

**ISSUE FOUR : FALL 2016**  
**OPEN RIVERS : RETHINKING THE MISSISSIPPI**

A photograph of a dam on the Mississippi River. The dam is a concrete structure with a staircase leading up to a walkway. Water is flowing over the dam, creating white foam. In the background, there is a city skyline with several buildings under a cloudy sky.

# **INTERVENTIONS**

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An interdisciplinary online journal rethinking the Mississippi  
from multiple perspectives within and beyond the academy.

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The cover image is of St. Anthony Falls Lock, closed in June 2015. Image courtesy River Life, University of Minnesota.

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## INTRODUCTION

# INTRODUCTION TO ISSUE FOUR

By Patrick Nunnally, Editor

**F**or as long as people have been living with rivers, we have been changing them. Put up a levee to keep water away from where we don't want it. Build a canal to move water to where we do want it. Put up a dam to stop floods or generate

water power. Over millennia, the possibilities have been endless.

More recently, though, we have started something new: intervening in rivers to undo some of



*St. Anthony Falls Lock, closed in June 2015. Image courtesy River Life, University of Minnesota.*

the changes we have previously made. My review of a couple of programs across the country gives a broad context for what has become a growing pattern of dam removal and alteration.

Close to home, the Upper St. Anthony Lock was closed in June 2015. That decision led to a study that asked: just what do we know about how the river's biological and physical systems are behaving at this point, now that the dam has closed? Now that the lock is closed, can we establish some scientific baseline data so that we can begin to monitor how the river behaves?

Some answers to these questions are detailed in Jane Mazack's feature article "The Once and Future River." Fellow scientists Jessica Kozarek and Carrie Jennings also contribute perspectives on the sorts of insights that come from detailed studies of particular river reaches.

Unfortunately, often rivers make the news through their destructive capacity. Last month's Hurricane Matthew unleashed torrents of rain, storm surge, and other watery mayhem on the low-lying areas in eastern North Carolina. In our Issue Two, published last spring, Richard M. Mizelle Jr. wrote about the racial dimensions of

flooding in this landscape; we reprint his article here with a head note connecting to coverage of the recent floods.

Every issue of *Open Rivers* contains shorter pieces covering particular aspects of the study and understanding of rivers, and this one of course is no exception. Laurie Moberg explores what we can learn from successive historic photographs of the site that now contains Minneapolis' Upper Harbor Terminal, a landscape sure to change now that barge traffic has ceased. Maxyne Friesen writes about how it felt to be an undergraduate student researcher on the bigger river study that Mazack led. Tim Frye reviews recent scholarship on rivers in Latin America. Mona Smith reminds us that St. Anthony Falls contains much more than our scientific studies can ever understand.

All of which is to serve as a reminder for one of our basic principles: scientific study is necessary, but not sufficient, in generating the knowledge and perspectives that we need in order to plan for sustainable, inclusive futures for our relationships with rivers.

Happy reading!

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## About the Author

Patrick Nunnally coordinates the River Life Program in the Institute for Advanced Study at the University of Minnesota. He serves as editor for *Open Rivers* and was one of the lead scholars for the University's John E. Sawyer Seminar, "Making the Mississippi: Formulating New Water Narratives for the 21st Century and Beyond," funded by the Andrew W. Mellon Foundation.

FEATURE

# WHAT DO YOU SEE WHEN YOU LOOK AT A RIVER?

By Jessica Kozarek

The Mississippi River in Minneapolis was the focus of a one-year study during 2015-16 to assess the current ecological condition of the river at the time of a major management event,

the closure of the Upper St. Anthony Falls Lock (see [Mazack](#), this issue).[1] From the compiled physical, chemical, and biological data, a baseline dataset was developed. Among other findings, the



*Sauk River, upstream of the confluence with the Mississippi River at Sauk Rapids, MN.  
Image by Jessica Kozarek.*

study determined that mussels are a significant component of the river's ecosystem. This article

discusses mussels and mussel monitoring in more detail.

# So, what do you see when you look at a river?

You might see physical characteristics of the water itself such as whirls from turbulence, waves, or water color and clarity. You might notice vegetation or birds and wildlife within the river. You might see large-scale river engineering projects: locks and dams, flood protection, bridges, or bank stabilization. All that you see and much that you likely can't see together compose the building blocks for an underwater ecosystem. These building blocks are all of the physical, chemical and biological conditions of the river that make it more or less livable for its underwater inhabitants. Physical habitat is the living space of aquatic biota represented by water currents and riverbed material. Physical river habitat is dynamic in space and time as water flow and

sediment sources vary with weather patterns and land use practices. Chemical parameters of a river environment include: dissolved oxygen, temperature, nutrients, and pollutants. River water chemistry changes with season, rainfall, and land use practices. Biological parameters of a river habitat include: fish, aquatic wildlife and vegetation, macroinvertebrates (insect larvae, mussels), and microorganisms such as bacteria or algae. Together the physical and chemical environment with the biological community makes up the river ecosystem. By definition, a system is comprised of interconnected components or processes that make up a whole, and the physical, chemical, and biological processes within a river ecosystem are strongly interconnected.

## Ecosystem Engineers

The interactions between the physical, chemical, and biological components of a river ecosystem are exemplified by those organisms that directly influence their physical habitat (which in turn affects the chemical and biological processes of the ecosystem). The concept of ecosystem engineering emerged in ecological literature in the 1990s (see review by Wright and Jones 2006). This concept generally refers to the modification of the physical features of ecosystems by a single species or collection of similar species. Human beings are the ultimate examples of ecosystem engineers, altering the physical habitat of rivers and landscapes to suit our needs by building dams, roads, cities, etc. that have cascading

effects on the ecosystem in which we live. In the animal kingdom, one of the most visible ecosystem engineering species is the beaver whose dams extensively alter riverine habitat with dramatic effects on aquatic community structure and ecosystem functioning. Other examples of ecosystem engineers include elephants, gophers, and earthworms, all species that alter their physical surroundings. Even vegetation can be considered an ecosystem engineer under certain conditions, as it can significantly modify river flow and sediment characteristics altering the shape and form of a river. Less visible ecosystem engineering organisms that can have significant impacts on the physical structure of riverbed



*Freshwater mussels in a river bed. Image by Jessica Kozarek.*



*Freshwater mussels in a mussel bed.  
Source: Mike Davis, Minnesota Department of Natural Resources.*



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habitat are freshwater mussels. These organisms tend to aggregate in large groups called mussel beds. Mussel beds stabilize sediment and create habitat for aquatic insects, algae, and fish. Note the significant differences between the concept of ecosystem engineering—a community of organisms working together to engineer their habitat—and our human concept of engineering, namely intent. Beavers likely do intend to alter their physical habitat, but it could be argued that mussels' impact on riverbed habitat, while great, was not the intent of the mussels.

See video *How Beavers Build Dams* by PBS.

I will note at this point that I'm not an ecologist, nor am I a malacologist (a scientist who studies mollusks), and that my perspective on rivers

is that of an engineer. I conduct research at St. Anthony Falls Laboratory at the University of Minnesota in a facility devoted to the study of the interactions between stream and river management and stream ecosystem response. This laboratory, dubbed the Outdoor StreamLab (OSL), is an experimental stream and floodplain designed to conduct experiments on a stream ecosystem such as the response of streambed composition, stream morphology, nutrient dynamics and/or biotic community to changes in water and sediment supply or engineering channel designs. Experiments conducted in the OSL during summer 2016 were focused on the feedbacks between mussels and channel morphology or how mussels respond to changing habitat and the impact of mussel presences on habitat in a changing environment.



*The Outdoor StreamLab at St. Anthony Falls Laboratory at the University of Minnesota.  
Image by Jessica Kozarek.*

# Freshwater Mussels

Mussels are incredibly fascinating creatures that deserve some investigation. I've had the opportunity to learn about mussels from local experts in state and federal government agencies and from my colleagues in academia, who can speak much more accurately to mussel biology than I can, but I will enumerate some key points that make mussels worth thinking about. Mussels are much more than living rocks (although this is what they most resemble); mussel shells come in a wide variety of shapes, sizes, and surface textures. Adult mussel shell length ranges from 1 to 10 inches for different species (for a detailed discussion, see Haag 2012). With common names like "warty back," "threeridge," "heelsplitter," or "pocketbook," you can imagine the shell sculpture for each of these species with bumps, ridges, wings, or smooth shells. Mussel shell morphology likely evolved to balance out the ability to maintain position without being scoured or dislodged, or to burrow (after dislodging or to avoid predation). Different morphology allows mussels to remain in riverbeds under different conditions. For example, a smooth-shelled mussel may be able to burrow faster, while a heavy, thick-shelled mussel with ridges or shell sculpture may be able to hold position in faster currents. Unfortunately, as mussels live on the bottoms of rivers, it is difficult to watch mussels during high flows, so it's hard to say what they actually do.

Freshwater mussels are abundant and diverse, but also highly imperiled. North America is home to approximately 300 species of mussels (Haag 2012); however, approximately 70 percent of these species are extinct, endangered, or otherwise of special concern. Mussel population decline cannot be attributed to a single factor, but rather a combination of often interacting factors from land use change (e.g., water quality degradation, habitat loss, altered streamflow,

and sedimentation), direct channel modification (e.g., dam building), host fish availability (more on this later), and invasive species impacts (e.g., predation and zebra mussel infestation). Because mussels are long lived (some species can live 50+ years), relatively sedentary, and have a complicated life cycle that requires suitable host fish populations, they are often used as indicators of river ecosystem wellbeing. A kind of "canary in the coalmine" organism, mussel response to environmental conditions can signify an early warning for a degraded ecosystem. In fact, instrumented



*The author holding a mussel collected from the Le Sueur River in Minnesota. Image used with permission from Amy Hansen.*

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mussels are being used as biomonitors for water quality. Mussels are filter feeders, and they have the ability to close their shells for a period of time when a contaminant is present. By monitoring mussel gape (i.e., the rate at which they open and close their shells), water resource managers can tell, for example, if all mussels close up quickly, that there is potentially harmful contamination.

Unlike fish, freshwater mussels are relatively sedentary and therefore subject to local environmental conditions. Mussels do have one foot, which allows them to anchor into sediment or crawl along slowly (generally inches to feet a day, at most). Unlike oysters or clams,

freshwater mussels have a unique life cycle that depends on a parasitic relationship with a host fish. It is this relationship that allows mussels to spread throughout a river network. Female mussels release mussel larvae (called glochidia), which must attach to the gills of a suitable host where they will grow and develop for several weeks before dropping off of the fish as juvenile mussels. Many mussel species have evolved intricate methods to attract the appropriate fish host to ensure successful attachment of glochidia. These methods range from displaying elaborate lures that mimic fish, to developing packages of glochidia that resemble fish food, to physically capturing the unsuspecting fish host long enough



*Diversity of mussel shell shapes and sizes in the Snake River, Minnesota.  
Image by Jessica Kozarek.*



*This illustration is from the booklet, “A Pocket Guide to Kansas Freshwater Mussels.”  
It is reproduced with permission from the artist, Karen Couch.*

to infest the fish with glochidia. These adaptations are next to impossible to observe in the wild without a snorkel, scuba gear, and/or lots of time and the expertise on when and where to look, but the curious can [check out the array of videos online](#). As they grow, mussels can keep a record of the water chemistry and environmental conditions in their shells. Like trees, mussels develop

rings as they grow. The size of each grow ring can show the mussels' growth, and a record of the river chemistry can be captured in the calcium carbonate that makes up the shell.

*See videos of mussel lures at the [Freshwater Mollusk Conservation Society](#).*

## Value of Freshwater Mussels

Descriptions of freshwater mussel diversity and abundance in the large rivers of the central U.S. prior to the 1900s evoked images of dense mussel beds hundreds of feet long and up to two or three feet thick in some areas (Haag 2012; Anfinson

2003). These beds provided the basis of a booming pearl button industry centered in Muscatine, Iowa in the late 1800s to early 1900s. Clammers dragged the Mississippi riverbed pulling up tens of thousands of tons of shells. In the same



*Clammers standing atop a mound of mussels killed to make mother-of-pearl buttons.  
Source: US Fish and Wildlife Service, circa 1911.*

time period, fortune seekers were on the hunt for elusive and valuable freshwater pearls. By the early 1900s, mussel beds had been depleted by the massive harvesting efforts and water quality was degrading due to growing human populations. Water pollution from agriculture and sewage made mussel population rejuvenation unlikely, and the button industry died out.

The New York Times published an article in 1902 about the end of the pearl mussel boom.

Modern wastewater treatment following the Clean Water Act of 1972 has greatly improved the water quality in our rivers, to the point that some mussel populations are beginning to recover. Today, freshwater mussels maintain a market as seed material for the cultured pearl industry but are illegal to collect in many states due to their

threatened status. The non-market value of freshwater mussels today is more difficult to quantify, although they provide important ecosystem services. As mentioned above, the physical presence of a mussel bed can have a significant influence on riverbed habitat. But mussels influence more than just physical habitat. Mussels are filter feeders, passing gallons of water through a single mussel in a day, removing suspended material from the water column. In large enough numbers, mussels can greatly improve the water clarity. The unused nutrients and organic material that mussels filter out of the water while feeding are deposited in the riverbed stimulating the food web at the river bottom through algal growth and macroinvertebrate production. These processes can cascade up the food chain, ultimately providing more food for fish.

## River Ecosystem Management in a Dynamic Environment

Freshwater mussel conservation efforts have shown some promise in rivers where water quality and physical habitat will support mussel populations; however, threats to freshwater mussels and causes for declining populations remain difficult to pin down, likely due, in part, to the interactions between many environmental stressors. Hansen and others published a modeling study in 2016 that provides an example of these interacting stressors in the heavily agricultural landscape in the Minnesota River basin. Land in this watershed is primarily used for row-crop agriculture (converted from a prairie-wetland system). Like much of the Midwest, extensive drainage practices (tile drains and ditches) and crop conversion compounded with changing precipitation patterns and earlier snowmelt have led to increased peak streamflows and suspended sediment concentrations. In turn,

suspended sediment can shade or absorb the light and reduce the availability of algae, mussel's primary food. This model indicated that chronic exposure over many years to increased suspended sediment concentrations, combined with food limitation, were the primary factors controlling freshwater mussel population density in the watersheds which they examined. Other environmental stressors, such as pollutants or unstable habitat, may be more critical in river reaches in cities, for example.

I have used freshwater mussels as an example of how one component of a river ecosystem changes and is changed by its environment. This example illustrates that the interactions, feedbacks, and thresholds between components of a river ecosystem can be intertwined and should all be considered when maintaining, restoring, or

otherwise managing a river to support life. Other less obvious, but non-structural components of river ecosystems can also drastically alter river ecosystems (see review by Corenblit et al. 2011). For example, feedbacks between hydrology, biogeochemistry (nutrient cycling), sediment transport, and vegetation growth can control river dimensions (width, depth, slope, etc.). As river management trends more toward restoration (see

Open Rivers Issue 2) incorporating more environmental goals, understanding the interactions between the physical, chemical, and biological processes in a river becomes critical to successful management. And as the river adjusts to the lock closure and future river management, mussels will serve as indicators of the changes occurring in the river ecosystem.

## For more information about freshwater mussels, see:

- <http://dnr.state.mn.us/mussels/index.html>
- <https://www.fws.gov/midwest/mussel/index.html>
- [http://molluskconservation.org/MC\\_Ftpage.html](http://molluskconservation.org/MC_Ftpage.html)

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Wright, J. P., and C. G. Jones. 2006. "The concept of organisms as ecosystem engineers ten years on: Progress, limitations, and challenges." *Bioscience* 56 (3):203-209. doi: 10.1641/0006-3568(2006)056[0203:tcooae]2.0.co;2.

## Footnotes

[1] Funding for this project was provided by the Minnesota Environment and Natural Resources Trust Fund as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR). Funding was awarded to the Minneapolis Riverfront Partnerships and work was completed in partnership with the Mississippi Watershed Management Organization, the Minnesota Department of Natural Resources, and the University of Minnesota's St. Anthony Falls Laboratory and River Life Program.

[2] Funding for this project, "Conserving Minnesota's Native Freshwater Mussels," was provided by the Minnesota Environment and Natural Resources Trust Fund as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR).

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## About the Author

Jess Kozarek leads ecogeomorphic research in the Outdoor StreamLab at St. Anthony Falls Laboratory. Jess' research links stream hydraulics to biological processes to develop guidance for stream and river management to protect and restore aquatic ecosystems.



FEATURE

# THE ONCE AND FUTURE RIVER: A PRESENT SNAPSHOT

By Jane E. Mazack

The Mississippi River is a story of interventions. Throughout history, people have relied on the river for water, food, transportation, energy, and recreation. The desire to maximize these ecological services has played out as a series of human interventions that, although designed to help people, have changed and often

harmed the river itself. It is simple to quantify the initial action; it is far less simple to measure and understand its implications for river ecology and health.

Rivers are complex ecological systems; they cannot be comprehensively and completely



*Figure 1. Oil painting, "St. Anthony Falls," done in 1857 by Danish-born landscape artist Ferdinand Reichardt. It shows the Mississippi River, looking upstream toward the gorge and St. Anthony Falls prior to alteration for locks and dams. Image courtesy of the Minnesota Historical Society.*

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measured. Rather, it is necessary to quantify them through the use of indicators. An indicator is a physical, chemical, or biological component of the river that can be measured and used to describe the condition of the river. For example, in order to study water quality in a river, specific indicators such as nitrogen, phosphorous, or *E. coli* must be selected and measured.

Many types of data are necessary in assessing and describing a river. We can't talk about water chemistry and ignore mussel and invertebrate populations. And we can't just talk about the biology of the river without looking at its physical characteristics. Looking at multiple data types is essential to an accurate understanding; the river is more than simply the sum of its parts,

because the physical and chemical components of an ecosystem cumulatively influence the biological community. Multiple pollutants may interact and impact fish and mussel populations in ways that would be unexpected from simply measuring their concentrations. The history of the Mississippi River, when viewed through the lenses of interventions and indicators, reveals that human actions have dramatically changed the river in Minneapolis.



*Figure 2. Pillsbury A Mill, Phoenix Mill, and Pillsbury elevator and machine shop above St. Anthony Falls, circa 1900. Image courtesy of the Minnesota Historical Society.*

# The Once River

The Mississippi River flows through the Twin Cities; its primary feature in Minneapolis is St. Anthony Falls, which has a 74-foot drop (US Army Corps of Engineers 2016a). The river directly downstream of the falls is known as “the gorge” due to its incised channel through a bedrock gorge. Historically, the gorge was characterized by its high-gradient 6-mile reach of boulder-cobble-gravel streambed – prime habitat for numerous fish and mussel species (Lenhart 2012). St. Anthony Falls, just upstream of the gorge, provided a barrier to upstream movement; consequently, more fish and mussel species were historically found downstream of the falls than upstream of the falls (Kelner and Davis 2002, ii). In 1962, fish populations were estimated to be nearly 120 species downstream of St. Anthony Falls and approximately 60 species above the falls (Eddy, Underhill, and Moyle 1962, 1).

St. Anthony Falls provided an optimal spot for hydropower, and industry soon lined its banks. The first dam was installed at St. Anthony Falls in the mid-nineteenth century to power the Minneapolis Mill Company and St. Anthony Falls Power Company (Anfinson 2003, 126). However, continued industrialization and urbanization associated with the mills took their toll on the river – St. Anthony Falls suffered severe physical damage and nearly collapsed, due to the overuse and poor engineering of water power systems from 1860 to 1887 (Anfinson 2003, 127-128).

The river was not only physically damaged; industrialization, agriculture, and growing populations degraded the quality of the water itself. As a consequence, fish and mussel populations declined dramatically in the early twentieth century (Kozarek). By 1926, fish survey data found only two living fish in the 25 miles downstream of St. Anthony Falls (Weller and Russell 2016). Mussel populations downstream of the falls were

similarly decimated, with the Army Corps of Engineers (the corps) stating that “the outlook for a mussel renaissance in this troubled reach is extremely poor” and will remain so “until radical improvement in water quality is accomplished” (Kelner and Davis 2002, 1). Improvements in wastewater treatment and reductions in pollution during the mid to late-twentieth century did occur, and were accompanied by recovering fish and mussel populations below St. Anthony Falls (Kelner and Davis 2002, 1).

As industrialization continued, the management of the river began to emphasize navigation. The Rivers and Harbors Act of 1930 authorized the construction of a system of navigation locks and dams in order to maintain a 9-foot channel in the Upper Mississippi River (US Army Corps of Engineers 2016b). In 1948, the corps dredged a 9-foot channel extending 3.7 miles upstream of the falls in preparation for the Lower and Upper St. Anthony Falls Lock and Dam projects (US Army Corps of Engineers 2016a). From 1963 to 2014, the corps continued dredging to maintain this channel, as well as the channel downstream of the falls, for navigation; an average of 45,000 cubic yards of sediment was removed annually from the river upstream of St. Anthony Falls (US Army Corps of Engineers 2014).

The Lower and Upper St. Anthony Falls Locks were a human construction designed to create a new connection in the river for the transportation of goods by barge. However, this connection, although built for boats, was also used by the biological community in the river. Fish and mussels, which had previously been unable to traverse the falls, were now able to expand their ranges. Lock installation allowed fish species downstream of St. Anthony Falls to move upstream of the falls; mussels, which rely on fish hosts for larval movement, were also able to expand their ranges

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(Kozarek). Nine mussel species were historically present above the falls, versus 43 below the falls; currently, over 15 species have been found upstream of the falls (Kelner and Davis 2002).

The most recent human intervention in the Mississippi River at St. Anthony Falls is somewhat different than those of the past. Rather than building a new lock and dam, the previously built Upper St. Anthony Falls Lock was closed in June 2015. In other rivers, similar changes

in management have occurred; for example, the Elwha Dam in Washington was removed in 2014 (Howard 2016). The focus has turned from creating new alterations (such as building locks and dams and dredging sediment) to reversing previous ones (such as closing locks, removing dams, and stopping dredging). Even so, these “reversals” still have significant implications for the river itself.



*Figure 3. Construction of the Upper St. Anthony Falls lock, 1960. The current horseshoe-shaped hydro-electric dam, completed in 1963, is 49 feet in height (US Army Corps of Engineers 2016a). Photo by Dale L. Sperline, US Army; courtesy of the Minnesota Historical Society.*

# A Present Snapshot

The 2015 closure of the Upper St. Anthony Falls Lock was the impetus for a one-year study of the Mississippi River in Minneapolis. Our study was designed to take advantage of this intervention – first as an occasion to assess the current ecological condition of the river, but also as an opportunity to look forward and explore how the river might change in the future. The data collected in this project provide a baseline against which to compare future changes and measurements of the river[1].

The precipitating event itself is relatively simple to quantify: the Upper St. Anthony Falls Lock was closed; the river upstream of the lock was closed to commercial navigation; and dredging activity upstream of the lock was stopped (US Army Corps of Engineers 2016a). However, it is far from simple to measure and understand the implications of this human action for river ecology and health. The lack of future dredging will cause sediment to fill in parts of the river bottom that would otherwise be dredged; the overall shape of the river channel will then change. Those changes in sediment may affect water quality by changing the amounts of suspended solids and nutrients that are transported downstream by the river. And those physical and chemical changes will combine to influence the biological communities that live in the river, such as fish, mussels, and aquatic insects. On top of that, the river is a naturally changing system.

Because the river is a complex system that is difficult to quantify, our goal was to obtain a wide range of data including physical, chemical, and biological indicators. By analyzing all of the primary components of the river, we increase our ability to complete an accurate assessment of its condition. Our data were both sourced from existing projects as well as collected over the past year in our study area.

The study area for this project is the 18.3-mile stretch of river centered around St. Anthony Falls. Within that area, we divided the river into four sections, or reaches, based on their dredging history and lock and dam locations. We selected monitoring sites for evaluation within each of these reaches, in order to differentiate how future changes in the river may be impacted by historical differences in management practices.

Reach 1 extends from the Coon Rapids Dam downstream to the former head of navigation. This 8.6-mile stretch of river has been the only free-flowing reach of the Mississippi within the study area – there has not been any dredging. It is shallow and wide, with three islands present in the river.

Reach 2 extends from the former head of navigation to the Upper St. Anthony Falls Dam (3.7 miles), and is set within a low-cut bedrock gorge. This dammed stretch of the river was formerly dredged to maintain a 9-foot channel. Following lock closure in 2015, dredging activity and commercial barge traffic have ceased in this reach.

Reach 3 extends from Upper St. Anthony Falls Lock and Dam to Lower St. Anthony Falls Lock and Dam. This short stretch of the river (0.6 miles) is characterized by turbulence and the St. Anthony Falls. Prior to the Upper St. Anthony Lock opening in 1963, the falls acted as a migration barrier to fish and mussels; since the lock closure in 2015, the falls again will act as a migration barrier.

Reach 4 extends from Lower St. Anthony Falls to Lock and Dam #1 and includes Pool 1 of the Mississippi River. This stretch of the river is set deeply within the Twin Cities gorge, with bedrock cliffs on each bank. Like Reach 2, this stretch of the river contains a 9-foot navigation channel,

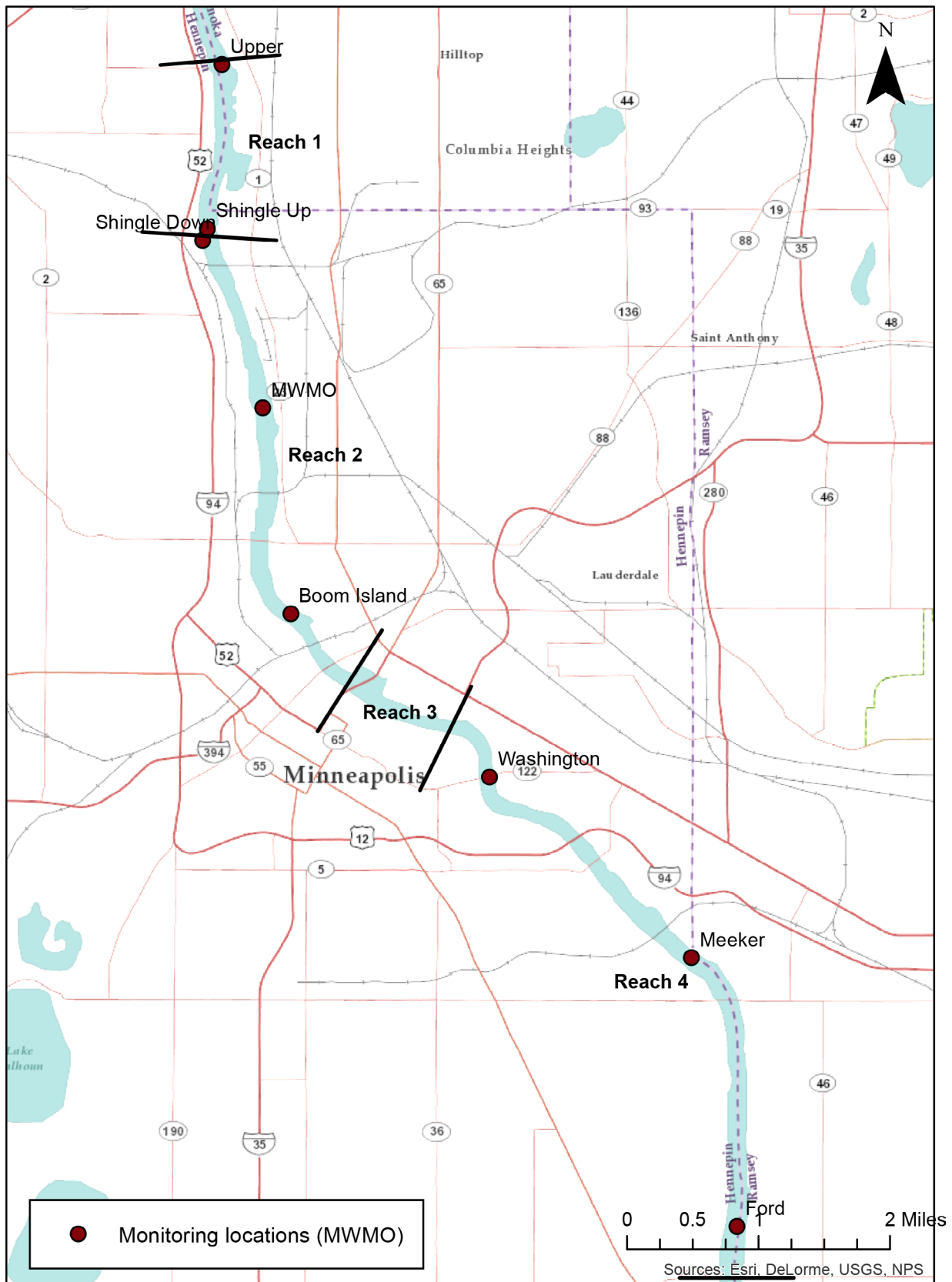


Figure 4. Map of the study area and primary monitoring sites, as developed by the Mississippi Watershed Management Organization (MWMO), labeled by reach.  
Image courtesy of the author.

which has been maintained through dredging. Although this stretch of the river is still open to commercial navigation, no future dredging is currently planned for this reach.

We first gathered a broad set of already-collected data; agencies and organizations have both historical data records and ongoing monitoring efforts. For example, the corps has collected bathymetry data of the shape of the river bottom on an annual basis in order to identify water depths in dredged areas. Additionally, the MWMO has an ongoing water quality monitoring program that will continue into the future.

Surveying the existing data revealed missing and incomplete data. Although physical bathymetry data were available, there were no data about the type and size of sediment in the bottom of the river. And although the Minnesota Department of Natural Resources had collected biological mussel data, the most recent information was from 2001 and needed to be updated. Consequently, we collected sediment, invertebrate, and mussel data over the course of this project in order to establish a complete, up-to-date baseline ecological condition.

Biological indicators, such as mussels and invertebrates, can provide essential information about a river ecosystem. Because they integrate the physical and chemical characteristics of their environments, they are effective indicators of change in the river. Mussels are long-lived and sedentary; their abundance and diversity is therefore influenced by long-term river contaminants and habitat conditions at the bottom of the river. Additionally, they are reliant on host fish species to complete their life cycles, so physical barriers to fish movement, such as dams and waterfalls, also restrict mussel population ranges (Kelner and Davis 2002, ii).

In contrast, aquatic insects are a short-term ecological indicator. They generally live for only one or two years; therefore, their abundance and

diversity would be more quickly impacted by changes in water quality and habitat conditions. However, aquatic insects are less impacted than mussels by barriers such as dams; most insect species leave the water as adults and are thus able to aerally disperse. Different species of aquatic insects respond differently to pollution. Some types of insects, such as mayflies, stoneflies, and caddisflies, are considered generally pollution intolerant, meaning that they tend to be more diverse and abundant in high-quality environments (Merritt, Cummins, and Berg 2008). High abundances of pollution intolerant insects in a riverine environment would indicate good water quality; in contrast, an aquatic insect community dominated by pollution tolerant organisms may indicate impairment or pollution in the ecosystem.

The most common types of insects found in the Mississippi River in Minneapolis are mayflies (Order: Ephemeroptera) and caddisflies (Order: Trichoptera); together, they make up over 85 percent of the invertebrate community. When we collected invertebrate data from our study area, we tended to find the most diversity in Reach 1, which is the most natural, undredged reach. Although stoneflies (which are also generally pollution intolerant) were relatively rare, they also tended to be found upstream of St. Anthony Falls, in Reaches 1 and 2. In contrast, midges (Family: Chironomidae) tend to be the more common downstream of St. Anthony Falls, and make up a higher percentage of the overall invertebrate community in Reach 4 (about 10%).

# The Future River

These types of data, along with others, measure the baseline condition of the Mississippi River at the time of lock closure. So what's next? We expect significant changes to the Mississippi River in response to the St. Anthony Falls Lock closure, and future ecological monitoring will be required to track and measure those changes.

Although all of the types of data previously discussed are important in assessing and describing the river, it isn't feasible to study every single one. Constant evaluation of all data types isn't economically practical, and it isn't efficient to collect every type of data every year, especially if changes are occurring on a long-term scale. Therefore, the second objective of this project was to develop a targeted set of indicators for continued and future monitoring. By choosing a limited set of indicators, the cost and complexity of future research efforts can be reduced. We evaluated potential indicators using a suite of metrics, including magnitude of change, response time, sampling effort, and public relatability.

Not all data types are equally effective as indicators, and each has its benefits and drawbacks. For example, fish are highly relatable to the public; however, it is difficult to accurately assess mobile fish populations. In considering potential indicators, we suggest that monitoring within each broad category of data (physical, chemical, and biological) would allow for the most complete assessment of future river changes. Each of these categories of data is likely to be directly impacted by the recent interventions to lock management and dredging. In the physical category, bathymetry data, although requiring high sampling effort and processing time, would be an effective indicator to accurately assess the impacts of stopping dredging on the shape of the river channel. In the chemical category, water quality data, although expected to show smaller changes,

are relatively simple to monitor and are part of ongoing programs. In the biological category, mussels are publicly relatable and also integrate physical (habitat) and water quality (total suspended solids) parameters in their responses to the riverine environment.

Further analysis, planning, policy, and the intentional introduction of social and cultural dimensions and questions are the future work of agencies, advocacy groups, community groups, and others. People will continue to interact with and intervene in the river's course; this latest intervention is just one in a series of past and future actions. The river does not depend on people, although it is deeply influenced, often for the worse, by human intervention.

With human management, such as the closure of the lock, the river will change – perhaps dramatically and with unexpected consequence. But without human interventions, the river will still change and water will still flow. The present river is just a snapshot of a dynamic system. The past river is different than the present river; the present river is different than the future river. This present snapshot of the river is just that—a single moment in time.



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## Footnotes

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Jane E. Mazack is a PhD candidate in the Water Resources Science program at the University of Minnesota. Her dissertation research identifies and quantifies the complex relationships between groundwater, temperature, and invertebrate dynamics in southeastern Minnesota trout streams. More broadly, her work explores the implications of climate change on winter-adapted invertebrate communities.

FEATURE

# WHY SO MUCH SAND IN THE LOWER MINNESOTA RIVER?

By Carrie E. Jennings

The Lower Minnesota River, from Carver Rapids to the confluence with the Mississippi, is a low-gradient, broad reach of the river. If you wade into the brown water you may be surprised

to find that the bottom is actually sandy. Based on the yearly gaging data, about half an inch of sand would accumulate in the channel each year if it were not dredged. That is about six times



*View of the Minnesota River near the I-35 bridge during high flows in summer 2016.  
Image by Carrie Jennings.*

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more than the average, pre-European-settlement accumulation rate.

So what? This stretch of river is meant to slowly fill in, or aggrade, with time. Why should we fight a natural process? Isn't the suspended sediment that is making the water muddy what everyone should be focused on?

The rapidity with which the sand is accumulating is affecting ecosystems and more immediately, it is inconvenient and costing taxpayers money. It has the potential to affect commercial barge traffic to the Port of Savage; it is using more taxpayer dollars as dredging tries to keep up with

the river-filling sand; and it will spread sand on a proposed paved bike trail that would run along the levee from the Bloomington Ferry Bridge to Ft. Snelling. (Fat-tire bikers and mountain bikers may be happy to hear this. They would like to keep this part of the river wild.)

This summer, archaeological test pits were being dug along the proposed bike trail route to make sure it would not impact or pave over important archaeological sites. Most of the pits were turning up nothing, which seemed odd to the team contracted by the Department of Natural Resources (DNR) to do the work. I was contacted for an opinion when they finally did hit a couple



*Excavation pit showing two layers with artifacts, at 10 and 20 inches deep. The white layer at 20 inches is mussel shells.*

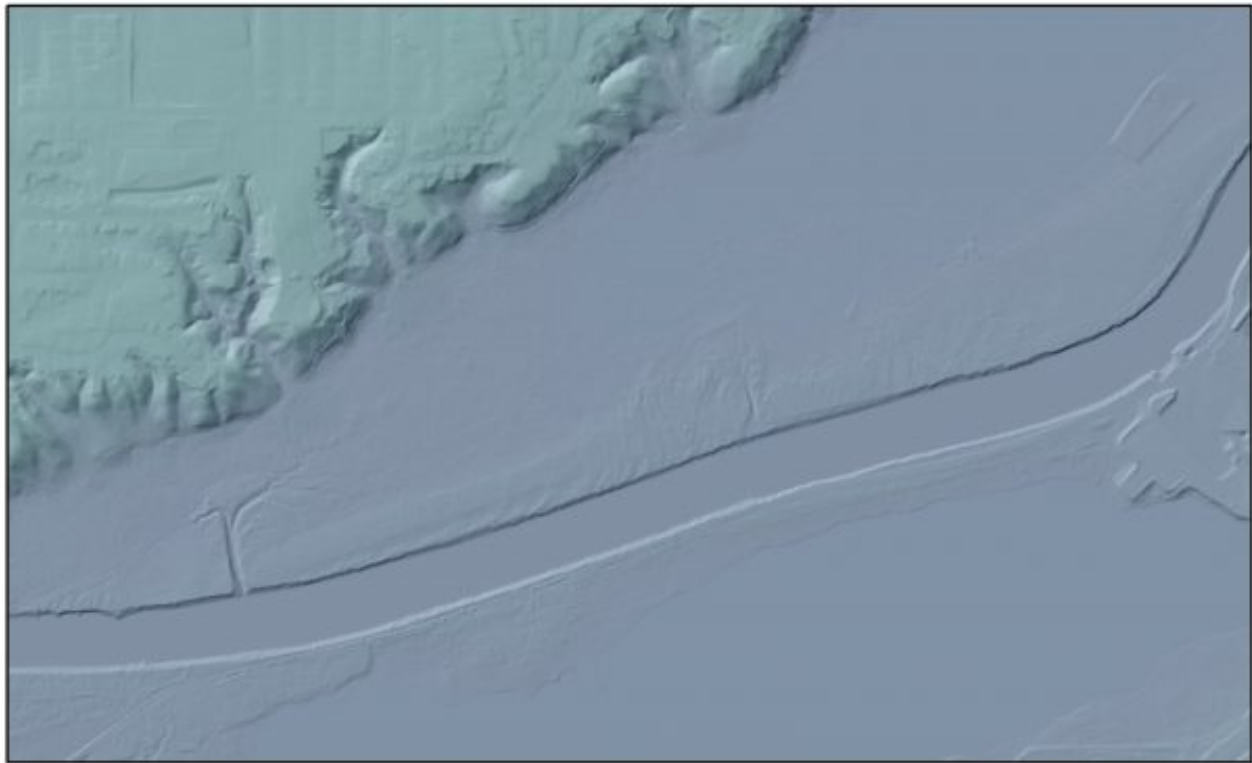
*Image by Carrie Jennings.*

of layers with artifacts near the natural levee of the river, south of Nine Mile Creek.

The layers of interest were buried by 10 and 20 inches of sand. One layer contained a confusing mess of items that included: a white ceramic pipe stem from Paris that could have dated to the European contact period, some abraded and some sharp pot sherds, some metal, and a small triangular piece of blue plastic. That the layer included metal and plastic means that it dated to the modern time and was redeposited here with older materials, possibly by a large flood event. The deeper layer was a bed of mostly disarticulated mussel shells.

The question the archaeologists asked me was, “How old are the layers and how did they get buried?”

If the half inch of sand accumulating in the channel were spread evenly over this part of the river valley, this site could date to the 1960s and the archaeologists would have to dig another 6 to 10 feet to get back 200 years, to the European-contact period. This is a valley-wide average based on just a few years of gaging data, so is at best a ballpark figure. However, this rapid sedimentation did make sense to the archaeologists. Most of their pits were barren, even though they expected this to be a rich area.



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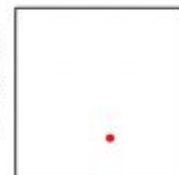
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Note: Elevation images and contours were generated from LiDAR derived elevation surfaces acquired 2007-2012.



Scale: 1:13,522



Created on 10/14/2016

*Sand is deposited on a levee during high flows of the Minnesota River and in some cases, breaches the levee and is deposited in a splay of sand farther back on the floodplain. Scale: 1:13,522, north is at the top of the image. Map created by the author from high resolution elevation data provided by the DNR, using the DNR tool MNTOP*

So we were probably only looking at decades of sediment burying the layers. The trash layer may even represent one of the big, historic floods in the valley such as the April 1965 flood—the flood of record until a 2010 fall flood surpassed it. With that recent of an event, it is even possible to review the flood history and Army Corps of Engineers photos to see when this portion of the valley was inundated. You can easily see on the shaded relief map (below) where splays of sandy sediment breach the levee and build up the level of the flood plain with each flood. Anything placed on the floodplain here will be slowly smothered with sand, as the buried root crowns of the floodplain trees attest.

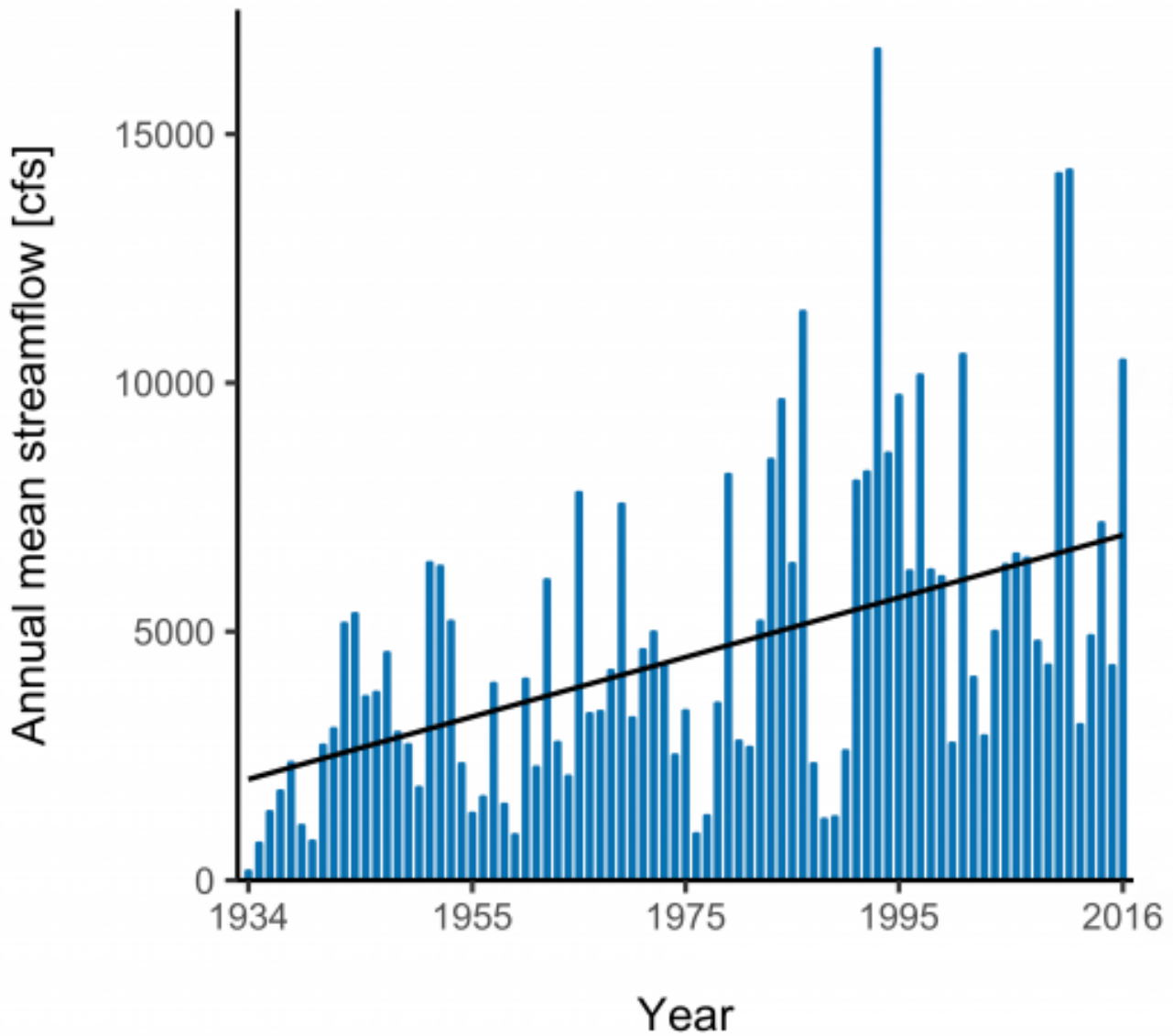
One intact mussel was found in the shell layer and tentatively identified by photograph by Bernard Sietman, DNR. He said that it “appears to be *Quadrula nobilis* (Gulf mapleleaf). We just discovered this species in Minnesota a little over 10 years ago from old shell deposits in the lower Minnesota River at Carver and a few sites around the I-35 bridge.... We would be interested to know how those shells were deposited there; naturally, by humans, etc.”

Mussels are filter feeders that need rocky substrates and clearer water to exist. Something changed in this reach of the river to make them unable to survive.



*An intact mussel, found in the shell layer, was tentatively identified by Bernard Sietman as *Quadrula nobilis* (Gulf mapleleaf). Image by Carrie Jennings.*

## Minnesota River near Jordan, MN USGS 0533000



*Annual mean streamflow on the Minnesota River near Jordan, MN, 1934-2016.  
Graph provided by the author.*

What do we, as a society, collectively decide to do with the Minnesota River?

- Stop trying to navigate this reach of the river or pay more and more to dredge it?
- Abandon the trail idea or shovel it after every flood?
- Forget that mussels used to thrive here or return to a water quality that they can live in?

By ignoring the question, we are making some of these the default decisions. By ignoring the cause, we may be locked in to a Sisyphean shoveling and dredging exercise because we didn't address the root cause of the increased sediment loads.

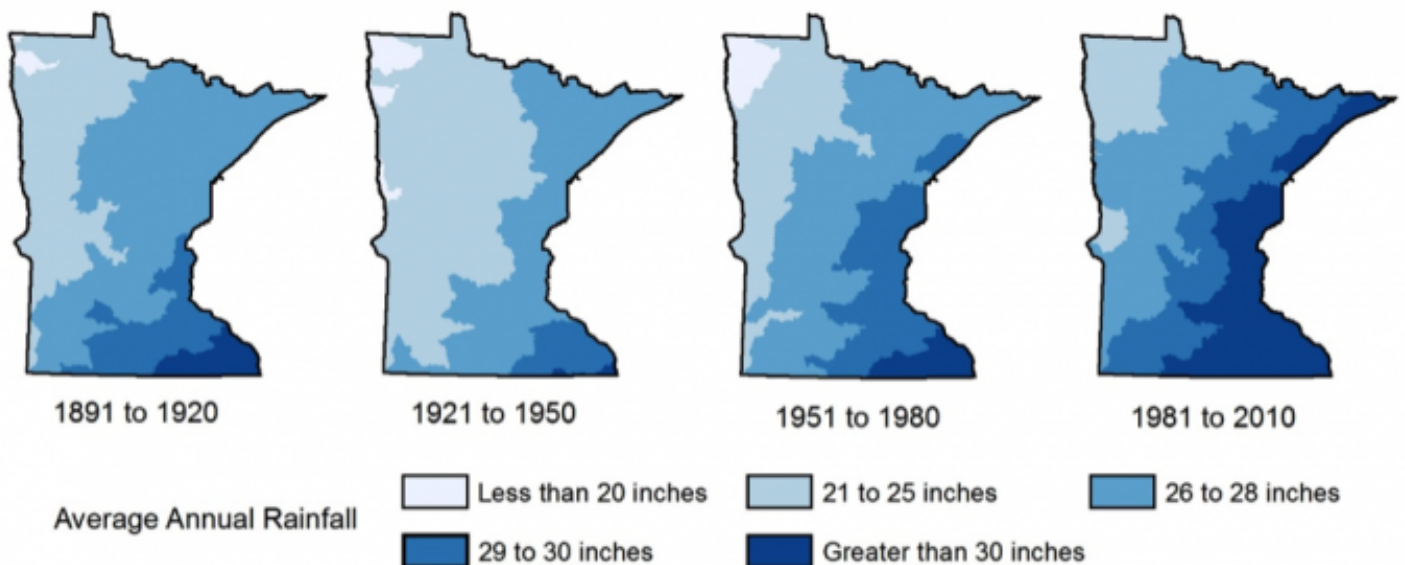
One tiny watershed district is trying to address the sedimentation problem. The Lower Minnesota River Watershed District (LMRWD) manages a 65-square-mile area that encompasses the lower 35 miles of the Minnesota River. Their narrow reach is the bottom of a funnel that

bears the brunt of what happens upstream in 90 percent of the rest of this primarily agricultural watershed. The district is responsible for maintaining a navigable channel up to the ports in Savage from which agricultural products are delivered to market and bulk materials needed for farming are delivered to those in the watershed. The LMRWD is running out of places to put dredge spoil and is looking for a more holistic, watershed-wide solution. They don't have the money or political clout to tell the rest of the watershed what to do.

One approach they are trying is to document the change that has happened. We know that southern Minnesota rivers have exhibited a significant increase in annual flows over the last several decades owing to a combination of changes in climate, ground cover, and artificial drainage.

As a result, rivers have been widening throughout the watershed and are consuming on average,

### Precipitation Change in Minnesota



Adapted from *Fields to Streams*, University of Minnesota (2015) and Gupta, S.C., A.C. Kessler, and M.K. Brown (2014).  
Based on data from MN DNR State Climatology Office

*Precipitation change in Minnesota showing average annual rainfall, 1891-2010. Image adapted by Freshwater Society, based on data from MN DNR State Climatology Office.*



80 acres of land per year, affecting over 10,000 properties in the Minnesota River and its tributaries. The eroded sediment ends up clogging the low-gradient reaches of the lower Minnesota River, before the confluence with the Mississippi. Some makes its way to Lake Pepin further downstream.

In 2016, LMRWD engaged Freshwater Society to synthesize and communicate with stakeholders what was known about changes in flow and to demonstrate how increased sedimentation in this reach has been the unintended result of land management practices. Ultimately, they are interested in facilitating the creation of more upstream water storage to reduce sedimentation, but recognize that existing organizations and structures are of insufficient scale to address the problem.

Modeled projections are for more intense April-June storms and an overall increase in annual precipitation. The precipitation patterns are shifting, too, with more rain falling in the Minnesota River basin. So even if we do nothing, the flows in the river will continue to increase,

resulting in increased flooding, erosion, and sediment transport.

Water storage is a likely way to slow the erosion of crop land and reduce the downstream impacts of sediment and flooding. The cumulative effect of each landowner helping a little bit, parcel by parcel, adds up. Importantly, we don't have to recreate the original lake, wetland, and river network to benefit from storage. We can store water in a variety of places, including by planting perennial plant cover that takes water up through its roots and evaporates it during key early spring times of year.

We know we don't have control over the weather, but sometimes it feels like we have even less control over what goes on in a watershed as large as the Minnesota. But this little watershed at the end of the pipe is attempting to find a solution to their sedimentation problems.

The science is pretty clear; it is the politics and policy that are holding us back now. If we pool resources to address the underlying cause of watershed change, then we will reap multiple benefits both upstream and down.

## Recommended Citation

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## About the Author

Carrie Jennings is director of research and policy at Freshwater Society. She was a field geologist for 24 years, most of those with the Minnesota Geological Survey at the U of Minnesota. She maintains a strong connection with the U of M where she did her MS and PhD, is adjunct faculty in Earth Sciences, a member of the faculty in Water Resources and the Natural Resources Science and Management Graduate Program. She has taught a field-oriented glacial geology course for the last 22 years and mentors graduate students across the U.

FEATURE

# PRINCEVILLE AND THE ENVIRONMENTAL LANDSCAPE OF RACE

By Richard M. Mizelle, Jr.

*Our second issue, titled “Imagining Water,” included a rich feature article by Richard M. Mizelle, Jr., “Princeville and the Environmental Landscape of Race.” Mizelle’s piece describes a case of river management in 1999 during Hurricane Floyd where water was let out of the Tar River Reservoir, relieving pressure on the city of Rocky Mount and dumping more water on the predominantly black community of Princeville downstream.*

*Hurricane Matthew has brought flooding to eastern North Carolina in October 2016. An October 11 feature from the New York Times focuses on Lumberton and the rising death toll in the region. An Associated press article carried in the Minneapolis Star-Tribune notes that: “The river gave this town (Lumberton) its life. Now it has torn the community apart.”*

Traveling east on Interstate 64 from the capital city of Raleigh, North Carolina you will see a sign for a town called Princeville. Like so many small towns and cities in the South, Princeville has a rich, contested, complicated, and all too forgotten history. There are no Civil War battle-grounds to commemorate inside the town limits nor was it particularly visible as a place of protest during the Civil Rights Movement. Nonetheless Princeville is a remarkable symbol of environmental resiliency dating back to the end of the American Civil War. This essay uses Princeville as a window into the long history of environmental

*The Washington Post coverage noted that the flood would last for days, if not weeks, unlike the more short-term high water that Matthew brought to the Atlantic coast.*

*It is tragic that devastating flooding has again come to the residents of eastern North Carolina. The coverage from the national media is both informative of the particulars of this flood event, and also illustrative of the deeply divided sensibility that attaches to rivers and urban communities.*

*We are re-posting Rick Mizelle’s feature that was included last spring in Issue Two (with his permission), and we urge readers to examine it for what it shows about racial dimensions of the river landscape.*

—Patrick Nunnally, Editor

racism. Princeville has a unique environmental history, initially situated on land, discarded and unwanted by whites, that was prone to frequent flooding, and surviving back-to-back hurricanes in 1999. Yet this was only half the environmental burden, as residents also dealt with Jim Crow-era vigilante violence directed at a self-sufficient all-black town. While scholars have often defined issues of environmental racism emerging from a post-Civil Rights era momentum in the 1970s and 1980s, Princeville provides an important case study of continuity; it links the disciplining of African Americans into marginal land in

the nineteenth century to questions of forced displacement in the late twentieth century.

Freedom Hill was the name given in 1865 to a settlement of recently freed slaves near the Tar River in territory occupied by Union troops.[i] Across the South former slaves bolted for Union encampments and protection during the Civil War, many willing to fight in exchange for their freedom. When word arrived that the defiant Confederacy would not prevail, angry and bitter planters evicted former slaves out into the cold, penniless and with only the clothes on their backs.[ii] Facing a harsh winter, ex-slaves often set up encampments along the border spaces of

sometimes unsympathetic Union settlements; the wives and children of enlisted men were being promised food and clothes that did not always come. Others died in the snow, suffering from malnutrition, hypothermia, and disease. As historian Jim Downs writes, “Bondspeople who fled from plantation slavery during and after the war, and embraced their freedom with hope and optimism did not expect that it would lead to sickness, disease, suffering, and death. The Civil War, however, produced the largest biological crisis of the nineteenth century...Emancipation liberated bondspeople from slavery, but they often lacked clean clothing, adequate shelter, proper food, and access to medicine in their



*The muddy deserted streets of flood ravaged Princeville, North Carolina stand in silent testimony to the destruction wrought by the Tar River. Princeville, NC 9/28/99.  
Photo By Dave Saville/FEMA News Photo.*

escape toward Union lines. Even after the war ended, they continually struggled to survive in a region torn apart by disease and destruction.”[iii] Former slaveholders and pro-slavery physicians would argue that African Americans were dying and becoming sick from tuberculosis, cholera, pneumonia, and other diseases because they were biologically unfit for freedom and citizenship. It was a convenient and self-serving scientific argument that hoped to re-inscribe control over former slaves by suggesting that African Americans were inherently and biologically prone to disease, and that the paternalistic plantation economy protected African Americans from illness.[iv] Diseases that ex-slaves suffered were the result of starvation, abject poverty, poor clothing and housing, and lack of resources. [v] The mere survival of African Americans in the years after the Emancipation Proclamation showed resiliency.

## A Town’s Namesake

Richard Turner Prince was among the roughly 10,000 slaves around Edgecombe County on the eve of the Civil War laboring on tobacco and cotton farms, and as brick masons and blacksmiths. Born in 1843 under slavery, Prince joined other former slaves in the early settlement of Freedom Hill. Though not much is currently known about this portion of Prince’s life, by 1873 he worked as a carpenter and purchased a plot of land to build a house for his wife Sarah and children Ephraim, Sarah, and Cora. Prince was instrumental in the early history of Freedom Hill, spearheading the construction of buildings and living spaces for residents. When Freedom Hill was officially incorporated in 1885, residents paid homage to the area’s strongest and earliest advocate by calling the new town, Princeville.[vi]

The area known as Freedom Hill, and later Princeville, was initially situated on marshy and swampy land along the Tar River, south of



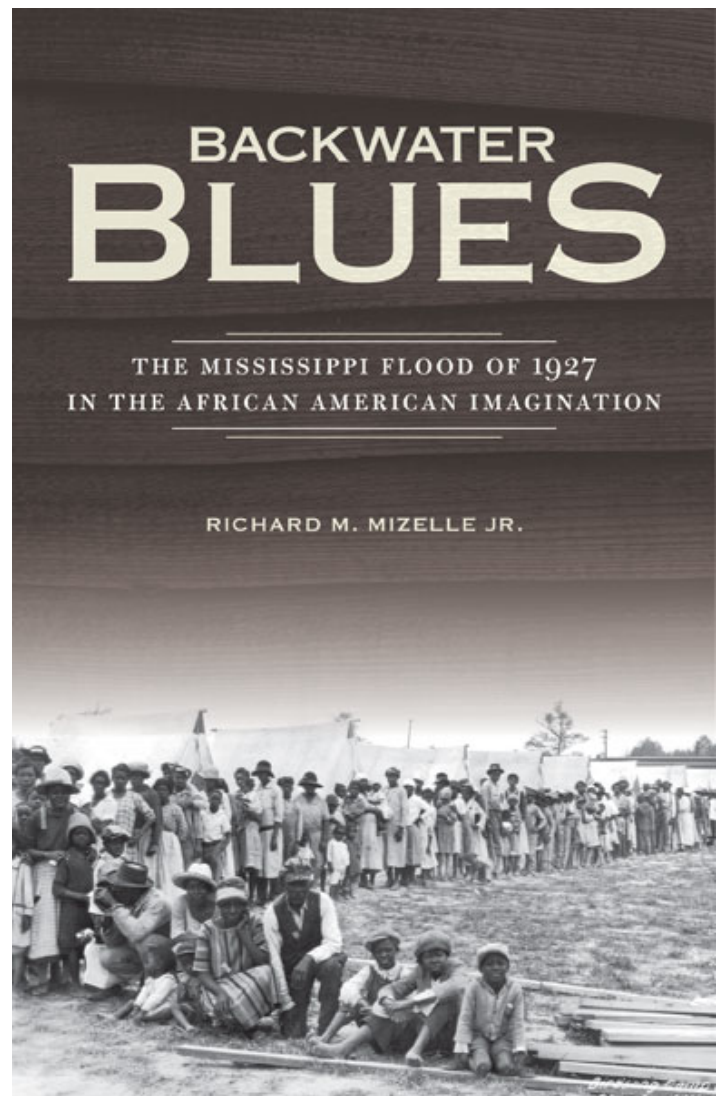
*Originally known as Freedom Hill, Princeville was settled by freed slaves on an unwanted floodplain.*

Tarboro, North Carolina.[vii] African Americans have often been forced into the most degraded and treacherous environmental spaces to live and work, the early history of Princeville providing an important example. Princeville represents an important case of historical environmental injustice because of the ways in which early Princeville settlers were forced to occupy the most vulnerable riparian landscape in the nineteenth century.

As I argue in my book, *Backwater Blues: The Mississippi Flood of 1927 in the African American Imagination*, too often scholars narrowly frame questions of environmental injustice as emerging from two moments. Beginning in 1978, mostly poor white and African Americans residents in upstate New York demanded answers regarding the toxic materials and carcinogens that began percolating from sealed underground containers causing nausea, deformity, birth defects, and other sickness. Known as the Love

Canal disaster, the events that unfolded in this Niagara Falls community have long been regarded as helping to shift the consciousness of environmental activism.[viii] Secondly, scholars point to the protest over the dumping of polychlorinated biphenyls in a predominately working-class African American community in Warren County, North Carolina in 1982.[ix] An interracial coalition of activists spearheaded the non-violent protests and demonstrations that mirrored strategies of the Civil Rights Movement. In what would become a powerful image of environmental activism, demonstrators attempted to prevent dump trucks carrying the toxic materials from entering the community by lying in the street.[x] On the heels of the Modern Civil Rights Movement and Black Power Era of the 1960s and 1970s, the environmental injustice era certainly gained momentum with the national attention and protests these two episodes of environmental racism generated. However, by placing too much of a focus on environmentalism and race in the 1970s and 1980s, we can miss earlier moments of environmental racism that in part help inform later movements and ideologies.

In his classic 1937 text, *Caste and Class in a Southern Town*, sociologist John Dollard uses a lens of mostly class, power, and occasionally race to highlight a historical connection between spatial vulnerability and environmental landscapes. [xi] Most likely Dollard was describing the Yazoo Mississippi Delta town of Indianola, Mississippi (MS) in Sunflower County, approximately 90 miles north of Jackson, MS. According to Dollard, Indianola “is a small town, just about large enough to qualify under the census as an urban area. It is flat as a tennis court but with a bit of a tilt, the white people living on the upper half. Should floods come, the Negro quarter would be first under water. Southerntown is bisected by a railroad, and its tracks divide people according to color, the whites living on one side and the Negroes on the other.”[xii] Dollard’s text provides a framework for thinking about the early history of Princeville and environmental injustice, in



*Backwater Blues: The Mississippi Flood of 1927 in the African American Imagination.*

particular how African Americans and people without power have often been relegated to the most dangerous, marginal, and vulnerable spaces.

Perhaps no space represents the periphery of human existence as do swamps. Not fully land and not fully water, swamps were dreaded spaces in the nineteenth century, a place of unknown danger where “miasmas” and “effluvias” arose from enigmatic and ghostly landscapes that caused sickness and death in pre-germ theory consciousness.[xiii] Nineteenth-century perceptions of swamps were that these places were inherently diseased and dangerous. Swamps were

places that foreign “beasts” or alligators inhabited; animals that did not reside fully in water or fully on land were particularly feared in swamplands. Historian Conevery Bolton Valencius describes these places as “alien and threatening, the animals inhabiting swamps were symbolic of their pervasive and clinging dangers.”[xiv] Both the animals that inhabited swamps and the terrain itself were dangerous. Yet, swamplands have a more complicated history and narrative. During slavery, swamplands, though dangerous and a place where it seemed like a multitudinous number of animals converged and evoked strange and frightening noises, provided a route for escape from slavery for runaways. Runaway slaves were safer fleeing near swamplands and escaping through these spaces as dogs might lose their scent and planters attempting to track them down might fear entering into these dreaded places.[xv] The Great Dismal Swamp between

North Carolina and Virginia was the home of maroons, runaway slaves who defied plantation slave economies throughout the New World by living in mountains, swamps, and forests within territories of slavery.[xvi]

Early Princeville residents had to endure harsh swampland to survive. Their existence in this space was not a matter of chance or choice, but instead the discarded and unwanted space was what former slaveholders allowed them to occupy. Historian Sylvia Washington Hood describes this as the environmental “others,” or those “forced to live in geographical spaces (communities) within the society that are or are becoming environmentally compromised because of their ‘otherness’...they are the proper place for everything deemed to be undesirable (people and waste).”[xvii]

## The Environmental Landscape of Race

The early years of Freedom Hill and Princeville were extremely difficult because of the landscape of place and the landscape of race. The Tar-Pamlico River’s headwaters begin in the Piedmont region of the state and the river slowly meanders through the eastern coastal part of the state, ultimately spilling into the Atlantic Ocean. Approximately 180 miles long, The Tar River-Pamlico basin is the fourth largest in the state, and one of only four rivers whose boundaries are located completely inside the state of North Carolina. The Tar River is a slow-moving body of water, low-lying, marshy, and swamp-like in certain places, historically susceptible to flooding and overflows.[xviii] Documented floods of the Tar-Pamlico River basin occurred in 1800, 1865, 1889, 1919, 1924, 1940, and 1958.

Like other towns in the river basin, Princeville’s legacy is one of perseverance and endurance against the constant threat of seasonal flooding in a very difficult landscape. But Princeville had more to persevere against than seasonal flooding. The mere presence and economic self-sufficiency and stability of an all-black town during the segregated Jim Crow south were an affront to racial segregationists. Put in more stark terms, Princeville infuriated segregationists who opposed any type of self-sufficiency and power among African Americans. Predominately African American and self-sufficient towns as well as black business districts in places like Tulsa, Oklahoma or Durham, North Carolina experienced violent opposition from segregationists in the early twentieth century.[xix] Historian Rayford Logan coined the term Nadir to describe the heightened racial violence and lynching

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experienced by African Americans between the 1880s and 1930s when roughly 3,800 people were lynched in the United States.[xx] African Americans were lynched for any of a number of transgressions against white society in Jim Crow America, including entrepreneurship and being self-sufficient. Well known is the story of Ida B. Wells-Barnett's friend lynched in Memphis, Tennessee for owning a successful store, an experience that would lead her into the anti-lynching crusade.[xxi] Throughout the twentieth century, Princeville residents constantly dealt with racial attacks and intimidation, as well as economic

social isolation from the state. Infrastructural neglect from state officials was consistent during the era of segregation and beyond. Princeville's story is, therefore, representative of an argument that I make in other contexts, particularly that African Americans have often dealt with a double burden of environment that includes human and non-human factors.[xxii] The frequent flooding of the Tar River can only be understood alongside the high tide of violence Princeville residents evoked by the mere audacity of their existence.



*Tar River water level elevated almost to reach the bridge. Date from negative sleeve.  
Daily Reflector (Greenville, N.C.), January 26, 1954.*

# Princeville and Contested Meanings of Water

The story of Princeville is also about the historical misuses of water. Leisure, for instance, has been defined through the politics of difference. During the Jim Crow era, public beaches, resorts and parks, from California to Florida, excluded African Americans from being able to swim and enjoy nature.[xxiii] African Americans and other minorities were often locked out of access to water in the form of leisure. Battles to desegregate access to beaches could be as vitriolic as those to desegregate lunch counters in Alabama, the desegregation of housing in Chicago, and schools in Topeka, Kansas. The large and sparkling municipal swimming pools built in southern cities were mostly off limits to black swimmers, who instead had to swim in creeks, lakes, and rivers that could be dangerous. Powerful undertows, water moccasins, and alligators were just some of what black swimmers had to contend with in these uncontrollable bodies of water. African Americans entering a southern municipal pool would have been perceived as a profound transgression of racial norms that could easily provoke violence, particularly when scantily clad white women and black men were in the same space. [xxiv]

The color line of segregation extended beyond pools and into other bodies of water. When the 1919 Chicago race riot began because of a black boy crossing an imaginary racial line while swimming, it reflected what was widely considered a commentary of race, but rarely considered an issue of race and nature, even though the key to the moment was access to nature and access to water.[xxv] For most scholars of African American history and environmental history, this key component of one of the most violent race wars in American history is subsumed under the

ensuing conflict. The important role of water is lost, and particularly the idea that white access to this public water was somehow natural; African Americans must always know their “place” even when that place is in water.

On yet another level, water infuses the narrative of the Civil Rights Movement. Swimming pools were not only a site of segregation in terms of swimming, but as I argue in my earlier work, water was harshly employed by cities and municipalities as a way of attempting to discipline black bodies away from activism. When civil rights activists attempted to bring segregation to an end in places like Birmingham, Alabama, the police and firefighters turned water hoses on them with such force that it knocked some protestors down and literally ripped the skin off others. A natural and life sustaining resource to all human beings, in this instance water was transformed into a weapon of racial violence.[xxvi]

By 1965 Princeville was successful in initiating some modern environmental improvements that allowed the town to continue to prosper and grow, including the construction by the United States Army Corps of Engineers of a dike for the protection of Princeville against flooding. [xxvii] While Princeville’s population remained small, there was an upsurge of population and business interest in the town during the decades after 1965. By the end of the twentieth century, Princeville and the region continued to face many economic problems, however. The eastern part of North Carolina is the poorest region in the state. The median family income for Edgecombe County, where Princeville is located, is just \$34,000 per year. The rate of individuals living below the poverty line in the county of over



55,000 residents is almost 23 percent, roughly 8 percent higher than the state-wide average. The 41 counties that make up the eastern portion of the state have a higher rate of almost every disease than the rest of the state. Morbidity and mortality rates from diabetes, cancer,

cardiovascular disease, and stroke are high in the region, as are rates of obesity that are directly related to questions of poverty. African Americans and Hispanics in the region suffer disproportionately from these diseases and illnesses, mirroring state-wide and national trends.[xxviii]

## Princeville and the 1999 Hurricanes

This was the backdrop in 1999 when back-to-back hurricanes occurred. In early September 1999, Hurricane Dennis struck the coast of North Carolina, bringing winds of just over 70 mph. Just 10 days later another hurricane, Floyd, would hit the coast bringing significantly higher winds of 130 mph. Floyd was a broad storm with a wing-span of some 580 miles that liberally spread rainfall and high winds up the east coast and Atlantic states. Still reeling from the saturated landscape and 6 to 8 inches of rain brought by Hurricane Dennis, North Carolinians nervously anticipated the arrival of Floyd which came ashore in the early morning hours of September 16th on the Cape Fear coast. The storm quickly brought an additional 12 to 15 inches of rain on the eastern part of the state during the first day, and altogether more than thirty North Carolina counties were impacted by the storm. The Tar River, Pamlico River, Neuse River, Roanoke River, and other smaller creeks and streams began flooding from the rainfall of Floyd, pushing floodwaters onto the farmland of eastern North Carolina. Officially there were 51 recorded deaths from Hurricane Floyd, though the accurate recording of deaths from environmental disasters has always been an inexact science. More than 17,000 homes were destroyed and another 56,000 partially damaged by wind force or flood waters that kept Princeville under water for 11 days. Still, thousands of eastern North Carolinians lived for years in what were called “FEMA-villes.” This compilation of make-shift trailers, nicknamed “Camp Depression” by some residents, was located outside of Rocky Mount

near a landfill. Using the lens of Princeville’s founding and the history of environmental activism against toxic materials and the unwanted placement of a dump in Warren County just under two decades earlier, Princeville residents found themselves once again in a continuum of poor people and minorities being forced into degraded spaces.

In many ways Princeville was a powerful, yet unacknowledged precursor to Hurricane Katrina six years later. Many of the frustrations with the Federal Emergency Management Agency (FEMA) were registered by both Princeville and Katrina survivors, particular in terms of how long it took the organization to provide relief. In a 2014 report on Princeville, current and former residents of Princeville believed that relief from FEMA after the hurricane was slow, echoing similar criticisms of FEMA after Katrina.[xxix] The report also acknowledged the strong historical ties of place that both Princeville and New Orleans residents voiced after being displaced from their homes. “Like New Orleans, the natives of Princeville exhibited a strong connection to the community.”[xxx] At stake was the legacy and memory of Freedom Hill.

By 1999 Princeville was still a relatively small town with just over 2,000 residents, many of whom were direct descendants of the original settlers. There were roughly 850 single-family homes, approximately 40 businesses, and 3 churches, one of which, Mt. Zion Primitive Baptist Church, was constructed in 1876.

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Flooding from Hurricane Floyd submerged the entire residential and business area of Princeville for almost two weeks with 15 to 20 foot high floodwaters. For this historic town, Hurricane Floyd was nothing short of devastating. For residents of Princeville, the hurricanes might have seemed fortuitous to those interested in their demise. Though Princeville's first settlers were initially forced into environmentally degraded land, by the mid-twentieth century their waterfront location had been re-defined by local and state officials as prime real estate property. The result is that Princeville has often dealt with both real and imagined pressure to cease existing as an all-black community, and to allow their property to be annexed by surrounding towns.

In the weeks after the storm hit the North Carolina coast, rumors began circulating that perhaps the suffering of Princeville was not completely the result of Hurricane Floyd. Soon the rumors were confirmed. The city of Rocky Mount, located roughly sixteen miles to the west of Princeville along highway 64, had opened the floodgates to the Tar River Reservoir Dam during the first days of the storm in the hopes of averting disaster. The Tar River Reservoir was completed in 1971 as a drinking water conservation project primarily for the city of Rocky Mount which had been suffering through severe droughts in recent years. The decision and actions of Rocky Mount seemed to have occurred very quickly during the first 48 hours of Hurricane Floyd as the Tar Reservoir, like other natural and unnatural water systems in the region, was threatening to



*Aerial photograph of inland flooding caused by Hurricane Floyd.  
Photographer J. Jordan of the US Army Corps of Engineers.*

flood. In an interview with UNC-TV that aired December 6, 1999, Peter Varney, the assistant city manager for Rocky Mount, suggested that the city was “wrapped up in an unbelievable flood of decisions, problems, and issues. We just went ahead and dropped that...gate. It appeared to us that what would come by lowering the gate by two feet would not be noticeable.”[xxxix]

By “dropping that gate” Rocky Mount became part of a long and contested narrative of self-preservation and folklore around flood control. During the 1927 Mississippi River Flood, the City of New Orleans deliberately destroyed the levee around Plaquemines Parish; their hope was that if a neighboring area flooded, New Orleans would remain safe from the harshest elements of the flood. Neighbors up and down the Mississippi River and tributaries placed armed guards on levees to prevent sabotage by neighbors.[xxxix] There were rumors that levees were deliberately blown in black neighborhoods during Hurricane Betsey in 1965 that nearly destroyed New Orleans, and again in 2005 during Hurricane Katrina. Because of what occurred in New Orleans during the 1927 flood, such rumors were never without some merit of concern as historical rumors and memory might hold grains of truth and reality.[xxxix] Importantly, the use of water technology in the creation of suffering is crucial to the story as well. In his classic work *The Whale*

and the Reactor: A Search for Limits in an Age of High Technology, social theorist Langdon Winner asks whether “artifacts have politics” and how we might imagine culture, politics, class dynamics, and race within the theoretical and practical development of technological systems. “At issue is the claim that the machines, structures, and systems of modern material culture can be accurately judged not only for their contributions to efficiency and productivity and their positive and negative environmental side effects, but also for the ways in which they can embody specific forms of power and authority.”[xxxix] Technological systems have politics precisely because technology does not and cannot exist outside of human intervention, therefore people make choices about levees and dams, and when to “drop that gate” or not.

State officials argued that Rocky Mount’s actions were acceptable under the circumstances, and made the point that opening the flood gate likely did not increase the level of downstream flooding to a significant degree. However it has never been confirmed how much water was actually sent downstream by Rocky Mount’s actions. The moral and ethical tension of the situation also revolved around whether Rocky Mount was required to, or should have informed their downstream neighbors of their impending action.

## Who Controls Water?

The fundamental question of the Princeville disaster was who controlled the water? Questions of water control, riparian laws, and the rights of upstream and downstream neighbors have been part of legal case studies since at least the early nineteenth century. Legal cases, dealing mostly with upstream actions on downstream neighbors, including but not limited to mill operations and dam use, leaned heavily upon precedent cases of ancient water use laws or “reasonable use.”[xxxv]

While this history of water use law is fairly extensive, the literature around more emergency uses of water in the context of environmental disasters is less developed. This is the particular niche where the Princeville disaster comes to light. To be sure, water rights laws remain complex in the twenty first century and it remains unclear if Rocky Mount city officials actually did anything wrong when they opened the floodgates that perhaps increased floodwaters toward their

downstream neighbors. The optimal word here is uncertainty. Water and particularly flooding can be a difficult concept to measure in this context, and perhaps we can never fully know whether the actions of Rocky Mount contributed significantly to the downstream flooding of Princeville. Perhaps the town of Princeville would have endured a similar fate regardless of the actions of Rocky Mount. However, I would make the case this is beside the point. The perception, whether real or imagined, that Princeville was sacrificed by their upstream neighbor goes a long way into tapping into the frustrations of not simply race and class, but the two century long struggle of downstream neighbors to fend off and demand equality from the seemingly sacrificial actions of those more pristinely situated up-river. In this particular case, it also represents Princeville's century long struggle for survival against both environmental and human threat.

The story provides an important case study for historians and others to think about water usage

## Conclusion

Princeville is a story of resiliency in the face of harsh environments. Though it never generated the headlines of Hurricane Katrina or Superstorm Sandy, Princeville represents an important narrative of disaster and survival. In ways similar to New Orleans, Princeville has struggled to

and law during environmental disasters and the ways in which decisions of water rights reflect long-standing legal narratives of the control of water. In a certain sense, history is just as much about what we can "prove" as what we think. The perception of African Americans in the eastern part of the state was that the water-front property of Princeville and the lives of Princeville residents were much less valuable than those of Rocky Mount. Interestingly enough, this was the argument made by riparian plaintiffs in the eighteenth and nineteenth centuries.[xxxvi] But Princeville also fits into the conversation of power and advantage. Decisions are not made within a vacuum, but importantly can be linked through history to questions of worthy and unworthy sufferers. Freedom Hill survived an environmentally difficult landscape in the immediate period after the Civil War. Princeville residents have been fighting all kinds of environments along the Tar River ever since.

rebuild its community fabric and infrastructure in the more than a decade since the hurricanes. Yet, traveling on highway 64 the sign for Princeville is still there, signaling the presence of a resilient community located on space that was as contested in the nineteenth century as it remains today.

## Footnotes

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PERSPECTIVES

# OWÁMNIYOMNI, A DAKOTA NAME FOR “ST. ANTHONY FALLS”

By Mona M. Smith

*Owámniyomni*, a Dakota name for “St. Anthony Falls,” means turbulent water, whirlpool, eddy. To Dakota people the Mississippi River has a few names, one is *ħaħáwakpá* – the river of the falls, a name that reveals the importance of the waterfall.

The current concrete cascade used to make me sad. Smooth water sliding not tumbling, curling water falling. More human interference. More human pretense. “We didn’t really completely destroy the ONLY waterfall on the Mississippi, see?” Artificial. Built. Meaningless. No evolution here, just engineering and pseudo waterfalls. Then I

spent time at the falls with a Dakota elder whose name connects her to *Owámniyomni*. She helped me feel the power of the falls that continues, that is stronger than human power. Then I could see and feel that at the bottom of the smooth slide down the human made part of the falls is the whirling water, the spray, the energy and power of the falls. The falls are manufactured, but the water’s spirit endures. Now I recognize why I feel clearer and soothed and somehow energized each time I spend time in the St. Anthony Falls area. I can’t provide specifics, but the water of the river looks and feels different to me since spending time there with her. I see an indescribable spirit



*Morning mist at St. Anthony Falls. Image courtesy of Mona M. Smith and Joanne Richardson.*



of the water. I feel the possibility of healing. When I spend enough time with the river, I know I will be better able to hear her messages.

Another elder in a video piece produced years ago for the Bdote Memory Map said, “Water is the most powerful medicine. Water can heal anything. All we have to do is ask.” When I see the river in that new way, when it doesn’t look like I used to see it, I ask.

See *Healing Place* video.

Yet another elder says that St. Anthony Falls is a teaching place. I’ve thought about what it

teaches me. One of the first things I learn from the falls is that change is part of everything, even the 2,320-mile long Mississippi River. The falls express change on a scale far beyond human timeline. Twelve thousand years ago the falls were near *Imnizaska* (St. Paul). Now they are in *Bde Ota Otunwe* (Minneapolis). Nothing stays the same. Another thing I learn is that power is not ours. Humans imagine being highest on some invented hierarchy of existence. Listening to St. Anthony Falls, one learns that humans are a part of *mitakuye owasin* (all my relations) and can manipulate, damage, distort, but *makha ina* (mother earth) has dominion

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IN REVIEW

# TROUBLED WATERS: RIVERS IN LATIN AMERICAN IMAGINATION

By Tim Frye

The 2013 *Hispanic Issues On Line*[1] volume, *Troubled Waters: Rivers in Latin American Imagination*, is a collection of essays that underscores an intellectual turn in Hispanic and Lusophone Studies toward the environment, and more specifically, the material, metaphysical, and literary “nature” emblematic of rivers that flow south of the Río Grande. For the purposes of this review, I will mention but a few rivers in

a pantheon of great rivers across the breadth of Latin America and how the writers in this volume re-think those rivers beyond poetic backdrops across which colonial, modern, and postmodern literature flow. Rather, these rivers, Pettinaroli and Mutis write in their introduction to *Troubled Waters*, must be understood in relational terms, “as boundary and as connection; as paths to death and life; as emblems of both



*lizdinovella. Rio Sumpul Mural. 2010. Arcatao, El Salvador. Via Flickr.*

transformation and an anchoring of identity; as signs of dissolution and transformation; and as change and continuity” (2).

In *Troubled Waters*, the Amazon, Magdalena, Orinoco, Sumpul, Río de la Plata, and Pastaza, among others, serve as avenues through which to better understand expansionism of the Spanish empire, its subsequent colonization of the Americas, independence and nation formation, and modern imaginaries, for these rivers themselves bear the marks of history in a way that makes their literary representation possible. While the most emblematic of these rivers—the Amazon (see Anderson’s “Traacherous Waters”) [2], Orinoco (see Arias’s “The Intellectual Development of the Orinoco”)[3], and Rio de la Plata (see Hill’s “Ariana Crosses the Atlantic”) [4]—hold a certain gravitas in Western imaginaries, scholarship on rivers like the Magdalena (Colombia) and the Sumpul (El Salvador) offers a distinct window into Latin American life, literature, and history, that remains outside the purview of the U.S. academy.

The Magdalena River flows across Colombia on a North-South axis, nestled between the Cordillera Central and Oriental, emptying the fluvial Andean runoff into the Caribbean Ocean. Its literary construction spans the very first moments of Spanish Conquest to contemporary greats like García Márquez, and more recently Laura Restrepo (see Mutis’s “The Death of the River and the River of Death”)[5]. In her essay “Watershed of Sorrows,” Pettinaroli analyzes some of the first writings of Spanish Conquest, those of Alonso de Santa Cruz, the cosmographer par excellence to Carlos V and Felipe II’s imperial regimes. Pettinaroli theorizes “that Alonso de Santa Cruz’s dramatic description emplaces the [Magdalena] river as a perceptual grid, opening up a discursive space in which to tackle the weightiest question in the dispute over the nature of the Tropics: the ethics of imperial expansion” (20). Already in the sixteenth century, the Magdalena River was written as the locus of enunciation of both localities (local communities,

topographies of the river) and the universal expansion of empire that attempted to engulf and thus erase these localities.

From the mid-twentieth century until contemporary times, Latin American rivers and their literary creation have become landscapes of political and social change and trauma. The Sumpul River forms a section of the border between El Salvador and Honduras, yet the river is more widely known for the massacre that occurred across its banks in 1980 during which some 600 unarmed civilians were killed by the Salvadorian and Honduran armies (see fig. 2.). In his essay, “Blood in the Water,” Kane reminds us just how important the rivers of Central America are, not only to poetics, but also as vehicles for enunciating trauma. He writes, “[T]he river itself becomes a medium of testimony, opens the door to a rereading of Latin American testimonial texts in which the concept of place, including the nonhuman natural world, receives much more careful consideration than it has in the past” (175). This type of relation to the river allows us consider how agency is not solely the arena of humans, and that in moments of trauma, violence, or civil unrest, we must look closer at these aquatic landscapes that we drink from, bathe in, and even die in, for answers.

In many ways, the Magdalena and the Sumpul are emblematic of rivers around the world in that they traverse rural and urban environs. In his essay, “Rural and Urban Rivers,” which is more of a treatise over a long career of Latin American literary scholarship, Raymond Leslie Williams maps urban and rural aquatic landscapes across Latin America, marking their change throughout twentieth-century literature: from the literature of the early republics to the literature of the 2000s. For Williams, moments of rupture read in writers like Julio Cortázar, Carlos Fuentes, and Roberto Bolaño echo the reworking of rivers by human intervention, and in doing so, require the re-imagining of what a river can be. He writes, “[T]he flâneur figure and the metro are both easily conceived as urban metaphors for the rural



Santa Cruz, Alonso. *Islario general de todas las islas del mundo*.  
Second Half of 16th Century. Biblioteca Nacional de España, Madrid.  
By Alonso Santa Cruz [Public domain], via Wikimedia Commons

river” (201). While river water rushes through pipes below the urban metropolises of Latin America, the reality comes to bear that rivers are becoming increasingly hidden from view, and are thus written through divergent modes such as urban landscapes, and in doing so, render the Romanticist image of the river of the tropics problematic.

Spadaccini and Gordillo remind us in the afterword of *Troubled Waters*, that in addition to rivers providing water, transportation, religious and metaphysical substance, “rivers are also literary, cultural, and political constructions forged by the minds of creative writers, cultural critics, scientists, and politicians of various ideological stripes” (213). They are sites of exchange, on the banks of which disciplines meet with their disparate methodologies in tow both within and without academia. What is increasingly important, however, is how local and indigenous knowledge of rivers is met by increasingly cemented and alienating modes of modern water: canals, dams, and refuse sites. Absent from “*Troubled Waters*” are important genres to arise out of this very type of confluence of knowledge in the

Hispanic and Lusophone world: in Panama the Canal Novels,[6] and the Dam Novels in Spain,[7] Brazil,[8] and Paraguay.[9] These genres spring up as a result of colossal displacement of people, a reshaping or erasure of the land and traditional practices along rivers, and are often coupled with environmental disaster—take for example the Bento Rodrigues Dam that burst in southeastern Brazil, inundating immense swaths of land and people in toxic mud.

*Troubled Waters* makes crucial steps toward rethinking the relationality of Latin American Rivers, their inseparability from the literature that writes them, and the lived experiences of those that inhabit their banks. Rivers of the Global South, like those of the Global North, are the sites of the often-opposed worlds of local and indigenous knowledge, and technocratic river management. *Troubled Waters* thus signals an important shift toward interdisciplinarity in the approach to rivers in Hispanic and Lusophone Studies, and in doing so allows more comparative work to be done on rivers across the world and the complex histories that flow through them.

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## About the Author

Tim Frye is a PhD student in the Department of Spanish and Portuguese at the University of Minnesota where he engages political and spatial imaginaries of infrastructure and the environment in Latin America. His dissertation project is a comparative analysis of megaprojects in Central America (The Panama Canal and The Gran Canal of Nicaragua) and Brazil (Free Economic Zone of Manaus) and how the intersections of literature, water use, and infrastructure are negotiated by those most affected by their construction.

TEACHING AND LEARNING

# LEARNING WITH THE FLOW: MY JOURNEY AS A STUDENT WORKING IN THE “REAL WORLD” OF RESEARCH AND COMMUNICATION

By Maxyne Friesen

A major piece of Twin Cities news in summer 2015 was the closure of the St. Anthony Falls Lock on the Upper Mississippi. This garnered a lot of attention, and raised many questions from the community. At the time, I was taking

a full-time summer course load, and was more worried about drowning in my chemistry and philosophy homework than about local river news. But the following winter I got the opportunity to be part of a research team looking at this



*Lithograph of Minneapolis, Minnesota, 1874, by Hoffman. Chas. Shober & Co., Proprietors of Chicago Lith. Co. via The David Rumsey Historical Map Collection.*

very event. It might seem strange to take a job on a topic you know very little about, but I'm fairly certain that if you look at a thesaurus you'll see that student is synonymous with I'll do anything that pays and is even vaguely related to my major. Just trust me on this one.

I began working with a small team of undergraduate students in early January 2016. Our objective was to look at scientific data and communicate it to the public. In my time thus far as an Environmental Science and Policy student at the University of Minnesota, I had written countless research papers, read plenty of technical and scientific writing, and given many presentations. I felt prepared. I was confident and self-assured that in my three semesters at the U of M, I had exactly the skills needed to do the job.

Walking out of our first meeting, I was not so confident. The data had not all been collected yet, and the data that had been collected was not consolidated or ready for us to access yet. At the end of the semester there would be a series of presentations to the community, but we didn't know yet exactly what would be presented, or where, or to whom. We were setting out on a project whose end-point was not yet fully determined. As a student, this level of ambiguity was not something I was familiar with. I realized I was going to have to step out of my comfort zone to do this job well.

Our first hurdle was to figure out how to understand the river without data – in a less scientific way. The data was not ready for us to work with yet, so we took a step back and looked at the history of the Mississippi River. We explored how it has been managed through time, coming to understand that the line between a “natural” and a “managed” river has been blurred for a very long time. By the end of January, I had a gigabyte of PDFs and Word documents in a folder on my computer that I was working to familiarize myself with. At this time, we were starting to talk more concretely about who our audiences would be

at the end of the semester. We knew from the beginning that we would be talking about river management, but as a student, the answer to the question “Who is my audience?” is roughly the same for virtually every assignment. Being in meetings and discussions where we were deciding who the audience would be was very new to me. But because nothing was definite yet, it was challenging to know what information would be useful or important. There was no assignment sheet or checklist; there was no grading rubric or study guide. I learned how to work toward a goal that was not yet explicitly defined and still being developed.

In this first phase of my work, I learned how to develop my own system of tracking information and determining what I thought would be important for each potential audience. This kind of self-guided discovery is not something I could easily learn in a lecture hall. College classes do a great job of building a necessary base of knowledge. But skills like creating my own benchmarks and goals can only be developed through real work experience.

In the next phase of the project, when the research was ready for us to access, we came across our next hurdle. We were given raw spreadsheets of the scientists' data, with reference numbers, markers, and abbreviations we were entirely unfamiliar with. How do we take all of these spreadsheets and pull out useful information? We weren't there for the data collection, and we weren't biology students. We had taken some classes that covered topics like bathymetry or water chemistry broadly, but we were not experts in these areas. We quickly realized that the research we had been doing on familiarizing ourselves with the river's history and significance left a gap in the knowledge we needed. We had not yet explored the physical state of the river.

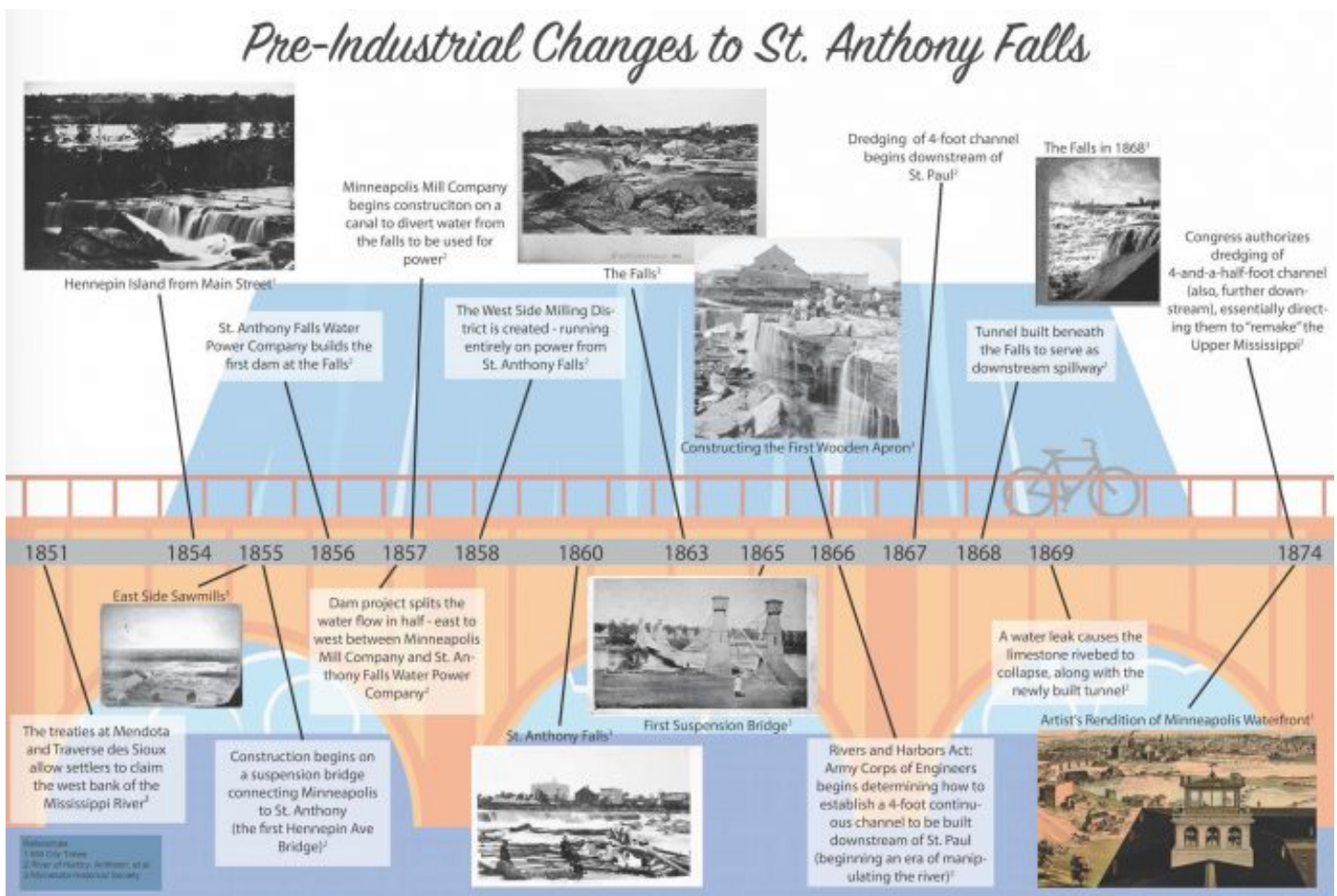
After a few days of looking up fish genus names and deciphering river mile markers, we began to notice that we were trying to get as familiar with



the data as the scientists who gathered it. We were trying to understand every aspect of every spreadsheet. This clearly was not going to work. So we formulated a new strategy – we would go back to the spreadsheets, and ask ourselves, “if I am a community member hearing about the closing of the St. Anthony lock, what information would I want to know?” This way, we gave ourselves our own direction, and our own assignment guidelines. Using these guidelines, we were able to make useful visual representations of the data for the team to use in our community presentations. All of our research, information-gathering, and data visualization boiled down to two 20-30 minute presentations. Each step of the process informed the next, and although every single piece of research wasn’t used, the process as a whole allowed me to be very informed on the

topic and ready to talk to the community about the river.

One of the most memorable moments of this whole experience was our last presentation, which took place at the Mill City Museum in Minneapolis. I took a lot of the information I had gathered throughout the semester, and distilled it down into a timeline of human interventions in the Mississippi River to share at the event. I got to bring my creativity, knowledge of the topic, and love for community engagement together and presented this on a poster to audience members. I had conversations with people who care deeply about the Mississippi River and the Twin Cities in general, and hear about how they connect to the river. I heard stories and perspectives from people I otherwise would not have had the chance



*Pre-Industrial Changes to St. Anthony Falls by Maxyne Friesen.*

*Images via Minnesota Historical Society and the David Rumsey Historical Map Collection.*

to interact with on a topic we all cared deeply about. It was a memorable evening in a beautiful location that brought an end my time on the research team.

*Download the poster: [Pre-Industrial Changes to St. Anthony Falls by Maxyne Friesen \(2.3 MB\)](#)*

The main theme of this issue is “intervention,” and I know this is primarily meant in the sense of literal interventions in the Mississippi River. But just as humans have intervened with the Mississippi throughout its history physically, in my time as a student worker with River Life I learned to constantly “intervene,” if you will,

in my own work. I learned to continuously ask myself and my teammates, “Is this the best way to do this?” or, “Should we be thinking about this differently?” Intervention in the sense of purposefully changing the current course of action is crucial in the world outside of the classroom where there are numerous changing variables. I had to learn this quickly in my time on the research team, and I know this will not only make me a stronger student, but will also aid in my success in future jobs or career endeavors. Plans change, people change, circumstances change, and only through work experience can we as students really learn to embrace them as part of a professional process.

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## About the Author

Maxyne Friesen is a junior at the University of Minnesota studying both Environmental Science Policy and Management, and Computer Science. She is drawn to the intersection of sustainability and technology. She feels strongly that some of the most profound progress in this area comes from education, advocacy, and community conversations.

PRIMARY SOURCES

# MINNEAPOLIS' UPPER HARBOR TERMINAL: A GEOSTORY OF COLLABORATIVE CREATION

By Laurie Moberg

Embedded in landscapes are the social histories of how a space has been shaped and reshaped by human and nonhuman forces over time. Each reinvigoration of a geography to suit human interests, desires, even human understandings of nonhuman capacities leaves traces, sometimes obscuring, eroding, or even erasing the previous human intentions. Yet how do our iterative landscape reconfigurations demonstrate our understanding of the material earth and its dynamic capacities? In the era of the Anthropocene, as arguments articulate how human projects and practices have irreparably altered and continue to transform the planet geologically, ecologically, and atmospherically, I pose this question neither as a theoretical enterprise of intellectual abstraction nor as a call for scrutiny of ecological changes or archaeological evidence. Instead, I ask this question in this way because the era of the Anthropocene is both daunting and full of potential: daunting because we teeter near the precipice of an irreversible tipping point beyond which humanity's existence is drawn into question; full of potential because in the face of an uncertain future, we have the capacity to reevaluate our histories and reimagine our relationships with the planet in more collaborative terms.

So what happens when we reposition humanity not as the central figure in shaping the world but as one of many co-creating agents, from rivers to fiber optic cables to insects? Social theorist Bruno Latour suggests that recognizing that we share agency with the earth and create the world together is a step toward beginning to tell what he calls "our common geostory" (2014:3). Using the following three images, I'd like to begin to tell a kind of abbreviated historic geostory grounded in a particular place: a stretch of the Mississippi River abutted by what is currently known as the Upper Harbor Terminal (UHT) in north Minneapolis. Perhaps not particularly photogenic or scenic according to typical aesthetic standards, this stretch of riverfront between the Lowry Avenue and Camden bridges on the west bank of the Mississippi River has been repeatedly reconfigured to suit the needs and visions of a particular period. The images here show three configurations of the UHT landscape across a century. Together, these images demonstrate the temporal layering of a physical and social landscape, highlighting changes over time; my analysis aims to illuminate how these changes emerge at the intersection of humans and nonhumans, and point us toward an alternative perception and ethic of co-creating the world.

# The Logging Trunk Line

At the turn of the twentieth century, much of Minneapolis' riverfront area was dominated by mills. As the St. Anthony Falls area became the primary home for flour mills, lumber mills eventually moved upstream to more spacious sites that could accommodate the need for growing lumber and train yards. From the 1890s through the first decade of the 1900s, the UHT in north Minneapolis was a key lumbering hub for the Upper Midwest, and the Mississippi River became a prosperous trunk line, carrying

felled trees downstream from across northern Minnesota.

The Bovey-DeLaittre sawmill and lumber yard pictured here was one of the myriad successful lumbering enterprises in Minneapolis. Opening its doors in 1869, the Bovey-DeLaittre sawmill found security by providing for lumber yards in smaller, rapidly developing agricultural prairie towns across the Upper Midwest (Larson [1949] 2007). After fire took their first sawmill operation



*Bovey-DeLaittre sawmill and lumberyard, circa 1905, photographed by Elgin R. Shepard.  
Image used with permission of the Minnesota Historical Society.*

on the east side of St. Anthony Falls, the Bovey-DeLaittre Company rebuilt upstream on what was previously farmland (Hotchkiss 1898) and what would later become the UHT. They remained at that site until closing their doors permanently in 1915 (Larson [1949] 2007).

In this image, human effort, industrial prowess, and development drive are evident. This era of American growth transformed forests into economic resources and rivers like the Mississippi into conduits for expanding the logging enterprise. In this portion of the geostory, the material presence of the river is a critical contributor to the shape of the UHT. The image shows the way log booms were erected in the water, the way the waters carried the logs and directed them to their destination. What it cannot show, however,

is that the logging industry depended on early spring flows of meltwater to make the rivers run high enough and forcefully enough to carry their timbers downstream. By reevaluating the mighty force of the river waters in this image, we can begin to appreciate the waters not as manipulated by human ingenuity but as a partner in shaping and reshaping the material and social worlds of the logging era. After 1905, logging companies would gradually begin to close their doors; fewer and fewer logs would flow on the Mississippi's mainstream to Minneapolis. The river that carved its course through the area long before the logging industry fleetingly marshalled its forces for particular ends, however, would continue to flow and to design the social and geological landscape into the future.

## The River at the Center

In the 1940s, the lumber business in Minneapolis had disappeared as the northern pine and fir sources diminished and the UHT site was in the process of a reformulation. After years of negotiations with the Army Corps of Engineers and federal legislators and offices, Minneapolis received congressional support and funding to build the Upper and Lower St. Anthony locks and dams (City of Minneapolis and Minneapolis Park & Recreation Board 2016). The aerial image here from the United States Geological Survey (USGS) was taken in 1947 as the Army Corps of Engineers made plans for the locks and dams that would allow for an industrial port upstream from downtown Minneapolis.

Complementary to the preliminary planning process for the UHT, this aerial image is somewhat indiscriminate in what it depicts: residential streets, industrial spaces, railroad tracks, bridges, and, of course, the Mississippi River as the centerpiece. Here, the river runs like a dark, narrow band dotted with islands, its subtle curves disrupting the linear grid of city streets. The area

that would become the UHT is featured along the lower west bank of the Mississippi River, distinguishable because it lacks the tree canopy and gridded repetition of neighboring urban residential landscapes. This riverfront area, previously occupied by lumber yards and later a shipping terminal, creates a border territory between the river and the residential spaces of north Minneapolis.

In the context of planning for the UHT, this image suggests a particular set of human relations with and understandings of the river: specifically, that rivers can be manipulated for human designs. For example, look at the islands protruding from the river in this aerial photo. While the logs floating downstream in a previous era could be maneuvered to avoid these obstacles during the high waters of spring, a shipping terminal would require a more consistent channel and flow that the islands might obstruct. In the context of 1947 imaginings, this photo indexes a set of human aspirations to restructure the waterway to better serve shipping interests. By the 1930s, the Army

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Corps of Engineers was invested in the nine-foot channel navigation project, which promised deep and consistent shipping avenues (US Army Corps of Engineers 2016). The St. Anthony locks and dams would eventually comply with these standards as well, thus necessarily changing the contours of this stretch of the Upper Mississippi. This image captures a critical moment before this future was enacted, a moment when other futures could have been imagined, but which have since been foreclosed, a moment when a particular

understanding of what the river should do for people was organized into the landscape.

Yet even as these plans formed the social and physical landscape, they were informed and ultimately reformed in part due to the untamable capacities of the river itself. The geostory is never complete.



*Aerial photo of north Minneapolis and the UHT area, 1947 (north is the top of the image).  
USGS Open Access.*

# The Upper Harbor Terminal and Its Futures

The final temporal layer is a photo of the Upper Harbor Terminal in action. Taken in the early years of the twenty-first century, the image shows the terminal as an industrial shipping center with mounds of coal, gravel, and road salt on the bank and barges aligning the water's edge. The UHT opened in the 1960s after the completion of both the Lower and Upper St. Anthony locks and dams made it accessible to barges and boats. Eventually the UHT replaced the municipal

port at Bohemian Flats, a downstream area beneath the Washington Avenue Bridge. With the skyline of the Minneapolis skyscrapers in the background, the UHT is positioned as feeding the economic development and growth of the metropolitan area. Once a productive port, The UHT remained an active barge terminal even as the site grew to be financially insolvent. As trains and trucking routes via Interstate-94 (visible on the right/west in this image) increasingly became



*The UHT as an active port terminal, circa 2005, looking south toward Minneapolis. Image from the Metropolitan Design Center Image Bank. Copyright Regents of the University of Minnesota, used with permission.*

the more economical choices for the transport of goods, the barge terminal became unsustainable. Minneapolis opted to close the terminal in 2014, opening its many acres for more fiscally responsible and possibly more community-engaged enterprises. The closure of the Upper St. Anthony lock followed the next year. As a result, the UHT is being redeveloped once again as a federal “Promise Zone” with both private and public interests guiding its revitalization.

The UHT as an active port terminal, circa 2005, looking south toward Minneapolis. Image from the Metropolitan Design Center Image Bank. Copyright Regents of the University of Minnesota, used with permission.

The UHT as an active port terminal, circa 2005, looking south toward Minneapolis. Image from the Metropolitan Design Center Image Bank. Copyright Regents of the University of Minnesota, used with permission.

This photo taken before the harbor closed reflects one set of human relations with the river – economic, industrial, and detached – that aligns with the development trajectory of the UHT’s geostory. The river’s capacities to carry have been molded to be useful to the changing forms of human needs; over time the river became a resource to be used and engineered, a means for economic development in the eyes of many. This stretch of river is grounded in and has enabled these relations for over a century, but the geostory – like the materials that form it – is ever-evolving, constantly in a state of becoming something different. As the future of this place is being reshaped once again, we have reached a critical moment when human relations with the river can be reconfigured to reflect an alternative ethos, possibly an ethos of collaboration and co-creation.

How might our understanding of the Mississippi River change if we considered it a collaborator in our projects, endowed with the agencies to participate in or disrupt our human designs? How

might our practices change if we considered the river as kin like many indigenous people do, from the Dakota of the Midwestern U.S. to the Karen of Southeast Asia? How might our geostory change if we consider rivers like the Mississippi to be storytellers themselves (McLean 2009)? Perhaps in reimagining the social and physical landscape of a place, we can begin a practice not only of seeing rivers as collaborating with us, but also of seeing humans as collaborating with rivers. After all, as anthropologist Hugh Raffles explains, nonhumans are “not just deeply present in the world but deeply there, creating it, too” (2010:3).



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## About the Author

Laurie Moberg is a PhD candidate in anthropology at the University of Minnesota. Her work investigates recurrent episodes of flooding on rivers in Thailand and queries how the ecological, social, and cosmological entanglements between humans and nonhumans, people and the material world, are reimagined and reconfigured in an era of global climate change. She is the 2016-2017 Graduate Research Assistant for Open Rivers at the Institute for Advanced Study.

## GEOGRAPHIES

# PERSPECTIVES ON RIVER INTERVENTIONS

By Patrick Nunnally

Over the past two decades, river management has added a new approach to the “toolbox” of efforts to undo some of the damage caused by earlier generations of river interventions. Humans have intervened in river flows for millennia, damming water courses and creating levees to shape river flows, all in the name of providing expanded benefits from managed river flows.

But things have changed recently. According to “[The Undamming of America](#),” some 500 dams have been removed in the United States over the past decade. Even more unusual, a recent program from The Nature Conservancy and the US Army Corps of Engineers, the Sustainable Rivers Program (SRP), seeks to alter the function of dams to increase the ecological functions of



*Elwha River at Goblin's Gate by Jeff Taylor.*

the rivers containing the dam. Rather than just eliminating the dam, the SRP aims at restoring some of the river's key functions while retaining the dam itself.

This "Geographies" column discusses the SRP and the removal of the Elwha Dam in Washington State (the largest dam removal project in the country to date) as contexts for the closure of the Upper St. Anthony Falls Lock in Minneapolis.

These two cases illustrate important elements of the theme of "interventions" in our management of rivers and point to complex ways in which, once we have interfered with a river's "natural" hydrology, some of that function may be "restored," while other parts may not be. Taken together, the SRP and the Elwha cases point to the possibilities and limits in thinking about "river restoration."

## The Sustainable Rivers Program

Typically dams are managed for a limited number of purposes, such as flood control and power generation, or navigation. Ecosystem management rarely comes into the picture, although that

is increasing in places like the Missouri River where endangered species are part of the river system. Conflicts emerge when multiple purposes are mutually exclusive. Managers may want to



*What little remained of the Elwha Dam as of February 14, 2012, by Ben Cody.*

release water for hydropower, but downstream sites would then get flooded. These are competing human uses within the mandate for building the dam in the first place.

The SRP changes the pattern by actively managing the dam and river flows to mimic the river's pre-dam dynamic. Typically rivers rise and fall on fairly regular cycles according to rainfall and snowmelt. Higher flows inundate floodplains, creating conditions where certain kinds of fish spawn and that are conducive to some kinds of vegetation that are important in a variety of ways such as roots holding soil. If a dam fixes the water level at one point, or fixes and then puts too much water on the floodplain, then the ecosystem loses out, in addition to the possibility that human benefits are potentially in conflict.

The SRP has conducted long-term experiments with dams and rivers in several parts of the country. On Kentucky's Green River, revised water releases kept lake levels higher and allowed commercial recreation to take place for an extended period each year. The Bill Williams

River in Arizona, which is a tributary of the Colorado River, had dam operations adjusted in coordination with Colorado River management to allow for more water storage upstream and rejuvenation of floodplain forest habitat to the benefit of hundreds of plant and animal species.

It sounds easy to manage the river as nature would, but there are a number of significant challenges. Scientists may find it hard to determine precisely the impacts of altering river flow and to match those impacts to what were the hoped-for benefits. The Corps of Engineers also does not always have authorization to change how it manages its dams. There are 472 reservoirs containing Congressionally authorized flood storage waters; 116 of those also generate hydropower. Changing management of these facilities in order to reflect better how the river would naturally work, and maximizing an expanded list of benefits to the human and natural communities, is a matter requiring better science, better engineering, and stronger arguments about the need for change.

## Read more:

- <http://www.nature.org/ourinitiatives/habitats/riverslakes/sustainable-rivers-project-fact-sheet-pdfnull.pdf>
- <http://www.iwr.usace.army.mil/Missions/Environment/Sustainable-Rivers-Project/>
- <http://www.nature.org/ourinitiatives/habitats/riverslakes/sustainable-rivers-project.xml>

## Elwha

While it's true that in some cases dams can be managed to achieve a greater range of benefits, sometimes a dam just needs to come out. The case of dam removal on the Elwha River illustrates the manifold benefits that can happen when dams are removed and a river "comes back to life" even after a century of blockage.

The Elwha River ran unchecked to Puget Sound until the early decades of the twentieth century, when two dams were built to provide hydroelectricity for industrial growth of the nearby community of Port Angeles, on the Olympic Peninsula west of Seattle, WA. The Elwha Dam went up in

1914, its 108-foot high bulk blocking salmon runs up the river and altering the river's hydrology. The Glines Canyon Dam (210 feet high) followed in 1927 to supply more power. In the late 1970s, both dams, by now located in what had been designated Olympic National Park, failed their relicensing tests and the possibility of removing them came to the fore. It was not until 1992 that an act of Congress called for the dams' removal and even later, in 2011, before demolition began. Decades of work by the Lower Elwha Klallam Tribe, the national advocacy group American Rivers, and a host of other organizations came to fruition in 2014 when the Glines Canyon Dam was finally completely opened and the river ran free again. The Elwha Dam had been removed by 2012.

The most notable ecological benefit from the dams' removal was the return of salmon up the river where they had been blocked for nearly a century. Fish started appearing in the river within a month of the demolition, and nesting sites appeared in the next season. The number of fish recorded in the river has steadily increased, although it could take a decade or more for numbers to approach pre-dam levels.

The return of salmon is just one of several ecological changes that have accompanied dam removal. Mammals such as bears and otters have appeared, drawn by salmon as food stocks, and dying salmon have meant nutrient replenishment to the river corridor. The former reservoir lakebeds, now exposed to the air, have reseeded, and forest and meadows have begun to appear. Overall, 70 miles of spawning habitat have been restored. The river has begun eroding its banks again, releasing large trees that move downstream and catch on the riverbed, providing both a more braided stream and habitat for a number of birds and animals.

The sediment pulse after the dam removal released 4.6 million cubic yards of sand and gravel downstream and into Puget Sound. Aquatic

invertebrates were smothered, but have begun to recover. The shape and material of the beach at the river's mouth have changed, which bodes well for the return of clams, crabs, and other long-lost species. An easily overlooked benefit of the dam removal was the restoration of a healthy intersection between river and ocean, the river contributing sediments that form a healthier nearshore environment.

Dam removal has had important cultural benefits as well. The Lower Elwha Klallam tribe has made its home along the river from time immemorial. After a pause to allow salmon stocks to replenish, the tribe hopes to begin ceremonial catches soon. Rejuvenation of a complex ecosystem with diverse plant and animal species is likewise important to tribal people.

The Elwha Dam removal is widely credited as the "largest dam removal in the world," but, as with so many other things, the claim appears to depend on what is being measured. The Glines Canyon Dam is the tallest that has been removed. Dam removal projects that are in process or complete on the Klamath (CA/OR), the Baraboo (WI), Milwaukee (WI), and Des Plaines (IL) Rivers have all involved removal of multiple dams. River management on the Penobscot River in Maine has restored some 1,000 miles of habitat either through dam removal or construction of fish passages. When complete, the Klamath work is estimated to restore 300 miles of habitat, in comparison to the 70 restored miles on the Elwha.

There is, rightly, a growing controversy about river "restoration." Up until very recently, practitioners spoke readily of "restoring" a river or a landscape around water to "presettlement" conditions. Of course, this view implies that Native people were not even present, that the land and waters were a "blank slate" before colonizing Europeans showed up. The many problems with this argument are by now well known, and there is growing recognition, as well, that in a regime

of climate change, “restoration” is simply not possible. Too many conditions have changed to say that the Elwha River has been “restored” to its pre-1900 conditions. Nevertheless, the project on the Elwha, as well as those on the Bill Williams

River and the Green River, demonstrates the number and range of benefits that are possible when we intervene in a river’s dynamic system, undoing the damage that we have previously committed.

## Learn more:

- [http://projects.seattletimes.com/2016/elwha/?utm\\_campaign=coschedule&utm\\_source=twitter&utm\\_medium=americanrivers](http://projects.seattletimes.com/2016/elwha/?utm_campaign=coschedule&utm_source=twitter&utm_medium=americanrivers)
- [https://tours.fishviews.com/tour.html?id=elwha-river&utm\\_campaign=coschedule&utm\\_source=twitter&utm\\_medium=americanrivers#1104](https://tours.fishviews.com/tour.html?id=elwha-river&utm_campaign=coschedule&utm_source=twitter&utm_medium=americanrivers#1104)
- <https://www.americanrivers.org/2016/04/worlds-biggest-dam-removal/>
- [http://news.nationalgeographic.com/2016/06/largest-dam-removal-elwha-river-restoration-environment/?utm\\_campaign=coschedule&utm\\_source=twitter&utm\\_medium=americanrivers](http://news.nationalgeographic.com/2016/06/largest-dam-removal-elwha-river-restoration-environment/?utm_campaign=coschedule&utm_source=twitter&utm_medium=americanrivers)
- <http://www.elwha.org/home.html>
- <https://www.americanrivers.org/2016/09/five-years-later-elwha-reborn/>

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Patrick Nunnally coordinates the River Life Program in the Institute for Advanced Study at the University of Minnesota. He serves as editor for *Open Rivers* and was one of the lead scholars for the University’s John E. Sawyer Seminar, “Making the Mississippi: Formulating New Water Narratives for the 21st Century and Beyond,” funded by the Andrew W. Mellon Foundation.