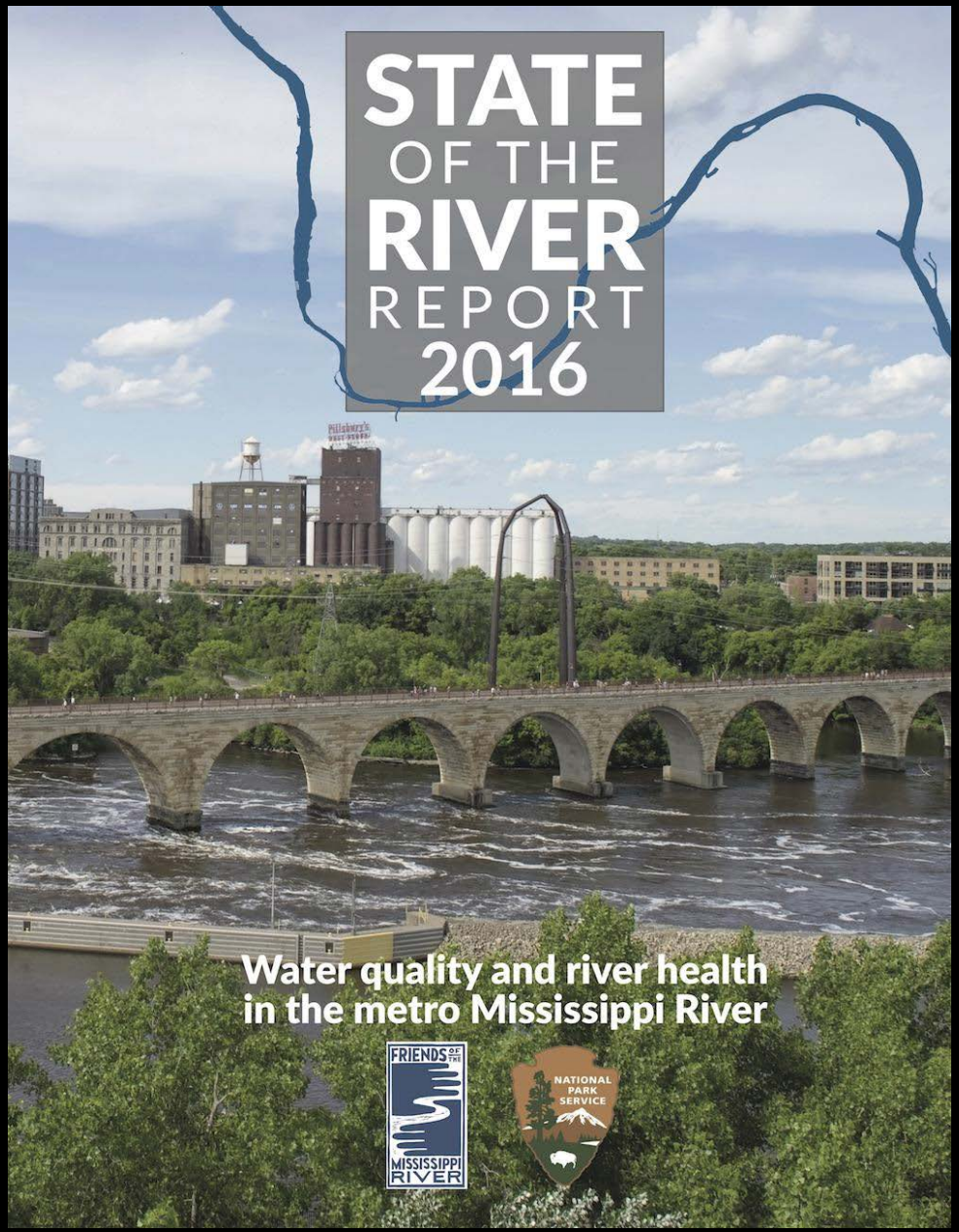
STATE
OF THE
RIVER
REPORT
2016
Water quality and river health
in the metro Mississippi River
FRIENDS OF THE MISSISSIPPI RIVER
NATIONAL PARK SERVICE

Acknowledgements

Science & Technical Advisors

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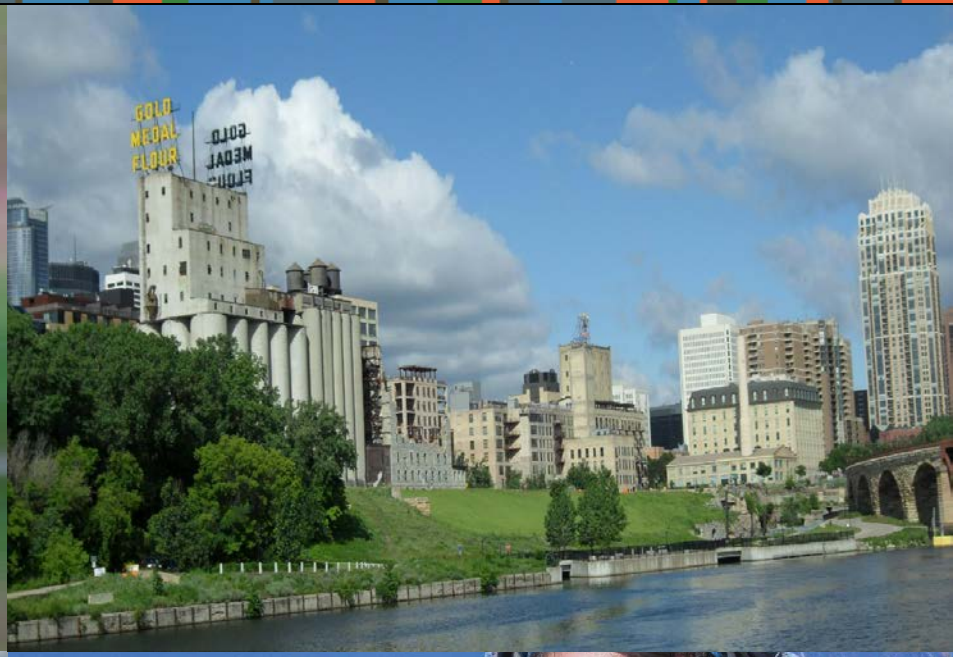
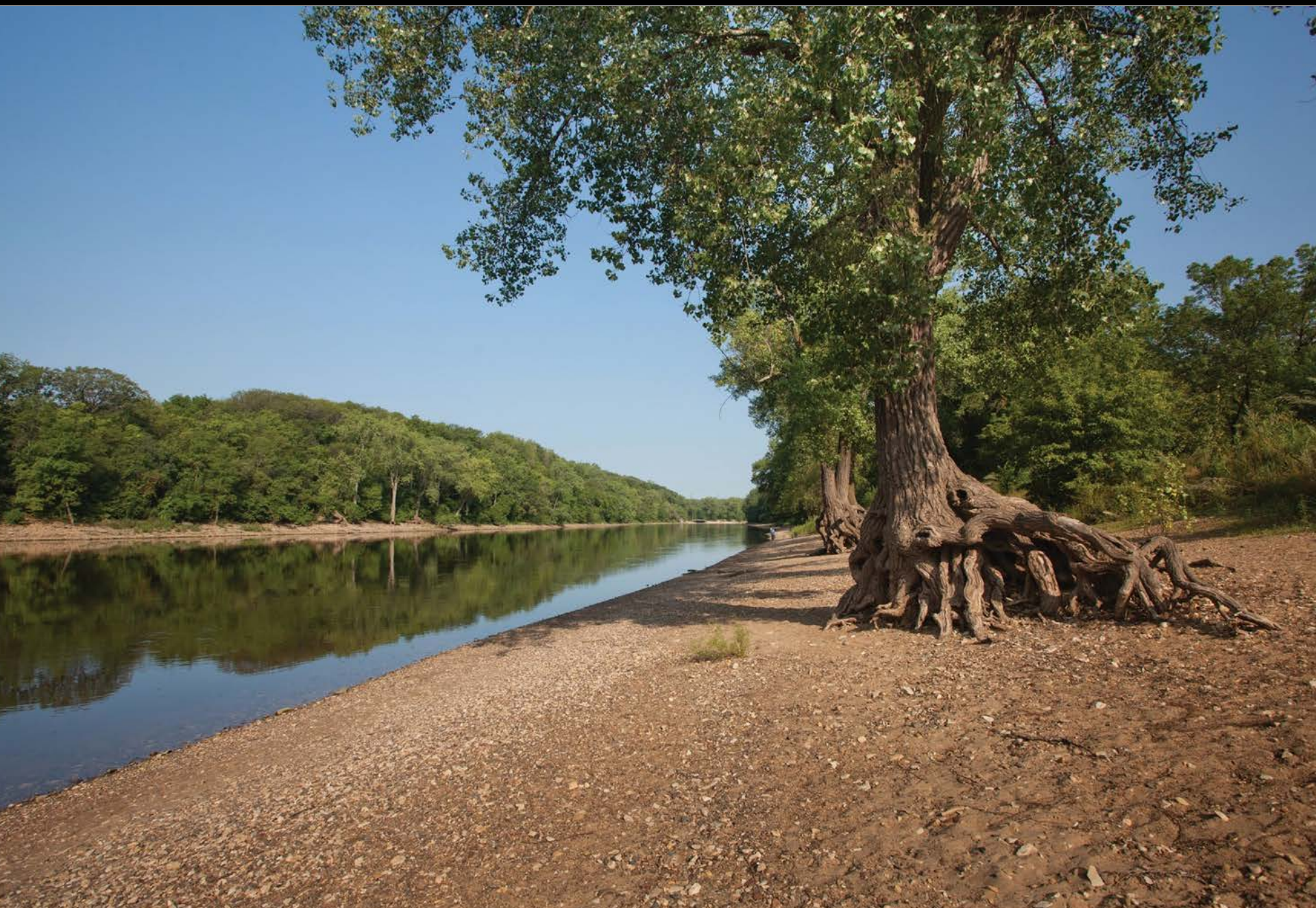

GOLD
MEDAL
FLOUR


NATIONAL PARK SERVICE

Report goals

- Clear and easy to understand
- Increase public awareness
- Build public support around priorities for action
- Audience: Minnesotans who want to know more about the Mississippi River



Report indicators

RIVER FLOW

- Flow & hydrology

SWIMMING & RECREATION

- Bacteria
- Phosphorus

RIVER LIFE

- Fish consumption
- Fish survey
- Invasive Asian carp
- Bald eagles
- Mussels

ECOLOGICAL HEALTH

- Sediment
- Nitrate
- Chloride
- Pesticides
- Microplastics

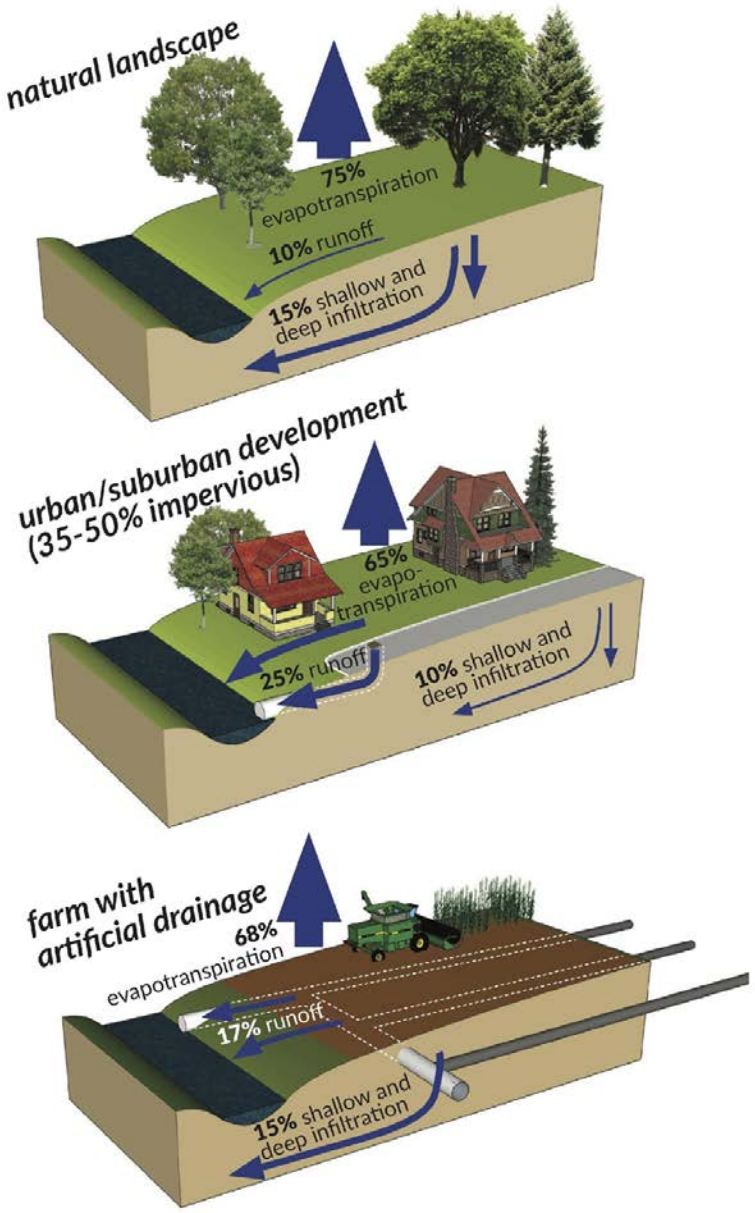
OTHER RIVER CONTAMINANTS

- Additional contaminants of concern

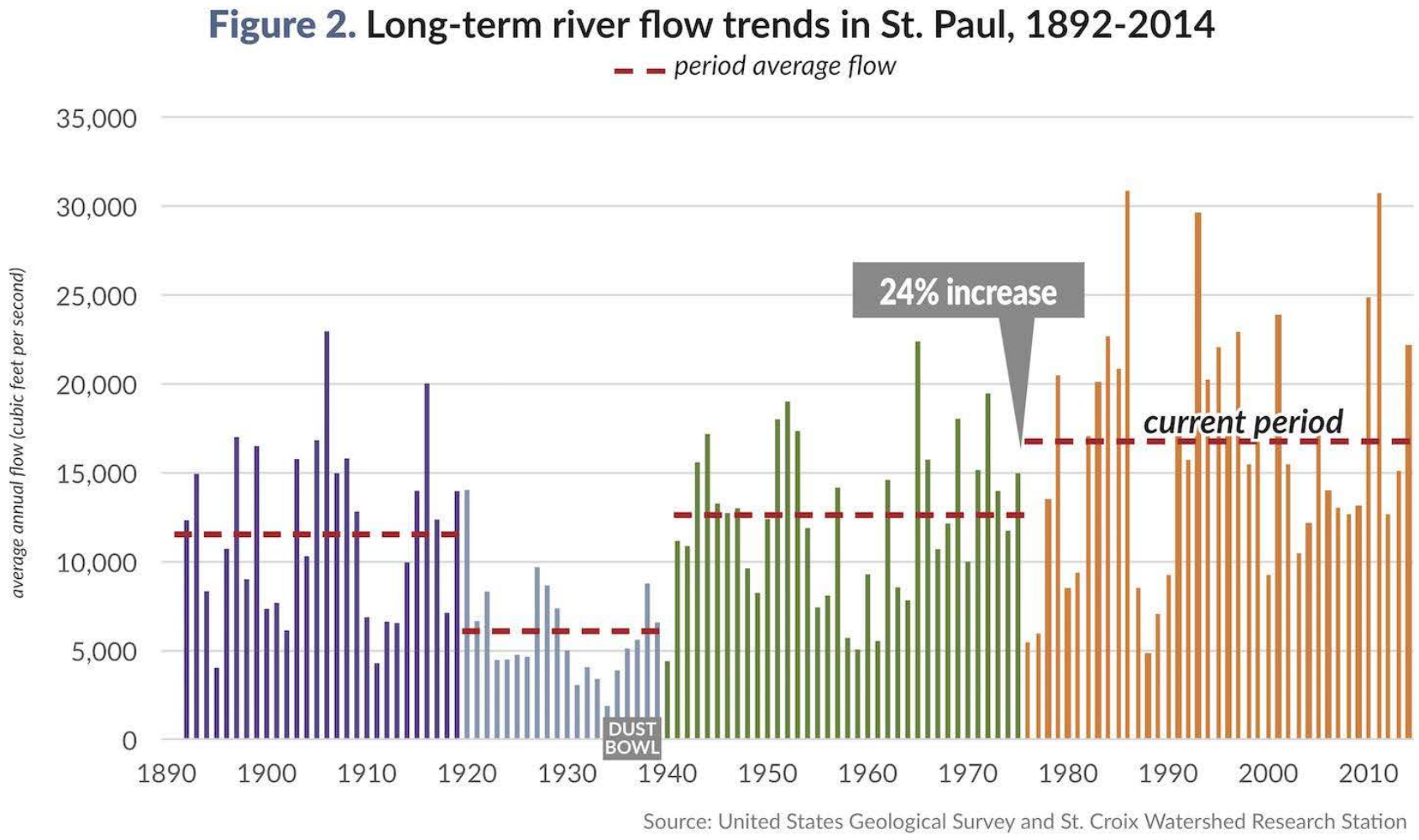
Flow & hydrology

Background

- Flow: how much water is in the river.
- High and low flows influence other indicators.
- Small changes in evapotranspiration = big changes in flow.



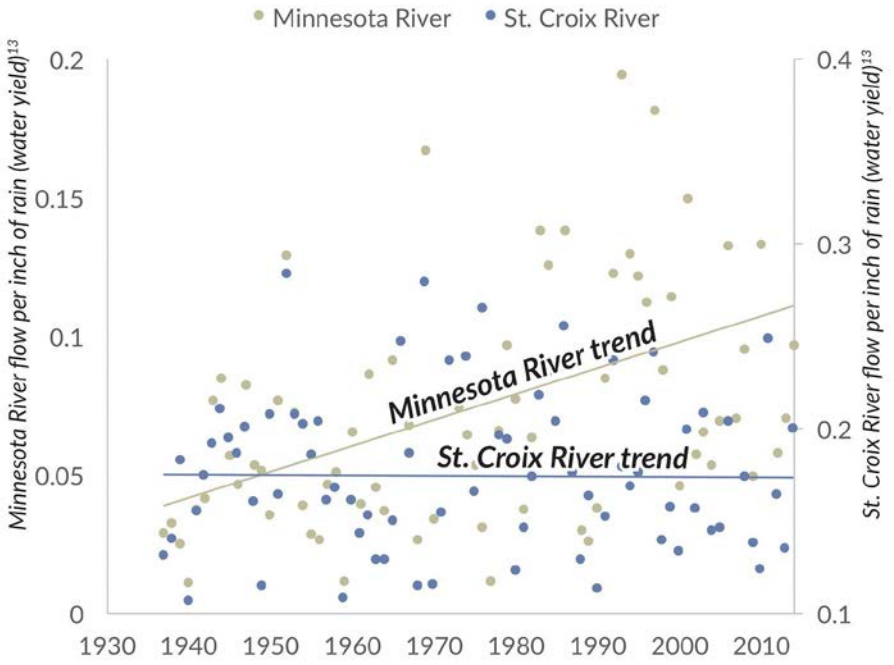
Status and trends



Why is flow changing?

- Land receives + delivers water differently today.
- Precipitation isn't only factor influencing this trend.
- Human factors influence flow + hydrology.

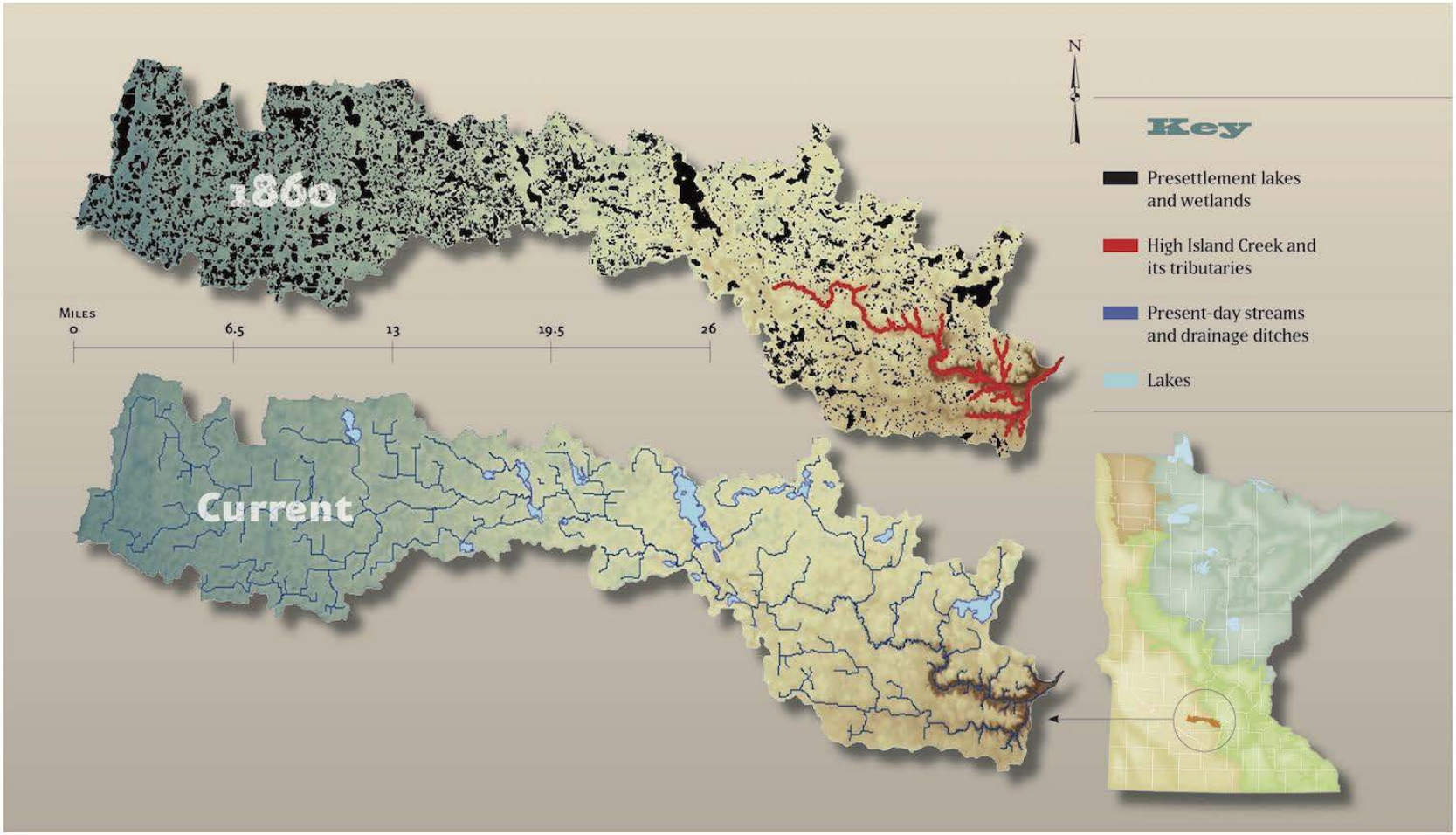
Figure 3. Flow per unit of precipitation in the Minnesota and St. Croix Rivers, 1937-2014



Source: United States Geological Survey, analysis provided by St. Croix Watershed Research Station

Landscape alteration

Figure 4. Landscape alteration in Minnesota



This graphic illustrates the conversion of the 238-square mile High Island Creek watershed (near Henderson, Minn.) between 1860 and today. Extensive artificial drainage has replaced many of the lakes and wetlands, which previously stored water on the landscape.

Source: DNR's Jan/Feb 2016 "MN Conservation Volunteer," pages 20-21. Jon Lore, MN DNR

What can we do?

- Restore natural hydrology
  - Drainage management
  - Cropping systems
  - Water storage
- Perennial vegetation
- Residential practices
  - Rain gardens
  - Rain barrels
  - Native landscapes

Phosphorus

Phosphorus

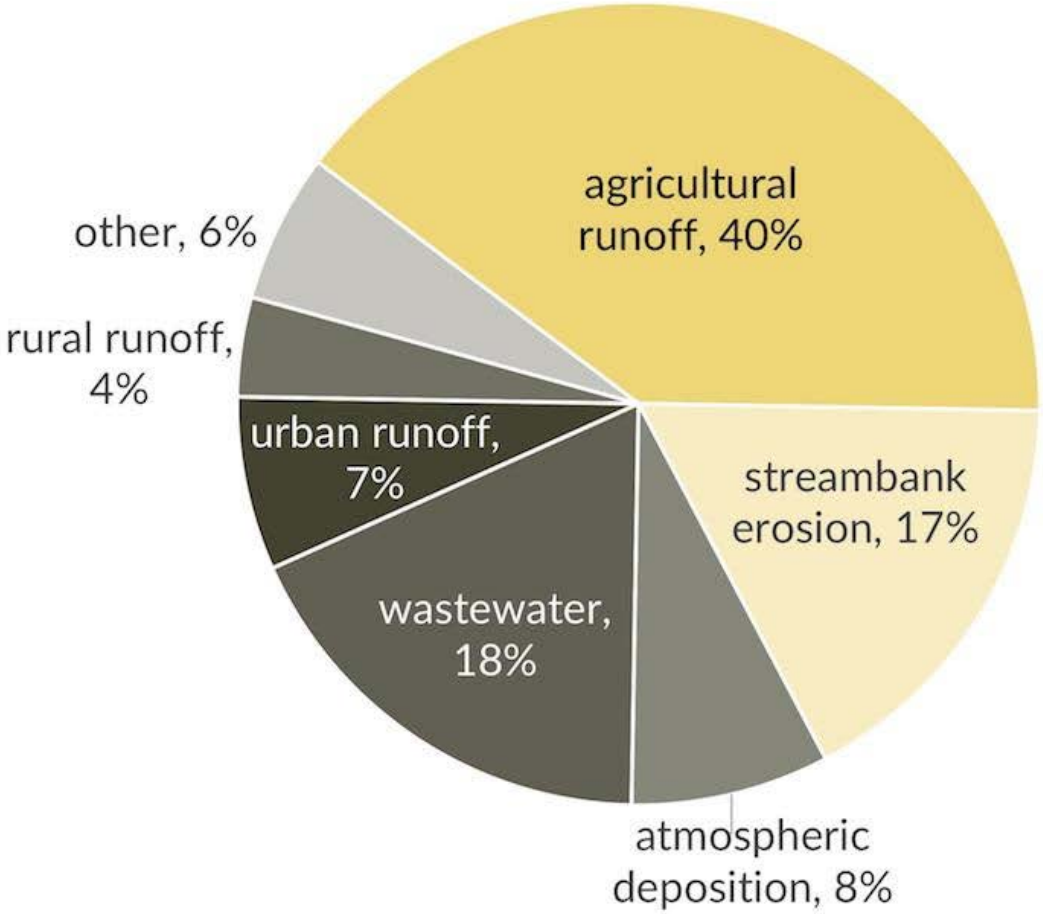
Description and impacts

- Phosphorus is a common element.

- Excess levels impair aquatic life and recreation:
  - Algae blooms
  - Fish kills
  - Pea-soup lakes
  - Blue-green algae

Phosphorus

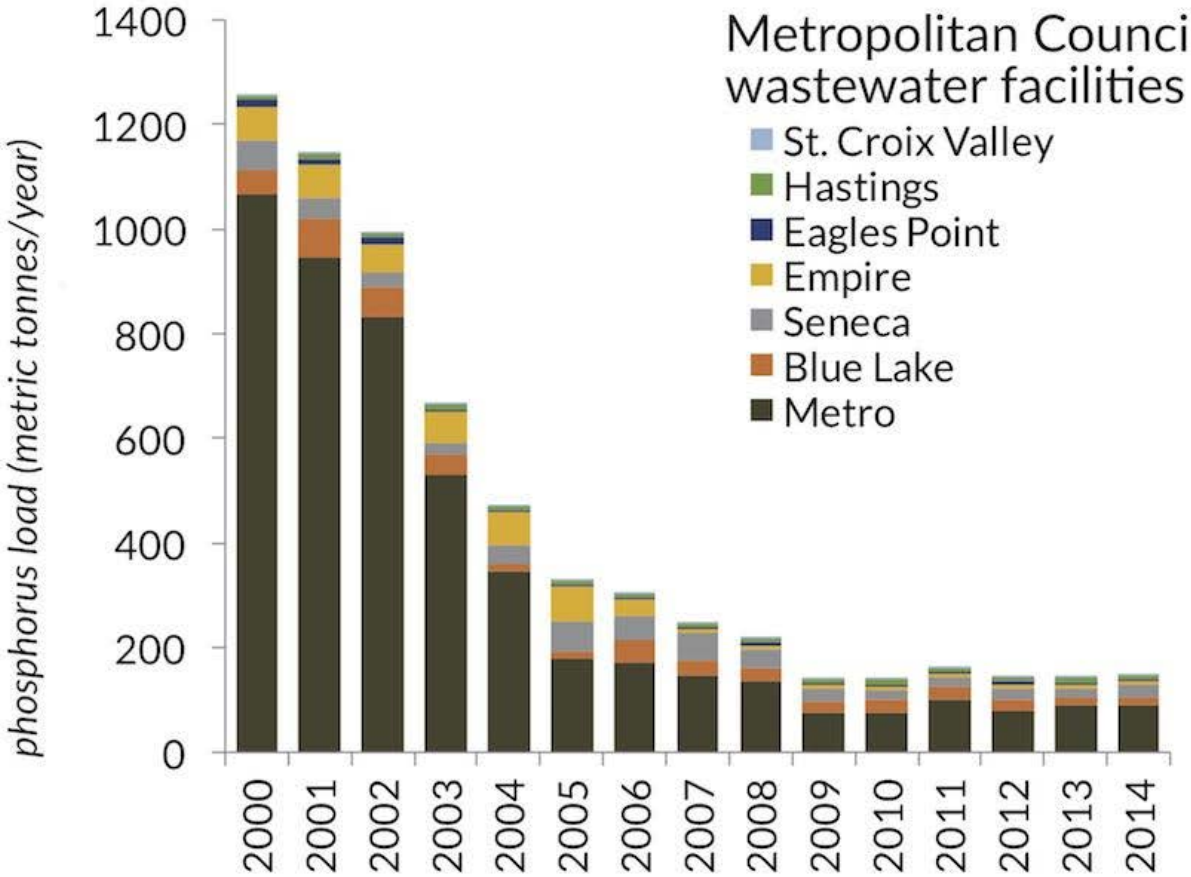
Figure 1. Sources of phosphorus to the Mississippi River in average conditions



Source: Minnesota Pollution Control Agency, 2014

Phosphorus

Figure 2. Annual Metropolitan Council wastewater phosphorus loads



Source: Metropolitan Council Environmental Services

Phosphorus

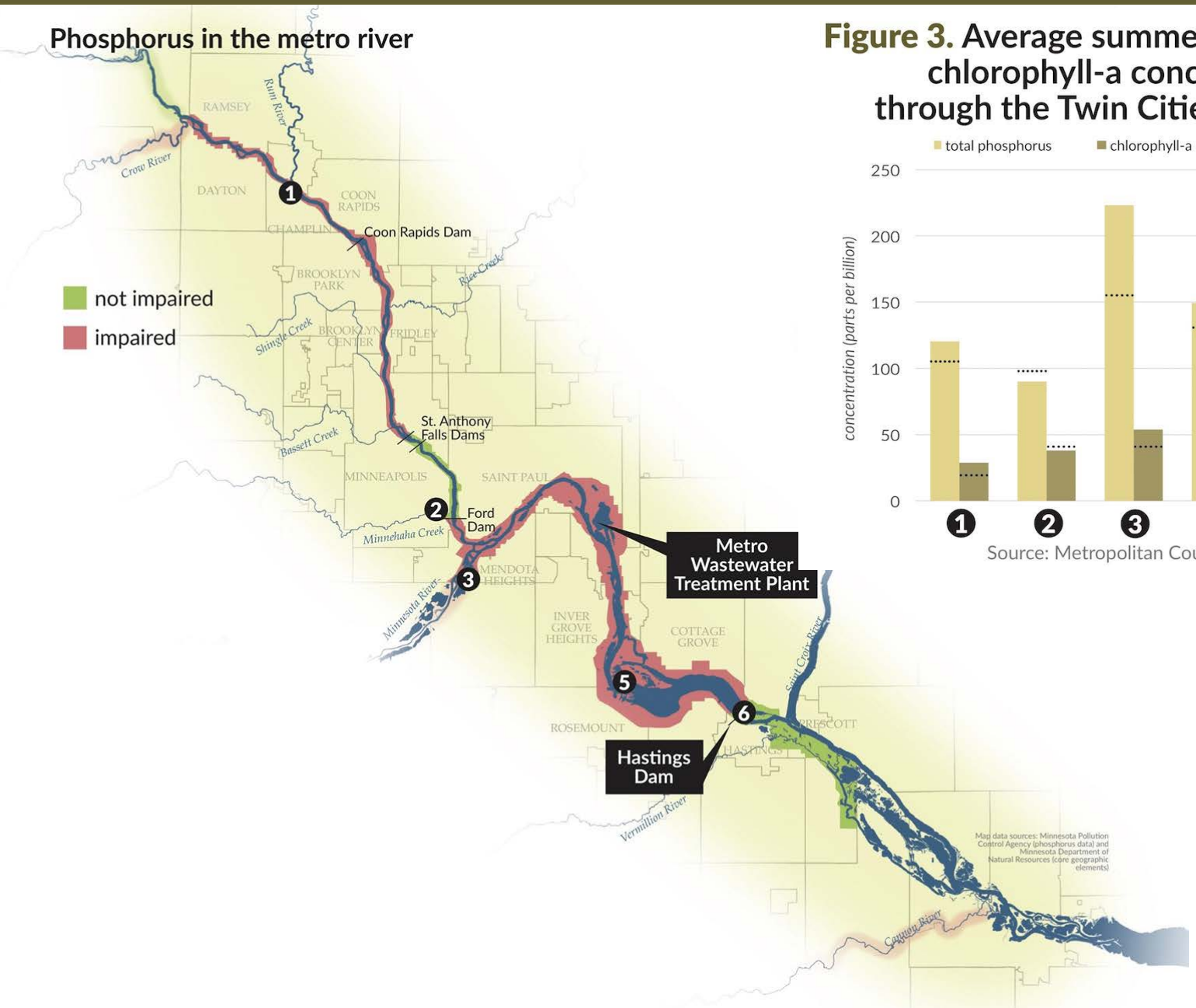
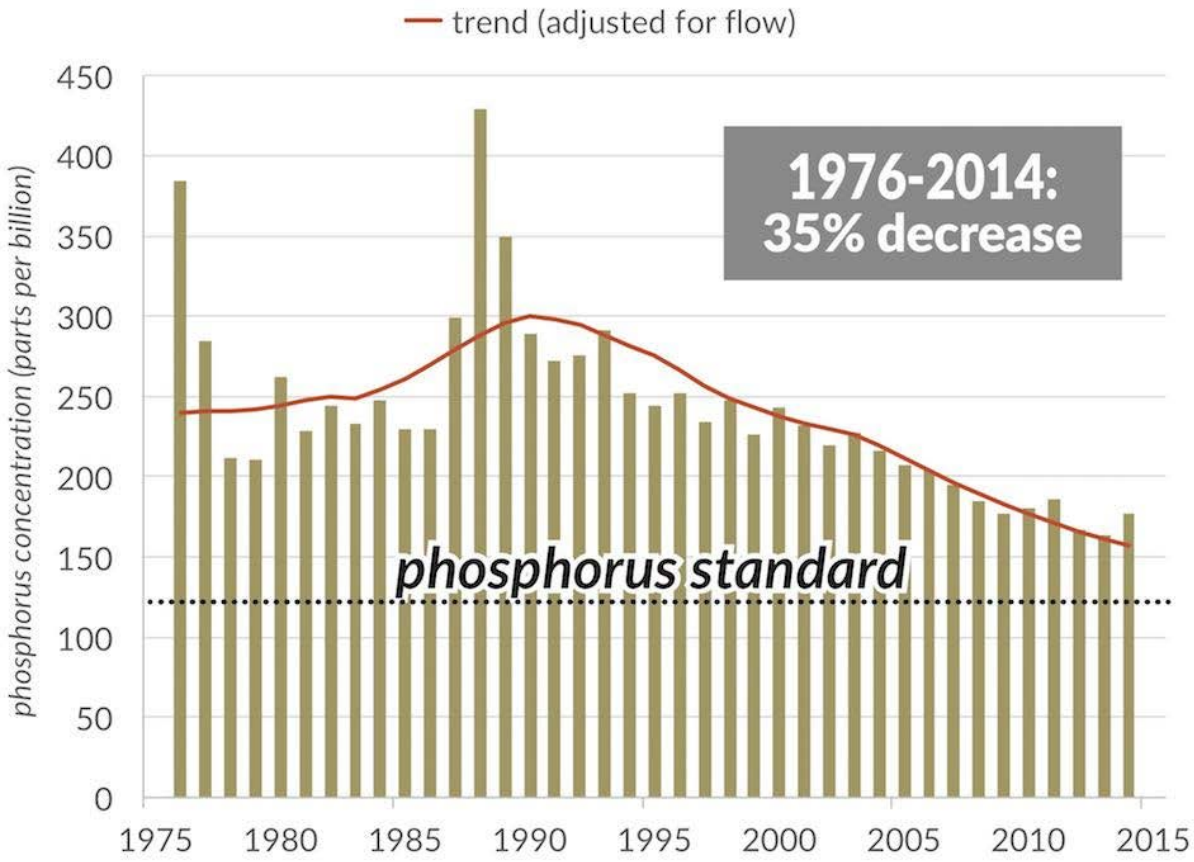


Figure 3. Average summer phosphorus and chlorophyll-a concentrations through the Twin Cities, 2005-2014

Source: Metropolitan Council Environmental Services

Phosphorus

Figure 4. Average summer phosphorus concentrations at Hastings Dam, 1976-2014



What can we do?

- Control major sources
  - Cropland
  - Pasture
  - Streambank erosion
- Residential best practices
  - Garden chemicals
  - Soaps and detergents
  - Pet waste
  - Rake up, sweep up, pick up

Nitrate

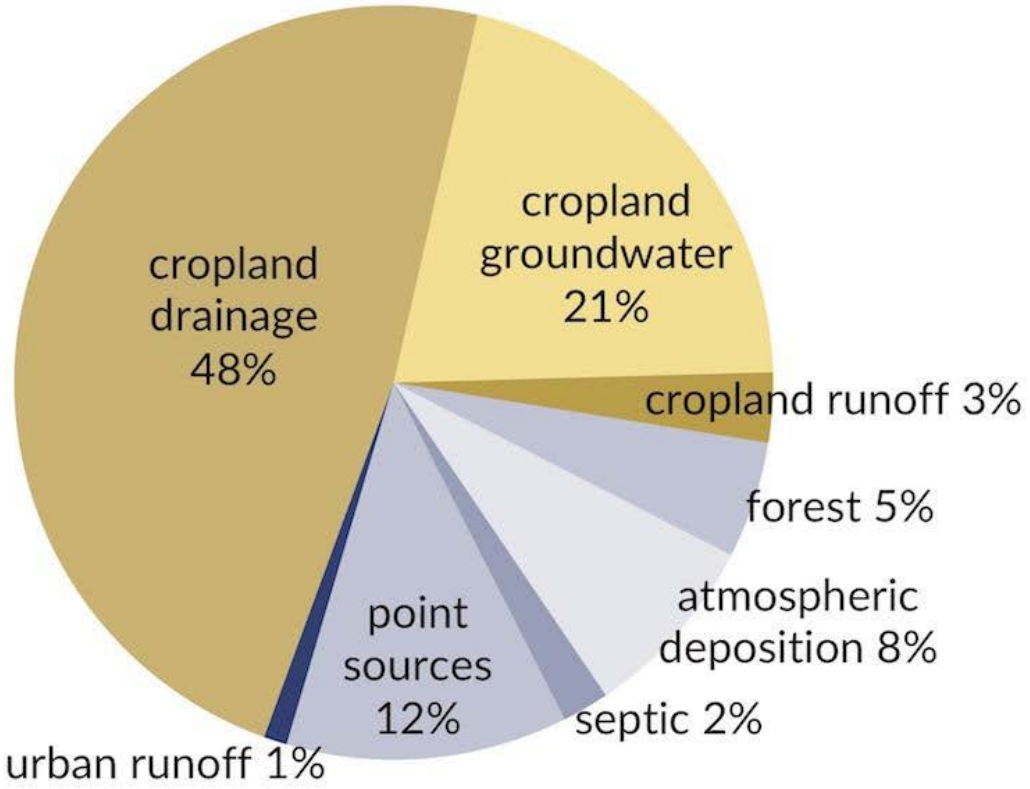
Nitrate

Description and impacts

- Nitrate is a common form of nitrogen.
- Three main risks:
  - Human health: drinking water standard (10 parts per million)
  - Aquatic life
  - Gulf “dead zone”

Nitrate

Figure 1. Sources of nitrogen to the Mississippi River in Minnesota in average conditions



Source: Minnesota Pollution Control Agency, Nitrogen in Minnesota Surface Waters

Nitrate

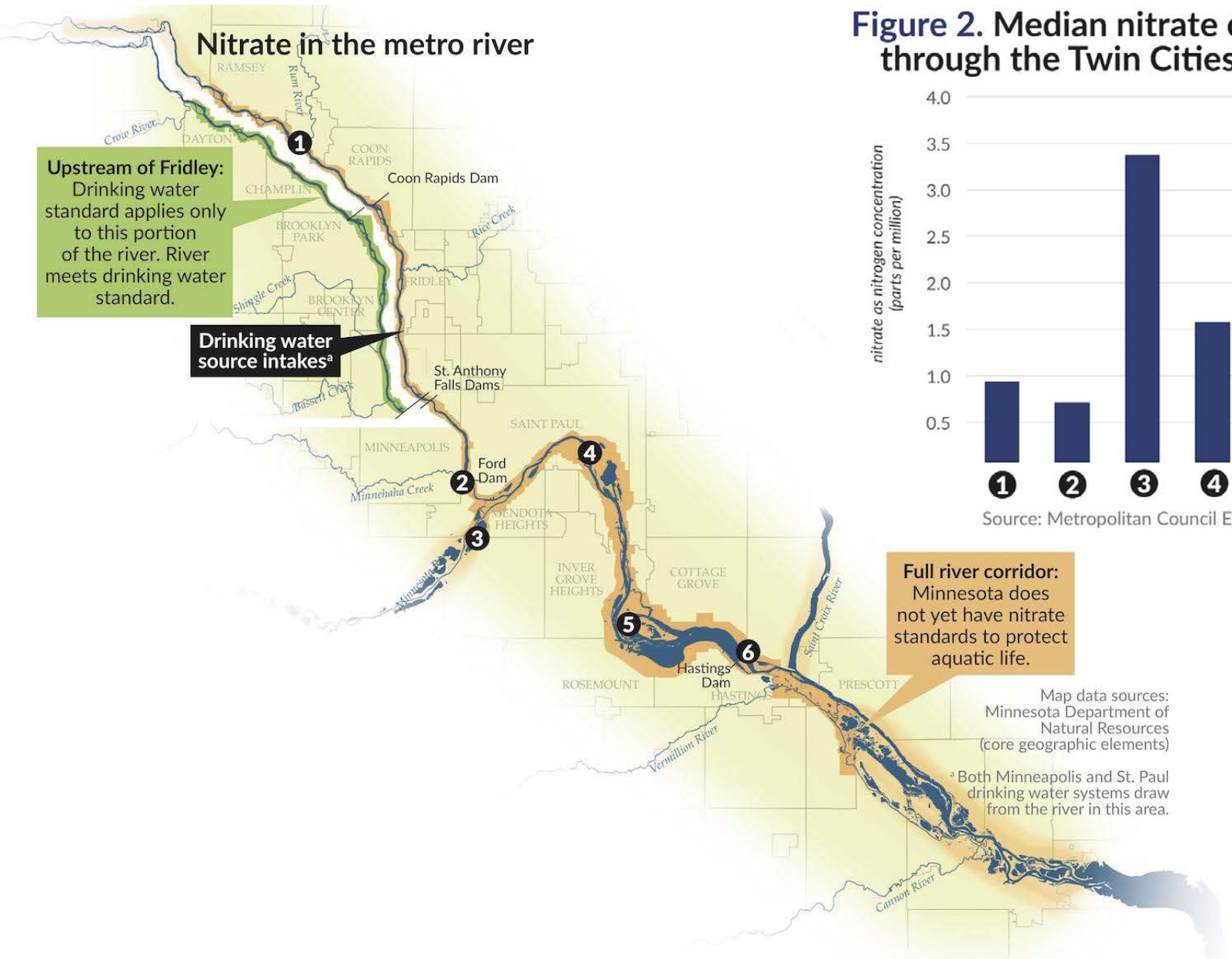
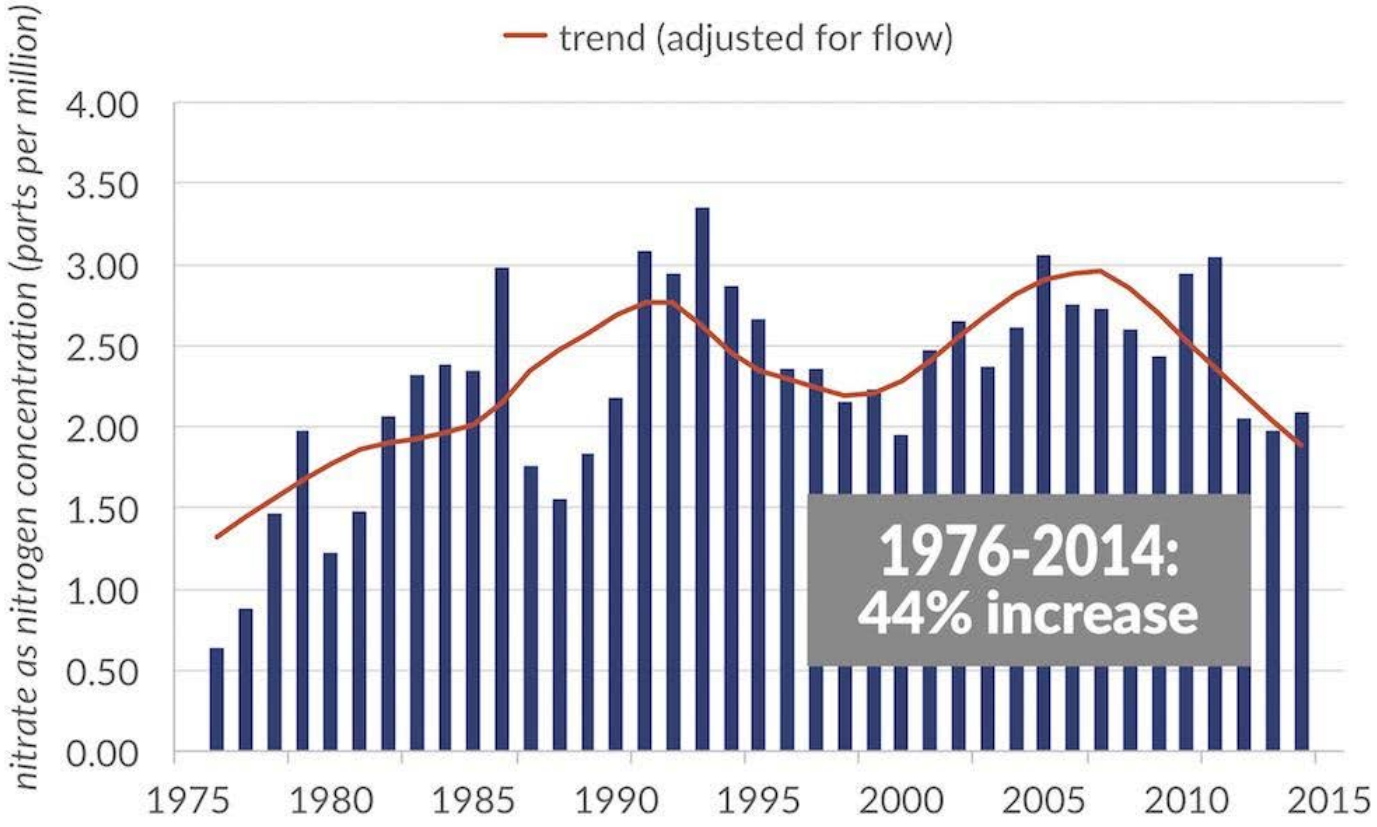


Figure 2. Median nitrate concentrations through the Twin Cities, 2005-2014

Source: Metropolitan Council Environmental Services

Nitrate

Figure 3. Average annual nitrate concentrations at Hastings Dam, 1976-2014



Source: Metropolitan Council Environmental Services, St. Croix Watershed Research Station

What can we do?

- Establish nitrate standards.
- State goal: 45% reduction by 2040.
- Reduce major sources:
  - Agricultural drainage
  - Fertilizer use
  - Perennial crops
  - Other sources

Bacteria

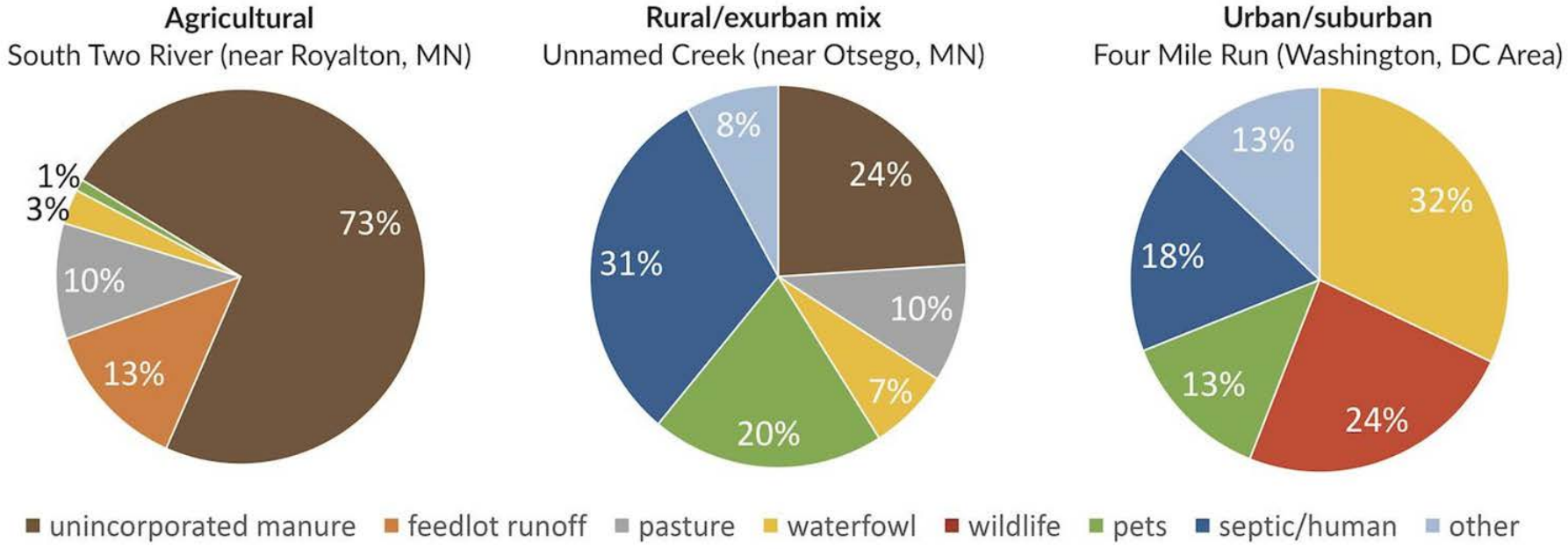
Description and impacts

- *E. coli* bacterium indicates potential presence of pathogens.
- Contact with water with high bacteria concentrations can make recreational users sick.

Sources

Figure 1. Estimated bacteria sources in example streams

These graphs show estimated bacteria sources in three representative landscape types



Source: Minnesota Pollution Control Agency, Northern Virginia Regional Commission[11]

History and trends

- Wastewater treatment systems greatly reduced human sewage in the river.

- 1985 >: separation of sanitary and storm sewers

- 1996 >: Some stretches showed excess fecal

- 2005>: *E. coli* data collected since

Bacteria

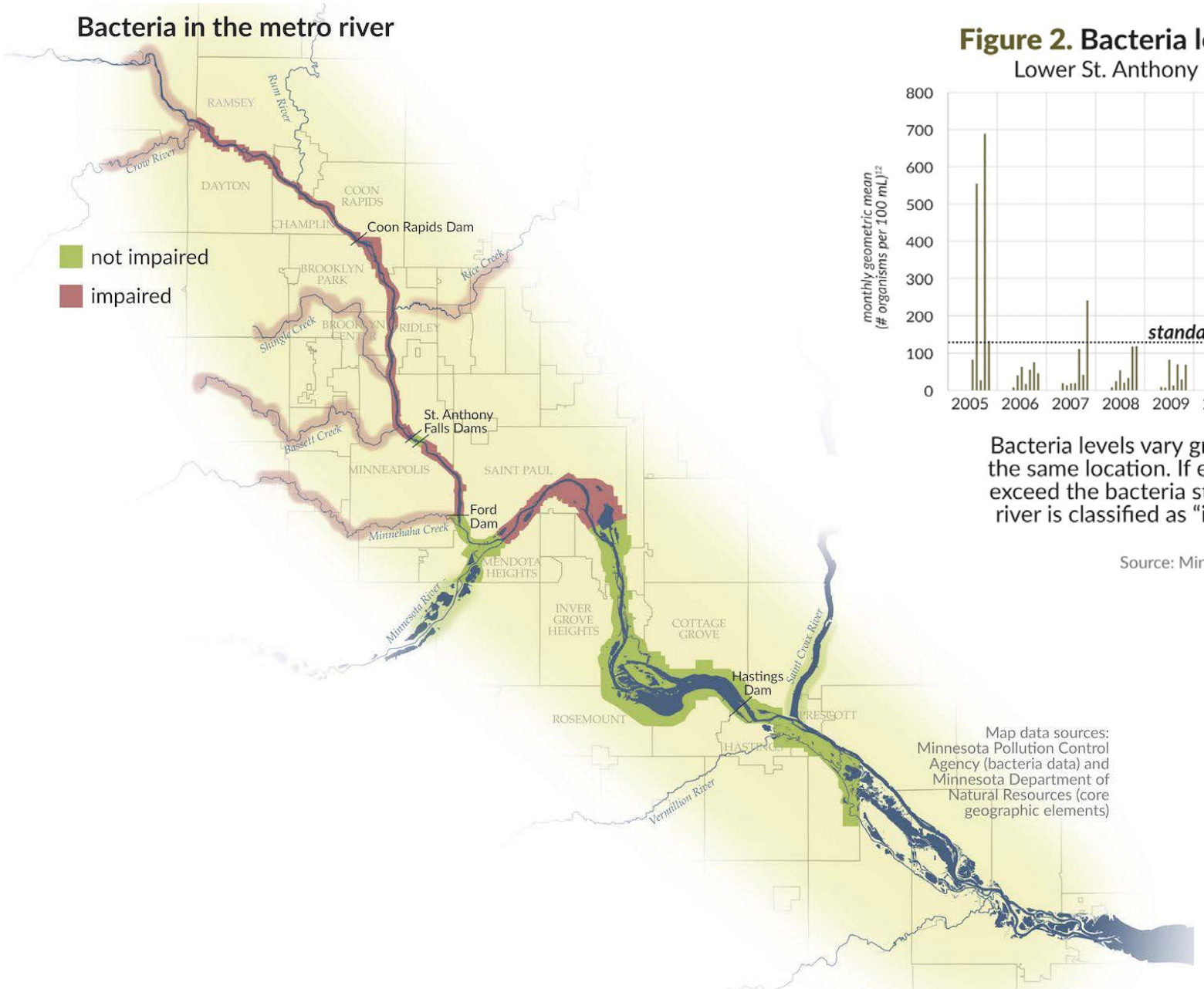


Figure 2. Bacteria levels, 2005-2014

Lower St. Anthony Falls to 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

What can we do?

- MPCA's clean-up plan
  - Identify sources
  - Propose source reductions

- You can help:
  - Pick up pet waste
  - Reduce runoff
  - Septic systems

So, can I swim in the river?

Swimming and recreation should be limited in impaired reaches of the river, and you should always wash up afterwards.

Swimming should be avoided throughout the river within 48 hours of rain events.


GOLD
MEDAL
FLOUR

Fish survey

The metro river is a world-class fishery.


24 RIVER LIFE

Fish survey

Anglers have embraced the metro 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, since the 1970s.

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

River managers lack data on species mix and trends.

Background. Historically, the river has been home to abundant populations of fish and wildlife. Scientists estimate there were nearly 120 native fish species below St. Anthony Falls and approximately 60 species above the falls, which served as a natural migration barrier.[1]

Fish populations dramatically declined following European settlement, when the river was used as a dumping ground for sewage, milling waste, stockyard waste and untreated runoff. In 1926, fish survey data showed only two living fish in the river between St. Anthony Falls and Hastings.[2]

Subsequent improvements in water management, including construction of the Metro Wastewater Treatment Plant in 1938, regulation of urban and industrial pollution, and passage of the 1972 Clean Water Act, along with other factors, have resulted in improved fish populations in the river.

Locks and dams. The construction of locks and dams has played an important part in the river's ecology. Dam construction impacts river flow (converting free-flowing water to more stagnant pools), impacting some fish and floodplain vegetation. In addition, sediment accumulation behind dams can bury fish habitat at important locations.

The dams also allowed sewage, mill and stockyard waste to accumulate on the river surface, capturing public attention on the need for river clean-up - particularly during hot summer months.

In addition, lock and dam installation has altered fish migration patterns. Whereas St. Anthony Falls was a

Figure 1. Walleye catches between Ford and Hastings Dams

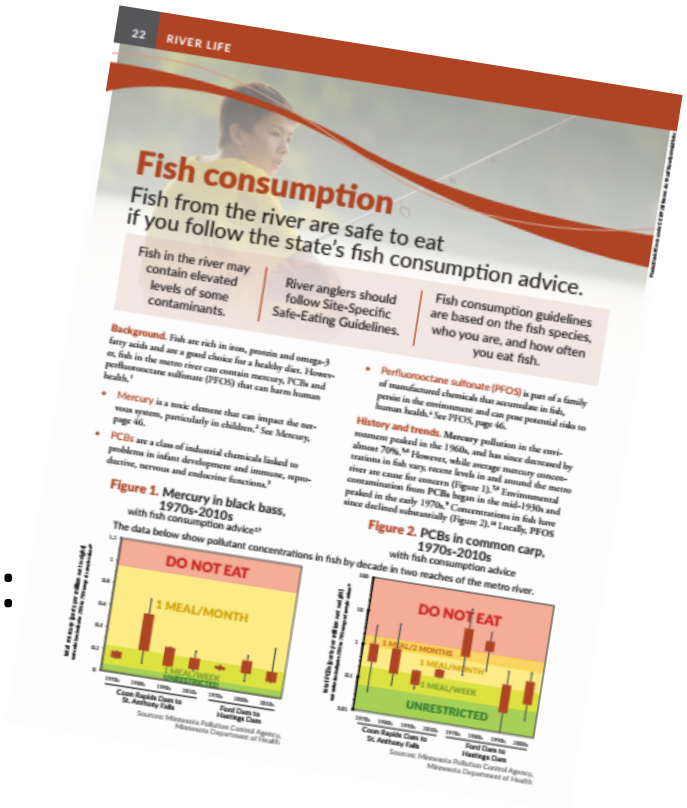
Source: Minnesota Department of Natural Resources

- Vastly improved fishery
  - Trophy walleye
  - World class smallmouth
- Catch-and-release regulations in place
- Need more data on species mix and trends

Fish consumption

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

- River fish may contain elevated levels of some contaminants.
- Follow site-specific consumption advice.
- Consumption guidelines based on:
  - Location + species + who you are
  - Exclude catch-and-release species



Invasive Asian carp continue moving into the metro river.

- Asian carp are an invasive fish.
- At least 19 have been caught in Lake Pepin and the metro river since 2011.
- Changes in lock management have been made.

26 RIVER LIFE

Invasive Asian carp

Invasive Asian carp continue moving into the metro river.

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

At least 19 grass, bighead and silver carp have been caught in Lake Pepin and the metro Mississippi River since 2011.

Changes in management of navigational locks have been made to slow the migration of Asian carp.

About Asian carp. Asian carp are a group of invasive fish consisting of four species: bighead, black, grass and silver carp. With large appetites, these voracious feeders can severely disrupt aquatic ecosystems as they outcompete native fish species and outgrow natural predators. Black, bighead and grass carp can all grow to over 100 pounds. Elsewhere on the river, established Asian carp populations have severely degraded boating, fishing and other recreation activities. Silver carp, which commonly grow to 20-40 pounds and leap as high as 10 feet from the water when disturbed, have caused injuries and boat damage in other states.[1]

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 by the 1980s,[2] their populations and ranges have increased dramatically in recent years, and the fish have reached states throughout the upper Mississippi River, including Minnesota (see map). In portions of the Illinois River where the infestation is extreme, over 60% of the weight of all the fish in the river is Asian carp.[3]

Status and trends. In Minnesota, over 76 bighead, silver and grass carp have been caught from the Mississippi and St. Croix Rivers since 1996, including at least 19 catches upstream of Winona since 2011.[4] A 47-pound bighead caught in Lake Pepin in November 2012 is the largest carp caught to-date in Minnesota. Two silver carp were caught between the Hastings Dam and the Ford Dam in 2014. Grass and bighead carp were also caught in the Minnesota River near New Ulm in December 2015 and February 2016. While no reproducing populations of Asian carp are known to exist in Minnesota, these data suggest the fish are present in the metro river area.

Solutions. Because they can move upstream when locks are opened, the recent closure of the Upper St. Anthony Falls Lock and reduced hours of operation at the Ford Lock (Lock and Dam 1) may help prevent the further spread of Asian carp into Minnesota.

Preventing the establishment of Asian carp in Minnesota's waters will require the following:

- **Deterrent technology:** Continue to research how modifying flow through dam gates and installing carp-deterrent technologies such as bubble, electric and acoustic barriers in the locks can be most effective.
- **Lock operations:** Modify lock operations to reduce recreational traffic wherever feasible. Manage lock operations to incorporate our growing understanding of Asian carp behavior, migration patterns and biology.
- **Research and biological control:** Enhance long-term funding for research into the behavior and biology of Asian carp.
- **Education and outreach:** Educate the public about the risks of Asian carp to build support for the

Bald eagles

The metro river is home to a resilient population of bald eagles.

28 RIVER LIFE

Bald eagles

The metro river is home to a resilient population of bald eagles.

Eagles along the river have made a dramatic comeback from near-extinction.

Lead levels in nestlings are higher in the metro river corridor than elsewhere in the region.

Levels of several contaminants are declining, but remain cause for concern.

Background. In 1963, only 417 bald eagle pairs nested in the lower 48 states. Today, nearly 10,000 pairs live in the lower 48 states, including over 1,300 in Minnesota.[1] This extraordinary recovery is linked to protections offered by the Bald Eagle Protection Act (1940),[2] the Clean Water Act (1972),[3] a national ban on DDT (1972),[4] and the Endangered Species Act (1973).[5]

Eagles feed primarily on aquatic prey and are susceptible to contaminants present in fish and other wildlife. Young bald eagles ("nestlings") are particularly vulnerable to these contaminants, and can help us understand overall ecosystem health.

Population status. Currently, the metro river is home to approximately 55 active nesting sites. This is approximately a 39% increase since 2011, indicating a strong and stable bald eagle population. Research is tracking this productive eagle population, which averages about one and a half nestlings per nest, well over the threshold for a healthy population (Figure 1).[6] Though the reproductive rate has varied over the years, it remains high relative to other areas monitored by the National Park Service.

Nestling health status. From 2006 through 2015, the National Park Service visited nests annually to take samples to measure levels of targeted contaminants, including:

- **PFCs.** Perfluorinated chemicals (PFCs) are a family of manufactured compounds widely used in stain-, grease- and water-resistant products. High levels of PFCs in humans are associated with obesity, diabetes and early menopause in women. PFCs, including PFOS (see PFOS, page 46), also contribute to fish consumption advisories in the metro river (see Fish consumption, page 22). Overall concentrations of PFCs declined in nestlings between 2006 and 2014. However, compared to upriver nestlings, PFC levels were nearly twice as high in the lower portion of the metro river, including record levels in a nestling near Hastings (Figure 2).[7]
- **Lead.** Lead is a neurotoxin with potentially harmful impacts to eagle nestlings and other wildlife. It is introduced into the environment via industrial uses, fishing tackle,

Figure 1. Nestlings per nest

- Eagles have made a dramatic comeback.
- Higher nestling lead levels.
- Levels of other contaminants are declining, yet cause for concern.

Mussels

Some native mussel populations are gradually being re-established.

RIVER LIFE 31

Mussels

Some native mussels are gradually being reestablished in the metro river.

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

River pollution eliminated mussels from much of the metro river in the early 1900s.

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

About mussels. Native mussels perform important functions in water bodies, and their presence is a good biological indicator of overall river health. Minnesota's native mussels filter solid material like plant debris, bacteria and runoff from the water, and excrete nutrients used by plants and other animals.[1]

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. Mussels reproduce by releasing larvae that attach to a host animal, usually fish (Figure 1). Once attached to their host, the larvae metamorphose into adults, leave the host, and take up life in the river bottom.[2]

Status. Because they can't swim away, mussels are directly impacted by river contaminants. The discharge of untreated waste to the river through the early 1900s eliminated the mussel population downstream of St. Anthony Falls.[3] Since then, mussels have responded favorably to improved sewage treatment, the separation of storm sewers from sanitary sewers, and other water quality improvements.[3]

Mussel habitat downstream of the confluence with the Minnesota River is degraded, most likely due to high loads of sediment and other pollutants. However, some mussel species have returned and this lower reach of the river now supports 28 of the original 43 native mussel species.[4] Upstream of

Figure 1. The lifecycle of a mussel

Source: Water Resources Center at Minnesota State University, Mankato

St. Anthony Falls, where lock construction aided host fish passage and mussel migration, there are 18 native mussel species.[3] Upstream of the Coon Rapids Dam, seven of nine historical native species are present.[4]

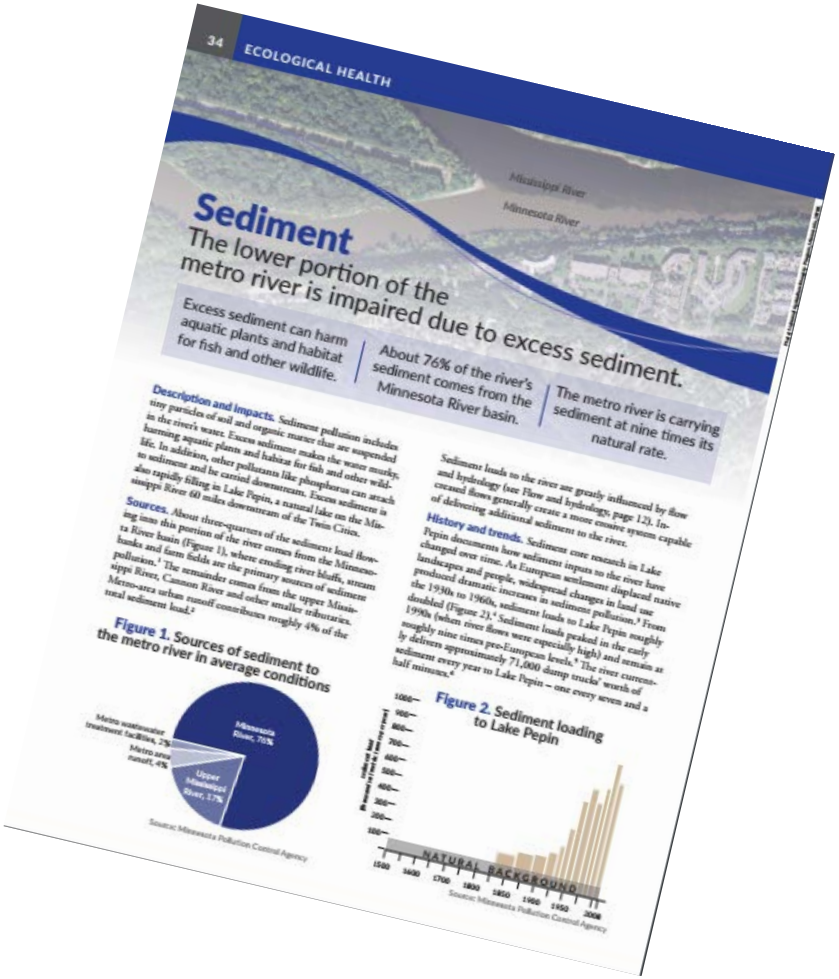
Management solutions. Reducing pollution is critical to improving mussel abundance in the river. Efforts to remove fish migration barriers like dams would also benefit mussel populations, but would need to be coordinated with efforts to control the spread of invasive Asian carp. In addition, ongoing efforts to reintroduce native mussels into the metro river will be important to their continued recovery.

- Indicator of river health.
- Mussel habitat degraded below Minnesota River confluence.
- Species diversity + abundance have not fully recovered to historic levels.

Sediment

The lower portion of the metro river is impaired due to excess sediment.

- Excess sediment can harm aquatic wildlife + habitat.
- 76% comes from the Minnesota River basin.
- Lake Pepin filling in at 9 times its natural rate.


34 ECOLOGICAL HEALTH

Sediment

The lower portion of the metro river is impaired due to excess sediment.

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

About 76% of the river's sediment comes from the Minnesota River basin.

The metro river is carrying sediment at nine 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 murky, 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 60 miles downstream of the Twin Cities.

Sources. About three-quarters of the sediment load flowing into this portion of the river comes from the Minnesota River basin (Figure 1), where eroding river bluffs, stream banks and farm fields are the primary sources of sediment pollution.[1] The remainder comes from the upper Mississippi River, Cannon River and other smaller tributaries. Metro-area urban runoff contributes roughly 4% of the total sediment load.[2]

Figure 1. Sources of sediment to the metro river in average conditions

Minnesota River, 70%

Upper Mississippi River, 17%

Source: Minnesota Pollution Control Agency

Sediment loads to the river are greatly influenced by flow and hydrology (see Flow and hydrology page 12). Increased flows generally create a more erosive system capable of delivering additional sediment to the river.

History and trends. Sediment core research in Lake Pepin documents how sediment inputs to the river have changed over time. As European settlement displaced native landscapes and people, widespread changes in land use produced dramatic increases in sediment pollution.[3] From the 1930s to 1960s, sediment loads to Lake Pepin roughly doubled (Figure 2).[4] Sediment loads peaked in the early 1990s (when river flows were especially high) and remain at roughly nine times pre-European levels.[5] The river currently delivers approximately 71,000 dump trucks' worth of sediment every year to Lake Pepin – one every seven and a half minutes.[6]

Figure 2. Sediment loading to Lake Pepin

NATURAL BACKGROUND

Source: Minnesota Pollution Control Agency

Chloride

The river meets standards for chloride, but levels are increasing in the metro area.

- Primarily from road deicing salt, water softeners.
- 1 teaspoon of salt permanently pollutes 5 gallons of water.
- 39 local water bodies impaired.

38 ECOLOGICAL HEALTH

Chloride

The river meets standards for chloride, but levels are increasing throughout the metro area.

Chloride comes primarily from road deicing salt and water softeners.

1 teaspoon of salt is enough to permanently pollute 5 gallons of water.

39 local water bodies are impaired by excess chloride, including several river tributaries.

Description and impacts. Chloride is an element that naturally occurs at low levels in Minnesota lakes and streams. However, at high concentrations, it can be toxic to aquatic life.[1] High chloride levels can also affect groundwater and drinking water supplies, vehicles, infrastructure, soil and plants, pets and wildlife.[2] Chloride is a permanent pollutant; it does not degrade over time, so it cannot be feasibly removed from surface waters.[3]

Figure 1. Sources of chloride to metro area waters

Source: Minnesota Pollution Control Agency

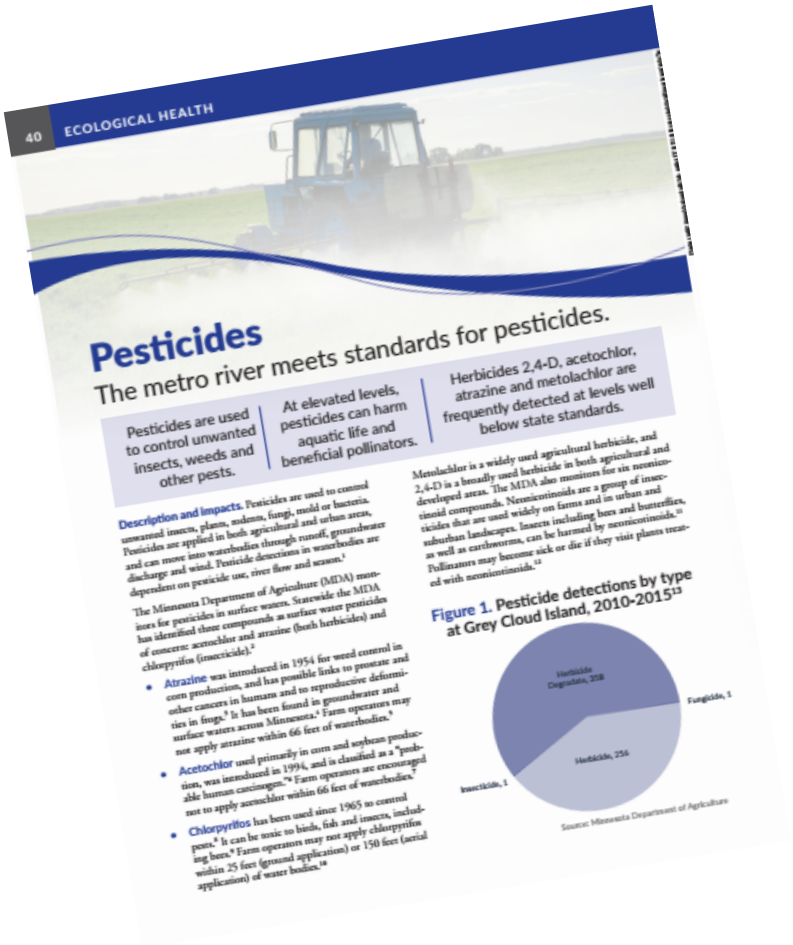
Sources. Winter road deicers are the primary source of chloride to Minnesota's waters; approximately 350,000 tons of deicing chemicals are applied in the metro area each year.[4] Seventy-eight percent of chloride applied in the Twin Cities area is retained in local surface and groundwater.[5] Water softeners, which discharge chloride to septic systems or wastewater treatment facilities (which do not remove chloride), are another important source. Other sources include fertilizers, dust suppressants, and landfill leachate (Figure 1).

Status. The river is currently well below the state's chloride standards to protect aquatic life. However, many local tributaries, lakes and wetlands fail to meet these standards (see map and Figure 2). Of tested metro area water bodies, 39 are impaired for excess chloride with another 38 close to exceeding state standards.[6] Monitoring data also show high chloride concentrations in area groundwater. Twenty-seven percent of the metro area sand and gravel wells exceed federal guidelines, as compared to 1% of non-metro wells.[7,8]

History and trends. Chloride levels in the metro river increased by 81% from 1985 to 2014 (Figure 3). Chloride concentrations are also increasing in metro area surface waters and groundwater.

Cyanide formation. Some deicing salts may contain iron-cyanide compounds to prevent caking when exposed to moisture. These compounds can break down when exposed to sunlight to form free cyanide, which can be toxic

The metro river meets standards for pesticides.


40 ECOLOGICAL HEALTH

Pesticides

The metro river meets standards for pesticides.

Pesticides are used to control unwanted insects, weeds and other pests.

At elevated levels, pesticides can harm aquatic life and beneficial pollinators.

Herbicides 2,4-D, acetochlor, atrazine and metolachlor are frequently detected at levels well below state standards.

Description and impacts. Pesticides are used to control unwanted insects, plants, rodents, fungi, mold or bacteria. Pesticides are applied in both agricultural and urban areas, and can move into waterbodies through runoff, groundwater discharge and wind. Pesticide detections in waterbodies are dependent on pesticide use, river flow and season.[1]

The Minnesota Department of Agriculture (MDA) monitors for pesticides in surface waters. Statewide the MDA has identified three compounds as surface water pesticides of concern: acetochlor and atrazine (both herbicides) and chlorpyrifos (insecticide).[2]

- **Atrazine** was introduced in 1954 for weed control in corn production, and has possible links to prostate and other cancers in humans and to reproductive deformities in frogs.[3] It has been found in groundwater and surface waters across Minnesota.[4] Farm operators may not apply atrazine within 66 feet of waterbodies.[5]
- **Acetochlor** used primarily in corn and soybean production, was introduced in 1994, and is classified as a "probable human carcinogen."[6] Farm operators are encouraged not to apply acetochlor within 66 feet of waterbodies.[7]
- **Chlorpyrifos** has been used since 1965 to control pests.[8] It can be toxic to birds, fish and insects, including bees.[9] Farm operators may not apply chlorpyrifos within 25 feet (ground application) or 150 feet (aerial application) of water bodies.[10]

Metolachlor is a widely used agricultural herbicide, and 2,4-D is a broadly used herbicide in both agricultural and developed areas. The MDA also monitors for six neonicotinoid compounds. Neonicotinoids are a group of insecticides that are used widely on farms and in urban and suburban landscapes. Insects including bees and butterflies, as well as earthworms, can be harmed by neonicotinoids.[11] Pollinators may become sick or die if they visit plants treated with neonicotinoids.[12]

Figure 1. Pesticide detections by type at Grey Cloud Island, 2010-2015[13]

Source: Minnesota Department of Agriculture

- Used to control unwanted insects, weeds, other pests.
- Can harm aquatic life and beneficial pollinators.
- Several herbicides frequently detected (at levels well below state standards).

Microplastics

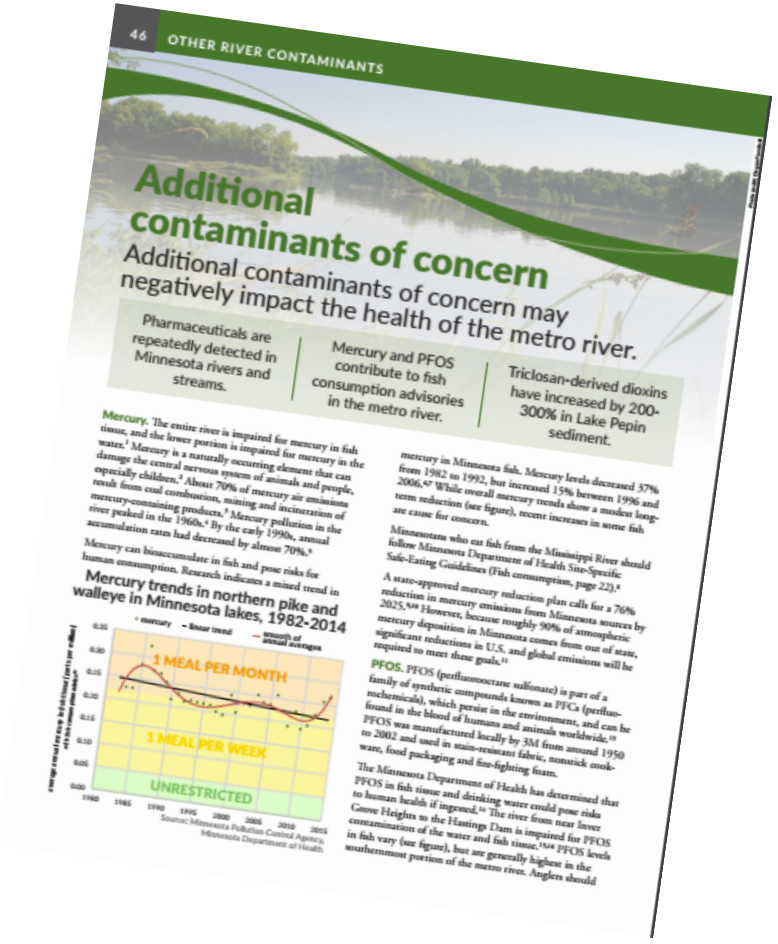
Fibers are the most common microplastic in the metro river.

- Tiny pieces of plastic, abundant in the environment.
- Potential risks to wildlife and human health.
- Research is underway to better understand their presence.

Additional contaminants of concern

Additional contaminants of concern may negatively impact the health of the metro river.

- **Pharmaceuticals** repeatedly detected in rivers and streams.
- **Mercury** and **PFOS** contribute to fish consumption advisories.
- **Triclosan**-derived dioxins up 200-300% in Lake Pepin


46 OTHER RIVER CONTAMINANTS

Additional contaminants of concern

Additional contaminants of concern may negatively impact the health of the metro river.

Pharmaceuticals are repeatedly detected in Minnesota rivers and streams.

Mercury and PFOS contribute to fish consumption advisories in the metro river.

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

Mercury. The entire river is impaired for mercury in fish tissue, and the lower portion is impaired for mercury in the water.[1] Mercury is a naturally occurring element that can damage the central nervous system of animals and people, especially children.[2] About 70% of mercury air emissions result from coal combustion, mining and incineration of mercury-containing products.[3] Mercury pollution in the river peaked in the 1960s.[4] By the early 1990s, annual accumulation rates had decreased by almost 70%.[5]

Mercury can bioaccumulate in fish and pose risks for human consumption. Research indicates a mixed trend in mercury in Minnesota fish. Mercury levels decreased 37% from 1982 to 1992, but increased 15% between 1996 and 2006.[6,7] While overall mercury trends show a modest long-term reduction (see figure), recent increases in some fish are cause for concern.

Minnesotans who eat fish from the Mississippi River should follow Minnesota Department of Health Site-Specific Safe-Eating Guidelines (Fish consumption, page 22).[8]

A state-approved mercury reduction plan calls for a 76% reduction in mercury emissions from Minnesota sources by 2025.[9,10] However, because roughly 90% of atmospheric mercury deposition in Minnesota comes from out of state, significant reductions in U.S. and global emissions will be required to meet these goals.[11]

Mercury trends in northern pike and walleye in Minnesota lakes, 1982-2014

1 MEAL PER MONTH

1 MEAL PER WEEK

UNRESTRICTED

PFOS. PFOS (perfluorooctane sulfonate) is part of a family of synthetic compounds known as PFCs (perfluorochemicals), which persist in the environment, and can be found in the blood of humans and animals worldwide.[12] PFOS was manufactured locally by 3M from around 1950 to 2002 and used in stain-resistant fabric, nonstick cookware, food packaging and fire-fighting foam.

The Minnesota Department of Health has determined that PFOS in fish tissue and drinking water could pose risks to human health if ingested.[13] The river from near Inver Grove Heights to the Hastings Dam is impaired for PFOS contamination of the water and fish tissue.[13,14] PFOS levels in fish vary (see figure), but are generally highest in the southernmost portion of the metro river. Anglers should

Summary and conclusions

Summary and conclusions

THE GOOD NEWS

Mussels

Bald eagles

Fish

Summary and conclusions

THE GOOD NEWS (FOR NOW)

Pesticides

Chloride

Summary and conclusions

CAUSE FOR CONCERN

- Sediment

- Bacteria

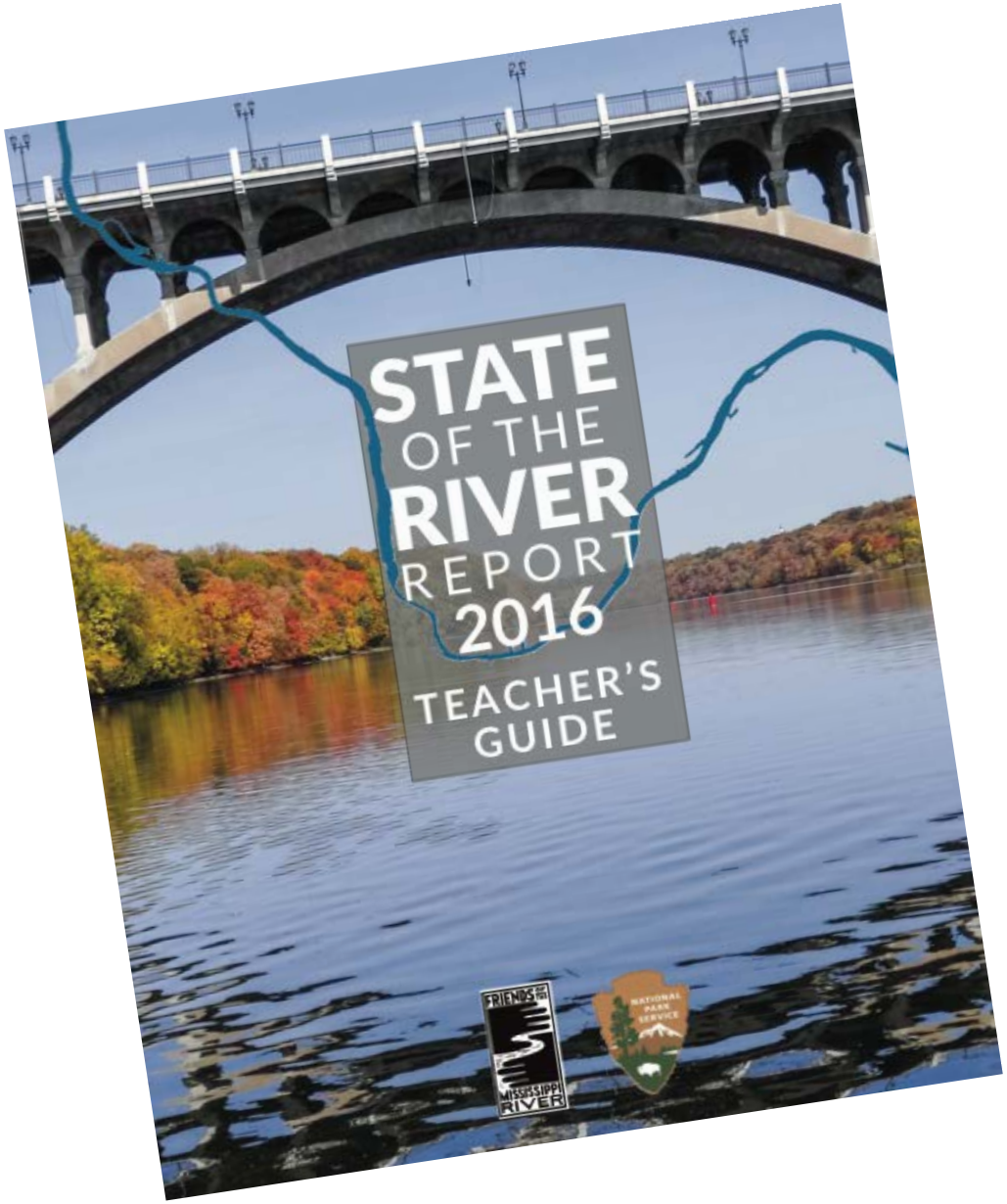
- Phosphorus
- Fish consumption

Summary and conclusions

CAUSE FOR ALARM

- River flow (up 24%)
- Nitrate (up 44%)
- Invasive Asian carp
- Emerging contaminants

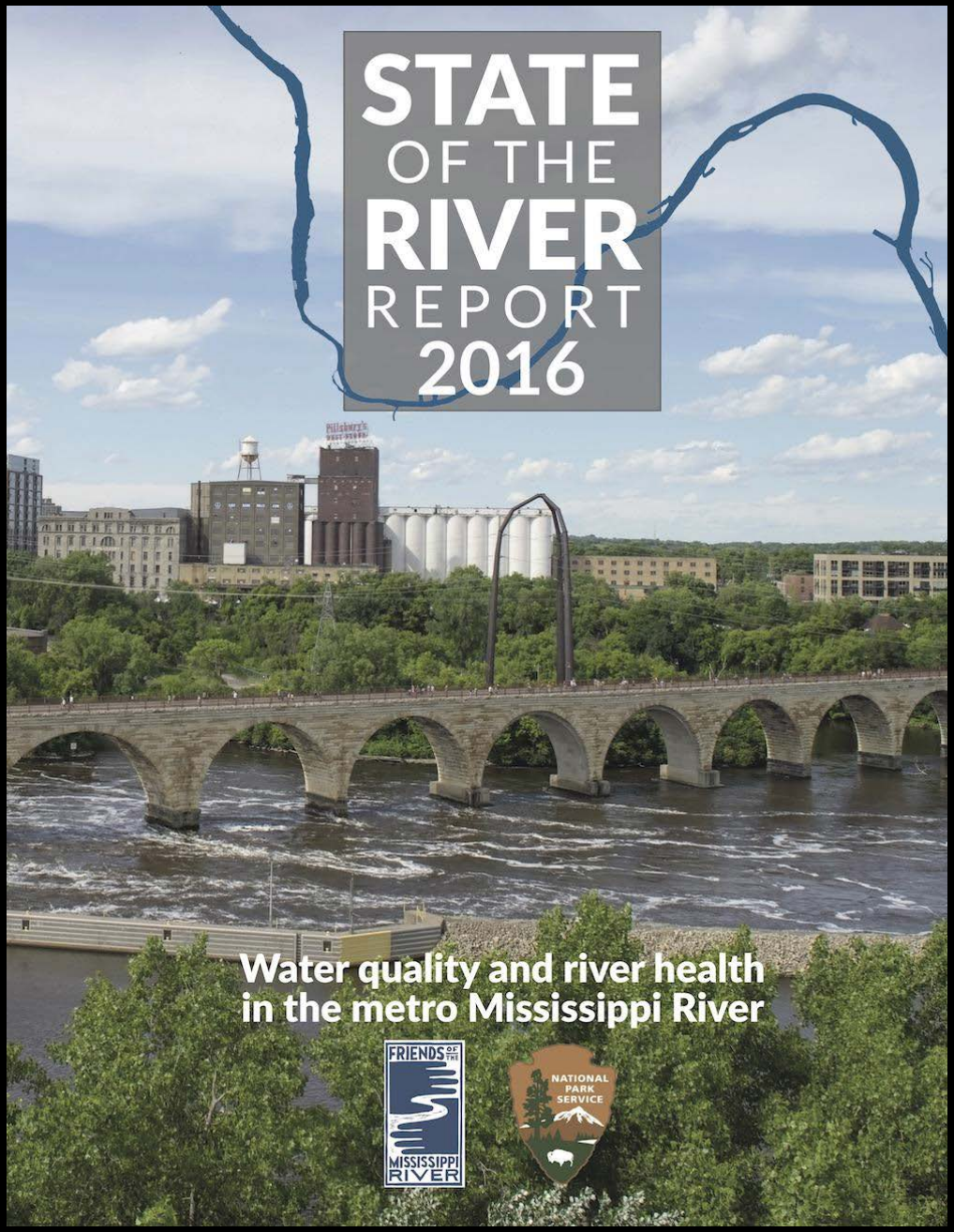
Stewardship Guide & Teacher's Guide



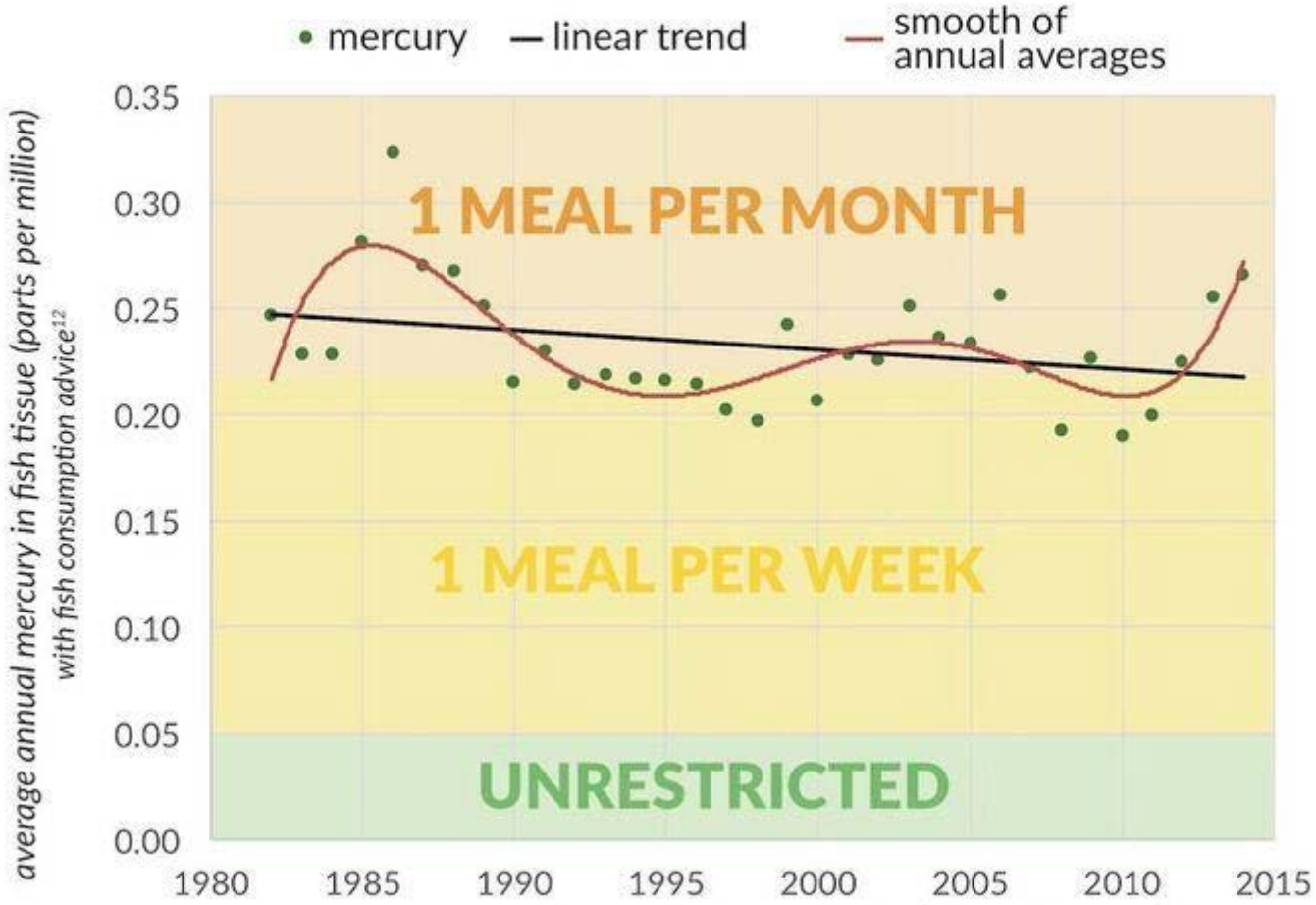
FMR's Policy Guide

FMR's Policy Guide

Top 10 actions that federal, state, and local leaders can take for the river


STATE
OF THE
RIVER
REPORT
2016
Water quality and river health
in the metro Mississippi River
FRIENDS OF THE MISSISSIPPI RIVER
NATIONAL PARK SERVICE

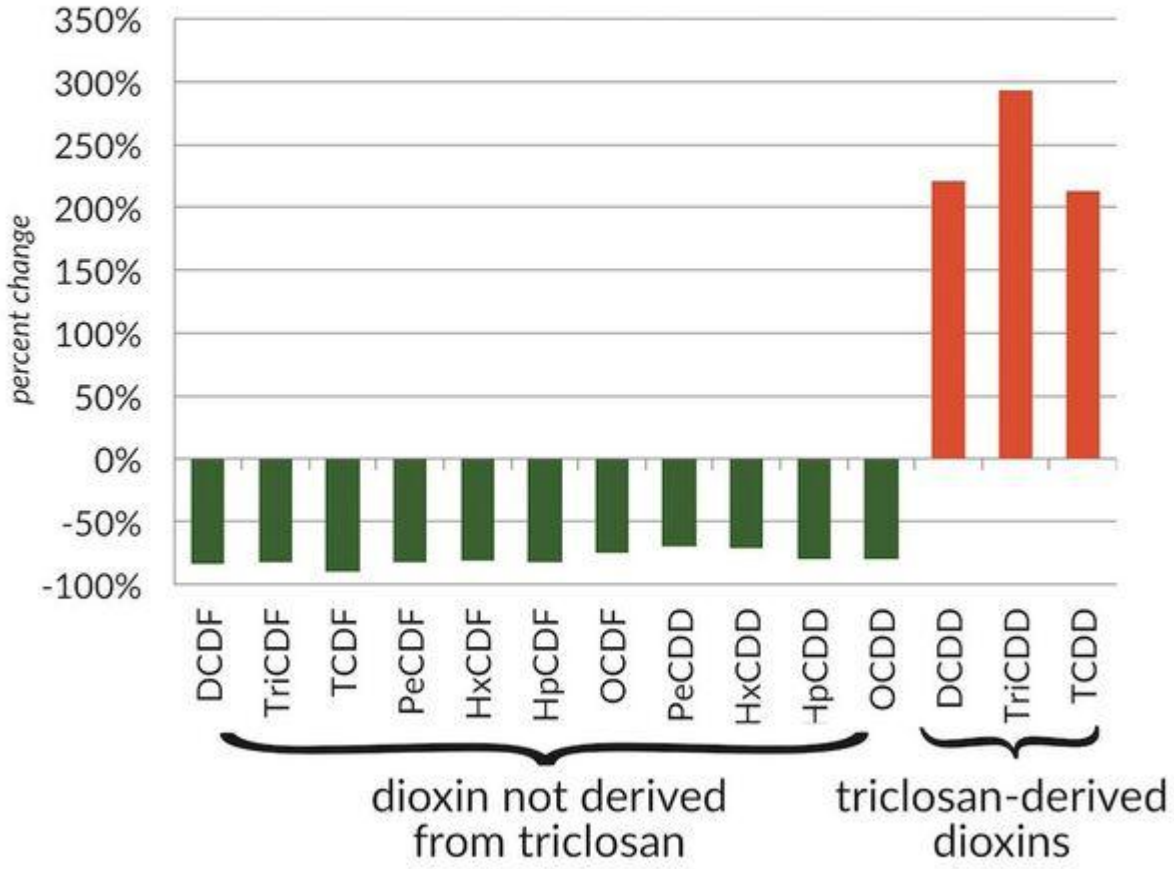
Mercury trends in northern pike and walleye in Minnesota lakes, 1982-2014



Source: Minnesota Pollution Control Agency, Minnesota Department of Health

Triclosan-derived dioxin trends in Lake Pepin

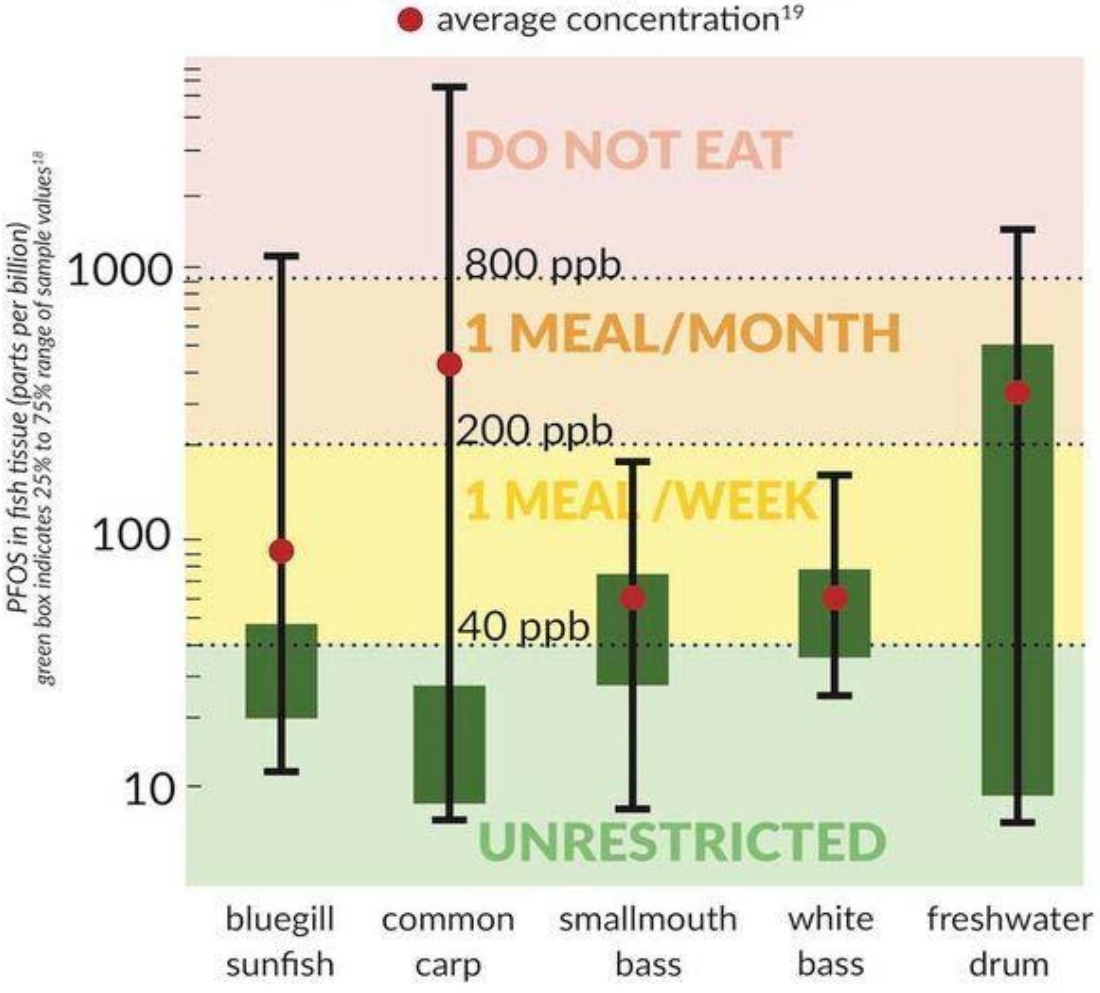
triclosan-derived dioxins vs. non-triclosan-derived dioxins in Lake Pepin sediment cores since the 1960s



Source: Buth et. al.

PFOS in fish above Hastings Dam, 2012

with fish consumption advice



Sources: Minnesota Pollution Control Agency (2012) and Minnesota Department of Health