

STATE OF THE RIVER REPORT

**Water Quality and River Health
in the
Metro Mississippi River**





“So, how is the Mississippi River?”

It’s a question we get asked quite often and it can be hard to know how to respond.

Forty years after the passage of the federal Clean Water Act, the river has come a long way. Gone are the days of sewage and industrial wastes choking the life out of the river. Fish and aquatic species have returned. Yet agricultural and urban runoff continues to pollute the resource, invasive species pose new threats, and industrial contaminants — some with frightening potential health risks — are being discovered in the river.

So, how is the Mississippi River? We wanted to find out how to answer that question accurately, and we knew a lot of people would be interested. So Friends of the Mississippi River (FMR) and the National Park Service teamed up to develop this report.

The *State of the River Report* highlights 13 key indicators of river health so that non-scientists can understand what it means. The report examines the status and trends of each indicator, and highlights key strategies for improvement moving forward. We hope to update the report periodically, following these key indicators over time and adding new ones as appropriate.

To help readers make use of this information in their communities, we’ve also created two companion guides. The *Stewardship Guide* provides practical steps

that individuals can take in their home, yard, and community to improve the health of the Mississippi. The *Policy Guide* offers priority actions that federal, state, and local leaders can take for the river. Visit www.stateoftheriver.com to learn more.

Clearly, as individuals and as a society, we can make choices that affect the river both for good and ill.

While the Mississippi River has suffered from careless treatment in the past, the big river is also resilient and can heal itself, if given a chance.

The conservationist Aldo Leopold said, “A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise.” We agree. We believe the long-term health of the Mississippi River is actually, itself, an indicator of the health of our community.

We hope the *State of the River Report* can help lead us toward a more healthy and sustainable Mississippi River, for ourselves and for generations yet to come.

For the river,

Whitney L. Clark, Executive Director,
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STATE OF THE RIVER

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THE MCKNIGHT FOUNDATION



MINNEHAHA CREEK
WATERSHED DISTRICT
QUALITY OF WATER, QUALITY OF LIFE

Project advisors

This *State of the River Report* would not have been possible without the generous assistance of many individuals and organizations, from a wide range of disciplines, whose research forms the basis of the document. They have given many hours of their time to help us interpret and characterize a variety of river data.

These professionals have been unstinting with their time and enthusiastic about the goal of producing a clear and concise report on the status and trends of the Mississippi River in the Twin Cities area. We are grateful to them for their support and cooperation.

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Lastly, a special thank you to former FMR intern Brandon Stephens, whose dedicated work helped bring this project to fruition.

The Mississippi River, flowing approximately 2,350 miles from Lake Itasca to the Gulf of Mexico, has long been one of the defining natural features of the United States.

The Ojibwe Indians of northern Minnesota called it “Messipi” or “Big River,” and it was also known as the “Mee-zee-see-bee” or the “Father of Waters.”¹

Today, the river drains all or part of 31 states and two Canadian provinces, or about 41% of the area of the lower 48 states. The river represents one of the most diverse and important natural resources in the U.S., serving as the migratory flyway for more than 40% all North American waterfowl and shorebirds. The river is also home to at least 260 species of fish, 50 mammal species, 145 species of amphibians and reptiles, and 38 species of mussel.²

The Mississippi River system is a vital public resource, and is essential in sustaining our nation’s economy. Fifty U.S. cities rely on the Mississippi for daily water supply, including roughly 1,000,000 Minnesotans.³

The 29 locks and dams on the Mississippi allow for navigation from St. Louis, Mo., to Minneapolis, Minn. To move goods up and down the Mississippi, the U.S. Army Corps of Engineers maintains a 9-foot shipping channel from Baton Rouge, La. to Minneapolis.

Roughly 60% of grain exported from the U.S. is transported and shipped from the Mississippi River,⁴ along with billions of dollars’ worth of freight each year.

The Mississippi River watershed



“The Mississippi is well worth reading about.

It is not a commonplace river, but on the contrary is in all ways remarkable.”

*-Mark Twain,
Life on the Mississippi*

The Mississippi River and Lake Pepin watershed

Lake Pepin is a natural lake on the Mississippi River 60 miles downstream of the Twin Cities metropolitan area.

Lake Pepin's watershed (drainage area) covers half of Minnesota's land area⁵ (about 50,000 square miles), and includes the upper Mississippi, St. Croix, and Minnesota Rivers, as well as several smaller tributaries.

In 2004, Lake Pepin was listed as "impaired" by the State of Minnesota; it has so much excess phosphorus (page 16) that the lake fails to meet state water quality standards, while excess sediment (page 28) continues to threaten the lake. These pollutants affect the lake a number of ways.

- The lake's excess phosphorus negatively impacts aquatic life and recreation (by reducing water clarity and depleting oxygen levels), and can lead to massive algae blooms in low-flow periods.
- High sediment levels cloud the water and disrupt habitat, making it difficult for plants and fish to thrive. At current rates of sedimentation, excess sediment threatens to completely fill in the upper third of the lake within a century.⁶

Because Lake Pepin drains such a large portion of Minnesota, efforts to clean it up have revived public awareness of the many challenges facing Minnesota's water resources.

Several indicators in this report (sediment, phosphorus, and triclosan) reference overall pollution levels in Lake Pepin. Much of the river's sediment settles out in Lake Pepin. Researchers examine that sediment to learn what has been happening in the river upstream over time, and have gained excellent insights into the history and trends of water quality and the ecological health of the Mississippi River.

The Lake Pepin watershed



Map data source: Minnesota Department of Natural Resources

Mississippi National River and Recreation Area

Did you know that the Mississippi River in the Twin Cities is a national park?

For 72 miles (from the Crow River confluence in Dayton and Ramsey, to just past the St. Croix River confluence near Hastings and Prescott), the river is so unique that in 1988 Congress designated it a national park: the Mississippi National River and Recreation Area (MNRRA).

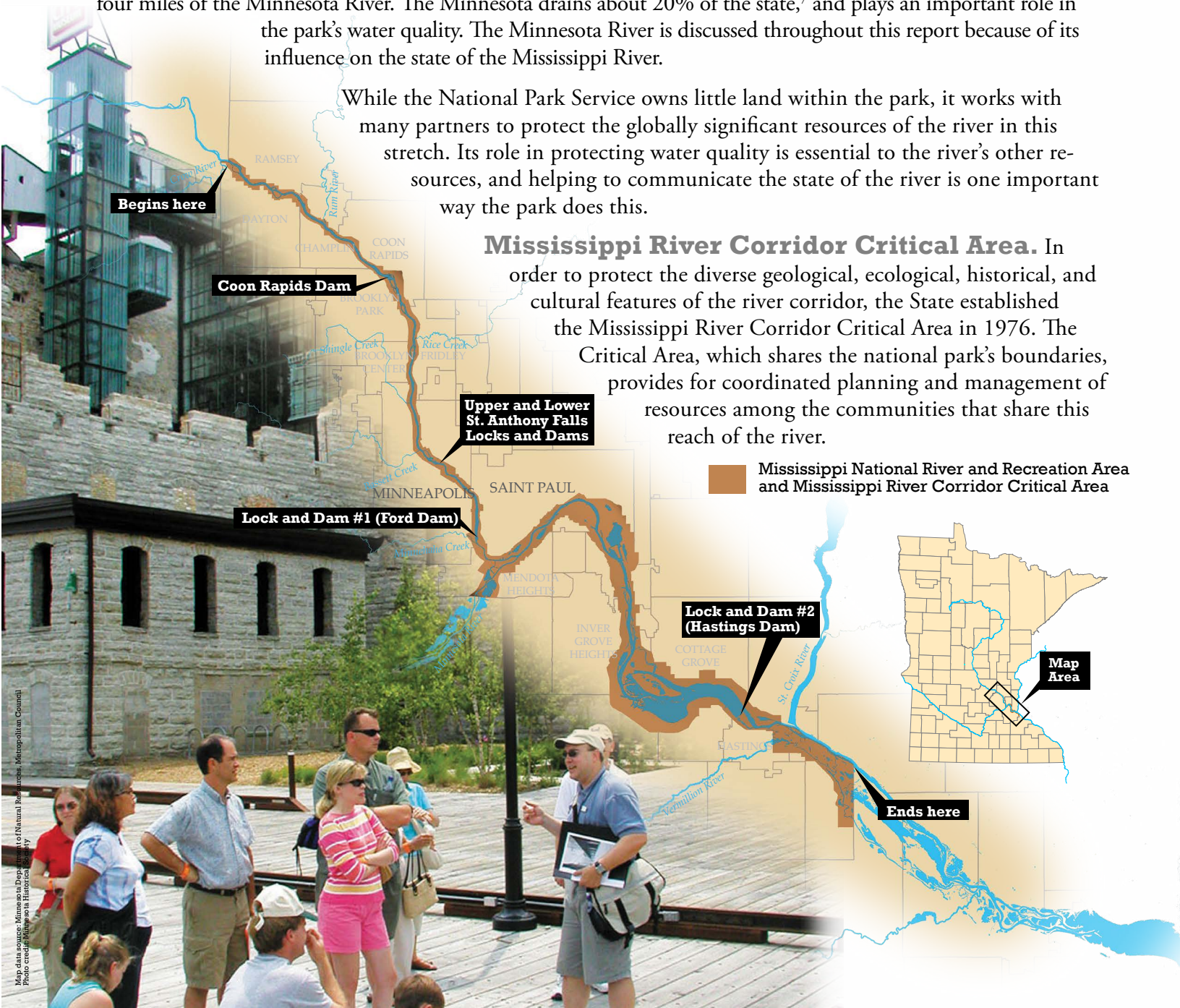
The river changes character more within this park than it does anywhere else along its entire length. Entering the park as a modest-sized prairie river, it plunges over St. Anthony Falls (the river's only true waterfall) and through a deep, wooded gorge (its only true gorge), emerging in St. Paul as a large floodplain river before flowing downstream to the Gulf of Mexico.

The Minnesota River enters the Mississippi about halfway through the park, and the park boundary includes the last four miles of the Minnesota River. The Minnesota drains about 20% of the state,⁷ and plays an important role in the park's water quality. The Minnesota River is discussed throughout this report because of its influence on the state of the Mississippi River.

While the National Park Service owns little land within the park, it works with many partners to protect the globally significant resources of the river in this stretch. Its role in protecting water quality is essential to the river's other resources, and helping to communicate the state of the river is one important way the park does this.

Mississippi River Corridor Critical Area.

In order to protect the diverse geological, ecological, historical, and cultural features of the river corridor, the State established the Mississippi River Corridor Critical Area in 1976. The Critical Area, which shares the national park's boundaries, provides for coordinated planning and management of resources among the communities that share this reach of the river.



Map data source: Minnesota Department of Natural Resources, Metropolitan Council. Photo credit: Minnesota Historical Society.

Indicators overview and critical terms

The Mississippi River is a complex natural system that can change dramatically from year to year, and even from season to season. So how do we assess the overall state of the river?

This *State of the River Report* highlights **13 key indicators** of water quality and ecological health in the river. These indicators were selected to portray the state of the river in a way that is easy to understand. These indicators describe river conditions in five categories:

RIVER FLOW: **Flow**

SWIMMING & RECREATION: **Bacteria** **Phosphorus**

FISH & FISHING: **Fish consumption**

Fish survey **Asian carp**

ECOLOGICAL HEALTH: **Sediment** **Nitrate**

Mussels **Bald eagles**

CONTAMINANTS OF CONCERN: **Triclosan** **PFOS**

Additional contaminants of concern

For each indicator, we include a brief description, and highlight its role in the river system. We also provide readers with a summary of each indicator's status, and, where possible, include information on history, trends, and management solutions for moving forward.

Several indicators highlight monitoring results from the 1976-2011 period. Extensive monitoring efforts over this time provide for an excellent understanding of river trends, and we've made use of this data whenever possible.

Critical terms

Throughout this report, we refer to several critical terms that are important to understanding the state of the river. Knowing the meaning of these terms will help you as you read the *State of the River Report*.

Impaired

If a portion of the river is "impaired," it means that reach of the river *fails to meet state or federal standards* for one or more pollutants.

Some reaches of the river are impaired for multiple pollutants.

Concentration

Pollution "concentration" refers to the *amount of a pollutant in a given volume of water*.

Pollutant concentrations are often used to compare existing pollution levels to water quality standards, and are important when we think of that pollutant's impacts on local river life and health.

Load

Pollution "load" refers to the *total amount of a pollutant moving into/through the river system*.

Load helps us understand the total quantity of a pollutant, and is especially important when we think of what we send to downstream waters like Lake Pepin or the Gulf of Mexico.

RIVER FLOW

This section highlights **one** indicator, river flow, which is the amount of water moving through the river.

Changes in rain and snowfall, how we use land, and how we use water and control runoff can result in changes to how much water is in the river. Because of its ability to erode soil and carry pollutants, flow plays an important role in water quality and the health of aquatic habitat.

Flow



Flow

River flow has increased significantly.

▼
The timing, amount, and intensity of rain and snowfall all impact river flow.

▼
Flow is an important factor in determining water quality and the health of aquatic habitat.

▼
River flow at Hastings increased by 25% between 1976 and 2005.

Description and impacts. The timing, amounts, and intensity of rain and snowfall can all impact the flow of the Mississippi River, as runoff moves over land and into the river. River conditions can change based on flow conditions. High or low flows can have positive or negative effects.

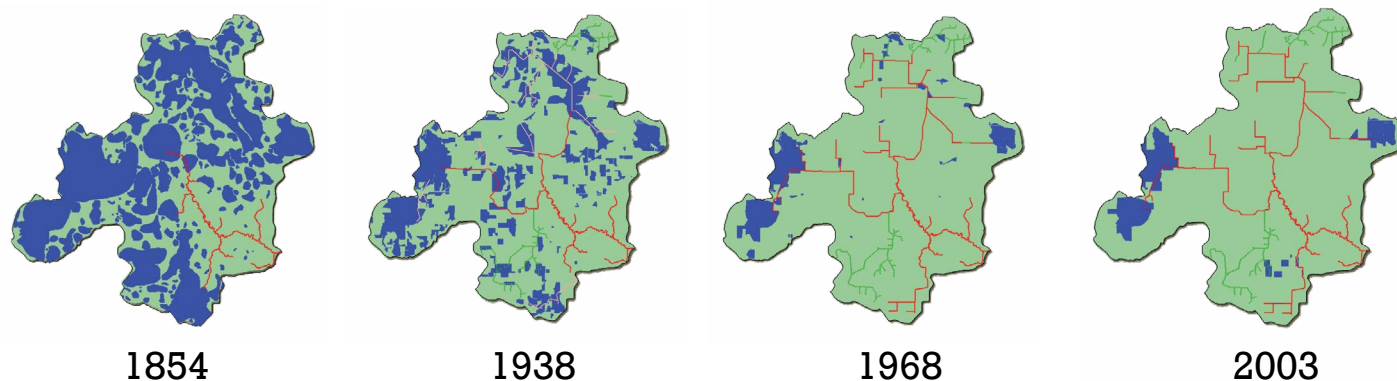
- High flows can cause increased erosion, flooding risk, habitat degradation, and can carry more pollutants into the river system. However, higher flows can also dilute concentrations of some key pollutants, which can reduce their local impacts on the river.
- Low flows tend to deliver less pollution to the river, and produce fewer flooding events. However, lower flows can contribute to increased algae levels in water. Algae can harm aquatic life and recreation, and have created problems in the lower Minnesota River and Lake Pepin.

Sources. In agricultural areas, row crops and artificially drained fields have largely replaced native prairies, forests, and wetlands (Figure 1). Recent studies show that these changes in how we use land result in increased runoff, which typically leads to downstream increases in stream flow.⁸

In cities and towns, hard surfaces such as roads, rooftops, and driveways result in increased runoff that can affect flows in nearby water bodies (Figure 2).⁹

In addition, computer climate models anticipate changes to the frequency and size of runoff-producing rainfalls in many parts of the state, which could alter Mississippi River flows in a variety of ways.¹⁰

Figure 1. An example of wetland loss in the Minnesota River basin



Graphic: Minnesota River Basin Trends – November 2009

This graphic illustrates the loss of 88% of wetlands (shown in blue) in the 7-Mile Creek watershed (near St. Peter, Minn.) between 1854 and 2003. The addition of extensive artificial agricultural drainage and the loss of so many wetlands have reduced the landscape's ability to retain and evaporate water. This increases downstream river flows in the Minnesota and Mississippi Rivers.

Status. Mississippi River flows were higher than the 30-year average throughout much of 2011. A rainy fall the previous year left soils full of water and contributed to more runoff in the spring and early summer. Summer rain resulted in higher stream flows throughout the summer and early fall. Later in the year, dry conditions resulted in lower flows throughout the late fall and early winter, and contributed to drought conditions in portions of the state.

History and trends. River flow has increased over time. Since 1976, median flow has increased by 25% at the Hastings Dam (Figure 3). Flows in the Minnesota River have doubled over the last 70 years.¹¹ Flow increases may be attributed to several factors, including increased artificial agricultural drainage, increased urban runoff, and changes in rain and snow patterns and climate.

Solutions. Rivers, lakes, and streams fare best when runoff infiltrates naturally into the ground. Statewide efforts to restore wetlands and keep more water within agricultural areas are critical to reversing the trends of increased Minnesota and Mississippi River flows.

Improved urban runoff controls may also help stabilize local flows by increasing natural infiltration throughout the state. To help maintain a healthy water balance, residents can install rain gardens, rain barrels, pervious pavers, green roofs, and restored prairie landscapes, which are proven strategies for reducing runoff and improving water quality in the Mississippi River.

Figure 2. Impacts of how we use the land

Hard surfaces increase runoff from the land.

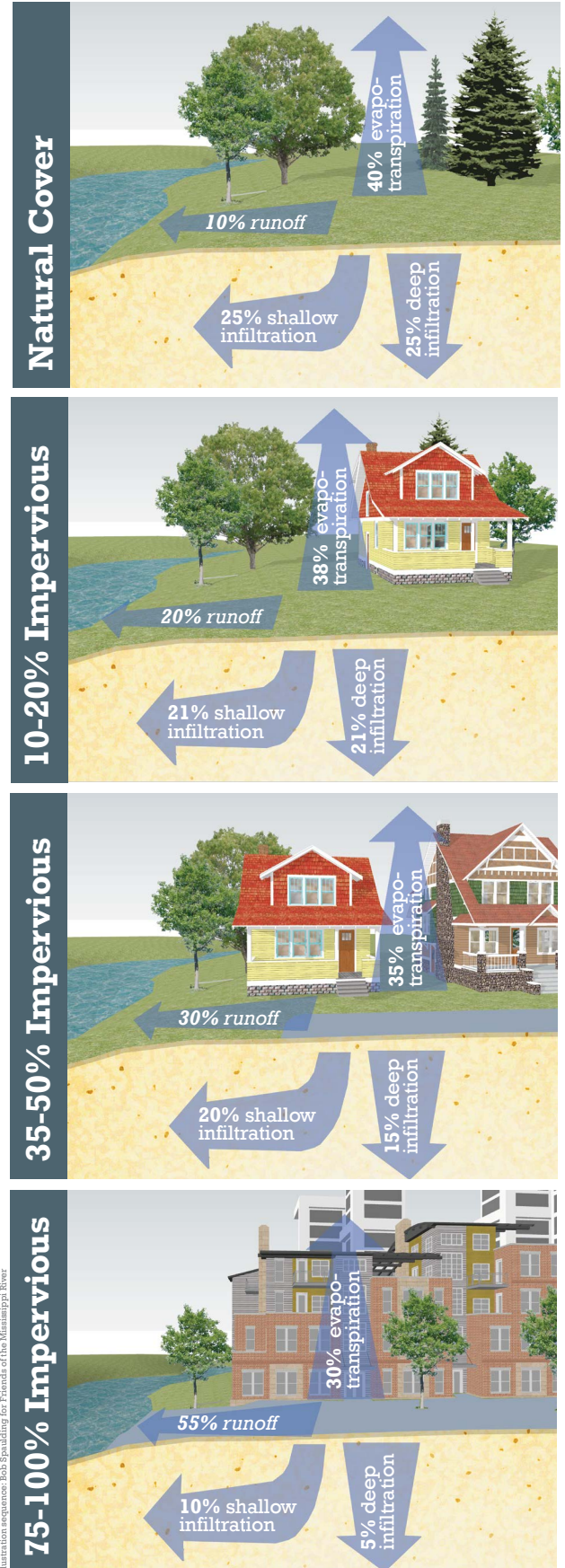
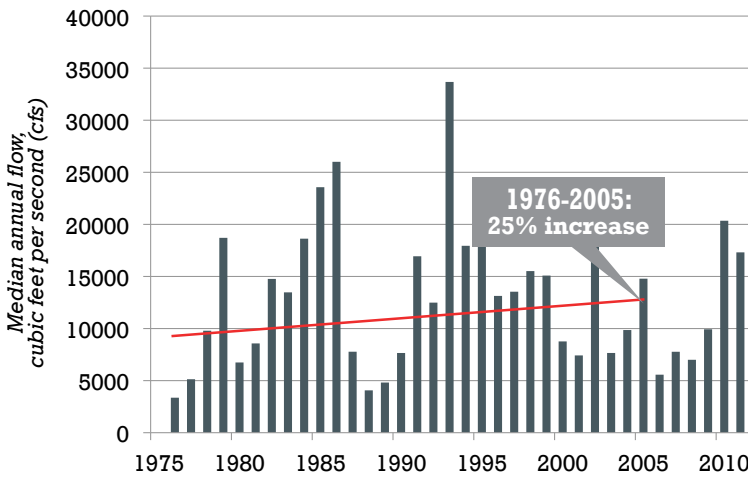


Figure 3. Annual river flow at Hastings Dam



Data source: Metropolitan Council Environmental Services.

Median annual flows for 1976-2010 were calculated based on flows at the U.S. Geological Survey stream gage in St. Paul plus flows at the Metro Wastewater Treatment Plant, as described in Lafrancois et al. (in prep). Similar flow data were not available for 2011 at the time of publication, and were instead inferred based on their long-term relationship to flow estimates from the U.S. Army Corps of Engineers gage site at the Hastings Dam (Lock and Dam #2).

Note: trend analysis only available through 2005.

Illustration sequence: Bob Spaulding for Friends of the Mississippi River



SWIMMING & RECREATION

This section highlights **two** key measures of the quality of the Mississippi River as a swimming and recreation amenity.

Bacteria pose a threat to human health and can limit the recreational uses of rivers, lakes, and streams. Phosphorus contributes to algae blooms, and other factors that negatively impact aquatic recreation, life, and health.

Bacteria

Phosphorus



Bacteria

Parts of the river are impaired with excess bacteria, which can create health concerns for recreational users.

Minnesota uses *E. coli* data to indicate the potential presence of waterborne pathogens in the river.

Bacteria pollution comes from human and animal sources.

A clean-up plan is currently under development to address this pollution problem.

Description and impacts. *Escherichia coli* (*E. coli*) is a bacterium indicating the potential presence of waterborne pathogens that can be harmful to human health. It typically results from the presence of human and animal fecal waste. To reduce the risk of people getting sick from exposure to these pathogens while recreating, the state has standards for concentrations of *E. coli* in the water.¹²

The river is a significant recreational resource (swimming, boating, or wading) for many Minnesotans. Contact with water with high bacteria concentrations can make recreational users sick (nausea, vomiting, fever, headache, and diarrhea).

Sources. Bacteria pollution can be a problem in rural, suburban, and urban areas. Harmful bacteria originate in the intestines of living creatures, and are generally spread when fecal matter enters the river. Sources of these bacteria include **human sources** (septic systems, combined storm and sanitary sewer overflows,¹³ leaking sanitary sewers), **livestock** (feedlots, grazing livestock, field-applied manure), **pets**, and **wildlife**. In addition, fecal bacteria appear to be able to survive for some time in sediment,¹⁴ so areas with stirred-up sediment may also suffer from elevated river bacteria concentrations. In general, the more runoff an area produces, the more susceptible its surface waters are to bacteria pollution.

There is no clear relationship between river bacteria concentrations and seasonal changes or flow levels.¹⁵ Bacteria in the river seems to come from a mix of local and regional sources, and can be found at a wide range of flows. Targeted monitoring could help determine with more clarity how, when, and where elevated bacteria concentrations are delivered to the river.

The acceptable *E. coli* limit is exceeded more often on Mississippi River tributaries than on the river itself.¹⁶ This indicates that the Mississippi may be “inheriting” some of its elevated bacteria concentrations from its tributaries. In rural areas, fecal waste can travel efficiently to streams and rivers through drain tiles and ditches; in urban areas, it can travel efficiently to streams and rivers via stormwater pipes and hard surfaces like roads.

History and trends. *E. coli* data has been consistently collected in this portion of the river since 2005, although some stretches were identified as having too much fecal bacteria as early as 1996.

Since 1985, efforts by the cities of Minneapolis and St. Paul to separate their sanitary and storm sewers (now largely complete) have kept millions of gallons of sewage from contributing bacteria to the river each year.¹⁷



Pet waste is one source of bacteria in the Mississippi. Always clean up after your dog!

Bacteria impairments through the Twin Cities

- not impaired
- impaired
- insufficient data

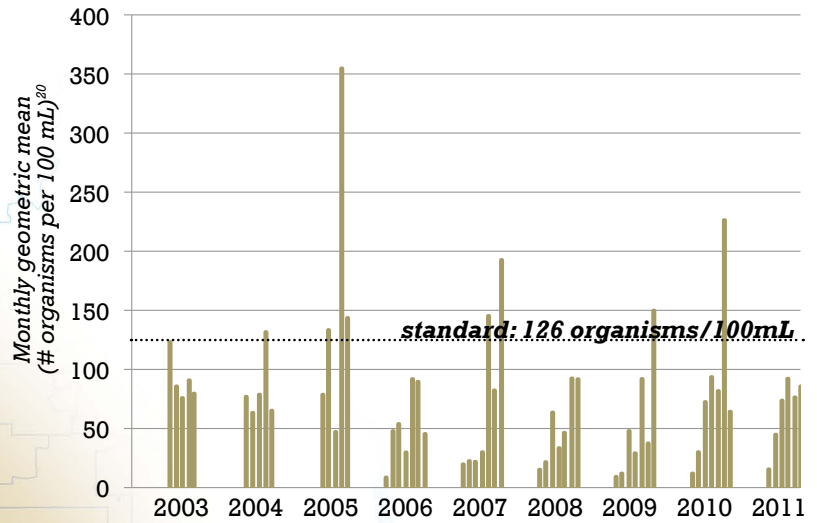
Status. In several reaches of this part of the river, average bacteria levels are below the state standard. However, most portions of the river from Coon Rapids Dam to St. Paul have average bacteria concentrations that are too high. These reaches of the river are “impaired” with excess bacteria (see map). Regardless of official “impairment” status, some parts of the river have experienced high bacteria spikes that can exceed the state standard.

The river’s bacteria concentrations are highest around the Twin Cities metropolitan area. It is recommended that swimming or other recreational contact be limited in “impaired” sections of the river and that it be avoided everywhere on the river within 48 hours of a rainstorm (including storms upstream), as this is when many pollutants are washed in with stormwater. Recreational users are advised to be especially cautious downstream of storm drain pipes and other places where runoff enters the river. Always rinse off well after swimming.

Drinking untreated river water that contains disease-causing bacteria poses a risk for animals as well as for people.^{18, 19} If you allow your dog to swim in the river, do not allow it to drink the water.

Solutions. The Minnesota Pollution Control Agency is working with a number of partners to develop a clean-up plan. That plan will identify the potential sources of

Figure 1. Bacteria Levels
from Lower St. Anthony Falls to the Ford Dam



Bacteria levels vary greatly over time, even at the same location. If enough samples at a site exceed the bacteria standard, that part of the river is classified as “impaired” for having too much bacteria.

Source: Minnesota Pollution Control Agency

Map data sources: Minnesota Pollution Control Agency (bacteria data) and Minnesota Department of Natural Resources (core geographic elements)

bacteria pollution and propose ways to reduce current bacteria levels in the river. This clean-up plan is currently under development and is anticipated to be ready in the next few years. Project information is available at <http://www.pca.state.mn.us/ktqha48>.

In the meantime, you can help reduce bacteria pollution in the Mississippi River by cleaning up your pet’s waste, making sure septic systems are up-to-date, and taking action to help reduce stormwater runoff at home and in your community.

Phosphorus

The metropolitan portion of the Mississippi River sends too much phosphorus pollution downstream to Lake Pepin.

Excess phosphorus harms aquatic life and recreation in water bodies.

Decreases in river phosphorus concentrations have been offset by higher overall flows.

State standards for river phosphorus are currently under development.

Description and impacts. Phosphorus is a common element in the environment and is essential for plant growth and health. However, excess levels of phosphorus in waters can harm aquatic life and recreation by reducing water clarity, depleting oxygen levels in the water, and causing toxic algae blooms.²¹ Algae have created problems in the lower Minnesota River and Lake Pepin.

Sources. Overall, the Minnesota River is the largest contributor of phosphorus to Lake Pepin (Figure 1). Major sources of phosphorus pollution include agricultural runoff, urban runoff, and wastewater treatment plants.²² Additional sources include atmospheric deposition, failing septic systems, and some road salt alternatives. Sediment levels in water also affect phosphorus pollution, as phosphorus can attach to soil particles as they move through the watershed (see Sediment, page 28).

The Metropolitan Wastewater Treatment Plant was a leading source of phosphorus (especially under low-flow conditions), but loads from this plant have greatly diminished since it implemented a new phosphorus reduction process in 2003 (Figure 2). Similar load reductions have taken place at other wastewater treatment plants throughout the Lake Pepin watershed.

River status and trends. State standards for river phosphorus are currently under development.²³ Without a standard to measure against, we cannot say whether the metropolitan portion of the Mississippi River is or is not “impaired” due to excess phosphorus.

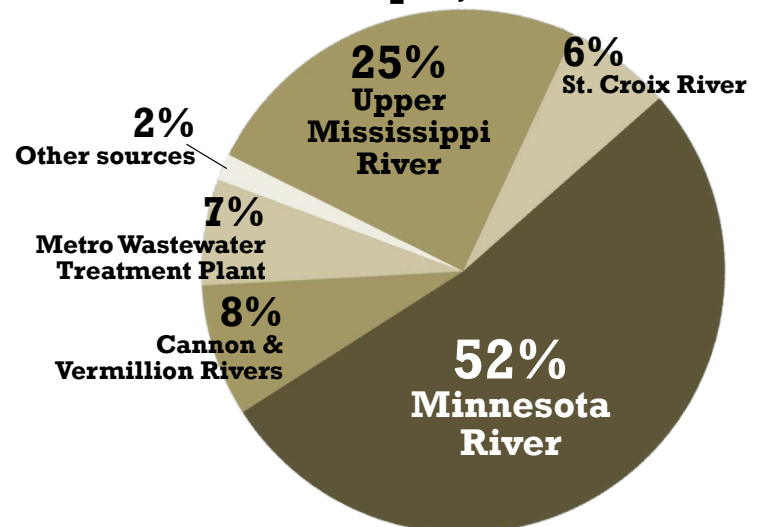
Overall phosphorus concentrations have decreased since 1976.²⁴ Median annual phosphorus concentrations declined by 28% at the Hastings Dam (Figure 3). On average, each gallon of water flowing through the river

contains less phosphorus than in previous years. But with dramatic increases in flow, there are many more gallons of water flowing, meaning the overall “load” (amount of phosphorus moving through the river) has remained fairly steady.²⁵

Lake Pepin status. Unlike the metropolitan portion of the river, Lake Pepin is listed as impaired with excess phosphorus concentrations, and can suffer from severe algae blooms and fish die-offs during low-flow summers such as 1988.²⁶ Upstream efforts to reduce phosphorus loads will help restore Lake Pepin.

Management solutions. Establishing phosphorus standards for the river is important. Substantial improvements in agricultural fertilizer and manure management, along with enhanced septic system maintenance and

Figure 1. Sources of phosphorus to Lake Pepin, 2006



Source: Minnesota Pollution Control Agency²⁹

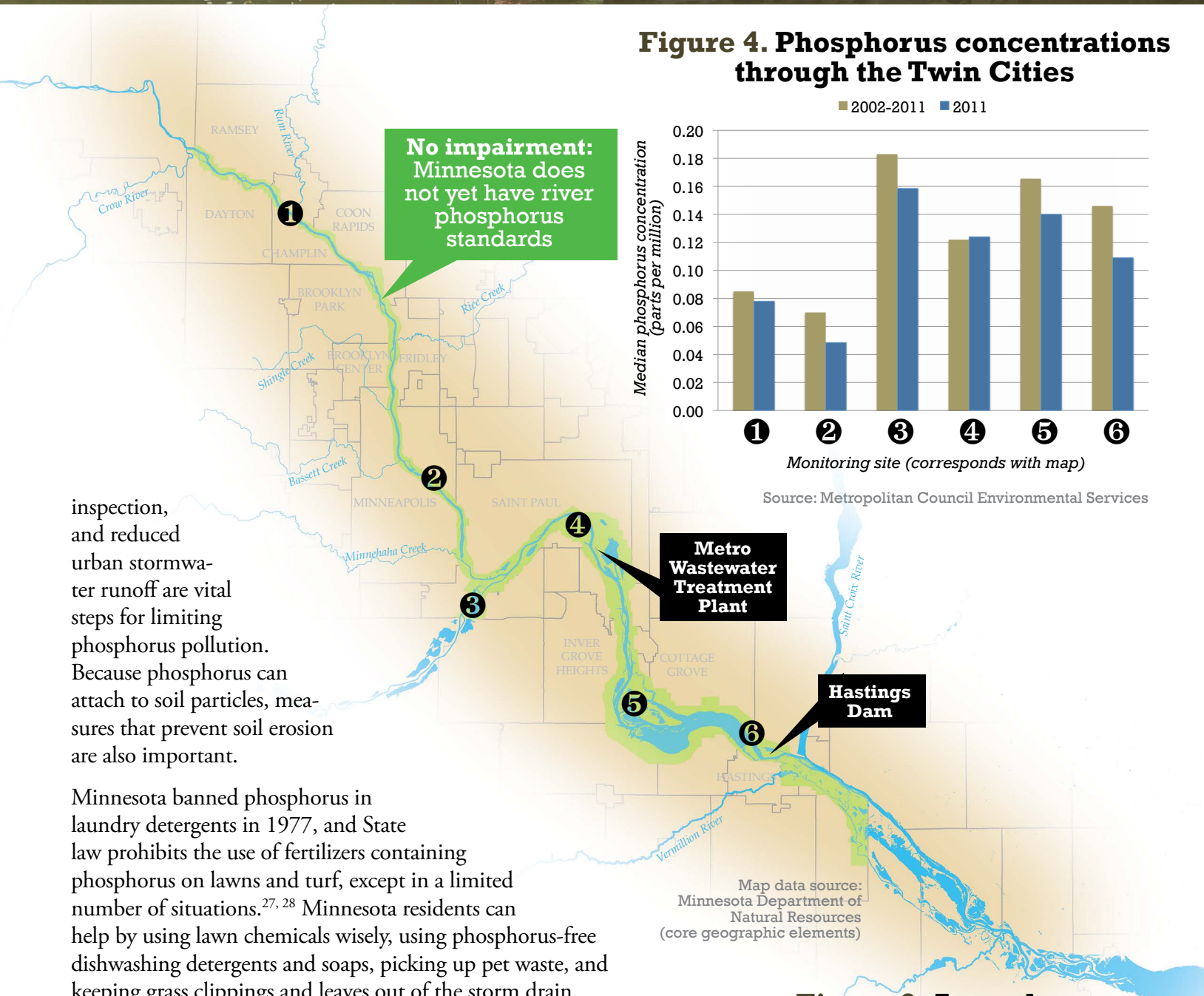
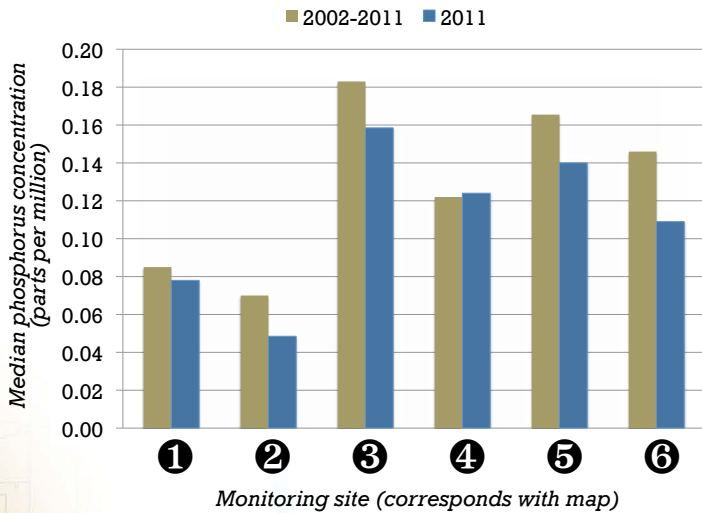


Figure 4. Phosphorus concentrations through the Twin Cities

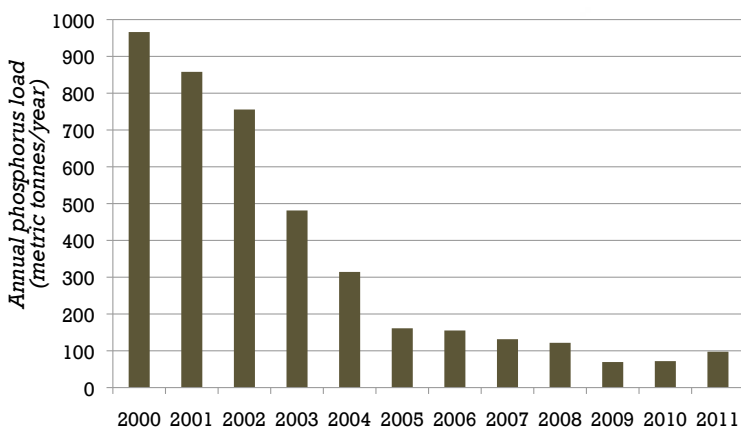


Source: Metropolitan Council Environmental Services

inspection, and reduced urban stormwater runoff are vital steps for limiting phosphorus pollution. Because phosphorus can attach to soil particles, measures that prevent soil erosion are also important.

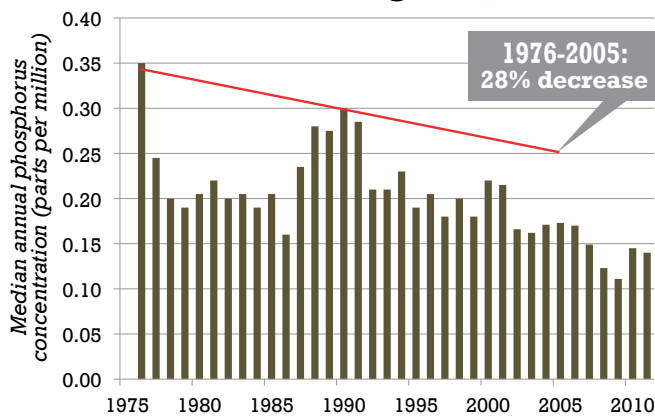
Minnesota banned phosphorus in laundry detergents in 1977, and State law prohibits the use of fertilizers containing phosphorus on lawns and turf, except in a limited number of situations.^{27, 28} Minnesota residents can help by using lawn chemicals wisely, using phosphorus-free dishwashing detergents and soaps, picking up pet waste, and keeping grass clippings and leaves out of the storm drain.

Figure 2. Annual Metro Wastewater Treatment Plant phosphorus loads



Source: Metropolitan Council Environmental Services

Figure 3. Annual phosphorus concentrations at the Hastings Dam



Source: Metropolitan Council Environmental Services
Note: trend analysis available only through 2005.

Map data source: Minnesota Department of Natural Resources (core geographic elements)



Photo: Whitney Clark/Friends of the Mississippi River

Photo: Mississippi River Challenge

FISH & FISHING

This section highlights **three** key measures of the quality of the Mississippi River fishery.

Fish survey data highlight the abundance and diversity of fish species in the metropolitan portion of the Mississippi River.

Fish consumption advisory information provides safe eating guidelines for fish from the river. Asian carp are invasive species threatening to move into the area.

Fish consumption

Fish survey

Asian carp



Fish consumption

Fish from the river are safe and healthy to eat if you follow the state's fish consumption advice.

Fish in the river may contain mercury, PCBs, and PFOS.

People who eat fish from the river should consult the state's Site-Specific Eating Guidelines.

Fish consumption guidelines are based on the fish species, who you are, and how often you eat fish.

Background. Both store-bought and locally caught fish may contain contaminants such as mercury or PCBs that can harm human health. As a result, the State of Minnesota has safe eating guidelines to help you make informed decisions about the fish you eat.

Statewide Safe Eating Guidelines. The Statewide Safe Eating Guidelines are based on mercury and PCB levels measured in fish throughout Minnesota. While not all waters in Minnesota have been tested for contaminants, the Statewide Safe Eating Guidelines can be used for both tested and untested waters. There are two types of guidelines: those for mothers and children (more protective), and those for the general population.³⁰

Site-Specific Eating Guidelines. In some of Minnesota's lakes and rivers, test results show that fish contain higher or lower than average levels of certain contaminants. In these cases, the resulting meal advice may be more or less restrictive than the Statewide Safe Eating Guidelines.³¹

Contaminants of concern. Fish are rich in iron, protein and omega-3 fatty acids and are a good choice for a healthy diet. However, fish can contain small amounts of some toxins. The three toxins of concern in this reach of the river are mercury, PCBs, and PFOS.³²

- **Mercury** is a toxic metal that can impact the nervous system, particularly in children and the developing fetus.
- **PCB** exposure is linked to problems in infant development and adult immune function.
- **Perfluorooctane sulfonate (PFOS)** is part of a family of man-made chemicals that accumulate in fish, persist in the environment, and can pose potential risks to human health.

For more information, see the "Other contaminants of concern" section of this report on page 37.

Figure 1. PCBs in fish, 1970s-2000s

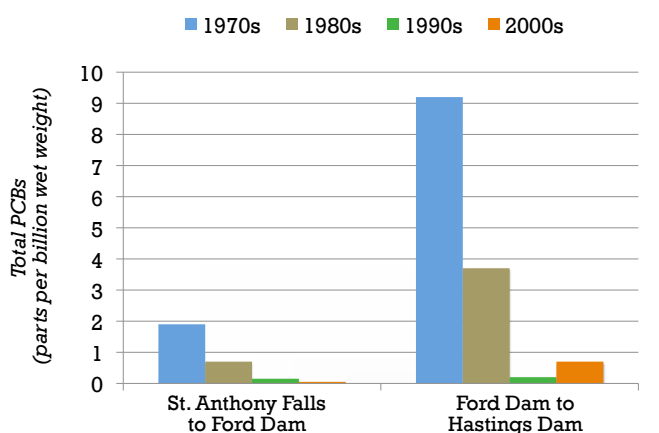
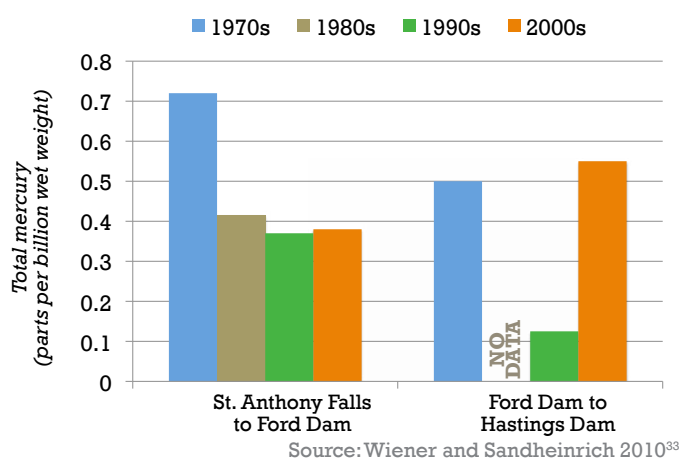


Figure 2. Mercury in fish, 1970s-2000s

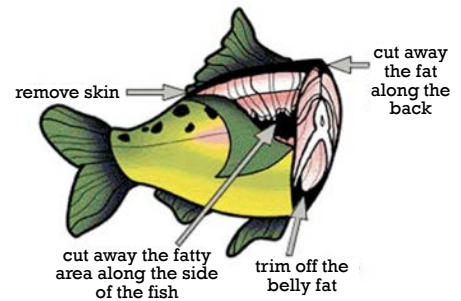


Fish consumption advisories

Anglers should follow Site-Specific Eating Guidelines for fish from the river.

Tips for eating fish

While mercury and PFOS cannot be removed through cooking or cleaning (they are in the flesh of the fish), you can reduce exposure to contaminants like PCBs by removing fat when you clean and cook fish.



Source: Minnesota Department of Health⁴⁰

Follow these tips when eating fish:

1. Eat smaller fish.
2. Eat more panfish (sunfish, crappies) and fewer predator fish (walleyes, northern pike, lake trout).
3. Trim skin and fat, especially belly fat. Also, eat fewer fatty fish such as carp, catfish, and lake trout. PCBs build up in fish fat.



Credit: Florida Fish & Wildlife Commission. Used under CC-BY-2.0 license

History and trends. Environmental contamination from PCBs began in the mid-1930s and peaked in the early 1970s (Figure 1).³³ Concentrations in fish have declined substantially since the manufacture of PCBs was banned nationally in the late 1970s.³⁴ Mercury pollution to the river peaked in the 1960s.³⁵ By the early 1990s, annual accumulation rates, as measured in Lake Pepin sediment, had decreased by almost 70%.³⁶ However, recent research on mercury accumulation in loons and fish shows an increase in recent years, suggesting the need to remain vigilant (Figure 2).^{37,38} For information on PFOS trends, see page 40 of this report.

Status. There are site-specific eating guidelines in place for the metropolitan portion of the river. Some of these guidelines are more restrictive than the Statewide Safe Eating Guidelines. People who eat fish from the river should consult the Site-Specific Eating Guidelines. More information is available through the Minnesota Department

of Health at <http://www.health.state.mn.us/divs/eh/fish/eating/sitespecific.html>.

Solutions. The Minnesota Pollution Control Agency recently approved a statewide mercury reduction plan that calls for a 76% reduction in mercury air emissions by 2025.³⁹ Achieving these goals will require major reductions from a range of sources, including coal-fired power plants, ferrous mining operations, and other foreign and domestic sources.

PCB manufacture was banned in the U.S. in the late 1970s. As a result, PCB concentrations in the river have decreased dramatically. PFOS clean-up work is underway; see page 40 to learn more.

Map data sources: Minnesota Department of Health (fish consumption guidelines); Minnesota Department of Natural Resources (core geographic elements)

Fish survey

Anglers have embraced the metropolitan portion of the Mississippi River as a world-class fishery.

There has been an increase in the diversity and quality of the river's fishery, particularly smallmouth bass and walleye fisheries, since the 1970s.

Catch-and-release regulations are in place for portions of the river.

River managers lack data on fish populations; few regular fish surveys have been conducted.

Background. Early settlers and explorers found abundant fish and wildlife throughout this reach of the river. Pre-settlement fish populations are estimated to have included nearly 120 native species below St. Anthony Falls and approximately 60 species above the falls, which historically served as a natural migration barrier.⁴¹

Unfortunately, fish populations declined dramatically following European settlement. By 1926, fish survey data showed only two living fish in the 25 miles downstream of St. Anthony Falls.⁴² Sewage and industrial contamination contributed to high pollution levels, while subsequent dam construction altered river flow patterns (converting free-flowing water to more stagnant pools) and increased sediment accumulation in the water (smothering important fish habitat).

Since then, improvements in regional and federal wastewater management, including substantial reductions in pollution following passage of the 1972 Clean Water Act, along with other factors, have resulted in improved fish populations in the river. In addition, lock and dam installation has aided fish migration upstream as far as the Coon Rapids Dam, which now acts as the primary fish migration barrier in the metropolitan portion of the river (the other metro-area dams have locks through which fish can pass).

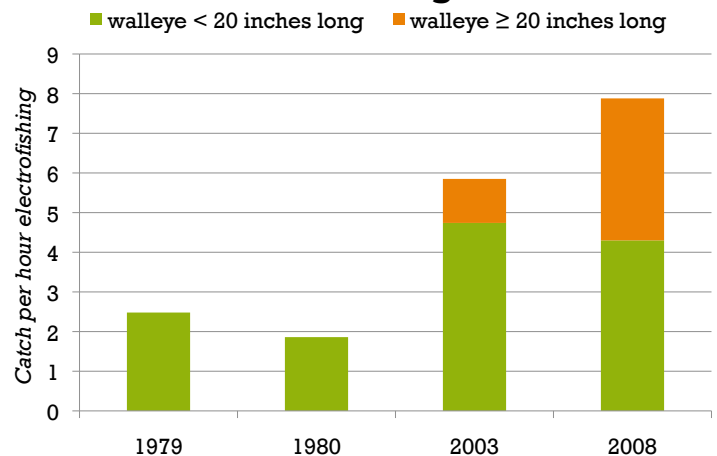
Status. Today, the river supports a high quality fishery for several trophy species, including smallmouth bass, catfish, and walleye. Between the Ford Dam and the Hastings Dam, the walleye fishery is one of the highest quality urban fisheries in the U.S. The smallmouth bass fishery upstream of the Coon Rapids Dam is considered world-class.⁴³

It is estimated that more than 127 species of fish (119 native, eight introduced) currently live in the river up to the Coon Rapids Dam, including some, like trout-perch, that are sensitive to pollution.⁴⁴ An estimated 75 species (65 native, 10 introduced) are now found above the Coon Rapids Dam. Some of these would not naturally be found there, and are present due to human actions or because they have been able to pass the dam during floods.

Despite these encouraging numbers, it is difficult to accurately estimate fish populations, and much remains unknown about the overall diversity and abundance of fish in the river. There have been few consistent surveys of aquatic life in this reach of the river, and fishery managers lack data to adequately manage the river's fishery.

Fishing catch-and-release rules. There are catch-and-release regulations for the river between the

Figure 1. Walleye catches between Ford and Hastings Dams



Source: Minnesota Department of Natural Resources

Catch-and-release regulations

Ford and Hastings Dams for walleye, sauger, largemouth bass, and smallmouth bass. These fish may be caught, but must be returned alive to the water. These guidelines were established in 1993 to protect and maintain high quality populations.

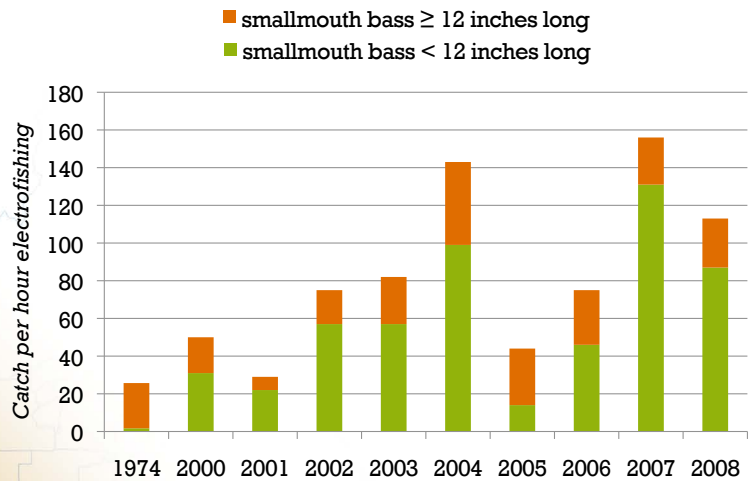
Emerging threats. The Department of Natural Resources (DNR) is actively pursuing information and management strategies for two emerging threats to fish populations in the Mississippi River.

Asian carp: These large invasive fish can destabilize the aquatic food web and outcompete native fish for food. Monitoring for the presence of Asian carp in the river is ongoing (see Asian carp, page 24).

VHS: Viral Hemorrhagic Septicemia (VHS) is a deadly virus that threatens a number of fish species in the river. The DNR has been testing for the presence of VHS in the metropolitan portion of the river. To date, no fish have tested positive.

Management tools and outcomes. Several important fishery management tools, including commercial and recreational angling regulations, and catch-and-release rules, are currently in place.

Figure 2. Smallmouth bass catches above Coon Rapids Dam



Source: Minnesota Department of Natural Resources

Ford Dam to Hastings Dam: catch-and-release regulations for walleye, sauger, smallmouth bass, and largemouth bass are in place here

Map data source: Minnesota Department of Natural Resources (fishing regulation data & core geographic elements)

While the fishery as a whole appears healthy, fishery managers lack clear data on species abundance and habitat condition throughout this reach of the river. Regular and consistent fish survey data are needed in order to establish “baseline” fish population information. The DNR is allocating additional resources to this work. Once baseline information exists for the river’s fish populations, strategic management options can be more effectively identified.

In addition to habitat restoration and water quality enhancement, the DNR is actively working to address overharvesting of protected species, and to prevent the spread of both VHS and Asian carp.

Asian carp

Asian carp are moving into the metropolitan portion of the Mississippi River.

Asian carp are invasive fish that pose a serious threat to river recreation and ecosystem health.

Grass, bighead and silver carp have reached Minnesota; eDNA tests suggest potential migration as far as the Coon Rapids Dam.

Federal and state agencies and nongovernmental organizations are working to prevent additional Asian carp migration.

About Asian carp. Asian carp are a group of invasive fish consisting of four species: bighead, black, grass and silver carp. The largest species, bighead carp, can grow to 111 pounds. With large appetites and no natural predators, these voracious feeders can severely disrupt aquatic ecosystems as they out-compete native fish species. In addition, Asian carp also threaten boating, fishing and other river recreation activities. Silver carp, which can grow to 60 pounds and leap as high as 10 feet from the water when disturbed, have injured boaters and damaged property in other states.⁴⁵

History and background. Asian carp were originally imported to the southern U.S. from China to control aquatic vegetation and parasites in fish farms. The carp escaped to the Mississippi River and its tributaries in the 1970s, and populations were well established in southern river states by the 1980s.⁴⁶ Their population and range have increased dramatically in recent years, and the fish have reached the Mississippi and Missouri River watersheds in Illinois, Missouri, Iowa and southern Wisconsin. In 2012, over 80 bighead and 50 silver carp were caught by commercial fisherman in Lake Okoboji in

northwest Iowa, near the Minnesota border.⁴⁷ In portions of the Illinois River where the infestation is extreme, 60% of the river's fish biomass is now Asian carp.⁴⁸

Status. In 2011 and 2012, bighead carp were caught in the St. Croix River (Prescott, Wisc.) and on the Mississippi River near Winona. Silver and grass carp were also caught near Winona.⁴⁹ About a dozen bighead and silver carp have been caught in the St. Croix and Mississippi Rivers along Minnesota's eastern border since 1996.⁵⁰ While no established populations of bighead or silver carp are known to exist in Minnesota, recent data suggests the fish may be present in the Mississippi River above Red Wing and in the lower St. Croix River.

Environmental DNA (eDNA) testing in 2011 found genetic evidence of silver carp above and below the Coon Rapids Dam, between the Lower St. Anthony Falls Lock and Dam and the Ford Dam (Lock and Dam #1), and below the Hastings Dam (Lock and Dam #2). In addition, eDNA was found in the St. Croix River below the dam at Taylor's Falls, and on the Minnesota River upstream of the confluence with the Mississippi (see map, page 26).⁵¹

continues on page 26 ►

Silver carp, one of the four major invasive species of concern, are known for jumping up to 10 feet out of the water.

The march of Asian carp up the Mississippi River

Map data sources:
Asian carp data compiled
by the National Park Service;
geographic data
from from USGS, NOAA
and Natural Earth
(naturalearthdata.com)

Black carp

Mylopharyngodon piceus



Black carp eat and threaten native mussels and snails. They take away food sources for native fish, waterfowl, and vertebrates.

There is no evidence of established populations in the upper Mississippi, but the USGS has reports of individuals caught as far north as Lock and Dam 24, 100 miles north of St. Louis.

Identifying features:
darker color • large scales • no scales on head • pointy shaped face • teeth that look like human molars

Silver carp are the kind that famously jump up to ten feet out of the water when disturbed by passing boats, causing injury to passing boaters.

Identifying features:
silver color • small scales, but no scales on head • no barbels on nose, unlike common carp • downward slanting mouth (frown) • low set eyes • keel that extends to throat



Silver carp

Hypophthalmichthys molitrix

Grass carp

Ctenopharyngodon idella

Grass carp eat massive amounts of vegetation, destroying habitat needed for other wildlife.

Identifying features: green-gray back • rounded snout • over-hanging upper lip • no barbels on nose, unlike common carp • covered with larger scales



KEY

Carp abundance by species

no findings

rare

uncommon

occasional

common

abundant

lock and dam (number)

Bighead carp

Hypophthalmichthys nobilis



Prefer zooplankton but also eat phytoplankton - the base of the aquatic food web.

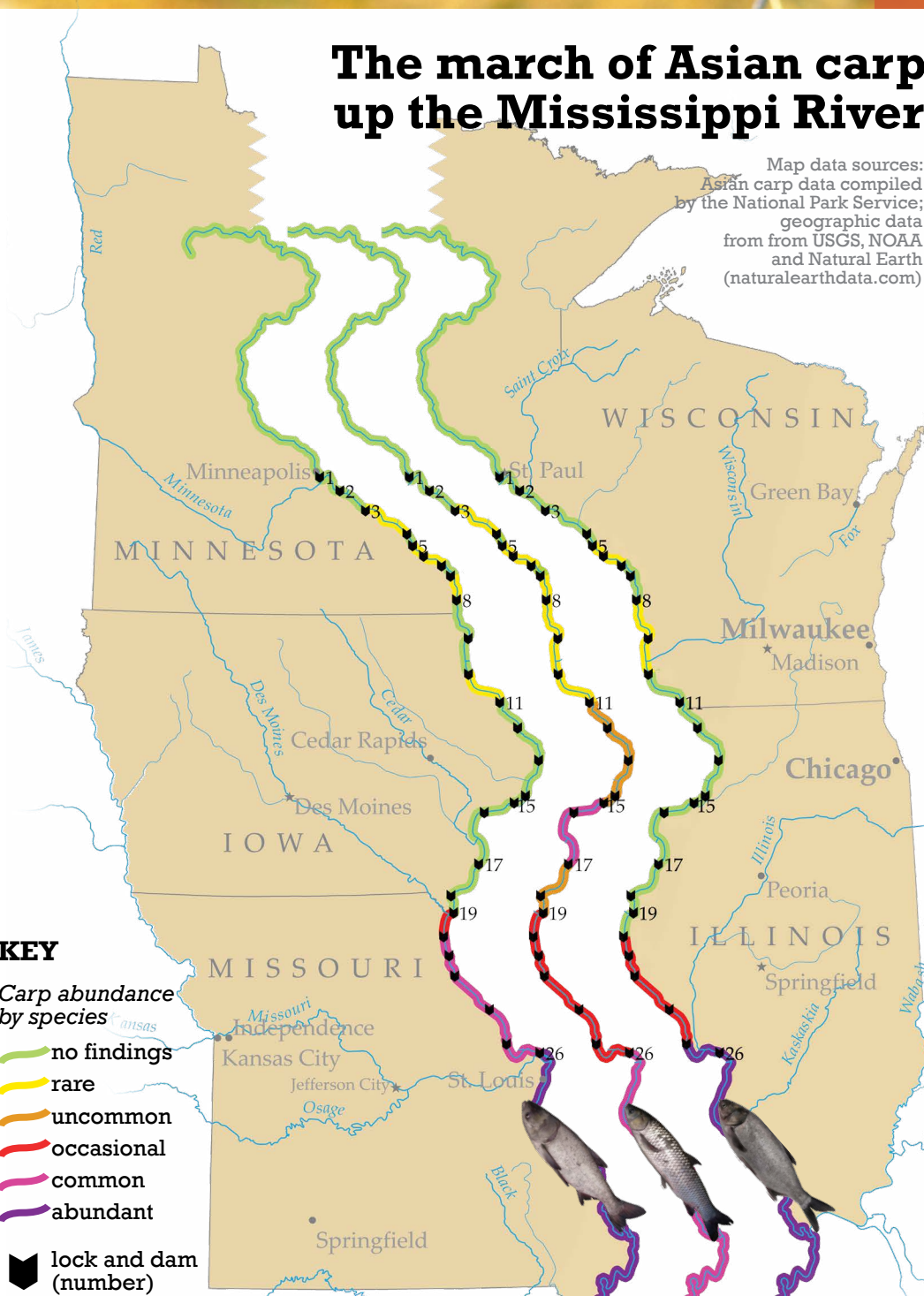
Identifying features: silver color • no scales on head • no barbels on nose, unlike common carp • downward slanting mouth (frown) • low set eyes • keel extends partway along belly

Fish photo credit: Asian Carp Regional Coordinating Committee/CIFR P.2.0 license

Fish photo credit: Wikipedia user Desor under CC-BY 3.0 license

Fish photo credit: United States Geological Survey Non-Indigenous Fish Database

Fish photo credit: Wikipedia user Desor under CC-BY 3.0 license



Silver carp eDNA sample locations, 2011

All locations tested positive for silver carp DNA

Map data sources:
Environmental DNA
Solutions, 2011 (eDNA
sample results); Minnesota
& Wisconsin Departments
of Natural Resources (core
geographic elements)

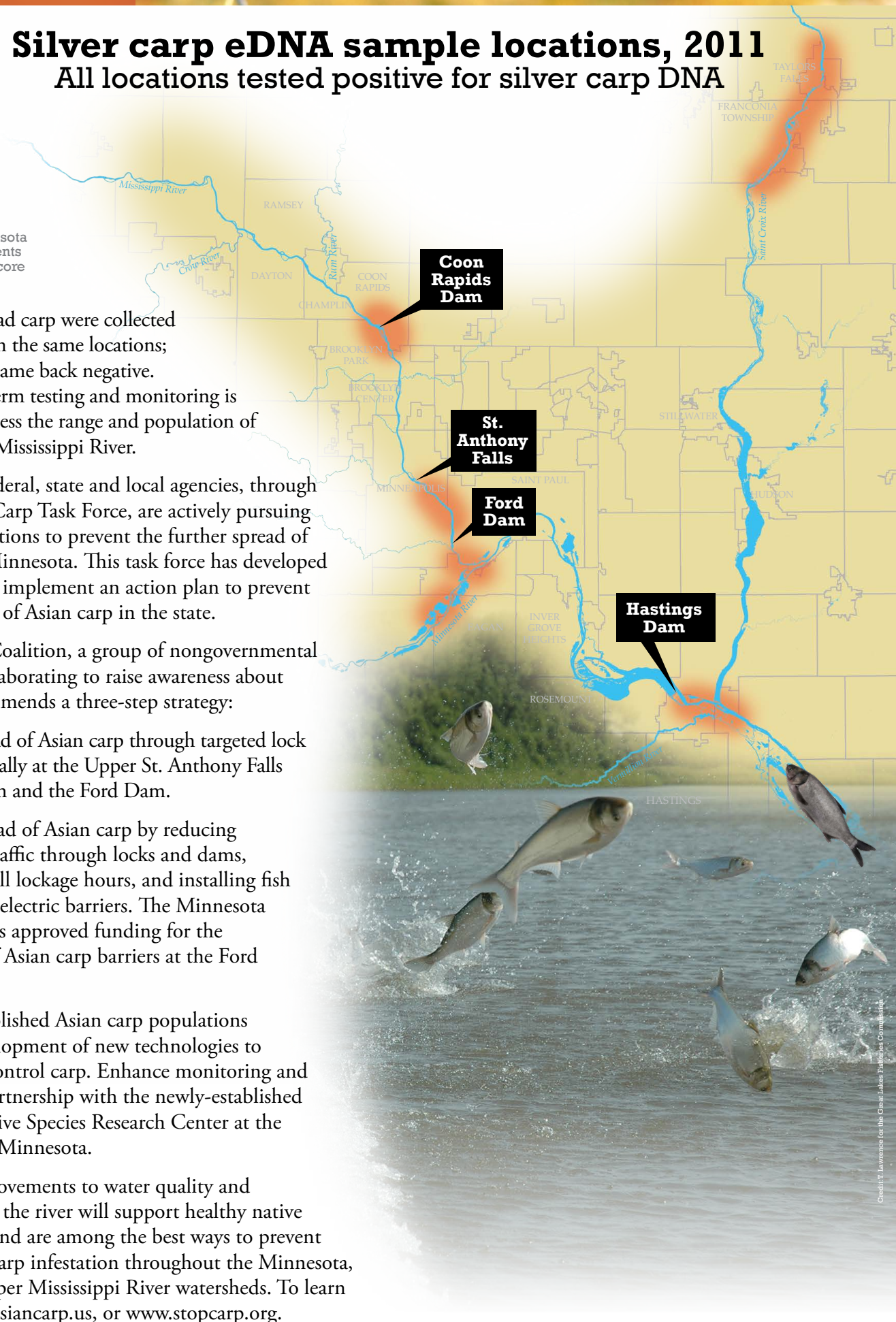
Samples for bighead carp were collected at the same time in the same locations; those samples all came back negative. Additional long-term testing and monitoring is needed to fully assess the range and population of Asian carp in the Mississippi River.

Solutions. Federal, state and local agencies, through an ad-hoc Asian Carp Task Force, are actively pursuing management solutions to prevent the further spread of Asian carp into Minnesota. This task force has developed and is working to implement an action plan to prevent the establishment of Asian carp in the state.

The Asian Carp Coalition, a group of nongovernmental organizations collaborating to raise awareness about Asian carp, recommends a three-step strategy:

- **Stop** the spread of Asian carp through targeted lock closure, especially at the Upper St. Anthony Falls Lock and Dam and the Ford Dam.
- **Slow** the spread of Asian carp by reducing recreational traffic through locks and dams, limiting overall lockage hours, and installing fish “bubble” and electric barriers. The Minnesota Legislature has approved funding for the installation of Asian carp barriers at the Ford Dam.
- **Control** established Asian carp populations with the development of new technologies to biologically control carp. Enhance monitoring and research in partnership with the newly-established Aquatic Invasive Species Research Center at the University of Minnesota.

In addition, improvements to water quality and aquatic habitat in the river will support healthy native fish populations and are among the best ways to prevent aggressive Asian carp infestation throughout the Minnesota, St. Croix, and upper Mississippi River watersheds. To learn more, visit www.asiancarp.us, or www.stopcarp.org.



ECOLOGICAL HEALTH

This section highlights the ecological health of the Mississippi River, including the status and trends of **four** key measures of water quality and aquatic life in the metropolitan portion of the Mississippi River.

Sediment and nitrate are important measures of water quality that affect aquatic life and habitat throughout the Mississippi River watershed.

Bald eagles and mussels are key measures of the health and vitality of the river.

Sediment

Nitrate

Mussels

Bald eagles

Sediment

The river is impaired with excess sediment below the confluence with the Minnesota River.

Excess sediment can harm aquatic plants and habitat for fish and other wildlife.

About 75% of the river's sediment comes from the Minnesota River basin.

Lake Pepin is filling in with sediment at 10 times its natural rate.

Description and impacts. Sediment pollution includes tiny particles of soil and organic matter that are suspended in the river's water. Excess sediment makes the water "turbid" or cloudy, harming aquatic plants and habitat for fish and other wildlife. In addition, other pollutants, like phosphorus, can attach to sediment and be carried downstream. Excess sediment is also rapidly filling in Lake Pepin, a natural lake on the Mississippi River, where extensive sediment research provides valuable long-term data.

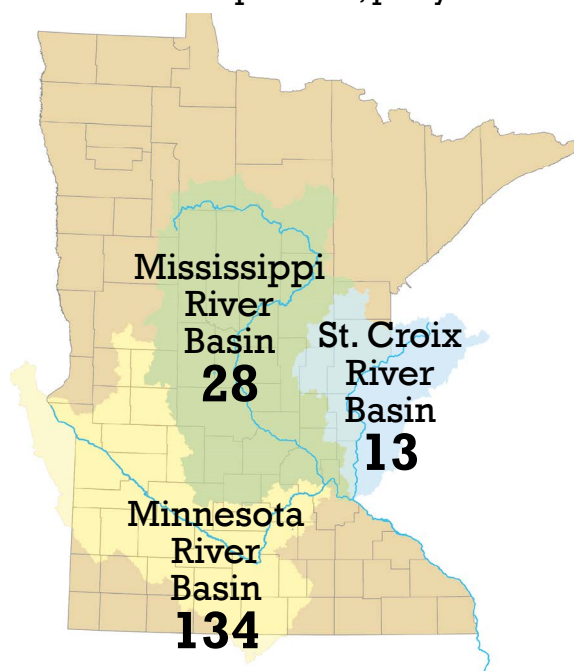
Sources. On average, about 75% of the sediment load flowing into the metropolitan portion of the river comes from the Minnesota River basin, where river banks, bluffs, and farm fields are the primary sources of sediment pollution.⁵² The rest of the sediment comes from the upper Mississippi River basin, along with the Cannon River and other smaller tributaries. Metro-area urban runoff contributes roughly 6% of the total sediment load, while the relatively clean St. Croix River contributes very little sediment to the river.⁵³

Total sediment loads to the river and Lake Pepin are greatly influenced by increased river flows, as large volumes of water move more sediment through the river system.

History and trends. Current sediment loads to Lake Pepin are roughly 10 times pre-European settlement rates.⁵⁴ From the 1930s to 1960s, sediment loads to Lake Pepin roughly doubled, from 300,000 to 700,000 metric tonnes per year (Figure 2).⁵⁵ This period coincides with the

Figure 1. Total sediment contribution

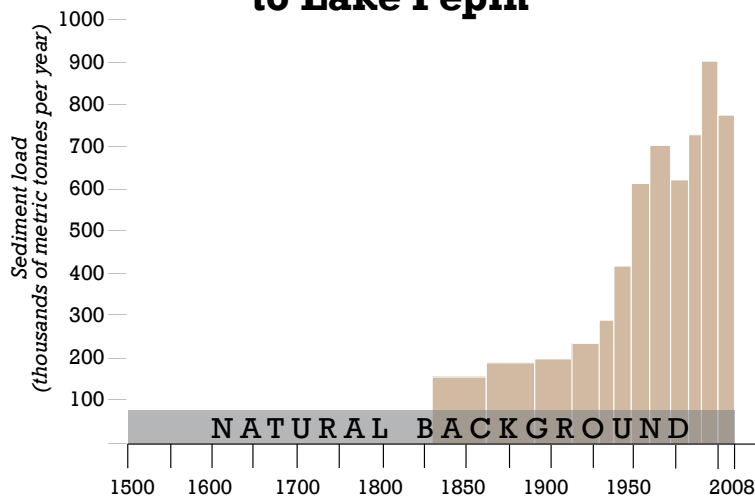
Pounds per acre, per year



On average, sediment loss in the Minnesota River basin is far greater than in the Mississippi or St. Croix River basins.

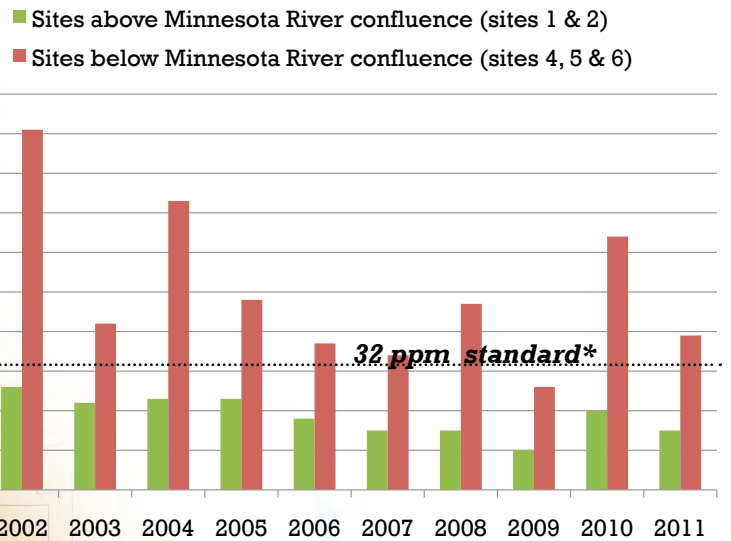
Sources: Engstrom & Almendinger, 2000, Nater & Kelley, 1998 via Minnesota River Trends - November 2009

Figure 2. Sediment loading to Lake Pepin



Source: Minnesota Pollution Control Agency

Figure 3. Average sediment concentrations



This graphic illustrates sediment concentrations in the river above and below the confluence with the Minnesota River.

*32 ppm site-specific standard applies to the south-metro portion of the river (including sites 4, 5, and 6).

Source: Metropolitan Council Environmental Services

River impaired

Map data source: Minnesota Department of Natural Resources (core geographic elements)

widespread loss of wetlands and intensification of agriculture, along with ditching of farmlands, and increased urban development.⁵⁶

⁵⁷ Sediment loads peaked in the early 1990s (when river flows were especially high) and have since leveled off at approximately 850,000 tonnes/year.⁵⁸

Changes in hydrology, particularly agricultural drainage and wetland loss, have increased river flow (see Flow, page 10).⁵⁹ Median Minnesota River flows near Jordan have doubled over the past 70 years, and its tributary flows have increased by similar magnitudes.⁶⁰ Increased flows have in turn amplified Minnesota River basin stream bank, ravine, and bluff erosion, which are now the primary sources of sediment to the Mississippi River and Lake Pepin.⁶¹

Status. The river is currently impaired with excess sediment below the confluence with the Minnesota River (Figure 3). Sediment levels in this reach of the river frequently exceed the state standard of 32 parts per million (ppm). As a result, the river has too much sediment for healthy aquatic plant growth, or for fish and wildlife to thrive.⁶²

Solutions. The Minnesota Pollution Control Agency recently drafted a clean-up plan for excess sediment in the river. The plan calls for major reductions in sediment

loads, including 50-60% reductions from the Minnesota River, 20% from the upper Mississippi River, and 25% from metro-area urban runoff.⁶³

Achieving these goals will require substantial changes in how we use land as well as increased water retention throughout the Mississippi River watershed. Improved agricultural conservation and water retention, urban runoff controls, and in-river restoration such as island building, are important steps in reducing sediment and restoring aquatic life in the river.

Nitrate

The river currently meets drinking water standards for nitrate, but overall nitrogen pollution to the Gulf of Mexico remains a serious problem.

Excess nitrate poses threats to human health and aquatic life, and is a primary contributor to the Gulf “dead zone.”

Nitrate concentration in the river increased by 47% from 1976-2005.

A drinking water nitrate standard exists to protect humans, but no nitrate standard exists to protect aquatic life. That standard is under development in Minnesota.

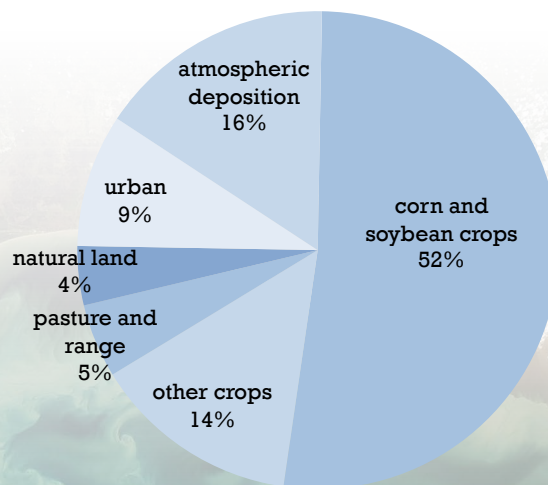
Description and impacts. Nitrate is an important form of nitrogen for plant and animal life, but too much in waters can be detrimental. Like most nitrogen compounds, nitrate easily dissolves in water. Excess nitrate can quickly enter surface waters and groundwater, where it presents two primary challenges:

- **Human health.** Nitrate in drinking water at levels above federal and state standards (10 parts per million) can pose health risks, including a potentially fatal condition known as “blue baby syndrome” in infants.⁶⁴
- **Hypoxia and the Gulf dead zone.** Further downstream, surplus nitrate contributes to the seasonal dead zone in the Gulf of Mexico. Excess nitrogen feeds massive algae blooms each spring. When the algae die off, their decomposition robs the water of oxygen (a condition called “hypoxia”), suffocating all marine life that is unable to escape.⁶⁵

Sources. U.S. Geological Survey researchers have documented the overall sources of nitrogen pollution to the Gulf of Mexico (Figure 1).⁶⁶ Total nitrate loads to the river are related to flow, as large volumes of water can move more nitrate through the river system.

Status. Locally, the river (above the confluence with the Minnesota River) is used directly for drinking water. As a result, the drinking water standard (10 parts per million) applies to that reach of the river.⁶⁷ The river meets the current standard. However, the state does not yet have a nitrate standard for the protection of aquatic life in the river. That standard is under development.⁶⁸

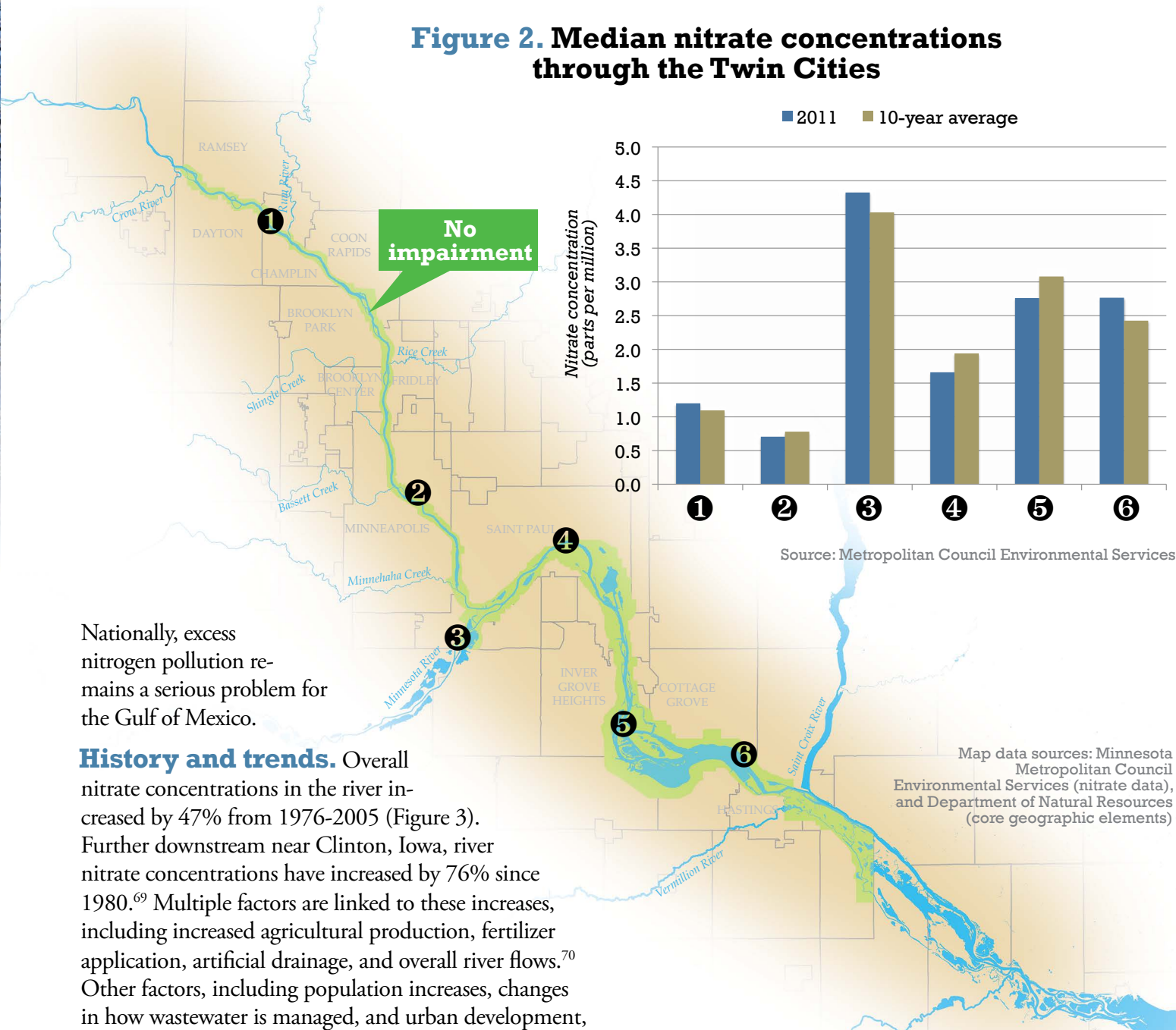
Figure 1. Sources of nitrogen to the Gulf of Mexico, 2006



Source: Alexander, et. al.⁶⁶

In 2011, the Gulf dead zone covered approximately 6,765 square miles.⁷²

Figure 2. Median nitrate concentrations through the Twin Cities



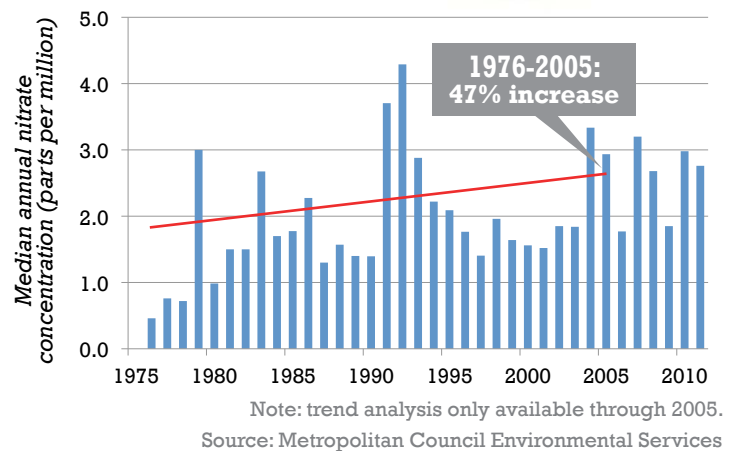
Nationally, excess nitrogen pollution remains a serious problem for the Gulf of Mexico.

History and trends. Overall nitrate concentrations in the river increased by 47% from 1976-2005 (Figure 3). Further downstream near Clinton, Iowa, river nitrate concentrations have increased by 76% since 1980.⁶⁹ Multiple factors are linked to these increases, including increased agricultural production, fertilizer application, artificial drainage, and overall river flows.⁷⁰ Other factors, including population increases, changes in how wastewater is managed, and urban development, also impact river nitrate levels.

Solutions. Establishing a state nitrate standard to protect aquatic life is an important first step in minimizing the impacts of excess nitrate in Minnesota. The state is conducting a thorough study of nitrate conditions in Minnesota's rivers, including sources, trends, and solutions. The study will be completed in 2013.⁷¹

Considering the overall sources to the Gulf of Mexico, substantial reductions in nitrogen loads from agricultural sources are an important part of the solution. In addition, reductions in urban runoff, wastewater treatment plant contributions, and air emissions are important components of protecting the river and restoring the Gulf of Mexico for future generations.

Figure 3. Nitrate concentrations at the Hastings Dam



Mussels

Some mussel populations are gradually being re-established in the river.

The presence of mussels is a good biological indicator of river health.

Mussel habitat is degraded below the confluence with the Minnesota River.

Species diversity and abundance have not fully recovered to historical levels.

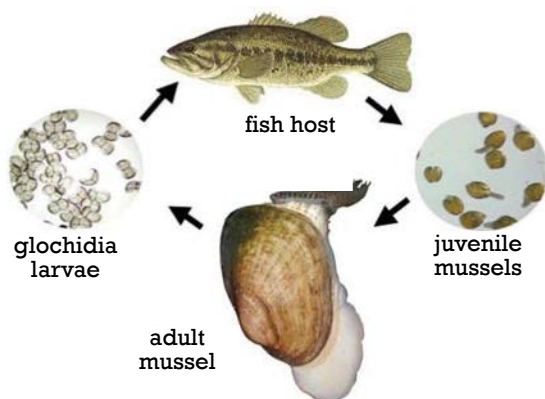
About mussels. The presence of mussels is a good biological indicator of overall river health. Minnesota's native mussels perform important functions in lakes and streams, and are considered ecosystem engineers because they enhance habitat for other organisms.⁷³ Mussels filter solid material (like plant debris and soil runoff) from the water, incorporate it into their bodies and shells, and excrete nutrients usable by plants and other animals back to the river.⁷⁴ The physical presence of both living mussels and their discarded shells creates habitat for other life, including fish, amphibians, and insects.⁷⁵ There are about 50 species of mussel that are native to Minnesota, some of which can live for more than 100 years.⁷⁶

Health and lifecycle. Mussels spend their lives partially or fully buried in mud, sand, or gravel in lakes, rivers, and streams. They require a stable surface, dissolved oxygen, and a food supply of organic matter to filter from the water passing over them. Since mussels can't swim away to escape, they are directly impacted

by river contaminants and habitat conditions. Mussels reproduce by releasing larvae that attach to a host animal, usually fish (Figure 1). Once attached to their host, the larvae metamorphose into adult form, leave the host, and take up life in the river bottom. Not just any fish host will do: some mussel species are only able to utilize a single species of fish, while others are adapted to use several different species.⁷⁷

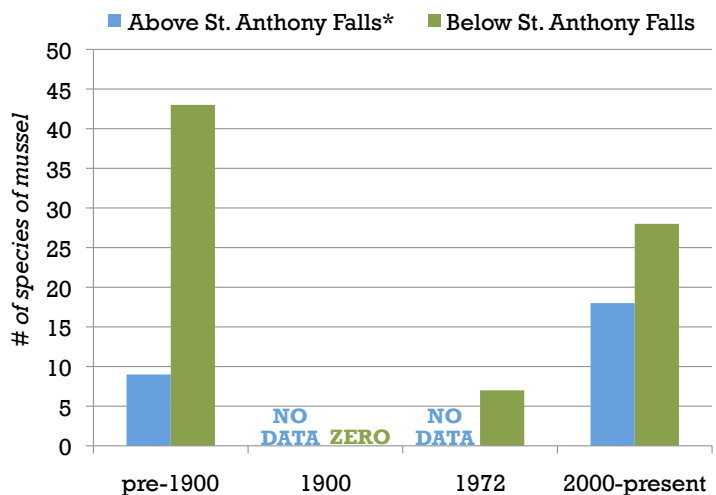
History and trends. Historically, St. Anthony Falls represented an important migration barrier that limited the distribution of mussels and fish. As a result, fewer species of mussel (nine) were historically present above the falls, while many more species (43) were historically present in the lower portions of the river (Figure 2).⁷⁸

Figure 1. The lifecycle of a mussel



Source: Water Resources Center at Minnesota State University, Mankato

Figure 2. Mussel species richness above and below St. Anthony Falls



*The construction of the St. Anthony Falls Locks and Dams aided fish and mussel passage upstream to the Coon Rapids Dam.

Sources: Minnesota Department of Natural Resources

Condition of mussel habitat in the Twin Cities

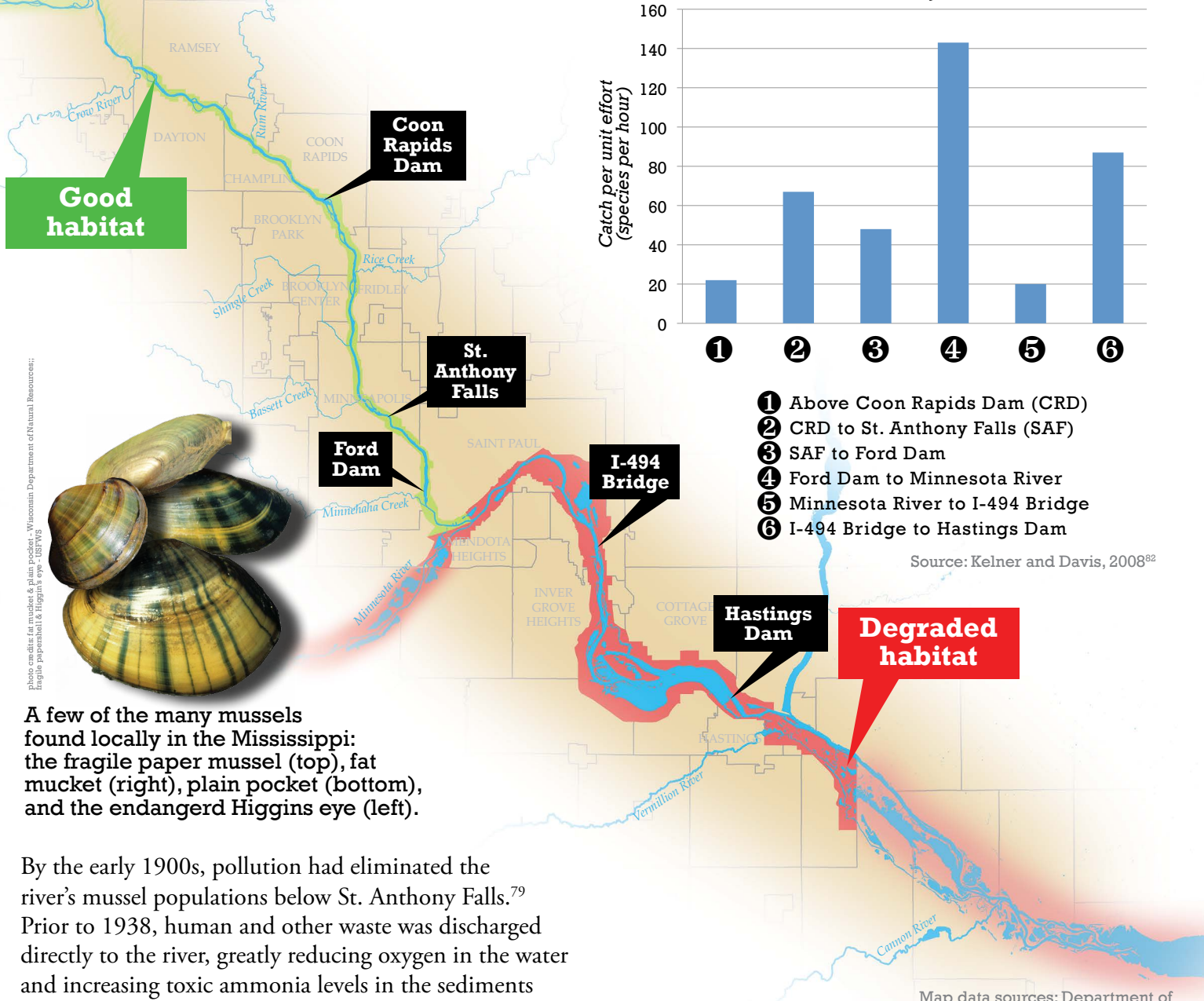


photo credits: fat mussel & plain pocket - Wisconsin Department of Natural Resources; fragile paper shell & Higgins eye - USFWS



A few of the many mussels found locally in the Mississippi: the fragile paper mussel (top), fat mucket (right), plain pocket (bottom), and the endangered Higgins eye (left).

By the early 1900s, pollution had eliminated the river’s mussel populations below St. Anthony Falls.⁷⁹ Prior to 1938, human and other waste was discharged directly to the river, greatly reducing oxygen in the water and increasing toxic ammonia levels in the sediments where mussels live.⁸⁰ Mussel populations have responded favorably to improved sewage treatment, storm sewer separation, and other water quality improvements, as year-round oxygen levels have increased and ammonia levels have decreased dramatically since the early 1980s.⁸¹

Status. Water quality and habitat for mussels in the upper portions of the river are good. From Dayton to the Coon Rapids reservoir, seven of nine historical native species are present. Below Coon Rapids Dam, improved water quality and the lock and dam system have allowed for greater upstream fish passage, resulting in more mussel species and larger populations. Unfortunately, mussel habitat below the confluence with the Minnesota River is degraded due to high sediment and pollutant loads.

However, some mussel species have returned and this lower reach of the river now supports 28 of the original 43 native mussel species.

Management solutions. Reducing pollution is the most important step we can take to improve mussel habitat in the river. Efforts to remove fish migration barriers (such as dams) would also benefit mussel populations, but these measures are at odds with efforts to control the spread of Asian carp. Presently, re-colonization of many historically present mussel species is largely dependent on human reintroduction.

Map data sources: Department of Natural Resources (mussel data and core geographic elements)

Bald eagles

The bald eagle population along the river has made a dramatic comeback; the river is now home to one of the densest populations in the Midwest.

Eagles along the river are highly productive, averaging two young per nest each year.

The dramatic increase in the bald eagle population is evidence of a healthier river compared to the 1960s, attributed to habitat protection and bans on certain chemicals.

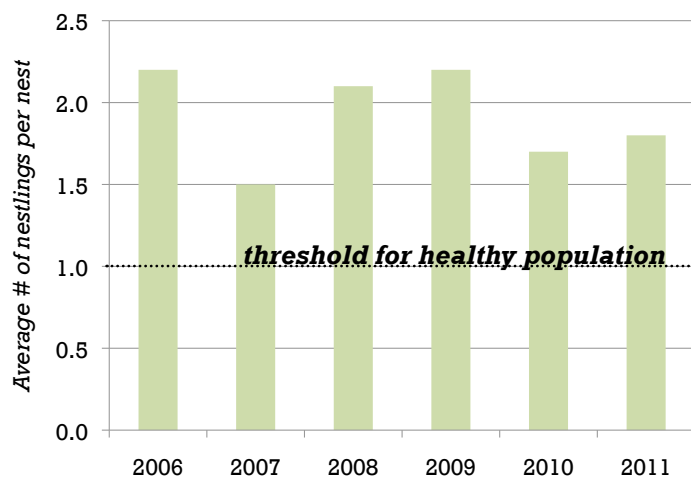
The National Park Service is monitoring levels of man-made chemicals in bald eagles along the river. This helps evaluate how contaminants impact fish, wildlife, and humans.

Background. The bald eagle in North America has made an extraordinary recovery since 1963, when only 417 pairs were known to be nesting in the lower 48 states. Protections offered by the Bald Eagle Act (1940), the Clean Water Act (1972), national bans on DDT and PCBs (1970s), and the Endangered Species Act (1973) helped the population to rebound. Today, nearly 10,000 pairs nest in the lower 48 states, including 1,300 in Minnesota.⁸³

Eagles feed primarily on aquatic prey, and can easily accumulate contaminants present in fish and other wildlife. Young bald eagles (“nestlings” or “eaglets”) are particularly susceptible to these contaminants, and are good indicators of overall ecosystem health. The National Park Service (NPS) began intensively monitoring bald eagle nestlings along the river in 2006 to assess the levels of several environmental contaminants, including lead, mercury, the pesticide DDT, PCBs, and PFCs (including PFOS).⁸⁴ See Figure 3 on page 36.

Population status. NPS data indicate there are approximately 36 active nesting sites along this reach of the river, indicating a strong and stable bald eagle population. From 2006 through 2011, the NPS visited up to 30 nests each year, assessed the health of 124 nestlings, and took blood samples to measure their levels of targeted contaminants. The findings indicate a well-nourished and productive eagle population, averaging about two nestlings per nest each year (Figure 1).⁸⁵ The reproductive rate has varied over the years, but remains high relative to other areas monitored by the National Park Service.

Figure 1. Nestlings per occupied nest



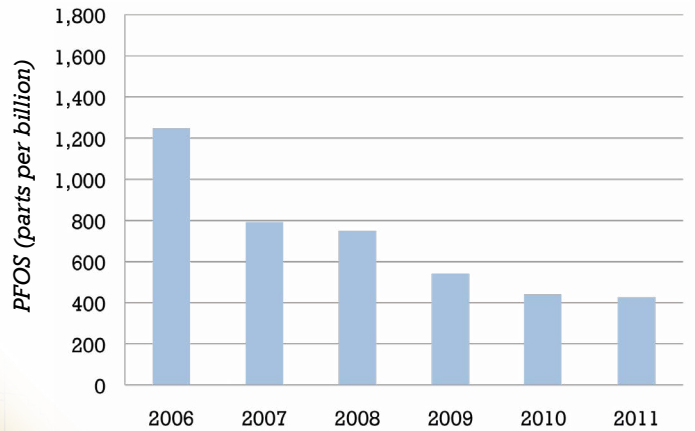
Source: National Park Service, 2012

Eaglet health status. As a general trend, levels of a number of contaminants have declined over the last six years. Monitoring data indicates that overall levels of PFOS have declined (Figure 2), and levels of PCBs and DDT are generally below values considered critical for eagle health. Combined with nestling population data, these trends indicate an overall positive outlook for eagle health along the Mississippi River.

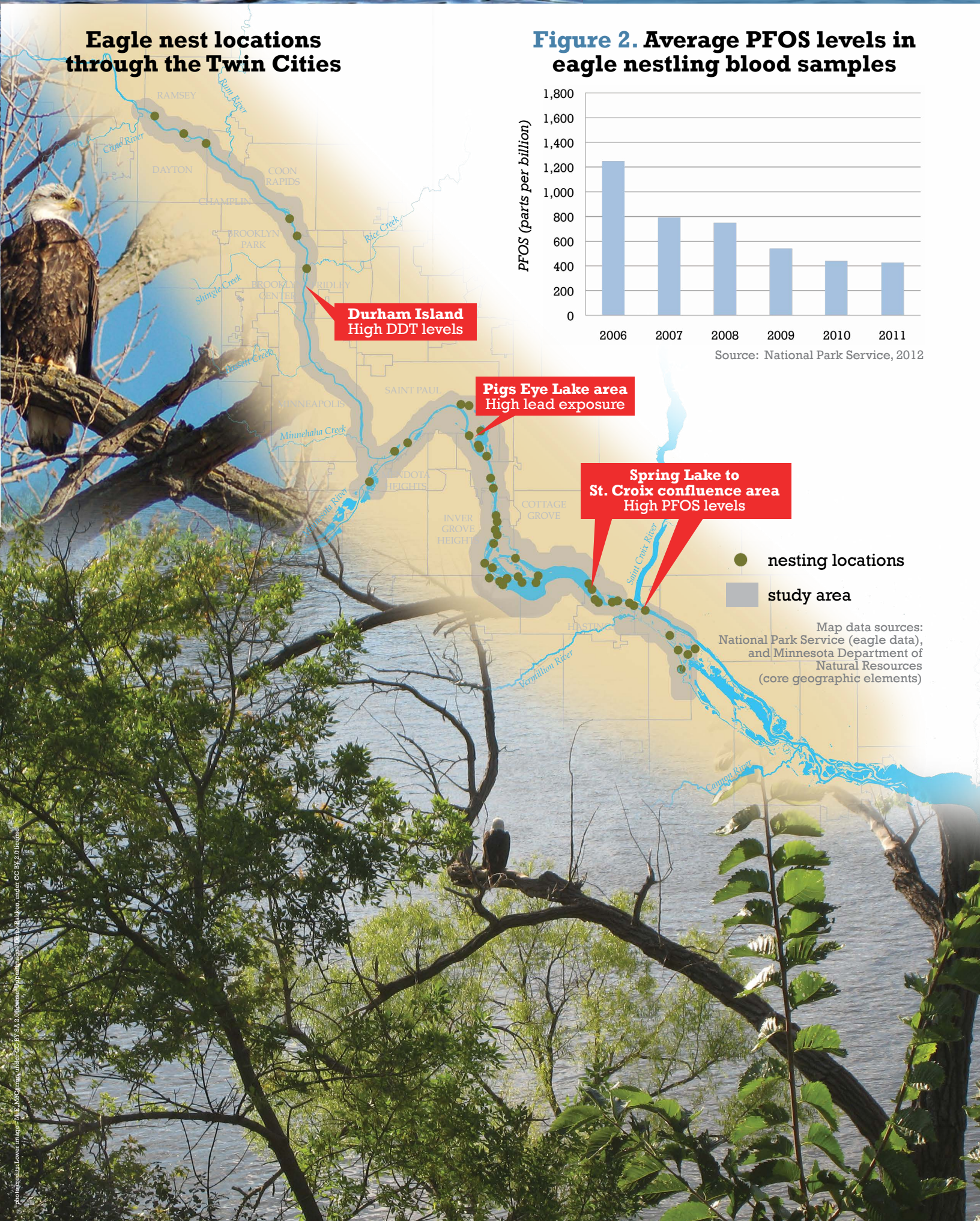
However, contamination concerns persist for this reach of the river. PFOS contamination remains elevated in portions of the river between the Ford Dam and the confluence with the St. Croix **continues on page 36** ►

Eagle nest locations through the Twin Cities

Figure 2. Average PFOS levels in eagle nestling blood samples



Source: National Park Service, 2012



Durham Island
High DDT levels

Pigs Eye Lake area
High lead exposure

Spring Lake to St. Croix confluence area
High PFOS levels

- nesting locations
- study area

Map data sources:
National Park Service (eagle data),
and Minnesota Department of
Natural Resources
(core geographic elements)

Photo credit: Lower Mississippi River, M.E. McCreary, Wildlife, CC BY SA 4.0 license. Photo credit: Twin Cities, M.E. McCreary, Wildlife, CC BY SA 4.0 license.

River. One nestling from Durham Island (in Minneapolis) had record-high DDT levels in 2009; the contaminant source is unknown.⁸⁶ There have been multiple instances of high lead exposure in nestlings from Pigs Eye Lake (in St. Paul).⁸⁷ Recent research on mercury accumulation in loons and fish shows an increase in recent years, suggesting the need to remain vigilant.^{88,89} In addition, the loss of critical habitat along the river poses potential long-term threats to the eagle population.

Management solutions. Continued monitoring of PFCs (including PFOS and its substitutes) in the south-metro portion of the river is highly recommended

to assess whether PFOS continues to decline, and how long (and where) PFOS and its substitutes may linger.

Additional research on record levels of DDT at the Durham Island nesting site, and high lead levels in the Pigs Eye Lake area, is recommended, as it appears that there may be local sources responsible for these high concentrations.

Action should be taken to address the lack of regeneration of cottonwoods and other nesting trees along the river. Planning now to phase in succession plantings can help avoid significant loss of large trees necessary for eagle nesting and perching.

Figure 3. Contaminants being monitored in the park's eagle population

Six man-made contaminants are being monitored in bald eagle nestlings in the MNRAA corridor.

Contaminant	Primary sources	Concern
Mercury	Coal-burning power plants, mining, and degradation of products containing mercury.	Neurotoxin; cause for fish consumption advisory in the river.
Lead	Past and current industrial uses, fishing tackle, and ammunition.	Neurotoxin; especially harmful to children.
PCBs	Banned in North America. Used in the past as an industrial lubricant and coolant. Can also be formed by incomplete burning of plastics and by chemical reactions in the environment.	Causes tumors in fish, implicated in crossed-bills in fish-eating birds; known to cause cancer. Cause for fish consumption advisory in the river.
DDT (including DDE & DDD)	Banned in North America. DDT and DDD were used as a pesticides; DDE is a breakdown product of DDT. DDT still used in other countries and is occasionally used illegally in North America.	The metabolite DDE was the primary cause of egg-shell thinning that caused declines in bald eagles, osprey and other predators.
PBDEs	Emissions from manufacturing and the degradation of textiles, plastics, electronic circuitry, and building materials containing these flame retardants.	Highest levels found in infants; chemically similar to PCBs; linked to impaired liver and thyroid function; possible carcinogen.
PFCs (including PFOA, PFOS)	Emissions from manufacturing and degradation of products such as coated fabrics, coated paper, and cookware.	High levels in infants; possible links to obesity, diabetes, and early menopause in women. Cause for fish consumption advisory in the river.

OTHER CONTAMINANTS OF CONCERN

This section highlights **two** primary contaminants of concern for this reach of the river, and includes an overview of some additional pollutants of concern.

Triclosan can affect public health and aquatic life in a variety of ways. PFOS contamination affects fish consumption in the south-metro portion of the river.

Additional contaminants, including PAHs, PDBEs, pharmaceuticals, and endocrine disrupting compounds, may also negatively impact the ecological health of the Mississippi River, and raise public health concerns as well.

Triclosan

PFOS

**Additional contaminants
of concern**



Triclosan

Triclosan contamination in Lake Pepin sediment is increasing.

Triclosan is an antimicrobial product used in a wide variety of household items.

Triclosan is present in 75% of Americans over age five.

Triclosan-derived dioxins have increased by 200-300% in Lake Pepin's sediment.

Background. Triclosan is an antimicrobial product developed in the 1960s and introduced in 1972 for use in health care facilities. Triclosan has since been added to a wide variety of household products including liquid hand soap, toothpaste and toothbrushes, deodorant, fabrics, toys, and cosmetics.

Risks. While additional research is required, numerous studies indicate that there are three primary risks associated with triclosan:

- **River environment.** As triclosan moves through the wastewater treatment process and into the river, it is exposed to sunlight and chemicals such as chlorine, which can cause it to degrade into potentially harmful dioxins and other carcinogens, some of which can persist in our environment for long periods of time.^{90,91} These contaminants pose a risk to aquatic life, and have been shown to interfere with the thyroid system and have other endocrine-disrupting effects in laboratory animals.⁹²
- **Health.** Humans can be exposed to triclosan via consumer products through skin contact, ingestion, or inhalation, as well as through contaminated drinking water.⁹³ Numerous studies indicate that triclosan exposure can lead to allergy susceptibility in humans.⁹⁴

Human triclosan exposure is now common; a recent survey found the chemical present in the urine of 75% of Americans over age five,⁹⁵ and overall levels of triclosan in the U.S. population increased by 50% between 2004 and 2009.⁹⁶

- **Bacterial Resistance.** The Minnesota Department of Health recommends against using

antibacterial products in most home applications because they may contribute to the emergence of resistant strains of bacteria.⁹⁷

Sources. Triclosan is used in a wide variety of household products and enters the environment primarily through the municipal wastewater treatment system. While wastewater treatment systems remove most of the triclosan, some of it is discharged directly to the river. Wastewater treatment byproducts are sometimes spread on agricultural fields for use as fertilizer, exposing nearby waters to triclosan-contaminated runoff, sometimes months after its application.⁹⁸ In addition, triclosan can be released to surface waters and groundwater through wastewater from septic systems.

Status. Since 1963, triclosan-derived dioxins have increased by 200 to 300% in Lake Pepin sediments, while levels of all other dioxins have decreased by 73 to 90% (Figure 1).⁹⁹ This increase in triclosan-derived dioxins is consistent with increased use of triclosan in household products since its introduction. Triclosan-derived dioxins now represent as much as 31% of the total mass of dioxins in Lake Pepin.¹⁰⁰

Drinking water and public health. While several recent studies have detected triclosan in surface water and tap water, concentrations were well below the Minnesota Department of Health's 2010 "Health Based Values" for drinking water and no adverse health effects are anticipated.¹⁰¹ Triclosan has not been detected in groundwater samples in Minnesota.¹⁰²

Consumer solutions. Consumers should follow the recommendations of both the Minnesota Department of Health and the American Medical Association by avoiding the use of triclosan products for household

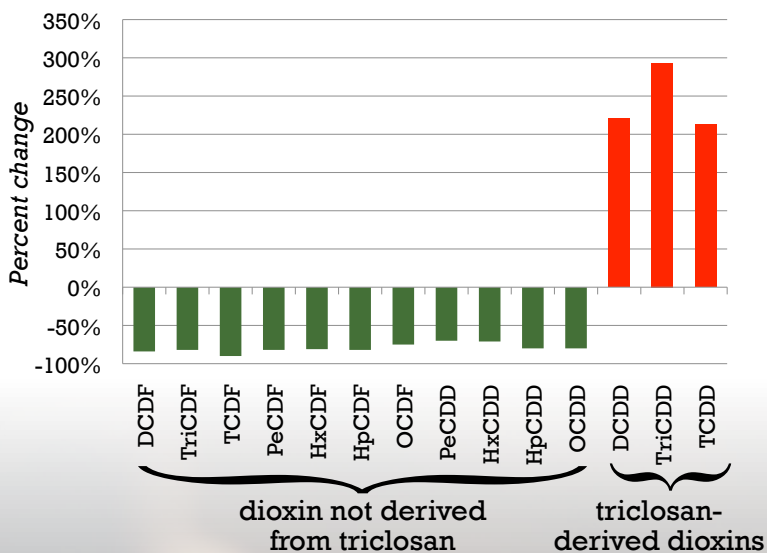
applications. The U.S. Food and Drug Administration (FDA) has found that household use of antibacterial soap provides no health benefits over plain soap and water.

If a cosmetic contains triclosan, it will be included in the ingredient list on the product label. If an over-the-counter drug contains triclosan, it will be listed as an ingredient on the label, in the “Drug Facts” box. Some product manufacturers have recently announced plans to phase-out the use of triclosan in their consumer products.¹⁰³

For information on products that contain triclosan, visit www.ewg.org/skindeep/ingredient/706623/TRICLOSAN.

Figure 1. Triclosan-derived dioxin trends in Lake Pepin

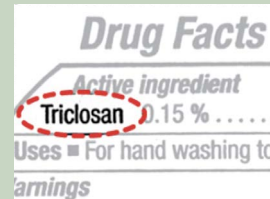
% change in triclosan-derived dioxins vs. non-triclosan derived dioxins in Lake Pepin sediment cores since the 1960s



Source: Buth et. al.⁹⁹

How to avoid triclosan

Be on the lookout for triclosan on the ingredient lists of soaps, facial cleansers, toothpaste, cosmetics, deodorant, and other personal care products.



When looking for triclosan in plastics or fabrics, watch out for products that are marketed as containing Microban® or Biofresh®.

Some examples of products that contain triclosan:

- Neutrogena** deep clean body scrub bar
- Lever 2000** special moisture response bar soap, anti-bacterial+
- CVS** antibacterial hand soap
- Dial** liquid soap, antibacterial hand soap
- Softsoap** antibacterial liquid hand soap
- Cetaphil** gentle antibacterial cleansing bar
- Clearasil** daily face wash
- Clean & Clear** oil-free foaming facial cleanser
- Dawn** complete antibacterial dish liquid
- Ajax** antibacterial dish liquid
- Colgate** total toothpaste
- Right Guard** sport deodorant
- Old Spice** red zone, high endurance and classic deodorants
- Vaseline** intensive care antibacterial hand lotion

Source: Food and Water Watch and Beyond Pesticides⁵²

PFOS

A portion of the river is impaired with PFOS based on its presence in fish tissue.

This compound is part of a family of man-made chemicals used in nonstick cookware, stain-resistant fabric, food packaging and fire-fighting foam.

PFOS levels in fish contribute to a site-specific fish consumption advisory in part of the river.

The state, 3M, and others are actively engaged in restoring the fishery to health.

Description and impacts. PFOS (perfluorooctane sulfonate) is part of a family of synthetic compounds known as PFCs, and is used in nonstick cookware, stain-resistant fabric, food packaging, fire-fighting foam, insecticides, and manufacturing processes. PFCs are extremely stable, persist in the environment, and can be found in the blood of animals and humans worldwide.¹⁰⁴

Health concerns. While the health impacts of human exposure to PFOS are not fully known, lab animal studies reveal that exposure to high concentrations can result in altered development, immune suppression, endocrine disruption, decreased organ health, and increased sensitivity to other chemicals.¹⁰⁵ While the Minnesota Department of Health (MDH) has determined that exposure to PFOS through swimming is not a concern,¹⁰⁶ PFOS concentrations in fish tissue and drinking water could pose potential risks to human health if ingested.¹⁰⁷

Status. The river from the Ford Dam to the Hastings Dam is impaired with PFOS contamination in fish tissue.¹⁰⁸ Fish in this reach of the river are more likely to contain PFOS levels that exceed state guidelines (Figure 1). Anglers should review MDH Site-Specific Eating Guidelines (see Fish consumption, page 20) and Minnesota Department of Natural Resources catch-and-release regulations (see Fish survey, page 22) in this reach of the river.

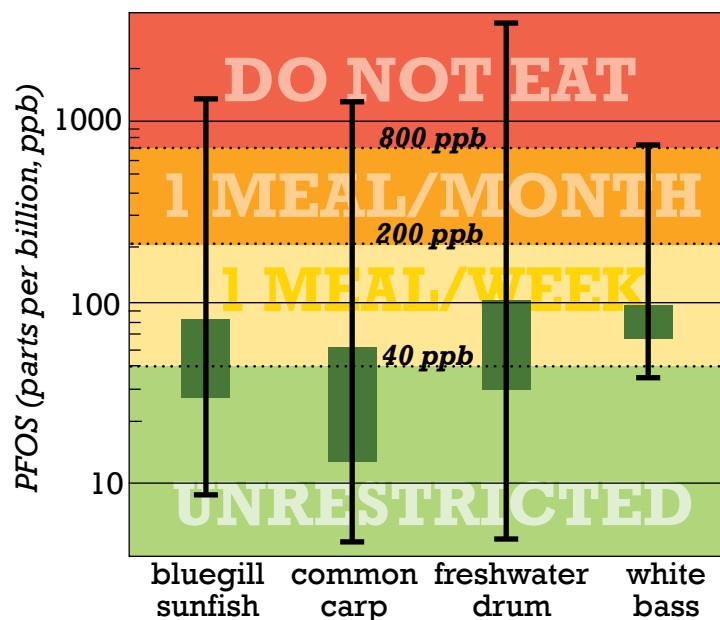
Elevated levels of PFOS have also been found in bald eagle populations throughout the river (see Bald eagles, page 34).

Sources. PFOS was originally manufactured in Minnesota by 3M at its Cottage Grove facility. Production began around 1950 and was phased out in 2002. During that period, PFOS was released into the river via 3M's wastewater

treatment plant.¹⁰⁹ In addition, production waste from this facility was disposed of onsite, as well as at three disposal sites in the east metro area (see map). The 3M-Oakdale and 3M-Woodbury disposal sites have groundwater pumping systems that were installed in the 1970s and 1980s that ultimately discharge to the river.¹¹⁰

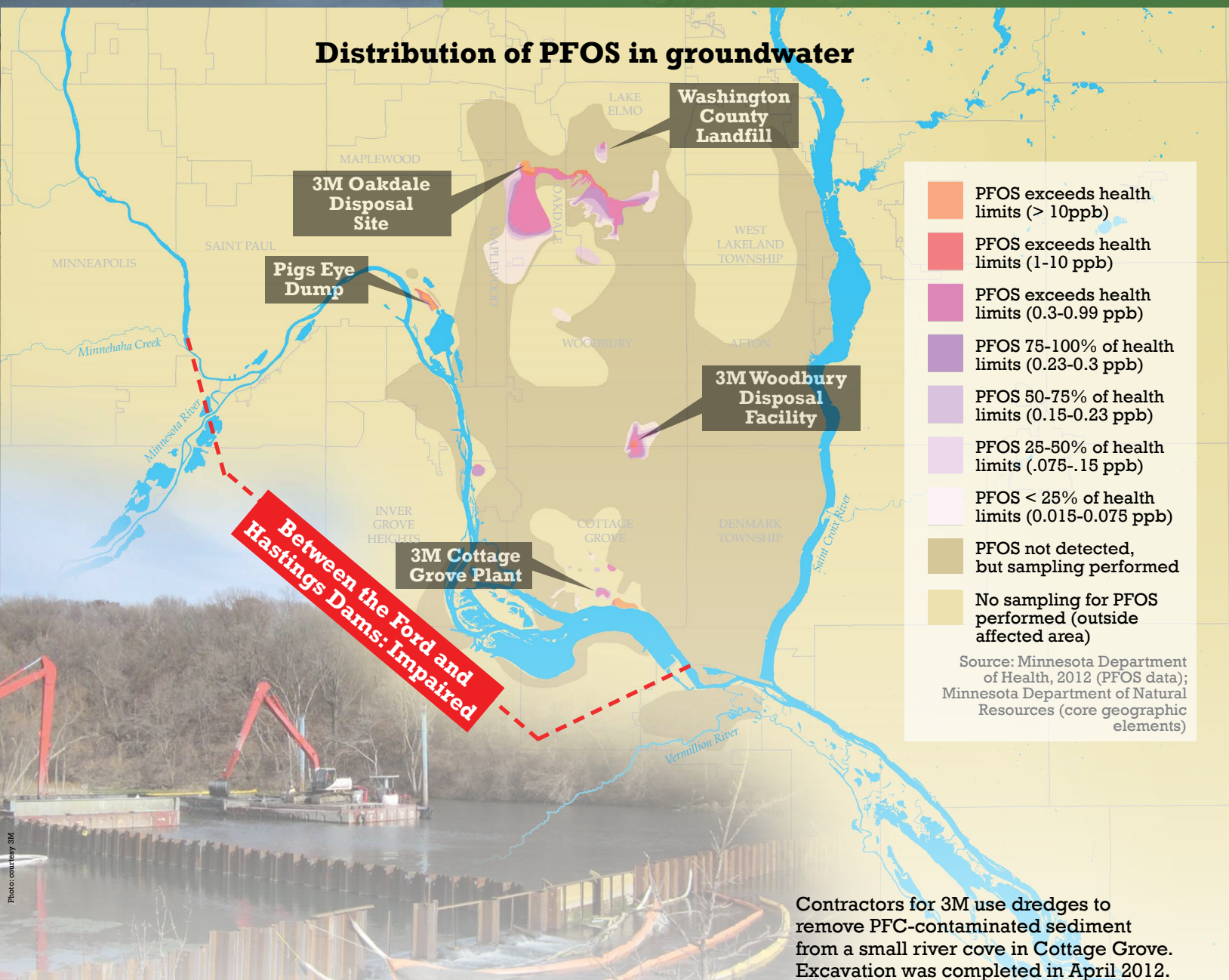
PFOS is common in numerous household and industrial products, and can enter our environment in a variety of ways including landfills, wastewater treatment plants, stormwater runoff, and household activities. PFOS contam-

Figure 1. PFOS in fish species between the Ford and Hastings Dams
Green box indicates 25-75% percentile range of sample values



Sources: Minnesota Department of Natural Resources, Minnesota Department of Health, and Minnesota Pollution Control Agency¹¹⁷

Distribution of PFOS in groundwater



Between the Ford and Hastings Dams: Impaired

Contractors for 3M use dredges to remove PFC-contaminated sediment from a small river cove in Cottage Grove. Excavation was completed in April 2012.

ination has been identified in soil, surface waters, groundwater, and river sediment in multiple locations in the east metro area, as well as other sites throughout the state.¹¹¹ Where PFOS is present in groundwater adjacent to the river, it will discharge into the Mississippi River over time.

PFOS and drinking water. The MDH is responsible for setting limits for contaminants in drinking water. PFOS is present in groundwater in some areas (see map), and the MDH has set a Health Risk Limit (HRL) for PFOS in drinking water of 0.3 parts per billion (ppb).¹¹² Although some Oakdale city wells and a number of private water supply wells exceed the HRL, filtration systems paid for by 3M and installed by the city and Minnesota Pollution Control Agency (MPCA) ensure the drinking water in the affected communities meets the HRL.¹¹³ MDH biomonitoring shows decreasing

concentrations of PFOS and other PFCs in the blood of residents following the installation of filter systems to city and private water supplies.¹¹⁴

For more information on PFOS and public health, visit the MDH website (<http://www.health.state.mn.us/divs/eh/hazardous/topics/pfcshealth.html>).

Management solutions. 3M completed additional clean-up at its disposal sites in early 2012. The former Washington County Landfill has also been successfully cleaned up.¹¹⁵ Additional work remains on containing, pumping and treating PFC-contaminated groundwater, and monitoring treatment effectiveness over time.¹¹⁶

The MPCA is currently reviewing additional data and collecting additional samples of PFOS in fish tissue in the river between the Ford and Hastings Dams.

Additional contaminants of concern

Additional contaminants of concern may negatively impact the health of the Mississippi River and its watershed.

Some compounds can disrupt human and animal hormone function and present potentially serious health risks.

PCBs and mercury are present in fish tissue in the Mississippi River.

Additional research is needed to fully understand the impacts of these pollutants.

Background. Additional contaminants of concern for this reach of the river include a number of chemicals and their byproducts that are highly persistent in our environment and may accumulate in fish, wildlife and humans over time. These pollutants pose unique risks, as many can have effects even at very low levels. Little is known about what happens when these contaminants of concern mix and interact in nature. Some of these chemicals may also act as **endocrine disrupting compounds (EDCs)**. EDCs mimic or alter hormone systems and can interfere with reproductive, developmental, and other biological functions and can lead to reproductive mutations in aquatic organisms.¹¹⁸ A recent U.S. Geological Survey (USGS) study found 73% of smallmouth bass at a site in Lake Pepin showed signs of mutated sexual organs.¹¹⁹

Additional research is required to fully understand the extent of the presence and impacts of these contaminants in this reach of the river.

PCBs. PCBs (polychlorinated biphenyls) are a class of man-made industrial chemicals manufactured domestically from 1929 until they were banned by the U.S. Environmental Protection Agency (EPA) in the late 1970s.¹²⁰ PCBs do not easily break down in the environment, and have remained in water and sediments for years. PCBs are classified by the EPA as probable human carcinogens,¹²¹ and can affect the human immune, reproductive, nervous, and endocrine systems.¹²²

Although PCB levels in Minnesota waters are slowly decreasing, they are still found in fish throughout Minnesota, including the Mississippi River.¹²³ While Minnesotans can still eat fish from the river, they should follow

Minnesota Department of Health Site-Specific Eating Guidelines (see Fish consumption, page 20).

Pharmaceuticals. In the U.S., about four billion prescriptions were dispensed in 2011.¹²⁴ Unused medication in human waste, along with expired or unwanted prescription and over-the-counter medications, are often disposed of down the drain. Wastewater treatment systems are not specifically designed to remove pharmaceuticals, many of which are discharged back into surface waters after treatment.¹²⁵ A nationwide USGS study done in 2000 found low levels of drugs such as antibiotics, hormones, contraceptives, and steroids in 80% of the rivers and streams tested.¹²⁶

Wastewater treatment systems are not specifically designed to remove pharmaceuticals.



Pharmaceuticals can have impacts on fish and other aquatic wildlife, including feminization of male fish exposed to estrogen in human waste and birth control medications. Other drugs, such as anti-depressants and beta-blockers, reduce fertility or affect spawning in certain aquatic organisms.¹²⁷ Unwanted or expired medications should never be flushed down the drain. For more information on household hazardous wastes and collection programs, contact your county solid waste office or the Minnesota Pollution Control Agency.

PAHs and coal tar sealants. PAHs (polycyclic aromatic hydrocarbons) are a group of compounds that can cause tumors, organ abnormalities, and disrupt immune and reproductive system function in fish and aquatic life.¹²⁸ Seven PAH compounds are classified as probable human carcinogens.¹²⁹ Coal tar sealants (coal by-products used to seal asphalt surfaces since the 1960s) are a major source of PAH pollution. PAH concentrations in coal tar sealants are about 1000 times higher than concentrations in asphalt-based sealant alternatives.¹³⁰

Over time, the sealants wear down and are carried into the environment by wind and rain, allowing PAHs to contaminate rivers, lakes, wetlands, and stormwater ponds. While little is known about PAH contamination in Mississippi River sediment, projected clean up costs for stormwater ponds contaminated with PAH runoff could


approach \$1 to \$5 billion in the Twin Cities metropolitan area alone.¹³¹

As of August 2012, 24 Minnesota communities have coal tar sealant restrictions of some kind, and the State has its own restrictions for state agencies.¹³² For more information on coal tar sealants, contact the Minnesota Pollution Control Agency.

Mercury. Mercury is a naturally occurring element that can damage the central nervous system of animals and people, especially children and fetuses.¹³³ About 70% of the mercury in the air is the result of emissions from coal combustion, mining, incineration of mercury-containing products and other human sources.¹³⁴ The vast majority of mercury in Minnesota's environment comes from out-of-state sources.¹³⁵ Over time mercury can build up in fish and pose risks for human consumption (see Fish consumption, page 20).

Mercury can be found in Mississippi River fish, as well as most fish tested from Minnesota lakes.¹³⁶ While Minnesotans can still eat fish from the river, they should follow Minnesota Department of Health Site-Specific Eating Guidelines.

Minnesota established a statewide mercury clean-up goal in 2007. This goal calls for reducing emissions from existing Minnesota sources to safe levels by 2025.¹³⁷



The Black Dog plant in Burnsville burns coal, a primary source of mercury in the air. Xcel Energy has recently converted two other local coal plants to natural gas.

Pesticides and herbicides. Pesticides and herbicides are used to control unwanted insects, plants, rodents, fungi, mold, or bacteria. They can be carried into the environment by wind and rain,¹³⁸ and can accumulate in both rural and urban waters. While there are many products in use, atrazine and acetochlor are two herbicides of particular concern.

Atrazine, used in corn production, has possible links to prostate and other cancers in humans and to reproductive deformities in frogs.¹³⁹ It has been found in groundwater and surface waters across Minnesota.¹⁴⁰ Farm operators may not apply atrazine within 66-feet of waterbodies.¹⁴¹

Acetochlor, used primarily in corn and soybean production, was introduced in 1994, and is classified as a “probable human carcinogen.”¹⁴² In Minnesota, the LeSueur River and Little Beauford Ditch (both in Blue Earth County) are classified as “impaired” due to high acetochlor levels in the water.¹⁴³ Farm operators are encouraged not to apply acetochlor within 66-feet of waterbodies.¹⁴⁴

In 2011, the Minnesota Department of Agriculture detected the presence of both acetochlor and atrazine at their river monitoring site (Grey Cloud Island, south of St. Paul);¹⁴⁵ however both were present at levels well below the State’s Health Risk Limit.¹⁴⁶

PBDEs. PBDEs (polybrominated diethyl ethers) are a family of compounds used as flame-retardants in many household products including electronics, furnishings, motor vehicles, and plastics. PBDEs have been found to accumulate in river sediment and fish tissue,¹⁴⁷ as well as human tissue and breast milk,¹⁴⁸ and are found in higher levels in children than adults. PBDEs are found in river sediments, though additional testing is needed to fully understand any possible effects on the river.¹⁴⁹ PBDEs have been found in the blood of all bald eagles sampled along the river.¹⁵⁰

Some research indicates that exposure to very small doses of PBDEs at critical points in development can damage reproductive systems and cause deficits in motor skills, learning, memory and hearing, as well as changes in behavior.¹⁵¹ Additional evidence suggests that these chemicals may cause liver, thyroid, and neurodevelopmental toxicity.¹⁵²

U.S. manufacture and import of some forms of PBDE were phased out in 2004. Another form of PBDE (DecaBDE) is banned in European electronics¹⁵³ and is restricted in some U.S. states.¹⁵⁴ Domestic manufacturers are now voluntarily phasing out production, though import of DecaBDE products continues.¹⁵⁵



Chemicals sprayed on Minnesota farm fields can find their way to the Mississippi River. If these chemicals continue to concentrate in the river, they could have concerning health impacts.

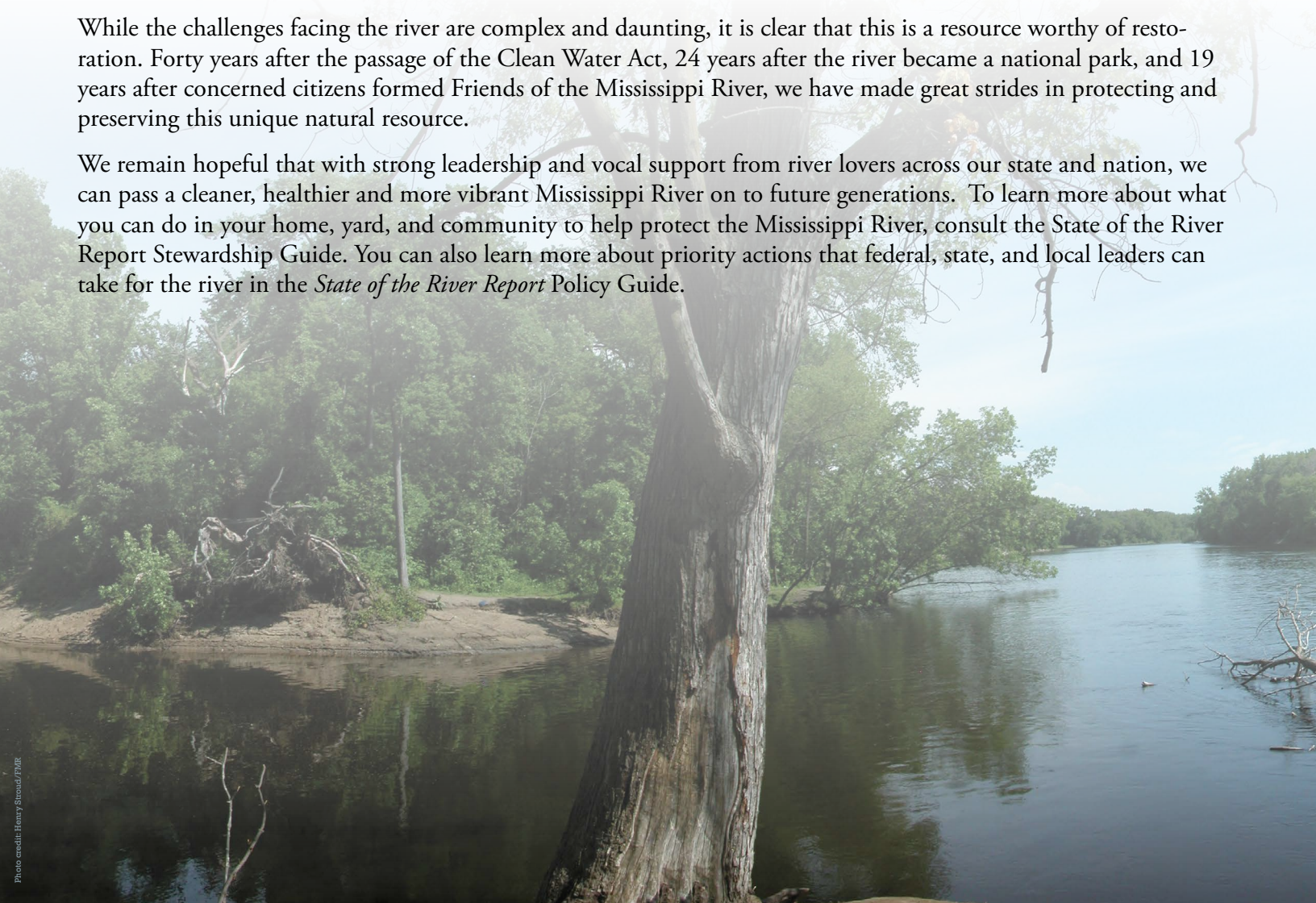
The Mississippi River is a complex natural system, with many factors affecting its overall health and vitality. In this report, we've selected 13 indicators that can illustrate the state of the river.

So, how is the Mississippi River? It's a river that has improved in both water quality and ecological health over time, but there are also some distressing trends and emerging concerns.

- Positive trends in our **bald eagles**, **mussels**, and **fish population** indicators are signs of a restored river that is once again home to healthy and abundant wildlife. As pollution has been cleaned up and habitat restored over the past 40 years, bald eagle, mussel, and fish populations have rebounded. These are symbols of our shared ability to rejuvenate and restore our Mississippi River – and are an inspiration for future success.
- Other indicators remain causes for concern. Excess **sediment** and **phosphorus** degrade aquatic habitat and recreation in the Mississippi River, including downstream in Lake Pepin. Some portions of the river are impaired with excess **bacteria**, while site-specific **fish consumption** guidelines are in place throughout the river due to elevated levels of **PFOS**, **mercury**, and **PCBs**. While we remain optimistic that these issues can be solved, it is clear that much more work remains to prevent these indicators from becoming larger problems.
- Several indicators are cause for serious concern moving forward. **River flows** have multiplied to worrisome levels, destabilizing the watershed and flushing large amounts of pollution into the river. **Nitrate** concentrations are increasing at an alarming rate, with disastrous impacts on the Gulf of Mexico. **Asian carp** continue to move upstream, with potentially devastating consequences to aquatic life and recreation throughout the state. And **emerging contaminants**, like **triclosan**, **PAH compounds**, and others present risks to the river that we do not yet fully understand. The solutions to these problems require new tools and decisive public action before they move beyond our reach.

While the challenges facing the river are complex and daunting, it is clear that this is a resource worthy of restoration. Forty years after the passage of the Clean Water Act, 24 years after the river became a national park, and 19 years after concerned citizens formed Friends of the Mississippi River, we have made great strides in protecting and preserving this unique natural resource.

We remain hopeful that with strong leadership and vocal support from river lovers across our state and nation, we can pass a cleaner, healthier and more vibrant Mississippi River on to future generations. To learn more about what you can do in your home, yard, and community to help protect the Mississippi River, consult the State of the River Report Stewardship Guide. You can also learn more about priority actions that federal, state, and local leaders can take for the river in the *State of the River Report Policy Guide*.



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