

State of the St. Croix River Report



The St. Croix River Association works throughout the watershed to protect the national park that flows through its heart. Established in 1968, the St. Croix National Scenic Riverway was the nation's first wild and scenic river-national park.

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Welcome to the State of the St. Croix River Report

The St. Croix River Association (SCRA) is often asked about the health of the river. For decades, scientists, resource managers, and volunteers have studied the St. Croix River and the extraordinary flora and fauna found here. This ongoing research is the basis for planning, protection, and restoration activities.

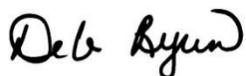
What we've learned is that information often does not translate well to the general public, even if they have access to the information. People are left wondering: "Can I swim in the river?" "Is water quality improving or getting worse?" "Can I eat the fish I catch?" This is especially true with a new segment of the St. Croix added to the Minnesota impaired waters list in 2020.

The *State of the St. Croix River Report* was designed to answer these questions and more. We hope to increase awareness and understanding of the issues that cause problems in the St. Croix River ecosystem. We hope the success stories motivate actions that lead to not just the enjoyment of the river, but inspire people to act to preserve and improve its integrity for future generations.

We are blessed with a truly special wild and scenic river, a generally healthy and intact Riverine system seldom seen elsewhere. But the river is vulnerable and will always be vulnerable. Development pressure, land use changes, increased occurrence of invasive species, and contaminants such as microplastics pose threats to the condition of the river. Fundamentally, it will take people to protect the Riverway. Continual work and public action will be necessary to preserve and protect the St. Croix River.

We hope you enjoy learning more about your wild and scenic St. Croix, and learn more about what it will take to keep it that way. Thank you to everyone that contributed to this report, and to all Riverway Stewards, we need you.

Respectfully,



Deb Ryun, Executive Director

St. Croix River Association
May 2020

Why is the St. Croix River Special?

The St. Croix River is part of the St. Croix National Scenic Riverway (abbreviated as “Riverway”), which also includes the Namekagon River. The Riverway is protected by the Wild & Scenic Rivers Act and is part of the National Park System. Flowing through northwest Wisconsin and eastern Minnesota, these rivers flow through some of the most scenic and least developed country in the Upper Midwest. With 7,760 square miles of land included in the St. Croix watershed, the health of this Riverway impacts many.

People from diverse cultures have been drawn to the St. Croix River for more than 12 millennia. Their lives have impacted the river in a variety of ways, including migration and trade routes, logging, transportation, settlement, and development. The river we appreciate in the present day shows the story of how we have treated it over those millennia. Thanks to conservation efforts, we can camp and hike along the St. Croix’s scenic shores and swim, paddle, float, and fish in its clear, free-flowing waters.

What will the river look like in 50 years? That depends on the actions we take today. This report will focus on the St. Croix River and its ecosystem, highlighting its journey, the current threats it faces, and how we can protect it for future generations.

The Wild and Scenic Rivers Act

When Congress established the Wild and Scenic Rivers Act in 1968, the Upper St. Croix (including the Namekagon) became one of the first eight rivers to receive federal protection as the St. Croix National Scenic Riverway—America’s first Wild and Scenic River National Park.¹ The Lower St. Croix was added to the system in 1972, forming a 230-mile-long national park that unites two states and rural and metropolitan areas alike. This federal section is managed by the National Park Service. In addition, the last 25 miles of the St. Croix River require special collaboration between the National Park Service, the Minnesota Department of Natural Resources, and the Wisconsin Department of Natural Resources. Wild and Scenic River designation protects the many values and characteristics which make the St. Croix special.²

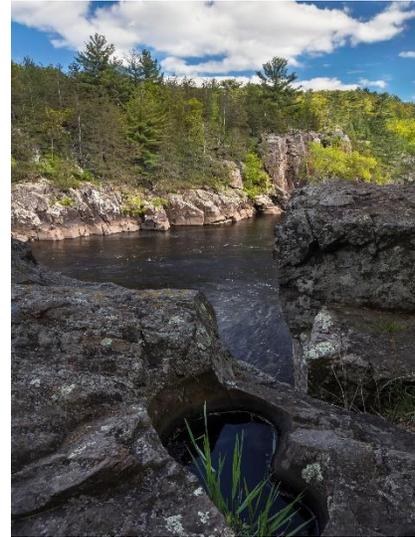


¹ National Wild and Scenic Rivers System. <https://www.rivers.gov/rivers/st-croix.php>

² Minnesota Department of Natural Resources. Lower St. Croix National Scenic Riverway Program.

Geology

The river we see today began its long journey about 1 billion years ago, when the North American continent split open and sent lava flows to the surface of the earth. This formed the Midcontinent Rift. After cooling, this lava became our region's underlying basalt and igneous rock. During the Cambrian Period 500 million years ago, this rock was covered by sedimentary rock laid down by a vast inland sea that covered the area of the present-day river. 10,000 years ago, the last of four glacial advances etched into the land, carving through areas of limestone and sandstone and scouring the earth. The last glacial retreat produced meltwater that drained into the area we know as the St. Croix River with a force that carved valley bluffs and the striking basalt walls and glacial potholes of The Dalles.³



Culture

The rich soils and clear waters, natural travel route, and sheer beauty of the St. Croix River have brought people to its banks since the end of the most recent ice age. As a result, human history has been closely woven to natural history. American Indian tribes have lived along the river since the last glacier retreated, with burial mounds, rock art, and remains of village sites offering hints of what life was like for the very first residents of the river.

The Dakota and the Ojibwe hunted, fished, and harvested wild rice in and along the river at the time Europeans arrived in the region. Drawn to this important route for trade and travel, French fur traders traded with the Ojibwe, Dakota, and other American Indian tribes here during the 1700s. In the 1800s, when animal pelts were a hot commodity, English and American fur traders joined them.

In 1837, U.S. government treaties with the Ojibwe and Dakota opened much of the region's land to European-American settlement and logging. Wisconsin gained statehood in 1848, and Minnesota followed in 1858.^{4,5,6} By 1914, much of the river valley's stunning white pine had been cut and floated down the river to use for construction. The end of the logging era marked the beginning of a new economy across the watershed based on agriculture, tourism, and recreation—one that would benefit from the return of a healthy forest ecosystem.⁷

³National Park Service, U.S. Dept of the Interior. (2019). *Foundation Document*. St. Croix National Scenic Riverway. <https://www.nps.gov/sacn/learn/management/foundation-document.htm>

⁴ National Park Service. (2019). History & Culture-Saint Croix National Scenic Riverway. <https://www.nps.gov/sacn/learn/historyculture/index.htm>

⁵Minnesota History Center. Gale Family Library. (2019). Overview- St. Croix River Valley. <https://libguides.mnhs.org/stcroix>

⁶Thorson, D. (2014). *Last log through the boom: the end of the St. Croix's timber industry*. <https://www.stcroix360.com/2014/06/last-log-through-the-boom/>

⁷ Thorson, D. (2014). *Last log through the boom: the end of the St. Croix's timber industry*. <https://www.stcroix360.com/2014/06/last-log-through-the-boom/>

Native Species

The St. Croix River is one of the cleanest rivers in the Midwest. Along with the Namekagon, it has been given the distinction of “Outstanding Resource Waters” in Wisconsin and Minnesota in addition to being recognized as a national wild and scenic river, a rare triple designation.⁸ Because of the health of the river, many species of fish, mussels, and other wildlife thrive here.⁹ If you peek under the water, you’ll see the boulders, gravel beds, sand bars, and backwaters where a wide range of fish, aquatic insects, and other wildlife nest, feed, and seek shelter.

Many of the creatures that live here are listed by the states of Wisconsin and Minnesota and the federal government as threatened or endangered species. Along the entire St. Croix River there are 110 species of fish, 41 species of freshwater mussels, and many other plants and animals on these state and federal lists. These creatures are one reason why this river is very special! Let’s take a closer look.

Threatened species are those at risk of becoming endangered.

Endangered species are those at risk of becoming extinct in the future.

Mussels



Although they might look like rocks at first glance, these freshwater clams are amazing. They have unique adaptations to live and reproduce and can tell us a lot about the health of the river. Most mussel species need really clean water and the right conditions to survive. They also filter water and cycle nutrients, helping the river stay healthy and clean.

A total of 41 different types of mussels call the St. Croix home, and 5 are on the federal endangered species list. Some of them, like the winged mapleleaf, are found almost nowhere else on Earth. Today, nearly two-thirds of all mussel species in the United States are threatened, endangered, or already extinct.¹⁰ Researchers believe that all of the mussel species found in the St. Croix River before European settlement are still present today. In comparison, most large rivers in the U.S. have lost many of their native mussel species. The St. Croix is one of the best places for mussels to live in the entire world and is a precious habitat. This makes the river a great place for researchers to learn more about mussels.

⁸ National Park Service, U.S. Dept of the Interior. (2019). *Foundation Document*. St. Croix National Scenic Riverway. <https://www.nps.gov/sacr/learn/management/foundation-document.htm>

⁹ Payne, G.A., Lee, K.E., Montz, G.R, Tammage, J.K. and Larson, J.D. (2000). Water-Quality and Aquatic-Community Characteristics of Selected Reaches of the St. Croix River, Minnesota and Wisconsin.

¹⁰ Hornbach, D. J. (2001). “Macrohabitat Factors Influencing the Distribution of Naiads in the St. Croix River, Minnesota and Wisconsin, USA.” *Ecology and Evolution of the Freshwater Mussels Unionoida Ecological Studies*, pp. 213–230., doi:10.1007/978-3-642-56869-5_12

Northern Wild Rice

In the river below Upper St. Croix Lake in Solon Springs, Wisconsin, you'll find wild rice growing three to six feet above the water level in the slow-flowing shallows. This plant provides food and a place to rest and nest for many creatures, including migrating waterfowl. Northern wild rice has been harvested by American Indian tribes, including the Ojibwe, for many centuries. Easily stored, transported, and traded, wild rice provided food for fur traders and early missionaries, and is still an important food source for many. French explorers on the St. Croix described the plant as "folle avoine" or wild oats. In later years the European-Americans called the St. Croix Valley "folle avoine country," showing the importance of wild rice in the region.¹¹

When dams were constructed, rich, shallow shoreland areas were flooded and many areas of wild rice on the St. Croix and surrounding waters were eliminated.¹² One significant stand of northern wild rice still grows below Upper St. Croix Lake, and smaller isolated patches of rice are found along other portions of the river. Harvesting and processing of wild rice requires long hours of work. In late summer, dedicated harvesters can be seen poling and paddling canoes on the river, gently knocking the rice into their canoes.

Lake Sturgeon

This ancient species was nearly driven to extinction by overfishing, habitat loss, and pollution. Now, lake sturgeon are making a slow comeback in the St. Croix River, laying their eggs on clean, gravel shallows and in rapids of the St. Croix from April to June. In the winter of 2019, a new Minnesota state record was set by a lake sturgeon caught and released through the ice of Lake St. Croix near Bayport. At 78 inches (6.5 feet) long, 29.5 inches around, and a weight of about 120 pounds, this fish was estimated to be 60 to 70 years old.¹³

With a life of slow growth, late adulthood (24-26 years for females and 8-12 years for males), and low reproduction (only 10% to 20% of adults breed in a year), lake sturgeon are sensitive to environmental change, overfishing, and barriers such as dams. Biologists documented significant decline in the upper river's sturgeon population from the 1960s to the early 1990s.¹⁴ Recovery is on its way, with good numbers of young fish and lots of protected river habitat. In order for lake sturgeon to thrive again in the St. Croix, fisheries experts say we will need strict limits on sturgeon taken from the river. Right now, both states have a limited catch-and-release-only season for sturgeon in the St. Croix River. Cleaner water will also support continued recovery.¹⁵

¹¹ McMahon, E.M. and J. Karamanski, T.J. (2002). *Time and the River: A History of the St. Croix, A Historical Resource Study of the Saint Croix National Scenic Riverway*. National Park Service, U.S. Dept of Interior. <http://npshistory.com/publications/sacn/hrs/>

¹² Vennum, T. (1988). *Wild Rice and the Ojibway People*. Minnesota Historical Society Press.

¹³ Seitz, G. (2019). *Famous fish: St. Croix sturgeon crowned as new champion, receives national attention*.

<https://www.stcroix360.com/2019/03/famous-fish-st-croix-sturgeon-crowned-as-new-champion-receives-national-attention/>

¹⁴ Wisconsin and Minnesota Department of Natural Resources. (2012). *A Population assessment of lake sturgeon in upper St. Croix River, Minnesota and Wisconsin 2003-2011*. (Report number MWIBC:2601400).

¹⁵ Kampa, J., G. Hatzenbeler and M. Jennings. (2014). "Status and management of lake sturgeon (*Acipenser fulvescens* Rafinesque, 1817) in the Upper St. Croix River and Namekagon River," *Journal of Applied Ichthyology*. 30:1387-1392.

Invasive Species

Whether introduced by accident or through carelessness, invasive species are out-of-place plants and animals whose presence along the river causes threats ranging from inconvenient to dangerous. Paying attention to the presence and spread of these species is essential to keeping the St. Croix a happy habitat for native species. Let's take a look at some of the most common invasive species found in and around the river.

Yellow Iris

With its ability to take over places where native plants grow, yellow iris is rapidly expanding its presence along the river.¹⁶ This beautiful but poisonous plant spreads quickly and crowds out native plants such as blue flag iris. Yellow iris is not eaten by wildlife and can cause skin irritation in humans.

Local conservation groups are working to remove yellow iris in the St. Croix River by cutting seed heads and digging out plants. They map the plants to help track growth and repeat removal efforts if needed. However, even after several years of hard work, the groups are struggling to keep the floating mats of this aggressive plant in check.¹⁷



Purple Loosestrife and Beetle Control

Although beautiful, the invasive plant known as purple loosestrife is known for its ability to quickly invade and dominate wetlands. It diminishes previously healthy homes for birds and other animals and out-competes wild rice and other valued native plants. Public agencies and citizen volunteers continue to work to control pockets of the plant that occasionally pop up along the river. Larger populations of purple loosestrife along the Yellow River in Burnett County are a source of seeds entering the St. Croix.

But there is a secret weapon against the spread of purple loosestrife, and it is a very hungry beetle. Galerucella beetles have been released along the Yellow River and in other seed source areas. Though small, they are effective at reducing the density of plants and slowing their ability to spread over time while leaving native plants alone.¹⁸ Their use in the battle against purple loosestrife is an



¹⁶ B. Karns, personal communication, March 20, 2019.

¹⁷ Parton, H. F. (2016). "Profile: Scott Peterson vs. the yellow iris." <https://www.stcroix360.com/2016/11/profile-scott-peterson-vs-the-yellow-iris/>

¹⁸ "Purple Loosestrife: What You Should Know, What You Can Do." *Aquatic Invasive Species* | Minnesota Sea Grant, Feb. 2017, www.seagrant.umn.edu/ais/purpleloosestrifeinfo

example of biocontrol, a pest control method that uses natural predators to control an invasive species without the use of pesticides.

What can I do?

- Report invasive plants to the Wisconsin or Minnesota DNR.
Wisconsin: <https://dnr.wi.gov/topic/Invasives/report.html>
Minnesota: https://www.dnr.state.mn.us/invasives/report_invasives.html
- Volunteer for invasive species removal and learn more about upcoming identification workshops by contacting Katie Sickmann, Invasive Species Coordinator at katies@scramail.com or by calling the St. Croix River Association at 715-483-3300 to learn more!

Zebra Mussels

Recognizable by their distinctive stripes and shells shaped like the letter D, zebra mussels are a serious threat to the St. Croix River's native mussels. They take food away from other animals, reduce the oxygen in the water, and colonize areas on the river bottom so nothing else can live there. Zebra mussels also attach themselves to native mussels, preventing them from eating, breathing, and reproducing. Damage to boats, docks, and beaches can also occur.



The first zebra mussels were found on boats in the Lower St. Croix in 1994. Currently, zebra mussel reproduction occurs below the Stillwater Lift Bridge. River currents appear to be preventing their upstream movement. But humans and their boats can move zebra mussels upstream and across land, and at this time, there are no foolproof ways to control or slow the spread of zebra mussels once they are introduced into a water body. This makes strong prevention efforts an essential requirement to stop the spread of zebra mussels. The St. Croix is at a juncture in its ecological history as current actions determine what will happen to native species threatened by zebra mussels.

What can I do?

Follow the state aquatic invasive species laws and these simple rules every time you launch and pull your boat:

- INSPECT—check your boat, trailer and equipment.
- CLEAN—remove all zebra mussels, and place them in a trash receptacle.
- DRAIN—this means all water (including pools of water in the boat) to eliminate tiny larval zebra mussels, and leave your drain plugs out during transport.
- Throw out all unused bait in a trash receptacle.
- DRY—leave your boat in the sun at least 5 days before moving between bodies of water.

Minnesota-DNR: https://www.dnr.state.mn.us/invasives/preventspread_watercraft.html

Wisconsin-DNR: <https://dnr.wi.gov/topic/invasives/fact/pdfs/ProtectYourBoat.pdf>

Invasive Asian Carp

Since escaping into the Lower Mississippi River in the 1970s, Invasive Asian carp have been populating new areas. This group of invasive species have the potential to devastate rivers by competing with and overcrowding native fish. Most fall into the 25-40 pound weight range, but they can get up to 70+ pounds in size. Asian carp are known for their big appetites, consuming up to 40% of their body weight in plankton (small plants and animals floating in the water) each day and removing huge amounts of food needed by other native species. One species, silver carp, also leaps out of the water when motor boats pass by, which can seriously injure people and damage watercraft.¹⁹ Imagine a fish of this size flying at your head!



Since 1996, a number of individual invasive bighead, grass, and silver carp have been captured in the St. Croix and the nearby waters of the Mississippi River. After much searching, we believe these carp are solo, wandering adults and are not part of a larger group present in lower reaches of the Mississippi and Minnesota Rivers.²⁰ While the St. Croix appears to have adequate food sources, the river might not flow at a speed and distance that supports the hatching of carp eggs in the stretch below the St. Croix Falls Dam. However, as the population of these species grows larger in the Mississippi, their numbers may increase in the St. Croix.²¹

What can I do?

If you are out fishing and catch an invasive carp, you must report your capture to the DNR immediately.

- For Minnesota, call 651-587-2781 or email invasivecarp.dnr@state.mn.us. Take a photo and transport the carp to the nearest DNR fisheries office or make arrangements for it to be picked up by a DNR official.
- For Wisconsin, print out the Asian carp brochure for your tackle box, take a photo, and transport the fish on ice to the local DNR office (locations listed here): https://dnr.wi.gov/news/mediakits/mk_carpcontrol.asp#basics

¹⁹ Jennings, D. P. (1988). *Bighead carp (Hypophthalmichthys nobilis): a biological synopsis*. U.S. Fish and Wildlife Service, Biology Report 88:1-35.

²⁰ Minnesota Department of Natural Resources Division of Fish and Wildlife Section of Fisheries. (2019). *Invasive carp sampling report January-December 2018*.

²¹ B. Karns, personal communication, March 20, 2019.

Water Quality

Although the tannin-tinted waters of the St. Croix are some of the cleanest in the Midwest, not all is well. Some of these problems are hard to see at a glance, while others are visible. For example, too much phosphorus (and other nutrients) can create scummy green and greenish-blue algae blooms that may also be harmful to people, pets, fish, and wildlife. This algae growth reduces our enjoyment of swimming and other fun activities on the river. It's important to remember that nutrient concentrations in the water reflect how we use and care for the land that drains to the river.

Phosphorus

Phosphorus is the primary source of green and blue-green algae growth in Lake St. Croix, located in the lower stretch of the river. In 2008, Lake St. Croix was designated as “impaired” and in need of improved water quality and better protection. More frequent algae blooms mean less clear water, which makes boating, fishing, and swimming less enjoyable. In addition, toxins produced by a type of algae called blue-green algae can be harmful to humans and pets. Exposure to these toxins can cause stomach cramps, diarrhea, vomiting, headache, fever, muscle weakness, and difficulty breathing.²²



Both Minnesota and Wisconsin are working with many local partners and the St. Croix Basin Water Resources Planning Team to keep the St. Croix on a “phosphorus diet” and meet the goals of water quality standards established by the states. Progress is slow and the goals have not yet been met, but long-term water quality monitoring at Stillwater and Prescott shows that concentrations (amount of pollutant measured in a specific volume of water) of sediment,

bacteria, and phosphorus have decreased a bit (and conditions improved) from 1976 to 2015. But there is still an impact on river enjoyment—the Minnesota Department of Natural Resources rates Lake St. Croix as not always suitable for swimming and wading because of low clarity or too much algae.²³

So where does all this algae-bloom-causing phosphorus come from? The simple answer is many sources: farm fields, feed lots, city streets, developed neighborhoods, and wastewater

²² Wisconsin Department of Natural Resources. Blue Green Algae. Contact and General Information. <https://dnr.wi.gov/lakes/bluegreenalgae/>

²³ Metropolitan Council, Metropolitan Council Environmental Services. (2018). *Water Quality of the St. Croix River in the Twin Cities Metropolitan Area 1976-2015*. <https://metrocouncil.org/Wastewater-Water/Publications-And-Resources/WATER-QUALITY-MONITOR-ASSESS/Water-Quality-of-the-St-Croix-River-Fact-Sheet.aspx>

treatment plants. Rain and snowmelt run over these surfaces and pick up natural and human-made pollutants, depositing them into the St. Croix.²⁴

There are many farms and farm fields across the St. Croix Basin that make an important contribution to our society, providing food and a way for many people to make a living. However, farming is also a major source of phosphorus to the St. Croix River. More than half the phosphorus that enters Lake St. Croix is estimated to come from agriculture. Improved farming methods that apply fertilizer according to crop needs and leave more cover on the soil have helped farmers reduce the amount of phosphorus leaving their lands and entering the water.²⁵

Farmers Help Protect the St. Croix

Farmers in Western Wisconsin are working to balance the farming business with cleaner area lakes and a healthier St. Croix River. Launched in 2014, local farms are working together in *farmer-led watershed councils* to find farming methods that support both farmers and cleaner water.



Figuring out how to keep vegetation on the fields during fall, winter, and spring is one of the key conservation practices farmer-led councils are developing. Growing crops that cover the soil (cover crops) keeps more water in the soil—and less running off the field. However, cover crops are difficult to establish in the region’s short growing season. They can delay planting and increase crop pests. It can also be difficult to find buyers for these uncommon crops. Local farmers are finding ways to get the benefits of cover crops and other conservation practices while avoiding the negative side effects on their crops and bottom line.

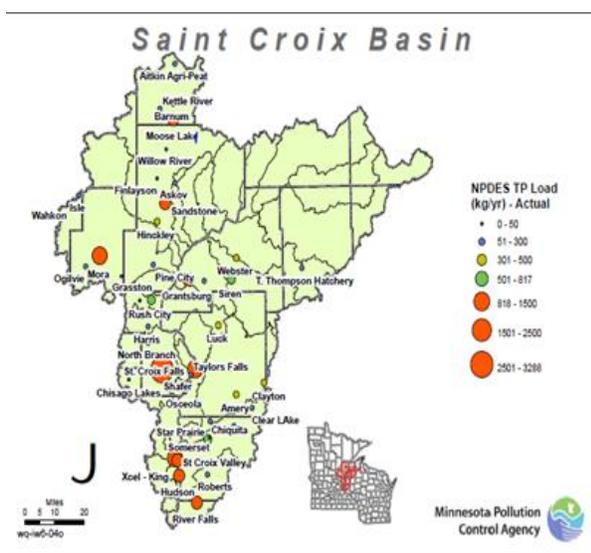
Farmer-led councils choose how much to pay their neighbors who participate in conservation practices, and host on-farm events to share knowledge and help their neighbors adopt conservation practices that are practical and effective. The councils are supported by private and public partners, including the state of Wisconsin, the McKnight Foundation, Polk County, Wisconsin, and the University of Wisconsin. The bottom line—

²⁴ Almendinger, J.E., D. Deb, M. X. Zhang, and R. Srinivasan. (2014). Constructing a SWAT Model of the St. Croix River Basin, Eastern Minnesota and Western Wisconsin.

²⁵ Limnotech. (2012). Implementation plan for the Lake St. Croix nutrient total maximum daily load.

farmers are in charge and are taking ownership of soil and water conservation seriously.

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Wastewater

Wastewater treatment plants receive dirty water from homes, businesses, and industry and treat the water to remove solids, nutrients, bacteria, and other contaminants. In the past, wastewater treatment plants were a big source of phosphorus to the St. Croix River. The St. Croix River receives water from fifty-two treatment plants, each with a permit limiting how many nutrients and other pollutants they can discharge.²⁷

Seventeen of these discharge in streams that drain to the St. Croix or directly to the St. Croix

River in the segment of the river between Grantsburg and Osceola, Wisconsin. While phosphorus levels have declined over the long-term²⁸, the river is still close to exceeding the Minnesota standards for levels of phosphorus in this area. Nearby streams flowing into the river most likely contribute higher amounts of phosphorus than found further upstream in the St. Croix.²⁹

The good news is that in recent years, these wastewater plants have become much better at removing phosphorus and other pollutants. These positive changes came from better treatment methods developed to meet tougher federal and state regulations for clean water. Wisconsin's wastewater treatment facilities in the St. Croix Basin have seen a 77% decrease in phosphorus discharge since 1993.³⁰

Chlorides

Chloride is one component of salt typically used to melt ice on roads, sidewalks, and parking areas, and used in in-home water softeners. It can also come from certain kinds of fertilizers. Excess levels of chloride in the environment can be toxic to aquatic life, as there are no natural processes that remove chlorides and they can stay in water bodies indefinitely.

²⁶Seitz, G. (2018). *Harvesting rain: Farmer group helps protect St. Croix River watershed, inspires additional action.* <https://www.stcroix360.com/2018/12/harvesting-rain-farmer-group-helps-protect-st-croix-river-watershed-inspires-additional-action/>

²⁷Balk, M. (2019). [St. Croix TMDL P Summary]. Unpublished raw data.

²⁸Minnesota Pollution Control Agency. Trends for Minnesota.

²⁹U.S. Environmental Protection Agency. (2016). *National Rivers and Streams Assessment 2008-2009 Report.* (EPA/841/R-16/008).

<http://www.epa.gov/national-aquatic-resource-surveys/nrsa>

³⁰Oldenburg, P. April 29, 2019. Personal interview.

While relatively low, measurements of chloride on the St. Croix River at Stillwater and Prescott increased slightly from 1976 to 2015. Winter road salt and home water softener increases chloride levels. While currently not a major concern, limiting use of salts whenever possible is a good choice for water quality.³¹

What can I do?

- Reduce runoff from your property with infiltration projects such as native plantings and rain gardens. Runoff carries nutrients, sediment, and salt to water bodies.
- Use phosphate-free soaps and detergents.
- Reduce or eliminate use of lawn fertilizers and other chemicals.
- Test your water to ensure a water softener is needed, and make sure your water softener works properly.
- Use non-salt forms of deicer on sidewalks and driveways.
- Check out state recommendations and tips for more ways to protect water quality:

<https://www.pca.state.mn.us/water/reduce-your-salt-use-home>



³¹ Metropolitan Council, Metropolitan Council Environmental Services. (2018). *Regional Assessment of River Water Quality in the Twin Cities Metropolitan Area 1976-2015*. <https://metro council.org/Wastewater-Water/Publications-And-Resources/WATER-QUALITY-MONITOR-ASSESS/Regional-Assessment-of-River-Quality.aspx>

Emerging Concerns and Threats

Due to its close proximity to a major metropolitan area, the river is a corridor surrounded by lands and waters that are used for a variety of purposes. These uses can have huge impacts on the health of the waters of the St. Croix River—often in ways we might not expect. Here are a few of the most pressing threats to the health of our river.

Microplastics

Microplastics are tiny plastic particles less than 0.2 inches on any side.³² In a 2015 study, particles were found in every single water, fish, mussel, and sediment sample in the St. Croix River.³³ Chemicals found in plastics can mimic the effects of hormones in animals and damage growth and development.³⁴

Most of the plastic found came from fabrics like fleece. For example, a single fleece jacket can release up to 250,000 fibers in its lifetime.³⁵ Plastic particles can also come from microbeads in cosmetics and soaps, synthetic clothing and fabrics, bags and wrappers, styrofoam containers, and other plastic products.

What can I do?

- Don't buy products that contain microbeads.
- Since microplastic fibers from fabrics like fleece are released into our water system when we wash clothes:
 - Buy and wear natural fiber clothing when possible.
 - Wash clothes, especially fleece, in cold water, use liquid laundry soap, wash less often, and wash full loads on gentle cycles to reduce the friction that causes fibers to be released.

Seitz, G. (2017). *Study: Plastic pollution prevalent in St. Croix and Namekagon Rivers*.
<http://www.stcroix360.com/2017/05/study-plastic-pollution-prevalent-in-st-croix-and-namekagon-rivers/>

Nitrates

Nitrogen is measured as nitrate, a nutrient used for growth and to support life. It is commonly used in agriculture. Excessive levels of nitrate can be caused by materials like fertilizers, animal

³² Minnesota Pollution Control Agency. (2014). *Plastic Microbeads in Minnesota*. Legislative Report.
<https://www.pca.state.mn.us/water/pollutants-emerging-concern>

³³ Baldwin, A.K., King, Kerensa, Mason, S.A., Hoellein, T.J., Kim, Lisa, and Karns, Byron. (2017). Data release for microplastics in water, sediment, fish, and mussels in the St. Croix National Scenic Riverway and Mississippi National River and Recreation Area, Wisconsin and Minnesota, 2015: U.S. Geological Survey data release, <https://doi.org/10.5066/F7HT2MJX>

³⁴ Minnesota Pollution Control Agency. (2014). *Plastic Microbeads in Minnesota*. Legislative Report.
<https://www.pca.state.mn.us/water/pollutants-emerging-concern>

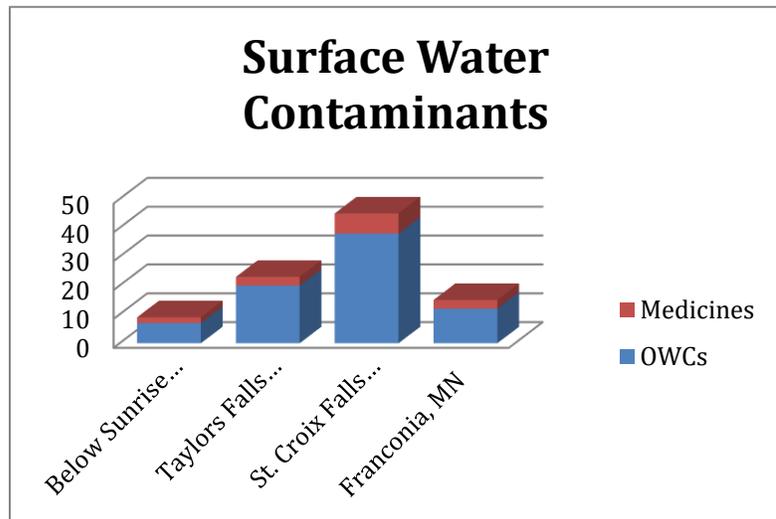
³⁵ Seitz, G. (2017). *Plastic Pollution Prevalent in St. Croix and Namekagon Rivers*. <https://www.stcroix360.com/2017/05/study-plastic-pollution-prevalent-in-st-croix-and-namekagon-rivers/>

manure, pet waste, or grass clippings. These excessive levels can in turn cause excessive algae growth, which harms aquatic wildlife, insects, and fish.

While nitrate levels are still low compared to other rivers in the metro area, they have been increasing. These changes can be caused by many factors, including alterations to the landscape, increased use of fertilizers, expansion of livestock production, and increased pollution from a growing population and industrial activities.³⁶

Chemicals and Contaminants

While we don't know exactly how these pollutants will affect human and animal health, they are cause for concern. Organic wastewater compounds, or OWCs, include plastic particles, antimicrobials, fragrances, and fire retardants. Wastewater from treatment plants in St. Croix Falls, Wisconsin and Taylors Falls, Minnesota was tested for organic contaminants including plastics, medicines



meant for people, and other chemicals. Many contaminants were detected in their outflows: 38 organic compounds and 3 medicines were found at St. Croix Falls, and 20 organic compounds and 3 medicines were found at Taylors Falls. Both wastewater treatment plants are located in the vicinity of concentrated mussel populations, including some that are on the endangered species list. Long-term exposures to human medicines and other contaminants are potentially threatening those mussel communities.³⁷ Although numbers were lower, similar pollutants were also found above the treatment plants where the Sunrise River flows into the St. Croix.³⁸

What can I do?

Never wash unused medicines down the drain!

- Take unused meds to a take-back program. Contact your local law enforcement agency to find a location near you. You can also call the Drug Enforcement Agency (DEA) at 1-800-882-9539 to find an authorized collector in your community.
- To dispose of on your own, mix the med with something inedible (like coffee grounds or cat litter), put in a sealed bag, and throw out in household trash.

U.S. Food & Drug Administration. (2019). Disposal of Unused Medicines: What You Should Know. <https://www.fda.gov/drugs/safe-disposal-medicines/disposal-unused-medicines-what-you-should-know>

³⁶ Metropolitan Council, Metropolitan Council Environmental Services. (2018). *Water Quality of the St. Croix River in the Twin Cities Metropolitan Area 1976-2015*. <https://metro council.org/Wastewater-Water/Publications-And-Resources/WATER-QUALITY-MONITOR-ASSESS/Water-Quality-of-the-St-Croix-River-Fact-Sheet.aspx>

³⁷ Canesi and others, 2007; Gagné and others, 2004; Gagné and others, 2007.

³⁸ Tomasek, A.A., Lee, K.E., and Hansen, D.S. (2012). *Wastewater indicator compounds in wastewater effluent, surface water, and bed sediment in the St. Croix National Scenic Riverway and implications for water resources and aquatic biota, Minnesota and Wisconsin, 2007-08*. U.S. Geological Survey Scientific Investigations Report 2011-5208.

PCBs and Mercury: Can I Eat the Fish?

Human-created chemicals in the St. Croix River are also of concern. The St. Croix River is included on the impaired waters lists for Minnesota and Wisconsin—developed under the Federal Clean Water Act—because of two chemicals present in fish tissue: polychlorinated biphenyls (PCBs) and mercury.³⁹ Both states recommend that people limit how much fish they eat because of these chemicals. It is safe to eat the fish within these guidelines.

About 90 percent of the mercury that contaminates Minnesota’s lakes and rivers is carried by the wind from other states and countries and falls in rain and snow. Most of the mercury in the air is from human activities such as burning coal to produce electricity and processing iron ore.⁴⁰ Exposure to mercury can damage the central nervous system, kidneys, and liver, and cause lasting problems with understanding and learning.⁴¹ Some people are more sensitive than others.

The manufacture of PCBs was banned in the U.S. in the late 1970s, but PCBs are still present in fish in the St. Croix River today.⁴² PCBs can cause acne-like skin conditions in adults and neurobehavioral and immunological changes in children. The chemicals also cause cancer in animals.⁴³



In general, you should eat less fish from the river if you are under 15 or pregnant (because of how developing babies are affected).⁴⁴ And, you should generally eat less fish when they are caught further downstream. These limits show how pollution can last a long time and come from far away. Consumption of Northern Pike and Walleye should generally be limited to 1 meal/week for the general population. Depending on the size of the fish, sensitive populations should eat only 1 meal/month of these fish.

³⁹ Wisconsin Department of Natural Resources. <https://dnr.wi.gov/water/impaired.search.aspx>

⁴⁰ Minnesota Pollution Control Agency. <https://www.pca.state.mn.us/sites/default/files/p-p2s4-06.pdf>

⁴¹ Minnesota Department of Health. <https://www.health.state.mn.us/communities/environment/hazardous/topics/mercury.html#health>

⁴² Minnesota Department of Health. <https://www.health.state.mn.us/communities/environment/fish/consortium/pcbprotocol.html>

⁴³ U.S. Department of Health and Human Services, U.S. Environmental Protection Agency. Public health implications of exposure to polychlorinated biphenyls (PCBs). <https://www.atsdr.cdc.gov/phs/phs.asp?id=140&tid=26>

⁴⁴ Minnesota Department of Health. <https://www.health.state.mn.us/communities/environment/fish/eating/sitespecific.html>

Table 1. Can I Eat the Fish from the River?⁴⁵ *

Fish Consumption Guidelines from the Minnesota Department of Health (June 2018)

| | Above Stillwater, MN | | Stillwater, MN to Prescott, WI | | |
|-------------------------|------------------------|--------------------|--------------------------------|--------------------|---------------|
| | *Sensitive Populations | General Population | *Sensitive Populations | General Population | Contaminants |
| Bluegill Crappie | 1 meal/week | unrestricted | 1 meal/week | unrestricted | Mercury |
| Carp | 1 meal/week | 1 meal/week | 1 meal/month | 1 meal/month | Mercury, PCBs |

*Sensitive Population: Children under 15 and women who are or may become pregnant.

Changing the Landscape

Changes in land use, especially removal of permanent land cover such as grass and trees, can increase pollution runoff. A shift away from small, diversified farms with relatively small fields that include crops, hay, and pasture land with dairy or other livestock in the fields to confined animal production can have devastating effects on air, land, and water quality.



A new threat to the St. Croix watershed is large animal production facilities. A proposed sow farrowing facility was proposed for the town of Trade Lake, Wisconsin, at a site located near a tributary flowing into the Trade River. As a tributary of the St. Croix, Trade River’s proximity to the proposed concentrated animal feeding operation (CAFO) was a grave concern.⁴⁶ On average, a typical sow produces 11-25lbs of manure each day.⁴⁷ With thousands of hogs proposed for the site, manure would quickly add up in a concentrated area draining into the St. Croix. Potential impacts of concern for CAFOs near the river also include changes in the levels of nitrogen and phosphorus in the water, land use, water usage and quantity, antibiotic seepage, and an overall negative impact on biodiversity, harmful air emissions, and quality of life for everyone living in the community and surrounding Riverway.⁴⁸

⁴⁵ Minnesota Department of Health. <https://www.health.state.mn.us/communities/environment/fish/eating/sitespecific.html>

⁴⁶ KnowCAFOs. <https://knowcafos.org/>

⁴⁷ Natural Resources Conservation Service, U.S. Department of Agriculture. (2008). Agricultural Waste Management Field Handbook. <https://www.wcc.nrcs.usda.gov/ftpref/wntsc/AWM/handbook/ch4.pdf>

⁴⁸ Natural Resources Conservation Service, U.S. Department of Agriculture. https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/nra/?&cid=nrcs143_014211

Climate Change

Climate change is a serious concern for the states of Wisconsin and Minnesota.⁴⁹⁵⁰ A changing climate will have impacts on the entire watershed of the St. Croix River. Increases in mean annual temperature, precipitation, extreme heat events, and storm frequency and intensity are projected for the region around the river. Warming water temperatures may cause harmful changes to aquatic life.⁵¹ Native animals and plants may become more stressed, increasing the potential for invasive species to take hold. Increased heavy rains may cause flooding, triggering streambank erosion and an increase in the runoff of pollutants. Preparations have begun to integrate climate change impacts and adaptation strategies into the processes of planning and programming stewardship and management for the future of the river.⁵²



Heavy rainfalls lead to an increase in erosion.
The soil washed downstream contains phosphorus, which leads to algae blooms.

⁴⁹ Wisconsin Initiative on Climate Change Impacts. <https://www.wicci.wisc.edu/climate-change.php>

⁵⁰ Minnesota Department of Natural Resources. Climate Change and Minnesota: What DNR is doing. https://www.dnr.state.mn.us/climate/climate_change_info/what-dnr-doing.html

⁵¹ Minnesota Pollution Control Agency. <https://www.pca.state.mn.us/air/effects-climate-change-minnesota>

⁵² National Park Service, U.S. Dept of the Interior. (2019). Foundation Document. St. Croix National Scenic Riverway. <https://www.nps.gov/sacn/learn/management/foundation-document.htm>

The Future of the River

As the St. Croix and Mississippi Rivers meet at the confluence at Prescott, Wisconsin, the water from the St. Croix helps to reduce the concentration of the pollutants in the Mississippi.⁵³ But the St. Croix is not immune to threats, and continual efforts to protect and restore the river will be essential in years to come—just as they have been in years past.

Scientists are gaining a better understanding of how this river and its lake function and the factors which drive algae growth.⁵⁴ The slow, long-term decline of phosphorus is hopeful, but more work is needed to understand and reduce algae in Lake St. Croix. Finding new ways to conserve and reduce phosphorus is a key piece in the process to the long-term health of the St. Croix River.

Over a decade after Lake St. Croix's impairment designation in 2008, the Minnesota Pollution Control Agency (MPCA) proposed adding a segment of the St. Croix River from Taylors Falls to Lake St. Croix to their impaired waterbody list in 2019. The proposal for this segment was due to excess nutrients, specifically phosphorus and increased levels of algae (expressed as the amount of chlorophyll a) in response to this excess phosphorus.

It's important to note that excess phosphorus leading to an overabundance of algae can harm aquatic life; therefore, this impairment proposal is for an "aquatic life" impairment and not for human activity. People can still safely use the river for recreation.

But this is a powerful example and reminder that **the river is vulnerable, and will always be vulnerable**. Continual work and public action will be necessary to preserve and protect the St. Croix River for generations to come.⁵⁵



⁵³ Metropolitan Council, Metropolitan Council Environmental Services. (2018). *Water Quality of the St. Croix River in the Twin Cities Metropolitan Area 1976-2015*. [https://metrocouncil.org/Wastewater-Water/Services/Water-Quality-Management/River-Monitoring-Analysis/Regional-Assessment-of-River-Quality-\(2\).aspx](https://metrocouncil.org/Wastewater-Water/Services/Water-Quality-Management/River-Monitoring-Analysis/Regional-Assessment-of-River-Quality-(2).aspx)

⁵⁴ Magdalene, Suzanne, et al. 2018. Report on the State of the Lake Assessing Lake St. Croix in 2018 On the Way to the 2020 TMDL Goals. Science Museum of Minnesota. www.smm.org/sites/default/files/public/attachments/2018_magdalene_report.pdf

⁵⁵ St. Croix River Association. <https://www.stcroixriverassociation.org/2020-proposed-stcroix-impairment/>

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Created in collaboration with:



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FOUNDATION**



For additional, important information about the health of the St. Croix, visit the Minnesota Pollution Control Agency's new report, *The St. Croix River: Study of the River's Health* by clicking [here](#).

References

Almendinger, J.E., D. Deb, M. X. Zhang, and R. Srinivasan. (2014). Constructing a SWAT Model of the St. Croix River Basin, Eastern Minnesota and Western Wisconsin.

Baldwin, A.K., King, Kerensa, Mason, S.A., Hoellein, T.J., Kim, Lisa, and Karns, Byron, 2017, Data release for microplastics in water, sediment, fish, and mussels in the St. Croix National Scenic Riverway and Mississippi National River and Recreation Area, Wisconsin and Minnesota, 2015: U.S. Geological Survey data release, <https://doi.org/10.5066/F7HT2MJX>

Balk, M. (2019). [St. Croix TMDL P Summary]. Unpublished raw data.

Canesi and others, 2007; Gagné and others, 2004; Gagné and others, 2007.

Hornbach, D. J. (2001). "Macrohabitat Factors Influencing the Distribution of Naiads in the St. Croix River, Minnesota and Wisconsin, USA." *Ecology and Evolution of the Freshwater Mussels Unionoida Ecological Studies*, pp. 213–230., doi:10.1007/978-3-642-56869-5_12

Jenning, D. P. (1988). *Bighead carp (Hypophthalmichthys nobilis): a biological synopsis*. U.S. Fish and Wildlife Service, Biology Report 88:1-35.

Kampa, J., G. Hatzenbeler and M. Jennings. (2014). "Status and management of lake sturgeon (*Acipenser fulvescens* Rafinesque, 1817) in the Upper St. Croix River and Namekagon River," *Journal of Applied Ichthyology*. 30:1387-1392.

Karns, B., personal communication, March 20, 2019.

KnowCAFOs. <https://knowcafos.org/>

Limnotech. (2012). Implementation plan for the Lake St. Croix nutrient total maximum daily load.

Magdalene, Suzanne, et al. (2018). *Report on the State of the Lake Assessing Lake St. Croix in 2018 On the Way to the 2020 TMDL Goals*. Science Museum of Minnesota.
www.smm.org/sites/default/files/public/attachments/2018_magdalene_report.pdf

McMahon, E.M. and J. Karamanski, T.J. (2002). *Time and the River: A History of the St. Croix, A Historical Resource Study of the Saint Croix National Scenic Riverway*. National Park Service, U.S. Dept of Interior.
<http://npshistory.com/publications/sacn/hrs/>

Metropolitan Council, Metropolitan Council Environmental Services. (2018). *Regional Assessment of River Water Quality in the Twin Cities Metropolitan Area 1976-2015*.
<https://metro council.org/Wastewater-Water/Publications-And-Resources/WATER-QUALITY-MONITOR-ASSESS/Regional-Assessment-of-River-Quality.aspx>

Metropolitan Council, Metropolitan Council Environmental Services. (2018). *Water Quality of the St. Croix River in the Twin Cities Metropolitan Area 1976-2015*. <https://metro council.org/Wastewater-Water/Publications-And-Resources/WATER-QUALITY-MONITOR-ASSESS/Water-Quality-of-the-St-Croix-River-Fact-Sheet.aspx>

Minnesota Department of Health.
<https://www.health.state.mn.us/communities/environment/fish/consortium/pcbprotocol.html>

Minnesota Department of Health.
<https://www.health.state.mn.us/communities/environment/fish/eating/sitespecific.html>

Minnesota Department of Health.
<https://www.health.state.mn.us/communities/environment/hazardous/topics/mercury.html#health>

Minnesota Department of Natural Resources. Clean In Clean Out.
https://www.dnr.state.mn.us/invasives/preventspread_watercraft.html

Minnesota Department of Natural Resources. Climate Change and Minnesota: What DNR is doing.
https://www.dnr.state.mn.us/climate/climate_change_info/what-dnr-doing.html

Minnesota Department of Natural Resources Division of Fish and Wildlife Section of Fisheries. (2019). *Invasive carp sampling report January-December 2018*.

Minnesota Department of Natural Resources. Lower St. Croix National Scenic Riverway Program.

Minnesota History Center. Gale Family Library. (2019). Overview- St. Croix River Valley.
<https://libguides.mnhs.org/stcroix>

Minnesota Pollution Control Agency. <https://www.pca.state.mn.us/sites/default/files/p-p2s4-06.pdf>

Minnesota Pollution Control Agency. <https://www.pca.state.mn.us/air/effects-climate-change-minnesota>

Minnesota Pollution Control Agency. (2014). *Plastic Microbeads in Minnesota*. Legislative Report.
<https://www.pca.state.mn.us/water/pollutants-emerging-concern>

Minnesota Pollution Control Agency. Trends for Minnesota.

National Park Service, U.S. Dept of the Interior. (2019). *Foundation Document*. St. Croix National Scenic Riverway. <https://www.nps.gov/sacn/learn/management/foundation-document.htm>

National Park Service. (2019). History & Culture-Saint Croix National Scenic Riverway.

<https://www.nps.gov/sacn/learn/historyculture/index.htm>

Natural Resources Conservation Service, U.S. Department of Agriculture. (2008). Agricultural Waste Management Field Handbook. <https://www.wcc.nrcs.usda.gov/ftpref/wntsc/AWM/handbook/ch4.pdf>

Natural Resources Conservation Service, U.S. Department of Agriculture.

https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/nra/?&cid=nrcs143_014211

National Wild and Scenic Rivers System. <https://www.rivers.gov/rivers/st-croix.php>

Oldenburg, P. April 29, 2019. Personal interview.

Parton, H. F. (2016). "Profile: Scott Peterson vs. the yellow iris."

<https://www.stcroix360.com/2016/11/profile-scott-peterson-vs-the-yellow-iris/>

Payne, G.A., Lee, K.E., Montz, G.R, Tammage, J.K. and Larson, J.D. (2000). Water-Quality and Aquatic-Community Characteristics of Selected Reaches of the St. Croix River, Minnesota and Wisconsin.

"Purple Loosestrife: What You Should Know, What You Can Do." *Aquatic Invasive Species | Minnesota Sea Grant*, Feb. 2017, www.seagrant.umn.edu/ais/purpleloosestrifeinfo

Seitz, G. (2019). *Famous fish: St. Croix sturgeon crowned as new champion, receives national attention.*

<https://www.stcroix360.com/2019/03/famous-fish-st-croix-sturgeon-crowned-as-new-champion-receives-national-attention/>

Seitz, G. (2018). *Harvesting rain: Farmer group helps protect St. Croix River watershed, inspires additional action.* <https://www.stcroix360.com/2018/12/harvesting-rain-farmer-group-helps-protect-st-croix-river-watershed-inspires-additional-action/>

Seitz, G. (2017). *Plastic Pollution Prevalent in St. Croix and Namekagon Rivers.*

<https://www.stcroix360.com/2017/05/study-plastic-pollution-prevalent-in-st-croix-and-namekagon-rivers/>

St. Croix River Association. <https://www.stcroixriverassociation.org/2020-proposed-stcroix-impairment/>

Thorson, D. (2014). *Last log through the boom: the end of the St. Croix's timber industry.*

<https://www.stcroix360.com/2014/06/last-log-through-the-boom/>

Tomasek, A.A., Lee, K.E., and Hansen, D.S. (2012). *Wastewater indicator compounds in wastewater effluent, surface water, and bed sediment in the St. Croix National Scenic Riverway and implications for water resources and aquatic biota, Minnesota and Wisconsin, 2007–08*: U.S. Geological Survey Scientific Investigations Report 2011–5208.

U.S. Department of Health and Human Services, U.S. Environmental Protection Agency. Public health implications of exposure to polychlorinated biphenyls (PCBs).

<https://www.atsdr.cdc.gov/phs/phs.asp?id=140&tid=26>

U.S. Environmental Protection Agency. (2016). *National Rivers and Streams Assessment 2008-2009 Report*. (EPA/841/R-16/008). <http://www.epa.gov/national-aquatic-resource-surveys/nrsa>

U.S. Food & Drug Administration. (2019). Disposal of Unused Medicines: What You Should Know.

<https://www.fda.gov/drugs/safe-disposal-medicines/disposal-unused-medicines-what-you-should-know>

U.S. Public Health Service, The Agency for Toxic Substances and Disease Registry.

Vennum, T. (1988). *Wild Rice and the Ojibway People*. Minnesota Historical Society Press.

Wisconsin Department of Natural Resources. <https://dnr.wi.gov/water/impaired.search.aspx>

Wisconsin Department of Natural Resources. Blue Green Algae. Contact and General Information. <https://dnr.wi.gov/lakes/bluegreenalgae/>

Wisconsin Department of Natural Resources. "Protect your boat and engine from zebra mussels." <https://dnr.wi.gov/topic/invasives/fact/pdfs/ProtectYourBoat.pdf>

Wisconsin Initiative on Climate Change Impacts. <https://www.wicci.wisc.edu/climate-change.php>

Wisconsin and Minnesota Department of Natural Resources. (2012). *A Population assessment of lake sturgeon in upper St. Croix River, Minnesota and Wisconsin 2003-2011*. (Report number MWIBC:2601400).

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