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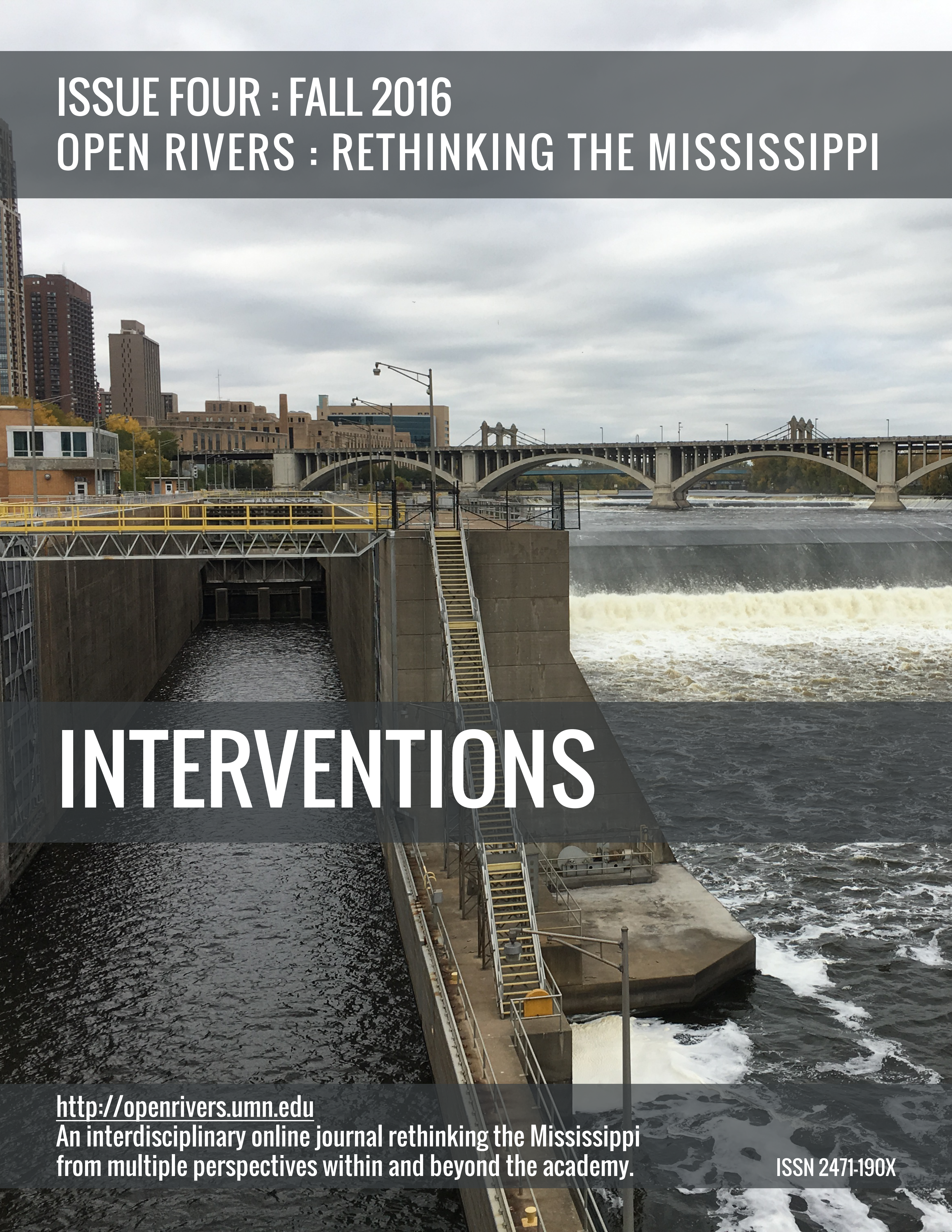
# OPEN RIVERS : RETHINKING THE MISSISSIPPI



# INTERVENTIONS

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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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## Editorial Board

# CONTENTS

## Introductions

## Features

## Perspectives

## In Review

## Primary Sources

## Geographies

## 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.*

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

(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,

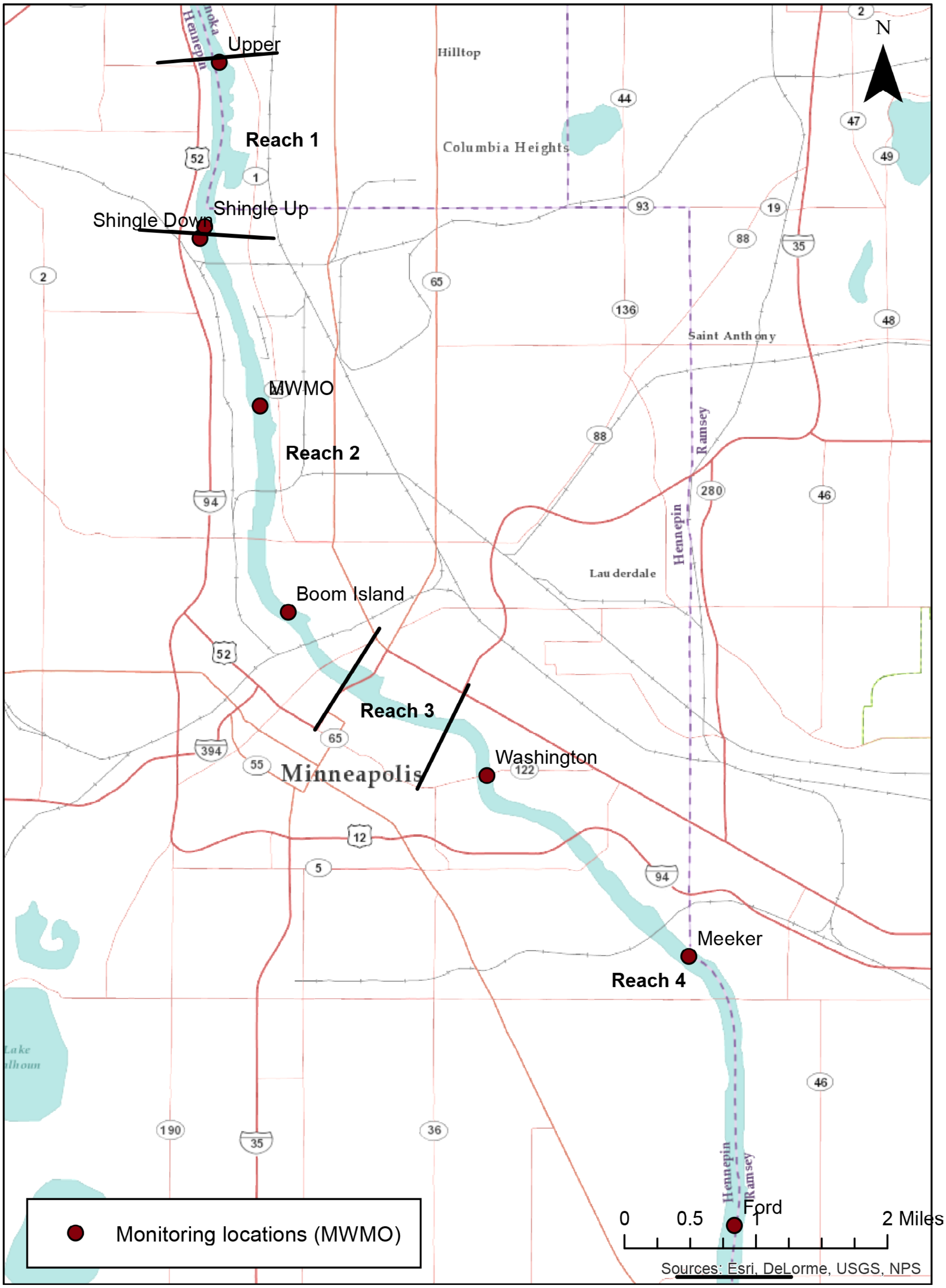

*Figure 4. Map of the study area and primary monitoring sites, as developed by the Mississippi Watershed Management Organization (MWMO), labeled by reach. Image courtesy of the author.*

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 aerially 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.

# References

Anfinson, John O. 2003. “St. Anthony Falls: Timber, Flour, and Electricity.” In River of History: A Historic Resources Study of the Mississippi National River and Recreation Area, 117-137. St. Paul: Army Corps of Engineers.

Eddy, Samuel, James C. Underhill, and John B. Moyle. 1962. The fish fauna of the Mississippi River above St. Anthony Falls as related to the effectiveness of this falls as a migration barrier. Paper presented at the Annual Meeting of the Minnesota Academy of Science, Winona, Minnesota.

Howard, Brian Clark. 2016. “River Revives After Largest Dam Removal in U.S. History.” National Geographic. Accessed October 7, 2016. http://news.nationalgeographic.com/2016/06/largest-dam-removal-elwha-river-restoration-environment/.

Kelner, Dan E., and Mike Davis. 2002. Final Report: Mussel (Bivalvia:Unionidae) survey of the Mississippi National River and Recreation Area Cooridor, 2000-01. Contract report to the National Park Service Mississippi River National River and Recreation Area and the Great Lakes Network Inventory and Monitoring Program. Minnesota Department of Natural Resources, Division of Ecological Services, St. Paul, MN. http://files.dnr.state.mn.us/eco/nongame/projects/consgrant_reports/2002/2002_kelner_davis.pdf.

Lenhart, Christian. 2012. “Restoration of the Mississippi River Gorge: Issues and Research Needs.” Ecological Restoration 30(3):218-227.

Merritt, Richard W., Kenneth W. Cummins, and Martin B. Berg, eds. 2008. An Introduction to the Aquatic Insects of North America. Kendall Hunt Publishing.

US Army Corps of Engineers. 2016a. “Upper St. Anthony Falls.” Accessed September 29. http://www.mvr.usace.army.mil/Portals/48/docs/CC/FactSheets/MISS/UpperStAnthonyFalls(2016).pdf.

US Army Corps of Engineers. 2016b. “Upper Mississippi River 9-Foot Channel Navigation Project.” Accessed September 29, 2016. http://www.mvp.usace.army.mil/Portals/57/docs/Public%20Affairs/Brochure/2016_9_Foot_Channel_Brochure.pdf.

US Army Corps of Engineers. 2014. “Summary of Dredging Locations – St. Paul District.” Accessed September 29, 2016. http://www.mvp.usace.army.mil/Portals/57/docs/Navigation/CMMP/Tab_4_1_2014.pdf.

Weller, Lark, and Trevor A. Russell. 2016. State of the River Report 2016: Water quality and river health in the metro Mississippi River. http://stateoftheriver.com/state-of-the-river-report/.

# 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.

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# About the Author

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.