University of Delaware

SCREENS Initiative

St. **C**roix **R**iver **E**cosystem **E**nhancement & **N**atural **S**ustainability Initiative

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UAPP 411

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Mission Statement

SCREENS proposes scientific solutions and promotes community initiatives to improve the waters and ecosystems of the St. Croix River basin, ensuring and sustaining the health of the waterways, environment, people, and economy. These solutions and initiatives will be effective as of January 2027, improving river conditions by 2040.

Background

Geography

The St. Croix River is one of the last undisturbed, large floodplain rivers in the upper Mississippi River System, forming much of the border between Wisconsin and Minnesota. Around 56% of the river can be found in Wisconsin, while the other 44% can be found in Minnesota. The river extends approximately 165 miles from its headwaters in northwestern Wisconsin near Solon Springs to its meeting with the Mississippi River near Prescott, Wisconsin. The total drainage area is approximately 7,760 square miles, making it a significant regional watershed in the Upper Midwest. The basin exhibits a clear north-to-south spatial gradient in both physical and land-use characteristics. Headwater regions are dominated by forest and wetlands, while downstream areas transition to mixed agricultural and developed land. StreamStats data from representative points along the river illustrate how watershed characteristics evolve with increasing drainage area. Near the upper basin (drainage area ≈ 138 mi^2), land cover is primarily forested (≈58.6%) with notable wetland presence (≈6.1%) and negligible agricultural influence (<1%). At a mid-basin location near St. Croix Falls (≈6,230 mi^2 drainage area), forest cover decreases to about 47.4% while agriculture increases to 18%. Near the lower river (≈7,714 mi^2 drainage area), agriculture becomes more dominant (≈24.4%) and forest cover declines further (≈43.8%). For the St. Croix Basin as a whole, forests cover around 56.2% of the land, while grasslands and agricultural land cover around 33.3%, and wetlands, urban areas, and shrubland make up the final 10.1%.

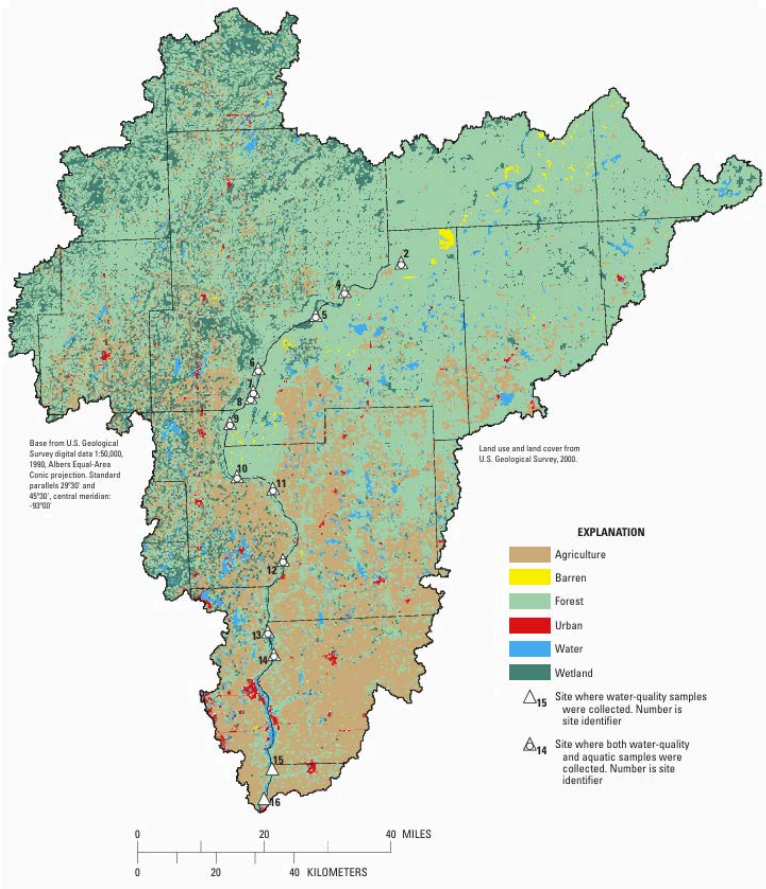

Figure 1. Generalized land use and land cover in the St.Croix River Basin

(source: U.S. Geological Survey, 2002, p. 4)

Physical characteristics of the river also change significantly downstream. Channel slope, estimated using the StreamStats 10–85% method, decreases from approximately 10.03 ft/mi in the upper basin to about 2.2–2.3 ft/mi in the middle and lower reaches, with the overall average gradient of the river being 2.6 ft/mi. This reflects a transition from a moderate-gradient headwater system to a low-gradient alluvial river. As slope decreases, the river shifts toward more pronounced meandering behavior, reduced flow velocity, and increased sediment deposition. Upper reaches tend to exhibit more riffle-pool sequences and higher energy conditions, while downstream sections are wider, slower, and more depositional in nature.

Importance/History

The St. Croix River is widely recognized for its ecological importance and diverse range of aquatic and terrestrial habitats within the Upper Midwest, including forested uplands, wetlands, coldwater tributaries, and warm mainstem river environments. This diversity contributes to a rich biological community, including over 100 fish species, freshwater mussels (some endangered), and a variety of bird and mammal species such as bald eagles and river otters. However, this biodiversity is increasingly threatened by invasive species, including zebra mussels and invasive aquatic plant species, which can alter habitat structure and ecosystem function. The relatively intact forest and wetland systems in the upper basin play a critical role in maintaining water quality by promoting infiltration, reducing runoff, and filtering pollutants.

In addition to its ecological value, the river is an essential regional water resource, supplying drinking water to millions of people in the Twin Cities metropolitan area and surrounding communities through interconnected surface water and groundwater systems. Maintaining water quality is therefore critical not only for ecosystem health but also for human use. While the river remains relatively clean compared to many systems in the region, it faces growing water quality challenges, particularly from nutrient inputs such as phosphorus and chloride contamination associated with road salts and urban runoff. These pollutants can contribute to issues such as eutrophication and long-term degradation of aquatic ecosystems.

Recreational use is a major component of the river's value. The St. Croix is a popular destination for canoeing, kayaking, fishing, and camping, all which attract visitors from across the region. Its scenic character and relatively undeveloped shoreline, particularly in the upper and middle

reaches, make it one of the premier recreational rivers in the Upper Midwest. Tourism associated with these activities contributes significantly to local economies, especially in smaller river communities. Additionally, the river has also played an important historical role economically.

During the 19th century, it was a major corridor for logging, with large volumes of timber transported downstream. Today, while industrial uses have declined, agriculture in the southern portion of the watershed represents a major land use and economic driver. Although urban land use remains relatively low across the basin, even small increases in impervious surface area can influence runoff dynamics and contribute to localized water quality impacts.

Policy/ Governance

The St. Croix River is notable for its long history of coordinated watershed management and protection, making it a model system for river conservation in the United States. A major milestone occurred in 1968 when the river was designated as one of the original 8 rivers apart of the National Wild and Scenic Rivers System, where it received federal protection aimed at preserving its free-flowing condition, water quality, and scenic character. Subsequent management efforts have emphasized cooperative governance among federal, state, and local entities. The lower portion of the river is managed through a partnership involving the National Park Service, the Minnesota Department of Natural Resources, and the Wisconsin Department of Natural Resources, along with local governments. This approach has led to the implementation of shoreline zoning regulations, development restrictions, and land-use planning strategies designed to preserve the river's scenic and ecological integrity while allowing for limited, controlled development.

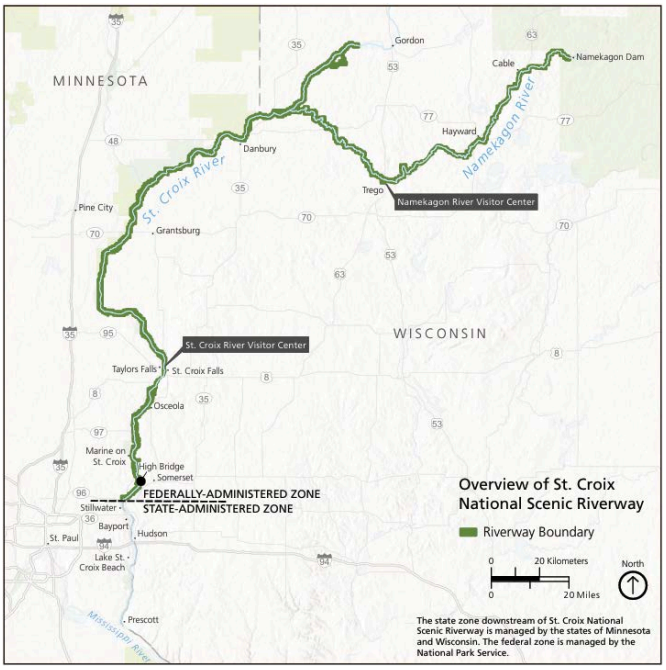

Figure 2. Overview of the St. Croix National Scenic Riverway

(Source: St. Croix and Namekagon Rivers Comprehensive River Management Plan, 2026, p. 3)

More recent watershed management efforts have focused on water quality improvement and nonpoint source pollution control. Agencies such as the Minnesota Pollution Control Agency and the Wisconsin DNR have implemented best management practices (BMPs) targeting agricultural runoff, including nutrient management and erosion control. In addition, conservation organizations have worked to acquire and protect key parcels of land, particularly along riparian corridors, to prevent development and maintain natural buffers.

Current and future management efforts are increasingly focused on addressing emerging challenges, including agricultural intensification and nutrient loading, urban expansion near the Twin Cities metropolitan area, and climate variability and its impact on hydrology. Many of these efforts are being led by Wisconsin Farmer–Led Councils to improve water quality, reducing phosphorus and sediment loading, and increasing producer knowledge. A

comprehensive river management plan led by the National Park Service is currently being developed to guide long-term decision-making. This plan emphasizes stakeholder engagement, adaptive management, and the integration of ecological, recreational, and economic objectives.

Problems

This watershed management plan proposes addressing three primary issues that the St. Croix River basin faces: water quality, invasive species, and changing landscapes. These issues all jeopardize the health and longevity of the river basin.

Problem	Description	Causes
P1: Water Quality	Excess amounts of phosphorus are causing eutrophication, forming green and blue-green algae growth in the river. High levels of chloride which can stay in water bodies indefinitely due to lack of natural removal processes.	Sources of phosphorus include farm fields, feed lots, erosion of soil, and wastewater treatment plants. Chloride commonly comes from runoff of roads, sidewalks, and parking areas during the winter, and fertilizers from agriculture.
P2: Invasive Species	Invasive plant species such as the Yellow Iris and the Purple Loosestrife are taking over habitats. Zebra Mussels are colonizing the river's bottom, depleting oxygen in the water.	Transportation from native locations to the St. Croix River by boats, other vehicles, and natural means such as wind, water, or animals.
P3: Changing Landscapes	Deforestation and the removal of other land cover causes more runoff to fall into the river. The area around the river is changing from farms with small crop fields and pasture land for dairy or other livestock to confined animal production, which is not a sustainable agricultural method.	The landscape of the St. Croix River is changing due to the removal of permanent land cover such as grass and trees, and an agricultural shift from small, diversified farms to confined animal production.

P1: Water Quality

The most pressing water quality hazard jeopardizing the health of the St. Croix River is phosphorus. Phosphorus is an essential part of matter as it is found in volcanic and sedimentary rocks, and used by plants during the biosynthesis process. Despite this, the element is not commonly found in nature and can pose ecological threats when it enters bodies of water. The main threat is eutrophication, the excessive richness of nutrients in a body of water, which the St. Croix River is facing. Eutrophication in the St. Croix River is causing algae, specifically green and blue-green algae, to grow and spread on its surface. This creates dangers as these algae species make the water less clear for recreational use and can produce toxins that are harmful to humans and pets. Due to this, the Minnesota Department of Natural Resources rates Lake St. Croix as not always suitable for swimming. Beyond these impacts, eutrophication also causes oxygen depletion in the river's waters. When algae die, their decomposition is performed by bacteria that consume oxygen from the water. This depletes oxygen from natural organisms that need it resulting in the death of many fish and other species, completely throwing off the balance of the river's ecosystem. Phosphorus enters the St. Croix River in the first place through local agriculture and wastewater treatment plants. The river receives water from fifty-two treatment plants. There are limitations on nutrients in outflow water, as shown in *Figure 3*, but the river is still close to exceeding the Minnesota standards for levels of phosphorus.

Another water quality issue the St. Croix River faces is high levels of chloride. This is dangerous as chloride can stay in water bodies indefinitely due to lack of natural removal processes. Chloride is extremely toxic to aquatic life and can cause effects such as reduced reproduction rates, reduced growth rate, and death. These impacts are caused by chloride's interference with

osmoregulation, the process of an organism maintaining proper concentration of salt and solutes in their bodily fluids. All of these impacts have the potential to throw the river's ecosystem off balance. Moreover, chloride has an even greater impact on the St. Croix River since it contains freshwater. Chloride specifically is harmful to species of planktons which are a food source for many fish and help to control algae growth, decreasing eutrophication. Without plankton, the river will further struggle from oxygen depletion. Chloride is used to melt ice on roads, sidewalks, and parking areas. Additionally, it is used in many fertilizers for agriculture. Due to this, it is very easy for chloride to runoff into the river. There has been an increase in chloride levels from 1976 to 2015 in the St. Croix River and in 2022, 35 water bodies in just southeastern Wisconsin were found not meeting the chloride toxicity standards under Section 303(d) of the Federal Clean Water Act. It is important for this issue not to worsen for the St. Croix River.

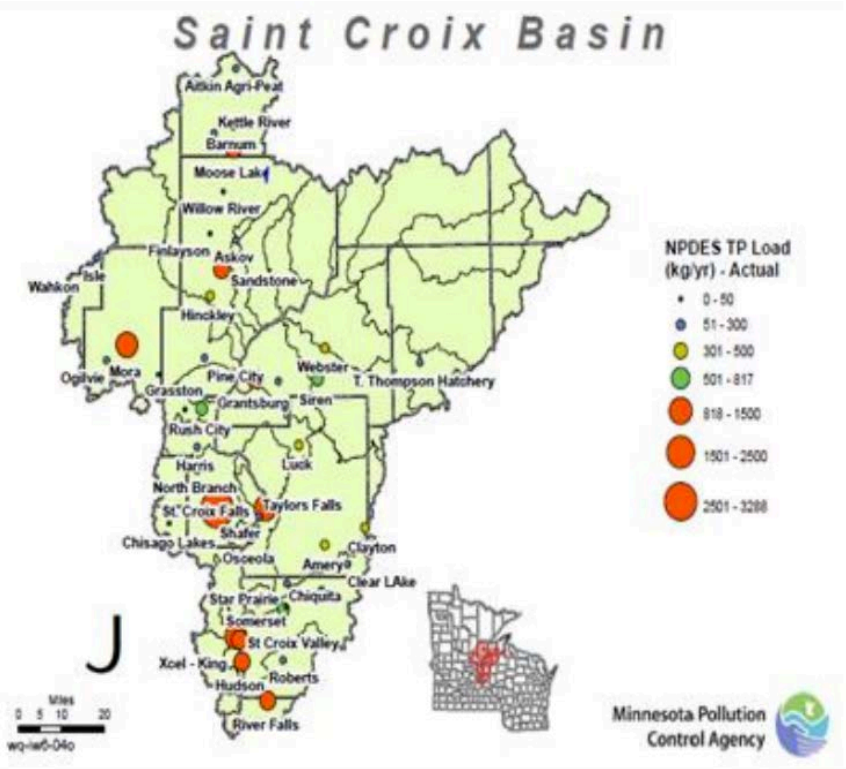

Figure 3. St. Croix Basin Wastewater Treatment Plant TP Loads

P2: Invasive Species

There are many invasive species in the St. Croix Watersheds that are harmful to ecosystems. Some of these include invasive plant species such as the Yellow Iris and the Purple Loosestrife. The Yellow Iris has been spreading along the river, overtaking natural species such as the blue flag iris. It is a poisonous plant that is not eaten by other wildlife and causes skin irritations for humans. Similarly, the Purple Loosestrife has been quickly invading wetlands, extremely important ecosystems to protect. They have outcompeted wild rice and other valuable plants. Additionally, they have reduced healthy homes for birds and other animals. The seeds of the Purple Loosestrife have also been found as the source of seeds entering the St. Croix River. Both these invasive species are harmful to native plants and animals in the watershed.

Moreover, there are also invasive species colonizing the river waters such as Zebra Mussels. Zebra Mussels attach themselves to native mussels preventing them from eating, breathing, and reproducing. They occupy river bottoms so no other species can inhabit them and take food away from other animals. Additionally, as Zebra Mussel populations grow they consume more organic matter, leading to increased decomposition which depletes oxygen levels in the water. They can also cause damage to boats, docks, and beaches. These invasive mussels were first found on boats in the Lower St. Croix in 1994. Once Zebra Mussels are introduced to a body of water there is no way to regulate their population growth and they can easily spread through river currents and human boats, posing a huge threat to native species.

Figure 4. Image of Zebra Mussels to the left followed by Yellow Irises and Purple Loosestrife

P3: Changing Landscapes

The landscape around the St. Croix River is vital to the health of the watershed as a whole. This is changing greatly as land cover such as trees and other vegetation are being removed. The St. Croix National Scenic Riverway uses a satellite-based change detection program called LandTrend to image the land use of the St. Croix River. As shown in *Figure 5*, the primary land cover of the watershed consists of forests, hay/pasture, and cultivated crops with some urban development. When looking at the change in this landscape from 1990 to 2020, results showed forest harvest and development were the main causes of land disturbance and change, which is shown in *Figure 6*. Development of urban areas was seen around the Minneapolis area in the southern half of the sub-watersheds. On the other hand, forest harvest was greatly seen in the more northern sub-watersheds. Both these landscape disturbances contribute to the removal of trees whether for urbanization or collection of resources. This in turn decreases land cover and vegetation, enabling more runoff into the St. Croix River and furthering water quality issues. Additionally, the change in the landscape of the watershed itself has the potential to impact ecosystems as erosion and impermeable cover can increase.

In addition to removal of landcover, agricultural practices in the St. Croix watershed have shifted, changing the landscape with it. Historically, agriculture around the river consisted of small, diversified farms with fields consisting of some crops, hay, and pasture land. These types of farms were more sustainable for the watershed as diversified crops build healthier soils that hold water better, reducing runoff into the river. Now, there has been a shift to confined animal production, an industrial farming method in which large numbers of livestock are kept on a small area of land. This is not only unethical for the animals, but can have devastating impacts on the watershed. Manure from these animals is concentrated among a small area and if the waste is not managed properly it can runoff into the St. Croix River causing more eutrophication and can contaminate groundwater supplies. Additionally, large amounts of ammonia and other gases released from animal waste will be emitted into the air and can settle back into the land, further impacting ecosystems.

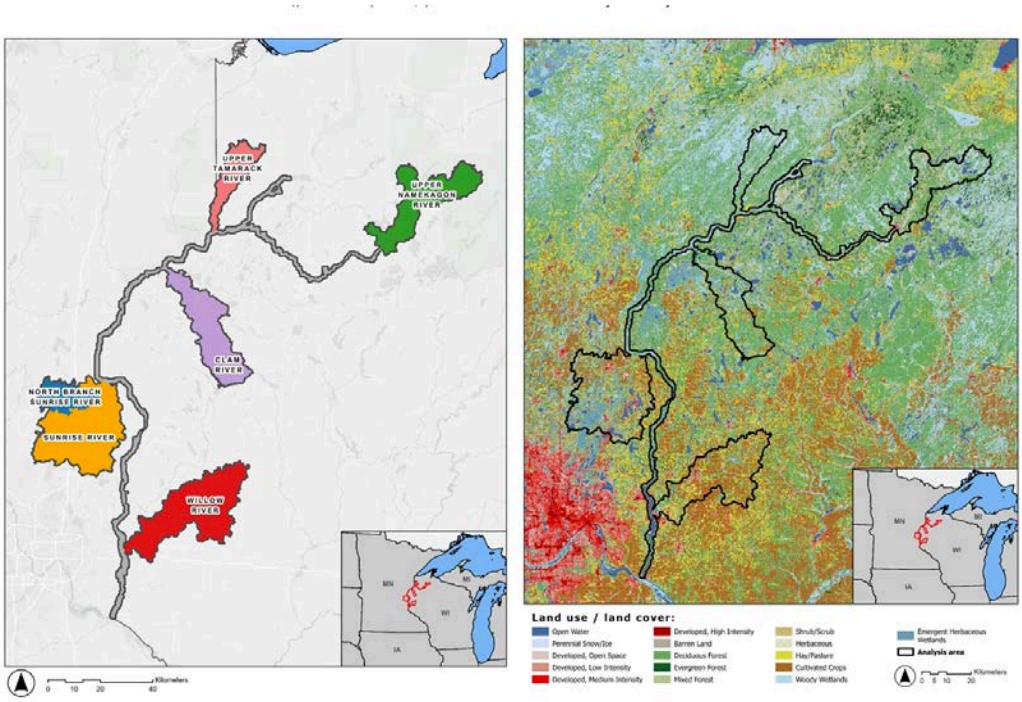

Figure 5. Map of the St. Croix River and six sub-watersheds comprising 857,591 acres (right) and land cover and land use classes mapped by the National Land Cover Database (left).

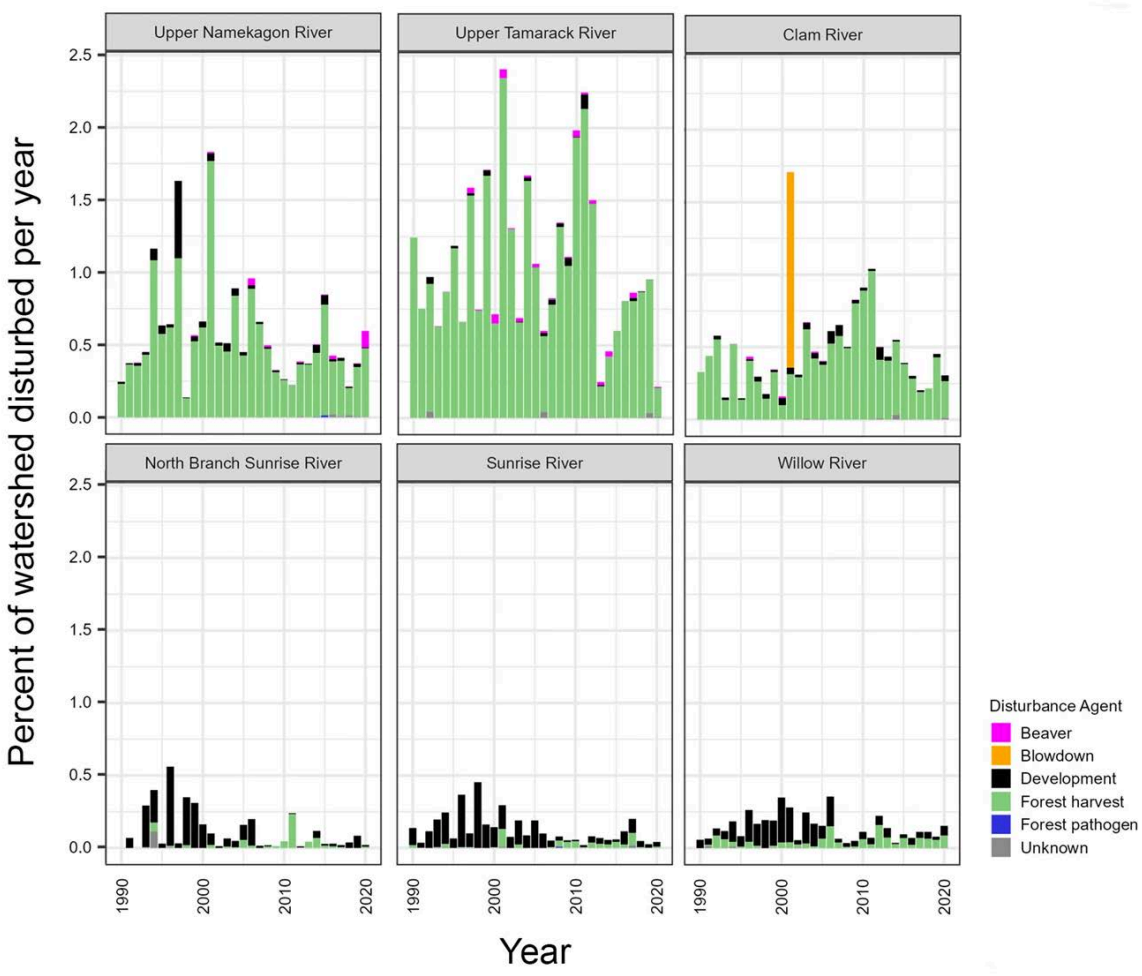

Figure 6. Percent of land disturbed and cause of disturbance in each sub-watershed from 1990–2020.

Solutions and Goals

G1: Water quality

The primary goal to address water quality issues in the St. Croix River is to significantly reduce phosphorus and chloride levels to prevent eutrophication, protect aquatic ecosystems, and ensure the river is safe for recreation and wildlife. Our goal is to reduce phosphorus and chloride levels by 20-30% by 2036. Achieving this goal will require a collaborative effort and sustainable practices in agriculture, urban development, and wastewater management.

One key solution to mitigating this problem is to implement optimized fertilization techniques. Being a main component of fertilizer, phosphorus has a large negative impact on water quality. Farmers can adopt practices that reduce phosphorus runoff including planting buffer strips along waterways, reducing fertilizer use, and implementing cover crops to prevent soil erosion. These strategies help stop excess nutrients from entering the river by absorbing them. In addition, if more implementation needs to take place then wastewater treatment plants can upgrade to more advanced phosphorus removal technologies but for a likely higher expense. Progress in this area will be monitored by measuring phosphorus concentrations in runoff and river water.

To address chloride pollution, the main solution would be to reduce the amount of road salt communities use during the winter months. By changing to alternative materials, using road salt more efficiently, and pre-treating roads there will be less harm to aquatic species. To measure the progress of limiting chloride use, concentration of chloride will be measured in rivers and nearby streams as well as tracking salt usage by zip codes. By assessing salt usage by municipalities, government officials can limit the amount of salt distributed to areas to limit excess.

By combining agricultural improvements, reduced chemical use, and community involvement, these solutions address the most alarming threats to water quality in the St. Croix River. Having a definite plan implemented for this watershed is the first step towards success in the health of the watershed.

G2: Invasive species

Our goal is to prevent the introduction and spread of invasive species in the St. Croix River while also reducing the current population of invasive species by 20% by 2030 and reducing invasive plant coverage by 30% by 2030. The actions we will be taking will help to protect the native ecosystem by having clear visions, goals, and action items.

Our first mitigation strategy to stop the spread of invasive species like Zebra Mussels and Asian Carp is to reduce human-related transmissions. Education campaigns will require boaters and recreational users to clean, drain, and dry boats and equipment before entering / leaving the river to limit contamination. Installing cleaning stations at boat launches will give users the opportunity to give back to the river by contributing to the reduction of invasive species. Progress of this movement will be monitored through regulations requiring inspections at these boat launches as well as reductions in new invasive species detections. This strategy will benefit the river by raising public awareness of this problem through participation in protecting the health of the watershed.

Another tangible solution is to control and manage the existing invasive plant species. This strategy will be implemented through a combination of mechanical removal (like cutting /

hand-pulling), biological control (introducing natural predators like beetles for purple loosestrife), and limiting herbicide (chemical pesticide used to stop growth by killing unwanted plants) use where necessary. To promote restoration, new native species will be replanted to stabilize the ecosystems. Progress of this will be measured through mapping / tracking invasive plant populations over time, monitoring growth of native species, and biodiversity assessments.

Addressing the invasive species problems in the St. Croix River requires prevention, active management, and long-term monitoring, all aspects of the *Top 10 Watershed Lessons*. By focusing on human behavior and ecosystem health, we should be able to measure our progress and eventually reach our goals.

G3: Changing Landscapes

The goal to address changing landscapes is to preserve and restore natural land cover in the St. Croix Watershed in order to reduce runoff, prevent erosion, and protect water quality for the health of the ecosystem. We aim to protect at least 20% of disturbed forest areas by 2040 and reduce storm water runoff from urban areas by 20% by 2036.

Our first strategy is to limit deforestation and restore previously forested areas so the river can maintain its natural land cover. This solution will be implemented by local governments and conservation organizations who will enforce land-use restrictions of excessive deforestation. The next step will be for reforestation projects to plant native trees in the most impacted areas. If necessary, incentives can be given out to private landowners. Progress will be measured in

satellite data (LandTrend) to measure forest cover over time as well as monitoring the acreage of land reforested.

To reduce the negative impacts of urbanization, our goal is to limit impervious surfaces and manage runoff. To ensure this happens, cities will adopt green infrastructure practices (permeable pavements, green roofs, and rain gardens). Additionally, zoning laws can ensure limitations in overdevelopment and require developers to include stormwater management systems in future projects. Progress of this strategy will be measured in runoff volume entering the river and improvements of downstream water quality measured in water quality tests.

To promote sustainable agriculture practices, our goal is to encourage farming methods that protect soil and reduce landscape degradation. Farmers will be asked to slightly modify their previous techniques to promote integrated livestock management and more sustainable agriculture through a farmers program. The progress of this project will be measured in tracking adoption rates of these conservation practices and reduction in sediment and nutrient runoff into the river. If farmers adapt to this program, our goal will be to have 50% of agricultural land in the watershed using this system by 2036.

Managing the changing landscapes in the St. Croix River requires balancing human development with environmental protection. Forest preservation encourages community engagement where member involvement will drive action towards preserving the quality of the St. Croix River as a whole.

Regulations

Notable regulations put in place are the Total Maximum Daily Loads (TMDLs) established in both Wisconsin and Minnesota. The following shows the calculations taken by the Minnesota Pollution Control Agency and the Wisconsin Department of Natural Resources to determine the total maximum daily phosphorus load for Lake St. Croix, which is the final 25 miles of the St. Croix River:

Total maximum daily phosphorus load = wasteload allocations + load allocations + tribal loads + margin of safety + reserve capacity = 2,172.8 pounds per day = 360 metric tons per year.

The majority of the TMDL focuses on load allocations (LAs), which represent pollutant sources not regulated under the National Pollutant Discharge Elimination System (NPDES). These LAs include internal loading, such as phosphorus released from bottom sediments; atmospheric deposition, including both precipitation and dryfall; and, most significantly, nonpoint source runoff from across the basin, excluding tribal lands and areas covered by regulated municipal separate storm sewer systems (MS4s).

Additionally, the St. Croix Basin Water Resources Planning Team decided upon the following numeric targets in 2004 to set applicable water quality standards:

- 40 µg/L Total Phosphorus
- 14 µg/L Chlorophyll a
- 1.4 m Secchi disc transparency

These criteria define the desired ecological and water quality conditions, while the TMDL determines the maximum allowable phosphorus load necessary to achieve them. In the 1990s,

phosphorus loading to the system was estimated at approximately 460 metric tons per year; the updated TMDL establishes a reduced allowable load that is about 100 metric tons per year lower. This corresponds to an overall required phosphorus reduction of approximately 27 percent. The TMDL then allocates allowable loads among point and nonpoint sources to meet these targets. In this way, the TMDL functions as an implementation framework designed to ensure that nutrient inputs remain low enough to limit algal growth and maintain water clarity.

Recommendations

P1: Buffer Zones

There should be legal requirements for buffer zones to be established along the St. Croix River at local government levels. One of the most important ways to protect the river is the strengthening of buffer zones along the St. Croix River. Buffer zones are designated and protected vegetated areas along waterways that help limit the amount of surface runoff that enters the waterway and filter contaminants from the surface runoff. These upgrades will help to further protect the integrity of the river ecosystem.

P2: Wetlands and Forests

Legal protection of the wetlands and forests around river regions should be put into effect as another protection measure for the river. Protecting the wetlands around the river and the forests around them will also serve to filter out extra contaminants and nutrients from the water over time. Limiting impact in this area around the river will preserve its overall ecosystem integrity.

R1: Limiting Development

Restrictions should be put on the development that can occur within protected river regions. A vital part of protecting the river into the future will be the implementation of protected river regions where development is limited. These protected regions look to limit damage and pollution from urbanization and the destruction of green spaces in important sections of the river to help the river ecosystem in the long term.

R2: Green Infrastructure

Green infrastructure should be mandated for new projects. Mandatory green infrastructure for all new developments is a technique often referred to as reservation. Green infrastructure includes things such as stormwater management systems, rain gardens, and permeable pavements. These practices help reduce pollution entering the river and control surface runoff.

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