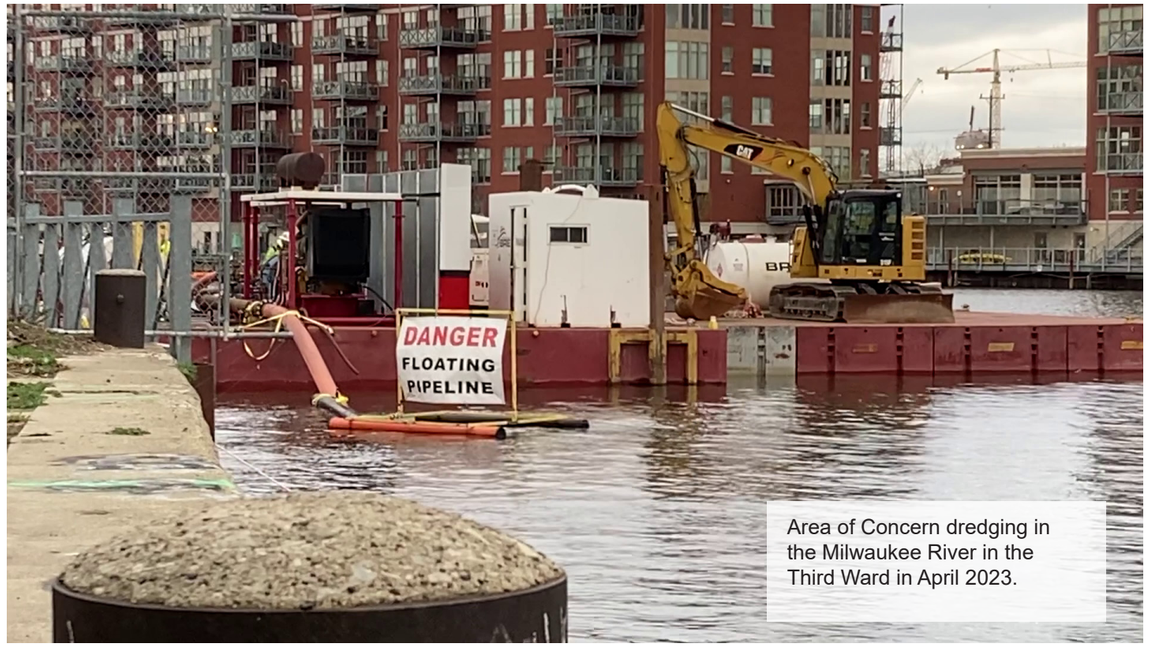
"One of my surveys was going all the way up and down the coastline of Lake Michigan," Eifert said. "It does seem like they [diatoms] were more concentrated near Milwaukee, so there could be something going on there. We know that the dredging occurred that year, but it was also a weird year for a lot of other things [including the Canadian wildfires and associated smoke particulates]. So, it's really hard to pinpoint



Drone photo of Milwaukee's inner harbor. Floating orange booms along the Milwaukee River during the 2023 We Energies dredging project are visible. The contaminated dredged materials from the river bottom were piped to the Confined Disposal Facility.

WCMP did not fund the drone photography, which is used with permission.

photo by Eric Halvie | @erichalvie



Area of Concern dredging in the Milwaukee River in the Third Ward in April 2023.

down exactly why the diatoms appeared that year, but if it is related at all to dredging, it's good to know."

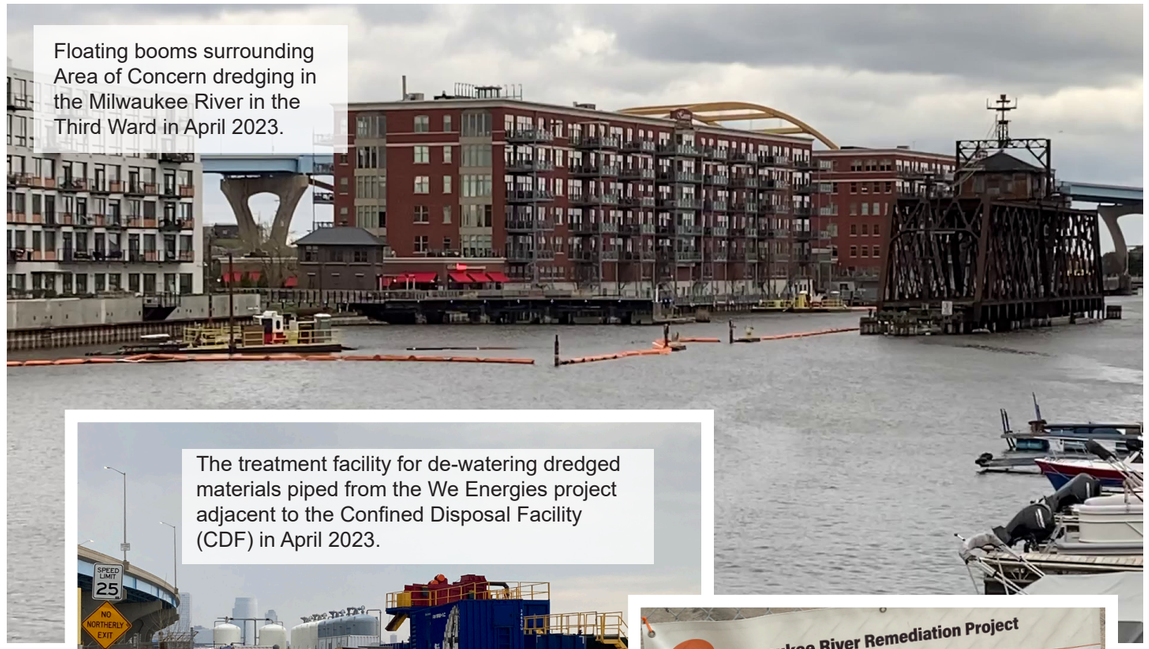
How the mystery ends and whether we know whodunit will depend on future research. Meantime, based on the bumper crop of diatoms observed that sometimes color Milwaukee waters with an olive hue, Cuhel predicts Milwaukee's young perch will do well in 2024.

In May 2024, the scientists were excited that a recent research cruise already turned up ribbons of diatoms an impressive eight miles offshore. And at a May 2024 School of Freshwater Sciences research symposium, two of their students presented different aspects of their lab's harbor research.

Undergraduate John DeTuncq studied how wind conditions and the physical harbor structure impact where and how nutrients feeding harbor diatoms move.



UW-Milwaukee student Mary Larson presents on her diatom research as part of the Cuhel-Aguilar Lab in May 2024.

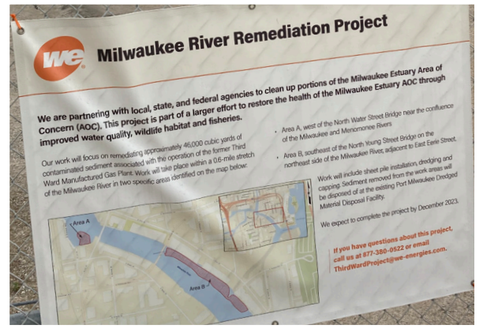


Floating booms surrounding Area of Concern dredging in the Milwaukee River in the Third Ward in April 2023.

The treatment facility for de-watering dredged materials piped from the We Energies project adjacent to the Confined Disposal Facility (CDF) in April 2023.



Pipes at the CDF in April 2023.



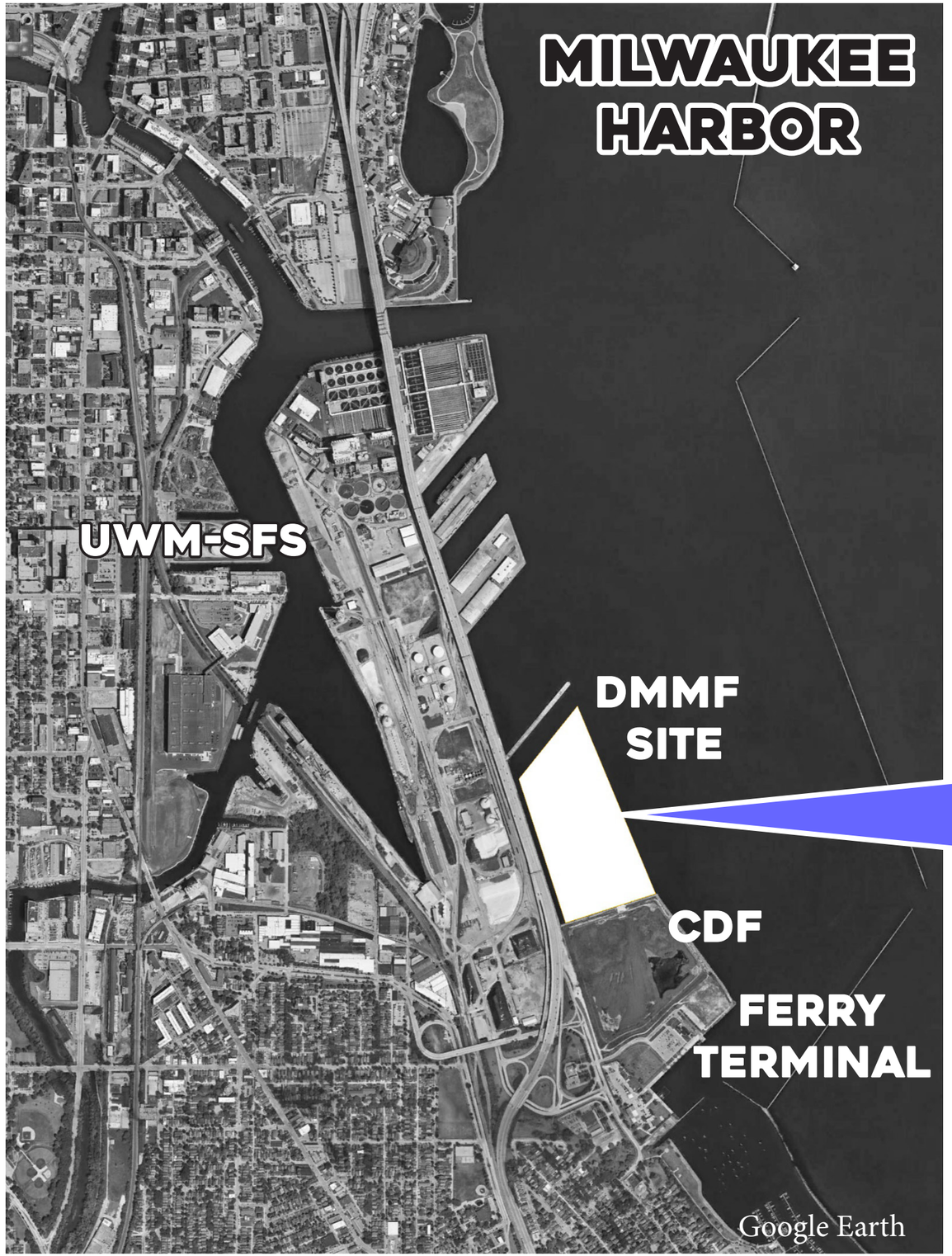
Grad student Mary Larson painstakingly isolated the diatom Tabellaria from field samples and exposed it in the lab to simulated day/night cycles. In the presence of enough nutrients, the diatoms kept growing and reproducing even in the absence of light.

For the summer 2024 field season, Larson plans to sample the harbor water column to observe what specific depths different algae prefer. Combined with knowledge and observations of the mixing and stratification of different water layers from the rivers and the lake, this could provide a clue of which algae benefit most from any influx of nutrients.

Aguilar-Diaz and Cuhel hope to do more research to predict how the harbor food web may respond to the dredging.

"We want to take mud from different areas of the Area of Concern and squeeze the water out of it," Cuhel said. Then, in the lab, they would use that water to enrich algae cultures grown in water samples collected from the harbor. The scientists predict this will stimulate the same kind of algal blooms found during the 2023 dredging. If it does, this means they can probably expect the influx of more nutrients into the harbor as the major dredging work commences.

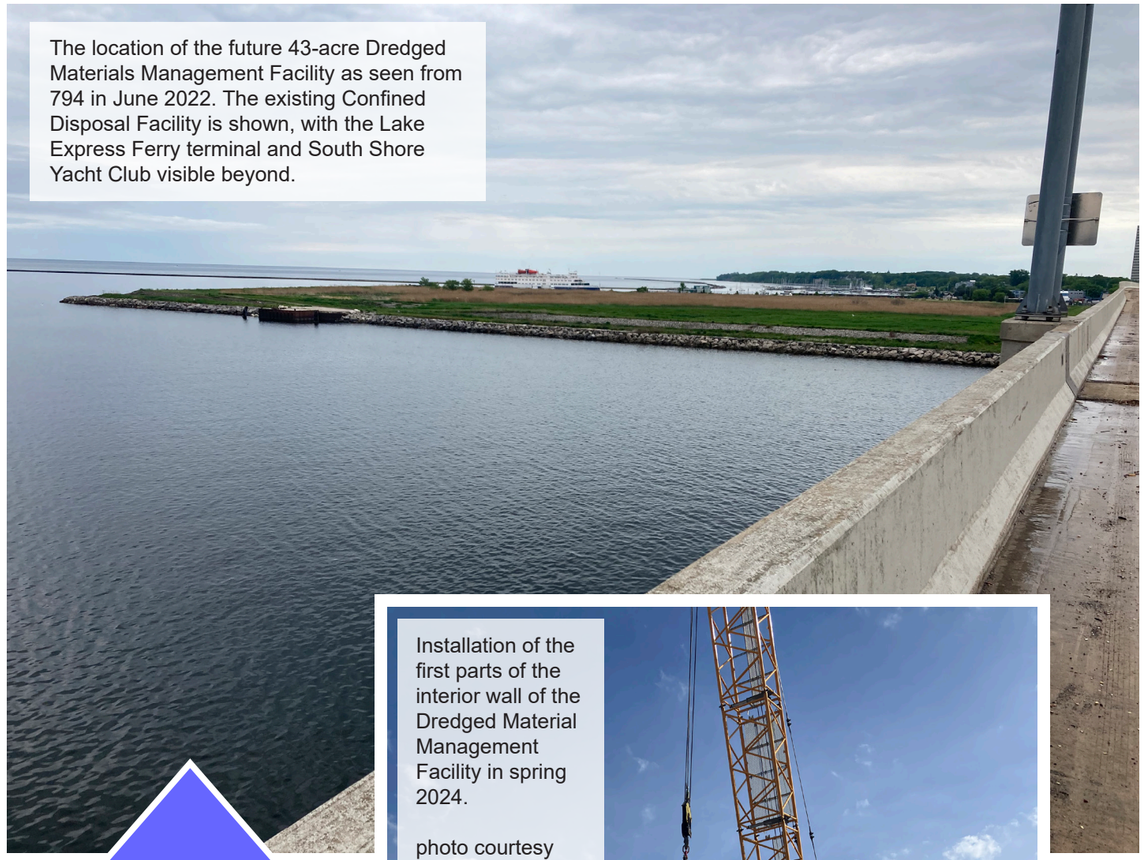
That would be "a nice resource for the food web," Cuhel said. And a feast for the lake's perch.



The Google Earth aerial image shows the location for the Dredged Materials Management Facility based on maps shared by the Waterway Restoration Partnership.

The DMMF is expected to be completed and ready to accept new dredged materials as early as 2026.

The dredging will occur in areas upriver beyond the area shown.



The location of the future 43-acre Dredged Materials Management Facility as seen from 794 in June 2022. The existing Confined Disposal Facility is shown, with the Lake Express Ferry terminal and South Shore Yacht Club visible beyond.



Installation of the first parts of the interior wall of the Dredged Material Management Facility in spring 2024.

photo courtesy of Milwaukee Metropolitan Sewerage District



In the field, Erin Povak, watershed program manager for the nonprofit Sweet Water, tests for bacteria and chlorides on behalf of an MS4.

photo courtesy Erin Povak

How 18 Municipalities Work Together on Water Quality

THEIR EFFORTS CLEAN AND REDUCE AMOUNT OF STORMWATER FLOWING INTO RIVERS AND LAKE

As stormwater flows over urban and suburban landscapes, it picks up many contaminants — everything from pet waste to weed killers to litter. In much of our area, stormwater drains into storm sewers that carry it untreated into our rivers — a major source of water pollution.

But behind the scenes, local municipalities are improving regional water quality through green infrastructure maintenance and public education campaigns that address stormwater.

The oft-unsung actions are part of regulatory compliance with state permits for municipal stormwater, but also represent a new way of working together across boundaries.

That approach is needed because watersheds don't observe city limits and neither do watershed-scale challenges like stormwater management.

A watershed is the area of land that drains into a water body like a river or lake. Stormwater is water that runs off the surfaces of a watershed. In the Milwaukee area, the straight-line borders of 29 municipal entities crisscross the more natural boundaries of five major river watersheds — the Milwaukee, Menomonee, Kinnickinnic, and Root Rivers and Oak Creek. Those rivers all flow to Lake Michigan.

To manage stormwater pollution, Milwaukee-area municipalities are co-signatories in "MS4" group permits — the nickname for their municipal separate storm sewer systems. MS4 discharges are permitted

through the Wisconsin Department of Natural Resources. These permits are for stormwater only, not wastewater flushed down the toilet, which is treated separately.

In the Milwaukee area, there are two permit groups comprising these unique intergovernmental collaborations: the Menomonee Group and the North Shore Group. The Menomonee Group has 11 co-signatories in the Menomonee River watershed. North Shore has seven in the Milwaukee River watershed.

"Obviously, the benefits are fantastic. We want to put this stuff in. But I think it's been a struggle."

That's where Sweet Water comes in, Imig said. "They have a vast volunteer group" that help with cleanup activities, for instance.

Sweet Water also helped Glendale obtain a $25,000 America in Bloom grant sponsored by CN Rail to improve landscaping at three stormwater ponds. "We're removing invasives, removing a couple of dead trees, and then [landscaping firm] David J. Frank is going to come back through and replant some of the area," Imig said of the 2024 project.

> "WE'RE PUTTING A LOT OF THIS GREEN INFRASTRUCTURE IN, BUT THE PROBLEM IS WE DON'T HAVE A LOT OF STAFF TO MAINTAIN IT."

The nonprofit Southeastern Wisconsin Watersheds Trust, Inc. — known as Sweet Water — works with municipal departments of public works (DPWs) to help them manage their MS4 permit compliance. Erin Povak, who joined Sweet Water in 2021, serves as the group's watershed program director.

Povak works directly with DPWs, which are often saddled with competing tasks and limited staff time. One common thread municipalities face is maintaining green stormwater infrastructure — built features which often include vegetation to manage water where it falls, versus "gray infrastructure" which refers to pipes.

"We're putting a lot of this green infrastructure in, but the problem is we don't have a lot of staff to maintain it," said Charlie Imig, director of public works for the City of Glendale, part of the North Shore Group.

Under their group permits, the municipalities must also conduct targeted education and outreach on a stormwater topic of local concern. Sweet Water assists.

In West Allis, part of the Menomonee Group, water quality intersects with the local concern over pet waste.

"West Allis is pretty landlocked, so we don't have all the tools that other areas have as far as building ponds, building large areas that can collect and treat rainwater," said Rob Hutter, assistant city engineer for the City of West Allis. "We have to choose our methods of rainwater quality and quantity a little bit differently than other communities. So, one of the things we worked on as part of the permit — we



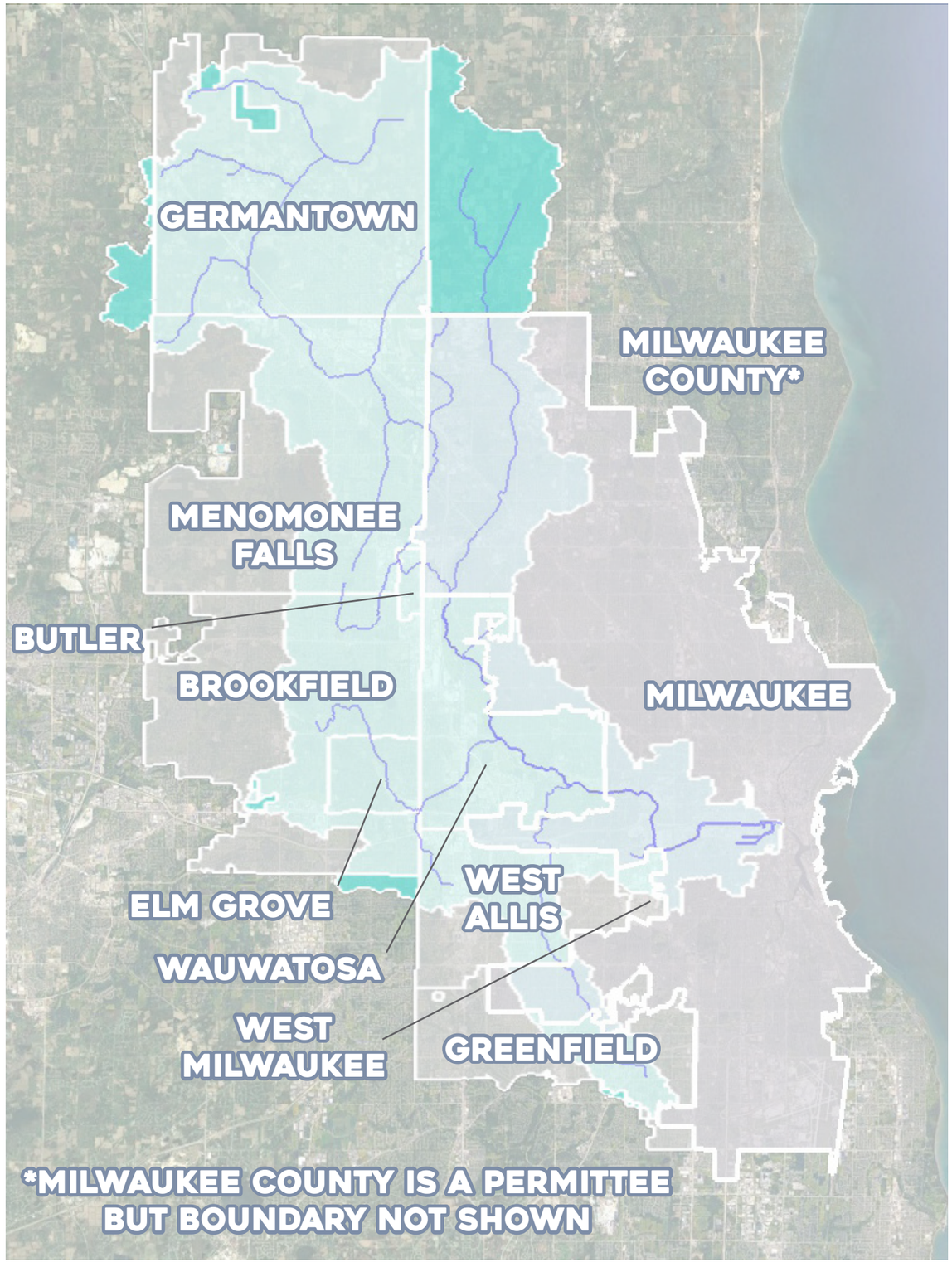
Canada geese patrol beside the stormwater pond in Glendale at the northwest corner of N. Lydell Street and W. Olive Street in May 2024. This is one of three Glendale's ponds to receive additional maintenance in 2024.

photo by Michael Timm



Sweet Water's Erin Povak stands with Charlie Imig, director of public works for the City of Glendale, at one of three sites to receive native plant restoration. Povak and Imig obtained an America in Bloom grant from CN Rail to support landscaping at stormwater management sites in 2024.

photo courtesy Erin Povak

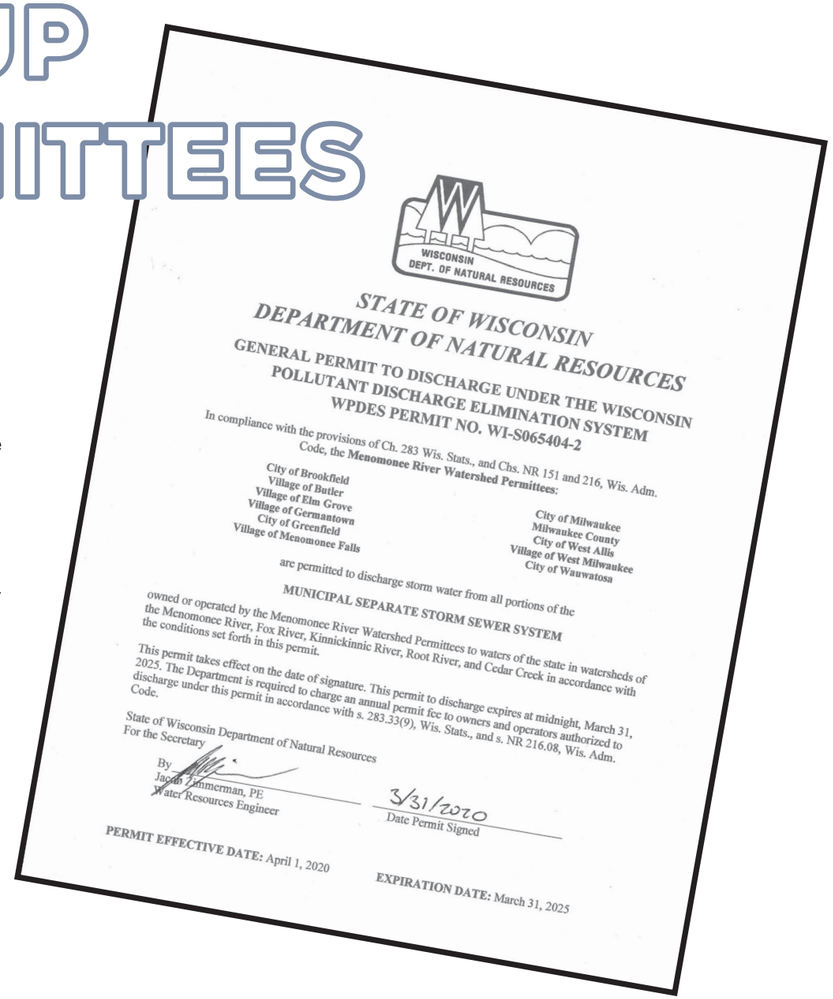


MENOMONEE RIVER WATERSHED MS4 GROUP PERMITTEES

This map overlaid on a Google Earth aerial shows the municipal boundaries of cities and villages that encompass the Menomonee River watershed.

Eleven municipalities have signed onto a five-year group stormwater permit committing to manage water pollution together.

*Milwaukee County is also a permittee but for clarity its overlapping boundary is not shown on the map.



WISCONSIN DEPT. OF NATURAL RESOURCES

STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES

GENERAL PERMIT TO DISCHARGE UNDER THE WISCONSIN POLLUTANT DISCHARGE ELIMINATION SYSTEM
WPDES PERMIT NO. WI-S065404-2

In compliance with the provisions of Ch. 283 Wis. Stats., and Chs. NR 151 and 216, Wis. Adm. Code, the **Menomonee River Watershed Permittees**:

City of Brookfield
Village of Butler
Village of Elm Grove
Village of Germantown
City of Greenfield
Village of Menomonee Falls
City of Milwaukee
Milwaukee County
City of West Allis
Village of West Milwaukee
City of Wauwatosa

are permitted to discharge storm water from all portions of the MUNICIPAL SEPARATE STORM SEWER SYSTEM owned or operated by the Menomonee River Watershed Permittees to waters of the state in watersheds of the Menomonee River, Fox River, Kinnickinnic River, Root River, and Cedar Creek in accordance with the conditions set forth in this permit.

This permit takes effect on the date of signature. This permit to discharge expires at midnight, March 31, 2025. The Department is required to charge an annual permit fee to owners and operators authorized to discharge under this permit in accordance with s. 283.33(9), Wis. Stats., and s. NR 216.08, Wis. Adm. Code.

State of Wisconsin Department of Natural Resources
For the Secretary

By _____ 3/31/2020
Jacob Zimmerman, PE — Date Permit Signed
Water Resources Engineer

PERMIT EFFECTIVE DATE: April 1, 2020

EXPIRATION DATE: March 31, 2025

worked on it a lot with Sweet Water — was picking up pet waste."

Pet waste adds bacteria to the watershed but also contributes to a rat problem. Sweet Water helped West Allis design and distribute postcards that remind the public to pick up pet waste in order to help with rat abatement. In addition, Hutter said many new apartment units in West Allis are incorporating pet waste stations to both attract tenants with pets and keep the area clean.

"We are rebranding our city," Hutter said. "So, [our motivation is] kind of two ways. We are compelled to do it with a permit, but we also [seek a] new way we want people to look at our city."

Hutter notes West Allis also continues to deliver subsidized $20 rain barrels to interested residents, a popular effort he said the council funds from their stormwater utility.

In Wauwatosa, Sweet Water helped amplify the impact of another education campaign, this one targeting owners of larger green infrastructure "best management practices" — shorthanded as BMPs. These are features like porous pavement, underground detention systems, wet detention ponds, biofiltration basins, catch basins or other proprietary systems.

Designed to minimize or manage stormwater runoff on commercial or institutional properties including schools and churches, "BMPs require ongoing



This glossy postcard-sized flyer was developed by Sweet Water to help the City of West Allis educate the public about the importance of picking up pet waste. This effort was part of West Allis's commitment under the Menomonee Group MS4 permit.

image courtesy Rob Hutter, City of West Allis



Above: A three-page brochure Sweet Water developed to help Wauwatosa educate its property owners inspect and maintain their stormwater BMPs.
Below: Vegetation establishing in the bio basins at Wauwatosa's Wilson Elementary in May 2024.

Images courtesy of Jessica Henderson, City of Wauwatosa

A foreground porous parking lot allows rainwater to infiltrate while the rain-slick impervious asphalt lot is seen beyond the alley. West Allis installed the porous lot using MMSD Green Solutions dollars in fall 2023.

photo by Rob Hutter, City of West Allis



inspection and maintenance by property owners to ensure that they are achieving their desired treatment goals," according to a May 2023 letter Sweet Water helped the City of Wauwatosa send to 52 property owners listed with stormwater BMPs.

"Inspections also reduce the risk of damages such as flooding," the letter said. "Even when a BMP appears as if it is working, it's possible that it is not functioning as designed. Therefore, regular inspection and maintenance is required."

Maintenance agreements requiring annual inspection reports are binding property deed restrictions, but some may be unfamiliar with their obligations, said Jessica Henderson, civil engineer with the City of Wauwatosa. Every year Wauwatosa sends property owners a reminder letter, but the response rate was low.

"We just don't have enough staff time generally to keep following up with property owners as it stands now," Henderson said, so Wauwatosa worked with Sweet Water to better educate property owners sooner. After sending out an additional letter, 34 Wauwatosa properties sent their inspection records in 2023, Henderson said, up from just 15 in 2022.

Participating in the watershed-based group permits also helps municipalities learn from each other.

Sweet Water convenes quarterly meetings with the groups. "They get together and we hear presentations on various topics that are of interest," Povak said. "The municipalities present on successes and failures."

Hutter said West Allis is learning a lot at these meetings. "What is Greenfield doing? What is Brookfield doing? What is Wauwatosa doing? We can learn from each other, take ideas from each other or — just as importantly — ideas that didn't work from each other are wonderful. None of this is top-secret intellectual property or anything. It's things that we're using public money to do, so we don't want to repeat mistakes."

For example, West Allis learned from Wauwatosa about porous paver best practices, he notes. West Allis initially had trouble with its porous pavers settling over the winter. Wauwatosa addressed this issue by using a fabric layer that stabilizes the pavers. West Allis changed practices to follow suit, Hutter said.

As municipalities gain more experience with maintenance, green infrastructure is growing more accepted.

"I FEEL LIKE ONE OF THE NEEDLES WE'RE PUSHING IS INTERNAL WITH THESE DPW DEPARTMENTS AND THE WAY THEY THINK ABOUT THEIR WORK."

Using Green Solutions dollars from the Milwaukee Metropolitan Sewerage District, West Allis installed a porous asphalt parking lot by its city hall in 2023, Hutter said. "We had a big lot and a small lot and they were separated by an alley, so we did the big lot with porous asphalt and the small lot just with regular asphalt," he said. "It's kind of neat to see the two on a rainy day." The asphalt lot remains slick with rainwater while the porous surface allows water to infiltrate.

None of these activities are headline-grabbing affairs, but taken together move the needle toward cleaner Milwaukee waters we all share. Reducing pet waste reduces bacteria. Green infrastructure maintenance ratchets down other pollution metrics that communities are working together through their permits to control.

The work is also helping to change cultures within municipal government.

In the lab, Sweet Water's Erin Povak prepares equipment to grab samples for an MS4 permit holder.
photo courtesy Erin Povak



"I feel like one of the needles we're pushing is with these DPW departments and the way they think about their work," Sweet Water's Povak said. "I've seen shifts happen in their perspective and thinking about stormwater from a different angle in considering the education component."

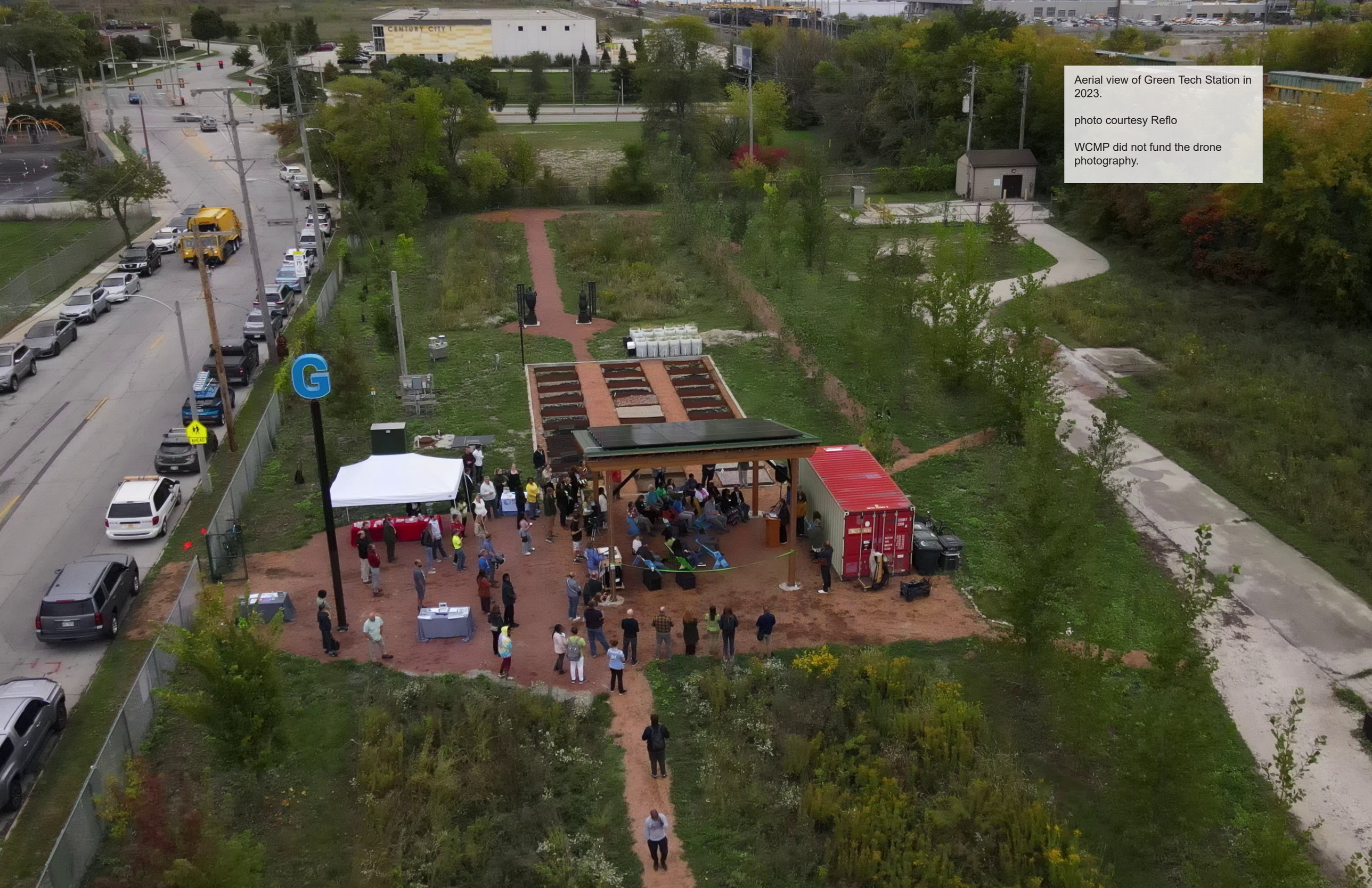
Every five years, the MS4 group permits expire. The Menomonee Group permit was signed March 2020, so the permit will need to be revised and renewed in March 2025. The North Shore Group permit was signed June 2021 and will expire in May 2026. Renewed five-year group permits should push the needle further, Povak said.



The side panel of Ali Benjamin's Aldo Leopold bench, "From a Trickle to a Roar," at Green Tech Station contains this painting of a human hand amid water.

Colorful Benches Tell Story of Stormwater Management

High school art interns created ten community benches illustrating unique Milwaukee story



Aerial view of Green Tech Station in 2023.

photo courtesy Reflo

WCMP did not fund the drone photography.



Throughout 2024, 10 high school interns planned and painted their own artwork on benches now used to support programming at the former-brownfield-turned-field-trip-destination, which hosts outdoor tours to showcase different practices that help manage stormwater.

The benches are the latest focus of the nonprofit's paid environmental arts internship, which has focused on community water projects in the 30th Street Corridor for years.



"We got a lot of creative liberty with this," said DeAnthony Roaf, who attends Golda Meir High School. On his bench, "Mario's Pipe Dream," Roaf featured green pipes from the popular Super Mario Brothers video games. He even hid a little Mario for people to find. "The idea came when we took a field trip to Green Tech Station where I could see how simple systems like pipes are able to do so much to help our community," Roaf said.

Milwaukee High School of the Arts student Marco Vallejo's bench is titled "Under the Surface." Their design reflects the path of water through green infrastructure like the bioswales the interns learned about during their tour. Bioswales are vegetated ditches engineered to manage water. "You have plants, you have a little tree growing, and you also have a pond, and you can see the water's going down to this part of the bench," explained Vallejo.

Jay Berry-McIntyre, who attends Whitefish Bay High School, titled her work "Native Plants." She wanted her design to be colorful and bold. "I wanted it to be like what we use water for and why we should be thankful for water and why we should protect it," Berry-McIntyre said. Bench panels show scenes of washing, showering, drinking, and watering plants. "And on the backside of the bench, it's the big G from Green Tech Station."

The "big G" is also art-related. It's a WaterMarker, a 30-foot solar-powered illuminated letter that pulses









when the Milwaukee Metropolitan Sewerage District (MMSD) issues a Water Drop Alert to advise residents to limit water use in event of heavy rains that could overwhelm the sewer system. As of 2024, there are four WaterMarkers across the city, with plans for at least six more.

Each WaterMarker, whose letter is selected to represent community themes — G stands for gritty, gather, growth, and the Garden Homes neighborhood — is also associated with local art project supported by the citywide WaterMarks initiative. At Green Tech Station, artist Glenn Williams created two sculptural pieces inspired by African water vessels that flank the south walking path. They contain proverbs: "Water has no enemies" and "Water is an ancestor."

WaterMarker letters worked their way into bench designs.

A swirling explosion of warm colors encircles the fiery letters A, Ñ, G, and H — the WaterMarker installations so far — on "From a Trickle to a Roar," the bench designed by Pius XI student Ali Benjamin. "The WaterMarkers are a light source, so the red and yellow and orange represent that light source," said Benjamin. "And then I wanted an element that brings in the people. So, I put the hands on either side. One of them has the light source and the other has running water."

The kaleidoscope of artistic perspectives afforded by painting simple places to sit reveals how intentional many Milwaukeeans are about co-creating a community that values all people and forms of life.

Rachel Lebeck, who attends Nathan Hale High School, painted vibrant butterflies and ruby-throated hummingbirds in her design, "Protect Pollinators," which also features the species' names in Ojibwe and Potawatomi. "I figured that with the native plants and native pollinators, I might as well throw in the native languages of the people who lived here before us," Lebeck said.

Interns felt an intimate connection to water — and the existential need to protect it.



"Water is in everything we do. The way we eat. The way we drink. It's in us. We use it every day," said Shamauri Harrington, who attends Golda Meir High School and called her bench "Water-based Relations." Her art shows a neighborhood with a flower-filled basin at its heart. On the back she included a fluid invocation: "Help water, help us."

Water relations are not always positive. As part of their preparation, the interns learned how intense 2008 and 2010 storms led to widespread flooding throughout Milwaukee's 30th Street Corridor. Addressing flood risk motivated MMSD to construct city-block-scale vegetated stormwater basins in the Garden Homes neighborhood north and east of Green Tech Station.

In her bench, “A Flood of Connection,” Adriana Rios, who attends Franklin High School, drew inspiration from this story. She painted a variety of Milwaukee homes rising above a field of blue. Rios, whose own family experienced a flooded basement, wanted to emphasize that people came together in response to the flooding. “Why not bring in the positive aspect of how [basins and bioswales] help decrease the amount of flooding and also bring the community together through recreational opportunities?” Rios said.

“Neighborhood Resilience” is bench title of Kayla Teague, who attends Pius XI High School — though her design came to focus on one tool in the green infrastructure toolkit. The seat says “AQUABLOX,” the trade name for a plastic-crate-like module used to manage stormwater.

When these hollow blocks are stacked together underground and enclosed, their void space is used to contain water, while their lightweight gridded structure supports the weight of the ground above. Green Tech Station’s test bed plaza overlies one such cistern built of blocks and able to hold 20,000 gallons of water collected from four bioswales. That water can be pumped up for irrigating over 400 trees planted on site or slow-released into the sewer system.

Teague’s design drew inspiration from the gridded pattern of individual blocks, each about the size of a large cooler, on display to help explain the system hidden below.

For some interns, creating art was less technical and more deeply personal — providing healing and solace.

Noah Calvin, who attends Alliance High School, titled his bench “Season Change.” All four seasons are shown. “There’s parts of my life — it’s broken,” Calvin said. “It can’t be fixed,” His winter scene shows cracks in ice symbolizing this brokenness, but Calvin also painted an autumnal “Love Tree” symbolizing good memories with family. Jagged summer lightning signifies the sudden power of things we cannot control but alter our lives. On the back he painted the metamorphosis of caterpillar into butterfly.

Ability Kostecki’s design featured rainbows surrounding sun and moon. “I feel like it’s just very inspiring and brings a sense of joy to be able to see the simple things in nature,” said Kostecki of her bench, “Simple Significance.” She graduated from Barack















Obama School of Career and Technical Education, works as a cook, and looks forward to studying environmental engineering at UW-Milwaukee.

Interns benefited from mentors just a few years older.

"I learned a lot about just how far kids this age can go if you give them even a little bit of encouragement. They're extremely talented," said Sydney Eserkaln, one of three lead artist assistants ArtWorks employed to support the interns, who watched them grow into "very professional people."

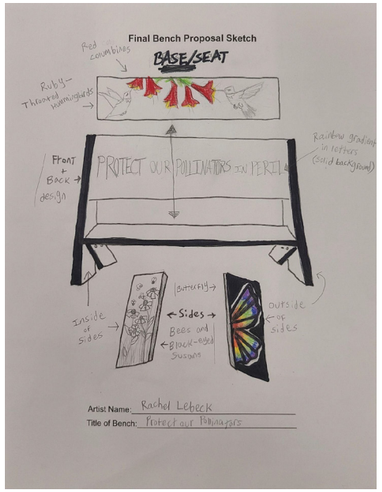
Eserkaln teamed with Lily Gruenewald and Mitchell Liebhauser on the mentors' own bench, "Unearthed," depicting subterranean critters, fossils, invertebrates, and pathways hidden underground.

Lead artist Marco Romantini led ArtWorks' environmental arts internship, and Tracy LoMenzo managed the program. The bench project was in partnership with the nonprofits Northwest Side Community Development Corporation, which manages Green Tech Station, and Reflo, which built the benches and supports the site.
The benches were unveiled on May 4, followed by a volunteer workday pulling weeds, spreading woodchips, and hauling gravel. Proud parents and partners witnessed the results of months of hard work.

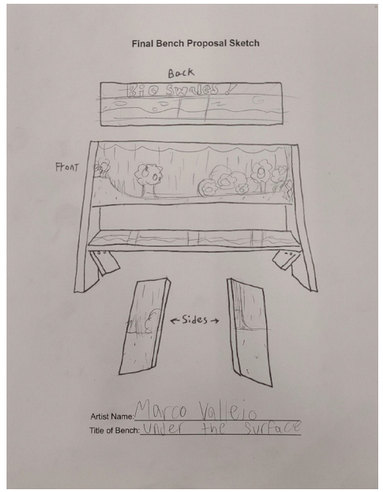
The interns also created custom murals surrounding storm drains at nearby Samuel Clemens School to remind the public that these carry water to our rivers and Lake Michigan.

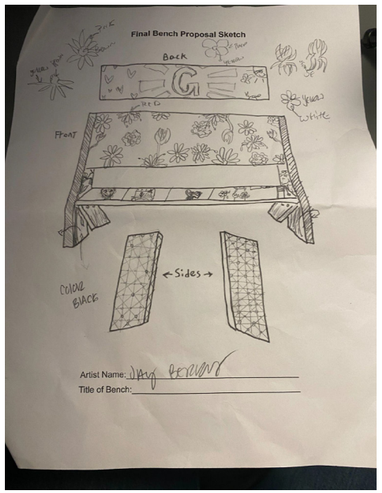
WaterMarks art by Mikal Floyd-Pruitt — along with a new "big C" WaterMarker for community, Century City, connections, clean, and collaboration — is planned for nearby Melvina Park, a city park being expanded with green infrastructure. Another WaterMarker and art are also planned for MMSD's West Basin stormwater management project on the former Bee Bus Line site.

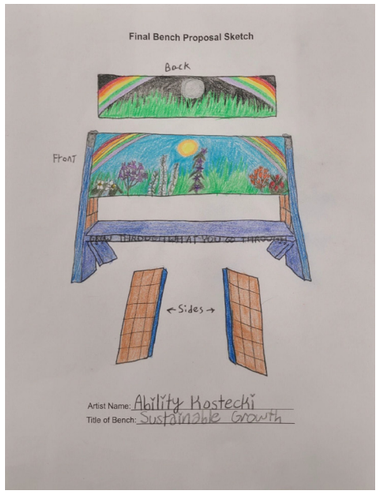
Green Tech Station is open for tours by appointment through Northwest Side Community Development Corporation's website.

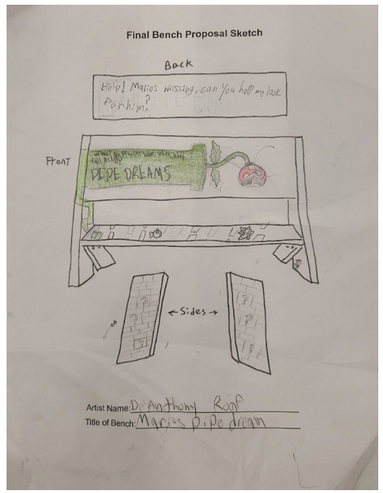

Final Bench Proposal Sketch
BASE/SEAT
Red columbines
Ruby-Throated Hummingbirds
Front + Back design
PROTECT OUR POLLINATORS ON PERCH
Rainbow grading in letters (solid background)
Butterfly
Sides
Inside of Sides
Bees and Bloom-egg Suspension
Outside of Sides
Artist Name: Rachel Lebeck
Title of Bench: Protect our Pollinators

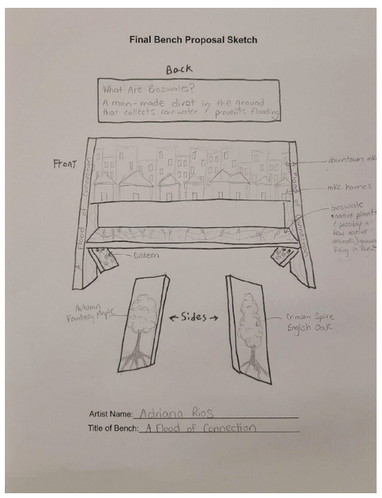

Final Bench Proposal Sketch
Back
Milwaukee's back
Front
Sides
Artist Name: Noah
Title of Bench: Milwaukee's back

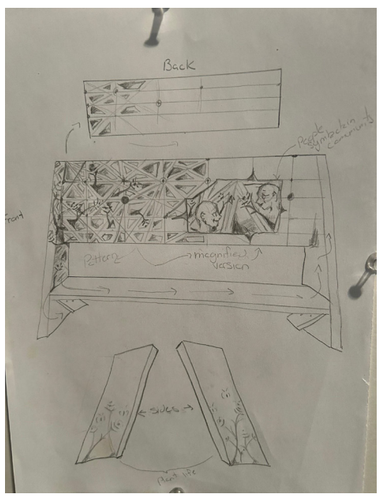

Final Bench Proposal Sketch
Back
Front
Sides
Artist Name: Marco Vallejo
Title of Bench: Under the Surface

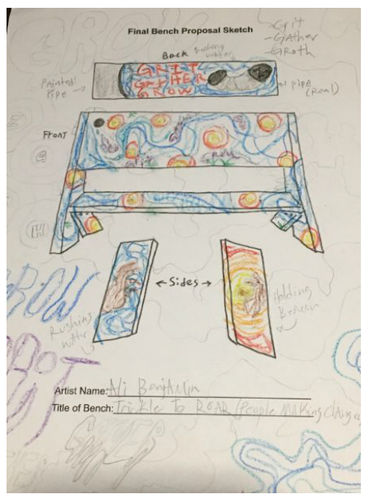

Final Bench Proposal Sketch
Back
Front
Sides
Color Black
Artist Name:
Title of Bench:


Final Bench Proposal Sketch
Back
Front
Sides
Artist Name: Ability Kostecki
Title of Bench: Sustainable Growth


Final Bench Proposal Sketch
Back
Help! Monarchs missing, can you help me find Penelope?
Front
Pipe Dreams
Sides
Artist Name: Dr. Anthony Roof
Title of Bench: Marie's Pipe dream


Final Bench Proposal Sketch
Back
What Are Bioswales?
A man-made divot in the ground that collects rainwater & prevents flooding
Front
Sides
Artist Name: Adriana Rios
Title of Bench: A flood of Connection


Back
Front
Sides


Final Bench Proposal Sketch
Back
Front
Sides
Artist Name:
Title of Bench:


Rachel Lebeck
PROTECT POLLINATORS
NANOKSHI · HUMMINGBIRD · NENOOKAASI · HUMMINGBIRD
AMO · BEE · AMOO · BEE · MEMEGE · BUTTERFLY
POLLINATORS · ENGLISH · OTIBWE

Shamauri Harrington



WATER-BASED RELATIONS









Noah Calvin

SEASON CHANGE







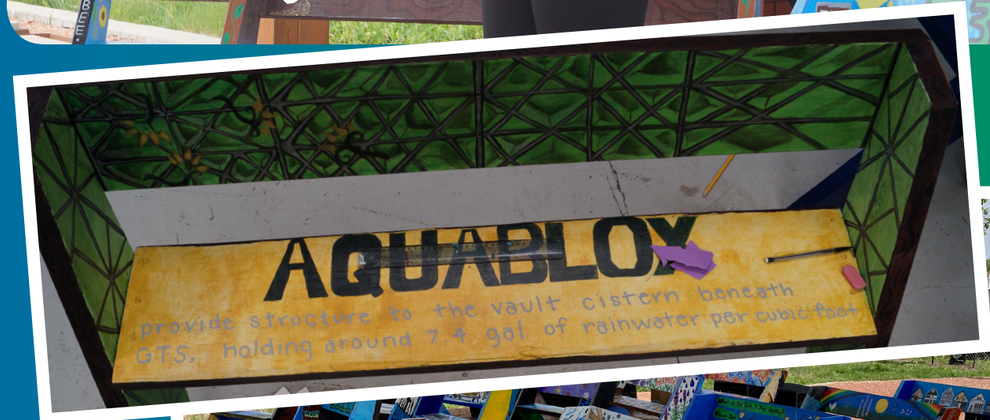
Ability Kostecki

SIMPLE SIGNIFICANCE






Kayla
Teague
NEIGHBORHOOD RESILIENCE


AQUABLOX
provide structure to the vault cistern beneath
G.T.S. holding around 7.4 gal of rainwater per cubic foot


AQUABLOX


Ali
Benjamin
FROM A TRICKLE TO A ROAR




GREEN TECH


THE FUTURE IS BRIGHT

Milwaukee's Green Schoolyards Gain National Attention

Milwaukee Mayor Cavalier Johnson presides at a ribbon cutting for the fifth cohort of five Green & Healthy Schoolyards on Oct. 11, 2023.

Milwaukee is quietly leading the nation with an innovative model changing what it means to grow up in a 21st-century American city.

Since 2019, Wisconsin's largest school district has transformed 26 schoolyards, replacing 17 acres of asphalt with educational green spaces that manage water where it falls and provide park-like community gathering spots spread across 14 of the city's 15 aldermanic districts.

The area of asphalt removed so far is equivalent to the entire footprint of the Fiserv Forum, the Deer District, and the adjacent vacant lot where the Bradley Center once stood — combined.

Thousands of students are daily impacted by rejuvenated surroundings, attracting public health researchers to quantify the benefits of these urban oases.

Five new schools are slated — and funded — to construct their "green and healthy" schoolyards in summer 2024. Another five schools are already raising funds for 2025, and five more drawing up community-based conceptual designs for construction in 2026.

Every fall, over a dozen Milwaukee Public Schools (MPS) apply to join the multi-year process currently with capacity to add five new schools per year.

With 41 of MPS's 140 school properties now in a community-supported process touted as a local success, advocates are calling to find resources to double the pace from five schools per year to 10.

Milwaukee's leadership attracted delegates from



Participants in the Children & Nature Network annual conference at Milwaukee's Kluge Elementary in May 2024 consider the giant bioswale cut into the middle of an asphalt expanse.

a dozen cities on May 28, 2024 as part of the Children & Nature Network's annual conference, held this year in nearby Madison.

Over 40 guests toured three MPS schoolyards across the city — Clement Avenue, German Immersion, and Richard Kluge. The schools represented different cohorts, highlighting lessons learned over the years.

At first glance, the green spaces were striking for their contrast with the asphalt-and-chain-link status quo. Bioswales — vegetated depressions engineered to manage water — are cut into the ground in kidney-bean curves. Visitors browsed verdant native plants soaking up water and attracting bees and butterflies, observed children using nature-based play structures hewn from black locust logs, and gathered beneath shade structures to learn about MPS's climate curricular alignments.

For many who had never visited Milwaukee, it was an excellent first impression.

How has Milwaukee made the magic happen?

Two key factors are widely credited: the Milwaukee Metropolitan Sewerage District (MMSD)'s investment in green stormwater infrastructure and the catalytic work of the Milwaukee nonprofit Reflo, which connects the school district to partners and resources to support long-term success.

MMSD has set the framework for collaboration and injects public dollars into project elements that manage water.

But multiple observers said Milwaukee's "secret sauce" is the nonprofit Reflo, a nine-person team led by environmental engineer Justin Hegarty.

Incorporated in 2013, the organization (pronounced "Re-flow") evolved from building rainwater harvesting systems for urban agriculture to its emphasis on greening schoolyards.

Reflo has repeatedly won the MMSD-issued contract to support conceptual design projects for MPS, working hand in hand with individual school communities. In a phased process, Reflo then supports fundraising efforts and coordinates with contractors and facilities staff.

The nimble group also helps schools maintain their green infrastructure. Reflo works with MPS to host summer high school internships. Interns pull weeds, maintain trails, and learn about jobs that keep these spaces vital.

Milwaukee's work — and its emphasis on partnerships — offers lessons for cities across the country.

In 2021, the Children & Nature Network hosted a peer learning exchange with teams from 11 cities. Milwaukee's team included MPS, Reflo, and MMSD representatives.

"In many ways Milwaukee is where a lot of teams would like to be," said Mikaela Randolph, then-green schoolyards technical consultant for the Children & Nature Network. "It'd be great to have a school selection process that feels open and transparent. It'd be great to have a healthy and green schools consortium that has a one-day conference on an annual basis. Because what those types of activities do is to amplify that this work is really important."

Cameron Steinback, program manager for Seattle-based nonprofit Earth Gen, whose work is similar to Reflo's, toured Milwaukee as part of the 2021 peer learning exchange. He said Seattle is learning from Milwaukee how to take a comprehensive approach to ensure its outdoor environmental learning spaces prioritize community needs. He said Milwaukee should be proud of its "incredibly inspiring" work. "The people there [in Milwaukee] have done such an excellent job and they're actually ahead of the curve," Steinback said.

In 2022, voters in the City of Austin, Texas, approved a $2.4 billion bond to modernize 26 of its 130 schools over five years, said Colleen Garland, Austin's outdoor learning specialist, including shade tree planting, green stormwater infrastructure, and outdoor learning spaces.

Garland's colleague Yasmine Anderson, who coordinates Austin's Cities Connecting Children to Nature program, said Austin is missing an entity like Reflo to help hold collaborations together and support long-term community stewardship. "We're missing that piece," she said. "We're still at the evolution phase."

Representatives from other cities pointed to other inspirations from Milwaukee's model.

The cohesion of Milwaukee's partner relationships impressed Sprinavasa Brown, co-founder and executive director of ELSO, a nonprofit based in Portland, Ore. "I think that's the key part," Brown said.

Public use of Milwaukee's schoolyards beyond school hours impressed Jac Kyle, who works through the Detroit Recreation Department to provide outdoors access to urban youth. "I love the fact that these are open after hours — that increased access," Kyle said.

Physical accessibility impressed Ingrid Kanics of Kanics Inclusive Design Services based in North Carolina, who toured Milwaukee's green schoolyards in a wheelchair. "You can do nature play and accessibility," Kanics said. "You just need to be really intentional about it."

“IN MANY WAYS MILWAUKEE IS WHERE A LOT OF TEAMS WOULD LIKE TO BE. IT’D BE GREAT TO HAVE A SCHOOL SELECTION PROCESS THAT FEELS OPEN AND TRANSPARENT. IT’D BE GREAT TO HAVE A HEALTHY AND GREEN SCHOOLS CONSORTIUM THAT HAS A ONE-DAY CONFERENCE ON AN ANNUAL BASIS. BECAUSE WHAT THOSE TYPES OF ACTIVITIES DO IS TO AMPLIFY THAT THIS WORK IS REALLY IMPORTANT.”

Delegates from a dozen U.S. cities pose for a group photo at Kluge Elementary in May 2024. Many sought to learn from or emulate Milwaukee’s model for greening urban schoolyards and connecting outdoor learning and play.



Aerial view of Milwaukee's German Immersion School in 2020.

photo courtesy Reflo

WCMP did not fund the drone photography.

Outdoor learning opportunities on display at Milwaukee's German Immersion School impressed Sheldon Cox, director of career and technical education at Rochester City School District. "It gives me a different perception to expand learning beyond the four walls of the classroom," Cox said.

Ninety miles to the south, Chicago is also greening schoolyards at a similar scale and pace, though Chicago's population is almost five times Milwaukee's.

Chicago has a different funding model, said Claire Marcy with Healthy Schools Campaign, who manages Chicago's Space to Grow program in partnership with the regional nonprofit Openlands.

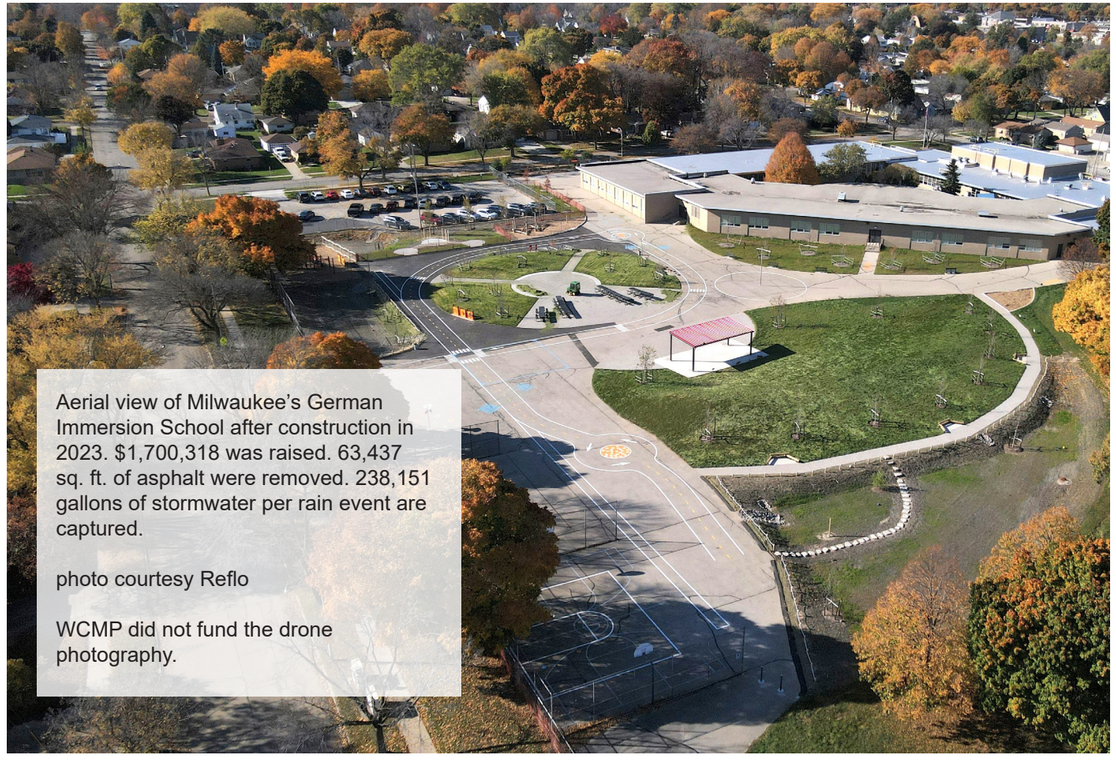
In Chicago, Marcy said dedicated capital funding flows from three partner agencies: Chicago Public Schools, the Department of Water Management, and the Metropolitan Water Reclamation District — under an EPA consent decree to build green stormwater infrastructure to help manage flood risk.

So far Chicago has upgraded 34 schoolyards, with three more in design in 2024. Looking ahead, Marcy said Chicago can count on a $48 million commitment from the three public agencies for its second phase.

Scrappy Milwaukee raised its own funds — with Reflo taking an active role in fundraising.

As of 2024, MMSD Green Solutions and Green Infrastructure Partnership Project dollars accounted for 40% of project costs, 21% flowed from various foundations, 16% from private grants, and 11% from government grants. School fundraisers, individual school accounts, and MPS budgets accounted for over 5% and the City of Milwaukee funds almost 4%.

Investment by Fund for Lake Michigan, a private foundation, accounted for less than 2% overall but represented flexibility critical to success. "Private philanthropy helps us connect the dots," Reflo's Hegarty said.



Aerial view of Milwaukee's German Immersion School after construction in 2023. $1,700,318 was raised. 63,437 sq. ft. of asphalt were removed. 238,151 gallons of stormwater per rain event are captured.

photo courtesy Reflo

WCMP did not fund the drone photography.

With neither mandate nor guarantee, MPS and its partners raised over $30 million from diverse sources.

"Each of our funding sources is identifying the things that are important to them," said Heather Dietzel, MPS Facilities and Maintenance sustainability project manager. "So, what Justin and I and Reflo do is piece together everything so we can have a comprehensive program."

In aging cities facing stormwater challenges, managing water is a motivation for public partners. But the benefits of greener schoolyards extend beyond stormwater management.

Perceived benefits of outdoor learning at schools include enhanced mental health and wellbeing, a deeper connection to nature, physical and socio-emotional development, and physical health, according to over 550 respondents to a nationwide survey of schools conducted by Luke Parker, doctoral student at University of Kansas.

Health researchers in Milwaukee are leading the field to help quantify benefits — like improved physical and socioemotional health of young people — that could attract new institutional partners motivated by health equity.

The Medical College of Wisconsin is one of the partners measuring the impact of greening schoolyards. Jean Bikomeye, a recent doctorate working on the research there, said Milwaukee has "decoded the code" for how to leverage partnerships at intersection of climate resilience, environmental justice, and health equity. "I think the work in Milwaukee — it's unique across the country," said Bikomeye.

Groups Promote Equitable Water Access and Recreation



Blue lights illuminating the Hoan Bridge are reflected on Milwaukee's inner harbor.

FOR FATHER'S DAY A FEW YEARS AGO, NORA GODOY-GONZÁLEZ TREATED HER PARENTS TO A DUFFY BOAT PONTOON RIDE ON THE MILWAUKEE RIVER. THOUGH MILWAUKEEANS SINCE THE EARLY 1990S, IT WAS THEIR FIRST TIME ON A BOAT HERE.

"We were listening to all the Mexican corridos on blast — all the while people staring at us," Godoy-González said with a laugh. "Drinking our chelas — it was such a beautiful moment and I'll never forget it."

As a first-generation daughter of immigrants from Central Mexico, Godoy-González brings a personal passion for connecting people to the water in her job as placemaking director at the nonprofit Harbor District, Inc.



Models wearing Native Nations designs of Sabrina Lombardo walk the runway during Indigenous Elegance at Harbor View Plaza on June 14, 2024. Sponsored by a grant by Joy Engine and organized by the nonprofit Harbor District, Inc., it the first ever fashion runway event by the water anywhere in Milwaukee.

Harbor District is among a bevy of groups working to welcome more Milwaukeeans of all colors, languages, cultures, ages, and identities to the water.

Indigenous Elegance, a fashion show at Harbor View Plaza held June 14 — Milwaukee's first outdoor runway event anywhere along the water — is just one example.

Featuring models wearing the Native Nation Designs couture of Sabrina Lombardo — a proud member of the Tarahumara and Tigua tribes and first graduate of the Edessa School of Fashion — the free event also included local Indigenous craft and food vendors.

Godoy-González also organizes Summer en la Plaza at Harbor View Plaza, 600 E. Greenfield Ave. — free activities ranging from dance, drumming, painting, and poetry.

"I think the biggest thing is people being able to see themselves in these spaces," Godoy-González said. "That authenticity piece has to be there in order for spaces like Harbor View Plaza and the lakefront to be really enjoyed by people of color — people who have been here for generations."



Designer Sabrina Lombardo, left, waves at Harbor View Plaza on June 14, 2024.



A photographer captures the fashion of designer Sabrina Lombardo at Harbor View Plaza on June 14, 2024.

"I THINK THE BIGGEST THING IS PEOPLE BEING ABLE TO SEE THEMSELVES IN THESE SPACES," GODOY-GONZÁLEZ SAID. "THAT AUTHENTICITY PIECE HAS TO BE THERE IN ORDER FOR SPACES LIKE HARBOR VIEW PLAZA AND THE LAKEFRONT TO BE REALLY ENJOYED BY PEOPLE OF COLOR — PEOPLE WHO HAVE BEEN HERE FOR GENERATIONS."



Local resident Damaris Santiago Laureano enjoys the festive atmosphere with a glamorous selfie during the Indigenous Elegance fashion show at Harbor View Plaza on June 14, 2024.

Indigenous Elegance



Cristina Bukowski makes frybread during Indigenous Elegance at Harbor View Plaza on June 14, 2024.



Melissa Lombardo, Indigenous flutist, performs at Indigenous Elegance at Harbor View Plaza on June 14, 2024.



A model strikes a pose on the runway.



Katie Latisha, a fashion designer and beadwork artist who is Gullah Geechee and Polish, shows her beadwork during Indigenous Elegance at Harbor View Plaza on June 14, 2024.

A close-up of beadwork by Little Earth Creations.



Felonee Marie Webster of Felonee Marie Artistry shows crocheted crafts including an octopus as part of Indigenous Elegance at Harbor View Plaza on June 14, 2024.



Niesh Kinnebrew, an Afro-Anishinaabe creator, shows beadwork from her business Little Earth Creations as part of Indigenous Elegance at Harbor View Plaza on June 14, 2024.

BETH HANDLE HAS OWNED AND OPERATED MILWAUKEE KAYAK COMPANY FOR 12 YEARS. SHE'S WITNESSED A MAJOR INCREASE IN PEOPLE ON THE WATER OVER THAT SPAN — PLUS A WAVE OF MORE DIVERSE BOATERS SINCE THE PANDEMIC. "I DON'T REMEMBER IT EVER BEING AS BUSY AS IT IS RIGHT NOW," HANDLE SAID.



Beth Handle


FunkToon

Kayaking is another opportunity to draw diverse demographics to the water. Partnering with Milwaukee Kayak Company, Harbor District hosted bilingual kayak tours starting from Harbor View Plaza's accessible launch.

Beth Handle has owned and operated Milwaukee Kayak Company for 12 years. She's witnessed a major increase in people on the water over that span — plus a wave of more diverse boaters since the pandemic. Handle started her business with just 12 kayaks. Now it has dozens. "I don't remember it ever being as busy as it is right now," Handle said.

Beyond individual outings, going kayaking in Milwaukee has become a summer social activity coupled with waterside beverages and entertainment.

Every Wednesday evening, the "Milwaukee River Roundup" features a veritable flotilla of Handle's kayaks paddling from Twisted Fisherman on the Menomonee River up to The Harp on the Milwaukee River.

On June 12, some 70 paddlecraft schooled together following the "Funktoon," a pontoon boat carrying a different live band every week.


Paddlers during the Milwaukee River Roundup on June 12, 2024.

About 70 paddlecraft followed the Funktoon during the Milwaukee River Roundup sponsored by Milwaukee Kayak Company with support from Joy Engine on June 12, 2024. View is south from the St. Paul Street Bridge.

As an increasing variety of recreational boats ply Milwaukee's summer waters — kayaks, fishing boats, jet skis, rowing crews, pontoon boats, sailboats, dinner boats, and now even cruise ships — crowding and boater awareness sometimes lead to tension on the waves.

Kristen Scheuing, president of the Irish Currach Club of Milwaukee, has been rowing the club's currachs — traditional canvas-bottom boats rowed by a team using bladeless oars — since 1999. She prefers to avoid the Milwaukee River and row the open waters of Lake Michigan.

Some powered boats fail to observe the five-knot no-wake limit inside the breakwater, Scheuing said, recounting multiple close calls including an incident when their boat was targeted with spray by jet skiers.

"The boat traffic is crazy," Scheuing said. "I mean, if Vista King doesn't know how to maneuver around me, I know for sure a pedal tavern isn't going to, or the pirate boat, or any of those booze cruises."

At the same time, getting more people comfortable on the water — especially young people in human-powered boats — is part of their club's mission.

For the past four summers Milwaukee Currach has partnered with fellow nonprofit All Hands Boatworks to get kids out on the water in boats that youth make themselves. They launch from the Emmber Lane public boat ramp, an Urban Water Trail access point near where All Hands Boatworks has a small boatyard.

All Hands Boatworks, based out of an industrial building near 12th and Bruce Street, runs other boat-building projects for youth. Patrick McBriarty manages the group's new 15-week On the Water internship program, started spring 2024 to connect urban youth with maritime career opportunities.

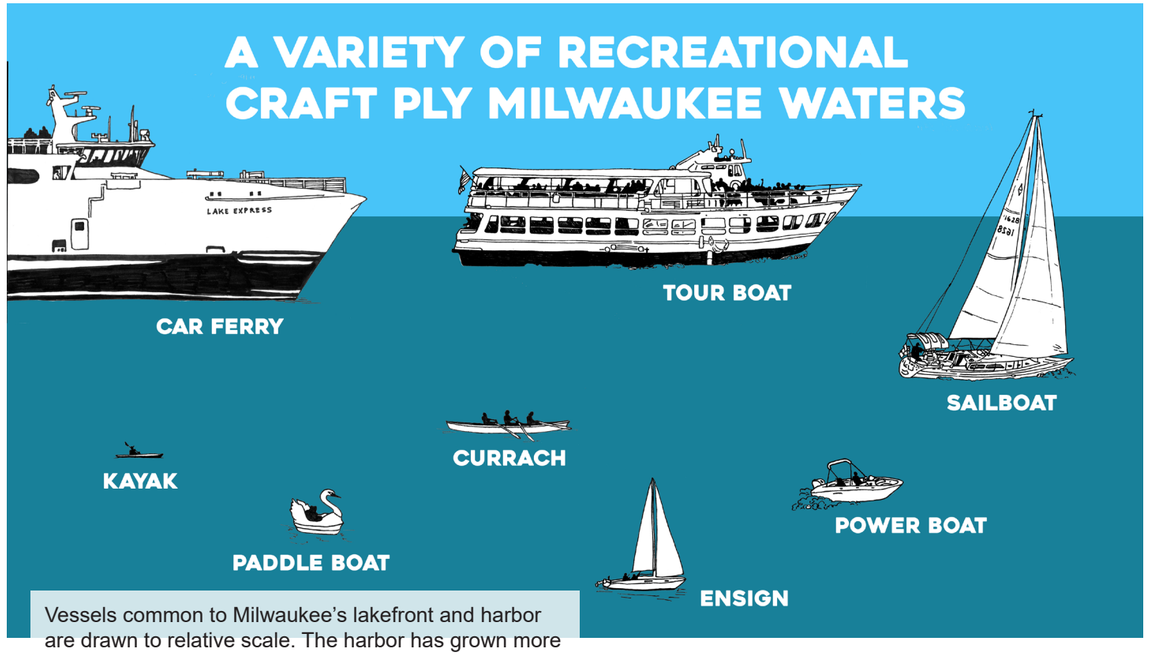
"THE BOAT TRAFFIC IS CRAZY," SCHEUING SAID. "I MEAN, IF VISTA KING DOESN'T KNOW HOW TO MANEUVER AROUND ME, I KNOW FOR SURE A PEDAL TAVERN ISN'T GOING TO, OR THE PIRATE BOAT, OR ANY OF THOSE BOOZE CRUISES."



People try out rowing a currach at Milwaukee Irish Fest in August 2023.



The Irish Currach Club of Milwaukee was founded in 1989. The traditional boat is wood framed with canvas bottom and rowed with bladeless oars.



Vessels common to Milwaukee's lakefront and harbor are drawn to relative scale. The harbor has grown more densely used by recreational vessels in recent years.

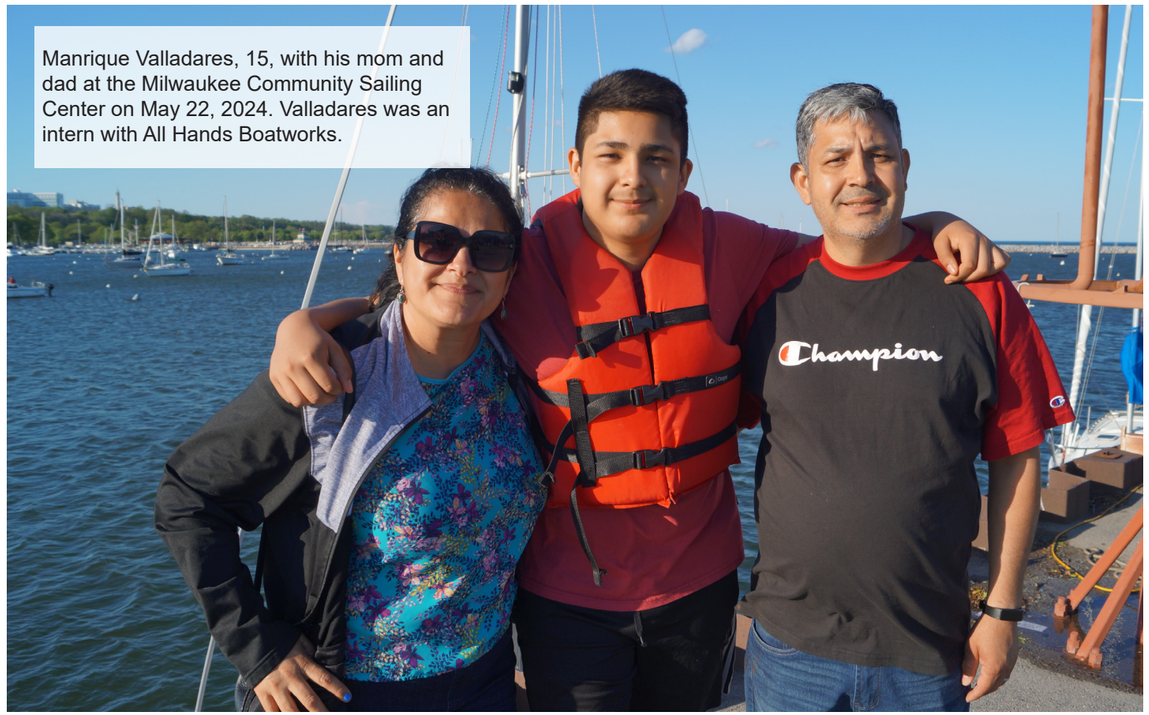
Sailboats near the Milwaukee harbor's north gap.

photo @Eric Halvie

WCMP did not fund the drone photography.



Interns in the nonprofit All Hands Boatworks' RAFT program carry the rowboat they made together, christened the Green Heron, just prior to launching the vessel -- a five-person dory where four rowers each are responsible for one oar -- at the Milwaukee Community Sailing Center on May 22, 2024.



Manrique Valladares, 15, with his mom and dad at the Milwaukee Community Sailing Center on May 22, 2024. Valladares was an intern with All Hands Boatworks.

McBriarty grew up hanging out at yacht clubs, and wants to share his passion for boating with the next generation. "It's something that if you have access to it, you forget how difficult it is to get in," he said.

The program included sessions with Coast Guard, Milwaukee Fire Department, and crews working aboard Milwaukee dinner and sightseeing boats, plus an online boating safety certification course.

Interns overcame fears of water and explored new interests.

Evaija Hubbart, 14, never had swimming lessons. For Hubbart, paddling with McBriarty on the Menomonee River was her first time in a canoe. A water safety course required the interns to get in a pool fully clothed wearing a life jacket to face what it would feel like overboard. From braving these experiences, "I'm way less nervous than I was before," Hubbart said with a smile.

Manrique Valladares, 15, who had never been into boats, grew into a leadership role. He got interested in carpentry and appreciates the internship as something he enjoys, earns him money, and helps other people. "It's a win-win-win," he said beside proud parents on May 22, when All Hands Boatworks launched a rowboat the interns worked together to build — christened the Green Heron — at the Milwaukee Community Sailing Center.

The nonprofit sailing center's Teresa Coronado pointed to Wisconsin's Public Trust Doctrine — part of the state constitution ensuring public access to the state's waters, including filled lakebed land like where the nonprofit has a 50-year lease with Milwaukee County Parks — as a point of pride allowing for these types of activities.

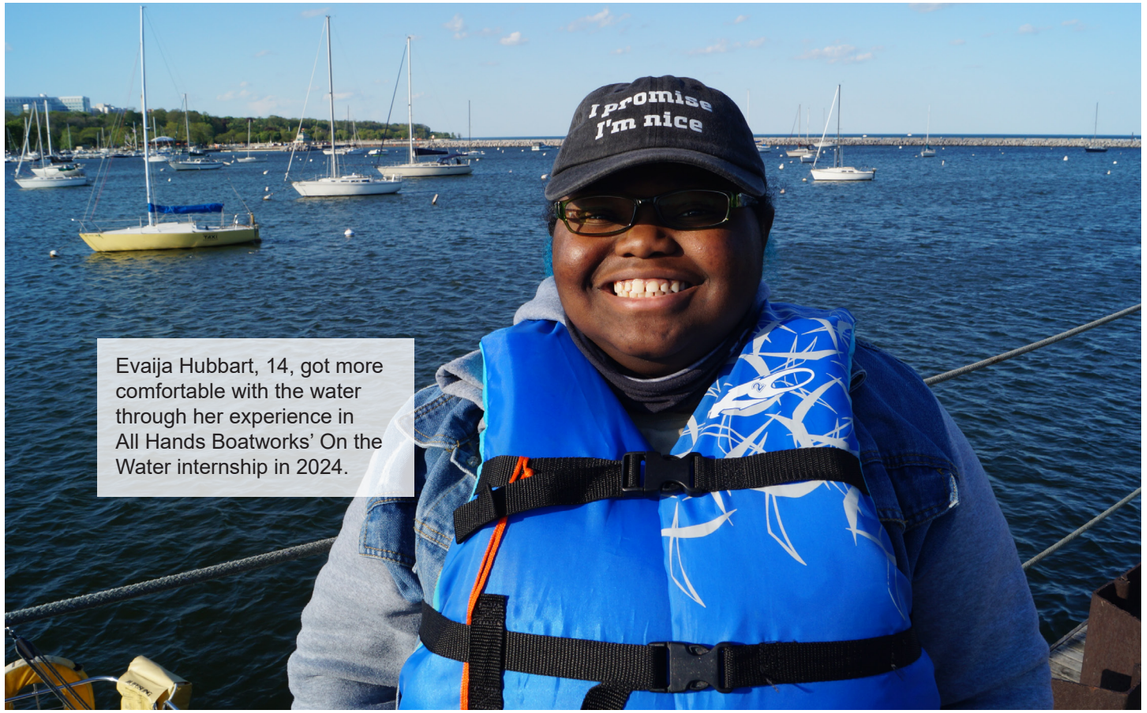
When she goes to community centers to share programming or promote water access, Coronado said she always starts by sharing her Mexican American



All Hands Boatworks interns and adult mentors hold oars beside the rowboat they built together, the Green Heron, prior to launch at the vessel's christening at the Milwaukee Community Sailing Center on May 22, 2024.



All Hands Boatworks interns row the dory Green Heron on May 22, 2024.



Evaija Hubbart, 14, got more comfortable with the water through her experience in All Hands Boatworks' On the Water internship in 2024.



Bill Nimke, executive director of All Hands Boatworks, presides at the christening of the Green Heron, the 150th vessel made by the nonprofit and its interns, on May 22, 2024.



All Hands Boatworks has a boatyard near the Emmber Lane Urban Water Trail canoe/kayak launch.



Milwaukee Riverkeeper maintains signs and a map to the Urban Water Trail. This sign marks the public access to the Menomonee River on Emmber Lane near 13th Street.

A view upstream on the Menomonee River from the Emmber Street Urban Water Trail paddlecraft launch.

identity and understanding of generational trauma around water.

It's a trauma that goes back to grandparents and parents who remember not being able to go to a pool because of discrimination against people who were Black or brown, Coronado said.

As Milwaukee County faces funding challenges, the sailing center is working with other groups to increase water comfort and safety for all.

Milwaukee Parks Foundation sponsors the Aquatic Ambassadors program to encourage people of color to become summer lifeguards with Milwaukee County Parks. In 2024, six Aquatic Ambassadors shared personal water stories on the group's website.

Milwaukee Water Commons, Milwaukee Riverkeeper, and UW-Sea Grant sponsor a Beach Ambassadors program, employing summer workers to educate beachgoers about water safety resources so they can make informed decisions about whether to swim.

Safety efforts complement physical infrastructure to accommodate people of differing abilities. In 2020, Bradford Beach was heralded as the country's most accessible beach when it installed a blue Mobi Mat atop a concrete path and four beach-accessible wheelchairs, supported by the Ability Center.

Aerial image of the McKinley Marina looking toward a cruise ship docked near Discovery World. The Milwaukee Community Sailing Center is just visible far left. Veterans Park and other filled lakebed are areas subject to the state's public trust doctrine, which reserves access for public recreational or navigational purposes.

photo @Eric Halvie

WCMP did not fund the drone photography

Angela Vickio of Wisconsin Department of Natural Resources leads a tour at Havenwoods State Forest on June 15, 2024. Havenwoods is scheduled for habitat restoration work for its woodlands, prairies, and wetlands as part of larger efforts to improve the Milwaukee Estuary Area of Concern.



Promoting equitable water access also means making residents aware of publicly accessible urban natural areas where water flows — "green and blue spaces."

On June 15, the nonprofit Nearby Nature hosted its Lincoln Creek Celebration at Havenwoods — Wisconsin's only urban state forest and free to the public. The creek flows through Havenwoods, where long-term habitat enhancement projects to woodland, prairie, and wetland are planned as part of larger efforts to rehabilitate the Milwaukee Estuary Area of Concern.

At the event, Nearby Nature speakers also highlighted Hopkins Hollow, 19 acres near 35th and Hopkins several miles downstream along Lincoln Creek.

Wisconsin Department of Natural Resources (WDNR) has worked with the group as well as UW-Milwaukee students to document wildlife here — including deer, coyote, dozens of bird species, bats, turtles, and the Butler's garter snake. Not to mention fish.

Fishing is another way Milwaukeeans of all colors share an intergenerational love of water's wonder.

For the past three years, Joseph Addison, with the group 100 Black Men for Milwaukee, has run free fishing clinics at Lakeshore State Park, partnering with WDNR to attract young people to the activity. One is planned for Sept. 7. "Fishing has no barrier," Addison said.



An older fisherman let young Elsa Godoy, Nora Godoy-González (center), and Deisy Godoy hold this fish during the girls' visit to Milwaukee's McKinley fishing pier in 2005 or 2006. Visiting Lake Michigan as a young girl was transformative for Nora Godoy-González, who now works as placemaking director for the nonprofit Harbor District, Inc. in a role that welcomes people of all backgrounds to the water.



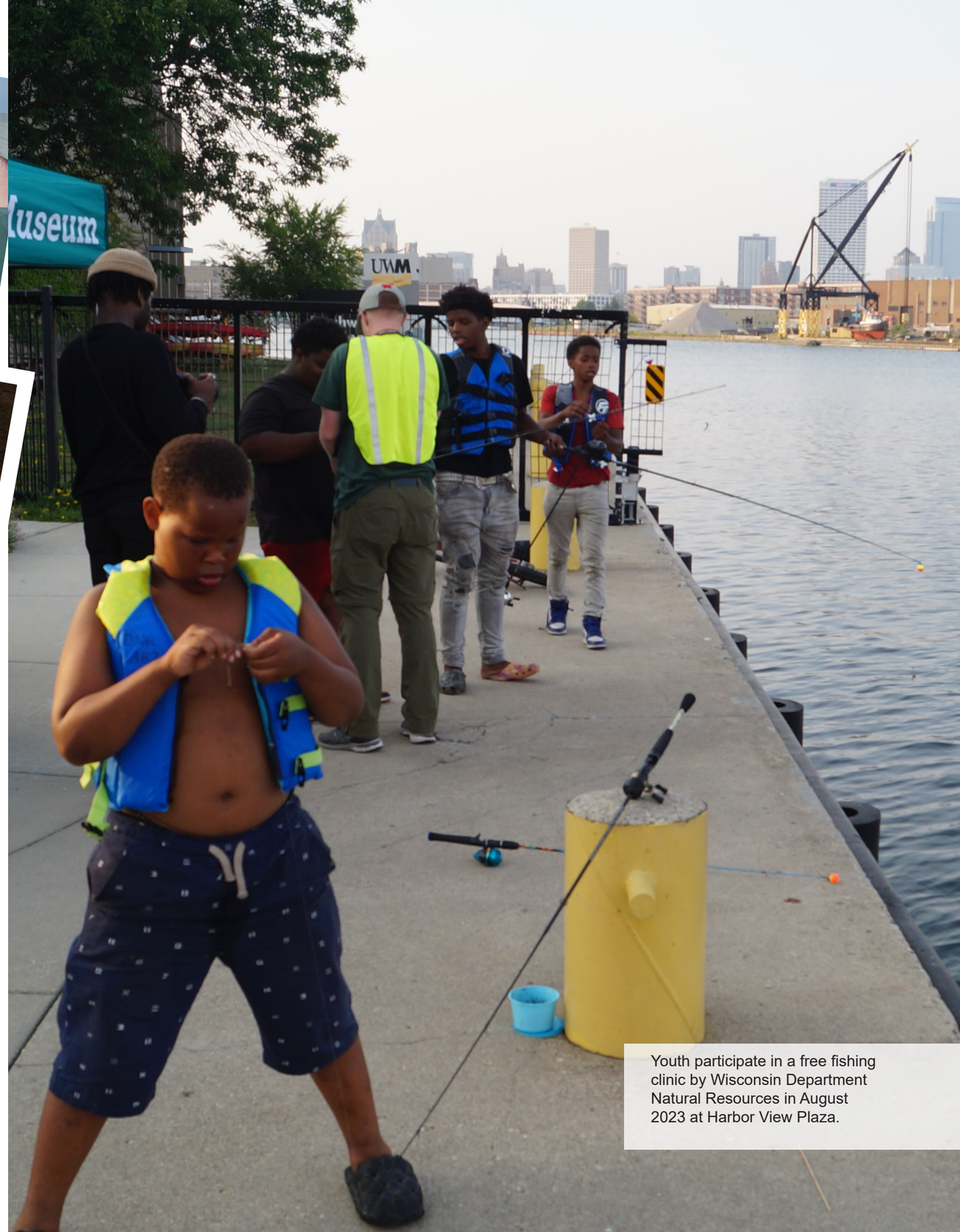


Evie Hayden holds a pinecone at Havenwoods State Forest on June 15, 2024. Her mother Kelly Hayden is co-project manager with Angela Vickio for the Milwaukee Estuary Area of Concern habitat restoration project.

Equity advocates hope the positive memories made gathering by the water — fishing, boating, or just being in nature — last a lifetime.

Some already have.

Harbor District's Godoy-González still recalls the first time she went down to Lake Michigan as a little girl. Her cousin took her to Bradford Beach for an ice cream. She felt she'd been transported from her Walker's Point neighborhood into a whole new world. was just sitting there eating my ice cream in awe," she said. "And I was like, wow, this is amazing. And I think that was the first time I truly felt connected to Lake Michigan."



Youth participate in a free fishing clinic by Wisconsin Department Natural Resources in August 2023 at Harbor View Plaza.

DO YOU BELIEVE IN BEAVERS?



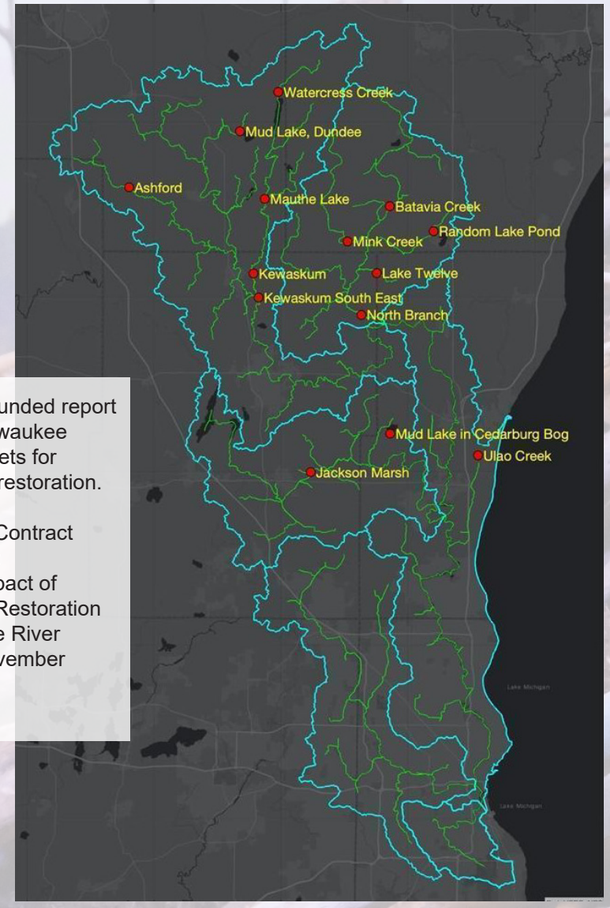
Over two dozen conservation professionals listen to Mike Engel, U.S. Fish and Wildlife biologist, who planned the beaver dam analog workshop at the Briggs Wetland, outside Beloit, in September 2024.

photo courtesy U.S. Fish & Wildlife Service

IN NOVEMBER 2020, AS THE COUNTRY BATTLED A GLOBAL PANDEMIC, A STUDY ON A QUITE DIFFERENT TOPIC WAS QUIETLY PUBLISHED ONLINE. THE 162-PAGE REPORT BY SIX RESEARCHERS FROM UW-MILWAUKEE AND TWO FROM MILWAUKEE RIVERKEEPER IDENTIFIED 14 SITES IN THE MILWAUKEE RIVER BASIN THAT POSED PRIME TARGETS FOR RESTORING BEAVER HABITAT.

WHY BEAVERS?

WHY MILWAUKEE?



A 2020 MMSD-funded report identified 14 Milwaukee River Basin targets for beaver wetland restoration.

source: MMSD Contract P-2890 “Project: Hydrological Impact of Beaver Habitat Restoration in the Milwaukee River Watershed,” November 2020

The potential benefits calculated were hydrological: 1.7 billion gallons of stormwater storage valued at $3.3 billion — almost twice the city’s annual budget. Stormwater is stored because beaver dams and the wetlands they “engineer” slow down and spread out water.

Modeling showed that reintroducing beaver wetlands upstream in the watershed — many on Milwaukee River tributaries in Ozaukee County — could reduce peak storm flows and remove 500 properties from the floodplain downstream in Milwaukee County.

For these benefits and others, the nonprofit Superior Bio-Conservancy — led by Bob Boucher, who also founded Milwaukee Riverkeeper — advocated a 900-square-mile “recovery zone” for beavers and other aquatic mammals in the Milwaukee River watershed. We wondered about follow-up since 2020: Was anyone piloting beaver projects in the Milwaukee River Basin?

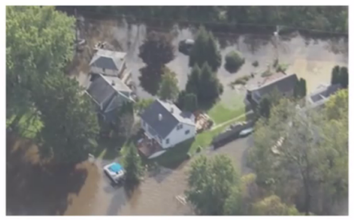
“This [2020 report] was funded by MMSD as a research project to identify possible downstream flood reductions by reintroducing beaver to the Milwaukee watershed,” wrote MMSD’s executive director Kevin Shafer in September 2024 in response to our inquiry. “Due to limited resources, MMSD has not implemented any recommendations at this time.”

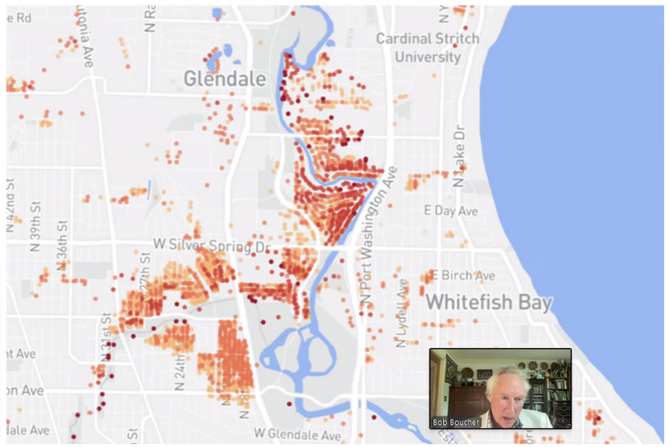
Boucher pointed to the state’s policies as a barrier to beaver projects. Wisconsin sets no bag limits during winterlong beaver hunting and trapping seasons,



Flood mitigation with beavers

500+ homes no longer in the flood plain





Peak flow reduction

Locations	Stage 1			Stage 4		
	Minimum	*Maximum*	*Average*	*Minimum*	*Maximum*	*Average*
East-West	26%	41%	33%	40%	51%	46%
North	21%	37%	26%	31%	47%	36%
Cedar Creek	40%	42%	41%	46%	50%	48%
Menomonee	9%	11%	10%	18%	23%	20%
South	28%	42%	33%	38%	50%	44%
Thiensville	27%	41%	33%	39%	50%	44%
Brown Deer	27%	41%	33%	39%	50%	44%
Glendale	27%	41%	33%	38%	50%	44%

The beaver dam and lodge exhibit at the Milwaukee Public Museum.

requires neither permits nor limits to landowners removing beavers deemed a nuisance, and does not require individuals to report a beaver harvest.

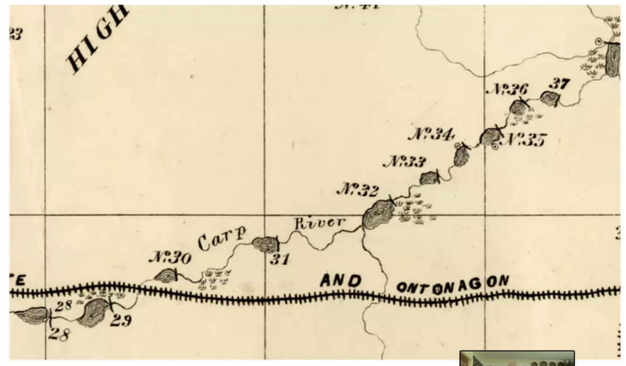
In August 2023, Boucher's group filed a lawsuit over Wisconsin's beaver policy. They argued it was time to incorporate the latest science into the Environmental Assessment (EA) — last updated in 2013 — informing the state's beaver management plan. The lawsuit included myriad references suggesting the many benefits beavers offer as "ecosystem engineers" and "keystone species" — slowing down flows, recharging groundwater, adding habitat for other species, and providing refuge for wildlife from wildfires.

The lawsuit was filed against the U.S. Department of Agriculture (USDA) for "Killing 28,141 Beavers, 1,091 River Otters, and Destroying 14,796 Beaver Dams in 10 Years Funded by the Wisconsin Department of Natural Resources."

The USDA's Animal and Plant Health Inspection Services, or APHIS, has a contract with WDNR to lethally manage the state's beaver population with an estimated $500,000 annual cost.

Late in 2023, USDA announced it would review the EA for Wisconsin. An update may be available in November 2024, according to Dan Hirchert, USDA APHIS state director.

All rivers within the Great Lakes Watershed in pre-settlement had a beaver pond structure like this. This is a map of beaver ponds (numbered) on the Carp River, published by Henry Morgan 1868, Ishpeming Mich.



MMSD Green Infrastructure Goals

Storm Water, Valued at $1.95 per gallon

Total Full Storage (acre –ft.)	5266
Total Full Storage (Billion Gallons)	1.7159314
Total Half Storage (Acre –ft.)	1683
Total Half Storage (Million Gallon)	548.40723

MMSD GIBB Program Value with full storage

$3,346,000,000 = Stormwater Ecosystem Services

Screen captures of Bob Boucher's slides from the 2024 Midwest Beaver Summit.

Meantime, momentum is building among so-called "beaver believers." The self-applied term refers to a loosely affiliated network of environmental practitioners and advocates embracing beaver coexistence strategies.

On Aug. 28, 2024, 1,200 people logged onto Zoom for the second annual Midwest Beaver Summit, maxing out the event's virtual capacity. Hosted by the Superior Bio-Conservancy and Illinois Beaver Alliance, it featured a range of speakers, with a keynote address by Dr. Emily Fairfax from the University of Minnesota.

In an interview, Fairfax called the 2020 MMSD report "really significant."

She said beaver flood mitigation is understudied, but where it has been in the U.K. and Canada, "they're finding absolutely incredible" reductions in flood waves by beaver ponds: "huge storms, hundred-year storms, hitting [beaver] complexes and barely breaching any of them." Flood waves that do pass downstream are less powerful, she said.

Fairfax stressed the need for more research to support 21st-century beaver policy across the Midwest.

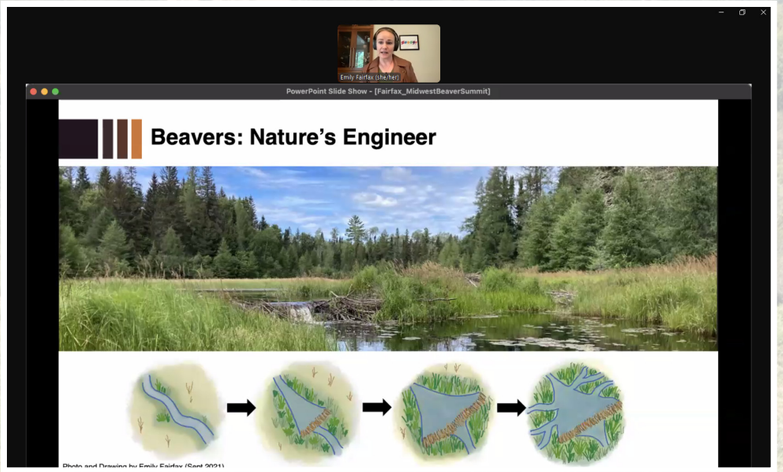
"There's just very little data in [Wisconsin] on what beavers are doing, what they're not doing, what their historical distribution was, what is their relationship to fish," Fairfax said.

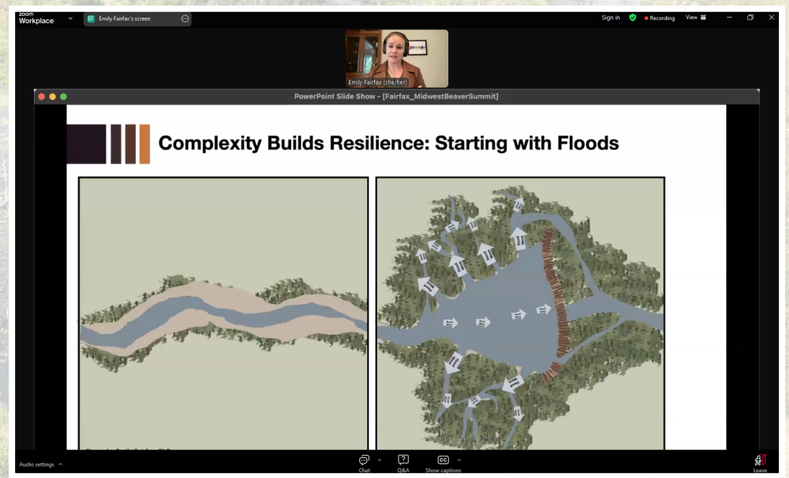
When it comes to managing Wisconsin's cold water streams for trout, beavers elicit polarizing viewpoints.

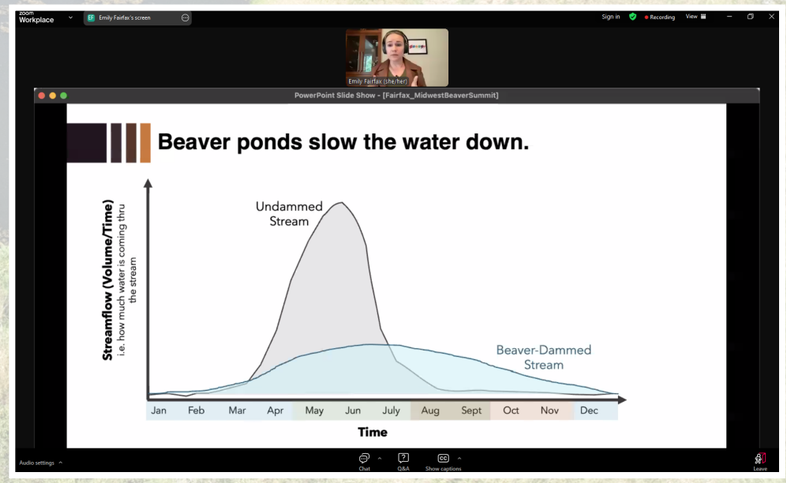
"The big challenge and the hurdle there is just this idea that the fish folks believe beaver dams and beaver dam analogs are impediments to fish mobility and fish passage" and cause "potential thermal negative impacts to cold water fisheries," said Clay Frazer, who leads the Madison-based environmental restoration firm Native Range Ecological.

Those inferences are based on one WDNR fisheries study published in 2002, which has been widely criticized by beaver believers who point to newer research that suggests more complex relationships.

"THERE'S JUST VERY LITTLE DATA IN [WISCONSIN] ON WHAT BEAVERS ARE DOING, WHAT THEY'RE NOT DOING, WHAT THEIR HISTORICAL DISTRIBUTION WAS, WHAT IS THEIR RELATIONSHIP TO FISH," FAIRFAX SAID.







Screen captures of Emily Fairfax's slides from the 2024 Midwest Beaver Summit.

“TROUT STREAM PROTECTION TAKES PRECEDENT OVER PROTECTION OF BEAVER ON HIGH-QUALITY TROUT STREAMS. REDUCED BEAVER POPULATION HAS OCCURRED…”

– WISCONSIN DEPARTMENT OF NATURAL RESOURCES

WDNR is currently amid a new statewide study, started in July 2018 and running through June 2026, to gather updated data on how beavers influence cold water stream habitat and trout populations in Wisconsin.

According to WDNR’s principal researcher Dr. Matthew Mitro, the study spans 48 trout streams across the state, 23 where beaver control was removed (with beavers building dams on 18), paired with 24 control streams (18 of those without beaver dams).

Data were not yet publicly available.

In response to emailed questions, a WDNR spokesperson summarized the state’s current policy: “Trout stream protection takes precedent over protection of beaver on high-quality trout streams. Reduced beaver population has occurred. Maintenance of a stable beaver population is desired.”

For many beaver believers, current state policy is detrimental and the new WDNR study does not go far enough.

“It’s not a bad study, it’s just a very myopic study,” said Courtney Dean, PSM Conservation Biology graduate student at UW-Stout speaking at the August 2024 summit. “And the concern is that this limited-scope study is going to be informing beaver policy for the next 10, 20, 50 years here in the state.”

While beavers are provoking policy conflict, they are also inspiring local cooperation — and providing a reminder that beaver and trout, two species that co-evolved for millennia, can coexist.

In September 2024, a few dozen conservation professionals gathered to participate in a “beaver dam analog” workshop just outside Beloit, Wis.



A beaver dam on the East Branch of the Raccoon River, adjacent to the Briggs Wetland near Beloit, Wis. in April 2024. The river is known brook trout native to Wisconsin.

“THE CONCERN IS THAT THIS LIMITED-SCOPE STUDY IS GOING TO BE INFORMING BEAVER POLICY FOR THE NEXT 10, 20, 50 YEARS HERE IN THE STATE.”

– COURTNEY DEAN SPEAKING AT 2024 MIDWEST BEAVER SUMMIT

Organized by Mike Engel, a Madison-based biologist with U.S. Fish and Wildlife Service, the collaborative learning exercise followed over a year of prep work and trust-building.

At the Briggs Wetland, a 24-acre site owned and managed by nonprofit The Prairie Enthusiasts, it's just a short muddy hike to the East Branch of the Raccoon River, where beavers have already built dams on a stream recognized for its native brook trout.

Briggs Wetland was historically a sedge meadow. Later, ditches were dug to drain artesian springs to dry out the spongy land for cattle grazing. Engel thought this made the site ideal: To improve the ecology, they could modify the ditch that feeds the river, but without using heavy machinery that could disrupt the wetland.

Building "beaver dam analogs" or "BDAs" takes a lesson from "nature's engineers": teams of humans pounded wooden posts into banks and weaved willow stakes across in an effort to slow flow, trap sediment, and encourage water to enter the ground.

"Even though we're in a rural area, the same principle applies," Engel said. "We don't necessarily want that spring water going immediately to the trout stream. What we'd like for it to do is saturate the ground and slowly trickle and be filtered in before it gets to the trout stream."

In September, Engel's assembled teams built multiple BDAs and will return to observe how the site responds over time. The hands-on learning opportunity was intended to provide natural resource managers with BDA familiarity and model how to engage youth and the public in nature-inspired land stewardship.

BDAs like those at Briggs Wetland and "flow devices" such as "pond levelers" — structures placed in streams to allow beavers to build dams but keep water

"WE DON'T NECESSARILY WANT THAT SPRING WATER GOING IMMEDIATELY TO THE TROUT STREAM. WHAT WE'D LIKE FOR IT TO DO IS SATURATE THE GROUND AND SLOWLY TRICKLE AND BE FILTERED IN BEFORE IT GETS TO THE TROUT STREAM."

– MIKE ENGEL, U.S. FISH & WILDLIFE BIOLOGIST



Building a beaver dam analog by hand at Briggs Wetland in September 2024.

photos courtesy U.S. Fish & Wildlife Service



Willow is woven between posts for this BDA.



Conservation professionals from different entities and parts of the state worked together to build and document multiple BDAs at Briggs Wetland. They will revisit the site to observe changes over time and use what they learn to inform other projects appropriate for hands-on nature-based practices.

photo courtesy U.S. Fish & Wildlife Service



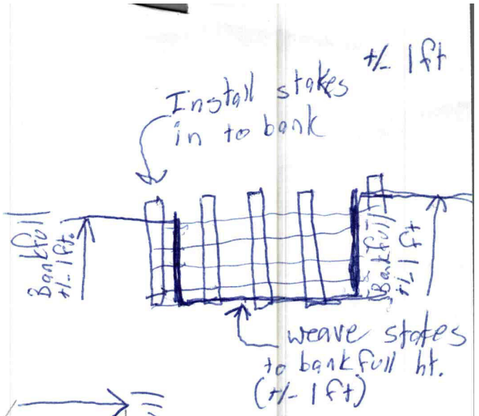
This team's BDA construction at Briggs Wetland, with their design notes on the facing page.

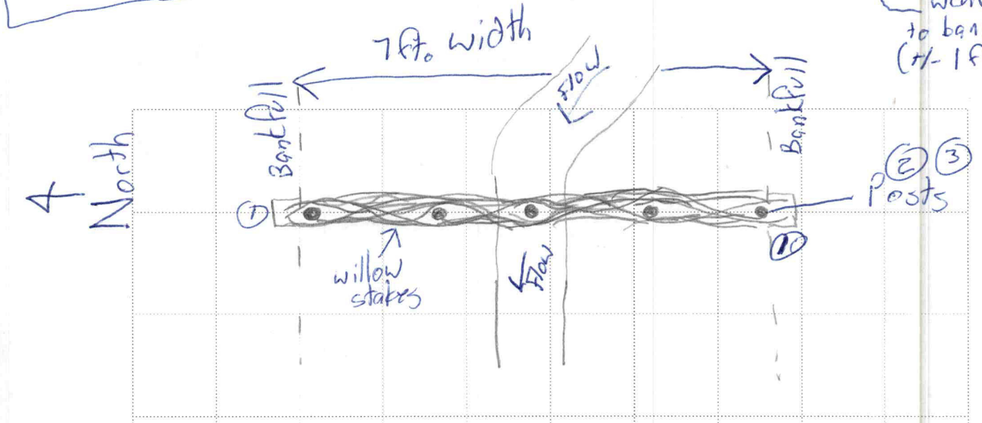
photo courtesy U.S. Fish & Wildlife Service

Conceptual Plan (30%) of your BDA

Take Photos Upstream, Downstream, & cross section

Site 5





(1) – Hand dig trench 8 inches wide to key into bank +/- 8 inches

(2) – Place 5 posts +/- evenly spaced. accross channel

(3) – Pound posts +/- 2 ft. deep

(4) – weave willow stakes in 6" flight

(5) – use excavated herbaceous & soil material to place on top of first 6" flight +/- 6" of earth material

(6) – weave stakes perpendicular & horizontal to flow +/- 6" ht.

(7) – ~~weave~~ place grass blanket over stakes. Compact by jumping.

(8) – Repeat until desired ht. is achieved 5

*Note: key stakes into bank when possible: 3 to 6"

Drone photo of a BDA at the Briggs Wetland in September 2024.

photo courtesy Ducks Unlimited

The Briggs Wetland ditch in September 2024 during the beaver dam analog workshop. View is to northeast.

photo courtesy Ducks Unlimited



The Briggs Wetland ditch with East Branch of Raccoon River beyond in April 2024. View is to southwest.

photo courtesy Ducks Unlimited



Clay Frazer poses with Daniel Fuhs during the installation of a pond leveler for a private land owner in Columbia County, Wis. in October 2023.

photo courtesy Clay Frazer

flowing to avoid damaging human infrastructure — are fairly simple structures, but complicated to permit.

Better known in other states, Wisconsin's permitting process has slowed their adoption in this state.

BDAs and flow devices require monitoring and maintenance, said Frazer, the environmental restoration professional, but are relatively inexpensive to build and deploy. However, the time and money it takes to navigate a lengthy permitting process discourages many property owners.

Frazer is working on several Wisconsin projects with motivated property owners and WDNR to streamline the permitting process.



A pond leveler being installed for a private land owner in Columbia County, Wis. in October 2023.

photo courtesy Clay Frazer



Testing the force borne by each post.



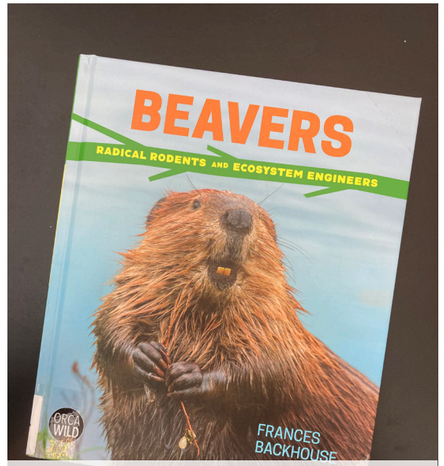
Pile driving posts for Alma Center BDA installation.

October 2024 construction photos of Jim Hoffman BDAs in Alma Center, Wis. similar to those more common to the Western and Eastern United States. BDAs are less common to Wisconsin but Native Range Ecological is among those with recent installations. Frazer hopes that projects like these can help streamline the WDNR permitting process.

photos courtesy Clay Frazer



Mike Cheslik's farcical Wisconsin film, Hundreds of Beavers, showed at Milwaukee's Oriental Theater.



Milwaukee Public Schools added Frances Backhouse's book on beavers to its climate curriculum resources.

"IF WE WANT TO PROTECT OUR WATER, PROTECT OUR WILDLIFE, AND PROTECT OURSELVES," BOUCHER SAID, "THE CHEAPEST, FASTEST SOLUTION THAT WE CAN DO TO THIS COUNTRY'S WATERWAYS IS TO EMBRACE — AND ACTUALLY INCENTIVIZE, ESPECIALLY ON RURAL LANDS AND WETLANDS — HAVING MILLIONS MORE BEAVERS."



Sign along the Hank Aaron Trail by the Menomonee River notes beaver presence.



Beaver art on the Kinnickinnic River Trail, by the river where beavers have been observed.



Fur trade exhibit in Milwaukee Public Museum notes the foundational importance for Milwaukee.

In what beaver believers call "ecological amnesia," we often forget that Milwaukee's very existence owes itself to the fur trade — fur extracted from a teeming population of beavers, which hundreds of years ago were far more enmeshed with the story of our waters.

Beavers remain prevalent throughout the state, though population estimates are uncertain. To gain a current snapshot of the Milwaukee River Basin, Reflo invited Dr. Fairfax to use the methodology her lab has used to document beaver dams in other regions. Reviewing aerial images available through Google Earth, she identified 19 probable beaver dams in the Milwaukee River Basin — including two Ozaukee County clusters in areas that the 2020 report recommended would make good beaver wetlands.

It seems beavers agree with Milwaukee's hydrological modelers. They have colonized prime semi-aquatic real estate on their own.

Boucher, whose nonprofit is based from his River Hills home, believes the entire Great Lakes region needs "a critical pivot" in beaver policy — especially in the face of climate change.

"If we want to protect our water, protect our wildlife, and protect ourselves," Boucher said, "the cheapest, fastest solution that we can do to this country's waterways is to embrace — and actually incentivize, especially on rural lands and wetlands — having millions more beavers."

MADE IN MILWAUKEE

HOW THREE MILWAUKEE WATER-TECH BUSINESSES ARE INNOVATING GLOBAL SUSTAINABILITY SOLUTIONS



Rapid Radicals principals Will Schanen, Paige Peters, and Dylan Waldhuetter speak at an August 2023 press conference with their Torrent3 modular treatment unit at MMSD's State Street property for testing.

Three little-known Milwaukee companies that received business accelerator support from The Water Council are playing a role innovating solutions to global water sustainability problems.

The stories of Rapid Radicals Technology, WellIntel, and P4 Infrastructure illustrate ways that Milwaukee water-tech startups survived to make their first ripples in the marketplace.



Rapid Radicals CEO Dylan Waldhuetter, founder and CTO Paige Peters, and COO Will Schanen in August 2023.

Problem 1: sewer overflows during heavy rains violate regulatory requirements and contribute contaminants to surface water.

Rapid Radicals' solution: a scalable catalyst to speed up ozone-based wastewater treatment at overflow locations.

Rapid Radicals' Torrent3 system fits within a 45-foot-long shipping container. Inside, wastewater is routed through a solids filter and then three tanks where ozone is injected with a proprietary catalyst to treat the effluent to meet permit criteria. Deploying multiple systems at overflow locations is intended to alleviate pressure on wastewater treatment facilities during heavy rains.

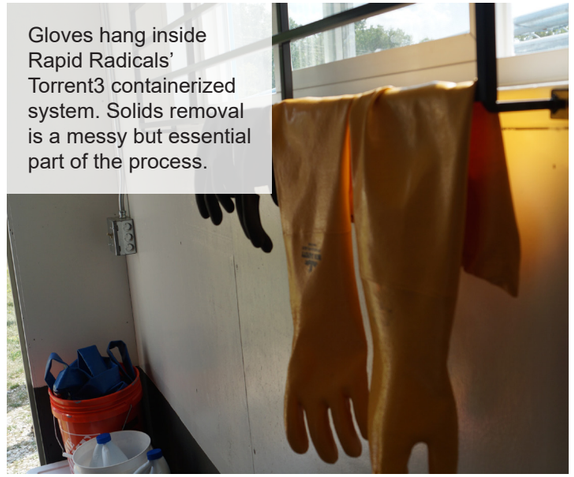
But company principals say their technology can also be adapted to augment existing treatment facility capacity, used for military or disaster-response situations as a mobile water treatment unit, or serve industrial clients with specific regulatory needs — for instance to manage PFAS or other contaminants.

Led by Dr. Paige Peters, founder and chief technology officer, CEO Dylan Waldhuetter, and chief operating officer Will Schanen, the young company has matured through a decade of research and development to the brink of commercialization.
Peters traces the company's origin story to the torrential July 2010 storm that triggered overflows and flooded basements across Milwaukee — including the basement of Dr. Daniel Zitomer, Marquette University's Water Quality Center director and then her academic mentor. It led the pair to explore how to speed up ozone treatment to help manage overflows.

Less commonly used for wastewater treatment, ozone is more commonly used to treat drinking water. After Milwaukee's 1993 Cryptosporidium episode caused the largest waterborne disease outbreak in U.S. history, for instance, Milwaukee Water Works added ozone treatment — a major reason Milwaukee's drinking water is now considered among the cleanest in the world.

But ozone treatment needs time and space. During a sewage overflow both are at a premium.

Starting in 2014 with support from the National Science Foundation (NSF), Peters and Zitomer developed a catalyst that worked in the lab. Over the years as a graduate student, Peters persisted in scaling up the technology.



Gloves hang inside Rapid Radicals' Torrent3 containerized system. Solids removal is a messy but essential part of the process.



A series of ozonation tanks inside Rapid Radicals' Torrent3 containerized system.

The result reduces treatment times that would take half a day using conventional biological methods to just half an hour.

"Rapid Radicals' patent-pending catalytically enhanced advanced oxidation process can treat wastewater to the same quality or greater than conventional treatment 20 times faster in 95% less space," according to its successful 2024 grant application to the National Oceanic and Atmospheric Administration (NOAA), one of multiple federal grants supporting the business.

NSF provided two phases of "America's Seed Fund" Small Business Innovation Research grants, totaling over a million dollars. The NOAA grant is supporting AI-assisted work to further reduce treatment times.

The Milwaukee Metropolitan Sewerage District (MMSD) has also been a key partner. From 2020 to 2022, MMSD South Shore hosted Rapid Radicals' containerized pilot system. In 2023 MMSD hosted a second scaled-up containerized system at its State Street property near the Menomonee River. In 2024, both systems were at MMSD South Shore, being used for further testing and process improvement.

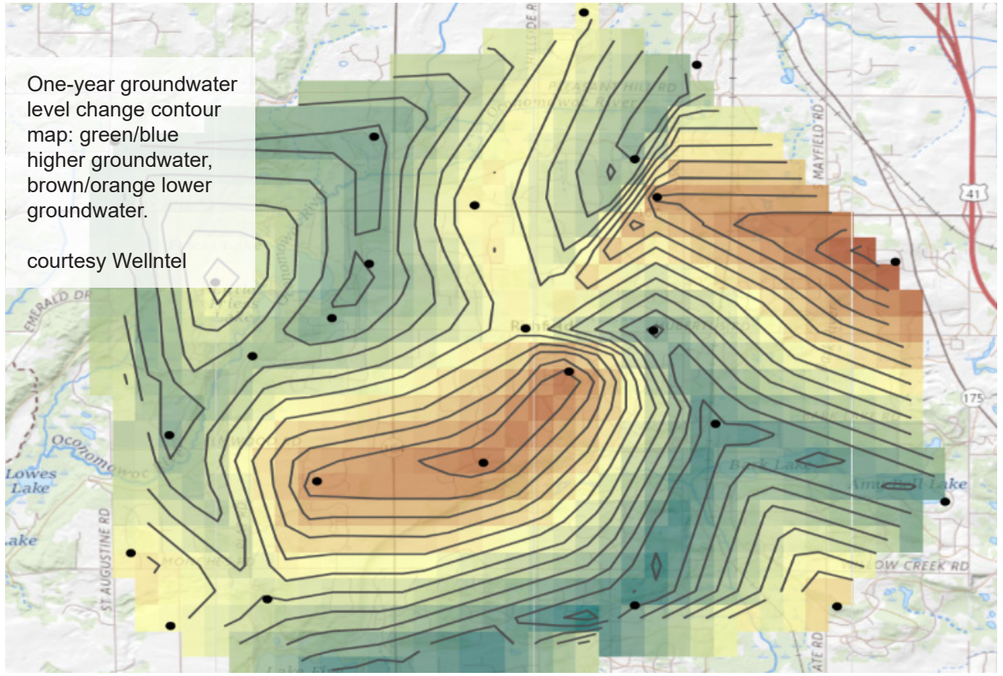
Founded in 2016 as an LLC, the company converted to a Delaware-based corporation in 2023, when it also celebrated a technology transfer agreement with Marquette University. Rapid Radicals has an office at 247 Freshwater — the Walker's Point building formerly called the Global Water Center.

Rapid Radicals' system is also participating in an NSF-funded Great Lakes ReNEW "Waste to Wealth" regional resiliency engine based from Chicago.
That work is intended to improve energy efficiency using automation and custom sensors responsive to wastewater composition.

Rapid Radicals is collaborating with Aqua-Aerobic Systems, Inc. (AASI), an advanced water treatment technology company based near Rockford, Ill., itself part of Metawater, based in Japan.

The Torrent3 system combines the two companies' technologies, Peters said, combining AASI's AquaStorm cloth media filtration technology for solids removal with Rapid Radicals' chemical oxidation process to achieve high-rate, wet-weather treatment.

"As we move the technology into the commercialization phase, we're excited by the advancement of Rapid Radicals and AASI's technologies to solve big problems with bold solutions," Peters said.



One-year groundwater level change contour map: green/blue higher groundwater, brown/orange lower groundwater.

courtesy Wellntel

Problem 2: as an invisible resource, groundwater is challenging to manage, especially as climate change stresses water-use patterns.

Wellntel's solution: subscription-based groundwater monitoring and cloud-based analytics to guide resource managers.

The company's acoustic sensors can be deployed into networks of existing wells without relying on drilling expensive dedicated monitoring wells, said Marian Singer, Wellntel CEO and co-founder with Nicholas Hayes.

Wellntel began operations in 2013, and spent three years developing the acoustic sensors which are deployed at the top of existing wells, measure water levels using sound, and transmit data via radio to an internet node connected to the cloud.

Based out of a Hamilton Street office on Milwaukee's East Side, Wellntel's eight-person team serves clients ranging from Napa Valley vineyards and Wisconsin dairies to groundwater conservation districts throughout the state of Texas.

Closer to home, the Village of Richfield deploys a Wellntel groundwater monitoring system that guides its growth plan,



Sensors on a small water utility.

photo courtesy Wellntel



Team in the field in Greece reviewing a candidate well for the Athens water utility.

photo courtesy Wellntel



Sensors on a small water utility and a vineyard in Napa.

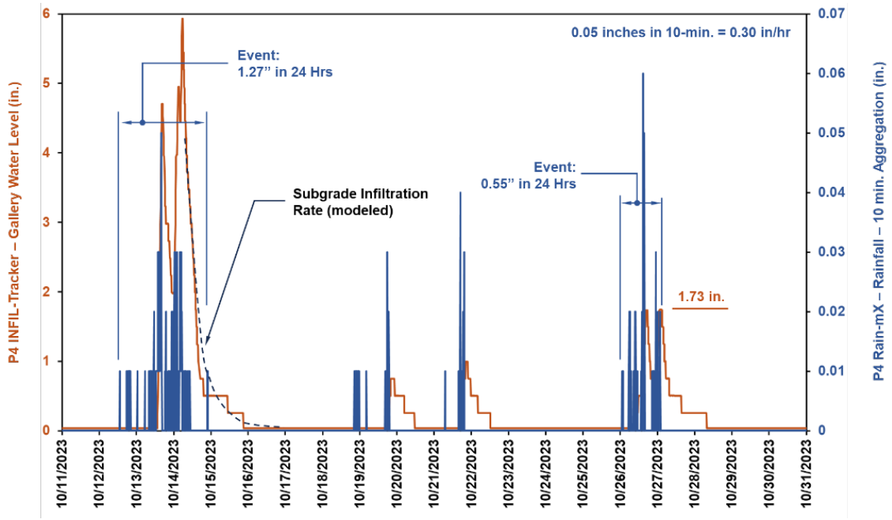
photo courtesy Wellntel

helping to inform lot sizes and coordinate with nearby Germantown, said Singer.

Milwaukee sources its drinking water from Lake Michigan but most of Wisconsin draws drinking water from groundwater wells — and Singer points to the fact that there are over 16 million existing wells throughout the United States as Wellntel's "aha moment."

"The bulk of our business is in the places where groundwater is really critical and also either managed or becoming a managed resource," Singer said. "So: California, Texas, New Mexico, Oregon, Indiana, Florida, South Carolina — places that are thinking about their water supply and how it's changing, and how they continue to ensure that down the road there is water."

In November 2024 Wellntel added as a client a water utility in Thessaloniki, Greece serving about 320,000 people. Talks were ongoing with potential clients in Mexico.



Data visualized from a porous alley in Cudahy showing four rain events (blue lines) and measuring the subterranean stone gallery water level in October 2023 (orange lines). Water moved rapidly through the gallery beneath the alley's porous pavers, infiltrating into the ground below. All the stormwater runoff was returned to the ground, managing 100% of solids and phosphorus.

courtesy P4 Infrastructure

Problem 3: water-quality benefits of green stormwater infrastructure are estimated from design specifications rather than measured from how it works in the field.

P4 Infrastructure's solution: monitoring systems that measure function to inform water-quality parameters and maintenance considerations for green stormwater management practices.

Chris Foley, a civil engineer with years of experience including at Marquette University, in 2017 teamed with two other engineers, Joe Diekfuss and Nick Hornyak, to form P4 – shorthand for "products for public-private partnerships."

Headquartered in a Brown Deer facility off 51st Street, the company builds monitoring systems for green stormwater infrastructure that integrate sensors measuring soil moisture, water levels, precipitation, velocity and flow. Clients access their data via digital dashboards.

One client is the City of Cudahy, where a pair of unassuming alleys – off Squire and Van Norman avenues – have been at the frontier of green stormwater infrastructure instrumentation since 2019.

That's because each contains a P4 instrument block that records and sends data about how water is managed below the alleys' porous paver blocks designed by another company, PaveDrain.

A skeptical glance at the organic debris pressed into cracks between the alley's pavers — where water is meant to infiltrate — raises concerns about clogging.

But three years of monitoring data tell a different story. When it rains, the water finds a way down.

"[When] you start to look at the performance of these systems with time, we find they perform better than you thought," Foley said.

P4 has deployed over 60 systems throughout the United States including a network of sensors in Peoria, Ill.



A residential alley in Cudahy, Wis. belies an innovative approach to measuring the function of green infrastructure like the paver blocks down the alley's centerline. P4's solar-powered instruments embedded in the block actually measure water below the surface. The first years of real-world data show that the system works better than designed.



One of two porous alleys in Cudahy, Wis. using PaveDrain pavers and P4 Infrastructure's instruments.

"Every time we instrument one of these pavements, that is data that can stitch together the behavior of a watershed."

"Every time we instrument one of these pavements, that is data that can stitch together the behavior of a watershed," Foley said.

This has implications for municipal governments and property owners seeking state credits for using green infrastructure to reduce pollution contributed to their watersheds.

Wisconsin's current guidance for porous pavement as a stormwater management practice provides a filtering credit of 65% removal for total suspended solids and 35% removal for total phosphorus, but 100% removal credit for the volume of water infiltrated.

On paper, Cudahy's porous alleys would only qualify for the partial credits. But measurement revealed that all the water managed by the alleys actually infiltrates into the ground below due to an incorrect assumption about the subgrade porosity. That means the alleys should qualify for full credit for removing all the pollutants.

"So, let's start designing according to the way [green infrastructure systems] behave," Foley said. "But you never get there until you start measuring. So, we hope to provide people better design tools."

Locally, a P4 system monitors a bioretention basin at MSOE's Viets Plaza. P4 also installed a solar-powered rain gauge and sensor that monitors the water level of an underground cistern draining four bioswales at Green Tech Station, a green infrastructure research and demonstration site near 31st and Capitol on Milwaukee's northwest side. Monitoring the cistern water level helped project partners to troubleshoot a leak in 2023.



The P4 data dashboard showing the water level measured in the underground cistern at Green Tech Station.



Reflo leads a student tour at Green Tech Station. Porous media types are installed in the test bed plaza, which overlies an underground cistern. P4 provided a solar-powered rain gauge.

About the Author



Michael Alan Timm is a writer, editor, and designer. He manages the Milwaukee Water Stories program for the nonprofit Reflo. In this role, he curates the Milwaukee Community Map and supports the WaterMarks initiative. He also writes grant proposals. Michael created the cooperative Great Lakes board game Mussel Madness and co-designed the MKE Waterscape Game. He lives in Cudahy between two Milwaukee County Parks on the Lake Michigan shore. Learn more or contact him at matimm.com.

NOTES:

1. CONTRACTOR WILL INSTALL BURIED 2-INCH HDPE CONDUIT AND PIT TAG ARRAY ANCHORAGE SYSTEMS.
2. WDNR WILL SUPPLY AND INSTALL PIT TAG ANTENNAS AND PROVIDE ASSOCIATED WIRING AND ELECTRICAL HOOKUPS. SEE SPECIFICATIONS FOR COORDINATION REQUIREMENTS.
3. INSTALLATION OF PIT TAG ANTENNA ANCHORS SHALL BE PERFORMED WITH THE ONSITE OBSERVATION OF WDNR STAFF AND THE ENGINEER.
4. ELECTRICAL CONNECTIONS AND ANTENNA SETUP WILL BE PERFORMED BY OTHERS UNDER A SEPARATE CONTRACT.
5. CONDUIT ALIGNMENTS SHOWN ARE APPROXIMATE. PIN-FLAG AND CONFIRM 2-INCH HDPE CONDUIT ALIGNMENT AND MASTER CONTROLLER FRAME LOCATION WITH WDNR STAFF AND ENGINEER PRIOR TO INSTALLATION.
6. 2-INCH HDPE CONDUIT SHALL BE INSTALLED TO A MINIMUM DEPTH OF 24 INCHES BELOW FINISHED GRADE.
7. THE CONTRACTOR SHALL PROTECT CONSTRUCTED FINISHED FEATURES AND EXISTING FEATURES TO REMAIN WHILE INSTALLING PIT ARRAY ANCHORAGE SYSTEMS AND 2-INCH HDPE CONDUIT.

LEGEND

- 2-INCH HDPE CONDUIT
- PIT ANTENNA LOCATION
- MASTER CONTROLLER FRAME

N

0 15 30 60

MILWAUKEE RIVER

PIT ANTENNA LOCATION A
STA. 4+42

2-INCH HDPE CONDUIT

EXISTING POWER POLE AND GUY WIRE. PROTECT IN PLACE

APPROXIMATE LOCATION OF MASTER CONTROLLER FRAME

EXISTING TREE, TYP. PROTECT IN PLACE

TEMPORARY STAGING AREA

PROPOSED CHANNEL ALIGNMENT

DO NOT DISTURB EXISTING VEGETATION WITHIN THIS AREA

EXISTING HYDRANT PROTECT IN PLACE

THE CONTRACTOR IS RESPONSIBLE FOR CONFIRMING THE LOCATION AND DEPTH OF ALL UTILITIES PRIOR TO CONSTRUCTION. PROTECT IN PLACE UTILITIES TO REMAIN.

EXISTING TREE, TYP. PROTECT IN PLACE

2-INCH HDPE CONDUIT

PIT ANTENNA LOCATION B
STA. 1+40

LIMITS OF DISTURBANCE, TYP.

4+00
5+00
5+42
3+00
2+00
1+00
0+00

Preliminary
Not for Construction

REUSE OF DOCUMENTS

THIS DOCUMENT AND THE IDEAS AND DESIGNS INCORPORATED HEREIN, AS AN INSTRUMENT OF PROFESSIONAL SERVICE (AEC) IS NOT TO BE USED, IN WHOLE OR IN PART, FOR ANY OTHER PROJECT WITHOUT THE WRITTEN AUTHORIZATION OF THE MILWAUKEE METROPOLITAN SEWERAGE DISTRICT.

HORIZONTAL DATUM
WISCONSIN STATE PLANE COORDINATES (NAD 83), SOUTH ZONE

VERTICAL DATUM
NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

DESIGN: N. JORDAN
DR: G. SHEAR
CHK: M. BURKE
APVD: M. BURKE

This Design Prepared For MMSD By:
INTER-FLUVE

REV. NO.	DATE	REVISION DESCRIPTION	BY	APVD

MMSD
PARTNERS FOR A CLEANER ENVIRONMENT

MILWAUKEE METROPOLITAN SEWERAGE DISTRICT
MILWAUKEE RIVER
KLETZSCH PARK DAM REPAIR AND FISH PASSAGE PROJECT
PIT TAG ARRAY LAYOUT

DRAWING NO.:	C-008
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DATE:	Sep-22
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MMSD FILE:	152-1343.dwg